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International Energy Outlook 2011

Independent Statistics & Analysis

U.S. Energy Information Administration

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Electronic access and related reports

IEO2011 will be available on the EIA Home Page (www.eia.gov/ieo) by September 19, 2011, including text, forecast tables, and graphics. To download the entire publication in Portable Document Format (PDF), go to www.eia.gov/ieo/pdf/0484(2011).pdf.

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Preface

The *International Energy Outlook 2011 (IEO2011)* presents an assessment by the U.S. Energy Information Administration (EIA) of the outlook for international energy markets through 2035. U.S. projections appearing in *IEO2011* are consistent with those published in EIA's *Annual Energy Outlook 2011 (AEO2011)* in April 2011. *IEO2011* is provided as a service to energy managers and analysts, both in government and in the private sector. The projections are published pursuant to the Department of Energy Organization Act of 1977 (Public Law 95-91), Section 205(c).

The *IEO2011* consumption projections are divided according to Organization for Economic Cooperation and Development members (OECD)[1] and non-members (non-OECD). OECD members are divided into three basic country groupings: OECD Americas (United States, Canada, and Mexico/Chile), OECD Europe, and OECD Asia (Japan, South Korea, and Australia/New Zealand). Non-OECD countries are divided into five separate regional subgroups: non-OECD Europe and Eurasia (which includes Russia); non-OECD Asia (which includes China and India); Middle East; Africa; and Central and South America (which includes Brazil). In some instances, the *IEO2011* production models have different regional aggregations to reflect important production sources (for example, Middle East OPEC is a key region in the projections for liquids production). Complete regional definitions are listed in Appendix M.

IEO2011 focuses exclusively on marketed energy. Non-marketed energy sources, which continue to play an important role in some developing countries, are not included in the estimates. The *IEO2011* projections are based on U.S. and foreign government laws in effect as of the start of 2011. The potential impacts of pending or proposed legislation, regulations, and standards are not reflected in the projections, nor are the impacts of legislation for which the implementing mechanisms have not yet been announced.

The report begins with a review of world trends in energy demand and the major macroeconomic assumptions used in deriving the *IEO2011* projections, along with the major sources of uncertainty in the projections. The projections extend through 2035. The demand projections and macroeconomic outlook are discussed in Chapter 1, "World Energy Demand and Economic Outlook."

In addition to Reference case projections, *IEO2011* includes several scenario cases that are used to estimate the impacts of oil prices and demand on global liquid fuel markets. The impact of alternative supply conditions on the projections is illustrated by the Traditional High and Traditional Low Oil Price cases. In addition, the impact of high and low non-OECD demand (where most of the uncertainty with respect to future energy markets lies) on world liquids markets is captured in the High Price and Low Price cases. All four cases are discussed in Chapter 2, "Liquid Fuels." The discussion in Chapter 2 includes regional projections of liquids consumption and production (primarily petroleum).

Chapters 3 and 4 review regional projections for natural gas and coal energy consumption and production, along with reviews of the current status of each fuel on a worldwide basis. Chapter 5 discusses the projections for world electricity markets—including nuclear power, hydropower, and other commercial renewable energy resources—and presents projections of world installed generating capacity. Chapter 6 provides a discussion of industrial sector energy use. Chapter 7 includes a detailed look at the world's transportation energy use. Finally, Chapter 8 discusses the outlook for global energy-related carbon dioxide emissions.

Objectives of the *IEO2011* projections

The projections in *IEO2011* are not statements of what will happen, but what might happen given the specific assumptions and methodologies used for any particular scenario. The Reference case projection is a business-as-usual trend estimate, given known technology and technological and demographic trends. EIA explores the impacts of alternative assumptions in other scenarios with different macroeconomic growth rates and world oil prices. The *IEO2011* cases generally assume that current laws and regulations are maintained throughout the projections. Thus, the projections provide policy-neutral baselines that can be used to analyze international energy markets.

While energy markets are complex, energy models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Behavioral characteristics are indicative of real-world tendencies, rather than representations of specific outcomes.

Energy market projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated. In addition, future developments in technologies, demographics, and resources cannot be foreseen with certainty. Key uncertainties in the *IEO2011* projections are addressed through alternative cases.

EIA has endeavored to make these projections as objective, reliable, and useful as possible. They should, however, serve as an adjunct to, not a substitute for, a complete and focused analysis of public policy initiatives.

[1]OECD includes all members of the organization as of September 1, 2010, throughout all time series included in this report. Israel became a member on September 7, 2010, and Estonia became a member on December 9, 2010, but neither country's membership is reflected in *IEO2011*.

Appendix A contains summary tables for the *IEO2011* Reference case projections of world energy consumption, GDP, energy consumption by fuel, carbon dioxide emissions, and regional population growth. Summary tables of projections for the High and Low Oil Price cases are provided in Appendixes B and C, respectively. Reference case projections of delivered energy consumption by end-use sector and region are presented in Appendix D. Appendix E contains summary tables of projections for world liquids production in all cases. Appendix F contains summary tables of Reference case projections for installed electric power capacity by fuel and regional electricity generation. Appendix G contains summary tables for projections of world natural gas production in all cases. Appendix H includes a set of tables for each of the four Kaya Identity components. In Appendix I, a set of comparisons of projections from the International Energy Agency's *World Energy Outlook 2010* with the *IEO2011* projections is presented. Comparisons of the *IEO2011* and *IEO2010* projections are also presented in Appendix I. Appendix J describes the models used to generate the *IEO2011* projections, and Appendix K defines the regional designations included in the report.

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Highlights

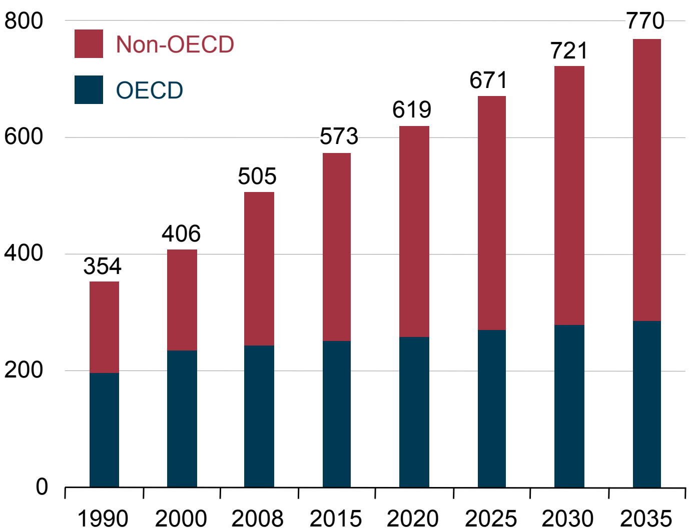
In the *IEO2011* Reference case, which does not incorporate prospective legislation or policies that might affect energy markets, world marketed energy consumption grows by 53 percent from 2008 to 2035. Total world energy use rises from 505 quadrillion British thermal units (Btu) in 2008 to 619 quadrillion Btu in 2020 and 770 quadrillion Btu in 2035 (Figure 1). Much of the growth in energy consumption occurs in countries outside the Organization for Economic Cooperation and Development (non-OECD nations),[2] where demand is driven by strong long-term economic growth. Energy use in non-OECD nations increases by 85 percent in the Reference case, as compared with an increase of 18 percent for the OECD economies.

Although the world continues to recover from the 2008-2009 global recession, the recovery is uneven. In advanced economies, recovery has been slow in comparison with recoveries from past recessions. Unemployment is still high among the advanced economies, and real estate markets and household income growth remain weak. Debt levels in a number of small economies of the European Union—Greece, Ireland, and Portugal—required European Union intervention to avert defaults. Concerns about fiscal sustainability and financial turbulence suggest that economic recovery in the OECD countries will not be accompanied by the higher growth rates associated with past recoveries. In contrast, growth remains high in many emerging economies, in part driven by strong capital inflows and high commodity prices; however, inflation pressures remain a particular concern, along with the need to rebalance external trade in key developing economies.

Beyond the pace and timing of the world's economic recovery, other events have compounded the uncertainty associated with this year's energy outlook. Oil prices rose in 2010 as a result of growing demand associated with signs of economic recovery and a lack of a sufficient supply response. Prices were driven even higher at the end of 2010 and into 2011 as social and political unrest unfolded in several Middle Eastern and African economies. Oil prices increased from about $82 per barrel[3] at the end of November 2010 to more than $112 per barrel in day trading on April 8, 2011. The impacts of quickly rising prices and possible regional supply disruptions add substantial uncertainty to the near-term outlook. In 2011, the price of light sweet crude oil in the United States (in real 2009 dollars) is expected to average $100 per barrel, and with prices expected to continue increasing in the long term, the price reaches $108 per barrel in 2020 and $125 per barrel in 2035 in the *IEO2011* Reference case.

The aftermath of the devastating earthquake and tsunami that struck northeastern Japan on March 11, 2011—which resulted in extensive loss of life and infrastructure damage, including severe damage to several nuclear reactors at Fukushima Daiichi—provides another major source of uncertainty in *IEO2011*. The near-term outlook for Japan's economy is lower than the already sluggish growth that was projected before the events, but the impact on the rest of Asia and on world economic health as a whole probably will be relatively small, given that Japan has not been a major factor in regional economic growth in recent years. However, the event may have more profound implications for the future of world nuclear power. The *IEO2011* projections do not reflect the possible ramifications of Fukushima for the long-term global development of nuclear power or the policies that some countries have already adopted in its aftermath with respect to the continued operation of existing nuclear plants.

Figure 1. World energy consumption, 1990-2035 (quadrillion Btu)



World energy markets by fuel type

In the long-term, the *IEO2011* Reference case projects increased world consumption of marketed energy from all fuel sources through 2035 (Figure 2). Fossil fuels are expected to continue supplying much of the energy used worldwide. Although liquid fuels—mostly petroleum based—remain the largest source of energy, the liquids share of world marketed energy consumption falls from 34 percent in 2008 to 29 percent in 2035, as projected high world oil prices lead many energy users to switch away from liquid fuels when feasible. Renewable energy is the world's fastest growing form of energy, and the renewable share of total energy use increases from 10 percent in 2008 to 14 percent in 2035 in the Reference case.

Liquid fuels

World use of petroleum and other liquids[4] grows from 85.7 million barrels per day in 2008 to 97.6 million barrels per day

[2]Current OECD member countries (as of September 1, 2010) are the United States, Canada, Mexico, Austria, Belgium, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, Japan, South Korea, Australia, and New Zealand. Israel became a member on September 7, 2010, and Estonia became a member on December 9, 2010, but neither country's membership is reflected in *IEO2011*.

[3]Nominal dollars per barrel of West Texas Intermediate crude oil at Cushing, Oklahoma.

[4]Petroleum and other liquid fuels include petroleum-derived fuels and non-petroleum-derived liquid fuels, such as ethanol and biodiesel, coal-to-liquids, and gas-to-liquids. Petroleum coke, which is a solid, is included. Also included are natural gas liquids, crude oil consumed as a fuel, and liquid hydrogen.

in 2020 and 112.2 million barrels per day in 2035. In the Reference case, most of the growth in liquids use is in the transportation sector, where, in the absence of significant technological advances, liquids continue to provide much of the energy consumed. Liquid fuels remain an important energy source for transportation and industrial sector processes. Despite rising fuel prices, use of liquids for transportation increases by an average of 1.4 percent per year, or 46 percent overall from 2008 to 2035. The transportation sector accounts for 82 percent of the total increase in liquid fuel use from 2008 to 2035, with the remaining portion of the growth attributable to the industrial sector (Figure 3). The use of liquids declines in the other end-use sectors and for electric power generation.

To meet the increase in world demand in the Reference case, liquids production (including both conventional and unconventional liquids supplies) increases by a total of 26.6 million barrels per day from 2008 to 2035. The Reference case assumes that OPEC countries will invest in incremental production capacity in order to maintain a share of approximately 40 percent of total world liquids production through 2035, consistent with their share over the past 15 years. Increasing volumes of conventional liquids (crude oil and lease condensate, natural gas plant liquids, and refinery gain) from OPEC producers contribute 10.3 million barrels per day to the total increase in world liquids production, and conventional supplies from non-OPEC countries add another 7.1 million barrels per day.

Unconventional resources (including oil sands, extra-heavy oil, biofuels, coal-to-liquids, gas-to-liquids, and shale oil) from both OPEC and non-OPEC sources grow on average by 4.6 percent per year over the projection period. Sustained high oil prices allow unconventional resources to become economically competitive, particularly when geopolitical or other "above ground" constraints[5] limit access to prospective conventional resources. World production of unconventional liquid fuels, which totaled only 3.9 million barrels per day in 2008, increases to 13.1 million barrels per day and accounts for 12 percent of total world liquids supply in 2035. The largest components of future unconventional production are 4.8 million barrels per day of Canadian oil sands, 2.2 and 1.7 million barrels per day of U.S. and Brazilian biofuels, respectively, and 1.4 million barrels per day of Venezuelan extra-heavy oil. Those four contributors to unconventional liquids supply account for almost three-quarters of the increase over the projection period.

Natural gas

World natural gas consumption increases by 52 percent in the Reference case, from 111 trillion cubic feet in 2008 to 169 trillion cubic feet in 2035. Although the global recession resulted in an estimated decline of 2.0 trillion cubic feet in natural gas use in 2009, robust demand returned in 2010, and consumption exceeded the level recorded before the downturn. Natural gas continues to be the fuel of choice for many regions of the world in the electric power and industrial sectors, in part because its relatively low carbon intensity compared with oil and coal makes it an attractive option for nations interested in reducing greenhouse gas emissions. In the power sector, low capital costs and fuel efficiency also favor natural gas.

In the *IEO2011* Reference case, the major projected increase in natural gas production occurs in non-OECD regions, with the largest increments coming from the Middle East (an increase of 15 trillion cubic feet between 2008 and 2035), Africa (7 trillion cubic feet), and non-OECD Europe and Eurasia, including Russia and the other former Soviet Republics (9 trillion cubic feet). Over the projection period, Iran and Qatar alone increase their natural gas production by a combined 11 trillion cubic feet, nearly 20 percent of the total increment in world gas production. A significant share of the increase is expected to come from a single offshore field, which is called North Field on the Qatari side and South Pars on the Iranian side.

Figure 2. World energy consumption by fuel, 1990-2035 (quadrillion Btu)

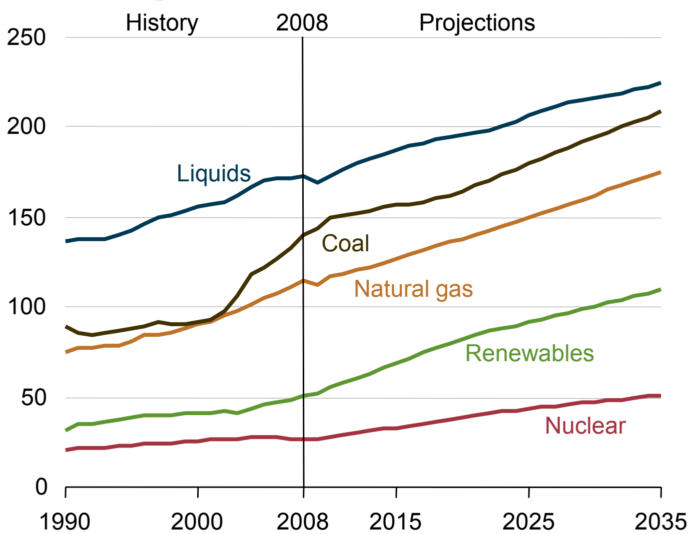
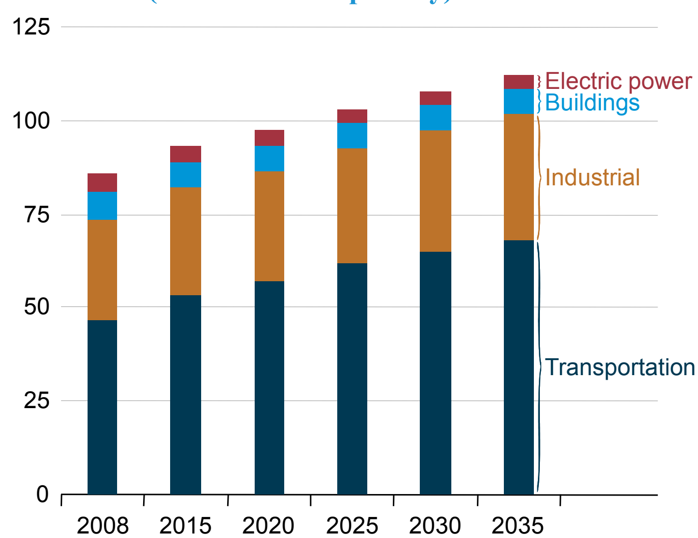


Figure 3. World liquids consumption by sector, 2008-2035 (million barrels per day)



[5]"Above-ground" constraints refer to those nongeological factors that might affect supply, including: government policies that limit access to resources; conflict; terrorist activity; lack of technological advances or access to technology; price constraints on the economical development of resources; labor shortages; materials shortages; weather; environmental protection actions; and other short- and long-term geopolitical considerations.

Contributing to the strong competitive position of natural gas among other energy sources is a strong growth outlook for reserves and supplies. Significant changes in natural gas supplies and global markets occur with the expansion of liquefied natural gas (LNG) production capacity and as new drilling techniques and other efficiencies make production from many shale basins economical worldwide. The net impact is a significant increase in resource availability, which contributes to lower prices and higher demand for natural gas in the projection.

Although the extent of the world's unconventional natural gas resources—tight gas, shale gas, and coalbed methane—have not yet been assessed fully, the *IEO2011* Reference case projects a substantial increase in those supplies, especially from the United States but also from Canada and China. An initial assessment of shale gas resources in 32 countries was released by EIA in April 2011.[6] The report found that technically recoverable shale gas resources in the assessed shale gas basins and the United States amount to 6,622 trillion cubic feet. To put the shale gas resource estimate in perspective, according to the *Oil & Gas Journal*[7] world proven reserves of natural gas as of January 1, 2011, are about 6,675 trillion cubic feet, and world technically recoverable gas resources—largely excluding shale gas—are roughly 16,000 trillion cubic feet.

Rising estimates of shale gas resources have helped to increase total U.S. natural gas reserves by almost 50 percent over the past decade, and shale gas rises to 47 percent of U.S. natural gas production in 2035 in the *IEO2011* Reference case. Adding production of tight gas and coalbed methane, U.S. unconventional natural gas production rises from 10.9 trillion cubic feet in 2008 to 19.8 trillion cubic feet in 2035. Unconventional natural gas resources are even more important for the future of domestic gas supplies in Canada and China, where they account for 50 percent and 72 percent of total domestic production, respectively, in 2035 in the Reference case (Figure 4).

World natural gas trade, both by pipeline and by shipment in the form of LNG, is poised to increase in the future. Most of the projected increase in LNG supply comes from the Middle East and Australia, where a number of new liquefaction projects are expected to become operational within the next decade. Additionally, several LNG export projects have been proposed for western Canada, and there are also proposals to convert underutilized LNG import facilities in the United States to liquefaction and export facilities for domestically sourced natural gas. In the *IEO2011* Reference case, world liquefaction capacity more than doubles, from about 8 trillion cubic feet in 2008 to 19 trillion cubic feet in 2035. In addition, new pipelines currently under construction or planned will increase natural gas exports from Africa to European markets and from Eurasia to China.

Coal

In the absence of national policies and/or binding international agreements that would limit or reduce greenhouse gas emissions, world coal consumption is projected to increase from 139 quadrillion Btu in 2008 to 209 quadrillion Btu in 2035, at an average annual rate of 1.5 percent. Regional growth rates are uneven, with little growth in coal consumption in OECD nations but robust growth in non-OECD nations, particularly among the Asian economies (Figure 5).

Strong economic growth and large domestic coal reserves in China and India lead to a substantial increase in their coal use for electric power and industrial processes. Installed coal-fired generating capacity in China nearly doubles in the Reference case from 2008 to 2035, and coal use in China's industrial sector grows by 67 percent. The development of China's electric power and

Figure 4. Natural gas production in China, Canada, and the United States, 2008 and 2035 (trillion cubic feet)

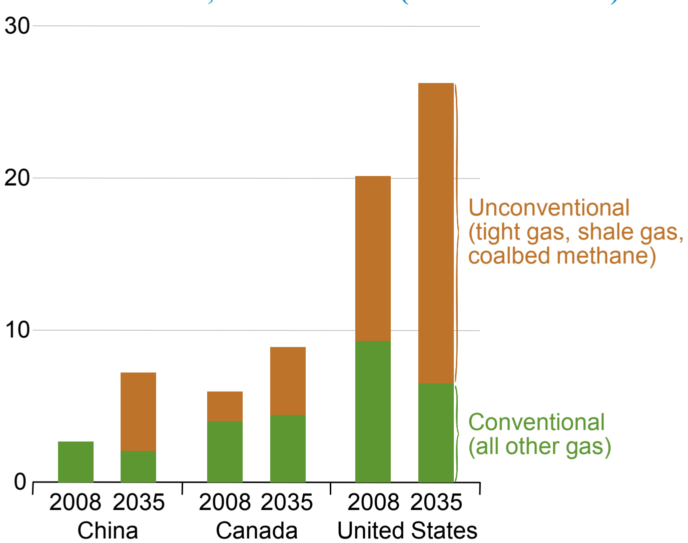
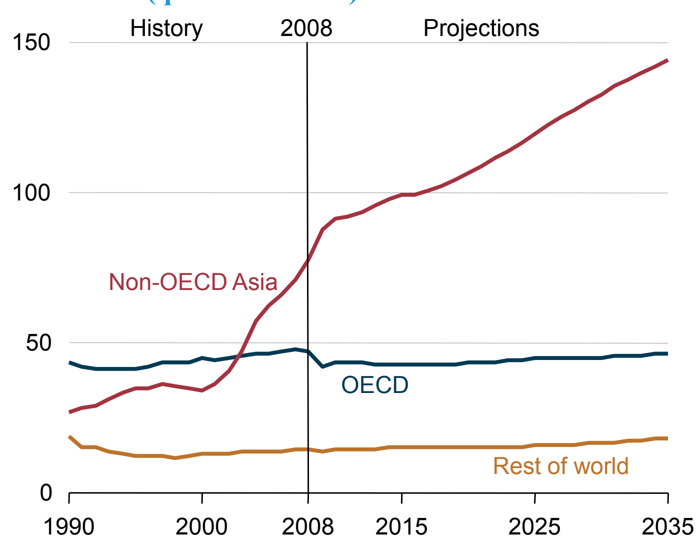


Figure 5. World coal consumption by region, 1990-2035 (quadrillion Btu)



[6] U.S. Energy Information Administration, *World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States* (Washington, DC, April 2011), website www.eia.gov/analysis/studies/worldshalegas/index.cfm#7.

[7] "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 47 (December 6, 2010), pp. 46-49, website www.ogj.com (subscription site), adjusted with the EIA release of proved reserve estimates as of December 31, 2010.

industrial sectors will require not only large-scale infrastructure investments but also substantial investment in both coal mining and coal transportation infrastructure. In India, coal-fired generating capacity rises from 99 gigawatts in 2008 to 172 gigawatts in 2035, a 72-percent increase, while industrial sector coal use grows by 94 percent.

Electricity

World net electricity generation increases by 84 percent in the *IEO2011* Reference case, from 19.1 trillion kilowatthours in 2008 to 25.5 trillion kilowatthours in 2020 and 35.2 trillion kilowatthours in 2035. Although the 2008-2009 global economic recession slowed the rate of growth in electricity use in 2008 and resulted in negligible change in electricity use in 2009, demand returned in 2010, led by strong recoveries in non-OECD economies. In general, in OECD countries, where electricity markets are well established and consumption patterns are mature, the growth of electricity demand is slower than in non-OECD countries, where a large amount of potential demand remains unmet. Total net electricity generation in non-OECD countries increases by an average of 3.3 percent per year in the Reference case, led by non-OECD Asia (including China and India), where annual increases average 4.0 percent from 2008 to 2035. In contrast, net generation among OECD nations grows by an average of 1.2 percent per year from 2008 to 2035.

In many parts of the world, concerns about security of energy supplies and the environmental consequences of greenhouse gas emissions have spurred government policies that support a projected increase in renewable energy sources. As a result, renewable energy sources are the fastest growing sources of electricity generation in the *IEO2011* Reference case at 3.1 percent per year from 2008 to 2035 (Figure 6). Natural gas is the second fastest growing generation source, increasing by 2.6 percent per year. An increase in unconventional natural gas resources, particularly in North America but elsewhere as well, helps keep global markets well supplied and prices competitive. Future generation from renewables, natural gas, and to a lesser extent nuclear power largely displaces coal-fired generation, although coal remains the largest source of world electricity through 2035.

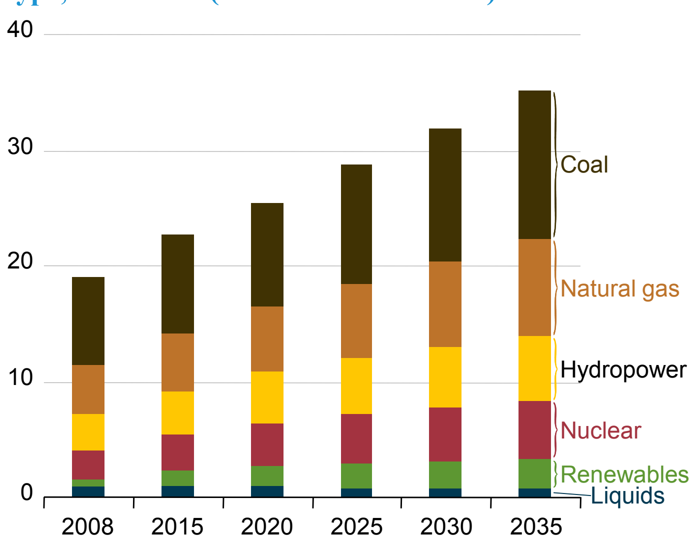
More than 82 percent of the increase in renewable generation is in the form of hydroelectric power and wind power. The contribution of wind energy, in particular, has grown swiftly over the past decade, from 18 gigawatts of net installed capacity at the end of 2000 to 121 gigawatts at the end of 2008—a trend that continues into the future. Of the 4.6 trillion kilowatthours of new renewable generation added over the projection period, 2.5 trillion kilowatthours (55 percent) is attributed to hydroelectric power and 1.3 trillion kilowatthours (27percent) to wind. The majority of the hydroelectric growth (85 percent) occurs in the non-OECD countries, while a slight majority of wind generation growth (58 percent) occurs in the OECD. High construction costs can make the total cost to build and operate renewable generators higher than those for conventional plants. The intermittence of wind and solar, in particular, can further hinder the economic competitiveness of those resources, as they are not operator-controlled and are not necessarily available when they would be of greatest value to the system. However, improving battery storage technology and dispersing wind and solar generating facilities over wide geographic areas could mitigate many of the problems associated with intermittency over the projection period.

Electricity generation from nuclear power worldwide increases from 2.6 trillion kilowatthours in 2008 to 4.9 trillion kilowatthours in 2035 in the *IEO2011* Reference case, as concerns about energy security and greenhouse gas emissions support the development of new nuclear generating capacity. In addition, world average capacity utilization rates have continued to rise over time, from about 65 percent in 1990 to about 80 percent today, with some increases still anticipated in the future.

There is still considerable uncertainty about the future of nuclear power, and a number of issues could slow the development of new nuclear power plants. Issues related to plant safety, radioactive waste disposal, and proliferation of nuclear materials continue to raise public concerns in many countries and may hinder plans for new installations. High capital and maintenance costs also may keep some countries from expanding their nuclear power programs. In addition, a lack of trained labor resources, as well as limited global manufacturing capacity for certain components, could keep national nuclear programs from advancing quickly. Finally, although the long-term implications of the disaster at Japan's Fukushima Daiichi nuclear power plant for world nuclear power development are unknown, Germany, Switzerland, and Italy have already announced plans to phase out or cancel all their existing and future reactors. Those plans, and new policies that other countries may adopt in response to the disaster at the Fukushima Daiichi plant, although not reflected in the *IEO2011* projections, indicate that some reduction in the projection for nuclear power should be expected.

In the Reference case, 75 percent of the world expansion in installed nuclear power capacity occurs in non-OECD countries (Figure 7). China, Russia, and India account for the

Figure 6. World net electricity generation by fuel type, 2008-2035 (trillion kilowatthours)



largest increment in world net installed nuclear power from 2008 to 2035: China adds 106 gigawatts of nuclear capacity over the period, Russia 28 gigawatts, and India 24 gigawatts.

World delivered energy use by sector

This section discusses delivered energy use in the buildings, industrial, and transportation sectors; it does not include losses associated with electricity generation and transmission.

Residential and commercial buildings

World residential energy use increases by 1.1 percent per year, from 52 quadrillion Btu in 2008 to 69 quadrillion Btu in 2035 in the *IEO2011* Reference case. Much of the growth in residential energy consumption occurs in non-OECD nations, where robust economic growth improves standards of living and increases demand for residential energy. One factor contributing to increased demand in non-OECD nations is the trend toward replacing nonmarketed energy sources (including wood and waste, which are not fully included in the energy demand totals shown in the *IEO*) with marketed fuels, such as propane and electricity, for cooking and heating. Non-OECD residential energy consumption rises by 1.9 percent per year, compared with the much slower rate of 0.3 percent per year for OECD countries, where patterns of residential energy use already are well established, and slower population growth and aging populations translate to smaller increases in energy demand.

Globally, *IEO2011* projects average growth in commercial energy use of 1.5 percent per year through 2035, with the largest share of growth in non-OECD nations. OECD commercial energy use expands by 0.8 percent per year. Slow expansion of GDP and low or declining population growth in many OECD nations contribute to slower anticipated rates of growth in commercial energy demand. In addition, continued efficiency improvements moderate the growth of energy demand over time, as relatively inefficient equipment is replaced with newer, more efficient stock.

In non-OECD nations, economic activity and commerce increase rapidly over the 2008-2035 projection period, fueling additional demand for energy in the service sectors. Total delivered commercial energy use among non-OECD nations is projected to grow by 2.8 percent per year from 2008 to 2035. Population growth also is expected to be more rapid than in OECD countries, portending increases in the need for education, health care, and social services and the energy required to provide them. In addition, as developing nations mature, they are expected to transition to more service-related enterprises, which will increase demand for energy in the commercial sector.

Industrial

Worldwide, industrial energy consumption grows from 191 quadrillion Btu in 2008 to 288 quadrillion Btu in 2035 in the Reference case. The industrial sector accounted for much of the recession-related reduction in energy use in 2009, primarily because of a substantial decline in manufacturing output that had a more pronounced impact on energy use in the industrial sector than in other sectors. In the Reference case, national economic growth rates and energy consumption patterns are projected to return to historical trends by 2015. Non-OECD economies account for about 89 percent of the world increase in industrial sector energy consumption in the Reference case (Figure 8). Rapid economic growth is projected for the non-OECD countries, accompanied by rapid growth in their combined total industrial energy consumption, averaging 2.0 percent per year from 2008 to 2035. Because OECD nations have been undergoing a transition from manufacturing economies to service economies in recent decades, and have relatively slow projected growth in economic output, industrial energy use in the OECD region as a whole grows by an average of only 0.5 percent per year from 2008 to 2035.

Figure 7. World nuclear generating capacity, 2008 and 2035 (gigawatts)

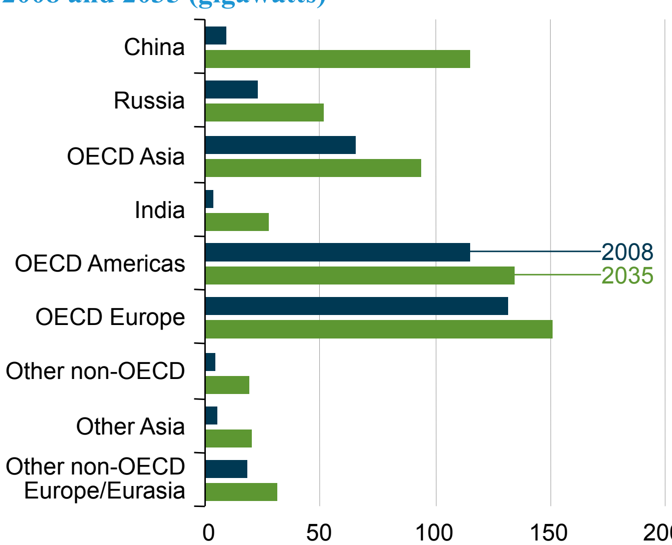
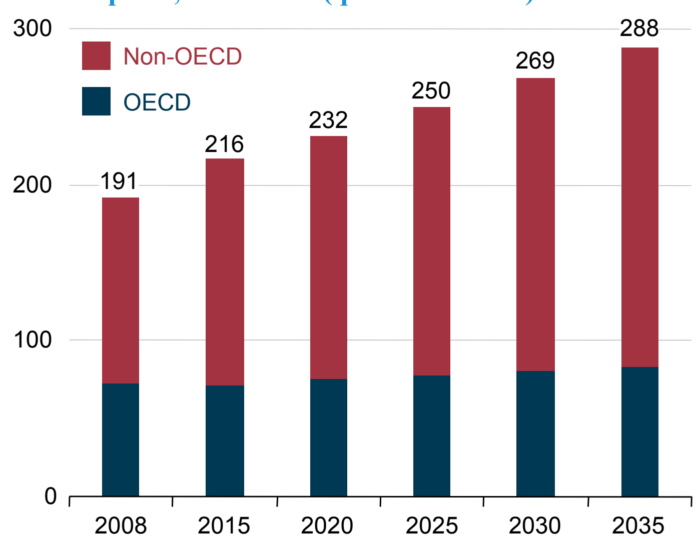


Figure 8. World industrial delivered energy consumption, 2008-2035 (quadrillion Btu)



Transportation

Energy use in the transportation sector includes the energy consumed in moving people and goods by road, rail, air, water, and pipeline. The transportation sector is second only to the industrial sector in terms of total end-use energy consumption. The transportation share of world total liquids consumption increases from 54 percent in 2008 to 60 percent in 2035 in the *IEO2011* Reference case, accounting for 82 percent of the total increase in world liquids consumption. Thus, understanding the development of transportation energy use is the most important factor in assessing future trends in demand for liquid fuels.

World oil prices reached historically high levels in 2008, in part because of a strong increase in demand for transportation fuels, particularly in emerging non-OECD economies. Non-OECD energy use for transportation increased by 4.1 percent in 2007 and 6.4 percent in 2008, before the impact of the 2008-2009 global economic recession resulted in a slowdown in transportation sector activity. Even in 2009, non-OECD transportation energy use grew by an estimated 3.3 percent, in part because many non-OECD countries (in particular, but not limited to, the oil-rich nations) provide fuel subsidies to their citizens. With robust economic recovery expected to continue in China, India, and other non-OECD nations, growing demand for raw materials, manufactured goods, and business and personal travel is projected to support fast-paced growth in energy use for transportation both in the short term and over the long term. In the *IEO2011* Reference case, non-OECD transportation energy use grows by 2.6 percent per year from 2008 to 2035 (Figure 9).

High oil prices and the economic recession had more profound impacts in the OECD economies than in the non-OECD economies. OECD energy use for transportation declined by an estimated 1.6 percent in 2008, followed by a further decrease estimated at 1.8 percent in 2009, before recovering to 0.7-percent growth in 2010. Indications are that the return of high world oil prices and comparatively slow recovery from the recession in several key OECD nations will mean that transportation energy demand will continue to grow slowly in the near to mid-term. Moreover, the United States and some of the other OECD countries have instituted a number of policy measures to increase the fuel efficiency of their vehicle fleets. OECD transportation energy use grows by only 0.3 percent per year over the entire projection period.

World carbon dioxide emissions

World energy-related carbon dioxide emissions rise from 30.2 billion metric tons in 2008 to 35.2 billion metric tons in 2020 and 43.2 billion metric tons in 2035—an increase of 43 percent over the projection period. With strong economic growth and continued heavy reliance on fossil fuels expected for most non-OECD economies under current policies, much of the projected increase in carbon dioxide emissions occurs among the developing non-OECD nations. In 2008, non-OECD emissions exceeded OECD emissions by 24 percent; in 2035, they are projected to exceed OECD emissions by more than 100 percent. Coal continues to account for the largest share of carbon dioxide emissions throughout the projection (Figure 10).

Carbon intensity of output—the amount of carbon dioxide emitted per unit of economic output—is a common measure used in analysis of changes in carbon dioxide emissions, and it is sometimes used as a standalone measure for tracking progress in relative emissions reductions. Energy-related carbon dioxide intensities improve (decline) in all *IEO* regions over the projection period, as economies continue to use energy more efficiently. Estimated carbon dioxide intensity declines by 1.8 percent per year in the OECD economies and by 2.4 percent per year in the non-OECD economies from 2008 to 2035.

Another measure of emissions intensity that can be useful for comparing emissions trends across countries is carbon dioxide emissions per capita. Carbon dioxide emissions per capita in OECD economies are significantly higher than those in non-OECD economies (Figure 11). OECD countries have higher levels of carbon dioxide emissions per capita, in part because of their higher

Figure 9. World transportation delivered energy consumption, 2008-2035 (quadrillion Btu)

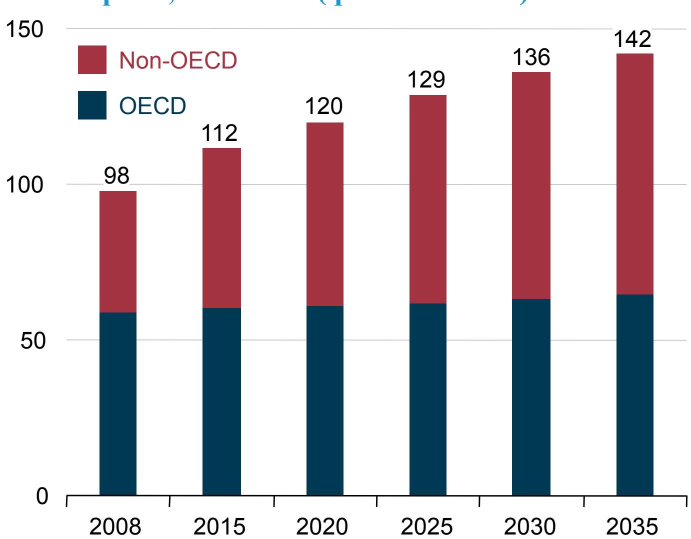
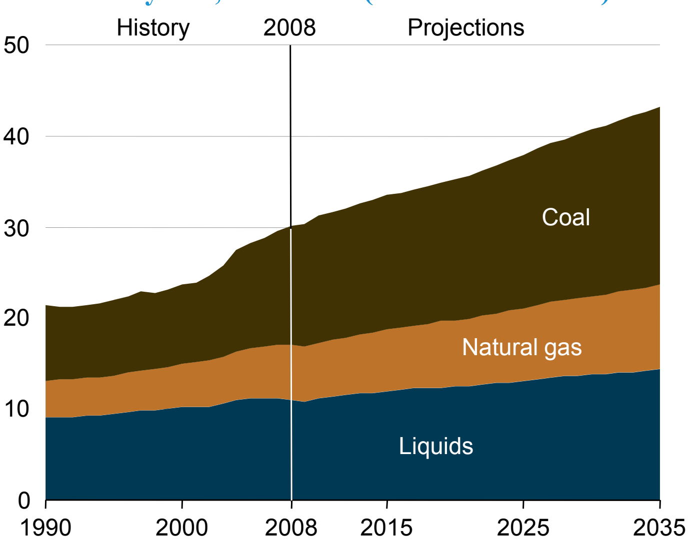
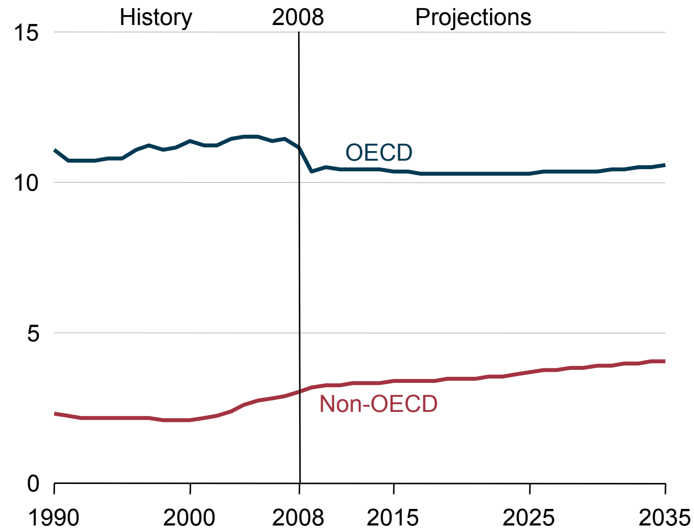


Figure 10. World energy-related carbon dioxide emissions by fuel, 1990-2035 (billion metric tons)



levels of income and fossil fuel use per person. Among non-OECD countries, China has the highest percentage increase in emissions per capita in the Reference case, from 5.1 metric tons per person in 2008 to 9.3 metric tons per person in 2035, an average annual increase of 2.2 percent. In contrast, OECD emissions per capita fall over the projection period, from 11.1 metric tons per person in 2008 to 10.6 metric tons per person in 2035.

Figure 11. World carbon dioxide emissions per capita, 1990-2035 (metric tons per person)



Chapter 1
World energy demand and economic outlook

Overview

In the *IEO2011* Reference case, world energy consumption increases by 53 percent, from 505 quadrillion Btu in 2008 to 770 quadrillion Btu in 2035 (Table 1). In the near term, the effects of the global recession of 2008-2009 curtailed world energy consumption.[8] As nations recover from the downturn, however, world energy demand rebounds in the Reference case and increases strongly as a result of robust economic growth and expanding populations in the world's developing countries. OECD member countries are, for the most part, more advanced energy consumers.[9] Energy demand in the OECD economies grows slowly over the projection period, at an average annual rate of 0.6 percent, whereas energy consumption in the non-OECD emerging economies expands by an average of 2.3 percent per year.

The global recovery from the 2008-2009 worldwide economic recession continues to advance, but the recovery remains uneven. In advanced economies, recovery is slow in comparison with recoveries from past recessions. Unemployment still is high among the advanced economies, and real estate markets and household income growth remain weak. Concerns about fiscal sustainability and financial turbulence means that advanced economies may not achieve the higher growth seen in past recoveries. In many emerging economies, growth remains high, in part driven by strong capital inflows and high commodity prices. Inflation pressures remain a concern, along with the need to rebalance external trade in key emerging economies.

The pace of economic recovery varies among the advanced, OECD nations. While the recession in the United States has officially ended,[10] recovery has been weaker than recoveries from past recessions. Europe's economic recovery has lagged even more. Japan's recovery had been sluggish before the devastating earthquake of March 11, 2011, and now the timing of economic recovery is more uncertain. In contrast to the OECD nations, developing non-OECD Asian economies have led the global recovery. The *IEO2011* Reference case assumes that, by 2015, most nations of the world will have resumed their expected rates of long-term growth before the recession. World GDP rises by an average of 3.4 percent per year from 2008 to 2035 in the Reference case, with non-OECD economies averaging 4.6 percent per year and OECD economies 2.1 percent per year. Future energy consumption will be driven by non-OECD demand. Whereas energy use in non-OECD nations was 7 percent greater than that in OECD nations in 2008, non-OECD economies consume 38 percent more energy than OECD economies in 2020 in the *IEO2011* Reference case and 67 percent more in 2035 (Figure 12).

Two nations that were among the least affected by the worldwide recession are China and India. They continue to lead world economic growth and energy demand growth in the Reference case. Since 1990, energy consumption in both countries as a share of total world energy use has increased significantly, and together they accounted for about 10 percent of total world energy consumption in 1990 and 21 percent in 2008. Although energy demand faltered in many parts of the world during the recession, robust growth continued in China and India, whose economies expanded by 12.4 percent and 6.9 percent, respectively, in 2009. U.S. energy consumption declined by 5.3 percent in 2009, and energy use in China is estimated to have surpassed that of the

Table 1. World energy consumption by country grouping, 2008-2035 (quadrillion Btu)

Region	2008	2015	2020	2025	2030	2035	Average annual percent change 2008-2035
OECD	**244.3**	**250.4**	**260.6**	**269.8**	**278.7**	**288.2**	**0.6**
Americas	122.9	126.1	131.0	135.9	141.6	147.7	0.7
Europe	82.2	83.6	86.9	89.7	91.8	93.8	0.5
Asia	39.2	40.7	42.7	44.2	45.4	46.7	0.6
Non-OECD	**260.5**	**323.1**	**358.9**	**401.7**	**442.8**	**481.6**	**2.3**
Europe and Eurasia	50.5	51.4	52.3	54.0	56.0	58.4	0.5
Asia	137.9	188.1	215.0	246.4	274.3	298.8	2.9
Middle East	25.6	31.0	33.9	37.3	41.3	45.3	2.1
Africa	18.8	21.5	23.6	25.9	28.5	31.4	1.9
Central and South America	27.7	31.0	34.2	38.0	42.6	47.8	2.0
World	**504.7**	**573.5**	**619.5**	**671.5**	**721.5**	**769.8**	**1.6**

[8]The International Monetary Fund (*World Energy Outlook 2008*, October 2008, p. 43) defines a global recession to be when the world's annual gross domestic product (GDP)—on a purchasing power parity basis—increases by less than 3.0 percent. According to IHS Global Insight, world GDP increased by 2.7 percent in 2008, 0.7 percent in 2009, and 4.6 percent in 2010.

[9]For consistency, OECD includes all members of the organization as of September 1, 2010, throughout all the time series included in this report. Israel became a member on September 7, 2010, and Estonia became a member on December 9, 2010, but neither country's membership is reflected in *IEO2011*.

[10]The National Bureau of Economic Research defines a recession as "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales." However, the shorthand version of a recession is often given as two consecutive quarters of negative growth in GDP. In September 2010, the National Bureau of Economic Research declared that the recession which began in the United States in December 2007 had ended in June 2009.

United States for the first time. In the *IEO2011* Reference case, strong economic growth continues in both China and India, and their combined energy use more than doubles, accounting for 31 percent of total world energy consumption in 2035. In 2035, China's energy demand is 68 percent higher than U.S. energy demand (Figure 13).

Energy use in non-OECD Asia (led by China and India) shows the most robust growth of all the non-OECD regions, rising by 117 percent from 2008 to 2035 (Figure 14). However, strong growth in energy use also is projected for much of the rest of the non-OECD regions. With fast-paced growth in population and access to ample domestic resources, energy demand in the Middle East increases by 77 percent over the projection period. Energy consumption increases by 72 percent in Central and South America and by 67 percent in Africa. The slowest projected growth among non-OECD regions is for non-OECD Europe and Eurasia, which includes Russia and the other former Soviet Republics. Growth in energy use for the region totals 16 percent from 2008 to 2035, as its population declines and substantial gains in energy efficiency are achieved through the replacement of inefficient Soviet-era capital equipment.

Outlook for world energy consumption by source

The use of all energy sources increases over the time horizon of the *IEO2011* Reference case (Figure 15). Given expectations that world oil prices will remain relatively high through most of the projection period, petroleum and other liquid fuels[11] are the world's slowest-growing source of energy. Liquids consumption increases at an average annual rate of 1.0 percent from 2008 to 2035, whereas total energy demand increases by 1.6 percent per year. Renewables are the fastest-growing source of world energy, with consumption increasing by 2.8 percent per year. Relatively high projected oil prices, as well as concern about the environmental impacts of fossil fuel use and strong government incentives for increasing the use of renewable energy in many countries around the world, improve the prospects for renewable energy sources worldwide in the outlook.

Although liquid fuels are expected to remain the largest source of energy, their share of world marketed energy consumption declines from 34 percent in 2008 to 29 percent in 2035. On a worldwide basis, liquids consumption increases only in the industrial and transportation sectors while declining in the buildings and electric power sectors. The decrease in liquid fuel use in the residential, commercial, and power sectors is a result of steadily rising world oil prices, which lead to switching to alternative fuels where possible. In contrast, the use of liquids in the transportation sector continues to

Figure 12. World energy consumption, 1990-2035 (quadrillion Btu)

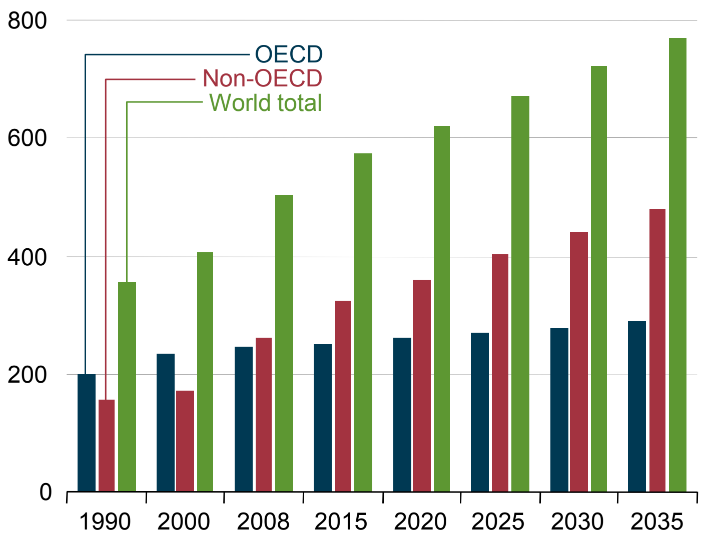


Figure 13. Energy consumption in the United States, China, and India, 1990-2035 (quadrillion Btu)

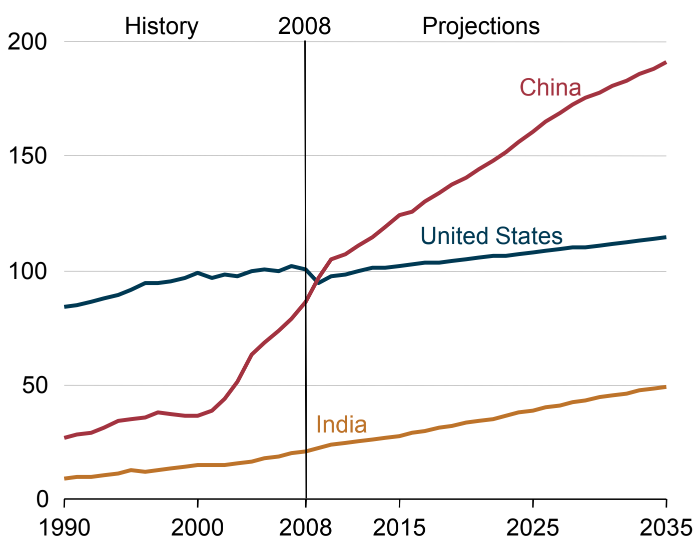
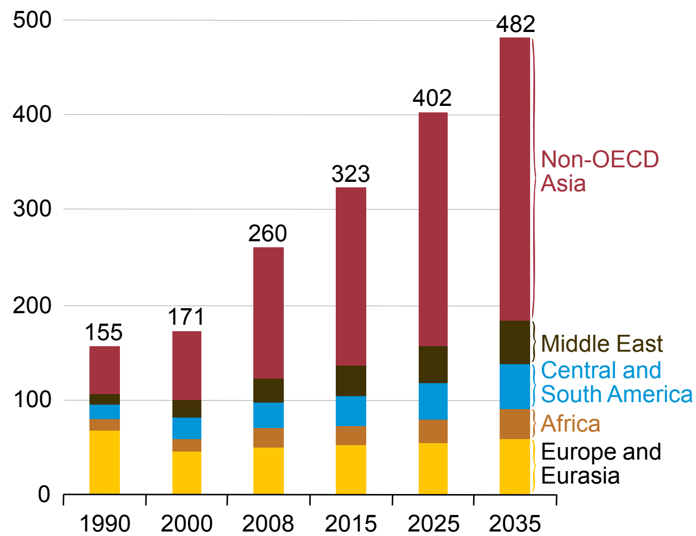


Figure 14. Non-OECD energy consumption, 1990-2035 (quadrillion Btu)



[11] In *IEO2011*, "petroleum and other liquid fuels" includes a full array of liquid product supplies, both conventional and unconventional. Conventional liquids include crude oil and lease condensate, natural gas plant liquids, and refinery gain; unconventional liquids include biofuels, gas-to-liquids, coal-to-liquids, and unconventional petroleum products (extra-heavy oils, oil shale, and bitumen) but do not include compressed natural gas (CNG), liquefied natural gas (LNG), or hydrogen.

increase despite rising prices, given the expectation that liquids will continue to dominate transportation markets absent significant technological advances. World liquids consumption for transportation grows by 1.4 percent per year from 2008 to 2035 and accounts for 82 percent of the total projected increment in liquid fuel use.

In the *IEO2011* Reference case, the world's total natural gas consumption increases by 1.6 percent per year on average, from 111 trillion cubic feet in 2008 to 169 trillion cubic feet in 2035. Increasing supplies of unconventional natural gas, particularly in North America but elsewhere as well, help keep global markets well supplied. As a result, natural gas prices remain more competitive than oil prices, supporting the growth in projected worldwide gas consumption. In the projection period, the most rapid expansion of natural gas use is for electric power generation and industrial uses (Figure 16). Worldwide natural gas used for power generation increases by 2.0 percent per year from 2008 to 2035, and consumption in the industrial sector increases by 1.7 percent per year. These two sectors alone account for 87 percent of the net increase in global natural gas use over the projection period.

Throughout the projection, coal continues to be an important source of fuel, especially in non-OECD Asia, where the combination of fast-paced economic growth and large domestic reserves supports growth in coal demand. World coal consumption increases by an average 1.5 percent per year on average from 2008 to 2035, while coal use in non-OECD Asia increases by 2.3 percent per year. World coal consumption increased by a total of 30 percent from 2003 and 2008, largely because of China's fast-growing energy demand. In China alone, coal consumption increased by 71 percent over the 5-year period. Although the global recession had a negative impact on coal use in almost every other part of the world in 2009, coal consumption continued to increase in China. In the absence of policies or legislation that would limit the growth of coal use, China and, to a lesser extent, India and the other nations of non-OECD Asia consume coal in place of more expensive fuels in the outlook. In the *IEO2011* Reference case, China alone accounts for 76 percent of the net increase in world coal consumption, and India and the rest of non-OECD Asia account for 19 percent of the world increase.

Electricity is the world's fastest-growing form of end-use energy consumption in the Reference case, as it has been for the past several decades. Net electricity generation worldwide rises by 2.3 percent per year on average from 2008 to 2035, while total world energy demand grows by 1.6 percent per year. The strongest growth in electricity generation is projected for non-OECD countries. Non-OECD electricity generation increases by an average annual rate of 3.3 percent in the Reference case, as rising standards of living increase demand for home appliances and electronic devices, as well as the expansion of commercial services, including hospitals, office buildings, and shopping malls. In the OECD nations, where infrastructures are more mature and population growth is relatively slow or declining, the growth in power generation is much slower, averaging 1.2 percent per year from 2008 to 2035.

Coal provides the largest share of world electricity generation, although its share declines over the projection period. From 40 percent of total generation in 2008, coal's share falls to 37 percent in 2035 (Figure 17). The liquids share of total generation also falls in the Reference case. With oil prices remaining high, alternative fuels are substituted for liquids-fired generation where possible, and the liquids share of generation falls from 5 percent in 2008 to just over 2 percent in 2035. In contrast to coal and liquids, natural gas and renewable energy sources account for increasing shares of total generation. The natural gas share of global generation grows from 22 percent in 2008 to 24 percent in 2035, and the renewable share increases from 19 percent to 23 percent. Renewable generation is the world's fastest-growing source of electric power in the *IEO2011* Reference case, rising at an average annual rate of 3.0 percent and outpacing the average annual increases for natural gas (2.6 percent), nuclear power (2.4 percent), and coal (1.9 percent). Government policies and incentives throughout the world support the rapid construction of renewable generation facilities.

Figure 15. World energy consumption by fuel, 1990-2035 (quadrillion Btu)

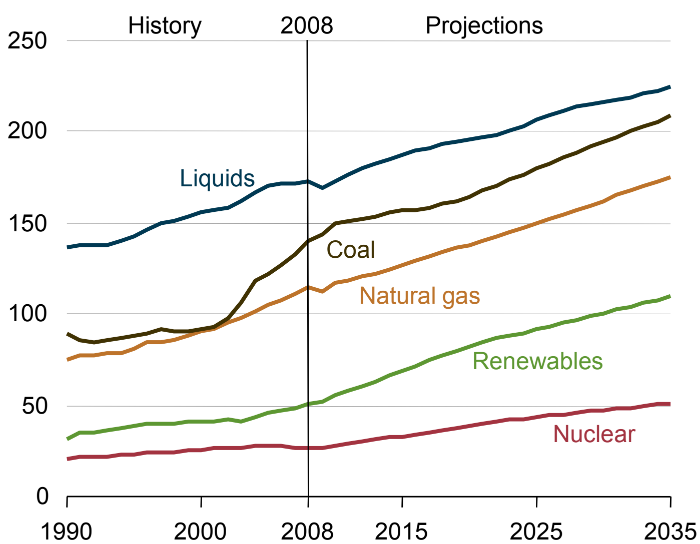
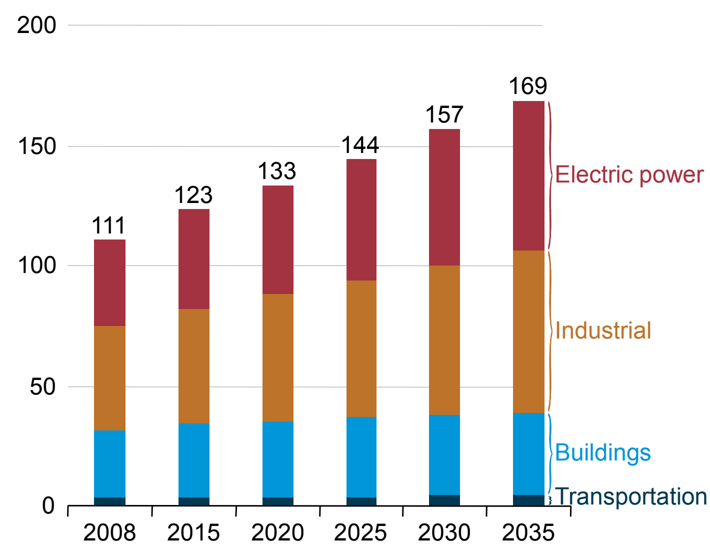


Figure 16. World natural gas consumption by end-use sector, 2008-2035 (trillion cubic feet)



Worldwide, hydroelectricity and wind are the two largest contributors to the increase in global renewable electricity generation, with hydropower accounting for 55 percent of the total increment and wind 27 percent. The mix of the two renewable energy sources in OECD and non-OECD regions differs dramatically, however. In OECD nations, the majority of economically exploitable hydroelectric resources already have been developed. Except in a few cases—notably, Canada and Turkey—there are few opportunities to expand large-scale hydroelectric power projects. Instead, most renewable energy growth in OECD countries is expected to come from nonhydroelectric sources, especially wind. Many OECD countries, particularly those in Europe, have government policies (including feed-in tariffs,[12] tax incentives, and market-share quotas) that encourage the construction of wind and other nonhydroelectric renewable electricity facilities.

In non-OECD nations, hydroelectric power is the predominant source of renewable energy growth. Strong increases in hydroelectric generation, primarily from mid- to large-scale power plants, are expected in Brazil and in non-OECD Asia (especially, China and India), which in combination account for 80 percent of the total increase in non-OECD hydroelectric generation over the projection period. Growth rates for wind-powered electricity generation also are high in non-OECD countries. The fastest-growing non-OECD regional market for wind power is China, where total generation from wind power plants increases from 12 billion kilowatthours in 2008 to 447 billion kilowatthours in 2035, an average annual increase of 14.2 percent. In China, wind generation accounted for only 2 percent of total renewable generation in 2008 but increases to 22 percent of the 2035 total in the Reference case (Figure 18).

Electricity generation from nuclear power worldwide increases from 2.6 trillion kilowatthours in 2008 to 4.9 trillion kilowatthours in 2035 in the *IEO2011* Reference case, as concerns about energy security and greenhouse gas emissions support the development of new nuclear generating capacity. In addition, world average capacity utilization rates have continued to rise over time, from about 65 percent in 1990 to about 80 percent today, with some increases still anticipated in the future. Finally, most older plants now operating in OECD countries and in non-OECD Eurasia probably will be granted extensions to their operating licenses.

There is still considerable uncertainty about the future of nuclear power, however, and a number of issues could slow the development of new nuclear power plants. In many countries, concerns about plant safety, radioactive waste disposal, and nuclear material proliferation may hinder plans for new installations. Moreover, the explosions at Japan's Fukushima Daiichi nuclear power plant in the aftermath of the March 2011 earthquake and tsunami could have long-term implications for the future of world nuclear power development. Even China—where large increases in nuclear capacity have been announced and are anticipated in the *IEO2011* Reference case—has indicated that it will halt approval processes for all new reactors until the country's nuclear regulator completes a "thorough safety review"—a process that could last for as long as a year [*1*]. High capital and maintenance costs may also keep some countries from expanding their nuclear power programs. Finally, a lack of trained labor resources, as well as limited global capacity for the manufacture of technological components, could keep national nuclear programs from advancing quickly.

In the *IEO2011* Reference case, 75 percent of the world expansion in installed nuclear power capacity occurs in non-OECD countries, with China, Russia, and India accounting for the largest increment in world net installed nuclear power from 2008 to 2035 (Figure 19). In the Reference case, China adds 106 gigawatts of nuclear capacity between 2008 and 2035, Russia 28 gigawatts, and India 24 gigawatts. Within the OECD, installed nuclear capacity increases to some extent in every region except Australia and New Zealand, where existing policies that prohibit nuclear power are assumed to remain unchanged through 2035.

Figure 17. World net electricity generation by fuel type, 2008-2035 (trillion kilowatthours)

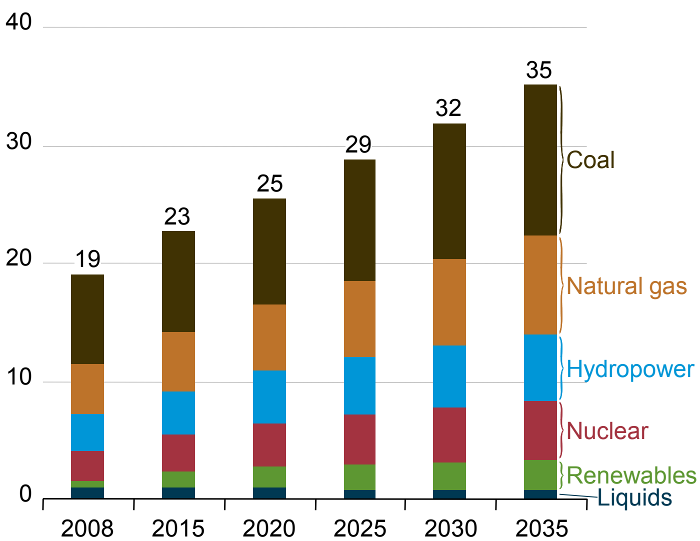
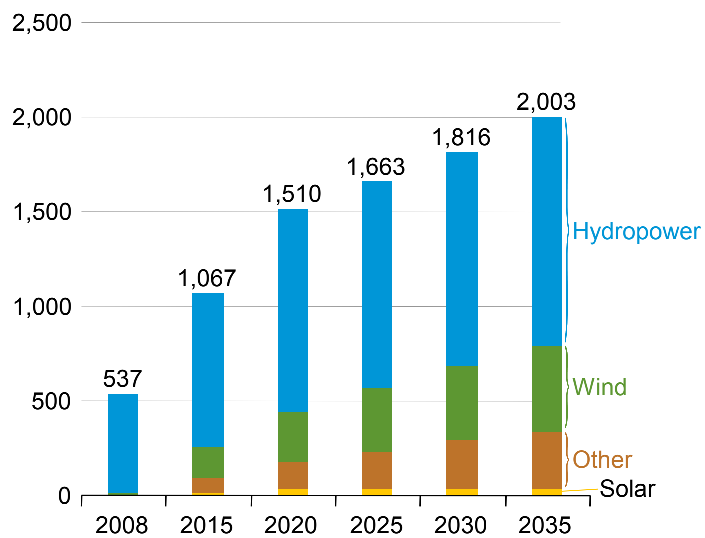


Figure 18. Renewable electricity generation in China by source, 2008-2035 (billion kilowatthours)



[12]A feed-in tariff is an incentive structure to encourage the adoption of renewable energy through government legislation. Under a feed-in tariff structure, regional or national electric utilities are obligated to purchase renewable electricity at a rate higher than retail, in order to allow renewable energy sources to overcome price disadvantages.

Prior to the Fukushima disaster, prospects for nuclear power in OECD Europe had improved markedly over the past few years, and many countries were reevaluating their nuclear power programs to consider plant life extensions or construction of new nuclear generating capacity. The governments of several countries had announced changes in their positions, including the Belgian government, which decided to delay its phaseout plans by 10 years; the German government, which extended the amount of time its nuclear reactors would be allowed to continue operating by between 8 and 14 years; and the Italian government, which formally ended its anti-nuclear policies and announced plans for constructing a new reactor by 2020 [*2*]. Even in Spain, where the government has remained steadfast in its opposition to the construction of new nuclear power plants, the main political parties—including the ruling Socialist Party—had agreed to allow nuclear facilities to operate longer than 40 years [*3*]. In addition, Poland and Turkey had announced plans to begin new nuclear generation programs with plants that could become operational soon after 2020 [*4*].

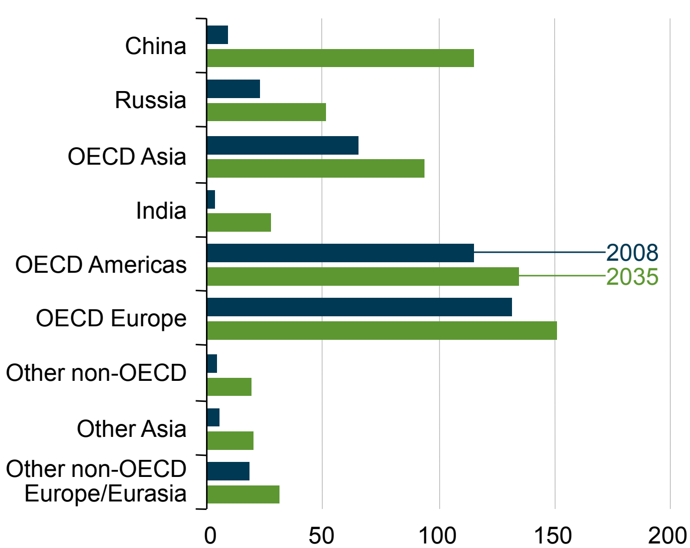
The projections in the *IEO2011* Reference case do not reflect the policy responses of some governments in the wake of the Fukushima disaster, which are likely to curtail the projections for nuclear power from both existing and new plants. The full extent to which governments in Europe and Japan might withdraw their support for nuclear power is uncertain, but some countries have already reversed their nuclear policies since the disaster occurred in March 2011. The German government, for instance, has announced plans to close all nuclear reactors in the country by 2022 [*5*]. The Swiss Cabinet also has decided to phase out nuclear power by 2034 [*6*], and Italian voters, in a country-wide referendum, have rejected plans to build nuclear power plants in Italy [*7*]. In addition, the European Commission has announced that it will conduct a program of stress tests at nuclear reactors operating within the European Union. (Turkey, in contrast, has announced that it will proceed with construction of the country's first nuclear power plant [*8*].) Still, environmental concerns and the importance of energy security provide support for future European nuclear generation.

In the United States, Title XVII of the Energy Policy Act of 2005 (EPACT2005, Public Law 109-58) authorizes the U.S. Department of Energy to issue loan guarantees for innovative technologies that "avoid, reduce, or sequester greenhouse gases." In addition, subsequent legislative provisions in the Consolidated Appropriation Act of 2008 (Public Law 110-161) allocated $18.5 billion in guarantees for nuclear power plants [*9*]. That legislation supports a net increase of about 10 gigawatts of nuclear power capacity, which would raise the U.S. total from 101 gigawatts in 2008 to 111 gigawatts in 2035. The projected increase in the *IEO2011* Reference case includes 3.8 gigawatts of expanded capacity at existing plants and 6.3 gigawatts of new capacity, including completion of a second unit at the Watts Bar site in Tennessee—where construction was halted in 1988 when it was nearly 80 percent complete—as well as four new nuclear power plants that are projected to be in operation before 2020 to take advantage of Federal financial incentives. One nuclear unit, Oyster Creek, is projected to be retired at the end of 2019, as announced by Exelon in December 2010. All other existing U.S. nuclear units continue to operate through 2035 in the Reference case.[13]

Delivered energy consumption by end-use sector

Understanding patterns in the consumption of energy delivered to end users[14] is important to the development of projections for global energy use. Outside the transportation sector, which at present is dominated by liquid fuels, the mix of energy use in the residential, commercial, and industrial sectors varies widely by region, depending on a combination of regional factors, such as the availability of energy resources, levels of economic development, and political, social, and demographic factors.

Figure 19. World nuclear generating capacity, 2008 and 2035 (gigawatts)



Residential sector

Energy use in the residential sector, which accounted for about 14 percent of world delivered energy consumption in 2008, is defined as the energy consumed by households, excluding transportation uses. Residential energy use grows at an average rate of 1.1 percent per year from 2008 to 2035. Projected robust economic growth among the emerging, non-OECD nations translates to much more rapid growth in residential energy use than in the developed OECD nations. As a result, non-OECD residential energy consumption increases at a rate more than seven times that of OECD nations—1.9 percent per year compared with 0.3 percent per year (Figure 20).

The type and amount of energy used by households vary from country to country, depending on income levels, natural resources, climate, and available energy infrastructure. In general, typical households in OECD nations use more energy than those in non-OECD nations, in part because

[13]For a discussion of the issues surrounding extension of the operating lives of U.S. nuclear reactors to 60 years, see "U.S. nuclear power plants: Continued life or replacement after 60?" in the Issues in Focus section of EIA's *Annual Energy Outlook 2010*, DOE/EIA-0383(2010) (Washington, DC, April 2010), pp. 43-46, website www.eia.gov/oiaf/archive/aeo10.

[14]Delivered energy consumption in the end-use sectors consists of primary energy consumption and retail sales of electricity, excluding electrical system energy losses.

higher income levels allow OECD households to have larger homes and purchase more energy-using equipment. In the United States, for example, GDP per capita in 2008 was $43,321 (in real 2005 dollars per person), and residential energy use per capita was estimated at 38.3 million Btu. In contrast, China's per-capita income in 2008, at $5,777, was only about one-eighth the U.S. level, and its residential energy use per capita, at 4.5 million Btu, was about one-ninth the U.S. level.

For residential buildings, the physical size of a structure is one key indicator of the amount of energy used by its occupants, although income level and a number of other factors, such as weather, also can affect the amount of energy consumed per household. Controlling for those factors, larger homes generally require more energy to provide heating, air conditioning, and lighting. In addition, occupants of larger homes tend to be more affluent, and as a result they tend to own more energy-using appliances, including multiple television sets and computers and a wide array of other electronic devices (such as digital video recorders and set-top boxes) whose operation consumes considerable amounts of electric power [*10*].

Smaller structures usually require less energy, because they contain less space to be heated or cooled, produce less heat transfer with the outdoor environment, and typically have fewer occupants. For instance, residential energy consumption is lower in China (where the average residence currently has an estimated 300 square feet of living space or less per person) than in the United States, where the average residence has an estimated 615 square feet of living space per person [*11*].

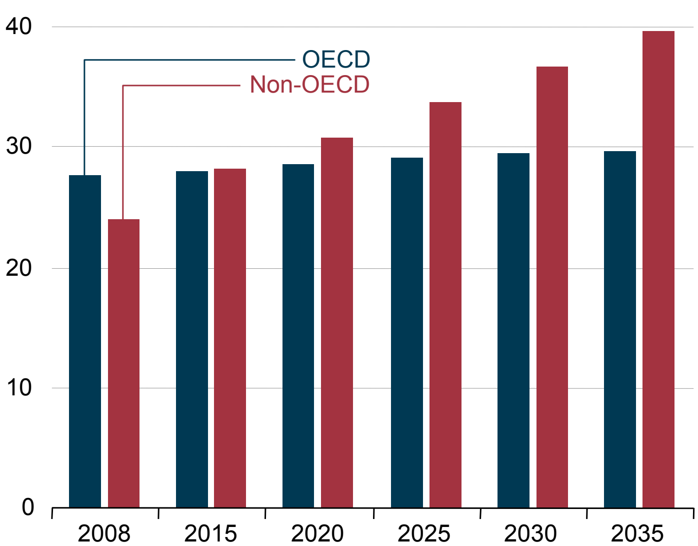
Although the *IEO2011* projections account for marketed energy use only, households in many non-OECD countries still rely heavily on traditional, non-marketed energy sources, including wood and waste, for heating and cooking. Much of Africa remains unconnected to power grids, and the International Energy Agency estimates that 1.4 billion people do not have access to electricity, most of them located in Sub-Saharan Africa [*12*]. About 40 percent of the world population—largely in Africa, India, and the rest of non-OECD Asia (excluding China)—still relies on traditional biomass for cooking fuel. As incomes rise in the developing world over the course of the projection, households replace traditional fuels with marketed fuels, such as propane and electricity, as they become more widely accessible. Although complete coverage of nonmarketed energy use is not included in the *IEO* Reference case, the trend toward replacing nonmarketed fuels is reflected in the growth in demand for marketed fuels.

Commercial sector

The commercial sector—often referred to as the service sector or the services and institutional sector—consists of businesses, institutions, and organizations that provide services. The sector, which accounted for 7 percent of total delivered energy consumption in 2008, encompasses many different types of buildings and a wide range of activities and energy-related services. Commercial energy use grows by an average of 1.5 percent per year from 2008 to 2035 in the *IEO2011* Reference case. Examples of commercial-sector facilities include schools, stores, correctional institutions, restaurants, hotels, hospitals, museums, office buildings, banks, and sports arenas. Most commercial energy use occurs in buildings or structures, supplying services such as space heating, water heating, lighting, cooking, and cooling. Energy consumed for services not associated with buildings, such as for traffic lights and city water and sewer services, is also categorized as commercial energy use.

Economic growth also determines the degree to which additional activities are offered and used in the commercial sector. Higher levels of economic activity and disposable income lead to increased demand for hotels and restaurants to meet business and leisure requirements; for office and retail space to house and service new and expanding businesses; and for cultural and leisure space such as theaters, galleries, and arenas. In the commercial sector, energy intensity—or energy use per dollar of income as measured by GDP— is much lower in non-OECD countries than in OECD countries. Non-OECD commercial energy intensity in 2008, at 281 Btu per dollar of GDP, was only about half the OECD level of 540 Btu per dollar of GDP.

Figure 20. World delivered residential energy consumption, 2008-2035 (quadrillion Btu)



In the future, slower expansion of GDP and low or declining population growth in many OECD nations contribute to slower anticipated rates of increase in commercial energy demand. In addition, continued efficiency improvements moderate the growth of energy demand over time, as energy-using equipment is replaced with newer, more efficient stock. Conversely, continued economic growth is expected to include growth in business activity, with its associated energy use, in areas such as retail and wholesale trade and business, financial services, and leisure services. The United States is the largest consumer of commercial delivered energy in the OECD and remains in that position throughout the projection, accounting for about 44 percent of the OECD total in 2035.

In non-OECD nations, economic activity and commerce increase rapidly, fueling additional demand for energy in the service sectors. Population growth also is more rapid than in OECD countries, portending increases in the need for education, health care, and social services and the energy required to provide them. In addition, as developing nations mature, they transition to more service-related enterprises, increasing demand for energy in the commercial sector. The energy needed to fuel growth in commercial buildings will be substantial, and total delivered commercial energy use among non-OECD nations grows by 2.8 percent per year from 2008 to 2035 in the Reference case (Figure 21).

Industrial sector

Energy is consumed in the industrial sector by a diverse group of industries—including manufacturing, agriculture, mining, and construction—and for a wide range of activities, such as processing and assembly, space conditioning, and lighting. The industrial sector consumed 52 percent of global delivered energy in 2008, and its energy consumption grows by an average of 1.5 percent per year over the projection. Industrial energy demand varies across regions and countries of the world, based on the level and mix of economic activity and technological development, among other factors. Industrial energy use also includes natural gas and petroleum products used as feedstocks to produce non-energy products, such as plastics and fertilizer.

In the *IEO2011* Reference case, industrial sector energy use increases by 2.0 percent per year in non-OECD nations, compared with 0.5 percent per year in OECD economies (Figure 22). Growth in non-OECD industrial energy use strongly outpaces the growth in OECD economies, not only because of faster anticipated economic expansion but also because of the composition of industrial sector production. OECD economies generally have more energy-efficient industrial operations than non-OECD countries, as well as a mix of industrial output that is more heavily weighted toward non-energy-intensive industry sectors. As a result, the ratio of industrial energy consumption to total GDP tends to be higher in non-OECD economies than in OECD economies. On average, industrial energy intensity (the consumption of energy consumed in the industrial sector per dollar of economic output) in non-OECD countries is double that in OECD countries.

It is also instructive to compare the mix of industrial sector fuels used in the OECD and non-OECD nations in the *IEO2011* Reference case. Of the five projected industrial fuel categories (renewable, electricity, natural gas, coal, and liquids), liquids is the dominant fuel throughout the projection period for OECD nations due to continued significant growth in the chemical sector in both the United States and the European Union, while coal is dominant in non-OECD countries due in part to China's continuing heavy reliance on this accessible and relatively inexpensive resource for its coal-reliant industries such as steel and cement. Coal for OECD nations drops from 13 percent of the total industrial fuel mix in 2008 to 11 percent in 2035, due in part to a decline in the steel industry. Renewable fuel (biomass) makes up a small but growing percentage of the industrial sector energy mix in OECD nations (from 7 percent in 2008 to 10 percent in 2035), but in the non-OECD nations the renewable energy percentage of all fuels consumed drops slightly, because renewable fuel consumption grows more slowly than consumption of fossil fuels. In both the OECD and non-OECD regions, natural gas and electricity account for increasing shares of total industrial fuel use.

Transportation sector

Energy use in the transportation sector includes the energy consumed in moving people and goods by road, rail, air, water, and pipeline. The transportation sector accounted for 27 percent of total world delivered energy consumption in 2008, and transportation energy use increases by 1.4 percent per year from 2008 to 2035. The growth in transportation energy demand growth in the *IEO2011* Reference case is largely a result of increases projected for non-OECD nations, where fast-paced gains in GDP raise standards of living and, correspondingly, the demand for personal travel and freight transport to meet consumer demand for goods. Non-OECD transportation energy use increases by 2.6 percent per year, compared with 0.3 percent per year

Figure 21. World delivered commercial energy consumption, 2008-2035 (quadrillion Btu)

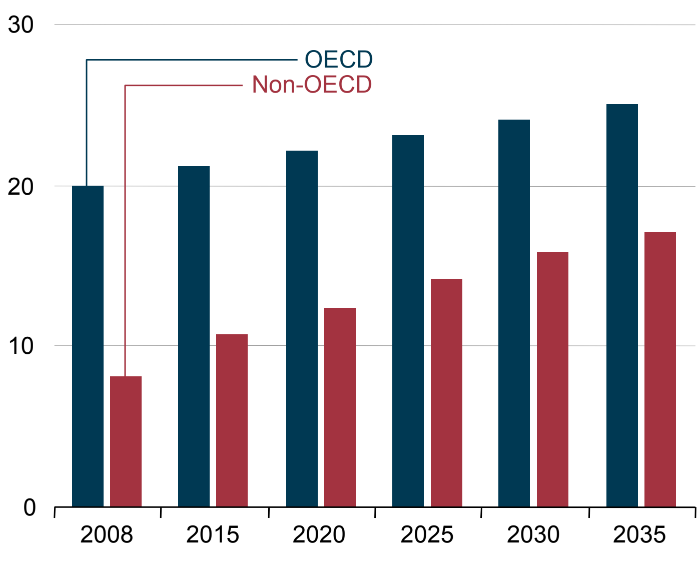
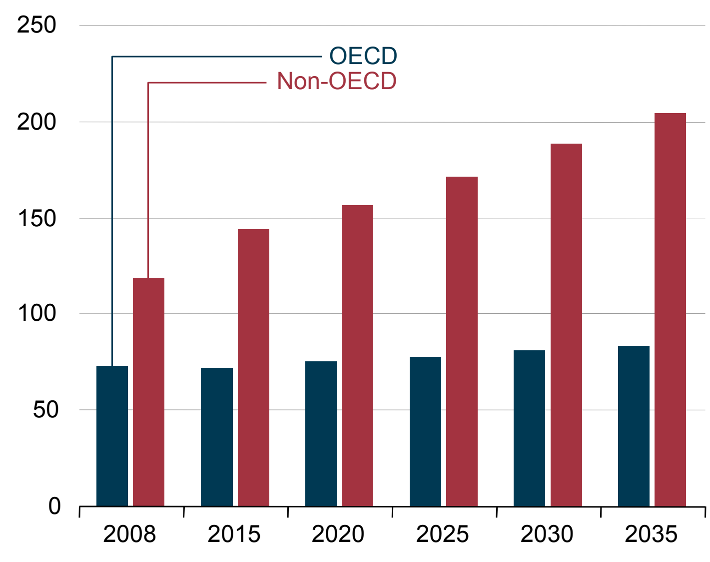


Figure 22. World delivered industrial energy consumption, 2008-2035 (quadrillion Btu)



projected for the OECD nations, where consuming patterns are already well established and slower growth of national economies and populations keeps transportation energy demand from increasing appreciably (Figure 23).

The road transport component includes light-duty vehicles, such as automobiles, sport utility vehicles, minivans, small trucks, and motorbikes, as well as heavy-duty vehicles, such as large trucks used for moving freight and buses used for passenger travel. Growth rates for economic activity and population are the key factors in transportation energy demand. Economic growth spurs increases in industrial output, which requires the movement of raw materials to manufacturing sites, as well as the movement of manufactured goods to end users.

For both non-OECD and OECD economies, increasing demand for personal travel is a primary factor underlying projected increases in energy demand for transportation. Increases in urbanization and in personal incomes have contributed to increases in air travel and motorization (more vehicles per capita) in the growing economies. For freight transportation, trucking leads the growth in demand for transportation fuels. In addition, as trade among countries increases, the volume of freight transported by air and marine vessels increases rapidly. Increases in the transport of goods result from continued economic growth in both OECD and non-OECD economies.

World economic outlook

Economic growth is among the most important factors to be considered in projecting changes in world energy consumption. In *IEO2011*, assumptions about regional economic growth—measured in terms of real GDP in 2005 U.S. dollars at purchasing power parity rates—underlie the projections of regional energy demand. Starting in 2008, the world experienced its worst recession of the past 60 years [*13*]. The recovery began for most economies in 2009 but was uneven across world regions. The world economy ran into a number of major obstacles in 2010, as a result of which world GDP growth decelerated to a below-trend pace of less than 3.0 percent in the second half of the year.

The weakest points of the global economy during the current expansion cycle have been in advanced economies, where household balance sheets remain under pressure because of high unemployment, weak demand for residential real estate, heavy debt loads, and tight credit. Household spending and bank lending have not been sufficiently robust to offset the phasing out of fiscal and monetary stimulus policies implemented in 2009 and 2010. Global economic growth is expected to improve over the next several years, however, as a result of increasing business investment, improving labor markets, and rising growth in world trade.

The emerging markets, particularly the economies of Asia (led by China and India), appear to be recovering quickly and driving current world economic growth. The latest releases of factory output data show that while the advanced economies' aggregate industrial production remains far below its pre-crisis peak, the corresponding number for emerging markets has surpassed it [*14*]. Thanks to their rapidly rising income and wealth, non-OECD Asian households managed to increase real spending through the 2008-2009 recession, while consumer spending was falling in North America and OECD Europe [*15*]. In fact, in the emerging countries, rising commodity prices and a narrowing gap between what is produced and what can be produced at full employment raise possible inflationary risks. Rising food prices also present inflationary risks that can slow economic recovery, although a recent increase in food prices related to weather damage should abate by 2012.

From 2008 to 2035, growth in world real GDP (on a purchasing power parity basis) averages 3.4 percent per year in the Reference case (Table 2). In the long term, the ability to produce goods and services (the supply side) determines the growth potential of each country's economy. Growth potential is influenced by population growth, labor force participation rates, capital accumulation,

Table 2. World gross domestic product by country grouping, 2008-2035 (billion 2005 dollars, purchasing power parity)

Region	2008	2015	2020	2025	2030	2035	Average annual percent change 2008-2035
OECD	**37,005**	**41,701**	**46,822**	**52,506**	**58,517**	**65,052**	**2.1**
Americas	16,125	18,759	21,457	24,759	28,305	32,246	2.6
Europe	15,007	16,378	18,241	20,150	22,126	24,222	1.8
Asia	5,873	6,565	7,124	7,596	8,086	8,584	1.4
Non-OECD	**28,774**	**42,131**	**54,052**	**67,107**	**81,345**	**96,596**	**4.6**
Europe and Eurasia	3,612	4,191	4,847	5,557	6,418	7,349	2.7
Asia	15,783	25,488	34,084	43,465	53,455	63,853	5.3
Middle East	2,415	3,229	3,924	4,682	5,569	6,577	3.8
Africa	2,891	3,906	4,744	5,646	6,631	7,776	3.7
Central and South America	4,073	5,317	6,454	7,757	9,272	11,041	3.8
World	**65,779**	**83,832**	**100,874**	**119,612**	**139,862**	**161,648**	**3.4**

Sources: IHS Global Insight and EIA.

and productivity improvements. In addition, for the developing economies, progress in building human and physical capital infrastructures, establishing credible regulatory mechanisms to govern markets, and ensuring political stability also are important determinants of medium- to long-term growth potential.

Annual growth in world GDP over the 27-year projection period in *IEO2011* (3.4 percent per year) is similar to the rate recorded over the past 30 years (3.3 percent per year). Growth in the more mature, industrialized OECD economies is expected to be slower, and growth in the emerging non-OECD economies is projected to be higher, than in the past. The combined GDP of OECD countries, which increased by an annual average of 2.9 percent from 1977 to 2008, averages 2.1 percent per year from 2008 to 2035 in the Reference case. In contrast, the combined GDP of non-OECD countries, which increased by an annual average of 3.7 percent from 1977 to 2008, averages 4.6 percent per year growth from 2008 to 2035, based in a large part on the strong growth projected for China and India. With non-OECD economies accounting for an increasing share of world GDP, their more rapid economic growth rates offset the slower growth rates for OECD economies in the Reference case (Figure 24).

OECD economies

In the *IEO2011* Reference case, overall OECD economic growth averages 2.1 percent per year, and U.S. GDP growth averages 2.5 percent per year from 2008 to 2035 (Figure 25). The U.S. recession, which began in December 2007, is the longest of the 10 recessions the United States has experienced since 1947, with four quarters of negative growth. It is also the country's deepest recession since 1957. In 2009, U.S. GDP declined by 2.6 percent. In 2010, growth increased by 2.8 percent per year, about the same as the 2.9-percent average of the past two decades [*16*], leading to a slower recovery of pre-recessionary levels. The U.S. economic recovery is expected to intensify in 2011, with employment recovering more slowly. As a result, real GDP returns to its 2008 pre-recessionary level by 2011, but employment rates do not return to 2008 levels until 2019.

Canada was also affected substantially by the world recession, with GDP contracting by 2.5 percent in 2009. The strong trade ties between Canada and the United States mean that weak U.S. economic growth, coupled with a relatively strong Canadian dollar (by historical standards), helped lead Canada into economic recession [*17*]. Since the Canadian dollar began its 50-percent appreciation in early 2003, Canada's export sector, particularly in manufacturing, has experienced slower growth. The strength of the Canadian dollar has been the result of both the general decline in the value of the U.S. dollar and strong commodity prices.

Canada's economic growth in 2011 is expected to be lower than its 2010 growth of 2.9 percent, as the impact of the 2009

Figure 23. World delivered transportation energy consumption, 2008-2035 (quadrillion Btu)

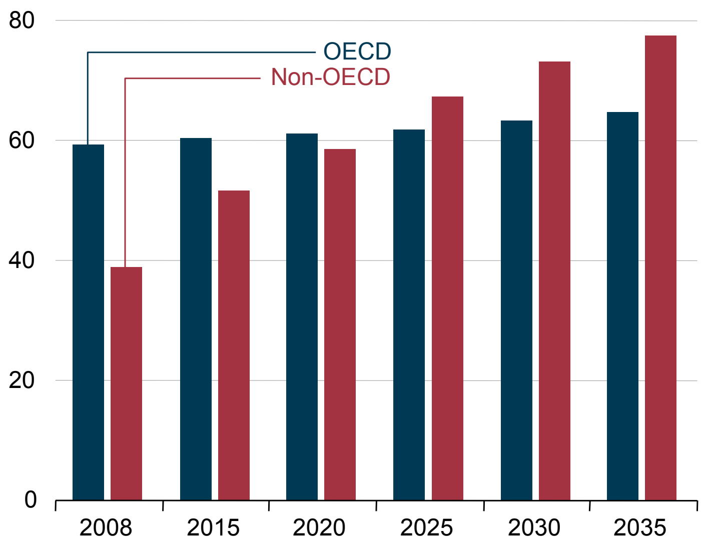
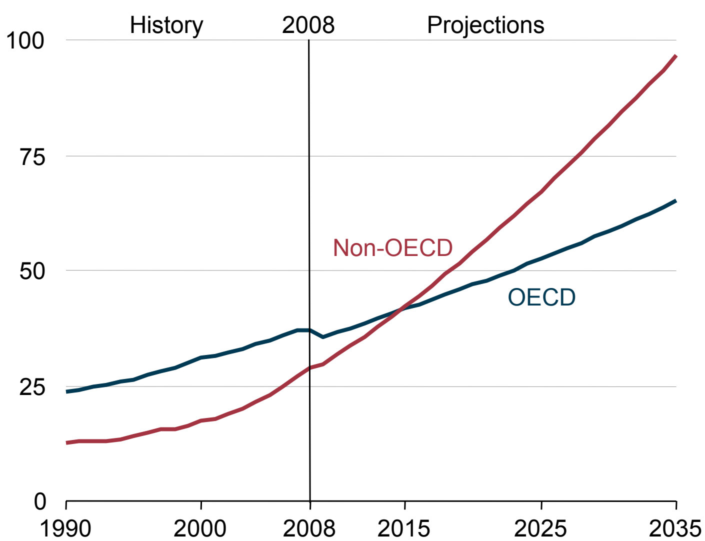
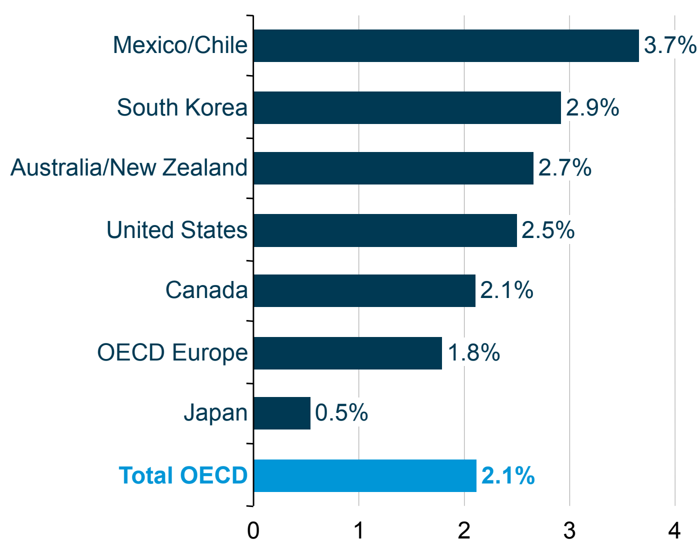


Figure 24. OECD and non-OECD total gross domestic product, 1990-2035 (trillion 2005 dollars)



Sources: IHS Global Insight and EIA.

Figure 25. OECD gross domestic product growth rates by country grouping, 2008-2035 (average annual percent change)



Sources: IHS Global Insight and EIA.

fiscal stimulus abates. The Canadian government had committed around $16 billion (Canadian) to 23,000 infrastructure programs in 2009 as the recession deepened [*18*]. Plans to end the stimulus spending were extended beyond March 31, 2011, when the government announced its decision to extend the deadline for spending to the end of October 2011 in order to ensure that projects under construction by March 31 would be able to be completed. In the near term, Canada's economic growth will depend on the U.S. economic recovery, and rising commodity prices over the medium and long term will lead to increased export growth. In the long term, as U.S. consumer demand returns and export markets improve, economic growth in Canada is expected to return to its potential. In the *IEO2011* Reference case, Canada's GDP grows by an average of 2.1 percent per year from 2008 to 2035.

For the two other countries in the OECD Americas region, Mexico and Chile, prospects for economic growth are higher than those for the United States and Canada. GDP growth in Mexico and Chile combined averages 3.7 percent per year from 2008 to 2035 in the Reference case. Mexico was the Western Hemisphere's hardest-hit economy in the 2008-2009 recession [*19*]. Not only did it suffer when worldwide commodity exports collapsed, but the impact of the recession was compounded by the outbreak of H1N1 "swine flu" in 2009. Its prospects for short-term growth may also be dampened by increased drug-related violence in some parts of the country that erodes business and consumer confidence [*20*]. Mexico's high reliance on the United States as a market for its manufacturing exports (about 80 percent of Mexico's exports are sent to the United States) suggests that its economic recovery also will depend on the U.S. recovery. Rising world oil prices and recovery of the U.S. economy are expected to support Mexico's return to trend growth. As commodity prices for base metals continue to increase, Chile's exports are expected to show robust growth. With relatively small fiscal deficits, a stable currency, sound monetary policy, low inflation, and reduced risk in financial systems, Chile's prospects for future economic growth are optimistic.

In OECD Europe, after declining by 3.9 percent in 2009, GDP returned to positive growth in 2010, increasing by an estimated 2.0 percent. In 2011, GDP growth is projected to slow to 1.7 percent as stimulus funds are withdrawn and several major economies adopt austerity measures to address budgetary deficits. In 2010, Greece and Ireland had to accept rescue packages to avoid debt crises. In Greece, a rescue package assembled by the International Monetary Fund (IMF), European Union, and European Central Bank was implemented in May 2010 to prevent default [*21*]. In Ireland, a similar bailout provided funds from the European Union and IMF to recapitalize the nation's banking sector after substantial bad loans were incurred when a real estate market bubble collapsed [*22*].

There still are concerns that several other "Eurozone" nations will need financial assistance—notably, Portugal and the European Union's fourth-largest economy, Spain. In fact, European Union governments are now considering ways to strengthen the financial terms of the Eurozone's financial rescue fund. Germany, in particular, as the European Union's largest economy, is concerned about the way in which future rescue packages will be implemented and their potential impacts on the German economy [*23*]. The success of the measures taken to repair the health of the European economies will affect regional GDP growth in the mid- to long term. In the *IEO2011* Reference case, OECD Europe's total GDP does not return to its 2008 level until 2012. Economic growth in the region averages 1.8 percent per year from 2008 to 2035, below the increase of 2.1 percent per year for the OECD as a whole.

On March 11, 2011, a devastating, magnitude 9.0 earthquake, followed by a tsunami, struck northeastern Japan, killing thousands of people and inflicting tens of billions of dollars worth of damage on the Japanese infrastructure in what Prime Minister Naoto Kan characterized as "Japan's most severe crisis since the war ended 65 years ago" [*24*]. In the short term, it is impossible to estimate the extent of damage from the disaster to Japan's economy, and *IEO2011* makes no attempt to incorporate the ultimate effects of the earthquake in the Reference case. In the longer term, after a return to normalcy and as the economy recovers, the *IEO2011* Reference case anticipates that Japan's aging labor force and declining population will support only slow economic growth, averaging 0.5 percent per year from 2008 to 2035.

Outside of Japan, more robust economic growth is projected for OECD Asia. In South Korea, GDP growth averages 2.9 percent per year from 2008 to 2035. South Korea, historically known for export success and large current-account surpluses, experienced trade deficits in 2008 as oil prices rose and exports declined. The situation was reversed in 2009 and 2010, allowing Korea to run external surpluses again. In response to the 2008 recession, the Bank of Korea kept interest rates low. In July 2010, for the first time since 2009, the Bank increased rates by one-quarter point, following up with another one-quarter point in November 2010 as a preventive measure against rising inflation. Further periodic increases in the interest rate are expected throughout 2011 and into 2012 [*25*]. A resurgence of world demand for Korean goods will support South Korea's economic recovery in the near term. In the long term, however, its growth is projected to taper off as the growth of its labor force slows.

GDP growth in Australia/New Zealand averages 2.7 percent per year from 2008 to 2035 in the *IEO2011* Reference case. Long-term prospects in both countries are relatively healthy, given their consistent track records of fiscal prudence and structural reforms aimed at maintaining competitive product markets and flexible labor markets. The reserve banks of both countries were proactive in managing their response to the global recession of 2008-2009. Starting in 2008, the Reserve Bank of Australia and the Reserve Bank of New Zealand eased monetary policies to lessen the impact of the global economic downturn [*26*].

Compared with many other industrialized nations, Australia's economy rebounded quickly. In fact, Australia was the first "Group of 20" nation to begin tightening monetary policy and increasing interest rates (in October 2009). Interest rates have been increased periodically since then, to 4.75 percent in November 2010, as the Reserve Bank of Australia has addressed concerns about the threat of inflation [*27*]. Large-scale flooding in Australia from December 2010 to January 2011 caused extensive damage—in excess of $15 billion—in the mining state of Queensland, a major resource-producing area that accounts for one-fifth of Australia's economy.

As a result, the country's export potential in 2011 was compromised and GDP growth potential was dampened significantly [*28*]. Australia is expected to return to GDP growth of about 2.5 percent in 2011, before accelerating again in 2012 and beyond [*29*].

Non-OECD economies

Overall economic growth in the non-OECD region averages 4.6 percent per year from 2008 to 2035 in the *IEO2011* Reference case (Figure 26), and growth in non-OECD Europe and Eurasia as a whole averages 2.7 percent per year. After several years of strong regional growth (the region's GDP grew by an average of 6.7 percent per year from 2000 to 2008), GDP in non-OECD Europe and Eurasia contracted by 7.3 percent in 2009. The region has a fairly diverse set of economies, and while some economies suffered deep recessions in 2008-2009, others saw economic growth slow but remain positive.

For the nations of non-OECD Europe and Eurasia, exports have led to increased growth in 2010, with household consumption showing signs of recovery in 2011. In the face of large fiscal deficits, government expenditures have been under pressure in many nations of the region, and fiscal austerity measures are expected to restrain the pace of economic growth in the region into the medium term. Monetary policy also will have to be relatively cautious, given that higher prices for key imported commodities and food and a return of upward pressure from wages could increase the risk of building inflationary expectations.

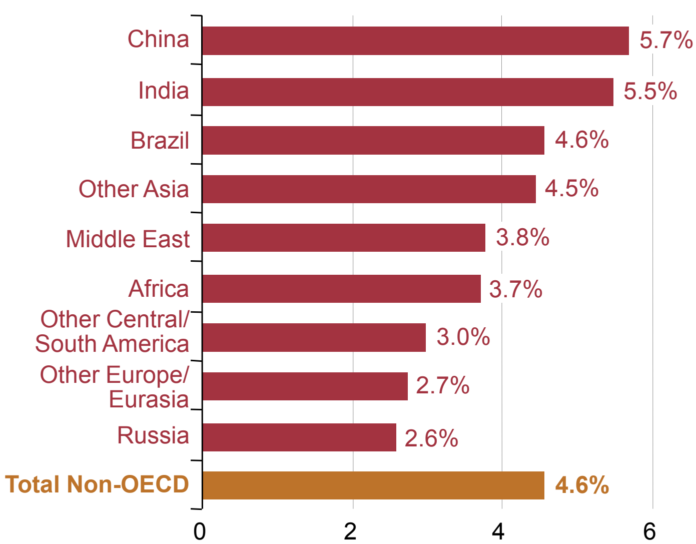
Beginning in late 2008, it became more difficult for banks and other entities in non-OECD Europe and Eurasia—particularly, Russia, Kazakhstan, and Ukraine—to gain access to foreign loans [*30*]. The impact was softened somewhat by higher world market prices for commodity exports, but with the subsequent collapse of commodity prices and worsening global economic situation, the region's economic growth declined sharply. In the mid- to long term, a return to high world oil prices is expected to stimulate investment outlays, especially in the energy sector of the Caspian region. Given the volatility of energy market prices, however, it is unlikely that the economies of non-OECD Europe and Eurasia will be able to sustain their recent growth rates until they have achieved more broad-based diversification from energy production and exports.

Much of the growth in world economic activity between 2008 and 2035 occurs among the nations of non-OECD Asia, where regional GDP growth averages 5.3 percent per year. China, non-OECD Asia's largest economy, continues to play a major role in both the supply and demand sides of the global economy. *IEO2011* projects an average annual growth rate of approximately 5.7 percent for China's economy from 2008 to 2035—the highest among all the world's economies.

Non-OECD Asia has led the recovery from the 2008-2009 global economic recession. In China, substantial stimulus and tax breaks in 2009, along with considerable loosening of lending terms, allowed GDP growth to reach 9.1 percent, even with considerable deceleration of exports. Further, growth in property sales and real estate prices was substantial in 2010, supporting renewed strength in construction activity. In fact, there is growing concern on the part of the Chinese government about a possible housing bubble. In an effort to control rapidly increasing prices in the country's real estate market, the government imposed restrictions on property acquisitions in more than 30 Chinese cities, making it more difficult for nonresidents to buy homes and for current homeowners to purchase second residences [*31*].

The growth of domestic demand in China is supported by an increase in credit expansion, despite the repeated tightening moves by the People's Bank of China—particularly in raising the reserve requirement ratio. Many non-OECD Asian economies that are trade partners with China also have benefited from their economic ties. Although those emerging Asian economies—particularly those strongly dependent on exports for revenues—experienced profound decreases in economic activity in 2008 and into 2009 as demand for goods among OECD economies declined sharply, the recovery in China has bolstered their recovery.

Figure 26. Non-OECD gross domestic product growth rates by country grouping, 2008-2035 (average annual percent change)



Sources: IHS Global Insight and EIA.

Structural issues that have implications for economic growth in China in the mid- to long term include the pace of reform affecting inefficient state-owned companies and a banking system that is carrying a significant amount of nonperforming loans. In large part, China's economic base has changed from agriculture and heavy industry to light manufacturing and services. In the late 1970s, the agriculture sector employed nearly 70 percent of China's labor and produced around 30 percent of its GDP; currently, the agriculture sector's employment and output shares are 43 percent and 12 percent, respectively [*32*]. By shifting its factors of production away from the low-productivity agricultural sector, China has boosted productivity significantly, adding to long-run prospects for growth. As China shifts from labor-intensive to more capital-intensive means of production, availability of capital becomes crucial. Development of domestic capital markets continues in the *IEO2011* Reference case, providing macroeconomic stability and ensuring that China's large domestic savings are used more efficiently.

India's GDP growth averages 5.5 percent per year from 2008 to 2035 in the *IEO2011* Reference case. India was affected far less by the global economic downturn than were many other nations of the world, with low dependence on exports, accommodating economic policies, and robust capital inflows supporting domestic activity [*33*]. India's GDP grew by 6.8 percent in 2009 and 8.3 percent in 2010 [*34*]. In the short term, concerns about sharply rising inflation—primarily because of increasing food and energy costs—are expected to result in increased tightening of monetary supply by the Reserve Bank of India. In the medium term, favorable export growth, continued economic reforms, and greater contributions from the service and construction sectors are expected to keep the economy advancing at rates near 7.0 percent through 2020. Accelerating structural reforms—including ending regulatory impediments to the consolidation of labor-intensive industries, labor market and bankruptcy reforms, and agricultural and trade liberalization—remain essential for stimulating potential growth and reducing poverty in India over the mid- to long term.

Outside China and India, recovery from the global recession in the countries of non-OECD Asia has varied. Those economies that are export-dependent (including Hong Kong, Indonesia, Singapore, and Taiwan) strengthened substantially in 2010, as demand in China supported their recovery. For nations where domestic demand has remained relatively healthy (including Vietnam and the Philippines), the impact of the global recession was less severe, but the recovery into the medium term may be more muted than in the years before the recession, because weaker demand in key export markets—notably, the United States and Europe—may dampen the potential to increase trade for some years into the future [*35*]. Overall, long-term economic activity in the nations of non-OECD Asia remains positive. From 2008 to 2035, national economic growth rates for the region—excluding China and India—average 4.5 percent per year in the Reference case.

In the Middle East, oil exports account for a substantial portion of GDP growth for the region's key economies. A sharp decline in world oil prices from their peak in mid-July 2008 had a significant impact on the region in 2009. Since then, oil prices have continued to rise—in part because of the recovering demand for liquids but also as a result of the political unrest that began with protests in the African countries of Tunisia and Egypt and then spread to Libya and to the Middle Eastern countries Bahrain, Yemen, Iran, and Syria. In the short term, it is difficult to balance the positive impact of rising revenues from oil exports in the Middle East against growing instability and political uncertainty [*36*]. Extremely high unemployment rates (particularly among the region's substantial younger populations), combined with concerns over rising food prices, sparked the domestic unrest. Political turmoil and domestic unrest threaten to depress consumer confidence, and looking forward inflationary risks could be a key factor affecting sentiment and consumer demand. The Middle East's reliance on oil and natural gas revenues continues throughout the projection period. In the long run, rising oil prices and rebounding demand for the region's export commodities support favorable prospects for economic growth.

The impact of the global recession on the economies of Africa varied across the continent. Most countries in sub-Saharan Africa have recovered quickly from the global crisis, with the oil-exporting countries, in particular, benefiting from increasing oil prices. Africa continues to gain major debt relief under the Heavily Indebted Poor Countries (HIPC) initiative. Despite the overhang of the global economic recession in 2010, four African countries reached key HIPC milestones, thus gaining access to more than $18.8 billion in debt relief [*37*]. Risks include continued uncertainty in the global financial markets and low growth in the more developed African countries. If financial flows from the leading economies in sub-Saharan Africa fall significantly because of fiscal retrenchment or risk aversion, the net effect will be a dampening of growth prospects in the region.

Recent social and political unrest in Tunisia, Egypt, Algeria, and especially Libya—where on March 19, 2011, an alliance of nations began efforts backed by the United Nations to establish a no-fly zone to ensure the safety of Libyan citizens—has added considerable uncertainty to prospects for northern Africa, especially in the near term [*38*]. It remains to be seen how events will unfold and how they will the affect the region's economic development in the mid- to long term. In the *IEO2011* Reference case, Africa's combined economy grows at an average annual rate of 3.7 percent from 2008 to 2035, supported by the expansion of exports and robust domestic demand in many of the continent's national economies. Nevertheless, both economic and political factors—such as low savings and investment rates, lack of strong economic and political institutions, limited quantity and quality of infrastructure and human capital, negative perceptions on the part of international investors, protracted civil unrest and political disturbances, and chronic widespread disease—present formidable obstacles to growth in a number of African countries.

In Central and South America, the impact of the global economic downturn varied across the nations of the region. Brazil, Colombia, Peru, and Uruguay all have experienced strong recoveries, but sustainable recoveries in Ecuador and Venezuela remain in question [*39*]. Further, economies with strong trade ties to Brazil—notably, Argentina and Paraguay—are likely to benefit from that relationship.

Brazil—the region's largest economy—experienced a relatively short and mild recession, and its recovery was much stronger than expected by the government [*40*]. As a result, authorities have been more concerned about an economy that is expanding too quickly, raising fears that fast-paced increases in demand growth will not be met by increased output and thus will lead to rising prices and high inflation. As the global recession deepened, the Central Bank of Brazil trimmed interest rates to a record low of 8.75 percent in July 2009; however, Brazil was among the first nations to begin increasing interest rates, starting in April 2010, to 11.25 percent in January 2011 as the Bank tried to slow the pace of economic expansion [*41*]. Brazil's continued favorable economic prospects are supported by domestic and foreign investment, along with strengthening domestic consumption.

Investment in the countries of Central and South America is constrained by adverse economic circumstances, and revenues from commodities exports are not expected to provide the level of government revenue that were seen from 2003 to 2008. The proximity of the region to the United States and the trade relationships of its national economies with the U.S. economy suggest that the region's recovery will be linked, in part, to the pace of the U.S. recovery. Even so, the long-term prospects for Central and South America remain positive. Most countries in the region have flexible exchange rates, positive trade balances, and relatively low fiscal deficits and public debts. Regional inflation is lower than it was in the mid-1990s, and a relatively young labor force supports the region's economic growth prospects over the next 30 years. Economic growth in Central and South America averages 3.8 percent per year from 2008 to 2035 in the *IEO2011* Reference case, as the region benefits from the expected recovery in world economic growth after 2010, and foreign capital flows are revived.

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Liquid fuels

Overview

Consumption of petroleum and other liquid fuels[15] increases from 85.7 million barrels per day in 2008 to 112.2 million barrels per day in 2035 in the *IEO2011* Reference case. Although world liquids consumption actually declined in 2009 (to 83.9 million barrels per day), it recovered in 2010 to an estimated 86.0 million barrels per day and is expected to continue increasing in 2011 and beyond as economic growth strengthens, especially among the developing non-OECD nations. In the long term, world liquids consumption increases despite world oil prices that rise to $125 per barrel (real 2009 dollars) by 2035. More than 75 percent of the increase in total liquids consumption is projected for the nations of non-OECD Asia and the Middle East, where strong economic growth and, in the case of the Middle East, access to ample and relatively inexpensive domestic resources drive the increase in demand (Figure 27).

To satisfy the increase in world liquids demand in the Reference case, liquids production increases by 26.6 million barrels per day from 2008 to 2035, including the production of both conventional liquid supplies (crude oil and lease condensate, natural gas plant liquids, and refinery gain) and unconventional supplies (biofuels, oil sands, extra-heavy oil, coal-to-liquids [CTL], gas-to-liquids [GTL], and shale oil) (Figure 28 and Table 3). In the Reference case, sustained high world oil prices allow for the economical development of unconventional resources and the use of enhanced oil recovery (EOR) technologies to increase production of conventional resources. High world oil prices also incentivize the development of additional conventional resources through technically difficult, high-risk, and very expensive projects, including wells in ultra-deep water and the Arctic.

The most significant non-OPEC contributors to production growth are Russia, the United States, Brazil, and Canada (Figure 29). Total non-OPEC liquids production in 2035 is 15.3 million barrels per day higher than in 2008, representing 57 percent of the total world increase. OPEC producers[16] are assumed to restrict investment in incremental production capacity in the Reference case, below the levels justified by high prices. As a result, OPEC provides roughly 42 percent of the world's total liquids supply over the 2008-2035 period, consistent with its share over the past 15 years.

Unconventional resources from both OPEC and non-OPEC sources become increasingly competitive in the *IEO2011* Reference case, although unconventional petroleum liquids production development faces some difficulties, such as environmental concerns for Canada's oil sands projects and investment restrictions for Venezuela's extra-heavy oil projects. Production of nonpetroleum unconventional liquids, such as biofuels, CTL, and GTL, is spurred by sustained high prices in the Reference case (Figure 30). However, their development also depends on country-specific programs or mandates. World production of unconventional liquids, which in 2008 totaled only 3.9 million barrels per day or about 5 percent of total world liquids production, increases in the Reference case to 13.1 million barrels per day in 2035, when it accounts for 12 percent of total world liquids production.

World oil prices

The impacts of world oil prices[17] on energy demand are a considerable source of uncertainty in the *IEO2011* projections. Prices have been exceptionally volatile over the past several years, reaching a high of $145 in July 2008 (daily spot price in nominal dollars)

Figure 27. World liquid fuels consumption by region, 1990-2035 (million barrels per day)

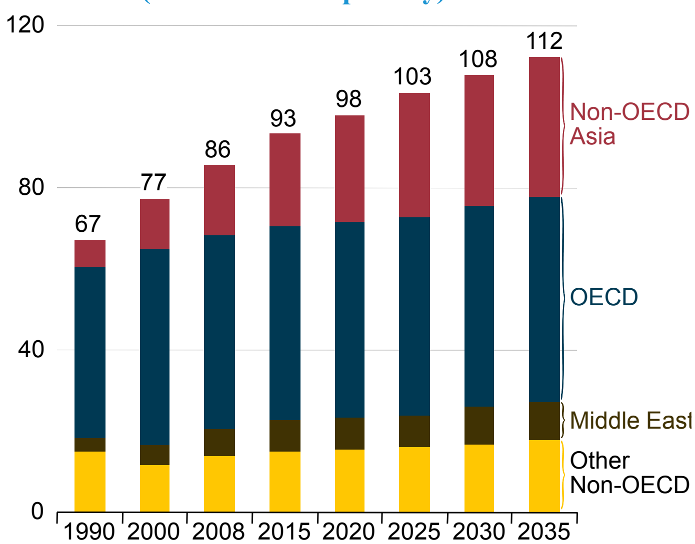
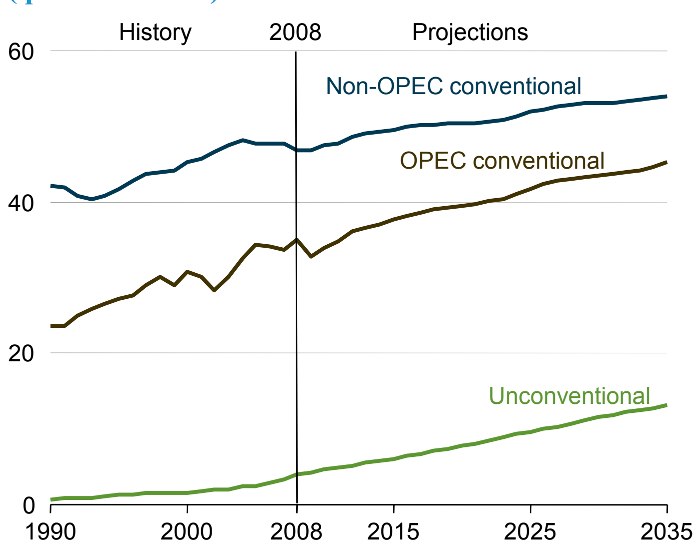


Figure 28. World liquid fuels production, 1990-2035 (quadrillion Btu)



[15]Petroleum and other liquid fuels include petroleum-derived fuels and non-petroleum-derived liquid fuels, such as ethanol and biodiesel, coal-to-liquids, and gas-to-liquids. Petroleum coke, which is a solid, is included. Also included are natural gas liquids, crude oil consumed as a fuel, and liquid hydrogen.

[16]For consistency, OPEC includes all members of the organization as of March 1, 2011, throughout all the time series included in this report.

[17]The oil price reported in *IEO2011* is for light sweet crude oil delivered to Cushing, Oklahoma. The price series is consistent with spot prices for light sweet crude oil reported on the New York Mercantile Exchange (NYMEX). All oil prices are in real 2009 dollars per barrel, unless otherwise noted.

and a low of $30 in December 2008, as the global recession substantially dampened demand and thus prices. Improving economic circumstances, especially in the developing economies, strengthened liquids demand, and prices rose in 2009 and 2010. More recently, growing demand and unrest in many oil-supplying nations of the Middle East and North Africa have supported price increases into 2011. Prices rose from an average $62 per barrel in 2009 to $79 per barrel in 2010, and they are expected to average about $100 per barrel in 2011 [*42*]. In the *IEO2011* Reference case, world oil prices continue increasing, to $108 per barrel in 2020 and $125 per barrel in 2035.

In addition to the Reference case prices, *IEO2011* includes analyses of high and low world oil price paths. The three alternative price paths, which are consistent with those presented in EIA's *Annual Energy Outlook 2011* [*43*], are used to develop five price scenarios that can be used to illustrate the range of uncertainty associated with prices in world liquids markets (Figure 31 and Table 4). The high and low oil price paths and resulting scenarios illustrate price uncertainty, but they do not span the complete range of possible price paths.

In past editions of the *IEO*, high and low oil price scenarios typically have examined the impacts of changes in liquids supplies relative to the Reference case, based on different assumptions about OPEC decisionmaking and access to non-OPEC resources and their impacts on world liquids supply. In the *IEO2011* Traditional Low Oil Price case, as in past *IEO*s, the available supply is higher at all price levels; and in the Traditional High Oil Price case, the available supply is lower at all price levels, reflecting shifts in the liquids supply curve. The traditional oil price cases assume that demand curves are constant, with changes in demand resulting only from movement along the demand curves as prices rise or fall.

Table 3. World liquid fuels production in the Reference case, 2008-2035 (million barrels per day)

Source	2008	2015	2020	2025	2030	2035	Average annual percent growth, 2008-2035
OPEC							
Conventional liquids[a]	35.0	37.6	39.5	41.7	43.4	45.2	1.0
Extra-heavy crude oil	0.7	0.8	1.1	1.2	1.3	1.4	3.0
Oil sands (upgraded)	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	--
Gas-to-liquids	0.0	0.2	0.2	0.3	0.3	0.3	16.0
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	--
Biofuels (physical volume)	0.0	0.0	0.0	0.0	0.0	0.0	--
OPEC total	**35.6**	**38.6**	**40.8**	**43.1**	**45.0**	**46.9**	**1.0**
Non-OPEC							
Conventional liquids[a]	46.8	49.6	50.3	51.9	53.1	53.9	0.5
Extra-heavy crude oil	0.0	0.0	0.0	0.1	0.1	0.1	8.5
Oil sands (upgraded)	1.5	2.3	2.9	3.5	4.1	4.8	4.4
Coal-to-liquids	0.2	0.3	0.5	0.8	1.3	1.7	9.0
Gas-to-liquids	0.0	0.1	0.1	0.1	0.1	0.1	1.3
Shale oil	0.0	0.0	0.0	0.0	0.1	0.1	12.1
Biofuels (physical volume)	1.5	2.4	3.0	3.8	4.4	4.7	4.3
Non-OPEC total[b]	**50.0**	**54.7**	**56.8**	**60.1**	**63.0**	**65.3**	**1.0**
World							
Conventional liquids[a]	81.7	87.2	89.8	93.6	96.5	99.1	0.7
Extra-heavy crude oil	0.7	0.8	1.1	1.2	1.4	1.5	3.1
Oil sands (upgraded)	1.5	2.3	2.9	3.5	4.1	4.8	4.4
Coal-to-liquids	0.2	0.3	0.5	0.8	1.3	1.7	9.0
Gas-to-liquids	0.1	0.3	0.3	0.3	0.3	0.3	7.4
Shale oil	0.0	0.0	0.0	0.0	0.1	0.1	12.1
Biofuels (physical volume)	1.5	2.4	3.0	3.8	4.4	4.7	4.3
World total	**85.7**	**93.3**	**97.6**	**103.2**	**108.0**	**112.2**	**1.0**

[a]Includes conventional crude oil and lease condensate, natural gas plant liquids (NGPL), and refinery gain.
[b]Includes some U.S. petroleum product stock withdrawals, domestic sources of blending components, other hydrocarbons, and ethers.

In contrast, the Low Oil Price and High Oil Price cases in *IEO2011* assume that changes in demand growth, resulting in different levels of demand, also affect prices. Thus, the Low Oil Price and High Oil Price cases incorporate alternative assumptions about economic growth and other structural factors in non-OECD countries that shift the "demand schedule" for liquids fuels while also continuing to maintain a portion of the change in "supply schedules" that drive the Traditional High Oil Price and Traditional Low Oil Price cases. The *IEO2011* Low Oil Price case assumes that liquids demand in the non-OECD countries (where most of the world's demand uncertainty lies) at any given price level is lower than in the Reference case, and that total liquids supply available at any price point is higher than in the Reference case. It also assumes that the shifts in demand and supply schedules lead to changes in the liquids quantities, resulting in price levels that are the same as those in the Traditional Low Oil Price case. That is, the only change is in the amount of oil consumed in the world market. Similarly, the *IEO2011* High Oil Price case assumes that liquids demand in the non-OECD countries at any given price level is higher than in the Reference case, and that the total liquids supply available at any price point is lower than in the Reference case, with the shifts in demand and supply schedules leading to changes in the quantities of liquids available, so that price levels that are the same as those in the Traditional High Oil Price case. Again, the only change is in the amount of oil consumed in the market.

In the Reference case, world oil prices are $95 per barrel in 2015 (real 2009 dollars), increasing slowly to $125 per barrel in 2035 ($200 per day in nominal terms). The Reference case represents EIA's current best judgment regarding exploration and development costs and accessibility of oil resources outside the United States. It also assumes that OPEC producers will choose to maintain their share of the market and will schedule investments in incremental production capacity so that OPEC's conventional oil production represents about 42 percent of the world's total liquids production. To retain that share, OPEC would have to increase production by 11.3 million barrels per day from 2008 to 2035, or 43 percent of the projected total increase in world liquids supply (Figure 32). Non-OPEC conventional supplies—including production from high-cost projects and from countries with unattractive

Figure 29. Non-OPEC liquids production by region, 2008 and 2035 (million barrels per day)

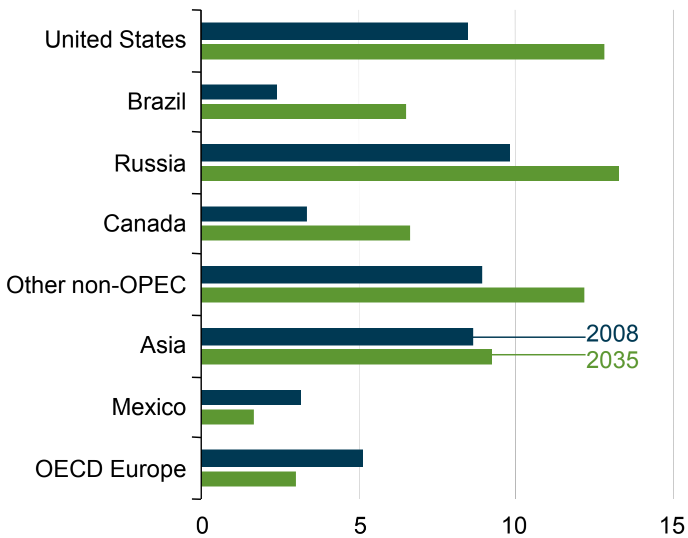


Figure 30. Unconventional liquids production by fuel type, 2008 and 2035 (million barrels per day)

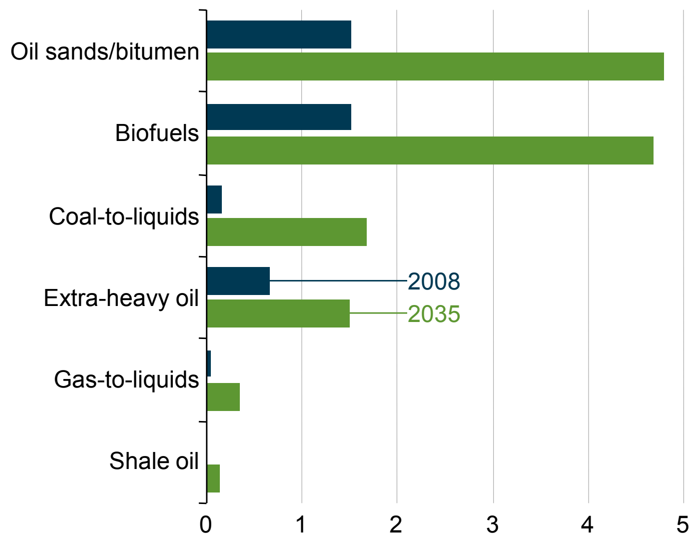


Figure 31. World oil prices in three cases, 1990-2035 (2009 dollars per barrel)

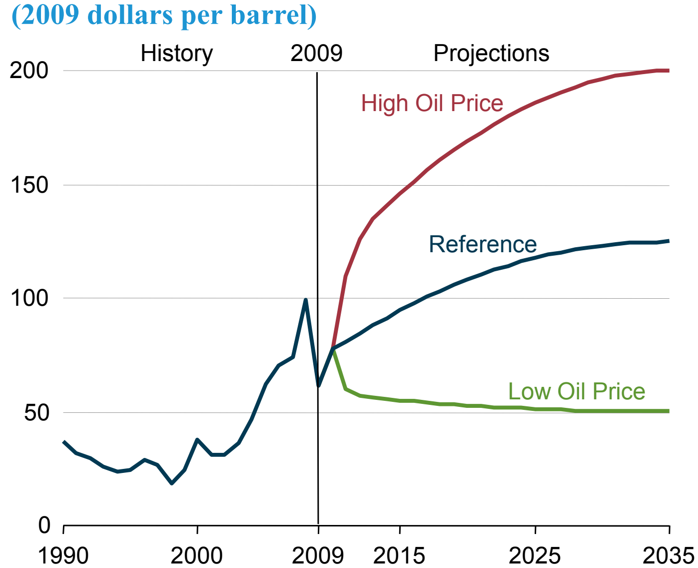
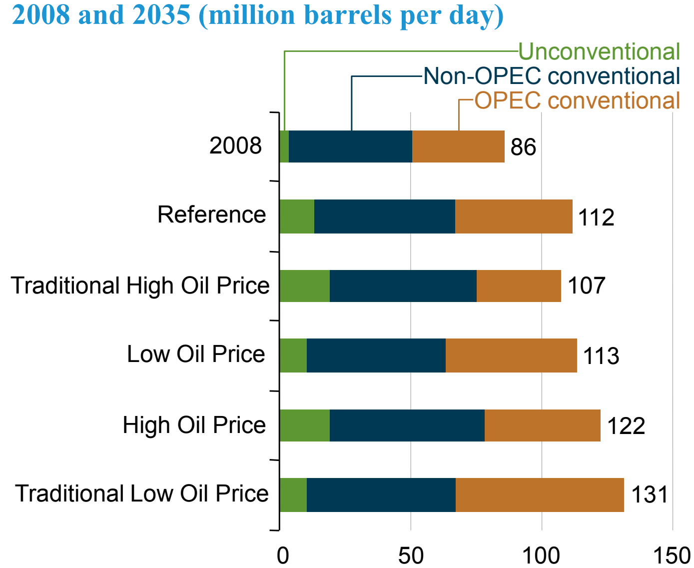


Figure 32. World liquid fuels production in five cases, 2008 and 2035 (million barrels per day)



fiscal or political regimes—account for an increase of 7.1 million barrels per day over the projection, and non-OPEC production of unconventional liquid fuels provides the remaining 8.2 million barrels per day of the increase.

In the High Oil Price case, world oil prices are about $200 per barrel in 2035 ($320 per barrel in nominal terms), with the higher prices resulting from the combination of an outward shift (greater demand at every price level) in the "demand schedule" for liquid fuels in the non-OECD nations and a downward shift (reduced supply at every price level) in the "supply schedule." The shift in the demand schedule is driven by higher economic growth relative to the Reference case in the non-OECD region, with non-OECD growth rates raised by 1.0 percentage point relative to the Reference case in each projection year starting with 2015. The downward shift in the supply schedule is a result of the assumption that several non-OPEC producers further restrict access to, or increase taxes on, production from prospective areas, and that the OPEC member countries reduce their production substantially below current levels. High oil prices encourage the expansion of unconventional production relative to the Reference case.

In the Traditional High Oil Price case, OPEC countries are assumed to reduce their production from the current rate, sacrificing market share, and oil resources outside the United States are assumed to be less accessible and/or more costly to produce than in the Reference case. As in the High Oil Price case, higher oil prices allow unconventional resources to become more economically attractive, and their production increases above the levels in the Reference case. Oil consumption is lower solely due to the higher prices (which are the same as in the High Oil Price case), reflecting a movement upward and to the left along the demand curve.

In the Low Oil Price case, world crude prices are $50 per barrel in 2035 ($82 per barrel in nominal terms), compared with $125 per barrel in the Reference case. The low prices result from the combination of a shift to lower demand at every price level in the demand schedule and a shift to increased supply at every price level in the supply schedule. The shift in demand is driven by lower economic growth in the non-OECD region relative to the Reference case, with non-OECD growth rates lowered by 1.5 percentage points relative to the Reference case in each projection year starting with 2015. The upward shift in the supply schedule in this case results from greater access and more attractive fiscal regimes in prospective non-OECD areas, as well as higher levels of production from OPEC members. However, the lower prices make it uneconomical to expand production of unconventional resources.

In the Traditional Low Oil Price case, the OPEC countries increase their conventional oil production to obtain a 52-percent share of total world liquids production, and oil resources are more accessible and/or less costly to produce (as a result of technology advances, more attractive fiscal regimes, or both) than in the Reference case. With these assumptions, conventional oil production is higher in the Traditional Low Oil Price case than in the Reference case, but low prices constraint the expansion of unconventional resources. Oil consumption is higher solely as a result of the lower prices (which are the same as in the Low Oil Price case), reflecting a movement downward and to the right along the demand curve.

World liquids consumption

World liquids consumption in the *IEO2011* Reference case increases from 85.7 million barrels per day in 2008 to 97.6 million barrels per day in 2020 and 112.2 million barrels per day (225 quadrillion Btu) in 2035. World GDP is a key driver of demand, growing by an average 3.6 percent per year from 2008 to 2020 and 3.2 percent per year from 2020 to 2035. Developing non-OECD nations, particularly in Asia and the Middle East, experience strong economic growth in the Reference case, which is accompanied by increasing demand for liquids in the transportation and industrial sectors.

Rising prices for liquids increase the cost-competitiveness of other fuels, leading many users of liquids outside the transportation sector to switch to substitute sources of energy when possible. As a result, the transportation share of total liquid fuels consumption increases, accounting for about 80 percent of the overall increase in liquids consumption in all sectors over the projection period (Figure 33). In 2035, the transportation sector consumes 60 percent of total liquids supplied, as compared with 54 percent in 2008.

Strong expansion of liquids use is projected for non-OECD countries, fueled by a return to robust economic growth, burgeoning industrial activity, and rapidly expanding transportation use. The largest increase in regional non-OECD consumption from 2008 to 2035 is projected for non-OECD Asia, at 17.3 million barrels per day. Within non-OECD Asia, the largest increases in demand come from China (9.1 million barrels per day) and India (4.6 million barrels per day), with the increase from China being the largest for any single country worldwide. Large consumption increases are also expected in the Middle East (2.9 million barrels per day), followed by Central and South America (2.5 million barrels per day) (Figure 34).

Liquids consumption in OECD regions generally grows more slowly over the next 25 years, reflecting slowly growing or declining populations and relatively low economic growth as compared with non-OECD nations. In addition, growth in demand for liquids in many OECD countries is slowed by government policies and legislation aimed at improving the efficiency of personal motor vehicles. This includes increased

Table 4. World oil prices in four cases, 2009-2035 (2009 dollars per barrel)

	IEO2011			
Year	Reference	Low Oil Price	High Oil Price	*IEO2010* Reference case
2009	62	62	62	**100**
2015	95	55	146	**95**
2020	108	53	169	**109**
2025	118	51	186	**116**
2030	123	50	196	**125**
2035	125	50	200	**134**

automobile efficiency standards and government incentives introduced in many nations during the recession, such as the U.S. "cash for clunkers" program, designed to encourage consumers to trade in older, less efficient cars for newer ones that are more fuel-efficient. In Japan and OECD Europe, liquids consumption declines by average annual rates of 0.4 percent (0.5 million barrels per day) and 0.2 percent (0.7 million barrels per day), respectively, from 2008 to 2035.

As a result of the different growth trends for the non-OECD and OECD regions, non-OECD liquids consumption in 2020 exceeds OECD consumption. The difference widens considerably over time, and in 2035 non-OECD consumption is 23 percent greater than OECD consumption. Although China's demand for liquids increases by 3.5 percent per year over the projection, its consumption in 2035 still is 5.0 million barrels per day less than U.S. liquids consumption.

In the Low Oil Price case, non-OECD consumption and OECD consumption are nearly identical, at 57.0 and 56.3 million barrels per day in 2035, respectively. OECD consumption is higher than in the Reference case, because low prices discourage conservation and allow consumers to continue to use liquid fuels without economic impact. Most of the increase in OECD consumption in the Low Oil Price case occurs in the Americas and in Asia.

In contrast to the OECD, non-OECD consumption is 4.8 million barrels per day lower in the Low Oil Price case than in the Reference Case. In this case, slower growth in demand for liquids among the developing nations keeps world oil prices low—in contrast to the Traditional Low Oil Price case, where low prices encourage increased consumption worldwide. Although OECD liquids consumption levels in 2035 are similar in the Low Oil Price and Traditional Low Oil Price cases, non-OECD consumption grows to a total of 74.4 million barrels per day in 2035 in the Traditional Low Oil Price case—17.4 million barrels per day higher than in the Low Oil Price case and 12.6 million barrels higher than in the Reference case.

In the High Oil Price case, where high oil prices are a result of strong growth in non-OECD demand for liquids, non-OECD liquids consumption represents 61 percent of the world total in 2035. China's consumption of liquids grows by an average of 3.8 percent per year (from 7.8 million barrels per day in 2008 to 21.2 million barrels per day in 2035), as compared with 3.5 percent per year in the Reference case. India and the Middle East also increase consumption by an average of more than 2.0 percent per year. OECD consumption declines slightly through the mid-term and increases only slightly in the longer term, with high world oil prices encouraging consumers to conserve fuel and turn to alternatives fuels whenever possible. OECD liquid fuel use in the High Oil Price case remains below the 2008 level of 48.0 million barrels per day through 2035.

Non-OECD demand, which is higher in the High Oil Price case than in the Reference case, provides support for higher world oil prices. For example, in the High Oil Price case China's liquids consumption in 2035 is equal to U.S. consumption. In contrast, in the Traditional High Oil Price case, demand for liquids in all regions is affected only by price, with high prices dampening liquids demand and encouraging conservation and fuel switching. As a result, liquids consumption in the Traditional High Oil Price case is lower than in the Reference case in every *IEO2011* region. In the Traditional High Oil Price case, non-OECD liquids consumption totals 59.4 million barrels per day in 2035, as compared with 74.2 million barrels per day in the High Oil Price case and 61.8 million barrels per day in the Reference case. OECD liquids consumption in 2035 in the Traditional High Oil Price case is almost the same as in the High Oil Price case.

Recent market trends

In 2010, world oil prices responded primarily to expectations about demand, with producers, consumers, and traders looking for some indication as to when the world's economy would recover, what shape the recovery would take, and how strong the

Figure 33. World liquids consumption by sector, 2008-2035 (million barrels per day)

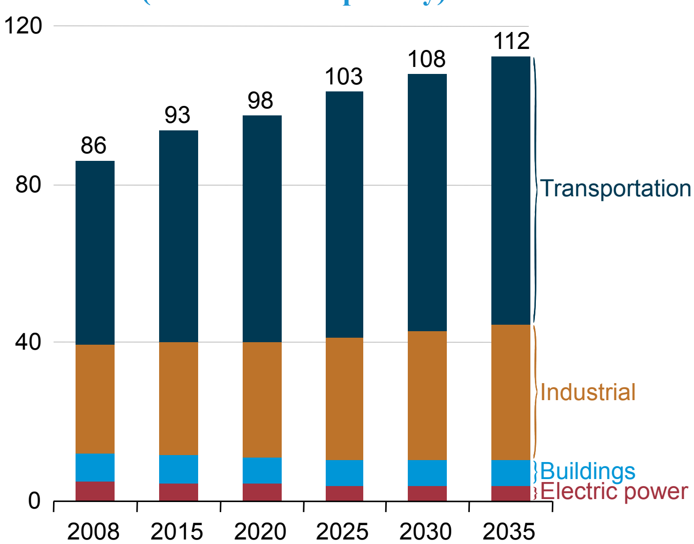
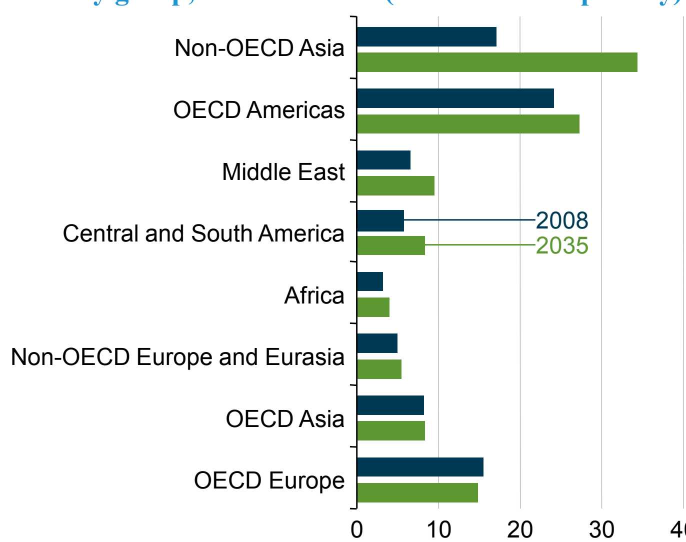


Figure 34. World liquids consumption by region and country group, 2008 and 2035 (million barrels per day)



corresponding increase in oil demand would be. While stronger than expected regional growth led many market players to expect a buoyant return of global liquids demand and an increase in oil prices, the financial crises in several European nations served as a caution about the still fragile global economy and the potential negative impact of higher oil prices on demand.

In addition, 2010 was an eventful year for supply factors that shape long-term pricing. The Deepwater Horizon oil spill in the U.S. Gulf of Mexico may have consequences for future U.S. production that are not yet fully understood. In addition, new discoveries and development in Africa's frontier exploration regions have increased production expectations for the continent and expanded the range of countries with future production potential, which not so long ago was generally limited to a few established producers relying on EOR and deepwater production in Angola and Nigeria [*44*].

In addition, although OPEC compliance[18] with its 2008 production quotas has held relatively steady, averaging under 60 percent for the year, the recent decision by OPEC not to increase official production targets despite rising oil prices, along with public statements by members calling for $80 to $100 per barrel as the new "fair" oil price, has drawn into question the organization's concern for world economic recovery [*45*].

Iraq, the only OPEC member not subject to a production quota, has seen initial production gains at the individual fields included in its two 2009 bid rounds; however, those gains have only compensated for other declines and have not lead to an increase in total production. Although foreign companies in Iraq have been able to establish operations and achieve initial production gains in relatively short order despite ongoing security risks and political uncertainty, most industry analysts still do not expect Iraq to reach its production target of 9.5 million barrels per day—almost four times the country's current production level—within the next decade [*46*].

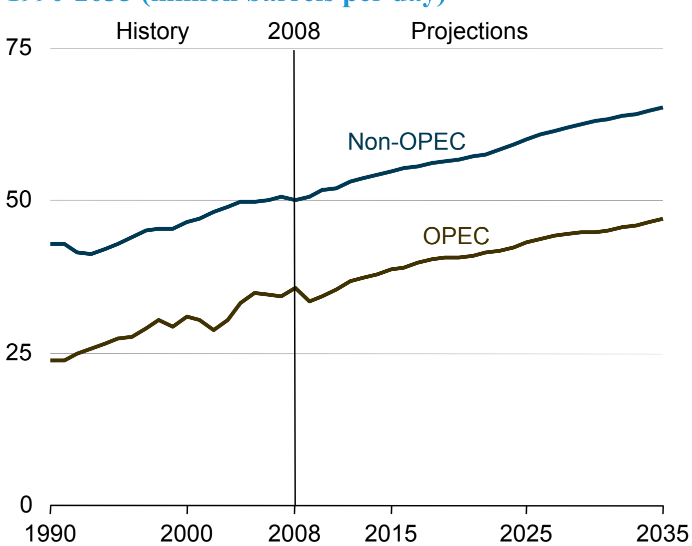
World liquids production

In the *IEO2011* Reference case, world liquids production in 2035 exceeds the 2008 level by 26.6 million barrels per day, with production increases expected for both OPEC and non-OPEC producers (Figure 35). Overall, 57 percent of the total increase is expected to come from non-OPEC areas, including 31 percent from non-OPEC unconventional liquids production alone. OPEC produces 46.9 million barrels per day in 2035 in the Reference case, and non-OPEC producers provide 65.3 million barrels per day.

The Reference case assumes that OPEC producers will choose to maintain their market share of world liquids supply and will invest in incremental production capacity so that their liquids production represents approximately 40 percent of total global liquids production throughout the projection. Increasing volumes of conventional liquids (crude oil and lease condensate, natural gas plant liquids [NGPL], and refinery gain) from OPEC members contribute 10.3 million barrels per day to the total increase in world liquids production from 2008 to 2035, and conventional liquids supplied from non-OPEC nations contribute 7.1 million barrels per day.

Unconventional liquids production increases by about 5 percent annually on average over the projection period, because sustained high oil prices make unconventional liquids more competitive, and "above-ground" factors limit the production of economically competitive conventional liquids.[19] Unconventional fuels account for 35 percent (9.2 million barrels per day) of the increase in total liquids production in the Reference case, and 8.2 million barrels per day of the increase in unconventional supply comes from non-OPEC sources. High oil prices, improvements in exploration and extraction technologies, emphasis on recovery efficiency, and the emergence and continued growth of unconventional resource production are the primary factors supporting the growth of non-OPEC liquids production in the *IEO2011* Reference case.

Figure 35. World total liquid fuels production, 1990-2035 (million barrels per day)



Liquids production modeling approach

The *IEO2011* projections for liquids production are based on a two-stage analytical approach. Production projections before 2015 are based largely on a project-by-project assessment of production volumes and associated scheduling timelines, with consideration given to the decline rates of active projects, planned exploration and development activity, and country-specific geopolitical situations and fiscal regimes. There are often lengthy delays between the point at which supply projects are announced and when they begin producing. The extensive and detailed information available about such projects, including project scheduling and the investment and development plans of companies and countries, makes it possible to take a detailed approach to the modeling of mid-term supply.

[18]Compliance is measured as the actual aggregate reduction in liquids production achieved by quota-restricted members as a percentage of the group's agreed-upon production cut.

[19]"Above-ground" constraints refer to those nongeological factors that could affect supply, including but not limited to government policies that limit access to resources; conflict; terrorist activity; lack of technological advances or access to technology; price constraints on the economic development of resources; labor shortages; materials shortages; weather; environmental protection actions; and short- and long-term geopolitical considerations.

Although some projects are publicized more than 7 to 10 years before their first production, others can come on line within 3 years. For that reason, project-by-project analyses are unlikely to provide a complete representation of company or country production plans and achievable production volumes beyond 3 years into the future. Instead, production decisions made after the mid-term, or 2015, are assumed to be based predominantly on resource availability and the resulting economic viability of production.

In view of the residual effects of previous government policies and the unavoidable lag time between changes in policy and any potential production changes, however, most country-level changes in production trends are noticeable only in 2020 and beyond. Geopolitical and other above-ground constraints are not assumed to disappear entirely after 2015, however. Longstanding above-ground factors for which there are no indications of significant future changes—for instance, the government-imposed investment conditions currently in place in Iran, or OPEC adherence to production quotas—are expected to continue affecting world supplies long after 2015. Even if above-ground constraints were relaxed, the expansion of production capacity could be delayed, depending on the technical difficulty and typical development schedules of the projects likely to be developed in a particular country.

For some resource-rich countries it is assumed that current political barriers to production increases will not continue after 2015. For instance, both Mexico and Venezuela currently have laws that restrict foreign ownership of hydrocarbon resources. Their resource policies have discouraged investment—both foreign and domestic—and hindered their ability to increase or even maintain historical production levels. In the Reference case, both Mexico and Venezuela ease restrictions at some point after 2015, allowing some additional foreign involvement in their oil sectors that facilitates increases in liquids production, including from deepwater prospects in Mexico and extra-heavy oils in Venezuela's Orinoco belt.

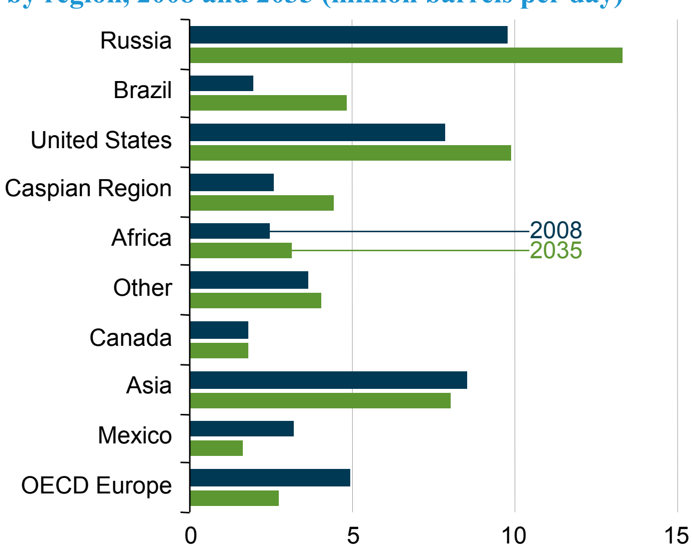
Iraq is another resource-rich country where currently there are significant impediments to investment in the upstream hydrocarbon sector. Liquids production in Iraq dropped substantially after the U.S.-led invasion in 2003. From 2002 to 2003 production declined from 2.0 million barrels per day to 1.3 million barrels per day, and since then it has achieved only inconsistent and slow growth. Although Iraq's production levels are not expected to increase substantially in the near term, it is assumed that political and legal uncertainty eventually will subside, and that renewed investment and development activity will ensue, resulting in significant growth in production from 2015 to 2035.

Non-OPEC production

The return to sustained high oil prices projected in the *IEO2011* Reference case encourages producers in non-OPEC nations to continue investment in conventional liquids production capacity and increase investment in EOR projects and unconventional liquids production. Non-OPEC production increases steadily in the projection, from 50.0 million barrels per day in 2008 to 65.3 million barrels per day in 2035, as high prices attract investment in areas previously considered uneconomical, and fears of supply restrictions encourage some net consuming nations to expand unconventional liquids production from domestic resources, such as coal and crops.

Despite the maturity of most non-OPEC producing basins, conventional liquids production in the Reference case increases from 46.8 million barrels per day in 2008 to 53.9 million barrels per day in 2035. The overall increase results primarily from production increases in four countries: Brazil, Russia, Kazakhstan, and the United States (Figure 36). Among non-OPEC producers, the near absence of prospects for new, large conventional petroleum liquids projects, along with declines in production from existing conventional fields, results in heavy investment in the development of smaller fields. Producers are expected to concentrate their efforts on more efficient exploitation of fields already in production, either through the use of more advanced technology for primary recovery efforts or through EOR. Those efforts are expected to allow most established non-OPEC producers to maintain or slow production declines but not to raise production volumes.

Figure 36. Non-OPEC conventional liquids production by region, 2008 and 2035 (million barrels per day)



In the Reference case, unconventional liquids production from non-OPEC suppliers rises to 6.5 million barrels per day in 2020 and 11.4 million barrels per day in 2035. In both the High Oil Price and Traditional High Oil Price cases, non-OPEC unconventional liquids production rises to about 17.4 million barrels per day in 2035, as significantly higher prices encourage the development of alternative fuel sources to the limits imposed by expected environmental protection measures and industry expansion in general. In contrast, in the Low Oil Price and Traditional Low Oil Price cases, fewer unconventional resources become economically competitive, and non-OPEC production of unconventional liquids rises to only about 7.0 million barrels per day in 2035 in each low price case.

Major areas of decline in non-OPEC liquids production

In the *IEO2011* Reference case, Mexico and the North Sea are the only non-OPEC production areas that lose more than 1 million barrels of liquids production per day from 2008 to 2035. The most significant decline in non-OPEC liquids production is projected for OECD Europe, with a decrease from 5.1 million barrels per day in 2008 to 3.0 million barrels per day in 2035. Most of the decline is in North Sea production, which includes offshore operations by Norway, the United Kingdom, the Netherlands, and Germany. Over time, fewer and fewer prospects capable of compensating for declines in existing fields have been discovered. The drop in North Sea liquids production does not vary significantly among the four price cases, both because the projected production is based on depletion of resources and because all the countries currently producing liquids from North Sea operations are expected to continue encouraging investment and providing open access to development.

In Mexico, liquids production sinks to approximately 1.4 million barrels per day in 2025 before rebounding slowly to 1.7 million barrels per day in 2035, still 1.5 million barrels per day below the 2008 production volume of 3.2 million barrels per day. The rebound after 2025 depends entirely on the development of potential resources in the deepwater Gulf of Mexico, which must begin some years in advance of any increase in production levels. The outlook for Mexico's liquids production is markedly different from the *IEO* projection just 5 years ago, in which production did not fall below 2.9 million barrels per day, and a long-term recovery began in 2013. The difference between the projections is the result of production declines at Cantarell, which have been more severe than expected, as well as diminished expectations for Chicontepec production and more pessimistic assumptions about the level of future investment, both foreign and domestic, in Mexico's deepwater production.

Although the shortage of investment in Mexico is expected to lead to a mid-term decline, Mexico has potential resources to support a long-term recovery in total production, primarily in the Gulf of Mexico. The extent and timing of a recovery will depend in part on the level of economic access granted to foreign investors and operators. Mexico's national oil company, Petróleos Mexicanos (PEMEX), currently does not have the technical capability or financial means to develop potential deepwater projects in the Gulf of Mexico.

Major areas of growth in non-OPEC liquids production

The largest increase in non-OPEC total liquids production is expected for Brazil, where total production in 2035 is 4.1 million barrels per day above the 2008 level of 2.4 million barrels per day. Of that increase, 2.9 million barrels per day is attributed to conventional liquids production. The strong growth in Brazil's conventional production results in part from short- and mid-term increases at producing fields for which expansions currently are either planned or in progress. In addition, recent and expected discoveries in the Campos and Santos basins, including the massive Tupi and related Guara and Iara discoveries, both add to production in the mid- and long term and suggest the presence of other large fields in the same formation [*47*]. The vast size of the sub-salt potential in Brazil, as well as national economic strategy and industrialization goals, has led Brazil to pursue new petroleum legislation [*48*]. The legislative change most pertinent to production potential is the requirement that the state oil company, Petrobras, be the sole operator and a minimum 30-percent equity holder for all sub-salt fields.

Although Petrobras has repeatedly proven itself a leader in deepwater development and is known to have the technical capabilities to develop sub-salt prospects, it is not expected to have the resources (financial, labor, etc.) to develop its domestic plays completely on its own. The different *IEO2011* price cases assume different investment terms offered by Brazil to foreign investors and hence different rates of sub-salt development. Although both the High Oil Price case and the Traditional High Oil Price case assume more restrictive terms of access to Brazil's conventional resources, the increase in world liquids demand in the High Oil Price cases supports a production level of 5.3 million barrels per day in 2035, compared with 5.0 million barrels per day in the Traditional High Oil Price case. In contrast, both the Low Oil Price and Traditional Low Oil Price cases assume open terms of access to Brazil's conventional resources, resulting in production increases averaging 3.4 percent per year and conventional production of 5.1 million barrels per day in 2035 in the Low Oil Price case (as a result of lower world liquids demand) and 5.6 million barrels per day in 2035 in the Traditional Low Oil Price case.

In addition to the growth in conventional liquids production, Brazil's biofuel production also increases, from 0.5 million barrels per day in 2008 to 1.7 million barrels per day in 2035 in the Reference case. The growth is a result of steadily increasing yields and expansion of crop production, with most of the increase consisting of ethanol. Brazil's major ethanol production is derived from sugar cane, currently the highest yielding and least expensive feedstock for ethanol. Brazil also has a large amount of land available for sugar cane production, in the form of previously cleared and currently underutilized pasture land. The country's domestic consumption is not expected to rise as fast as its expansion of ethanol production, making Brazil a net ethanol exporter over the course of the projection. Thus, its production depends largely on other countries' policies and demand for ethanol.

In the High Oil Price case, Brazil's ethanol production totals 1.9 million barrels per day in 2035, reflecting higher demand for ethanol both at home and abroad. In the Low Oil Price case, which assumes reduced domestic and international demand for ethanol, Brazil's ethanol production totals 1.1 million barrels per day in 2035. Even in the Low Oil Price case, however, there is only a small drop in Brazil's domestic ethanol consumption, because of the country's mandatory minimum E25 blend and the fact that ethanol makes up nearly 50 percent of the country's domestic gasoline market [*49*].

The second-largest contributor to future increases in non-OPEC total liquids production is the United States. U.S. conventional liquids production grows from 7.8 million barrels per day in 2008 to 9.9 million barrels per day in 2035 in the Reference case, as rising world oil prices spur both onshore and offshore drilling. In the short term, the vast majority of the increase in crude oil production comes from deepwater offshore fields. Fields that started producing in 2009, or that are expected to start producing in the next few years, include Great White, Norman, Tahiti, Gomez, Cascade, and Chinook. All are in water depths greater than 2,600 feet, and most are in the U.S. Central Gulf of Mexico. Production from those fields, combined with increased production from fields that started producing in 2007 and 2008, contributes to the near-term growth in U.S. offshore production. The reduction in crude

Is Brazil the world's next major oil producer?

In 2007, a consortium led by Petrobras, Brazil's national oil company, discovered the Tupi field in the Santos Basin off the coast of Brazil. The field, now known as a "pre-salt deposit," was found 18,000 feet below the ocean surface underneath a 6,000-foot layer of salt. Tupi and other pre-salt finds hold the potential to make Brazil one of the world's most prolific oil exporters. Although Brazil already produces 2.1 million barrels per day of crude oil and lease condensate, it did not become a net exporter until 2009. In the next decade, Brazil aspires to more than double its conventional production and significantly expand its oil exports.

According to *Oil & Gas Journal*, Brazil's proven oil reserves are estimated currently at 12.9 billion barrels, not including major pre-salt fields. Estimates of Brazil's pre-salt reserves have varied widely. In 2008, Haroldo Lima, Director General of Brazil's National Petroleum Agency, stated that the country's pre-salt deposits could contain between 50 and 70 billion barrels of oil [*50*]. More recently, in January 2011, Petrobras announced its assessment that the Tupi and Iracema fields (renamed Lula and Cernambi) contain 6.5 billion and 1.8 billion barrels of commercially recoverable oil, respectively [*51*]. It will be some time before the Brazil's pre-salt reserves are fully quantified, but knowledge of exact reserve levels is not critical to assessing the viability of Brazil's proposal to expand their production in the coming years.

In its 2010-2014 business plan, Petrobras outlined production targets of 3.0 million barrels per day in 2014 and 4.0 million barrels per day in 2020. In the plan, more than one-quarter of the company's Brazilian production in 2020 comes from pre-salt fields [*52*]. In the *IEO2011* Reference case, Brazil's conventional liquids production increases to 3.3 million barrels per day in 2020 and 4.9 million barrels per day in 2035; and its total liquids supply, including unconventional liquids such as ethanol and biodiesel, increases to 6.6 million barrels per day in 2035. The projections reflect a somewhat more conservative view of the pace of expansion, given the financial, regulatory, and operational challenges that Petrobras will need to overcome in order to realize the full potential of Brazil's pre-salt resources.

Financing the development of pre-salt oil fields will be expensive. One analyst has suggested that Brazil's current undertaking could be "the largest private sector investment program in the history of mankind [*53*]." The Petrobras business plan includes investments of $224 billion between 2010 and 2014, more than half of which will be spent on exploration and production activities. To facilitate the plan, the company raised $67 billion in the world's largest initial public offering ever in September 2010. However, most of the capital came in the form of a reserves-for-shares swap with the Brazilian government [*54*]. Petrobras will need to fund the majority of its investments through operating cash flow. The increase in the government's equity points to an expansion of state involvement in the petroleum sector.

The government's capitalization of Petrobras was part of a set of laws passed in 2010 to regulate development of Brazil's pre-salt reserves. The legislation also established a new federal agency (Petrosal) to administer pre-salt production and set up a fund to align the expenditure of pre-salt revenues with Brazil's development goals. Most importantly in terms of Brazil's investment climate, the law changed the country's concession-based system for exploration to a production-sharing agreement (PSA) system. Under the PSA system, Petrobras will hold at least a 30-percent share of each project and be the operator [*55*]. Some analysts fear that the new system will reduce foreign interest in investing in Brazil and overburden Petrobras. The re-launch of Brazil's latest bid round for oil exploration blocks is scheduled for 2011, pending settlement of a dispute over the distribution of pre-salt royalties among Brazilian states. The results of the bid round will highlight the full impact of the legislative changes on the development of pre-salt resources [*56*].

Development of pre-salt deposits represents a daunting task, with considerable technological uncertainty about how the geologic formations will behave once production has begun. In addition, the reserves are located more than 150 miles off Brazil's coast, making them difficult for pipelines and people to reach. Petrobras plans to purchase 45 floating production, storage, and offloading (FPSO) vessels to extract the pre-salt oil; however, only 75 such rigs currently exist in the world [*57*].

In addition to massive investments in physical capital, the planned expansion of Brazil's production will require additional human capital. Petrobras plans to train 243,000 technical professionals to work in the petroleum industry in the coming decade and to invest hundreds of millions of dollars in oil-related research and development centers at Brazilian universities [*58*]. Given the scale of the task, the predominant role played by Petrobras, and local-content requirements, operational challenges introduce a nontrivial amount of uncertainty into projections of Brazil's liquids production.

Brazil's pre-salt discoveries represent some of the most promising oil finds, and its role as an oil producer will grow in the coming decades. The extent of that expansion is uncertain, however, given the financial, regulatory, and operational challenges involved in such a large-scale undertaking.

oil production resulting from the current moratorium on deepwater drilling in the Gulf of Mexico is estimated to average about 31,000 barrels per day in the fourth quarter of 2010 and about 82,000 barrels per day in 2011, but production levels are expected to recover in the mid-term. Production from other recently discovered and yet-to-be discovered fields offsets production declines in older fields in the projection, resulting in a net increase in liquids production through 2035.

U.S. lower 48 onshore production of crude oil continues to grow through 2035, primarily as a result of increased application of EOR techniques. In 2035, EOR accounts for 37 percent of total onshore production in the Reference case. The rate of growth in domestic crude oil production depends largely on assumptions about world oil prices and improvements in technology, because remaining onshore resources typically require more costly secondary or tertiary recovery techniques. On the other hand, if carbon dioxide emissions were captured and sequestered in the future, the availability of relatively plentiful and inexpensive supplies of carbon dioxide could spur additional EOR activities that would make onshore production more economical.

U.S. unconventional liquids production becomes more significant as world oil prices rise, with domestic production of biofuels increasing from 0.7 million barrels per day in 2008 to 2.2 million barrels per day in 2035 in the Reference case. Although advances in coal liquefaction technology have made CTL fuels commercially available in other countries, including South Africa, China, and Germany, the technical and financial risks of building what would be essentially a first-of-a-kind facility in the United States have discouraged significant investment thus far. In addition, the possibility of new legislation aimed at reducing U.S. greenhouse gas emissions creates further uncertainty for future investment in CTL. Similarly, although ongoing improvement in oil shale technology leads to the start of commercial production in 2029 in the Reference case and a rapid increase to 1.1 percent of total U.S. liquids supply in 2035, oil shale development also would have to overcome environmental, technical, and financial uncertainties similar to those for CTL.

Canada's production of conventional liquids declines slowly in the Reference case, by a total of just under 20 thousand barrels per day from 2008 to 2035. However, increased production of unconventional petroleum liquids from oil sands more than offsets the decline in conventional production. As a result, Canada's total liquids production increases from 3.4 million barrels per day in 2008 to 6.6 million barrels per day in 2035.

Russia and Kazakhstan are the other key players in non-OPEC production growth. However, the non-OECD Europe and Eurasia region is prone to territorial disputes, transportation blockages, contractual changes, and political intervention. After declining to 9.0 million barrels per day in 2014, Russia's liquids production begins a slow increase to 11.4 million barrels per day in 2020 in the Reference case, as uncertainty about tax regimes lessens. In addition, annual increases in the world oil price in the *IEO2011* Reference case spur liquids development that boosts Russia's production to 13.3 million barrels per day in 2035. Although exploration in eastern Siberia and the Arctic is expected during the projection period, Arctic exploration does not contribute much to production in the Reference case. Across the five *IEO2011* scenarios that assume different levels of economic access granted to investors in the long term, Russia's total liquids production in 2035 ranges from 13.3 to 15.3 million barrels per day. In the Low Oil Price case, as access to resources is opened up, production in 2035 totals 14.1 million barrels per day—more than in the Reference case but less than in the Traditional Low Oil Price case, because worldwide demand for liquids is lower.

In Kazakhstan, mid-term growth in liquids production depends predominantly on the resources of the Kashagan and Tengiz oil fields, as well as the ability of investors to transport production from those projects to the world market. Although known and potential resources are sufficient to support the growth of liquids production in Kazakhstan, they could be undermined by a lack of easy export routes. Currently, exports are limited to six routes: the CPC pipeline, Atyrau-Samara pipeline, and railway shipments can transport a total of 0.8 million barrels per day to Russia; another pipeline can move 0.2 million barrels per day to China; and two barge routes allow shipments of about 0.1 million barrels per day to Azerbaijan and Iran.

Kazakhstan's export potential is affected strongly by its geographical position. Attaining the production levels projected in the Reference case depends not only on resource availability and production but also on the construction of export routes—a task requiring regional cooperation that has not been easy to achieve in the past. A number of possible projects to expand Kazakhstan's capacity for liquids exports have been proposed over the past several years. The most likely expansions in the near term are capacity increases in the pipelines to Russia and China [*59*].

In addition to the problem of transportation capacity, Kazakhstan has previously reopened legal contracts with private foreign investors, forcing renegotiation of investment returns and making companies reluctant to increase their investment in the country's energy sector. Across the five *IEO2011* oil price cases (including the Reference case), Kazakhstan's production in 2035 ranges from a low of 3.1 million barrels per day to a high of 3.5 million barrels per day.

OPEC production

In the *IEO2011* Reference case, total liquids production from OPEC nations increases from the 2008 level of 35.6 million barrels per day at an average annual rate of 1.0 percent, resulting in the production of 46.9 million barrels of liquids per day in 2035. Of the total OPEC increase, 11.0 million barrels per day originates in the Middle East (Figure 37).

Throughout the projection period, Saudi Arabia remains the largest liquids producer in OPEC, with total production increasing from 10.7 million barrels per day in 2008 to 15.4 million barrels per day in 2035, as prices stabilize at historically high levels and world consumption continues to grow. Seventeen percent of the increase (0.8 million barrels per day) is expected to be NGPL production related to expansion of natural gas production. The total production increase equates to an average annual growth rate of 1.4 percent, based on the assumption that Saudi Arabia will continue with its current plan to maintain spare production capacity at levels between 1.5 and 2.0 million barrels per day.

Iraq increases its liquids production by 3.7 percent per year in the *IEO2011* Reference case, the largest annual average growth in total liquids production among all OPEC members. The projection assumes that political, legislative, logistical, investment, and security uncertainties in Iraq will be resolved in the long term, and that OPEC constraints and resource availability will be the factors with the strongest influence on Iraq's willingness and ability to increase production.

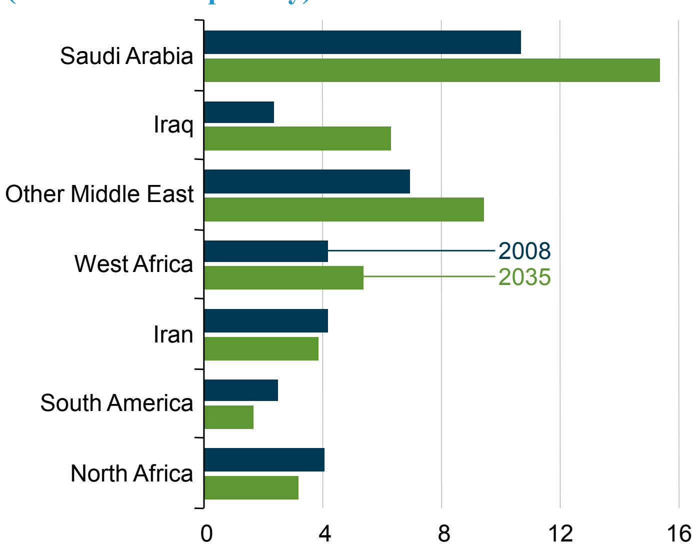
In addition to political and legislative uncertainty, import and export infrastructure also are expected to limit production growth in Iraq to 0.6 million barrels per day from 2008 to 2015. If the country is able to achieve long-term political and economic stability and expand the capacity of import and export routes as projected in the Reference case, investment in production capacity could rise by an average of 4.2 percent per year from 2015 and 2030 before slowing to a more modest 3.0 percent per year from 2030 to 2035. The fact that Iraq has the resources necessary to support such growth in the long run, yet produced only 2.4 million barrels per day in 2008, illustrates the significant impacts that the political environment and other above-ground constraints can have on production projections.

Qatar has the second-highest average annual growth rate in total liquids production among OPEC nations from 2008 to 2035 in the Reference case, at 2.7 percent, with total volumes increasing from 1.2 million barrels per day in 2008 to 2.5 million barrels per day in 2035. About 55 percent of the increase consists of crude oil and lease condensate production; NGPL production contributes another 0.3 million barrels per day; and GTL projects add just over 0.2 million barrels per day. Despite the current negative outlook for many previously announced GTL projects around the world, the return and persistence of historically high oil prices in the Reference case supports the operation of Qatar's Pearl facility (0.1 million barrels per day capacity) and expansion of its Oryx facility (adding another 0.1 million barrels per day).

Total liquids production in Iran is restricted by political rather than resource-related factors in the *IEO2011* Reference case. The political factors include the effectiveness of the national oil company's operations, the ability of the government and foreign investors to agree on contractual terms, and continuing financial sanctions. In the Reference case, Iran's oil production declines from 2008 through 2035 because of both financial and political constraints on the development of new oil and natural gas prospects. In addition, the amount of natural gas available for improving oil recovery through natural gas reinjection is limited in the projections by natural gas demand for domestic electric power and heat production. Political factors and investment constraints affect Iran's liquids production so severely that production in 2035 varies by 3.5 million barrels per day across the *IEO2011* projections, from 2.7 million barrels per day in the Traditional High Oil Price case to 6.3 million barrels per day in the Traditional Low Oil Price case.

In the OPEC nations of Western Africa, total liquids production increases from 4.2 million barrels per day in 2008 to 5.4 million barrels per day in 2035 in the Reference case. Angola expands production to 2.3 million barrels per day in 2020—almost entirely by increasing crude oil and condensate production from offshore projects—before entering a slow but steady resource-driven decline in the long term. Nigeria's liquids production is likely to be hampered in the short term by conflict and infrastructure difficulties; in the long term, however, a higher level of known resources enables its liquids production to grow by an average of 1.7 percent per year, from 2.2 million barrels per day in 2008 to a total of 3.4 million barrels per day in 2035.

Figure 37. OPEC conventional liquids production by country and region, 2008 and 2035 (million barrels per day)



Recent history suggests that Venezuela's national government reacts to high oil prices by tightening the terms for foreign direct investment and limiting access to its reserves. As a result, in the Reference case, with prices rising in real terms through 2035, further mandated changes in contractual terms, along with threats of actions to recapture upside returns from potential investors, are likely to hinder Venezuela's production potential in the short term and discourage investment in and development of additional projects in the long term. The trend is particularly evident in the mature conventional oil basins, with conventional production declining by 0.3 million barrels per day over the projection period from 2008 levels of 2.0 million barrels per day. However, development of several extra-heavy oil projects in the Orinoco belt offsets some of the decline in conventional liquids production.

Ecuador rejoined OPEC in October 2007, after having suspended its membership in 1999. Ecuador is a relatively small oil producer in comparison with other OPEC members, producing 0.5 million barrels of oil per day in 2008. Liquids production in Ecuador declines through 2015 in the Reference case, as uncertainties associated with the country's Hydrocarbons Law make foreign companies reluctant to investment in Ecuador's oil sector [*60*]. After 2015, although investment in the country's oil sector continues to be hindered by high investment risk, development of its ITT heavy oil field in the Amazon helps to stabilize its production. Consequently, liquids production in Ecuador rebounds to 0.7 million barrels per day in 2025 and remains fairly flat through 2035.

OPEC investment decisions regarding additional new production capacity are the primary difference between the Traditional High and Traditional Low Oil Price cases. In the *IEO2011* High and Low Oil Price cases, non-OECD demand is also an important market determinant. In the Low Oil Price case, OPEC production increases to 53.7 million barrels per day in 2035, representing a 47-percent share of total world liquids production. The Low Oil Price case assumes that OPEC members will increase investment either through their own national oil companies or by allowing greater economic access to foreign investors, depending on the country. It also assumes that OPEC members will expand production capacity in an attempt to maximize government revenue through increased production. OPEC production in the Traditional Low Oil Price case increases by 32.4 million barrels per day from 2008 to 2035, to 68.0 million barrels per day or approximately 52 percent of total world liquids production in 2035.

In the High Oil Price case, high demand and high prices encourage development of expensive non-OPEC resources. As a result, OPEC supports only a 37-percent market share of total world liquids production, with a production level of 45.7 million barrels per day in 2035, less than the Reference case level of 46.9 million barrels per day. Alternatively, in the Traditional High Oil Price case, OPEC member countries maintain record high prices by restricting production targets to a smaller share of world total liquids production each year. As a result, OPEC production accounts for 32 percent of the world total in 2035. Production totals 34.8 million barrels per day in 2025, and after 2026 it begins a slight decline to 34.1 million barrels per day in 2035.

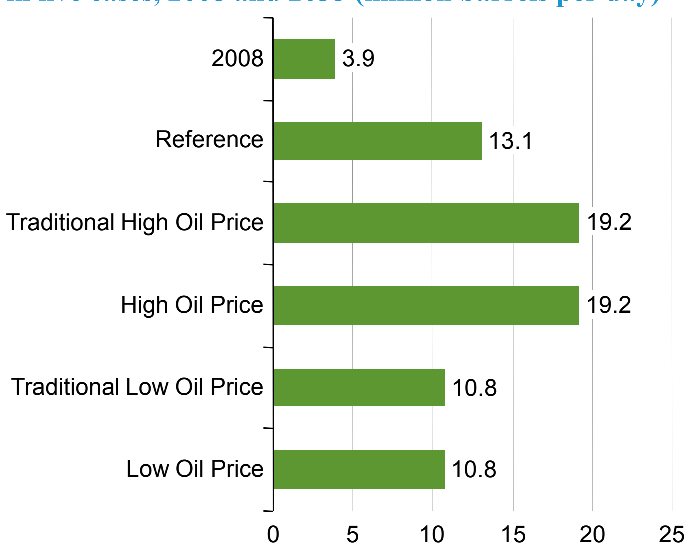
Unconventional liquids production

Unconventional liquids play an increasingly important role in meeting demand for liquid fuels over the course of the *IEO2011* projections. In the Reference case, 12 percent of world liquids supply in 2035 comes from unconventional sources, including 1.7 million barrels per day from OPEC and 11.4 million from non-OPEC sources. Although the volume and composition of unconventional production vary across the *IEO2011* price cases (from 19.2 million barrels per day in the Traditional High Oil Price case to 10.8 million barrels per day in the Low Oil Price case), the geographic origin of each unconventional liquid type is relatively constant across the cases, usually being limited to countries where projects currently are underway or advertised. Because world oil prices largely determine whether relatively expensive unconventional supplies are developed, there is little difference between the volumes of unconventional resources supplied in the Low Oil Price case and in the Traditional Low Oil Price case. The same is true of the two high oil price cases (Figure 38).

OPEC unconventional production

OPEC's unconventional production consists predominantly of extra-heavy oil production in Venezuela (from the Orinoco belt) and GTL production in Qatar. In the *IEO2011* Reference case, Venezuela's extra-heavy oil production rises from 0.7 million barrels per day in 2008 to 1.4 million barrels per day in 2035, and Qatar's GTL production increases from a negligible amount in 2008 to 0.2 million barrels per day in 2035. Although the resources to support production at those levels abound in the two countries, large investments will be required to bring them to market, and the timing of such investment is uncertain.

Figure 38. Unconventional liquids production in five cases, 2008 and 2035 (million barrels per day)



There are four major projects currently operating in Venezuela's Orinoco belt, but they have been suffering from poor maintenance and lack of investment. Venezuela's ability to increase its extra-heavy oil production will depend on the level of foreign investment and expertise it is able to attract for extraction and upgrading projects. In the Reference case, only two Orinoco belt projects are developed over the course of the projection—Junín 4 (operated by a consortium of Chinese companies) and Junín 6 (operated by a consortium of Russian companies). The two projects add 0.4 million barrels per day of production capacity each.

In the Low Oil Price case, Venezuela improves contract terms and stabilizes its investment climate to attract more foreign investment in the development of Orinoco resources, including Junín 2 and the Carabobo area, which contribute 0.2 and 1.2 million barrels per day, respectively. In addition, several other development projects are undertaken in the long term.

Non-OPEC unconventional production

Outside OPEC, unconventional liquids production comes from a much more diverse group of countries and resource types. As a whole, non-OPEC unconventional liquids production in the *IEO2011* Reference case increases by 8.2 million barrels per day, from 3.2 million barrels per day in 2008 to 11.4 million barrels per day in 2035. OECD countries account for 71 percent of total non-OPEC unconventional liquids production in 2035. By volume, the countries making the largest contribution to the increase in non-OPEC unconventional liquids are Canada (an increase of 3.3 million barrels per day), the United States (2.3 million barrels per day), Brazil (1.2 million barrels per day), and China (0.9 million barrels per day).

In each of the five oil price cases, Canada's bitumen (oil sands) production makes up more than 40 percent of total non-OPEC unconventional production, ranging from 3.1 million barrels per day in the Low Oil Price and Traditional Low Oil Price cases to 6.5 million barrels per day in the High Oil Price and Traditional High Oil Price cases. Bitumen production in the two high price cases ramps up quickly in the short to mid-term then begins to slow in the long term, closely following the assumed world oil price path in high price cases. In the low oil price cases, production growth stagnates because the price is too low for new projects to be economical. Over time, however, reductions in the cost of the technology lead to an overall increase in production.

Biofuels production in the Reference case increases from 1.5 million barrels per day in 2008 to 4.7 million barrels per day in 2035, at an average annual growth rate of 4.3 percent. The largest increase in biofuels production over the projection period comes from the United States, where production grows by 1.6 million barrels per day, from 0.7 million barrels per day in 2008 to 2.2 million barrels per day in 2035. The growth in U.S. biofuels production is supported by the Energy Independence and Security Act of 2007, which mandates increased use of biofuels. Strong growth in biofuels consumption is also projected for Brazil, where production grows by 1.2 million barrels per day from 2008 to 2035.

Government policies provide the primary incentive for non-OPEC biofuels production. Biofuels are used as a means to reduce greenhouse gas emissions, promote energy security, and support local economic development. To achieve those goals, many countries set mandates for the amount of biofuels to be used and give tax credits to biofuel producers. The United States, for example, mandates 36 billion gallons of biofuels by 2022 under the Energy Independence and Security Act of 2007. The European Union mandates that biofuels must make up 10 percent of the liquid fuels market by 2020, according to the European Union Biofuels Directive [*61*]. Canadian producers receive payments or operating grants based on output, and the Chinese government has a flexible subsidy scheme with payments based on plant profitability [*62*]. The Canadian and Chinese tax credits are designed to expire over time as the cost of production falls and oil prices rise.

Despite the wide range of biofuels incentive programs, some recent studies suggest that biofuels may not be as effective in reducing greenhouse gas emissions as previously thought. As a result, many countries have relaxed or postponed renewal of their mandates. For example, Germany reduced its biofuels quota for 2009 from 6.25 percent to 5.25 percent [*63*]. The global economic recession has also dampened investment in biofuels development. Consequently, world biofuels production in 2030 is 40 percent lower in the *IEO2011* Reference case than was projected in the *IEO2009* Reference case and essentially the same as in the *IEO2010* Reference case.

In the *IEO2011* oil price cases, as in the Reference case, biofuels become more competitive with conventional oil products over time; however, the level of competitiveness depends on the oil price assumption. In the low price cases, only the cheapest and most cost-effective feedstocks and production technologies are competitive with gasoline and diesel fuels. In the high price cases, more feedstocks and production processes are competitive. Total biofuel production in 2035 ranges from 3.5 million barrels per day in the Low Oil Price case to 6.2 million barrels per day in the Traditional High Oil Price case. The growth of biofuel production slows in all cases from 2008 to 2015, as the current generation of crops reach their economic potential, then accelerates after 2016 with the advent of new technologies that use cellulosic feedstocks.

China is the primary CTL producer in all the *IEO2011* cases, with 2035 production levels ranging from 0.2 million barrels per day (or 50 percent of the world total) in the two low oil price cases to 2.1 million barrels per day (51 percent of the world total) in the two high oil price cases. Other major producers are the United States and South Africa, which produce about 0.5 and 0.3 million barrels per day, respectively, in the Reference case; 1.6 and 0.3 million barrels per day in the High Oil Price and Traditional High Oil Price cases; and about 0.1 million barrels per day each in the Low Oil Price and Traditional Low Oil Price cases.

The unconventional liquid product that consistently contributes the least to total unconventional production in each of the *IEO2011* cases is GTL. In the Reference case and the two low oil price cases, GTL production is limited primarily to Qatar, although South Africa and Nigeria also produce small volumes. In the two high oil price cases, the United States rapidly becomes the world's third-largest GTL producer, accounting for 96 thousand barrels per day of the world's total of 400 thousand barrels per day in 2035.[20]

World oil reserves

As of January 1, 2011, proved world oil reserves, as reported by the *Oil & Gas Journal*,[21] were estimated at 1,471 billion barrels—115 billion barrels (about 9 percent) higher than the estimate for 2010 [*64*]. According to the *Oil & Gas Journal*, 51 percent of the

[20]For a discussion of GTL prospects in the United States, see EIA's *Annual Energy Outlook 2010*, pages 39-40.

[21]Reported reserves from *Oil & Gas Journal* were adjusted for the United States using the most recent estimates released by the U.S. Energy Information Administration (in late December 2010).

world's proved oil reserves are located in the Middle East (Figure 39). Just under 79 percent of the world's proved reserves are concentrated in eight countries, of which only Canada (with oil sands included) and Russia are not OPEC members (Table 5).

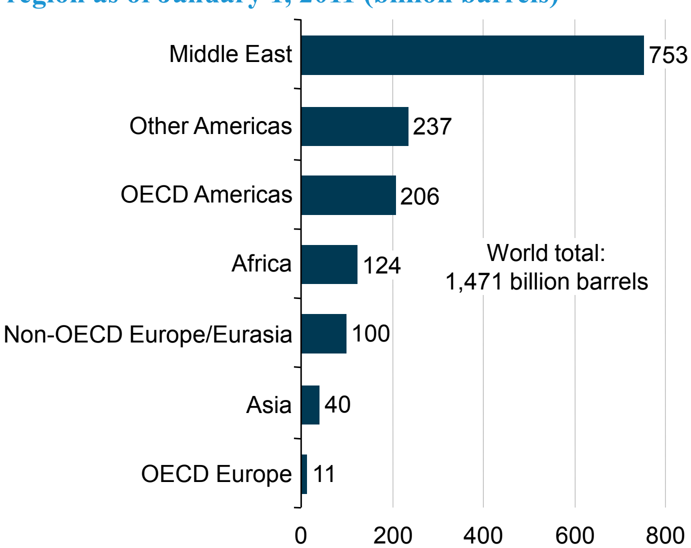
In 2011, the largest increase in proved reserves by far was attributed to Venezuela, as the country now reports its Orinoco belt extra-heavy oil in its totals [65]. As a result, Venezuela's reserves alone increased by 113 billion barrels from 2010 to 2011. Smaller but notable increases were reported for Libya, Uganda, and Ghana. Libya's proved reserves increased by almost 2 billion barrels (4 percent). Uganda, which previously did not report any oil reserves, now claims 1.0 billion barrels. Ghana's recent discoveries of the Jubilee, Tweneboa, and Owo fields, among others, raised its reserves from 15 million barrels in 2010 to 660 million barrels in 2011. The largest decreases in regional reserves were attributed to Europe, including notable declines for Norway, Denmark, and the United Kingdom, which in combination saw a 14-percent decline (1,485 billion barrels) in reserves from 2010 to 2011. Although several OPEC member countries in late 2010 reported large additions to reserves, the *Oil & Gas Journal* chose not to include the new figures, citing the "politics involved in reserves estimates as they relate to output targets" within OPEC [66].

Country-level estimates of proved reserves from the *Oil and Gas Journal* are developed from data reported to the U.S. Securities and Exchange Commission (SEC), from foreign government reports, and from international geologic assessments. The estimates are not always updated annually. Proved reserves of crude oil are the estimated quantities that geological and engineering data indicate can be recovered in future years from known reservoirs, assuming existing technology and current economic and operating conditions.

Companies whose stocks are publicly traded on U.S. stock markets are required by the SEC to report their holdings of domestic and international proved reserves, following specific guidelines. In December 2008, the SEC released revisions to its reserves reporting requirements in an attempt to provide investors with a more complete picture of the reserves held by reporting companies, by recognizing the technologies and reserve quantification methods that have evolved over time. Proved reserves include only estimated quantities of crude oil from known reservoirs, and therefore they are only a subset of the entire potential oil resource base. Resource base estimates include estimated quantities of both discovered and undiscovered liquids that have the potential to be classified as reserves at some time in the future. The resource base may include oil that currently is not technically recoverable but could become recoverable in the future as technologies advance.

Readers may notice that, in some cases in the *IEO2011* projections, country-level volumes for cumulative production through 2035 exceed the estimates of proved reserves. This does not imply that resources and the physical limits of production have not been considered in the development of production forecasts, or that the projections assume a rapid decline in production immediately after the end of the projection period as reserves are depleted. EIA considers resource availability in all long-term country-level projections, the aggregation of which gives the total world production projection. However, proved reserves are not an appropriate measure for judging total resource availability in the long

Figure 39. World proved oil reserves by geographic region as of January 1, 2011 (billion barrels)



Source: *Oil & Gas Journal.*

Table 5. World oil reserves by country as of January 1, 2011 (billion barrels)

Country	Oil reserves	Percent of world total
Saudi Arabia	260.1	17.68
Venezuela	211.2	14.35
Canada	175.2	11.91
Iran	137.0	9.31
Iraq	115.0	7.82
Kuwait	101.5	6.90
United Arab Emirates	97.8	6.65
Russia	60.0	4.08
Libya	46.4	3.16
Nigeria	37.2	2.53
Kazakhstan	30.0	2.04
Qatar	25.4	1.73
United States	20.7	1.41
China	20.4	1.38
Brazil	12.9	0.87
Algeria	12.2	0.83
Mexico	10.4	0.71
Angola	9.5	0.65
Azerbaijan	7.0	0.48
Ecuador	6.5	0.44
Rest of world	74.9	5.09
World total	**1,471.2**	**100.00**

Source: *Oil & Gas Journal.*

run. For example, despite continued production, global reserves historically have not declined as new reserves have been added through exploration, discovery, and reserve replacement.

In order to construct realistic and plausible projections for liquids production, and especially for petroleum liquids production, underlying analysis must both consider production beyond the intended end of the projection period and base production projections on the physical realities and limitations of production. The importance of approaching an assessment of liquids production in this way is illustrated by the recent history of U.S. reserve estimates. Whereas the United States reported 22.5 billion barrels of proved reserves in 1998, proved reserves of 20.7 billion barrels were reported in 2010—a decrease of only 1.8 billion barrels despite the cumulative 26.2 billion barrels of liquids supplied from U.S. reserves between 1998 and 2010.

Proved reserves cannot provide an accurate assessment of the physical limits on future production but rather are intended to provide insight as to company- or country- level development plans in the very near term. In fact, because of the particularly rigid requirements for the classification of resources as proved reserves, even the cumulative production levels from individual development projects may exceed initial estimates of proved reserves.

EIA attempts to address the lack of applicability of proved reserves estimates to long-term production projections by developing a production methodology based on the true physical limits of production, initially-in-place volumes, and technologically limited recovery factors. By basing long-term production assessments on resources rather than reserves, EIA is able to present projections that are physically achievable and can be supported beyond the 2035 projection horizon. The realization of such production levels depends on future growth in world demand, taking into consideration such above-ground limitations on production as profitability and specific national regulations, among others.

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Chapter 3
Natural gas

Overview

In the *IEO2011* Reference case, natural gas is the world's fastest-growing fossil fuel, with consumption increasing at an average rate of 1.6 percent per year from 2008 to 2035. Growth in consumption occurs in every *IEO* region and is most concentrated in non-OECD countries, where demand increases nearly three times as fast as in OECD countries (Figure 40). Increases in production in the non-OECD regions more than meet their projected consumption growth, and as a result non-OECD exports to OECD countries grow through 2035. Non-OECD producers account for more than 81 percent of the total growth in world natural gas production from 2008 to 2035.

The global recession of 2008-2009 resulted in a decline of nearly 4 percent in natural gas demand in 2009. As the recession receded and economic growth resumed, natural gas demand reached an estimated 113.1 trillion cubic feet in 2010, exceeding annual consumption levels before the economic downturn [*67*]. Natural gas continues to be favored as an environmentally attractive fuel relative to other hydrocarbon fuels. Natural gas consumption grows robustly in the *IEO2011* Reference case, from 110.7 trillion cubic feet in 2008 to 168.7 trillion cubic feet in 2035.

Growth in natural gas consumption is particularly strong in non-OECD countries, where economic growth leads to increased demand over the projection period. Consumption in non-OECD countries grows by an average of 2.2 percent per year through 2035, nearly three times as fast as the 0.8-percent annual growth rate projected for natural gas demand in the OECD countries. As a result, non-OECD countries account for 76 percent of the total world increment in natural gas consumption, as the non-OECD share of world natural gas use increases from 51 percent in 2008 to 59 percent in 2035.

Natural gas continues to be the fuel of choice in many regions of the world in the electric power and industrial sectors, in part because of its lower carbon intensity compared with coal and oil, which makes it an attractive fuel source in countries where governments are implementing policies to reduce greenhouse gas emissions, and also because of its significant price discount relative to oil in many world regions. In addition, it is an attractive alternative fuel for new power generation plants because of low capital costs and favorable thermal efficiencies. In the Reference case, total world natural gas consumption for industrial uses increases by an average of 1.7 percent per year through 2035, and consumption in the electric power sector grows by 2.0 percent per year. The industrial and electric power sectors together account for 87 percent of the total projected increase in natural gas consumption.

Contributing to the strong competitive position of natural gas among other energy sources is a strong growth outlook for reserves and supplies. Significant changes in natural gas supplies and global markets continue with the expansion of liquefied natural gas (LNG) production capacity, even as new drilling techniques and other efficiencies have made production from many shale basins economical worldwide. The net impact has been a significant increase in resource availability, which contributes to lower prices and higher consumption in the *IEO2011* Reference case projection.

The largest production increases from 2008 to 2035 (Figure 41) are projected for the Middle East (15.3 trillion cubic feet) and non-OECD Asia (11.8 trillion cubic feet). Iran and Qatar increase natural gas production by a combined 10.7 trillion cubic feet, or nearly one-fifth of the total increment in world gas production. A significant share of the increase is expected to come from a single offshore field, which is called North Field on the Qatari side and South Pars on the Iranian side.

Figure 40. World natural gas consumption, 2008-2035 (trillion cubic feet)

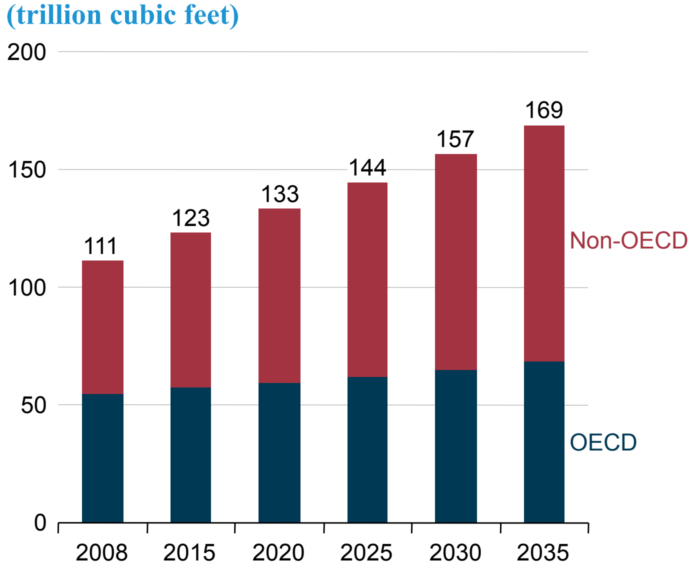
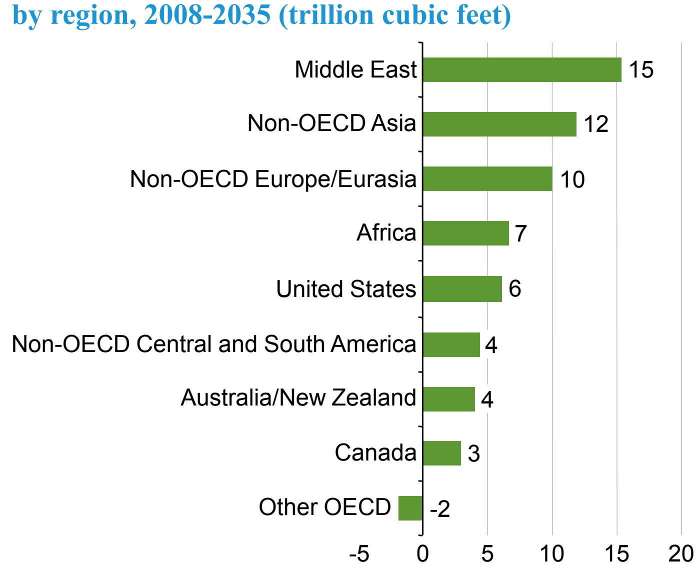


Figure 41. Change in world natural gas production by region, 2008-2035 (trillion cubic feet)



Although the extent of the world's unconventional natural gas resource base (which for the purposes of the *IEO2011* consists of tight gas, shale gas, and coalbed methane) has not yet been assessed fully, the *IEO2011* Reference case projects a substantial increase in those supplies—especially in the United States and also in Canada and China (Figure 42). In the United States, one of the keys to increasing natural gas production has been advances in the application of horizontal drilling and hydraulic fracturing technologies, which have made it possible to develop the country's vast shale gas resources and contributed to a near doubling of total U.S. technically recoverable natural gas resource estimates over the past decade. In the Reference case, shale gas accounts for 47 percent of U.S. natural gas production in 2035. Unconventional resources are even more important for the future of domestic natural gas supplies in Canada and China, where they account for 51 percent and 72 percent of total domestic production, respectively, in 2035 in the Reference case.

LNG accounts for a growing share of world natural gas trade in the Reference case. World natural gas liquefaction capacity nearly doubles, from about 8 trillion cubic feet in 2009 to 15 trillion cubic feet in 2035. Most of the increase in liquefaction capacity is in the Middle East and Australia, where a multitude of new liquefaction projects are expected to be developed, many of which will become operational within the next decade. Utilization of liquefaction capacity is expected to remain high over the entire projection. Given the capital-intensive nature of liquefaction projects, long-term contracts requiring the purchase of high volumes (or high "takes") often are used to ensure high utilization rates and acceptable returns on investments.

World natural gas consumption

OECD natural gas consumption

OECD Americas

Natural gas consumption in the OECD Americas increases by 0.9 percent per year in the *IEO2011* Reference case, from 28.8 trillion cubic feet in 2008 to 37.1 trillion cubic feet in 2035, accounting for 60 percent of the total increase for OECD countries and 14 percent of the total increase for the world over the projection period. U.S. consumption increases by 0.5 percent per year on average (Figure 43), considerably less than the annual increases in Canada (1.5 percent) and Mexico/Chile (3.4 percent). The United States and Mexico/Chile each account for 40 percent of the growth in OECD America's natural gas consumption, with Canada accounting for the remaining 20 percent.

In the United States, natural gas use increases by slightly more than 14 percent from 2008 to 2035, primarily as a result of growth in the price-sensitive industrial and electric utility sectors, where natural gas use increases by 1.4 and 1.2 trillion cubic feet, respectively, over the period. Absent pending environmental regulations, which were not considered in the Reference case, natural gas demand for electricity generation remains flat through about 2025, primarily because of an increase in other generation capacity with lower operating costs, such as renewable capacity and some nuclear capacity that comes on line early in the projection period with support from various incentive programs. Toward the end of the period, when additional capacity is required, the more favorable economics of natural gas—in spite of increasing natural gas prices—lead to strong growth, with natural-gas-fired capacity accounting for 82 percent of capacity additions between 2025 and 2035. In contrast, industrial natural gas consumption grows sharply in the near term and levels off after 2020. The near-term growth is a result of a strong recovery in industrial production, growth in combined heat and power generation, and relatively low natural gas prices. When natural gas prices rise toward the end of the projection, the growth in industrial natural gas use levels off.

Although the United States remains by far the largest consumer of natural gas in the OECD Americas, demand growth also is robust in the other nations of the region. For example, natural gas consumption increases by 3.4 percent per year in Mexico/Chile and by 1.5 percent per year in Canada, strongly outpacing the 0.5-percent average annual growth projected for the United States. In

Figure 42. Natural gas production in China, Canada, and the United States, 2008 and 2035 (trillion cubic feet)

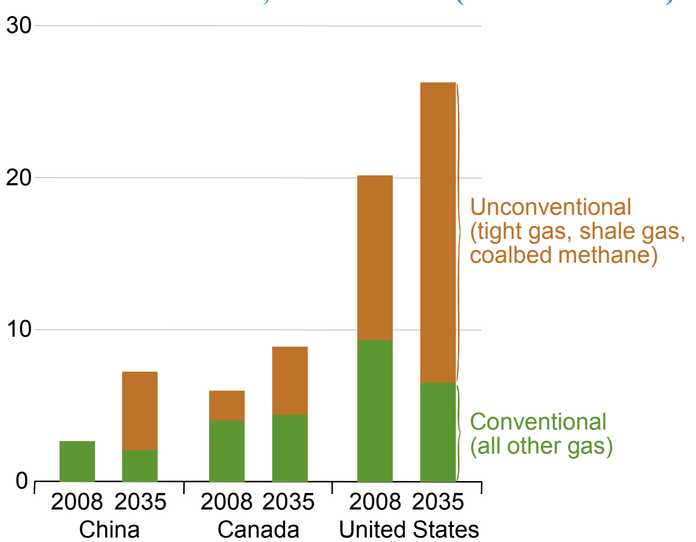
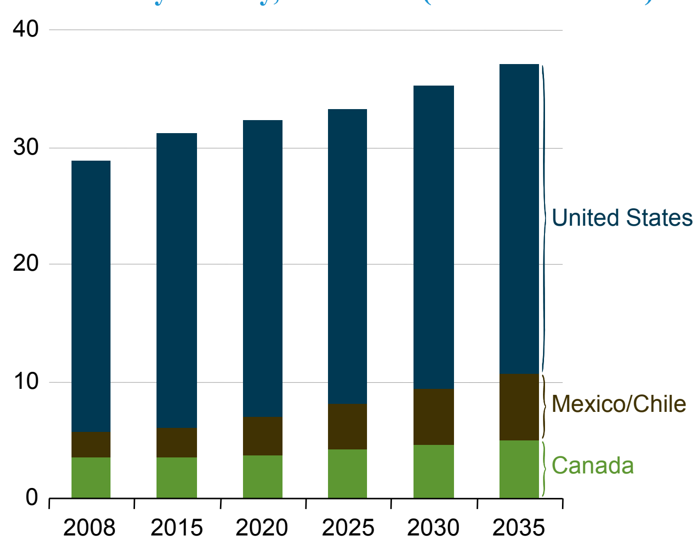


Figure 43. Natural gas consumption in OECD Americas by country, 2008-2035 (trillion cubic feet)



Canada, 66 percent of the growth in natural gas consumption is for industrial uses (including significant amounts of natural gas used in the development of Canada's vast oil sands deposits) and 29 percent is for electricity generation.

In Mexico/Chile, the strongest growth in natural gas consumption is concentrated almost exclusively in the electricity generation and industrial sectors, where consumption increases by 1.9 and 1.3 trillion cubic feet, respectively, from 2008 to 2035. Chile's natural gas consumption shrank from 302 billion cubic feet in 2005 to 93 billion cubic feet in 2008 as a result of constraints on imports from Argentina. However, the opening of two LNG import terminals in 2009 has helped to reverse the decline in Chile's natural gas use, and total consumption is expected to surpass the country's historical peak use within a few years.

OECD Europe

Natural gas consumption in OECD Europe grows by 0.7 percent per year on average, from 19.5 trillion cubic feet in 2008 to 23.2 trillion cubic feet in 2035 (Figure 44), primarily as a result of increasing consumption in the electric power sector. Many governments in OECD Europe have made commitments to reduce greenhouse gas emissions and promote development of "clean energy." Natural gas potentially has two roles to play in reducing carbon emissions, as a replacement for more carbon-intensive coal-fired generation and as backup for intermittent generation from renewable energy sources. In the *IEO2011* Reference case, natural gas is second only to renewables as Europe's most rapidly growing source of energy for electricity generation, as its share of total power generation grows from 20 percent in 2008 to 22 percent in 2035. Although not considered in the *IEO2011* projections, recent actions by some European governments to reduce their reliance on nuclear power in the wake of Japan's Fukushima Daiichi nuclear disaster are likely to provide a further boost to natural gas use in electricity generation.

The growth of Europe's natural gas markets has been hampered somewhat by a lack of progress in reforms that would make natural gas markets more responsive to, or supportive of, electric power markets. The European Union has been attempting to implement legislation that would ease third-party access to Europe's natural gas transmission pipelines and thus allow independent operators access to existing infrastructure [68]. The European Commission ratified its Third Energy Package in 2009, and its stipulations were required to be passed into local law by March 3, 2011. The regulatory changes should increase spot trading and make natural gas markets more flexible by making it easier for market participants to purchase and transmit gas supplies (see box on page 46).

OECD Asia

Natural gas consumption in OECD Asia grows on average by 1.0 percent per year from 2008 to 2035. Over the projection period, natural gas consumption in Japan increases by only 0.3 trillion cubic feet, while consumption in South Korea increases by 0.6 trillion cubic feet and consumption in Australia/New Zealand increases by 0.9 trillion cubic feet (Figure 45). Total regional natural gas consumption increases from 6.2 trillion cubic feet in 2008 to 8.0 trillion cubic feet in 2035.

Japan's natural gas consumption grows modestly, by an average of 0.3 percent per year, from 3.7 trillion cubic feet in 2008 to 4.0 trillion cubic feet by 2035. In the short term, the country is likely to increase its use of natural gas to offset the loss of nuclear generating capacity that occurred when the Fukushima Daiichi power reactors were severely damaged by the March 2011 earthquake and tsunami. In the long term, declining population and an aging work force limit the country's natural gas demand, although a long-term shift away from previously planned reliance on nuclear power in the wake of the Fukushima disaster could boost natural gas use beyond the level projected in the *IEO2011* Reference case. South Korea's natural gas consumption rises by

Figure 44. Natural gas consumption in OECD Europe by end-use sector, 2008-2035 (trillion cubic feet)

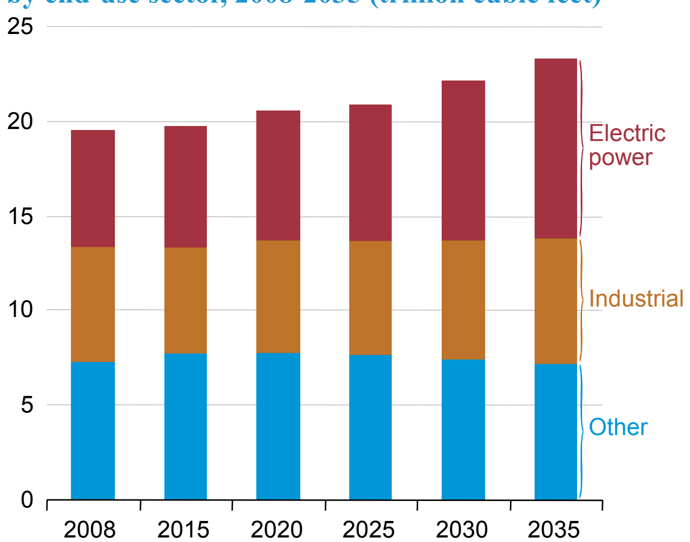
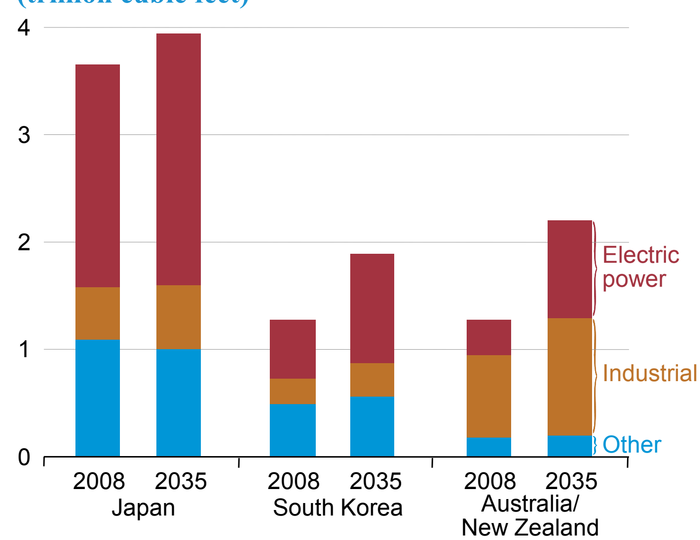


Figure 45. Natural gas consumption in OECD Asia by country and end-use sector, 2008 and 2035 (trillion cubic feet)



1.5 percent per year from 2008 to 2035, led by strong growth in the electric power sector. The share of the country's natural gas consumption used for electricity generation increases from 43 percent in 2008 to 54 percent in 2035.

In Australia/New Zealand, the industrial sector currently is the largest consumer of natural gas, accounting for about 60 percent of the region's total consumption in 2008. However, its share declines to less than 50 percent in 2035, despite average annual growth of 1.3 percent. A significant share of the mid-term growth in industrial natural gas consumption is attributable to fuel use at LNG plants. LNG exports more than double from 2008 to 2020, and LNG fuel use also more than doubles, while over the same period total industrial consumption increases by only 10 percent. In addition, natural gas use in the electric power sector grows strongly, from 0.3 trillion cubic feet in 2008 to 0.9 trillion cubic feet in 2035, as Australia—in its efforts to reduce carbon dioxide emissions—gradually increases the share of natural gas in its power generation mix in order to reduce its more carbon-intensive coal-fired generation.

Natural gas prices in Europe

As natural gas markets have changed over the past several decades, the pricing of natural gas in Europe has evolved. Until the 1980s, when the United Kingdom began liberalizing its natural gas market, European markets consisted largely of national or regional monopolies, which held exclusive control over all aspects of natural gas within their territories. Prices most often were set by long-term contracts and were linked to the price of oil. Over time, as regulations have been enacted to encourage free markets, and as new infrastructure has made European markets more interconnected, pricing has begun to change. Although long-term contract pricing has not been abandoned, the influence of spot market pricing is growing. Natural gas prices in Europe are likely to become more competitive in the future as infrastructure expands and as new potential supply sources—such as unconventional natural gas—become commercial.

Belgium, Germany, and France were the first European countries to import natural gas. The imports were sourced from the Netherlands' Groningen field, discovered in 1959. In choosing an approach to commercialization of the Groningen field, the Dutch state had to balance its desire to maximize its own revenues with the need to price the gas competitively and the need to invest in massive new infrastructure to transport the gas to new markets. The resulting contract structure was largely adopted by later exporters to continental Europe, including Norway, Algeria, the Soviet Union, and later Russia.

To justify investment in long-distance natural gas pipelines and other required infrastructure, import contracts were long-term and offered with take-or-pay provisions that required buyers to purchase specified minimum volumes whether or not they accepted delivery of the natural gas. To ensure that natural gas would earn the highest price but still be competitive, it was priced not at the wellhead, based on the cost to produce it, but at the end-use market. Prices to end users were discounted relative to the prices of competing fuels (mainly, heavy fuel oil in the industrial sector and distillate in the retail sector). To ensure that natural gas priced for one market could not undercut natural gas priced for another market, contracts included clauses specifying the destination for the gas. Also, to ensure that the contract price would remain competitive if prices for competing fuels changed over time, the natural gas contracts included price review clauses [*69*].

The United Kingdom began opening its natural gas markets to competition in the 1980s, and by 2000 the task was largely completed. Continental Europe did not begin liberalizing its natural gas markets until the 1990s, when the European Union (EU) officially abolished national and regional gas monopolies. In the early 2000s, through the EU's Second Gas Directive and other measures, continental gas markets were further liberalized, with elimination of destination clauses in all new import contracts and some existing contracts; requirements for third-party access to natural gas transmission, distribution, and LNG infrastructure; requirements for legal and functional unbundling of transmission operators from competitive businesses; creation of national natural gas regulators; and the establishment of policies allowing consumers to choose their natural gas providers (beginning in 2004 for commercial consumers and in 2007 for retail consumers).

In some respects, the Second Gas Directive stopped short of full liberalization. For example, it did not require third-party access to storage, nor did it mandate full ownership unbundling of transmission assets. However, its biggest weakness was that it failed to directly address market concentration in individual nations, leaving intact companies that were still effectively national gas monopolies [*70*]. As a result, competition across the value chain was limited by supply and import contracts that encompassed most of the available natural gas. Further, transmission contracts governed most of the available pipeline capacity, and downstream contracts governed most of the existing consumers.

Contracts between national incumbents and downstream customers effectively removed many buyers from the market for long periods. Consequently, the Second Gas Directive initially had little impact on natural gas prices. In 2004, the volume-weighted average duration of downstream contracts was 15 years in Germany, around 6 years in the Netherlands and Poland, around 4 years in France, and less than 2 years in Italy. Further, downstream contracts could include provisions that minimized the possibility for contractual buyers to participate in markets as buyers or sellers—for example, by encouraging or even requiring a buyer under contract to purchase natural gas exclusively from the incumbent seller over the life of the contract, and by use restrictions and destination clauses to make the contracted gas difficult to resell [*71*].

Since the implementation of the Second Gas Directive, additional measures have been taken in Europe to encourage market development. Europe's natural gas markets have become physically more connected to each other and to the rest of the world. Pipelines have been expanded to link the United Kingdom's liquid gas market to the rest of Europe through Belgium and the Netherlands, and additional pipeline connections currently are planned or under construction to better interconnect nations on the European continent.

(continued on page 47)

Also, Europe's LNG regasification capacity has almost tripled in just 6 years, from 2.2 trillion cubic feet in 2004 to around 6.2 trillion cubic feet in 2010. The United Kingdom, which had no LNG regasification capacity in 2004, had built 1.8 trillion cubic feet of capacity by 2010, accounting for 45 percent of the recent increase in Europe's total regasification capacity [*72*].

The EU's Third Gas Directive was adopted in 2009, requiring implementation by March 2011. It seeks to improve EU-wide coordination of transmission regulations and strengthen third-party access requirements and transmission unbundling requirements. It still does not require full unbundling of the ownership of transmission assets, nor does it deal directly with the market concentration of incumbent national gas companies [*73*]. However, the European Commission took more direct action in 2007, launching antitrust cases against German natural gas transmission owner and marketer RWE, as well as Italy's Eni, for denying third-party access to their natural gas pipeline systems. The lawsuits have had mixed results. The case against RWE was closed when the company offered to sell its transmission assets, but Eni decided instead to fight its case [*74*]. Gas de France, which also was under investigation, decided to release capacity on some of its import pipeline routes and at some of its LNG import terminals to appease European competition authorities [*75*].

Although the EU gas directives did not directly challenge the dominance of national incumbents, the 2008-2009 economic downturn did. Natural gas demand in Europe declined sharply after the economic downturn in late 2008, while at the same time the supply of "free gas" (natural gas not controlled by incumbent gas companies, mainly in the form of LNG) was increasing. Long-planned increases in Qatari exports to the United Kingdom and Italy began to materialize in 2009, and additional quantities of LNG imports became available to the relatively liquid markets of Belgium and the United Kingdom as a result of declining demand in Japan and growing availability of shale gas supplies in North America.

The increase in available natural gas supply caused spot prices for natural gas in European markets to fall. However, long-term contract prices, because of their lagged linkage to oil prices, did not fall as far or as fast after the economic downturn. The significant differential that opened up between natural gas prices in spot markets and the prices under oil-linked contracts incentivized many European customers to abandon the incumbents with their oil-linked contracts and instead buy gas from the developing spot markets, causing a "take-or-pay crisis" that left incumbent natural gas companies in continental Europe committed to buying too much gas at too high a price and with too few customers wanting too little gas.

The pressures on Europe's incumbent gas companies as a result of their take-or-pay commitments have so far been managed through price review clauses in the contracts and through quantity flexibilities beyond the amounts normally allowed by the contracts. Neither long-term contracts nor contract prices linked to oil were entirely abandoned as a result of the take-or-pay crisis. Even in the United Kingdom, with its liquid natural gas hub, term contracts still existed 18 years after liberalization began, with the prices in just over half of the contracts linked to something other than the hub price [*76*].

In continental Europe, contract price reviews have resulted in some incorporation of hub natural gas prices into formulas that previously linked contract gas prices to oil prices, but the extent to which hub prices have been adopted varies. Norway was the most willing to incorporate hub prices; Algeria was not at all willing. Russia in small measure incorporated hub prices into some contracts to North European customers, where relatively liquid gas hubs exist, but refused to incorporate them into Southern European contracts, citing the limited liquidity at natural gas hubs in the region. The additional quantity flexibility comes at a high price. Companies that have been unable to take their minimum quantities still have had to pay for them, but they will be allowed to take them at a later point, sometime in the next few years.

Natural gas volumes paid for but not delivered under take-or-pay provisions grew in 2009 and 2010 as LNG imports into Europe, and especially the United Kingdom, continued to increase, and imports from Russia continued to decline. It is still unclear whether take-or-pay volumes will continue to increase in 2011, or whether companies will instead be able to take delivery of some accrued volumes in addition to their minimum volumes for 2011. Several factors have helped lessen the pressures on European long-term contracts. Demand for natural gas in Europe and for LNG in Asia recovered in 2010, helping to keep global LNG markets and European spot markets from loosening further, even as LNG production increased by almost 20 percent from 2009. In addition, as a result of political unrest in Libya, flows on the Greenstream natural gas pipeline to Italy were suspended in February 2011. Finally, the tragic earthquake, tsunami, and meltdown at the Fukushima nuclear plant in Japan in March 2011 has resulted in greater demand for LNG in Japan. With little additional growth in global liquefaction capacity expected until after 2015, LNG markets are likely to tighten somewhat in response to the additional demand.

European spot markets for natural gas are likely to continue to grow steadily as a result of continued improvement of physical and regulatory infrastructures. Progress could be slowed, however, by regulation that is relatively weak in comparison with still-powerful national incumbents that often are championed by their home governments. Other factors could push markets to develop more quickly. Significant additional LNG liquefaction capacity is under construction or proposed for 2015 and beyond, and while most of it is in the Pacific basin, it could still indirectly affect Europe, by pushing more flexible LNG back into the Atlantic basin and into European markets. Further, a significant amount of new LNG export capacity has been proposed for the U.S. Gulf coast; and while most of the new Pacific liquefaction capacity is likely to be tied up in relatively inflexible long-term oil-linked contracts, adding little short-term liquidity to Pacific markets, the same cannot be said for any potential U.S. exports. Finally, European spot markets could develop more rapidly than expected if natural gas production from shale formations comes online more quickly or in greater quantities than European incumbents are expecting, as happened in North America. And, with physical and regulatory barriers continuing to lessen over time, the next time such a boom in "free" market-oriented natural gas occurs, the consumer shift from incumbent wholesalers with oil-linked purchase obligations to spot purchases at gas hub prices could be much greater than was seen in 2009 and 2010.

Non-OECD natural gas consumption

Non-OECD Europe and Eurasia

The countries of non-OECD Europe and Eurasia relied on natural gas for 50 percent of their primary energy needs in 2008—a larger share than for any other country grouping in *IEO2011*. Russia is the world's second-largest consumer of natural gas after the United States, with consumption totaling 16.8 trillion cubic feet in 2008 and representing 56 percent of Russia's total energy consumption. In the Reference case, Russia's natural gas consumption grows at a modest average rate of 0.1 percent per year from 2008 to 2035, reflecting a declining population and a shift away from natural gas to nuclear power in the electricity sector in an effort to diversify the power sector fuel mix and monetize natural gas through exports to OECD Europe and Asian markets. Expected efficiency improvements and other demand-side management measures limit growth in natural gas consumption over the long term.

Outside of Russia, natural gas consumption in non-OECD Europe and Eurasia increases by 0.4 percent annually over the projection period, from 8.2 trillion cubic feet in 2008 to 9.1 trillion cubic feet in 2035 (Figure 46). Natural gas is the largest component of the region's primary energy consumption, representing more than 40 percent of the total throughout the Reference case projection. The industrial sector remains the largest consumer of natural gas in non-OECD Europe and Eurasia, accounting for approximately 40 percent of total natural gas consumption in non-OECD Europe and Eurasia.

Non-OECD Asia

Among all regions of the world, the fastest growth in natural gas consumption is projected for non-OECD Asia, which accounts for 35 percent of the total increment in natural gas use in the Reference case and nearly doubles its share of total world natural gas consumption from 10 percent in 2008 to 19 percent in 2035. Natural gas use in non-OECD Asia increases by an average of 3.9 percent annually, from 11.3 trillion cubic feet in 2008 to 31.9 trillion cubic feet in 2035 (Figure 47).

India and China lead the growth in natural gas consumption in non-OECD Asia. In both India and China, natural gas currently is a minor part of the overall energy mix, accounting for only 8 percent and 3 percent, respectively, of total energy consumption in 2008. Those shares are poised to increase over the projection, however, and natural gas accounts for 11 percent of total energy use in India and 6 percent in China in 2035 in the Reference case, as total natural gas consumption in the two countries combined increases by 12 trillion cubic feet from 2008 to 2035. For the other countries of non-OECD Asia, natural gas consumption increases by a total of 8 trillion cubic feet from 2008 to 2035.

China's central government is promoting natural gas as a preferred energy source. It has set an ambitious target of increasing the share of natural gas in its overall energy mix to 10 percent or approximately 8.8 trillion cubic feet by 2020 [*77*]. In the *IEO2011* Reference case, China's natural gas consumption grows at an average rate of 5.5 percent annually over the projection period—the highest growth rate worldwide—to 6.8 trillion cubic feet in 2020 and 11.5 trillion cubic feet in 2035. Nevertheless, China does not achieve its targeted natural gas share, and coal continues to account for the largest share of its energy consumption. Natural gas provides 5 percent of China's energy supply in 2020 in the Reference case and surpasses 8.8 trillion cubic feet of consumption after 2025.

In India, natural gas consumption more than doubles between 2008 and 2015, with much of the growth resulting from increasing domestic supply. Natural gas demand has outstripped supply in India, with many industrial concerns and power generators being underutilized or having to run on more expensive liquid fuels for lack of natural gas. With the start of production from the

Figure 46. Natural gas consumption in non-OECD Europe and Eurasia, 2008-2035 (trillion cubic feet)

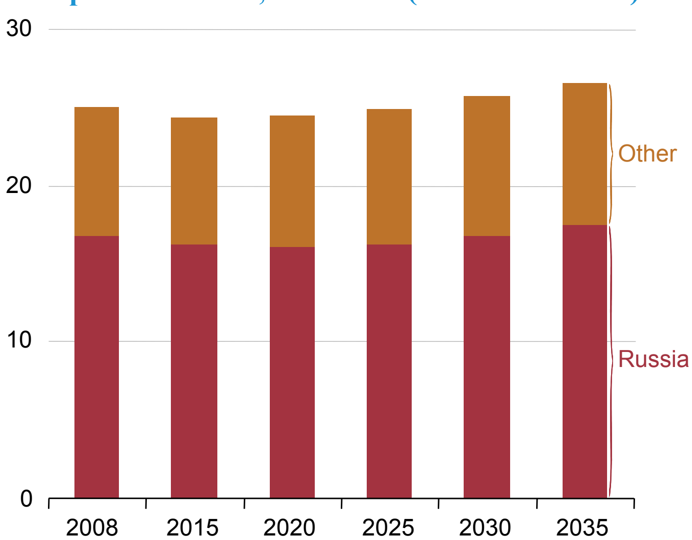
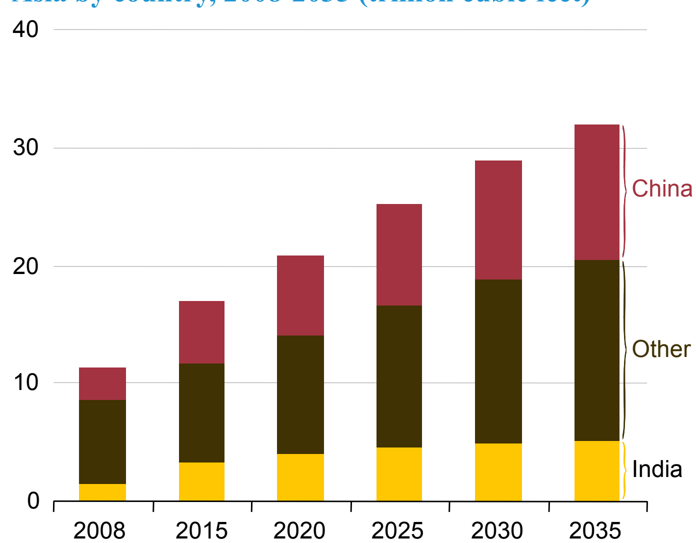


Figure 47. Natural gas consumption in non-OECD Asia by country, 2008-2035 (trillion cubic feet)



Krishna Godavari field in 2009, some of the latent demand has begun to be met. Preliminary data indicate that India's natural gas consumption in 2009 was 23 percent above its consumption in 2008. Over the entire projection period, India's natural gas use grows by 4.6 percent per year, with supply constraints continuing to hold down consumption.

In the other countries of non-OECD Asia, natural gas already is a large component of the energy mix, representing 23 percent of the region's combined total energy consumption in 2008. In the Reference case, natural gas consumption in the region more than doubles, from 7.2 trillion cubic feet in 2008 to 15.4 trillion cubic feet in 2035.

Middle East

Total natural gas consumption in the Middle East doubles from 2008 to 2035, growing by an average of 2.7 percent per year. The region's industrial sector remains the most important natural gas consumer and accounts for 55 percent of total gas use in 2035. A significant portion of the increase in industrial consumption from 2008 to 2015 is attributed to the use of natural gas in LNG liquefaction plants and in gas-to-liquids (GTL) plants. Qatar more than doubles its LNG liquefaction capacity over the 7-year period and consequently more than doubles its fuel use in LNG liquefaction plants. The country's two GTL facilities also ramp up production over the same period. The Oryx GTL plant, which started production in 2007, is expected to consume around 120 billion cubic feet of natural gas per year and produce 30 thousand barrels of liquids per day. The Pearl GTL facility, when it reaches full production in 2012, will be the world's largest GTL plant. At full capacity it will consume 660 bllion cubic feet of natural gas per year and produce 140 thousand barrels of liquids per day, including diesel, naphtha, and kerosene. Industrial consumption of natural gas in the Middle East grows by an average of 4.5 percent per year from 2008 to 2015, with consumption in LNG and GTL facilities accounting for around one-half of the increase. After 2015, industrial gas consumption growth slows to a still robust rate of 2.9 percent per year.

Africa

In Africa, the electric power and industrial sectors account for most of the increase in demand for natural gas, as Africa's total natural gas consumption grows from 3.6 trillion cubic feet in 2008 to 9.1 trillion cubic feet in 2035. In West Africa, Nigeria is taking measures to end natural gas flaring and to prioritize natural gas use for domestic consumption over exports in order to support growing use in the electric power sector. Similarly, in Egypt, the government announced a moratorium on new export contracts until 2010. In order to continue development of its natural gas reserves, however, Egypt will need to maintain investment from the international oil and gas companies currently developing those reserves, but low domestic natural gas prices make it unlikely that Egypt will attract the necessary level of investment.

Non-OECD Central and South America

In the non-OECD nations of Central and South America, natural gas consumption increases on average by 2.5 percent per year, from 4.6 trillion cubic feet in 2008 to 8.8 trillion cubic feet in 2035. The electric power sector accounts for 42 percent of the region's total increase in demand for natural gas. Several countries in the region are particularly intent on increasing the penetration of natural gas for power generation, in order to diversify electricity fuel mixes that currently are heavily reliant on hydropower (and thus vulnerable to drought) and to reduce the use of more expensive oil-fired generation, which is often used to supplement electricity supply.

World natural gas production

In order to meet the consumption growth projected in the *IEO2011* Reference case, the world's natural gas producers will need to increase supplies by almost 60 trillion cubic feet—or more than 50 percent—from 2008 to 2035. Much of the increase in supply is expected to come from non-OECD countries, which in the Reference case account for 81 percent of the total increase in world natural gas production from 2008 to 2035. Non-OECD natural gas production grows by an average of 2.0 percent per year in the Reference case, from 69 trillion cubic feet in 2008 to 117 trillion cubic feet in 2035 (Table 6), while OECD production grows by only 0.9 percent per year, from 41 trillion cubic feet to 52 trillion cubic feet.

Production of unconventional gas, which for the purposes of *IEO2011* includes tight gas, shale gas, and coalbed methane, grows rapidly over the projection period, with OECD unconventional production growing on average by 3.2 percent per year, from 13 trillion cubic in 2008 to 31 trillion cubic feet in 2035. Over the same period, non-OECD unconventional production grows from less than 1 trillion cubic feet to 12 trillion cubic feet. However, numerous uncertainties could affect future production of unconventional natural gas resources. There is still considerable variation among estimates of recoverable shale resources in the United States and Canada, and estimates of recoverable unconventional gas for the rest of the world are more uncertain given the relatively sparse data that currently exist (see box on page 52). Additionally, the hydraulic fracturing process used to produce shale gas resources requires a significant amount of water, and many of the areas that have been identified globally as having shale gas resources have limited supplies of water. Furthermore, there is additional uncertainty surrounding access to the resources due to environmental concerns (see box on page 53). For instance, development in parts of the Marcellus shale in the United States has been inhibited somewhat by limitations on the issuance of drilling permits, especially in the State of New York. France has recently taken legislative actions to ban hydraulic fracturing in that country, and South Africa has placed a moratorium on hydraulic fracturing while it investigates how best to regulate it to ensure that the environment is protected.

OECD Production

OECD Americas

Natural gas production in the OECD Americas grows by 34 percent from 2008 to 2035. The United States, which is the largest producer in the OECD Americas and in the OECD as a whole, accounts for more than 60 percent of the total regional production growth, with an increase from 20.2 trillion cubic feet in 2008 to 26.4 trillion cubic feet in 2035 (Figure 48). Increases in U.S. shale gas production more than offset declines in other categories, growing more than fivefold from 2.2 trillion cubic feet in 2008 to 12.2 trillion cubic feet in 2035. In 2035, shale gas accounts for 47 percent of total U.S. natural gas production, tight gas accounts for 22 percent, lower 48 offshore production accounts for 12 percent, and coalbed methane accounts for 7 percent. The remaining 12 percent comes from Alaska and other associated and nonassociated lower 48 onshore resources. As a result of lower natural gas prices, an Alaska pipeline is not economical before 2035, and so it does not get built in the forecast.

One of the keys to the U.S. production growth is advanced production technologies, especially the combined application of horizontal drilling and hydraulic fracturing techniques that has made the country's vast shale gas resources accessible. Rising estimates of shale gas resources have been the primary factor in nearly doubling the estimated U.S. technically recoverable natural gas resource

Table 6. World natural gas production by region/country in the Reference case, 2008-2035 (trillion cubic feet)

	History		Projections					Average annual percent change, 2008-2035
Region/country	2008	2009	2015	2020	2025	2030	2035	
OECD								
United States[a]	20.2	20.1	22.4	23.4	24.0	25.1	26.4	1.0
Conventional	9.4	8.4	7.7	7.8	6.8	6.8	6.6	-1.3
Unconventional	10.9	11.7	14.8	15.6	17.1	18.4	19.8	2.3
Canada	6.0	5.6	7.0	7.7	8.3	8.7	9.0	1.5
Conventional	4.0	3.6	4.3	4.3	4.4	4.4	4.4	0.4
Unconventional	2.1	2.0	2.7	3.4	3.9	4.3	4.6	3.0
Europe	10.6	10.1	8.1	7.5	7.5	7.9	8.3	-0.9
Conventional	10.6	10.1	8.1	7.1	6.6	6.2	6.0	-2.1
Unconventional	0.0	0.0	0.1	0.3	0.9	1.7	2.3	19.1
Australia/New Zealand	1.7	1.8	2.6	3.1	3.8	4.8	5.7	4.5
Other OECD	1.9	2.0	2.1	2.0	2.0	2.1	2.4	0.9
Total OECD	**40.6**	**39.6**	**42.3**	**43.7**	**45.5**	**48.7**	**51.8**	**0.9**
Non-OECD								
Russia	23.4	20.6	23.0	24.9	27.3	29.6	31.2	1.1
Europe and Central Asia	7.1	5.7	7.4	7.7	8.1	8.7	9.2	1.0
Iran	4.1	4.6	5.7	6.9	7.8	8.6	9.4	3.1
Qatar	2.7	3.2	6.3	7.0	7.4	7.8	8.1	4.1
Other Middle East	6.7	6.6	7.8	8.5	9.4	10.4	11.3	2.0
North Africa	5.8	5.8	7.4	8.5	9.3	10.0	10.4	2.2
Other Africa	1.7	1.4	2.4	2.6	2.9	3.3	3.7	3.0
China	2.7	2.9	3.1	3.7	4.7	6.0	7.3	3.8
Conventional	2.7	2.9	2.6	2.3	2.2	2.1	2.0	-1.0
Unconventional	0.0	0.0	0.5	1.4	2.6	3.9	5.2	--
Other Asia	10.0	10.4	12.5	13.7	14.9	16.2	17.3	2.0
Central and South America	5.1	4.9	5.8	6.6	7.5	8.5	9.5	2.3
Total non-OECD	**69.3**	**66.0**	**81.3**	**90.0**	**99.4**	**109.1**	**117.4**	**2.0**
Total world	**109.9**	**105.6**	**123.6**	**133.8**	**145.0**	**157.8**	**169.2**	**1.6**
Discrepancy[b]	-1.0	-1.2	0.4	0.3	0.6	1.0	0.5	

[a]Includes supplemental production, less any forecast discrepancy.
[b]Balancing item. Differences between global production and consumption totals result from independent rounding and differences in conversion factors derived from heat contents of natural gas that is produced and consumed regionally.

over the past decade. Although shale gas resources are distributed widely across the United States, current estimates indicate that more than one-half of the shale gas resource base of 862 trillion cubic feet is concentrated in the Northeast. The Gulf Coast States also have considerable shale gas resources, and in the *IEO2011* Reference case production increases occur predominantly in the Northeast and along the Gulf Coast, with smaller increases expected in other areas. U.S. shale gas production has continued to grow despite low natural gas prices. However, as North American natural gas prices have remained low and liquids prices have risen with international crude oil prices, U.S. shale drilling has concentrated on liquids-rich shales such as the Bakken formation in North Dakota and the Eagle Ford formation in Texas.

Natural gas production in Canada grows by 1.5 percent per year on average over the projection period, from 6.0 trillion cubic feet in 2008 to 9.0 trillion cubic feet in 2035. As in the United States, much of the production growth comes from growing volumes of shale gas. Although Canada produced only about 4 billion cubic feet of shale gas in 2008, it has the potential to reach 169 billion cubic feet by 2012, according to estimates from Canada's National Energy Board [*78*]. In addition, three proposed LNG liquefaction and export facilities would use feedstock gas from the Horn River and Montney shales and tight gas plays. If all three facilities were built and operated at their maximum proposed capacity, Canada would need to produce approximately 1.3 trillion cubic feet per year to support them—incidentally, about the same volume as the decrease in net pipeline exports of natural gas from Canada to the United States projected in the *IEO2011* Reference case.

In addition to the small but growing volumes of shale gas that Canada produces, it also currently produces small volumes of gas from coalbeds and significant volumes from tight reservoirs. In 2008, about 30 percent of Canada's natural gas production came from tight reservoirs, which Canada considers to be conventional production [*79*]. Most of the country's coalbed methane production is in the province of Alberta, which had more than 11,000 producing coalbed methane wells and 0.28 trillion cubic feet of coalbed methane production in 2008. In 2001, coalbed methane activity in the province consisted of no more than a few test wells [*80*].

Mexico's natural gas production remains fairly flat, growing only from 1.7 trillion cubic feet in 2008 to 2.1 trillion cubic feet in 2035. The country faces substantial difficulties in attracting the investment and technology improvements needed to increase production, especially if it wants to try to produce hydrocarbons from its shale plays, the most prospective of which are extensions of the successful Eagle Ford shales in the United States. In March 2011, Mexican state-owned petroleum company, Petróleos Mexicanos (PEMEX), announced that it had results from its first shale gas evaluation well in the Eagle Ford shales and that it was considering drilling 10 additional evaluation wells targeting shales that had as much potential of yielding crude oil as of yielding natural gas or other liquids [*81*].

OECD Europe

Outside of Norway, natural gas production in OECD Europe is generally in decline, with production falling from 8.6 trillion cubic feet in 2000 to 7.1 trillion cubic feet in 2008. Over the same period, Norway's production grew from 1.9 trillion cubic feet to 3.5 trillion cubic feet, slowing the rate of decline in OECD Europe as a whole, but not reversing it. Over the projection period, production of natural gas in OECD Europe continues to decline at an average annual rate of 0.9 percent (Figure 49).

While production of natural gas from conventional reservoirs declines, growing production of tight gas, shale gas, and coalbed methane slows the rate of overall decline. Exploratory drilling and/or leasing for shale gas is ongoing in several countries in OECD Europe. Poland is at the forefront of shale gas exploration activity in Europe, offering attractive fiscal terms and enjoying the participation of multiple companies actively drilling in multiple basins. Halliburton, working for the Polish state gas firm Polskie Górnictwo Naftowe i Gazownictwo (PGNiG), fractured the country's first shale well in late 2010 [*82*]. In addition, leasing and drilling activity for coalbed methane is ongoing in at least five European countries (Turkey, Italy, France, Poland and the United Kingdom), with the United Kingdom and Poland both having recently begun producing small amounts of coalbed methane gas [*83*].

Figure 48. OECD natural gas production by country, 1990-2035 (trillion cubic feet)

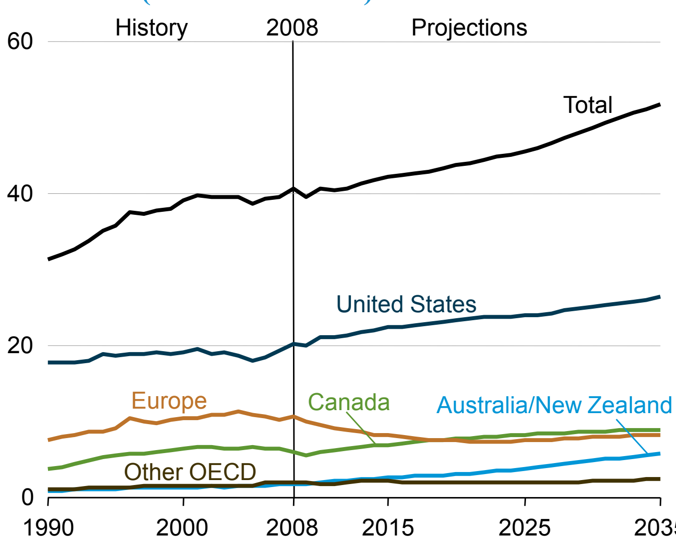
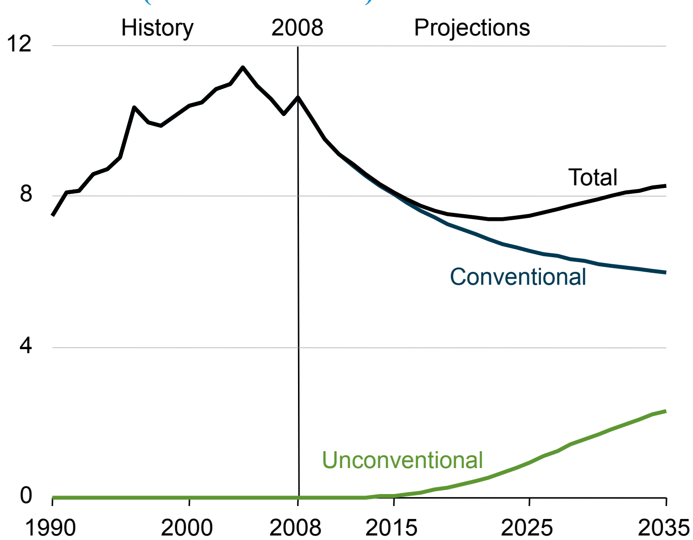


Figure 49. OECD Europe natural gas production, 1990-2035 (trillion cubic feet)



OECD Asia

Natural gas production in the Australia/New Zealand region grows from 1.7 trillion cubic feet in 2008 to 5.7 trillion cubic feet in 2035 in the Reference case, at an average rate of 4.5 percent per year—the strongest growth in natural gas production among OECD regions. In 2008, the Northwest Shelf area of Australia's Carnarvon Basin accounted for around 59 percent of total production in the Australia/New Zealand region [*84*], with much of the production used as feedstock at the Northwest Shelf LNG liquefaction facility. Other areas and basins in Australia provided another 32 percent of the region's total production in 2008. New Zealand's natural gas production accounted for around 9 percent of the 2008 regional total.

Coalbed methane, from the Bowen-Surat Basin in eastern Australia, accounted for between 8 percent and 9 percent of total production in Australia in 2008 [*85*], and its share is certain to grow in the future, as it provides natural gas supplies to satisfy the area's demand growth and to feed proposed LNG export projects. In late 2008, New Zealand also began producing natural gas from coalbeds, with small volumes from pilot production being piped to a nearby power plant and used to generate electricity [*86*].

International shale gas resources

To gain a better understanding of potential international shale gas resources, EIA sponsored a study by Advanced Resources International, Inc. (ARI) to assess 48 shale gas basins in 32 foreign countries, containing almost 70 shale gas formations. The effort culminated in the report, *World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States* [*87*], which examined prospective shale gas resources in basins with relatively near-term promise and sufficient available geologic data for resource analysis.

Although the shale gas resource estimates are likely to change over time as additional information becomes available, the international resource base for shale gas appears to be extensive. The initial estimate of technically recoverable shale gas resources in the 32 countries examined is 5,760 trillion cubic feet. Adding the estimate of 862 trillion cubic feet for technically recoverable U.S. shale gas resources results in a total estimated shale resource base of 6,622 trillion cubic feet in the United States and the other 32 countries assessed. To put that estimate in perspective, *Oil & Gas Journal* has estimated world proven reserves of natural gas as of January 1, 2011, at about 6,647 trillion cubic feet and world technically recoverable natural gas resources—largely excluding shale gas—at roughly 16,000 trillion cubic feet [*88*].

Estimates of shale gas resources outside the United States are relatively uncertain, given that the available data are relatively sparse. At present, many nations have efforts underway to develop more detailed assessments of shale gas resources, some of which are supported by U.S. Government agencies under the auspices of the Global Shale Gas Initiative (GSGI) launched in April 2010 [*89*]. As the assessments are completed, estimates of shale gas resources are likely to be revised upward.

Two groups of countries appear to have the best prospects for shale gas development. The first group consists of countries that currently are highly dependent on natural gas imports, have some exisiting gas production infrastructure, and are estimated to have substantial shale gas resources relative to their current natural gas consumption. They include France, Poland, Turkey, Ukraine, South Africa, Morocco, and Chile, among others. For these countries, shale gas development could significantly alter their future gas balances, which may motivate development. South Africa's shale gas resource may be of particular interest, because it could be used as a feedstock in existing gas-to-liquids (GTL) and coal-to-liquids (CTL) plants.

The second group consists of countries that also are estimated to have considerable shale gas resources (more than 200 trillion cubic feet) and extensive infrastructure for the production of natural gas for domestic consumption, export, or both. In addition to the United States, this group includes Canada, Mexico, China, Australia, Libya, Algeria, Argentina, and Brazil. Existing infrastructure could facilitate timely conversion to shale gas production in these countries, but it could also lead to competition with other sources of natural gas supply.

Clearly, the United States has had the greatest success in developing its shale gas resources to date, with production increasing from 1.0 trillion cubic feet in 2006 to 4.8 trillion cubic feet—23 percent of total U.S. natural gas production—in 2010. However, several of the countries represented in the ARI report also have started developing their shale gas resources. Canada already has produced and marketed shale gas, mainly from the Horn River basin in British Colombia, beginning in 2008, with production in early 2011 approaching 200 million cubic feet per day. Production will likely increase, and companies have recently received regulatory approval for additional gas processing and transport infrastructure that would also help them access other North American markets [*90*].

Countries in Europe, Asia, and other parts of the world are also exploring development of their shale gas resources. In Poland, for instance, local and foreign energy companies have conducted more than seven shale gas test drillings and have pledged to carry out an additional 120 tests [*91*]. In May 2011, China selected six companies in its first shale gas exploration tender, the first of its kind held in China, which is set to involve eight blocks, covering 7,000 square miles [*92*]. Worldwide, the amount of interest and investment made in preliminary shale gas leasing activity over the past few years suggest the growing potential for international shale gas, a fuel that could play increasingly important role in global natural gas markets in the future.

Several companies also are pursuing tight gas and shale gas resources in Australia. Both the Perth and Canning basins in the state of Western Australia are prospective for tight gas and shale gas. The Australian company Latent Petroleum drilled its first appraisal well in the Warro tight gas field in the Perth basin in 2009, and it plans to start producing natural gas from the field in 2013 [*93*]. The Western Australia state government has been actively promoting the development of unconventional natural gas resources. In 2009 the state government cut in half the royalty rate for tight gas, from 10 percent to 5 percent [*94*], and in 2010 it announced that it would appoint a drilling expert in an effort to help alleviate the deficit that exists in the state for rigs that can drill to the necessary depths for tight and shale gas, and for equipment for hydraulically fracturing tight gas and shale gas wells [*95*]. Shale gas development is most active in the Cooper basin, which lies mainly in the state of South Australia. The country's first test well aimed specifically at a shale formation was drilled in the Cooper Basin by Beach Petroleum in late 2010. The company plans to hydraulically fracture the well in 2011 [*96*].

Both Japan and South Korea have limited natural gas resources and, consequently, very limited current and future production. Both countries receive the vast majority of their natural gas supplies in the form of imported LNG. In 2008, natural gas production in Japan and South Korea accounted for only 5 percent and 1 percent of their natural gas consumption, respectively. Although the presence of substantial deposits of methane hydrates in both Japan and South Korea has been confirmed, and both countries are investigating how those resources could be safely and economically developed, the *IEO2011* Reference case does not include methane hydrate resources in its estimates of natural gas resources, and the development of hydrates on a commercial scale is not anticipated during the projection period.

Non-OECD Production

Middle East

Four major natural gas producers in the Middle East—Qatar, Iran, Saudi Arabia, and the United Arab Emirates—together accounted for 85 percent of the natural gas produced in the Middle East in 2008. With more than 40 percent of the world's proved natural gas reserves, the Middle East accounts for the largest increase in regional natural gas production from 2008 to 2035 (Figure 50) and for 26 percent of the total increment in world natural gas production in the Reference case.

The strongest growth among Middle East producers from 2008 to 2035 in the *IEO2011* Reference case comes from Qatar, where natural gas production increases by 5.4 trillion cubic feet, followed by Iran (5.3 trillion cubic feet of new production) and Saudi Arabia (2.3 trillion cubic feet). Although Iraq is the region's fastest-growing supplier of natural gas, with average increases of 9.8 percent per year over the projection, it is a relatively minor contributor to regional gas supplies. In 2035, Iraq's natural gas production totals only 0.8 trillion cubic feet, or about 3 percent of the Middle East total.

Shale gas: Hydraulic fracturing and environmental issues

Hydraulic fracturing ("fracking") is a well completion technique designed to improve oil and gas production. The process involves injecting large volumes of fluids and proppants—small spheroids of solid material—at high pressure to create fractures in the source rock and carry the proppants into the fractures to hold them open when production commences. The hydraulic fracturing fluid is typically water-based and contains various chemicals, including bactericides, buffers, stabilizers, fluid-loss additives, and surfactants, to promote the effectiveness of the fracturing operation and prevent damage to the formation. Without hydraulic fracturing, shale deposits would not produce natural gas, and most low-permeability deposits would be uneconomical. It is estimated that hydraulic fracturing is used for more than 50 percent of the natural gas wells currently drilled each year in the United States. In 2010, shale and low-permeability reservoirs accounted for about 52 percent of U.S. natural gas production and about 46 percent of total consumption [*97*].

Concerns about the extensive use of hydraulic fracturing have been raised by the public in the United States and elsewhere in the world because of the large volumes of water required, the chemicals added to fracturing fluids, and the need to dispose of the fluids after wells have been completed. A principal concern is the potential for contamination of aquifers and ground water, either from wells passing through aquifers or from surface spills. Other environmental concerns range from air emissions and noise pollution to surface impacts (such as increased truck traffic and road damage), infrastructure considerations (such as roads, pipelines, and water treatment facilities), and public disclosure of the chemical makeup of fracking fluids.

Studies are underway to assess specific environmental concerns. The U.S. Environmental Protection Agency (EPA) is developing a study to examine the relationship between hydraulic fracturing and drinking water resources [*98*]. The scope of the proposed research includes study of the full life cycle of fracking water, from its acquisition to the mixing of chemicals to the fracturing and post-fracturing stages, including management of flowback and produced water and the ultimate treatment and/or disposal of the water recovered. In early 2011, the EPA submitted its draft study plan on hydraulic fracturing for review by the agency's Science Advisory Board (SAB). Initial research results are expected by the end of 2012, and a final report is expected in 2014. In addition, environmental issues related to shale gas are being addressed in public hearings on the safety of shale gas development, held by the U.S. Secretary of Energy Advisory Board [*99*].

It is too early to tell whether environmental concerns will result in any long-term restrictions that significantly impede application of hydraulic fracturing techniques. Every country with an interest in developing its shale gas resources will develop its own policies to address such concerns, and the resulting framework could influence the pace of shale gas development around the world.

Iran has the world's second-largest reserves of natural gas, after Russia, and currently is the Middle East's largest natural gas producer. Iran is also the Middle East's largest user of reinjected natural gas for enhanced oil recovery operations. In 2008, Iran reinjected more than 1 trillion cubic feet of natural gas, or 16 percent of its gross production. In 2009, Iran began enhanced oil recovery operations at the Agha-Jari oil field, where it plans to raise oil production by 60,000 barrels per day by injecting 1.3 trillion cubic feet of natural gas annually, more than doubling the 2008 reinjected volumes [*100*]. In 2020, Iran is estimated to need between 3.7 trillion and 7.3 trillion cubic feet of natural gas per year for reinjection [*101*]. The higher estimate is greater than the projected total for Iran's marketed natural gas production in 2020. The actual figure for reinjection use, whatever it turns out to be, will have a significant impact on Iran's marketed natural gas production in the future.

Natural gas production in Saudi Arabia grows by an average of 2.3 percent per year, from 2.8 trillion cubic feet in 2008 to 5.2 trillion cubic feet in 2035. The Saudi national oil company, Saudi Aramco, has made several natural gas finds in the Persian Gulf that are not associated with oil fields. Three gas fields, the Karan, Arabiyah and Hasbah, are expected to begin producing in the next 5 years, adding at least 1.3 trillion cubic feet of production when fully operational. Both Arabiyah and Hasbah are offshore, and both are also sour natural gas fields, making them relatively expensive to produce, at an estimated cost of $3.50 to $5.50 per million Btu [*102*]. The *IEO2011* Reference case assumes that Saudi Arabia's policy of reserving natural gas production for domestic use persists throughout the projection period, and that no natural gas is exported. Thus, in the long term, production is more dependent on domestic demand growth and domestic prices than on resource availability.

Non-OECD Europe and Eurasia

Almost 17 percent of the global increase in natural gas production is expected to come from non-OECD Europe and Eurasia, which includes Russia, Central Asia, and non-OECD Europe. In the Reference case, natural gas production in the region as a whole increases from 30.4 trillion cubic feet in 2008 to 40.4 trillion cubic feet in 2035 (Figure 51). Russia remains the dominant natural gas producer, accounting for more than 75 percent of the region's production throughout the projection.

In 2008, Russia produced 23.4 trillion cubic feet of natural gas. Preliminary estimates indicate that its production fell by 12 percent in 2009 to 20.6 trillion cubic feet. The production decline was due not to a lack of resources or production capacity but rather to the global economic downturn and resulting decline in natural gas demand in Russia and its gas export markets. Russian natural gas, whether consumed domestically or exported, generally is not priced according to gas market fundamentals. Normally, a decrease in demand for natural gas when supply is relatively abundant tends to drive prices down, encouraging a recovery in demand. Instead, Russian natural gas prices remained largely unchanged after the economic downturn. Prices for natural gas exports from Russia usually are linked to world oil prices by contract. Because domestic prices are largely regulated, however, the artificially low prices in place before the economic crisis did not change, and as Russia's domestic demand for natural gas declined, production for the domestic market also dropped, by 8 percent (1.3 trillion cubic feet) from 2008 to 2009. In addition, Russia's apparent net exports of natural gas declined by 23 percent to 5.1 trillion cubic feet in 2009. In the *IEO2011* Reference case, Russia's natural gas production grows on average by 1.1 percent per year over the projection period, as exports to Europe recover and both LNG and pipeline exports to Asia increase.

If Russia is to increase exports to Asia while at least maintaining exports to Europe, it must invest in new fields. Moreover, it will require such investment simply to maintain current production levels, because production is in decline at its three largest gas fields (Yamburg, Urengoy, and Medvezh'ye) [*103*]. The giant Koykta field in eastern Siberia, estimated to hold 70 trillion cubic feet of natural gas and to be capable of producing 1.6 trillion cubic feet per year, is a likely candidate as a source for pipeline exports to

Figure 50. Middle East natural gas production, 1990-2035 (trillion cubic feet)

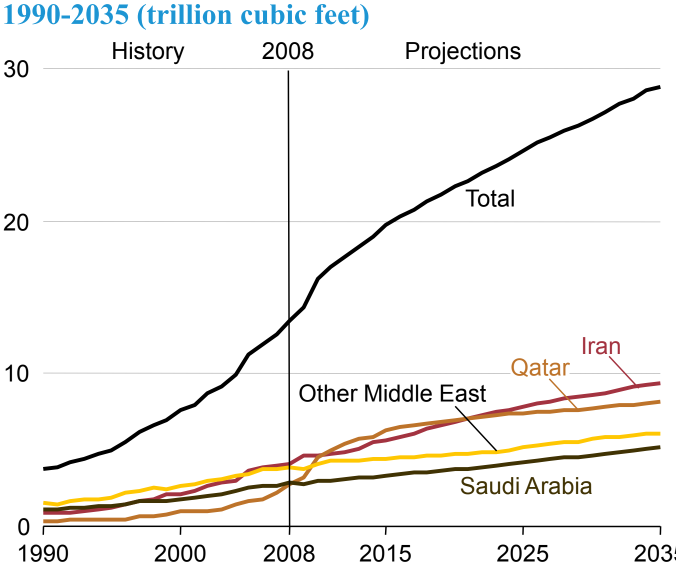
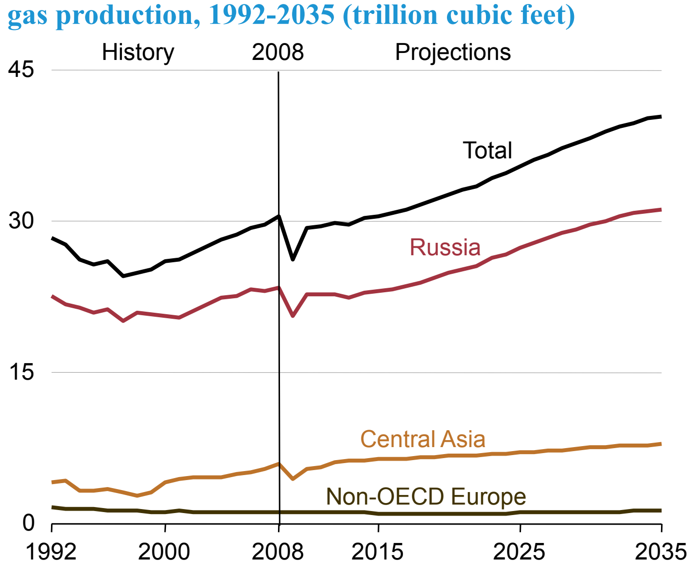


Figure 51. Non-OECD Europe and Eurasia natural gas production, 1992-2035 (trillion cubic feet)



China. Ownership of the field changed hands in early 2011, when it was bought by Russian state firm Gazprom [*104*]. There had been little progress on exporting gas from the field under the previous joint venture owners, TNK-BP.

The Yamal Peninsula is another major area for future Russian production growth. The Bovanenkovo field, which is owned by Gazprom, is estimated to hold more than 170 trillion cubic feet of recoverable natural gas. Production at the field is scheduled to start in 2012 and over the course of several years ramp up to more than 4 trillion cubic feet per year [*105*]. To the northeast of Bovanenkovo lies the Tambeiskoye field, which is majority-owned by Russia's largest independent gas producer, Novatek. The field has estimated reserves of 44 trillion cubic feet, and Novatek has proposed building an LNG liquefaction facility with the capacity to export 0.7 trillion cubic feet of natural gas production per year [*106*]. Finally, Gazprom is scheduled to make a final investment decision on its Shtokman field in the Barents Sea by the end of 2011. The field is estimated to hold more than 130 trillion cubic feet of natural gas reserves, and the first development phase would see production of 0.8 trillion cubic feet per year [*107*].

Natural gas production in Central Asia (which includes the former Soviet Republics) grows by 1.1 percent per year on average, from 5.9 trillion cubic feet in 2008 to 7.9 trillion cubic feet in 2035. Much of the growth is expected to come from Turkmenistan, which already is a major producer and accounted for more than 40 percent of the region's total production in 2008. Turkmenistan is just beginning to develop its recently reassessed giant Yolotan field. It will be developed in several phases, with each of the initial four phases adding around 0.4 trillion cubic feet of annual natural gas production. First production from the field is expected by the end of 2011 [*108*]. Initial natural gas production from the Yolotan field probably will be exported by pipeline to China. Further expansion of production in Turkmenistan and Central Asia will depend on securing markets and transit routes to reach markets in China. Also contributing to Central Asia's projected production growth is Azerbaijan, which has been planning to bring on line the second phase of natural gas production at its Shah Deniz field. Upon reaching peak production, Shah Deniz will add around 0.7 trillion cubic feet to the country's annual production.

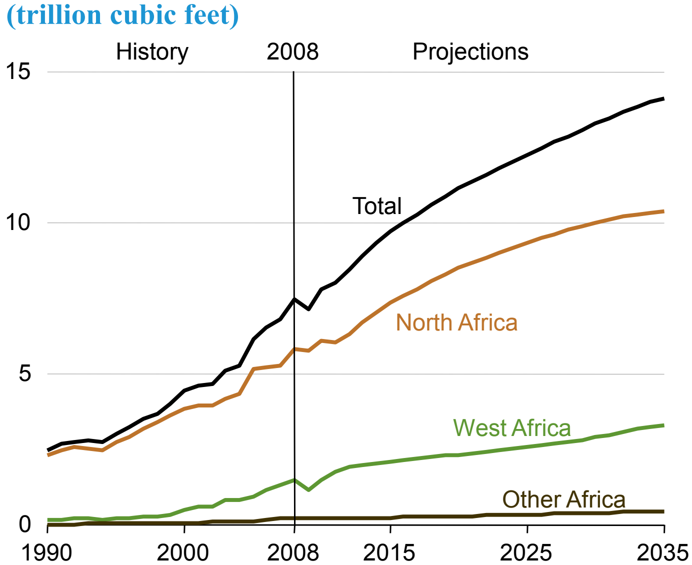
Africa

Substantial growth is projected for natural gas production in Africa, from a total of 7.5 trillion cubic feet in 2008 to 11.1 trillion cubic feet in 2020 and 14.1 trillion cubic feet in 2035 (Figure 52). In 2008, almost 78 percent of Africa's natural gas was produced in North Africa, mainly in Algeria, Egypt, and Libya. West Africa accounted for another 20 percent of the 2008 total, and the rest of Africa accounted for almost 3 percent. Remaining resources are more promising in West Africa than in North Africa, which has been producing large volumes of natural gas over a much longer period. Indeed, faster production growth is projected for West Africa, with annual increases averaging 3.1 percent, as compared with an average of 2.2 percent for North Africa.

Nigeria is the predominant natural gas producer in West Africa, although there also have been recent production increases from Equatorial Guinea, which brought an LNG liquefaction facility on line in 2007. Angola also is expected to add to West Africa's production in the near term, with its first LNG liquefaction facility expected to come on line in 2012 [*109*]. Still, because security concerns and uncertainty over terms of access in Nigeria limit production growth in West Africa, North Africa remains the continent's leading region for natural gas production over the course of the projection.

North Africa also leads the region in shale gas activity. Cygam Energy conducted hydraulic fracturing at a well in the Tunisian portion of the Ghadames basin in 2010, and Cygam and other companies have plans for several more exploration and appraisal wells to be drilled in Tunisia and Morocco over the next year [*110*]. There is also interest in shale gas development in South Africa, where several companies are involved in evaluating permit areas for shale gas potential. However, no new wells aimed at shale gas have been drilled so far, and several of the current permits do not actually allow new drilling activity [*111*]. Companies are also exploring coalbed methane opportunities in South Africa, as well as in neighboring Zimbabwe and Botswana [*112*]. In the shorter term, conventional offshore discoveries in the Rovuma basin off the coast of Mozambique and increased estimates of natural gas resources in the Kudu field off the coast of Namibia could add to southern Africa's natural gas production.

Figure 52. Africa natural gas production, 1990-2035 (trillion cubic feet)



Non-OECD Asia

Natural gas production in non-OECD Asia increases by 11.8 trillion cubic feet from 2008 to 2035 in the *IEO2011* Reference case, with China accounting for 39 percent of the growth and India 23 percent (Figure 53). From 2008 to 2035, China has the largest projected increase in natural gas production in non-OECD Asia, from 2.7 trillion cubic feet in 2008 to 7.3 trillion cubic feet in 2035, for an average annual increase of 3.8 percent. Much of the increase in the later years comes from unconventional reservoirs (Figure 54). China already is producing small volumes of coalbed methane and significant volumes of tight gas. The actual volumes of tight gas are unknown, as China considers tight gas to be conventional and does not report it separately. However, China produced and utilized 88 billion cubic feet of coalbed methane in 2009 and 127 billion cubic feet in 2010. China is trying to encourage the development of coalbed methane resources, and one way it is doing so is by offering producers a subsidy of roughly $1 per million Btu [*113*]. In addition, there has been great interest in China's potential for shale gas production, and several international companies have partnered with Chinese companies to explore potential shale resources. So far, most of the activity is at the evaluation stage, but a few wells targeting shale resources have been drilled or are planned [*114*].

Natural gas production in India grows at an average annual rate of 4.6 percent over the projection period. Most of the growth in India's natural gas production is expected in the near term, averaging 11.8 percent per year as total production grows from 1.1 trillion cubic feet in 2008 to 2.5 trillion cubic feet in 2015. Much of the expected increase comes from a single development, the Dhirubhai-6 block in the Krishna Godavari Basin, where production began in April 2009. Production had been anticipated to reach 2.8 billion cubic feet per day (1.02 trillion cubic feet per year), but actual production peaked at 2.1 billion cubic feet per day (0.77 trillion cubic feet per year) in the third quarter of 2010 before falling back to 1.5 billion cubic feet per day (0.55 trillion cubic feet per year) in the fourth quarter [*115*]. Even if production is maintained at the lower level of 0.55 trillion cubic feet per year, it will represent a 50-percent increase over 2008 production in a period of just 2 years.

In the longer term, unconventional resources are expected to account for a significant portion of the growth in India's natural gas production. India is already producing small volumes of natural gas from coalbed methane deposits. In 2008, total coalbed methane production amounted to less than 1 billion cubic feet [*116*]. Leasing and drilling activity has been progressing for several years, and more meaningful volumes could be produced as early as the 2013 to 2014 time frame [*117*]. In addition, India has several basins that are prospective for shale gas. In late 2010 the Indian state Oil and Natural Gas Company (ONGC) drilled the country's first well specifically targeting shale gas resources [*118*]. The Indian government plans its first licensing round for shale gas acreage in the second half of 2011, after it has established new financial and contractual regimes for shale gas activity [*119*].

Outside China and India, non-OECD Asian natural gas production grows at an average annual rate of only 1.5 percent. The two largest producers in the region, Malaysia and Indonesia, both face declining production from many older fields and must make substantial investments to maintain current production levels. In the mid-term, Indonesia's natural gas production increases somewhat as a result of the new Tangguh LNG export project, which came on line in the second half of 2009 and ramped up to full production in 2010 [*120*]. Indonesia could also become the first country to produce LNG from an unconventional gas source, ahead of Australia's coalbed methane to LNG projects, which are scheduled to come on line around 2015. Indonesia has at least 20 active production-sharing contracts for ongoing coalbed methane drilling [*121*]. Indonesia expects first coalbed methane production in 2011, with small production flows feeding a local power plant. In 2012, natural gas from coalbeds could flow to the Bontang LNG liquefaction plant [*122*].

Non-OECD Central and South America

Natural gas production in the non-OECD economies of Central and South America grows by more than 85 percent from 2008 to 2035 (Figure 55). The fastest growth, averaging 6.9 percent per year, is projected for Brazil, where recent discoveries of oil and natural gas in the subsalt Santos basin are expected to increase the country's natural gas production. Much of that natural gas lies far from shore, and because of a lack of current infrastructure to bridge the distances, initial natural gas production associated with oil extraction from the subsalt fields is likely to be reinjected for enhanced oil recovery rather than being brought to market. Over the longer term there are plans to connect the subsalt gas and oil fields to shore with natural gas pipelines, or to produce and

Figure 53. Non-OECD Asia natural gas production, 1990-2035 (trillion cubic feet)

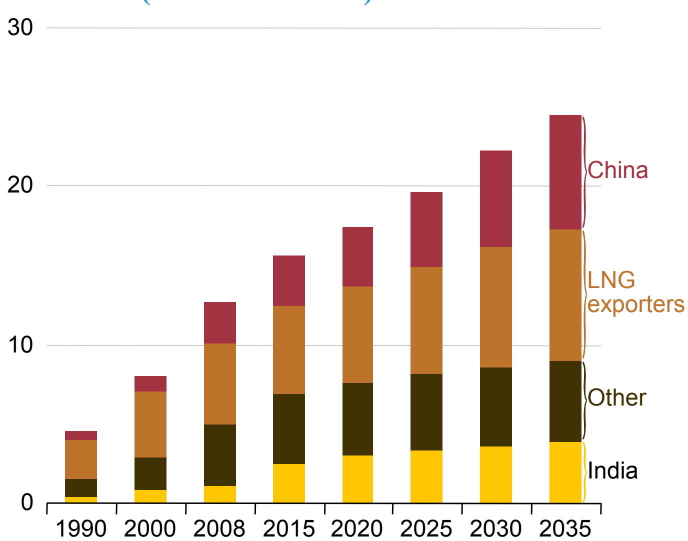
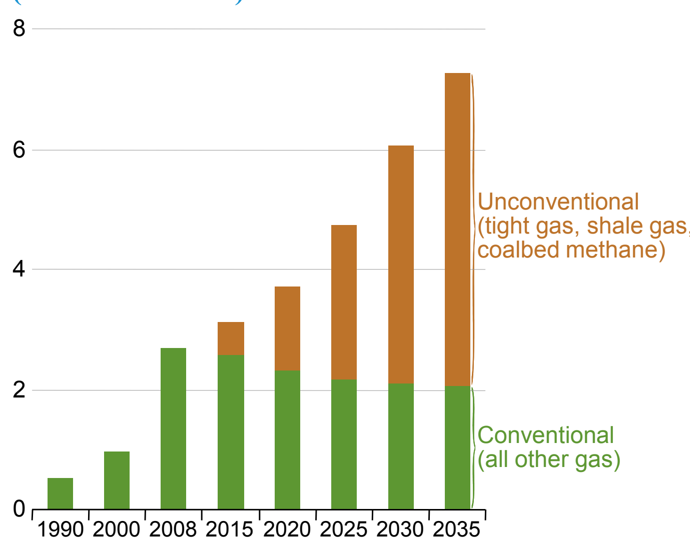


Figure 54. China natural gas production, 1990-2035 (trillion cubic feet)



liquefy Brazil's natural gas at sea, on floating platforms from which LNG could be loaded onto ships for transport to existing regasification terminals on the country's coast.

Despite recent declines in production, Argentina is still the leading producer of natural gas in Central and South America, accounting for more than 40 percent of the region's total production in 2008. Argentina is also leading the region in its pursuit of tight gas and shale gas. Much of the decline in production from conventional reservoirs can be attributed to wellhead price controls instituted in 2004, which froze wellhead prices at around $1.40 per million Btu [*123*]. Much of the interest in tight and shale gas can be attributed to Argentina's Gas Plus program, which allows natural gas to be sold at prices of up to $5.00 per million Btu [*124*]. Argentina already is producing natural gas from tight reservoirs, and Apache Corporation in December 2010 drilled the first horizontal well with multiple fracture stages in a shale play in Argentina [*125*].

World natural gas trade

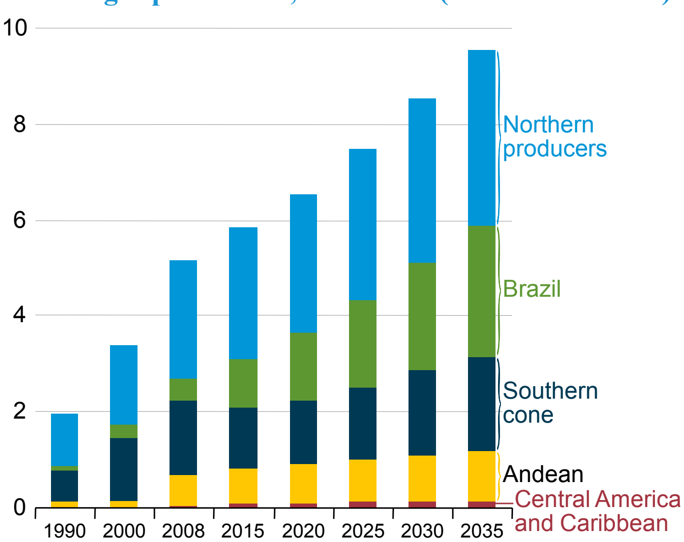
The geographical mismatch of locations with natural gas resources and locations with rising demand indicates continued expansion of international trade through 2035. In the *IEO2011* Reference case, trade in natural gas between OECD and non-OECD countries grows throughout the projection at an average rate of around 1 percent per year, so that in 2035 the total volume crossing between the two country groups is 17.4 trillion cubic feet. Much of the driving force behind the increase is demand for deliveries into countries of OECD Europe. In 2035, approximately 15.6 trillion cubic feet per year of natural gas imports flow to OECD Europe alone—almost double the volume of current imports to the region. At the same time, the required volumes of net imports for OECD regions in Asia and the Americas decline.

The increase in world trade results in part from efforts in many countries to commercialize natural gas resources through construction of LNG production facilities. International trade in natural gas currently is undergoing rapid transformation, as a massive expansion of LNG production capacity in several countries continues. In the past 5 years there has been a 40-percent increase in world LNG production capacity, from approximately 176 million metric tons per year at the end of 2005 to 260 million metric tons per year at the end of 2010, with an impact on world markets that is likely to provide increased flows among regions for many years. As world economies recovered in 2010, LNG flows increased by nearly 20 percent and set a new record high for trade levels. Consumption of LNG—much of which crosses regional boundaries—totaled approximately 10.4 trillion cubic feet in 2010 [*126*].

Although LNG trade has grown considerably faster in recent years, flows of natural gas by pipeline still are an integral part of world natural gas trade in the *IEO2011* Reference case, which includes several new long-distance pipelines and expansions of existing infrastructure through 2035. Current international trade of natural gas by pipeline occurs in the largest volumes in North America (between Canada and the United States) and in Europe among numerous OECD and non-OECD countries. By the end of the projection period, the *IEO2011* Reference case includes large volumes of pipeline flows into China from both Russia and Central Asia.

Increased LNG trade and cross-border natural gas pipeline flows have long indicated transformation of markets around the world, including increased natural gas consumption in growing economies and likely changes in interregional pricing practices. Although the emergence of a global natural gas market has yet to occur with a depth rivaling other global commodities such as oil, an evolution toward greater interregional trade and pricing continues. By the end of 2011, 19 countries are expected to be exporting LNG, as compared with 12 in the years before 2000. Suppliers of LNG, including new exporting countries such as Yemen and Russia, have successfully expanded marketing efforts, so that the list of LNG importing countries has grown to 26 in 2011 from 12 before 2000. In the past two years alone, Brazil, Argentina, Chile, Canada, and Kuwait have begun importing LNG for the first time.

Figure 55. Non-OECD Central and South America natural gas production, 1990-2035 (trillion cubic feet)



Although the rapid expansion of LNG trade in recent years has occurred primarily through the commercialization of large reserves of conventional resources, interest in developing unconventional resources such as natural gas shale formations also has grown significantly. The results already are noticeable in North America, with the current development of shale resources and coincident reduction in demand for imports. Although North America once was considered to be a likely destination for LNG supplies, increases in U.S. natural gas production and decreasing prices in U.S. markets have resulted in the movement of LNG supplies to higher-priced markets in South America, Europe, and Asia instead.

It is likely that significant shale resources also exist in other large consuming countries, including China and several European nations. Although development of shale resources in China and other countries could slow the growth of their demand for imports, exploitation of unconventional resources is not necessarily a countervailing force to growing international trade. For example, the development of shale gas resources in Canada and coalbed methane in Australia already has resulted in proposals for the construction of liquefaction facilities from which LNG would be transported to Asian markets.

OECD natural gas trade

In 2008, about one-quarter of natural gas demand in OECD nations was met by net imports from non-OECD countries. OECD reliance on supplies from non-OECD countries is expected to remain fairly constant over the projection, even as significant differences in the trade profiles of the OECD regions of the Americas, Europe, and Asia evolve. With continued exploitation of unconventional resources in the United States and Canada, the OECD Americas region remains relatively self-sufficient throughout the projection. Both OECD Europe and OECD Asia have large requirements for natural gas imports through 2035, but OECD Asia's decline while OECD Europe's expand significantly.

OECD Americas

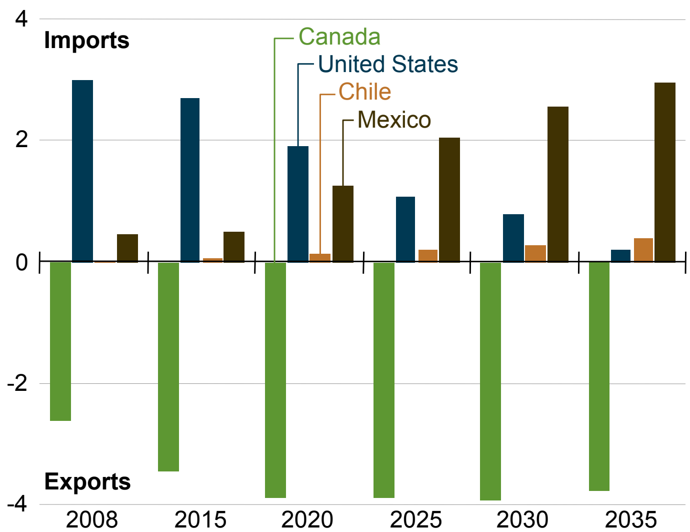
Regional net imports among the nations of the OECD Americas begin a downward trend early in this decade that extends through 2035 in the *IEO2011* Reference case (Figure 56). In the United States, rising domestic production reduces the need for imports, primarily as a result of robust growth in regional production of shale gas, which totals 12 trillion cubic feet per year in 2035, double the level projected in last year's outlook.

Increased domestic production lessens the need for U.S. net imports from approximately 13 percent of total supply in 2008 to less than 1 percent in 2035. The reduction is reflected through most of the years of the projection in lower pipeline flows from Canada, which has delivered more than 2.5 trillion cubic per year to the United States since 1995. In addition, several new LNG import facilities that have come on line in the United States over the past 5 years are largely underutilized in the projection. In fact, the facilities currently are serving as temporary storage sites for LNG that has been brought to the United States for re-export to other countries. Although applications have been filed for the liquefaction and export of domestically produced natural gas from the Gulf Coast, considerable uncertainty surrounds the issue. Two applications to export to Free Trade countries have been approved, and applications to export to non-Free Trade countries are under consideration but have not been approved as of early 2011.[22] Currently, the only liquefaction and exportation of domestically produced LNG from the United States is from a Conoco facility in Kenai, Alaska. The facility has been in operation since 1969, exporting less than 65 billion cubic feet per year to Japan, with authorization to export through 2013. Recently, Conoco has announced plans to mothball the facility and has indicated that the nuclear crisis in Japan has not altered the decision [*127*].

In the *IEO2011* Reference case, the near-term decline in pipeline exports from Canada to the United States is reversed by increases in Canada's production of tight gas, shale gas, and coalbed methane. The unconventional resources are concentrated in the western portions of the country, where substantial infrastructure additions will be needed to bring the supplies to market. Nonetheless, substantial reserves in the Montney Shale in east central British Columbia have shown significant potential and attracted developmental interest and investment by several large producers. Canada has an operating LNG import terminal at St. Johns, New Brunswick, and several others that are either approved or in the planning stages. However, construction of the facilities has been postponed. Interest on behalf of project developers has lessened as U.S. production has grown over the past 2 years [*128*]. In fact, LNG could play a significant role in Canada's exports by the end of the projection period, with three export terminals proposed for the Kitimat area in British Columbia, all to serve Asian markets.

In the OECD Americas as a whole, the growing dependence of Mexico and Chile on imports offsets the reduction in U.S. import demand. As Mexico's domestic production fails to keep pace with consumption growth, its net imports grow from 0.4 trillion cubic feet in 2008 to 2.9 trillion cubic feet in 2035. Flows from the United States, which currently account for about 15.7 percent of Mexico's natural gas supply, increase substantially in the projection. LNG supply, a steady volume of which has been delivered to the country since 2005, also is increasingly important to meeting growing demand in the country. The newer Costa Azul LNG Terminal in Baja California on the country's western coast has been used infrequently. Supplies from Indonesia, once envisioned for the terminal, have been redirected to Asian markets. However, the Altamira LNG Terminal on Mexico's eastern coast has received LNG

Figure 56. OECD Americas net natural gas trade, 2008-2035 (trillion cubic feet)



[22]The approval covers countries with which the United States currently has, or in the future will enter into, Free Trade Agreements (FTAs) calling for "national treatment for trade in natural gas." The United States has FTAs that require national treatment for trade in natural gas with the following countries: Australia, Bahrain, Singapore, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Chile, Morocco, Canada, Mexico, Oman, Peru, and Jordan. The United States has FTAs that do not require national treatment for trade in natural gas with Costa Rica and Israel.

shipments on a regular basis, with volumes totaling more than 100 billion cubic feet per year since 2008. LNG supplies also are expected to increase following the completion in 2011 or 2012 of another terminal on the west coast, in Manzanillo. The Manzanillo terminal is expected to receive supplies regularly from Peru's LNG export terminal, which was completed in 2010 [*129*].

Chile produced a relatively modest amount of natural gas in 2008—66 billion cubic feet, as compared with Mexico's 1,694 billion cubic feet. Until recent years, Chile relied on Argentina to supply most of its natural gas demand. In 2004, imports from Argentina supplied 282 billion cubic feet of the 293 billion cubic feet of natural gas consumed in Chile [*130*]. Wellhead gas prices, held artificially low by Argentina's price controls, had the dual effect of encouraging demand for natural gas and discouraging investment in exploration and production. As a result, Argentina had to limit natural gas supplies available for export in order to meet domestic demand. Consequently, Chile moved to ensure that it would be able to receive gas from other sources, by building two LNG regasification terminals, one in Quintero near Santiago and one in the northern town of Mejillones [*131*]. To increase natural gas supplies, GDF Suez announced that it would construct an onshore LNG storage facility in Northern Chile by 2013 [*132*]. The diversification of natural gas suppliers already has helped Chile improve its energy security, and natural gas imports are likely to continue to rise in the future.

OECD Europe

Continued growth is expected for natural gas imports into OECD Europe, as global LNG supplies continue to expand rapidly over the next few years, and as the Medgaz pipeline from Algeria begins exporting gas to Spain in 2011. Over the term of the projection, OECD Europe's total natural gas imports increase by an average of 2.1 percent per year, as local production sources in the Netherlands and United Kingdom decline while demand increases. Pipeline sources are projected to be significant contributors to the incremental 6.6 trillion cubic feet of imports needed in the region. The Nord Stream pipeline from Russia and the Galsi pipeline from Algeria could push additional natural gas supplies into OECD Europe as soon as 2011 and 2014, respectively, according to planned start dates.

For the second year in a row, LNG supplies to OECD Europe increased significantly in 2010, even as overall consumption generally declined [*133*]. Major shifts in international trade partners and pricing are occurring in the region. European buyers continue to favor LNG as a result of lower spot prices relative to prices for oil-indexed pipeline supply contracts. For example, imports of LNG were up by 26 percent in 2010, and imports of pipeline gas from Russia were down by almost 2 percent. The contrast was even more striking in 2009, when LNG imports to the region increased by more than 20 percent, and imports from Russia were down by 11.9 percent [*134*].

The recent increase in LNG supplies to Europe, and particularly to the United Kingdom, has added complexity to natural gas pricing in the region. In comparison to long-term contracts with prices linked to oil and petroleum product prices, LNG supplies have improved the prospects for spot market trading. Since the onset of the financial crisis in late 2008, which resulted in lower natural gas demand and excess supplies worldwide, buyers have resorted to buying greater volumes of LNG on spot markets rather than opting for supplies through oil-linked contracts.

Continental Europe's long-term contracts with suppliers of pipeline gas, which include Russia, Algeria, and Norway, among others, have some flexibility in terms of volumes, but the prices generally are linked to lagged prices for oil products. Although some suppliers, such as Norway, switched as much as 30 percent of their contracted volumes to spot market pricing, other countries, such as Algeria, altered their pricing far less or not at all [*135*]. The subsequent loss of market share by suppliers with less flexibility in pricing over the past 2 years may indicate eventual changes in the pricing of pipeline imports from a variety of countries—including Russia, which is by far the largest exporter to Europe. The extent of such changes over the long term remains to be seen.

Contributing to the abundance of natural gas supplies available for import to OECD Europe in 2009 were additional LNG imports from Qatar, which at least in part are priced to coincide with spot market prices in the United Kingdom. Qatar in early 2011 completed a massive investment in its LNG production capacity, establishing itself as by far the largest producer of LNG in the world. As a result of the construction program, Qatar's LNG production capacity has risen to 3.8 trillion cubic feet per year, and new regasification facilities have been opened in the United States, the United Kingdom, and Italy.

OECD Asia

Currently, the largest LNG importers in the world are in OECD Asia, which receives a substantial portion of its overall natural gas supply in the form of LNG imports. In the *IEO2011* Reference case, Japan and South Korea continue to receive the vast majority of their natural gas supplies as LNG; however, demand growth is relatively low in both countries, and the growth in their natural gas imports is more than offset by growing exports from Australia. As a result, OECD Asia's net demand for imports declines over the projection period, from 4.3 trillion cubic feet in 2008 to 2.1 trillion cubic feet in 2035 (Figure 57).

Japan and South Korea continue to be major players in world trade of LNG, despite consuming relatively small amounts of natural gas on a global scale (representing 4.4 percent of world consumption in 2008). Because the two countries are almost entirely dependent on LNG imports for natural gas supplies, overall consumption patterns are translated directly into import requirements. As a result, Japanese and South Korean companies actively pursue opportunities to be foundation customers for greenfield Pacific liquefaction projects. For example, Japanese and South Korean companies have signed firm contracts for significant shares of the output from a variety of LNG projects in the Asia Pacific region, including Russia's Sakhalin 2 project, completed in 2009, and Australia's Pluto project, which is scheduled for completion in 2011.

Australia is by far the most active LNG exporter among OECD countries and one of the most active countries in the world for future LNG development. In 2008, Australia exported 0.5 trillion cubic feet of natural gas from its two operating LNG export facilities. Both North West Shelf LNG and Darwin LNG are located in the northwest part of the continent, an area rich in natural gas resources that is targeted for substantial development in coming years. Australia had two new liquefaction projects under construction in 2011, Pluto and Gorgon, both drawing gas from fields in the Carnarvon Basin in the northwest. First exports of LNG from the Pluto project, which is majority-owned by Woodside Petroleum, Ltd., are expected by the end of 2011, and shipments of LNG from Chevron's mammoth Gorgon project are expected in 2014 [*136*]. The two projects together will expand Australia's export capacity by close to 1.0 trillion cubic feet per year.

As a result of the two projects above and numerous others that have been proposed, Australia's exports of natural gas more than triple from 2008 to 2020 in the Reference case, to 1.6 trillion cubic feet, and continue growing through 2035. Two additional liquefaction projects based off Australia's northwest coast aim for final investment decisions in 2011. The Wheatstone project would be the fourth independent liquefaction project to draw gas from the Carnarvon Basin, and Ichthys LNG would be the first project to draw gas from the Browse Basin, which lies between the Carnarvon and Bonaparte Basins [*137*].

Additionally, there are also at least four separate liquefaction projects planned for eastern Australia. In October 2010, BG Group approved a final investment decision for the Queensland Curtis LNG Project, which is planned to export up to 0.4 trillion cubic feet of LNG per year by 2014 and is underpinned by contracts with buyers in Chile, China, Japan, and Singapore [*138*]. Three other projects also are planned, using coalbed methane supplies from the Bowen-Surat Basin. Final investment decisions are expected in 2011 and first gas production around 2015 [*139*]. Not all of the proposed projects and expansions are assumed to go forward in the *IEO2011* Reference case, because some of them appear to be competing for the same reserves to supply their facilities.

Non-OECD natural gas trade

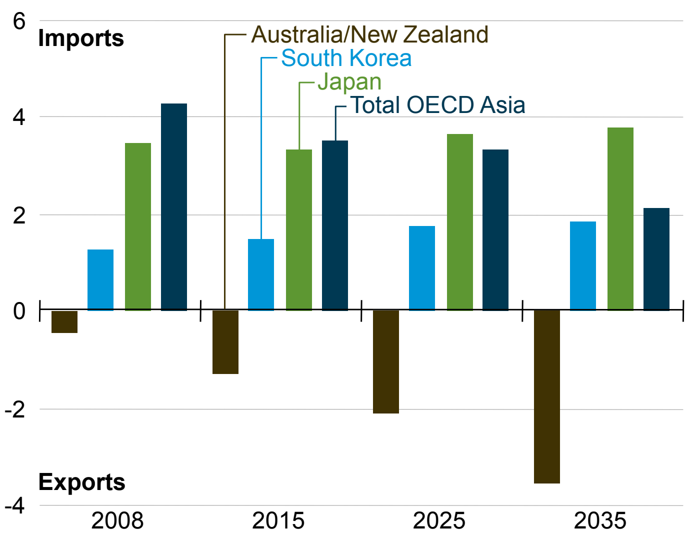
Net exports of natural gas from the non-OECD region as a whole grow from 13.0 trillion cubic feet in 2008 to 17.4 trillion cubic feet in 2035 in the *IEO2011* Reference case. The fastest growth in international trade occurs in the near term, as a result of growing exports from new LNG projects in the Middle East and new natural gas pipelines from Africa to Europe. The vast natural gas resource base in non-OECD countries points to their continued ability to meet incremental growth in natural gas demand both among countries in the region and among the OECD countries. However, with demand in non-OECD countries (excluding non-OECD Europe and Eurasia) rising rapidly in the projection, non-OECD countries export considerably less of their overall production to OECD countries over time. In 2008, 18.8 percent of non-OECD natural gas production was exported. The share peaks before 2015 at nearly 20 percent, as the current construction of LNG infrastructure and resulting boost in LNG exports is not met by a similar surge in consumption. Consequently, the share of non-OECD natural gas production exported to OECD countries declines gradually through the remainder of the projection.

Non-OECD Europe and Eurasia

Net exports of natural gas from Russia, the largest exporter in the world, are the most significant factor in exports from non-OECD Europe and Eurasia—exceeding the combined net exports of all other non-OECD regions in the *IEO2011* Reference case. Net exports from non-OECD Europe and Eurasia rise from 5.3 trillion cubic feet in 2008 to 14.2 trillion cubic feet in 2035, at an average annual rate of 3.7 percent (Figure 58). Russia provides the largest incremental volume to meet the increase in demand for supplies from non-OECD Europe and Eurasia, with its net exports growing by an average of 2.8 percent per year, from 6.6 trillion cubic feet in 2008 to 14.0 trillion cubic feet in 2035. LNG and pipeline exports from Russia to customers in both Europe and Asia increase throughout the projection.

Despite recent declines in demand for Russian natural gas in Europe, the country has numerous projects under construction or in planning that, along with its extensive resource base, could meet future needs of importers. In late 2011, construction of the first of two parallel lines for the new Nord Stream pipeline is scheduled to be completed, with a capacity of almost 0.8 trillion cubic feet of natural gas per year across the Baltic Sea to Germany. Flows through the Nord Stream pipeline, for which a second, parallel pipe is under construction and planned for completion by 2013, are

Figure 57. OECD Asia net natural gas trade, 2008-2035 (trillion cubic feet)



expected be significant in part because the pipeline route bypasses eastern European transit states with which Russia has had pricing and payment disputes in the past.

Russia has several other proposed export pipeline projects, including the South Stream pipeline, which would carry natural gas across the Black Sea, bypassing Ukraine on its way to European markets. In addition, Russia is moving forward on developing its massive Shtokman field in the Barents Sea, with plans to make a final investment decision by the end of 2011 to build related LNG facilities and a pipeline into Europe by 2017 [*140*]. The *IEO2011* Reference case also incorporates pipeline flows from Russia to China.

Exports from Central Asia could add substantial supplies to markets in both the East and West. In late 2009, flows of natural gas to China from Turkmenistan began with the completion of a pipeline running from the Bagtyyarlyk, Saman-Depe, and Altyn Asyr fields in Turkmenistan through Uzbekistan and Kazakhstan and eventually connecting to China's second West-East pipeline in Xinjiang province [*141*]. By the end of 2011, the pipeline will have a capacity of 1.1 trillion cubic feet per year. Initial flows to date have been considerably less than capacity, however. Additional export volumes are expected to come from Turkmenistan's giant South Yolotan-Osman field and could also come from fields in Kazakhstan. In the *IEO2011* Reference case, exports from Central Asia grow from 2.4 trillion cubic feet in 2008 to 3.7 trillion cubic feet in 2035, with increases averaging 1.7 percent per year.

Middle East

Net exports of natural gas from the Middle East grow at an annual rate of 3.6 percent, as flows from the region increase from 1.8 trillion cubic feet in 2008 to 4.8 trillion cubic feet in 2035 (Figure 59). An important factor in the increase, particularly in regard to brisk growth in volumes in the near term, is the rise of LNG supplies from Qatar, which went from exporting its first LNG in 1999 to being the largest LNG exporter in the world in 2009. Qatar's LNG exports continue to increase through 2035. Its total LNG export capacity reached 77 million tons (3.6 trillion cubic feet) per year in early 2011 with the completion of the last in a line of six mega-sized liquefaction trains under construction since 2008. Each train has the capacity to produce the equivalent of 0.36 trillion cubic feet of natural gas per year for export [*142*].

Qatar's natural gas exports grow by an estimated average of 12.5 percent per year from 2008 to 2015 in the Reference case, then slow to an average increase of just 0.9 percent per year after 2015. Because of a current moratorium on further development from the North Field, no new LNG projects are being initiated. Qatar enacted the moratorium in 2005 in order to assess the effect of the ongoing increase in production on the North Field before committing to further production increases [*143*]. If Qatar decides to lift the moratorium on North Field development in 2014, its stated development priority is to ensure that it can meet long-term domestic natural gas needs for power generation, water desalination, and local industry. Only after those needs are met will it consider further increases in exports, and any increases are expected to come primarily from optimization of current facilities.

Despite possessing the second largest reserves of natural gas in the world, Iran continues to struggle with the formation of an export program that will result in significant commercialization of its resources. The country shares the North Field/South Pars Field with Qatar and has numerous export projects under consideration through the development of its portion of those reserves. The *IEO2011* Reference case projects significant flows from Iran, so that by 2035 the country is a net exporter of 1.4 trillion cubic feet per year. Nonetheless, the country as of 2008 was just barely a net importer, receiving slightly higher volumes of natural gas from Turkmenistan than it sent to Turkey (resulting in net imports of 0.1 trillion cubic feet). Although its first LNG export plant is under construction, Iran is without international partners and without any obvious source for obtaining liquefaction technology. Other export projects continue to be discussed, but as a result of international sanctions and internal politics there has been little progress on most projects.

Figure 58. Non-OECD Europe and Eurasia net natural gas trade, 2008-2035 (trillion cubic feet)

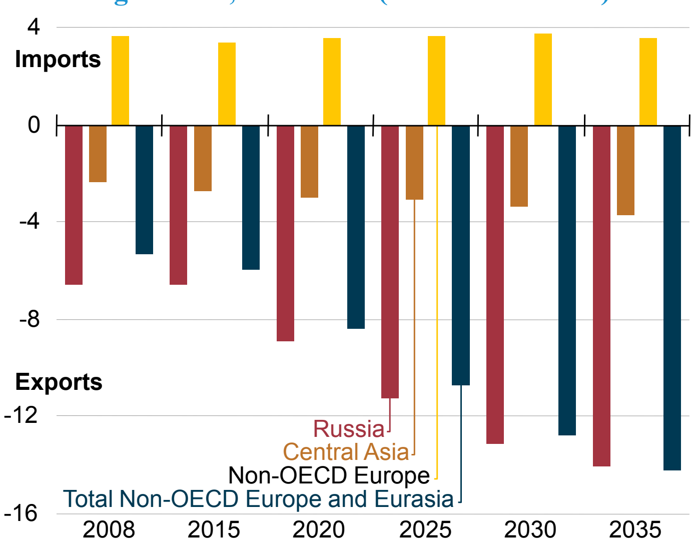
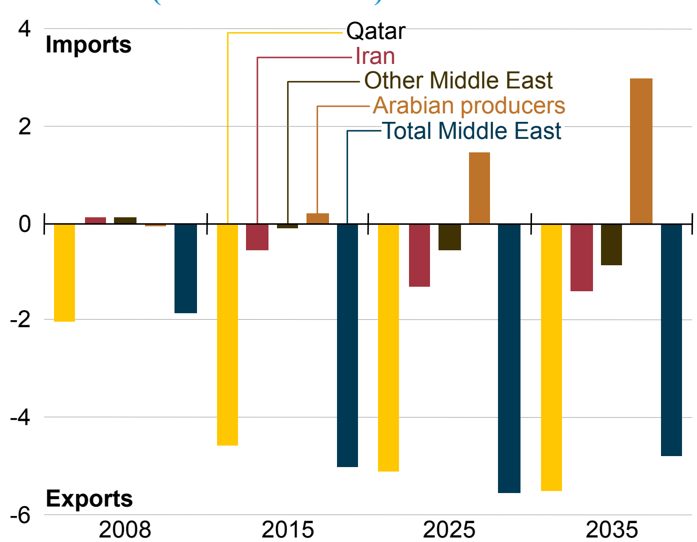


Figure 59. Middle East net natural gas trade, 2008-2035 (trillion cubic feet)



Elsewhere in the Middle East, a second LNG train was completed in Yemen in 2010, giving the country total LNG export capacity of 0.4 trillion cubic feet per year [*144*]. Additionally, Oman and the United Arab Emirates also export LNG from the Middle East. Nonetheless, the potential for growth in exports from those and other countries in the Middle East appears to be limited by the growth of domestic demand, which has even resulted in significant volumes of LNG imports for Kuwait and likely upcoming volumes for the United Arab Emirates (UAE), which completed construction of a facility for importing LNG in November 2010 and received its first cargo a month later [*145*]. Both Oman and UAE also are currently importing natural gas via pipeline from Qatar. The *IEO2011* Reference case projects a similar trend for producers in the Arabian Peninsula region as a whole, including Kuwait, Oman, UAE, and Yemen. As a group, they received net imports of less than 0.1 trillion cubic feet of natural gas in 2008, but the volume of imports rises throughout the projection, and net imports into the Arabian Peninsula in 2035 total 3.0 trillion cubic feet.

Africa

Net exports of natural gas from Africa increase in the projection at a rate of 1.0 percent per year (Figure 60). In 2008, the region's net exports totaled about 3.9 trillion cubic feet, led by net exports of 3.0 trillion cubic from North Africa. Approximately one-half of the exports from North Africa are deliveries by pipeline from Algeria, Egypt, and Libya to Spain, Italy, and parts of the Middle East. The remainder is exported as LNG throughout the world, primarily to European countries, from liquefaction facilities in Algeria, Egypt, and Libya.

The increased volumes of natural gas exports from Africa result in part from a large expansion of infrastructure underway in Algeria for export capacity by pipeline and from LNG terminals. The Medgaz pipeline, which has a planned capacity of 0.3 trillion feet per year, began transporting supplies from Algeria to Spain in March 2011 [*146*]. Two liquefaction projects also are progressing in Algeria: the Gassi Touil project and a new liquefaction train at the existing Skikda export facility. Together they are expected to increase Algeria's LNG export capacity by 0.4 trillion cubic feet per year by 2013. In addition, a consortium led by Algeria's national oil and natural gas company, Sonatrach, and Italian utility Edison S.p.A. is planning to construct the Gasdotto Algeria-Sardegna-Italia Pipeline (GALSI) from Algeria to Italy by 2014, increasing the capacity for natural gas trade between the two countries by a total of 0.4 trillion cubic feet per year. The project timeline for GALSI, however, has slipped several times and a final investment decision has not been made on the project.

Any additional major expansions of export capacity from North Africa are projected to be dependent on the Trans-Sahara natural gas pipeline. The pipeline, if built, would stretch 2,800 miles to bring natural gas from Nigeria, across Niger, and connecting in Algeria to export pipelines to Europe. The Trans-Sahara pipeline was given the official go-ahead in 2009, having been declared economically and technically feasible, and 2015 was set as the official targeted start date [*147*]. However, the project still faces significant security issues and has not yet obtained the neceesary financing.

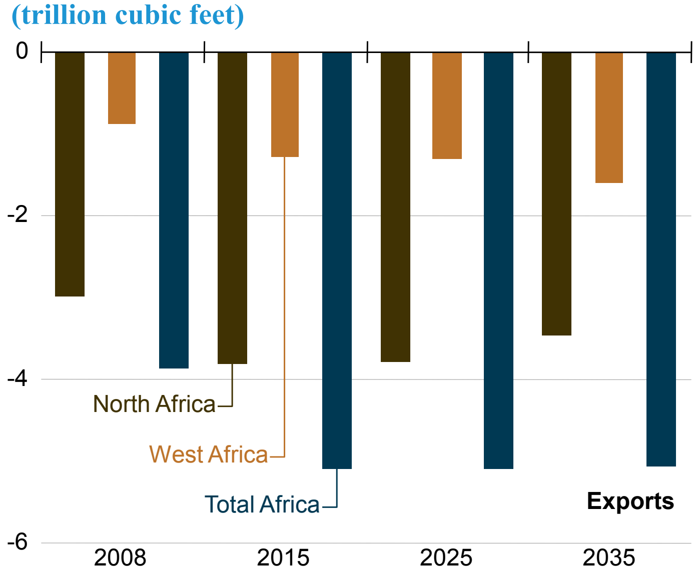
Non-OECD Asia

In the *IEO2011* Reference case, non-OECD Asia is the only regional grouping that changes from a net exporter to a net importer of natural gas. In fact, with net imports of 7.6 trillion cubic feet in 2035, the region becomes the world's second-largest importing region, behind only OECD Europe. The largest increases in import demand are projected for China and India, which together require imports of 6.0 trillion cubic feet per year in 2035. In 2035, China meets 40 percent of its annual consumption with imported natural gas and India 28 percent (Figure 61).

To meet its future demand, China is actively pursuing multiple potential sources for natural gas imports. At the end of 2010, China had four LNG import terminals in operation, four under construction, and several more proposed or in various stages of development. The country is currently importing natural gas under long-term contract from four different countries, with no single country signed up to provide more than 37 percent of the total contracted volume. In addition, Chinese companies have signed contracts to increase imports from Australia, Qatar, and Malaysia.

At the same time that China is pursuing multiple sources for LNG imports, it is also pursuing multiple sources for pipeline natural gas imports. China's first natural gas import pipeline, completed in late 2009, transports supplies from Turkmenistan and Kazakhstan. Another new pipeline from Myanmar, scheduled for completion in 2013, will carry 0.4 trillion cubic feet of natural gas per year from Myanmar's offshore fields in the Bay of Bengal to Kunming in China's Yunnan province [*148*]. China and Russia continue to discuss future natural gas pipeline connections between the two countries. In 2009, the heads of the countries reached an agreement envisioning two separate large-diameter pipelines from eastern and western Siberia by 2014 or 2015. The 2009 agreement suggested that volumes of 2.5 to 2.8 trillion cubic feet of natural gas per year would be exported through the proposed pipelines.

Figure 60. Africa net natural gas trade, 2008-2035 (trillion cubic feet)



In the *IEO2011* Reference case, India's imports as a share of its total natural gas consumption begin rising several years into the projection. In 2010, import growth remained muted as LNG deliveries continued to account for about 17 percent of overall supplies while new production from the Krishna Godavari Basin was ramped up [*149*]. Over the long term, India's import requirements are expected to increase as its domestic production fails to keep up with demand, and in 2035 its imports total 1.4 trillion cubic feet. Accordingly, India is expected to continue expanding its LNG import infrastructure. The country currently has three active LNG terminals, and its new Kochi terminal is expected to be completed in 2012. Numerous other facilities have been proposed, but progress has been slow as industry participants have chosen first to evaluate the production potential from the Krishna Godavari field.

Non-OECD Central and South America

Until 2008, South America's natural gas market was almost entirely self-contained. The lone facility operating in international trade was an LNG liquefaction facility on the island of Trinidad and Tobago. However, natural gas in South America has become increasingly globalized, as several countries have become involved in the LNG value chain. Since beginning operations in late 2008 and 2009, floating LNG regasification facilities in Chile (now an OECD member), Argentina, and Brazil have received LNG supplies fairly consistently over the past 2 years. In 2010 alone, their combined LNG imports totaled 0.3 trillion cubic feet [*150*]. In addition, the first LNG export project in Andean South America was completed in Pampa Melchorita, Peru, in mid-2010. The plant, which has a capacity to produce up to 0.2 trillion cubic feet per year and is supplied by the Camisea gas field, is expected to provide deliveries to Mexico beginning in 2012 and is already sending cargos to the United States and other destinations in Europe and Asia. Pipeline exports from Bolivia, also in the Andean region, remain more or less flat over the projection period but switch from being directed mainly toward Brazil to being directed mainly toward Argentina in the Southern Cone region (Figure 62).

Reserves

The reported level of global natural gas reserves has grown by 50 percent over the past 20 years, outpacing the growth in oil reserves over the same period. Natural gas reserve estimates have grown particularly in non-OECD Europe and Eurasia, the Middle East, and the Asia-Pacific region. As of January 1, 2011, proved world natural gas reserves, as reported by *Oil & Gas Journal*[23] were estimated at 6,675 trillion cubic feet—about 66 trillion cubic feet (about 1 percent) higher than the estimate for 2010.

The largest revision to natural gas reserve estimates for 2011 was made in Egypt. Egypt's estimated natural gas reserves increased by 18.7 trillion cubic feet (3.2 percent) over the 2010 estimate, from 58.5 trillion cubic feet to 77.2 trillion cubic feet. In the Middle East, higher reserve estimates were also reported by Abu Dhabi and Saudi Arabia, with increases of 13.5 trillion cubic feet (6.8 percent) and 12.2 trillion cubic feet (4.6 percent), respectively. Also in the Middle East, Israel, which had recorded a minimal level of reserves previously, increased its estimate by nearly 6 trillion cubic feet, to a total of 7 trillion cubic feet. Several countries reported substantial decreases in reserves: Norway with a loss of 9 trillion cubic feet (12 percent), Qatar with a loss of 3.5 trillion cubic feet (less than 1 percent), and the United Kingdom with a decrease of 1.3 trillion cubic feet (12.3 percent).

Despite output from this reserve base over the past 30 years, world natural gas reserves have increased since the 1980s by an average of 3.1 percent each year (Figure 63). The growth in reserves has even accelerated slightly since 2000, including a massive increase in 2004 by Qatar (from 508 to 910 trillion cubic feet). In 2010, there were large increases in reported natural gas reserves

Figure 61. Non-OECD Asia net natural gas trade, 2008-2035 (trillion cubic feet)

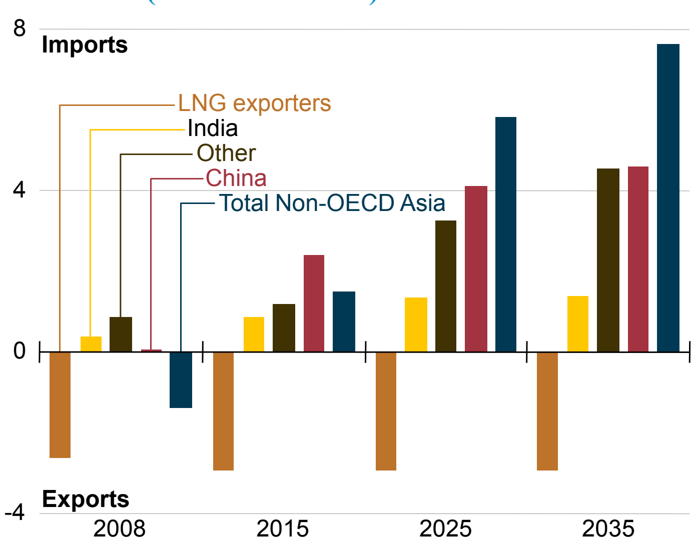
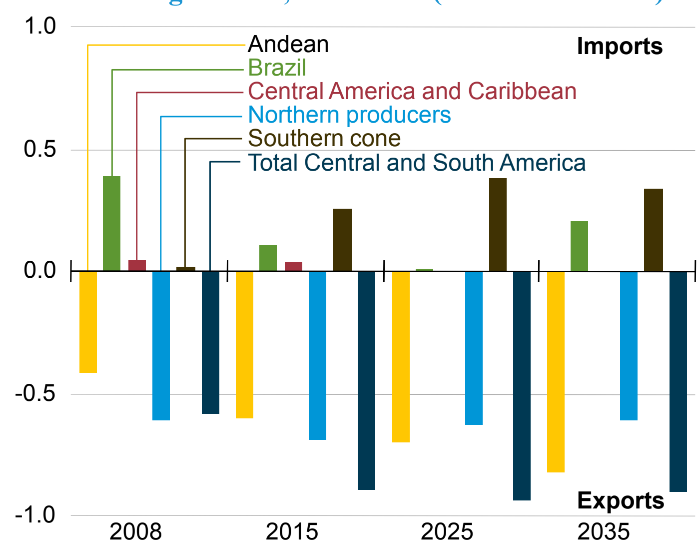


Figure 62. Non-OECD Central and South America net natural gas trade, 2008-2035 (trillion cubic feet)



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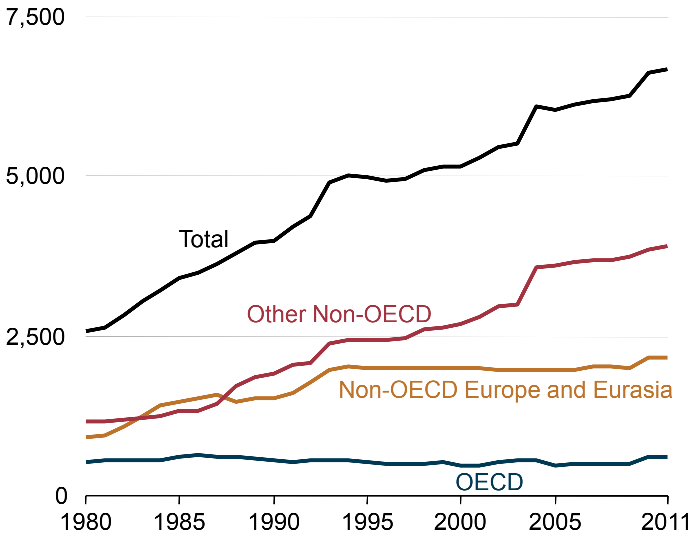
in Turkmenistan and Australia. In Turkmenistan, estimated reserves increased from 94 trillion cubic feet to 265 trillion cubic feet following reappraisals of the giant South Yolotan-Osman field. In Australia, a change in the governmental reporting system led to an increase of 80 trillion cubic feet to 110 trillion cubic feet.

Current estimates of natural gas reserve levels indicate a large resource base to support growth in markets through 2035. Like reserves for other fossil fuels, natural gas reserves are spread unevenly around the world. Natural gas reserves currently are concentrated in Eurasia and the Middle East, where ratios of reserves to production suggest decades of resource availability. In the OECD countries, however, including many where there are relatively high levels of consumption, ratios of reserves to production currently are significantly lower. The impact of the disparity in these ratios is reflected in the *IEO2011* projections for increased international trade in natural gas.

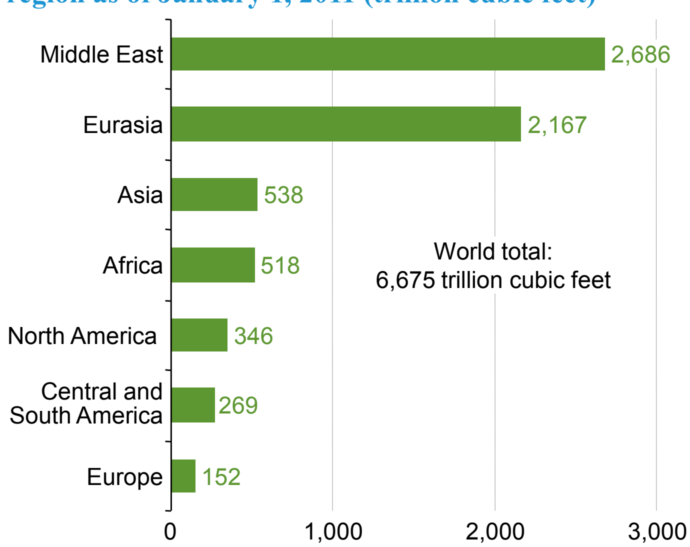
Almost three-quarters of the world's natural gas reserves are located in the Middle East and Eurasia (Figure 64). Russia, Iran, and Qatar together accounted for about 54 percent of the world's natural gas reserves as of January 1, 2011 (Table 7). Reserves in the rest of the world are distributed fairly evenly on a regional basis. Despite high rates of increase in natural gas consumption, particularly over the past decade, most regional reserves-to-production ratios have remained high. Worldwide, the reserves-to-production ratio is estimated at 60.2 years [*151*]. Central and South America has a reserves-to-production ratio of 51.6 years, Russia 82.0 years, and Africa 64.7 years. The Middle East's reserves-to-production ratio exceeds 100 years.

Figure 63. World natural gas reserves by region, 1980-2011 (trillion cubic feet)



Sources: *Oil & Gas Journal* and EIA.

Figure 64. World natural gas reserves by geographic region as of January 1, 2011 (trillion cubic feet)



Sources: *Oil & Gas Journal* and EIA.

Table 7. World natural gas reserves by country as of January 1, 2011

Country	Reserves (trillion cubic feet)	Percent of world total
World	**6,675**	**100.0**
Top 20 countries	**6,067**	**90.9**
Russia	1,680	25.2
Iran	1,046	15.7
Qatar	896	13.4
Saudi Arabia	275	4.1
United States	273	4.1
Turkmenistan	265	4.0
United Arab Emirates	228	3.4
Nigeria	187	2.8
Venezuela	179	2.7
Algeria	159	2.4
Iraq	112	1.7
Australia	110	1.6
China	107	1.6
Indonesia	106	1.6
Kazakhstan	85	1.3
Malaysia	83	1.2
Egypt	77	1.2
Norway	72	1.1
Uzbekistan	65	1.0
Kuwait	63	0.9
Rest of world	**608**	**9.1**

Sources: *Oil & Gas Journal* and EIA.

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Coal

Overview

In the *IEO2011* Reference case, which does not include prospective greenhouse gas reduction policies, world coal consumption increases by 50 percent, from 139 quadrillion Btu in 2008 to 209 quadrillion Btu in 2035 (Figure 65). Although world coal consumption increases at an average rate of 1.5 percent per year from 2008 to 2035, the growth rates by region are uneven, with total coal consumption for OECD countries remaining near 2008 levels and coal consumption in non-OECD countries increasing at a pace of 2.1 percent per year. As a result, increased use of coal in non-OECD countries accounts for nearly all the growth in world coal consumption over the period.

In 2008, coal accounted for 28 percent of world energy consumption (Figure 66). Of the coal produced worldwide in 2008, 60 percent was shipped to electricity producers and 36 percent to industrial consumers, with most of the remainder going to consumers in the residential and commercial sectors. In the *IEO2011* Reference case, coal's share of total world energy consumption remains relatively flat throughout the projection, declining slightly from a peak of 29 percent in 2010 to 27 percent in 2015, where it remains through 2035.

In the electric power sector, a more rapid rate of increase in the use of other fuels, particularly renewables, leads to a decline in coal's share of total energy consumption for power generation from 43 percent in 2008 to 37 percent in 2020. After 2020, however, similar growth rates for the consumption of all fuels except liquids keep coal's share of total energy use in the electricity sector relatively stable through the remaining years of the projection.

International coal trade grows by 66 percent in the Reference case, from 21.2 quadrillion Btu in 2009 to 35.2 quadrillion Btu in 2035. The share of total world coal consumption accounted for by internationally traded coal holds steady at about 17 percent for most of the projection, up from 15 percent in 2009. The stable share of coal traded primarily reflects the ability of the world's largest coal consumers, China and India, to meet substantial portions of their future coal demand with domestic production.

World coal consumption

OECD coal consumption

In the Reference case, OECD coal consumption declines from 46.8 quadrillion Btu in 2008 to an estimated 43.5 quadrillion Btu in 2010 and remains near that level through 2020. After 2020, OECD coal consumption increases to 46.7 quadrillion Btu in 2035, largely because of an increase in natural gas prices in the United States that allows coal—in the absence of policies or regulations to limit its use—to compete more effectively with natural gas in the electricity sector. Almost all of the increase after 2020 is attributable to coal consumption in the OECD Americas (Figure 67).

OECD Americas

Coal use in the United States totaled 22.4 quadrillion Btu in 2008—92 percent of total coal use in the OECD Americas region and 48 percent of the OECD total. U.S. coal demand rises to 24.3 quadrillion Btu in 2035 in the Reference case. Nevertheless, coal's share of total U.S. electricity generation (including electricity produced at combined heat and power plants in the industrial and commercial sectors) declines from 48 percent in 2008 to 43 percent in 2035.

Figure 65. World coal consumption by region, 1980-2035 (quadrillion Btu)

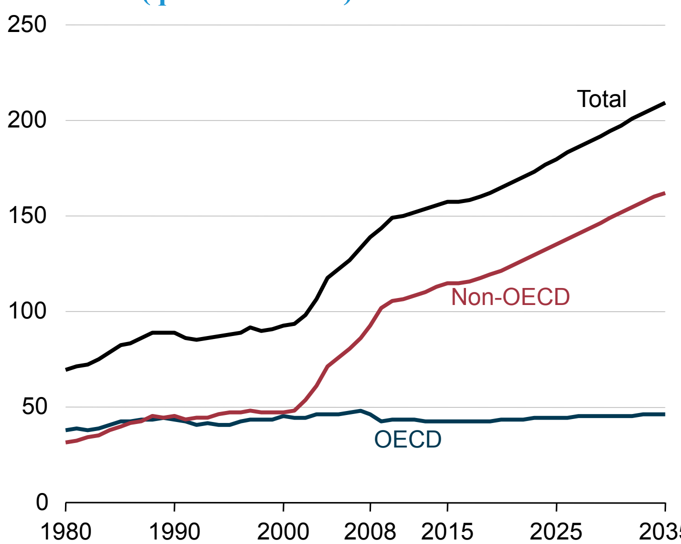
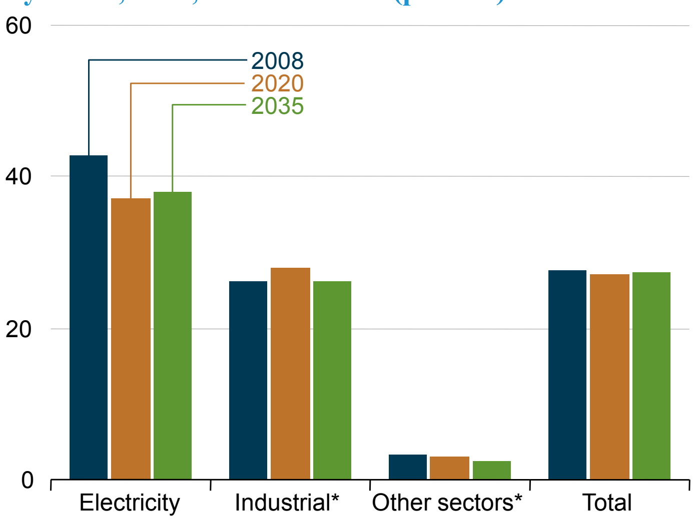


Figure 66. Coal share of world energy consumption by sector, 2008, 2020 and 2035 (percent)



*Share of delivered energy, excluding electricity-related losses.

Increasing use of coal for electricity generation at existing coal-fired power plants and at several new plants currently under construction, combined with the startup of several CTL plants toward the end of the projection, leads to modest growth in U.S. coal consumption, averaging 0.3 percent per year from 2008 to 2035. Although U.S. coal-fired electricity generation increases between 2008 and 2035 and accounts for 22 percent of the growth in total U.S. electricity generation, high cost estimates for new coal-fired power plants result in limited projections of new coal-fired capacity in the Reference case. Furthermore, in the near term, low natural gas prices lead to considerable displacement of coal-fired generation from existing plants in the early years of the projection period. Increased generation from natural gas accounts for 39 percent of the growth in total U.S. electricity generation from 2008 to 2035, and increased generation from renewables satisfies 32 percent of the increase. U.S. production of coal-based synthetic liquids, which is expected to commence in 2015, increases to 549,620 barrels per day in 2035.

In Canada, a projected decline in coal consumption totaling 0.2 quadrillion Btu from 2008 to 2035 results primarily from the Ontario government's plans to phase out the Province's coal-fired generating capacity by the end of 2014 [*152*]. In late 2010, Ontario Power Generation retired approximately 1.9 gigawatts of coal-fired generating capacity at its Nanticoke and Lambton plants, leaving the Province with 4.2 gigawatts of remaining coal-fired capacity.

In Mexico/Chile, coal consumption rises by 0.5 quadrillion Btu from 2008 to 2035, primarily because of increasing demand for electricity. In Mexico, a new 0.7-gigawatt coal-fired generating unit on the country's Pacific coast was brought on line in late 2010, and in Chile 1.7 gigawatts of new coal-fired capacity has either been completed or is nearing completion [*153*]. Chile's renewed interest in coal-fired generating capacity is based on substantial growth in electricity demand, coupled with a lack of reliable natural gas supplies from Argentina [*154*].

OECD Europe

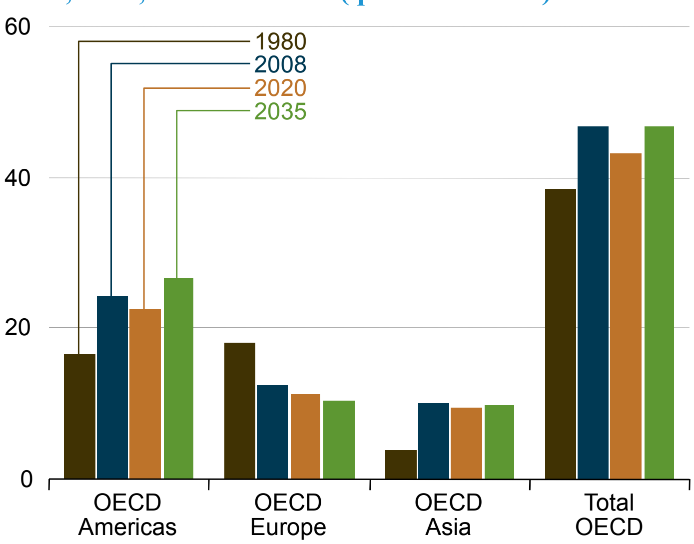
Total coal consumption in the countries of OECD Europe declines in the *IEO2011* Reference case from 12.5 quadrillion Btu in 2008 (27 percent of the OECD total) to 10.4 quadrillion Btu in 2035 (17 percent). In 2008, the electricity and industrial sectors accounted for 94 percent of the coal consumed in OECD Europe, with electricity producers using 8.7 quadrillion Btu of coal and industrial plants using 3.1 quadrillion Btu. Over the projection period, the use of coal declines in both sectors, falling at average rates of 0.9 percent per year in the industrial sector and 0.5 percent per year in the electricity sector.

Total installed coal-fired electricity generating capacity in OECD Europe declines from 200 gigawatts in 2008 to 169 gigawatts in 2035, and coal's share of total electricity generation declines from 25 percent in 2008 to 16 percent in 2035. Plans to retire aging and inefficient generating capacity are, to some extent, offset by new coal-fired capacity. Approximately 20 gigawatts of new coal-fired generating capacity currently is under construction in OECD Europe, approximately one-half of which is represented by projects in Germany [*155*]. In light of the recent nuclear crisis in Japan and the subsequent decision by the German government to reassess its September 2010 decision to extend the life of 21 gigawatts of nuclear generating capacity, it is possible that the planned retirement of 13 gigawatts of older coal-fired generating capacity may not occur [*156*]. Rather, these older coal plants may be retrofitted with environmental equipment and kept on line to replace the electricity supply lost from a shutdown of Germany's nuclear reactors.

OECD Asia

The relatively flat outlook for coal consumption in the OECD Asia region in the Reference case is the net result of two divergent trends: a decline in coal use of 0.9 quadrillion Btu for Japan and an increase of 0.8 quadrillion Btu projected for South Korea from 2008 to 2035. Japan is the region's largest coal-consuming nation, but its declining population and expected shift away from coal to alternative energy sources, including renewables and natural gas, for electricity generation lowers the demand for coal in the future.

Figure 67. OECD coal consumption by region, 1980, 2008, 2020 and 2035 (quadrillion Btu)



South Korea's coal use increases by an average of 1.0 percent per year, from 2.6 quadrillion Btu in 2008 to 3.4 quadrillion Btu in 2035. Increasing use of coal in South Korea's power sector accounts for more than three-fourths of the growth in overall coal consumption, although most of the growth is expected after 2020. According to South Korea's most recent long-term power plan, generating subsidiaries for the state-controlled Korea Electric Power Corporation (KEPCO) added a total of 3.7 gigawatts of new coal-fired capacity in 2008 and 2009; however, those new builds mark the end of planned coal-fired capacity additions until after 2015 [*157*].

Coal consumption in Australia and New Zealand remains nearly constant through 2035. Of the two countries, Australia is by far the larger coal consumer, with 96 percent of the regional total in 2008. With substantial coal reserves (primarily in Australia), the region continues to rely on coal for much of its electricity generation, although the coal share of total generation does decline substantially over the projection period. Coal-fired power plants, which supplied 66 percent of the region's electricity generation in 2008, account for only 39 percent in 2035. Compared with coal, generation from both renewables and natural gas increases at a more rapid pace, so that those fuels capture an increasing share of Australia/New Zealand's total generation.

Non-OECD coal consumption

In contrast to coal consumption in the OECD economies, fast-paced growth is projected for non-OECD nations, particularly among the Asian economies. Led by strong economic growth and rising energy demand in non-OECD Asia, total coal consumption in non-OECD countries increases to 162.5 quadrillion Btu in 2035, growing by 76 percent from the 2008 total of 92.2 quadrillion Btu (Figure 68). The substantial increase in non-OECD coal consumption illustrates the importance of coal in meeting the region's energy needs. Over the entire period from 2008 to 2035, coal accounts for more than one-third of total non-OECD energy consumption.

Non-OECD Asia

The countries of non-OECD Asia account for nearly all of the projected increase in world coal consumption from 2008 to 2035. Strong economic growth is expected for non-OECD Asia, averaging 5.3 percent per year from 2008 to 2035, with China's economy averaging 5.7 percent per year and India's 5.5 percent per year. In *IEO2011*, much of the increase in demand for energy in non-OECD Asia, particularly in the electric power and industrial sectors, is met with coal.

Coal use in China's electricity sector increases from 28.7 quadrillion Btu in 2008 to 63.4 quadrillion Btu in 2035, at an average rate of 3.0 percent per year. In comparison, coal consumption in the U.S. electricity sector grows by 0.2 percent annually, from 20.5 quadrillion Btu in 2008 to 21.6 quadrillion Btu in 2035. At the end of 2008, China had an estimated 557 gigawatts of operating coal-fired capacity. To meet increasing demand for electricity that accompanies the relatively strong outlook for China's economic growth, the *IEO2011* Reference case projects a need for 485 gigawatts of coal-fired capacity additions (net of retirements) from 2008 through 2035. The substantial amount of new capacity represents, on average, 18 gigawatts of new coal-fired capacity additions per year, which is a considerably slower rate of construction than occurred during the 5-year period ending in 2008, when coal-fired capacity additions averaged 55 gigawatts per year. Coal's share of total electricity generation in China declines from 80 percent in 2008 to 66 percent in 2035 (Figure 69), as generation from nuclear, renewables, and natural gas each grows more rapidly than generation from coal.

Approximately one-half (52 percent) of China's coal use in 2008 was in the end-use sectors, and primarily in the industrial sector. In the *IEO2011* Reference case, industrial sector coal consumption in China increases by 18.8 quadrillion Btu, or 67 percent, from 2008 to 2035. Within the sector, the single largest use of coal is for production of coke, which in turn is used primarily to produce pig iron. In 2008, Chinese coke plants consumed 457 million tons of coal,[24] representing approximately 34 percent of total coal consumption in the industrial sector on a tonnage basis [*158*]. China was the world's leading producer of both steel and pig iron in 2008, accounting for 38 percent of global raw steel output and 50 percent of world pig iron production [*159*].

Coal remains the leading source of energy for China's industrial sector in the Reference case, although its share of industrial energy consumption declines in the projection, with electricity and other energy sources making up an increasing share of the total. Electricity's share of total industrial energy use rises from 18 percent in 2008 to 26 percent in 2035, while coal's share drops from 63 percent to 55 percent. However, with coal-fired power plants satisfying a substantial portion of China's total power generation requirements throughout the period, the increase in electricity demand in the industrial sector can, to a certain extent, be viewed as an increase in demand for coal.

Figure 68. Non-OECD coal consumption by region, 1980, 2008, 2020 and 2035 (quadrillion Btu)

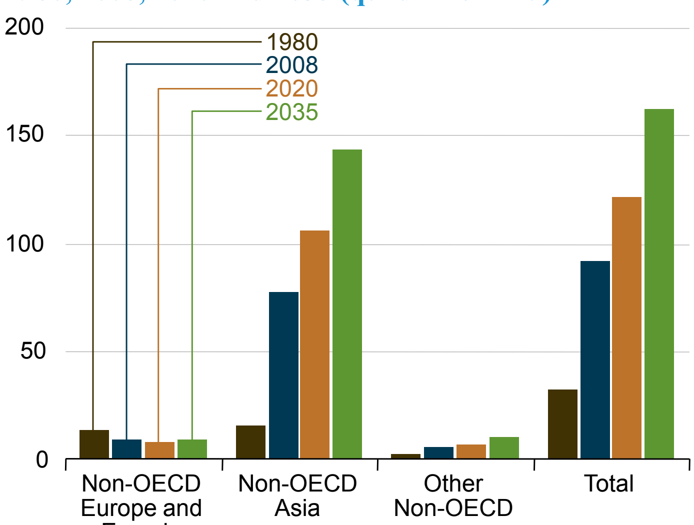
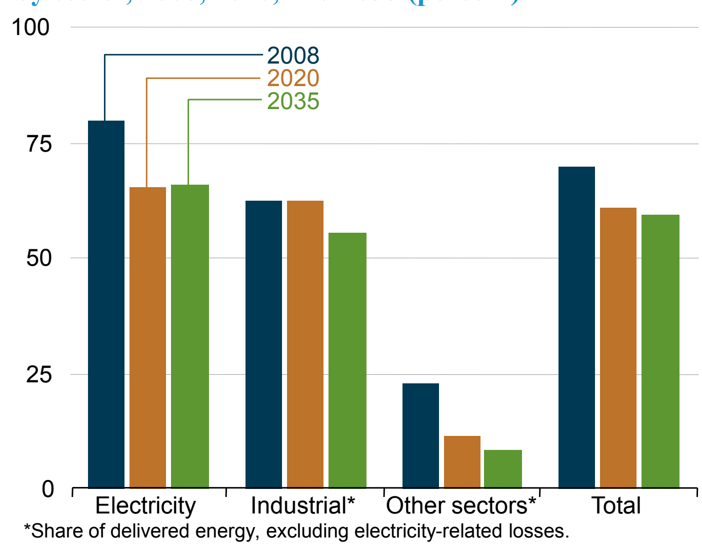


Figure 69. Coal share of China's energy consumption by sector, 2008, 2020, and 2035 (percent)



[24]Throughout this chapter, tons refer to short tons (2,000 pounds).

In India, 54 percent of the projected growth in coal consumption is in the electric power sector and most of the remainder in the industrial sector. In 2008, India's coal-fired power plants consumed 6.7 quadrillion Btu of coal, representing 62 percent of the country's total coal demand. Coal use for electricity generation in India grows by 2.0 percent per year on average, to 11.4 quadrillion Btu in 2035, requiring an additional 72 gigawatts of coal-fired capacity (net of retirements). As a result, India's coal-fired generating capacity increases from 99 gigawatts in 2008 to 171 gigawatts in 2035. Despite an increase in coal-fired electricity generation of 107 percent over the period, growth in generation from natural gas, nuclear power, and renewable energy sources is even more rapid, and the coal share of India's total generation declines from 68 percent in 2008 to 51 percent in 2035.

In the other nations of non-OECD Asia, coal consumption grows by an average of 2.1 percent per year, from 6.3 quadrillion Btu in 2008 to 11.0 quadrillion Btu in 2035. Growing demand for energy in the region's electric power and industrial sectors drives the increase in coal use. In the electric power sector, significant growth in coal consumption is expected in Indonesia and Vietnam, where considerable amounts of new coal-fired generating capacity are expected to be built.

Non-OECD Europe and Eurasia

In the *IEO2011* Reference case, coal consumption in non-OECD Europe and Eurasia declines slightly from the 2008 level of 8.9 quadrillion Btu. Russia, which used 4.5 quadrillion Btu of coal in 2008 (50 percent of the total for non-OECD Europe and Eurasia), leads the region's coal consumption. Coal met 15 percent of Russia's total energy requirements in 2008, and coal-fired power plants provided 18 percent of its electricity; in 2035 those shares are slightly lower, at 14 percent and 16 percent, respectively. In the Reference case, Russia's coal consumption increases to 4.9 quadrillion Btu in 2035. Although natural gas continues to be the leading source of electricity generation in Russia throughout the projection period, its share of total generation declines substantially, while both nuclear and renewables garner increasing shares of the total. Additional generation from nuclear and renewables, taken together, account for 82 percent of the growth in Russia's total electricity supply from 2008 to 2035, with increasing output from coal- and natural gas-fired power plants supplying 19 percent.

Coal consumption in the other countries of non-OECD Europe and Eurasia declines from 4.5 quadrillion Btu in 2008 to 3.7 quadrillion Btu in 2035. For the region as a whole, coal-fired electricity generation remains near its current level, and as a result the coal share of total generation declines from 34 percent in 2008 to 24 percent in 2035. From 2008 to 2035, nuclear and natural gas satisfy much of the additional electricity requirement for non-OECD Europe and Eurasia (excluding Russia), with increased output from nuclear plants meeting 38 percent of the growth and natural-gas-fired plants 39 percent.

Africa

Africa's coal consumption increases by 2.5 quadrillion Btu from 2008 to 2035 in the Reference case. South Africa currently accounts for 93 percent of coal consumption on the continent and is expected to continue to account for much of Africa's total coal consumption over the projection period.

Increasing demand for electricity in South Africa in recent years has led to a decision by Eskom, the country's state-owned electricity supplier, to restart three large coal-fired plants (Camden, Grootvlei, and Komati) that have been closed for more than a decade [*160*]. The individual units at those plants, with a combined generating capacity of 3.8 gigawatts, are scheduled to return to service by 2012. Approximately one-half of the capacity was back in service at the end of 2008. In addition, Eskom is proceeding with the construction of two new coal-fired power plants (Medupi and Kusile) with a combined generating capacity of 9.6 gigawatts. The 12 individual units at the Medupi and Kusile plants are scheduled to be fully operational by the end of 2017. In April 2010, the World Bank approved a $3.8 billion loan for Eskom to help with the financing of several energy-related projects, including $3.1 billion allocated for completion of the Medupi plant [*161*].

Recent power shortages and a general lack of spare generating capacity in southern Africa also have led to increased interest in new coal-fired power projects in countries other than South Africa. Of particular significance are major investments being made by several international energy companies to develop coal reserves in Mozambique and Botswana for the purpose of supplying both domestic coal-fired generating plants and international markets[*162*].

In the industrial sector, an increase in coal consumption of 0.6 quadrillion Btu from 2008 to 2035, representing 26 percent of the total increase for Africa, results from production of steam and process heat for industrial applications, production of coke for the steel industry, and production of coal-based synthetic liquids. Currently, two large-scale CTL plants in South Africa (Sasol II and Sasol III) can supply up to 150,000 barrels of synthetic liquids per day, accounting for about 25 percent of the country's total liquid fuel supply [*163*]. Approximately 25 percent of the coal consumed in South Africa is for the production of synthetic fuels [*164*]. In the *IEO2011* Reference case, production of coal-based synthetic liquids in all of Africa increases to 274,000 barrels per day in 2035.

Central and South America

Central and South America consumed 0.8 quadrillion Btu of coal in 2008. Brazil, with the world's ninth-largest steel production in 2008, accounted for 61 percent of the region's coal demand. Colombia, Peru, Argentina, and Puerto Rico accounted for most of the remainder [*165*]. In the Reference case, coal consumption in Central and South America increases by 1.5 quadrillion Btu from 2008 to 2035, with most of the increase in Brazil, primarily for the production of coke for use in the steel industry. To meet increasing demand for steel in both domestic and international markets, Brazil's steel companies have plans to expand their production capacity considerably over the next several years [*166*]. In the near term, coal consumption in Brazil's electricity sector is set to increase with the completion of three new coal-fired power plants in 2011, 2012, and 2013. The Pecem I, Pecem II, and Itaqui plants will have a combined generating capacity of 1.4 gigawatts [*167*].

Middle East

Countries in the Middle East consumed 0.4 quadrillion Btu of coal in 2008. Israel accounted for 83 percent of the total and Iran most of the remainder. The region's coal use remains near the current level through 2035.

World coal production

In the *IEO2011* Reference case, 67 percent of the increase in world coal production occurs in China, where output rises by 45.4 quadrillion Btu from 2008 to 2035 (Table 8). This outlook projects that much of the demand for coal in China will continue to be met by domestic production. Other substantial increases in regional coal production from 2008 to 2035 include 6.5 quadrillion Btu in Australia/New Zealand (representing 9 percent of the increase in world coal production), 4.5 quadrillion Btu in India, 4.5 quadrillion Btu in non-OECD Asia (excluding China and India), 3.6 quadrillion Btu in Africa, 2.7 quadrillion Btu in the United States, and 2.5 quadrillion Btu in Central and South America.

Most of the growth in coal production in Australia/New Zealand and Central and South America (excluding Brazil) is based on continuing increases in coal exports, whereas production growth in Africa and non-OECD Asia (excluding China and India) is attributable to both rising levels of coal consumption and increasing exports. For the United States, growth in coal production is a result primarily of increases in domestic coal consumption.

Table 8. World coal production by region, 2008-2035 (quadrillion Btu)

Region	2008	2010	2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD Americas	**25.7**	**24.6**	**23.4**	**24.4**	**26.6**	**27.4**	**29.0**	**0.4**
United States	23.8	22.6	21.5	22.4	24.5	25.3	26.5	0.4
Canada	1.6	1.7	1.7	1.8	1.9	2.0	2.1	1.1
Mexico/Chile	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.7
OECD Europe	**7.1**	**6.4**	**5.3**	**5.4**	**5.1**	**4.9**	**4.8**	**-1.4**
OECD Asia	**9.2**	**10.2**	**11.2**	**11.3**	**12.4**	**14.1**	**15.6**	**1.9**
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
South Korea	0.1	0.1	0.1	0.0	0.0	0.0	0.0	-0.3
Australia/New Zealand	9.1	10.1	11.1	11.3	12.3	14.1	15.6	1.9
Total OECD	**42.0**	**41.2**	**39.9**	**41.1**	**44.1**	**46.4**	**49.4**	**0.6**
Non-OECD Europe and Eurasia	**11.0**	**10.3**	**10.6**	**10.4**	**10.3**	**10.5**	**11.1**	**0.0**
Russia	6.4	6.4	6.7	6.7	6.7	7.0	7.6	0.6
Other	4.6	3.9	3.9	3.7	3.6	3.5	3.5	-1.0
Non-OECD Asia	**80.7**	**89.8**	**96.9**	**102.1**	**113.7**	**125.4**	**135.1**	**1.9**
China	62.2	70.5	76.8	81.4	91.5	100.9	107.6	2.0
India	9.4	9.1	9.3	9.8	10.9	12.3	13.8	1.4
Other	9.1	10.2	10.8	10.9	11.2	12.2	13.7	1.4
Middle East	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**0.1**	**0.1**	**1.7**
Africa	**6.0**	**6.0**	**7.2**	**7.6**	**8.0**	**8.6**	**9.6**	**1.7**
Central and South America	**2.3**	**2.0**	**2.9**	**3.7**	**4.1**	**4.5**	**4.8**	**2.7**
Brazil	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-0.4
Other	2.2	2.0	2.9	3.6	4.1	4.4	4.8	2.7
Total Non-OECD	**100.1**	**108.2**	**117.6**	**123.9**	**136.2**	**149.1**	**160.8**	**1.7**
Total World	**142.0**	**149.4**	**157.5**	**164.9**	**180.3**	**195.5**	**210.1**	**1.4**

Note: With the exception of North America, non-seaborne coal trade is not represented in EIA's forecast scenarios. As a result, the projected levels of production assume that net non-seaborne coal trade will balance out across the IEO2011 regions. Currently, a significant amount of non-seaborne coal trade takes place in Eurasia, represented by exports of steam coal from Kazikhstan to Russia and exports of coking coal from Russia to Ukraine.

World coal trade

International coal trade became increasingly complex and less predictable over the past decade with the rapid rise of coal demand in developing countries, supply disruptions, and the emergence of new international coal supply sources. For some countries, rising demand has contributed to less supply diversity. Some suppliers, including Australia and South Africa, have concentrated on the Chinese market, and China itself has withheld coal exports from the market. On the other hand, some countries have been able to diversify their supplies by capitalizing on expanded production from Colombia, Russia, and Indonesia among other countries. The overarching trend expected for coal trade through 2035 is an increase in trade for both steam and coking coal, a continued competitive environment among suppliers, and a tendency to diversify coal suppliers to mitigate risk associated with periodic supply disruptions.

In *IEO2011*, the volume of seaborne coal trade continues its long-term trend, rising through 2035 mainly in response to large increases in non-OECD coal demand—predominantly from China and India. Although both steam coal and coking coal are traded internationally, most of the trade is in steam coal, which represents 71 percent of world coal trade in 2035 (slightly lower than the 2009 level of 72 percent). In 2009, 67 percent of the world's exported steam coal was imported by Asian countries, and their share of the total increases to 71 percent in 2035. The share of coking coal imports destined for Asia increased to 73 percent in 2009—when Asian countries had largely recovered from the global economic downturn and other countries' recovery still lagged—compared with 62 percent in 2008. Asia's share of coking coal imports falls from its high in 2009 as coking coal demand recovers or grows in some countries, particularly Brazil; however, its share never falls below 66 percent in the Reference case.

International coal trade, which accounted for about 15 percent of total world coal consumption in 2009, grows at an average annual rate of 2.0 percent in the Reference case, from about 21.2 quadrillion Btu in 2009 to 35.2 quadrillion Btu in 2035. Because the largest increases in consumption occur in non-OECD Asia—particularly India and China, which meet most of the increase in their coal demand with domestic supply rather than seaborne imports—the share of coal trade as a percentage of global coal consumption grows modestly to 17 percent in 2035.

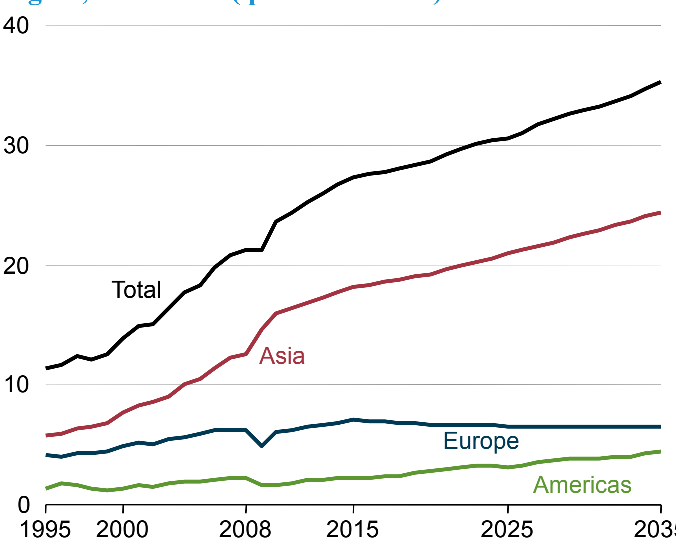
Coal imports

Asia

Asia remains the world's largest importer of coal in the *IEO2011* Reference case, accounting for 70 percent of the growth in total world coal imports from 2009 to 2035. Asia's coal imports total 24 quadrillion Btu in 2035 (Table 9 and Figure 70).[25]

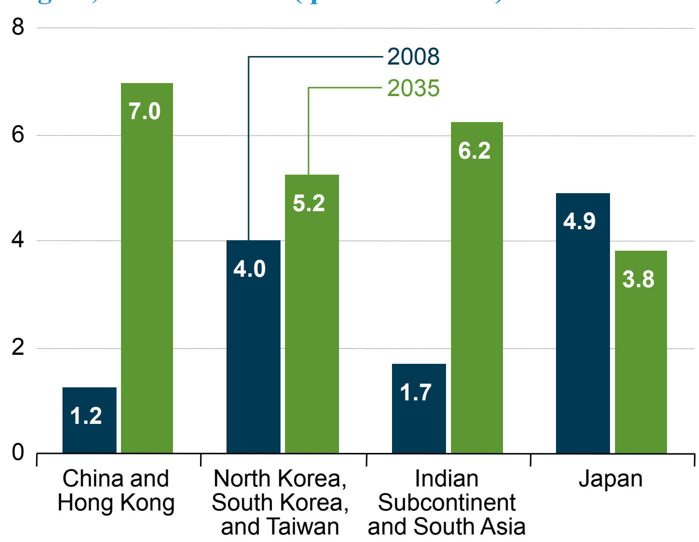
Japan currently is Asia's largest coal importer (Figure 71). Although 2001 was the last year in which Japan produced a significant amount of coal from domestic resources, the country has continued to rely on coal to meet its energy requirements. Australia continues to provide about 60 percent of Japan's coal supply (both steam and metallurgical coal, on a tonnage basis), but its share falls to about 50 percent in 2035. Japan was previously a large importer of Chinese coal, receiving about 18 percent of its coal from China in 2002. In 2009, however, China's share of coal imports to Japan was about 4 percent. Seeking to diversify sources of coal supply for the long term, Japanese companies have pursued investments in coal production in other countries, including Russia and Canada [*168*]. Japan is the second-largest steel producer in the world, after China [*169*], and it continues to import coking coal for its steelmaking plants through 2035 in the Reference case projection.

Figure 70. World coal imports by major importing region, 1995-2035 (quadrillion Btu)



Sources: SSY Consultancy and Research, Ltd., and EIA.

Figure 71. Coal imports to Asia by major importing region, 2008 and 2035 (quadrillion Btu)



Sources: SSY Consultancy and Research, Ltd., and EIA.

[25]In Figure 70, coal imports to Europe include small amounts imported by countries in the Middle East and Africa.

Table 9. World coal flows by importing and exporting regions, Reference case, 2009, 2020, and 2035 (quadrillion Btu)

	Importers											
	Steam				Coking				Total			
Exporters	Europe[a]	Asia	Americas	Total[b]	Europe[a]	Asia[c]	Americas	Total[b]	Europe[a]	Asia	Americas	Total[b]
	2009											
Australia	0.05	3.31	0.10	**3.47**	0.38	3.17	0.13	**3.68**	0.42	6.48	0.23	**7.15**
United States	0.24	0.02	0.21	**0.46**	0.57	0.15	0.30	**1.02**	0.81	0.17	0.51	**1.48**
Southern Africa	0.85	0.62	0.02	**1.57**	0.00	0.00	0.01	**0.01**	0.85	0.62	0.02	**1.58**
Eurasia	1.10	0.56	0.00	**1.66**	0.08	0.11	0.00	**0.20**	1.19	0.67	0.00	**1.86**
Poland	0.11	0.00	0.00	**0.11**	0.01	0.00	0.00	**0.01**	0.12	0.00	0.00	**0.12**
Canada	0.00	0.14	0.01	**0.15**	0.10	0.45	0.06	**0.60**	0.10	0.59	0.07	**0.75**
China	0.00	0.55	0.00	**0.55**	0.00	0.02	0.00	**0.02**	0.00	0.57	0.00	**0.57**
South America[d]	1.05	0.00	0.69	**1.75**	0.00	0.00	0.00	**0.00**	1.05	0.00	0.69	**1.75**
Vietnam	0.00	0.60	0.00	**0.61**	0.00	0.00	0.00	**0.00**	0.00	0.60	0.00	**0.61**
Indonesia[e]	0.40	4.40	0.06	**4.87**	0.00	0.48	0.00	**0.48**	0.40	4.89	0.06	**5.36**
Total	**3.80**	**10.20**	**1.09**	**15.20**	**1.14**	**4.38**	**0.49**	**6.03**	**4.94**	**14.59**	**1.58**	**21.23**
	2020											
Australia	0.05	4.15	0.00	**4.20**	0.32	3.89	0.39	**4.60**	0.37	8.04	0.39	**8.80**
United States	0.32	0.14	0.04	**0.50**	0.67	0.63	0.51	**1.81**	0.99	0.77	0.55	**2.31**
Southern Africa	0.93	1.01	0.02	**1.96**	0.21	0.20	0.00	**0.40**	1.13	1.21	0.02	**2.36**
Eurasia	1.47	0.51	0.09	**2.07**	0.07	0.21	0.00	**0.28**	1.54	0.72	0.09	**2.35**
Poland	0.10	0.00	0.01	**0.11**	0.03	0.00	0.00	**0.03**	0.12	0.00	0.01	**0.14**
Canada	0.11	0.00	0.00	**0.11**	0.32	0.47	0.08	**0.87**	0.43	0.47	0.08	**0.98**
China	0.00	0.64	0.00	**0.64**	0.00	0.02	0.00	**0.02**	0.00	0.66	0.00	**0.66**
South America[d]	2.08	0.00	1.45	**3.52**	0.00	0.00	0.00	**0.00**	2.08	0.00	1.45	**3.52**
Vietnam	0.00	0.31	0.00	**0.31**	0.00	0.00	0.00	**0.00**	0.00	0.31	0.00	**0.31**
Indonesia[e]	0.00	6.58	0.16	**6.74**	0.01	0.49	0.00	**0.50**	0.01	7.07	0.16	**7.24**
Total	**5.05**	**13.34**	**1.76**	**20.16**	**1.62**	**5.91**	**0.98**	**8.51**	**6.67**	**19.25**	**2.75**	**28.67**
	2035											
Australia	0.07	7.53	0.00	**7.59**	0.33	4.45	0.73	**5.51**	0.39	11.97	0.73	**13.10**
United States	0.39	0.21	0.03	**0.63**	0.62	0.50	0.96	**2.07**	1.00	0.71	0.99	**2.70**
Southern Africa	0.68	1.52	0.01	**2.20**	0.15	0.34	0.00	**0.50**	0.83	1.86	0.01	**2.70**
Eurasia	1.41	0.64	0.21	**2.25**	0.22	0.27	0.00	**0.49**	1.62	0.91	0.21	**2.74**
Poland	0.09	0.00	0.00	**0.09**	0.01	0.00	0.00	**0.01**	0.10	0.00	0.00	**0.10**
Canada	0.21	0.00	0.00	**0.21**	0.27	0.54	0.19	**0.99**	0.48	0.54	0.19	**1.20**
China	0.00	0.64	0.00	**0.64**	0.00	0.02	0.00	**0.02**	0.00	0.66	0.00	**0.66**
South America[d]	2.02	0.46	2.06	**4.53**	0.00	0.00	0.00	**0.00**	2.02	0.46	2.06	**4.53**
Vietnam	0.00	0.24	0.00	**0.24**	0.00	0.00	0.00	**0.00**	0.00	0.24	0.00	**0.24**
Indonesia[e]	0.00	6.52	0.22	**6.74**	0.01	0.49	0.00	**0.50**	0.01	7.01	0.22	**7.24**
Total	**4.85**	**17.75**	**2.52**	**25.12**	**1.61**	**6.62**	**1.88**	**10.10**	**6.46**	**24.37**	**4.39**	**35.22**

[a]Coal flows to Europe/Mediterranean include shipments to the Middle East and Africa.
[b]In 2009, total world coal flows includes a balancing item term used to reconcile discrepancies between reported exports and imports. For 2009, the balancing items by coal type were: steam, 0.1 quadrillion Btu; coking, 0.01 quadrillion Btu; and total, 0.11 quadrillion Btu.
[c]Includes 0.8 quadrillion Btu of coal for pulverized coal injection at blast furnaces shipped to Asian steelmakers in 2009.
[d]Coal exports from South America are projected to originate from Colombia and Venezuela.
[e]In 2009, coal exports from Indonesia include shipments from other countries not modeled for the forecast period. For 2009, these non-Indonesian exports by coal type were: steam, 0.09 quadrillion Btu; coking, 0.02 quadrillion Btu; and total, 0.12 quadrillion Btu.
Sources: SSY Consultancy and Research, Ltd., and EIA.

Like Japan, South Korea and Taiwan import most of the coal they consume and continue to do so through 2035 in the Reference case. With planned increases in coal-fired generating capacity, South Korea (in OECD Asia) and Taiwan (in non-OECD Asia) maintain a combined 16-percent share of world imports in 2035, despite sizable increases in coal imports by other countries. The two countries together nearly doubled their steam coal imports in the last decade, to a total of about 3.2 quadrillion Btu (148 million tons), with the increase met primarily by coal from Indonesia and Australia. In 2010, South Korea exceeded its 2008 level of steel production and Taiwan nearly matched its 2008 level; as a result, demand for coking coal in the two countries returned to the levels recorded before the global economic slowdown [*170*].

China's coal imports total 6.7 quadrillion Btu in 2035 in the *IEO2011* Reference case, as compared with an estimated 2.8 quadrillion Btu in 2009. China remains a net coal importer through 2035, surpassing Japan in 2015 as the world's largest importer of coal. Regardless of the substantial increase in coal imports, however, a preponderant share of the coal consumed in China continues to be supplied by its own coal mines throughout the projection.

China remains the largest source of uncertainty with respect to world coal trade projections, particularly with respect to its increasing reliance on imports of seaborne coal. As the world's largest coal consumer and producer, even small percentage shortfalls in China's domestic coal production can have a large impact on the world trade market as a whole. Since 2001 China has increased its coal consumption significantly every year, but because it also has increased domestic coal production aggressively, it has not needed large increases in imports in most years. In 2004, for instance, coal consumption in China increased by 9.1 quadrillion Btu, while imports rose by less than 0.2 quadrillion Btu. In 2007, China imported 1.1 quadrillion Btu of coal, and in 2008 imports actually declined to 0.8 quadrillion Btu. In 2009, however, its coal consumption increased by 8.7 quadrillion Btu, and its coal imports more than tripled.

In the long run, several factors may slow or reduce the growth in China's seaborne coal imports. For one, China already has implemented, or plans to implement, freight transportation improvements to support domestic coal production. In addition, strong growth in imports from Mongolia, which are likely to be moved overland rather than by sea, would lessen the need for seaborne coal imports. Efficiency gains at mining complexes and large expansions of domestic mine capacity, such as Inner Mongolia's plan to increase production capacity by 500 million metric tons by 2015, also could reduce the need for imports [*171*]. High international coal prices could encourage reliance on domestic sources of supply, and low steel prices could make high-priced imported coking coal—an input to the steelmaking process—less affordable. Finally, the use of minemouth plants in combination with transmission infrastructure to connect distant Chinese coal sources with electricity demand centers also would alleviate the need for imports.

India, like China, has been increasing its coal imports in recent years with expectations of additional demand. In 2035, India's coal imports in the Reference case are 2.6 times the 2009 level (on an energy basis), spurred by rising imports of both coking and steam coal. India's demand for coal continues to grow, but the country has had problems expanding its production of poor-quality (i.e., low energy content) domestic reserves. In addition, infrastructure issues have impeded the movement of domestic coal to markets. As a result, large coal-fired electricity plants planned for India's coastal areas are expected to be fueled with imported steam coal.

Difficulties in expanding India's coal production make the prospect of strong growth in coal imports more likely. In 2010, India's Environmental Ministry labeled many major Indian coalfields as "no go" production sources, refusing to permit mining in those areas because of the environmental sensitivity of the overlying land. [*172*] According to a representative from India's largest coal producer (the state-controlled Coal India, Ltd.), estimated shortfalls in India's domestic coal production could be as high as 220 million tons by 2015, up from an estimated 110 million tons in 2010 [*173*]. Preliminary data suggest that India's steam coal imports have doubled since 2008, to 83 million tons in 2010. For 2 years in a row, India has raised its coal import level by an incremental 22 million tons. Currently, Indonesia and South Africa together supply nearly all of India's imports of steam coal, and Australia supplies the vast majority of its coking coal imports.

India has had some success in recent years in expanding its port infrastructure to support increases in coal imports. Several new ports have been commissioned since 2008, including Krishnapatnam (with an expected capacity of at least 66 million tons in 2011) and Gangavaram (with an eventual capacity of 39 million tons and capable of handling capesize vessels) [*174*]. The new port of Dhamra, with capesize ship handling capability, received its first coal shipments in 2010. The private port of Mundra alone will have an ultimate capacity of 66 million tons, equivalent to about 60 percent of India's total coal imports in 2010 (based on preliminary data). An expansion of coal-handling capability at the port of Mormugao from 6 million tons to 19 million tons is expected to be completed by 2015, although environmental opposition could delay the project.

India has domestic resources of coking coal, but its quality is poor, and typically it is located at mining depths much greater than those for foreign-sourced coking coal. India's long-term plans include expansion of its steel industry to between 165 and 198 million tons of raw steel output by 2020, up from about 67 million tons in 2010 [*175*], with increased imports of coking coal supporting the expansion. India is the world's fourth largest producer of pig iron, and in 2010 its production total was 34 percent higher and in 2008. Some plans for new steelmaking capacity, such as ArcelorMittal's new coastal steel plant in Orissa, appear to have been delayed by land acquisition difficulties and environmental issues and thus are unlikely to add to India's demand for coking coal imports until after 2014. In the *IEO2011* Reference case, India surpasses Japan's coal import levels, making it the second largest importer of coal after China. India continues to import most of its coking coal from Australia in the Reference case, with some growth in imports from Africa.

Europe, Middle East, and Africa

In the *IEO2011* Reference case, total coal imports to Europe, the Middle East, and Africa recover from the 2009 dropoff in coal demand but remain at about the 2008 level through 2035 (Figure 70).[26] With most European countries placing greater emphasis on natural gas for power generation, coal becomes a less significant component of the fuel mix for electricity. Europe's demand for lower sulfur coal (from Eurasia and South America, for example) is tempered over time by the gradual addition of flue gas desulfurization equipment at existing coal-fired power plants.

Some European countries import more coal to compensate for their own dwindling coal production, offsetting some of the projected decline in coal imports to other European nations. For example, Germany's planned closure of its remaining hard coal mines by 2018 (which, as a result of the recent government announcement concerning the closure of the country's remaining nuclear power plants, might not occur) results in an increase in imports of coal for electricity generation [*176*]. Germany's coal imports level off over time, because no incremental coal-fired capacity is expected to be built. For Turkey, growth of electricity demand and steel industry output offsets some of the decline in Europe's coal use through 2035. Turkey has accounted for most of the growth in steam coal trade to the region over the past decade, with Russia supplying the bulk of the coal. Although Turkey is expected to add about 3 million metric tons of steelmaking capacity (which requires coking coal) from 2009 to 2015 [*177*], over time electric arc furnaces for steelmaking, which do not require coking coal, are assumed to gain market share. Italy's conversion of power plants from oil to coal, including the recently commissioned Torrevaldaliga North plant, also offsets some of the decline in Europe's coal demand in the *IEO2011* Reference case. The Torrevaldaliga North plant alone could raise Italy's steam coal imports by 9 million tons per year in 2015 [*178*].

The Americas

In the United States, coal imports are expected to rise from current levels through 2035. With mine productivity declining in Central Appalachia and domestic demand for coal rising, imports are expected to remain competitive for coastal States in the East and South. South America (Colombia, in particular) is expected to be an important source of U.S. coal imports.

Most of Canada's imported coal comes from the United States, and Canada is the largest importer of U.S. steam coal. However, projected exports of U.S. steam coal to Canada in 2035 are substantially below historical levels. Canada's current coal imports are more than 50 percent below the peak volumes of the past decade, and they do not recover in the projection. In 2010, Units 3 and 4 of the Nanticoke Generation Station and Units 1 and 2 of the Lambton Generating Station were permanently shut down as part of Ontario's plan to shutter all coal plants. Accordingly, an additional 4 gigawatts of generating capacity fired with imported coal is assumed to be shut down by 2035 for environmental reasons, as legislated by the Provincial government.

Brazil's steelmaking capacity increases in the Reference case, taking advantage of its domestic resources of iron ore but requiring increased use of coking-grade coal that the country does not produce domestically [*179*]. The United States, Australia, Canada, and southern Africa have the potential to provide a portion of the coal needed to meet Brazil's import requirements. Overall, America's imports of coking coal—driven primarily by demand in Brazil—grow from about 0.5 quadrillion Btu in 2009 to 1.9 quadrillion Btu in 2035. Brazil and Chile account for most of the increase in imports of thermal coal to South America through 2035.

Coal exports

Most of the world's coal trade is in the form of steam coal, at nearly 15.2 quadrillion Btu (about 72 percent of total coal exports) in 2009. The top five exporters of steam coal in 2009 were Indonesia, Australia, South America (primarily Colombia), Eurasia (primarily Russia), and southern Africa (primarily South Africa). Although Indonesia currently is the world's largest exporter of steam coal and remains so for most years of the projection, Australia surpasses Indonesia toward the end of the projection. In terms of coking coal, Australia, the United States, and Canada rank as the three top exporters and are projected to remain the top three through 2035.

Australia is the world's leading exporter of steam and coking coal combined. About 78 percent of its coal production was exported in 2009. Over the projection, Australia dominates international coal trade as it continues to improve and expand its inland transportation and port infrastructure to expedite coal shipments to international markets. Australia remains the primary exporter of metallurgical coal to Asian markets in the *IEO2011* Reference case, supplying about 67 percent of Asia's imports of coking coal in 2035, compared with about 72 percent in 2009. The reduction in Australia's share of Asia's coal imports is partly a result of the expected availability of new sources of coking coal in Africa, as well as growth in coking coal demand for India, whose geographic location enables it to receive supplies from a number of countries. Although Australia dominates coking coal exports, its exports did not increase at all from 2007 to 2009. However, preliminary data suggest that 2010 will show substantial increases (at least 20 million tons) in Australia's exports of coking coal.

Some of Australia's numerous infrastructure and capacity expansions have come on line in recent years or will soon become operational. Expansion of Queensland's Dalrymple Bay port from a capacity of about 75 million tons to 94 million tons was completed in 2009 [*180*]. The Newcastle Third Port Project, completed in 2010, added 33 million tons of additional capacity, and a new coal terminal at Kooragang Island in New South Wales will add some 66 million tons of capacity, about one-half of which is

[26] In Figure 70, coal imports to Europe include small amounts imported by countries in the Middle East and Africa.

expected to be operational by 2011 [*181*]. Several mine expansions could add close to 100 million tons of coal production capacity by 2015, equivalent to nearly one-quarter of Australia's coal production in 2008. For coking coal alone, the Australian Bureau of Agricultural and Resources Economics and Sciences estimates that about 68 million tons of new mine capacity will be added by 2015 [*182*]. The primary choke point in Australia's supply chain appears to be in rail movement from mine to port, which may continue to present challenges in the future.

Indonesia, with its relatively low-cost surface mines, also has demonstrated its potential for significant growth in coal exports, with export levels approaching an estimated 330 million tons in 2010 from about 66 million tons in 2000. The Indonesian company PT Bumi Resources Tbk, the largest Indonesian coal producer, plans to increase its production to 122 million tons by 2012 from 69 million tons in 2009. Another Indonesian company, PT Adaro Energy Tbk, also plans to expand coal production by about 44 million tons from 2009 to 2014, including an expansion of its Kelanis Terminal to a planned overall annual capacity of 33 million tons [*183*].

Over the long term, areas of uncertainty for Indonesia's coal exports include the adequacy of its internal transportation infrastructure; the continued development of new mines; environmental concerns; the rate of growth in its domestic coal consumption; and whether domestic coal demand is given preference over coal exports. In early 2011, Indonesian government officials once again stated the government's intention to restrict coal exports under a proposed regulation that, as of 2014, would restrict exports to coal with high thermal content. Some analysts suggest that the new restriction would effectively eliminate 50 to 60 percent of Indonesia's coal exports [*184*]. In the Reference case, Indonesia simultaneously meets its growing domestic demand for coal and increases its coal exports, although at a slower pace than in the recent past.

South Africa's coal exports have remained flat at about 72 million tons over the past few years, primarily as a result of domestic infrastructure constraints. However, coal mining is expected to continue playing an important role in South Africa's economy. Examples of additional mine capacity projects include the Douglas Middelburg Optimisation project (11 million tons of thermal coal capacity) and Optimum Coal's Boshmannpoort and Kwangaa mines (an additional 6 million tons) [*185*]. Richards Bay Coal Terminal, despite the completion of its expansion to an annual capacity of 100 million tons, has been unable to reach its full potential because of incompatible rail infrastructure capacity at the port. Export levels will continue to be below 100 million tons in the short run, because rail capacity into the port is limited to about 67 million tons. Additional proposed capacity investments supporting South African coal exports include an incremental 10 million tons each at Richards Bay terminal and the Matola terminal at Maputo port in neighboring Mozambique [*186*].

Mozambique and Botswana play an emerging role in world coal trade in the *IEO2011* Reference case. India's Tata Steel, Brazil's Companhia Vale do Rio Doce (Vale or CVRD), and Australia's Riversdale Mining all have financial stakes in mine operations in the Moatize basin of Mozambique [*187*]. The Moatize project ultimately will produce 9 to 14 million tons of marketable coking coal and 3 to 5 million tons of thermal coal. Initial coal exports from Moatize are expected in 2011. A rail link between Moatize coal basin and the port of Beira (Sena Railway) is being updated and should be capable of moving about 7 million tons in 2011. An expansion of the port of Beira in Mozambique to handle an annual capacity of about 20 million tons is also being explored, as well as a new railway to the northern Mozambique port of Necala [*188*]. Landlocked Botswana is also interested in expanding coal mining and in constructing a railroad to connect inland coal mines to an Atlantic port on the Namibian coast.

In Russia, rail bottlenecks from coal basins to port facilities appear to be the primary limitation on efforts to expand exports. Nevertheless, Russia has managed to triple its seaborne coal exports from 2000 levels to a total of 76 million tons in 2008, and in 2010 Russia was the largest exporter of seaborne coal to Europe. The Russian mining and steel production company Mechel has begun operations at Russia's Elga coking coal deposit and ultimately plans to produce 27 to 30 million tons per year [*189*]. Russia's coal exports to Asia will be facilitated by capacity expansion at the new Pacific port of Muchka, where SUEK (Siberia's coal energy company) has built about 13 million tons of annual export capacity. In addition, Mechel has plans for about 28 million tons of export capacity at the new Muchka Bay Terminal 2 [*190*]. Construction of a new terminal at Lavna on the Barents Sea to serve European and North American markets is scheduled to begin in 2012, and the terminal is expected to be operational by the end of 2014, with an initial export capacity of 7 million tons and long-term potential for 39 million tons [*191*]. As in 2009, in 2035 Eurasia (primarily Russia) supplies less than 10 percent of the seaborne coal traded internationally.

U.S. coal exports in the *IEO2011* Reference case rise from about 1.5 quadrillion Btu in 2009 to 2.7 quadrillion Btu in 2035, buoyed by the overall increase in world coal demand. Because U.S. coal export facilities are located primarily in the east, the geographic distance to transport coal between U.S. markets and Asian markets—where much of the growth in coal demand is centered—currently places the United States at a distinct disadvantage relative to other countries with large coal reserves. The comparatively high transportation costs associated with shipping coal from the eastern United States to Asian markets historically has meant that U.S. coal exports cannot compete economically in that region. According to preliminary data, however, in 2010 the United States saw growth in its coking coal exports to Asia at levels unseen in the recent past, estimated at 13 million tons in the third quarter of 2010, compared with 4 million tons in the third quarter of 2009.

One obstacle to increasing U.S. coal exports is the lack of a large coal export terminal on the West Coast, which is closer to both Asian markets and the top U.S. steam coal-producing region in the Powder River basin. Although two prospective western port projects in Longview and Cherry Point, Washington, are being explored, environmental protests and the extensive permitting process could impede or delay those investments. Alternatively, Powder River coal producer Arch Coal has secured a deal that will allow it to export coal (about 2 million tons in the first year) through Ridley Terminal in British Colombia through 2015. On the U.S. Gulf Coast, Kinder Morgan is planning to expand its International Marine Terminal in Louisiana by 7 million tons, with an expected completion date of 2012 [*192*].

In the short term, low bulk rates and the expansion of the Panama Canal may improve U.S. competitiveness in coal export markets. In addition, sustained high international demand and prices and supply constraints in other coal-exporting countries support expectations of larger U.S. export volumes. On the other hand, new supplies of coal (including additional supplies of coal from Mongolia, Africa, and Australia) and the resolution of transportation bottlenecks in other supply countries could provide substantial increases in international coal supply and, as a result, reduce international coal prices. Thus, in the *IEO2011* Reference case, the United States remains a marginal supplier in world coal trade despite achieving higher export levels than in the early 2000s. Brazil remains the largest importer of U.S. coking coal, and Europe remains the largest destination for U.S. coal exports overall.

Canada is an exporter of coking coal, typically supplying about 10 percent of international seaborne trade in coking coal. Despite strong international demand, Canada's exports have not grown in recent years. Some Canadian companies are positioning themselves to compete more effectively internationally. Canadian coal producer Western Coal has improved productivity, reportedly lowering costs at many of its mines, and has also poised itself to begin shipping coal in larger capesize ships in order to bring its per-unit costs down to a more competitive level. In 2011, Tech Resources secured long-term coal export capacity at Westshore Terminals [*193*]. On the transportation infrastructure side, Ridley Terminal in British Colombia is proposing to double its coal capacity to 24 million short tons [*194*]. In the Reference case, Canada holds 10 percent of the market for seaborne coking coal trade in 2035.

South America remains the world's third largest coal-exporting region in 2035, primarily as a result of continued increases in exports from Colombia. The government of Colombia expects the nation's coal production to reach 160 million tons by 2020, up from about 87 million tons in 2009 [*195*]. The expansion will require sizable investments in mine capacity, rail infrastructure, and port capacity. Drummond Coal is now producing from its El Descanso mine in Colombia, and it expects ultimately to attain export production of 40 million tons per year through 2032 [*196*]. The Cerrejon mine, jointly owned by Anglo American and BHP Billiton, also plans to boost its production by 25 percent, to 40 million tons by 2014, and eventually to expand annual production to 60 million metric tons [*197*]. In addition, the El Hatillo mine is planning to increase production from 1.8 million tons to about 5 million tons by 2012 [*198*].

Increasing coal transportation infrastructure is also a concern for Colombia. An expanded river-to-port terminal at Barranquilla, Colombia, with an annual capacity of about 39 million tons, is planned [*199*]. There is a proposal to build a tunnel that would expedite coal transportation via truck to Colombia's Pacific Ocean port of Buenaventura when it is completed in 2013. The Carare railway project, which was intended to facilitate coal transport from central Colombia to the Caribbean coast, may be reinitiated as it has recently attracted foreign investment interest [*200*]. Other expansion projects on Colombia's Caribbean coast appear to be on track, including a coal terminal at the port of Cienaga, Puerto Nuevo, ultimately handling 66 million tons per year, roughly one-half of which would be available by 2013 [*201*]. Brazil's MPX is planning a coal export terminal, Dibulla, along Colombia's Atlantic seaboard, with a capacity of 20 million tons per year and capable of taking larger capesize ships [*202*].

Many of Colombia's port expansion projects lie on the Caribbean near the eastward opening of the Panama Canal. Begun in 2008 and slated for completion by 2015, the Panama Canal expansion should enhance opportunities for coal exports from both the United States and South America traveling westward to Asian markets. The so-called "post-panamax" vessels, which are capable of holding about 20 percent more than current panamax vessels, will be able to transit the Canal. Because many ports may not be able to accommodate the larger vessels without dredging, however, some export potential could be limited.

World coal reserves

Total recoverable reserves of coal around the world are estimated at 948 billion tons—reflecting a current reserves-to-production ratio of 126 years (Table 10).[27] Historically, estimates of world recoverable coal reserves, although relatively stable, have declined gradually from 1,145 billion tons in 1991 to 909 billion tons in 2008. In 2009, however, the estimate increased to 948 billion tons [*203*]. To a large extent, the upward revision of 39 billion tons for 2009 reflects a new assessment of Germany's lignite reserves. Although the overall decline in estimated reserves from 1991 to 2009 is sizable, the large reserves-to-production ratio for world coal indicates that sufficient coal will be available to meet demand well into the future. Further, because recoverable reserves are a subset of total coal resources, recoverable reserve estimates for a number of regions with large coal resource bases—notably, China and the United States—could increase substantially as coal mining technology improves and additional geological assessments of the coal resource base are completed.

Although coal deposits are widely distributed, 79 percent of the world's recoverable reserves are located in five regions: the United States (27 percent), Russia (18 percent), China (13 percent), non-OECD Europe and Eurasia outside of Russia (11 percent), and Australia/New Zealand (9 percent). In 2008, the five regions together produced 5.4 billion tons (106.1 quadrillion Btu) of coal, representing 72 percent of total world coal production by tonnage and 75 percent on a Btu basis [*204*]. By rank, anthracite and

[27]Recoverable reserves are those quantities of coal which geological and engineering information indicates with reasonable certainty can be extracted in the future under existing economic and operating conditions. The reserves-to-production ratio is based on the reserves estimates and data on world coal production for 2008 shown in Table 10.

bituminous coal account for 47 percent of the world's estimated recoverable coal reserves on a tonnage basis, subbituminous coal accounts for 30 percent, and lignite accounts for 23 percent.

Quality and geological characteristics of coal deposits are important parameters for coal reserves. Coal is a heterogeneous source of energy, with quality (for example, characteristics such as heat, sulfur, and ash content) varying significantly by region and even within individual coal seams. At the top end of the quality spectrum are premium-grade bituminous coals, or coking coals, used to manufacture coke for the steelmaking process. Coking coals produced in the United States have an estimated heat content of 26.3 million Btu per ton and relatively low sulfur content of approximately 0.9 percent by weight [*205*]. At the other end of the spectrum are reserves of low-Btu lignite. On a Btu basis, lignite reserves show considerable variation. Estimates published by the International Energy Agency for 2008 indicate that the average heat content of lignite in major producing countries varies from a low of 5.9 million Btu per ton in Greece to a high of 13.1 million Btu per ton in Canada [*206*].

Table 10. World recoverable coal reserves as of January 1, 2009 (billion short tons)

	Recoverable reserves by coal rank					
Region/Country	Bituminous and anthracite	Subbituminous	Lignite	Total	2008 production	Reserves-to-production ratio (years)
World total	**445.7**	**287.0**	**215.3**	**948.0**	**7.5**	**126.3**
United States[a]	119.2	108.2	33.2	260.6	1.2	222.3
Russia	54.1	107.4	11.5	173.1	0.3	514.9
China	68.6	37.1	20.5	126.2	3.1	40.9
Other non-OECD Europe and Eurasia	42.2	19.1	40.1	101.4	0.3	291.9
Australia and New Zealand	40.9	2.5	41.4	84.8	0.4	191.1
India	61.8	0.0	5.0	66.8	0.6	117.5
OECD Europe	6.2	0.8	54.3	61.3	0.7	94.2
Africa	34.7	0.2	0.0	34.9	0.3	123.3
Other non-OECD Asia	3.9	3.9	6.8	14.7	0.4	34.4
Other Central and South America	7.6	1.0	0.0	8.6	0.1	95.8
Canada	3.8	1.0	2.5	7.3	0.1	97.2
Brazil	0.0	5.0	0.0	5.0	0.0	689.5
Other[b]	2.6	0.6	0.1	3.4	0.0	184.5

[a]Data for the U.S. represent recoverable coal estimates as of January 1, 2010.
[b]Includes Mexico, Middle East, Japan and South Korea.
Sources: World Energy Council and EIA.

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Electricity

Overview

In the *IEO2011* Reference case, electricity supplies an increasing share of the world's total energy demand, and electricity use grows more rapidly than consumption of liquid fuels, natural gas, or coal in all end-use sectors except transportation. From 1990 to 2008, growth in net electricity generation outpaced the growth in delivered energy consumption (3.0 percent per year and 1.8 percent per year, respectively). World demand for electricity increases by 2.3 percent per year from 2008 to 2035 and continues to outpace growth in total energy use throughout the projection period (Figure 72).

World net electricity generation increases by 84 percent in the Reference case, from 19.1 trillion kilowatthours in 2008 to 25.5 trillion kilowatthours in 2020 and 35.2 trillion kilowatthours in 2035 (Table 11). Although the 2008-2009 global economic recession slowed the rate of growth in electricity use in 2008 and resulted in negligible change in electricity use in 2009, worldwide electricity demand increased by an estimated 5.4 percent in 2010, with non-OECD electricity demand alone increasing by an estimated 9.5 percent.

In general, projected growth in OECD countries, where electricity markets are well established and consumption patterns are mature, is slower than in non-OECD countries, where a large amount of demand goes unmet at present. The electrification of historically off-grid areas plays a strong role in projected growth trends. The International Energy Agency estimates that 21 percent of the world's population did not have access to electricity in 2009—a total of about 1.4 billion people [*207*]. Regionally, sub-Saharan Africa is worst off: more than 69 percent of the population currently remains without access to power. With strong economic growth and targeted government programs, however, electrification can occur quickly. In Vietnam, for example, the government's rural electrification program increased access to power from 51 percent of rural households in 1996 to 95 percent at the end of 2008 [*208*].

Non-OECD nations consumed 47 percent of the world's total electricity supply in 2008, and their share of world consumption is poised to increase over the projection period. In 2035, non-OECD nations account for 60 percent of world electricity use, while the OECD share declines to 40 percent (Figure 73). Total net electricity generation in non-OECD countries increases by an average of 3.3 percent per year in the Reference case, led by annual increases averaging 4.0 percent in non-OECD Asia (including China and India) from 2008 to 2035 (Figure 74). In contrast, total net generation in the OECD nations grows by an average of only 1.2 percent per year from 2008 to 2035.

The outlook for total electricity generation is largely the same as projected in last year's report. However, the projected mix of generation by fuel in the *IEO2011* Reference case has changed. The largest difference between the two outlooks is for natural-gas-fired generation—which is 22 percent higher in this year's outlook in 2035. The more optimistic outlook for generation from natural gas-fired power plants is a result of a reassessment of available gas supplies. This year's *IEO* includes an upward revision in potential gas supplies, largely because of increases in unconventional supplies of natural gas in the United States and other parts of the world. The increase in the natural gas share of generation to a large extent displaces coal-fired generation, which is 14 percent lower than in last year's report. In addition, projected nuclear power generation is 9 percent higher, and generation from renewable sources is 3 percent higher in 2035 than projected in *IEO2010*. The nuclear projection does not reflect consideration of policy responses to Japan's Fukushima Daiichi nuclear disaster, which are likely to reduce projected nuclear generation from both existing and new plants. Liquids-fired generation, in contrast, is 3 percent lower in this year's projection.

Figure 72. Growth in world electricity generation and total delivered energy consumption, 1990-2035 (index, 1990=1)

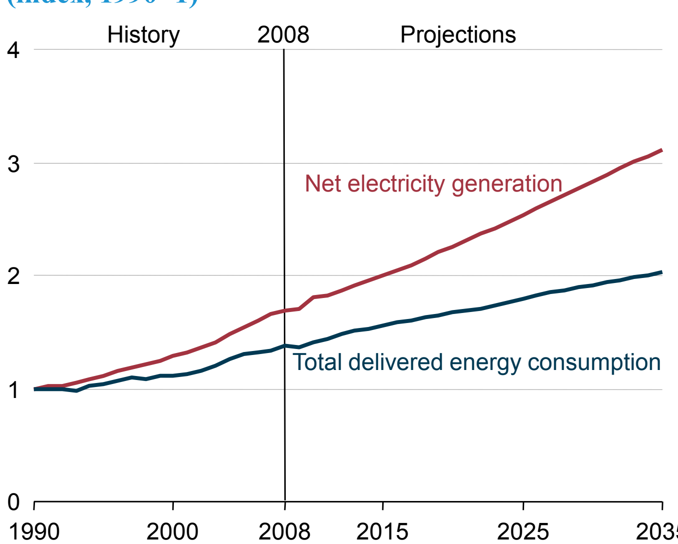
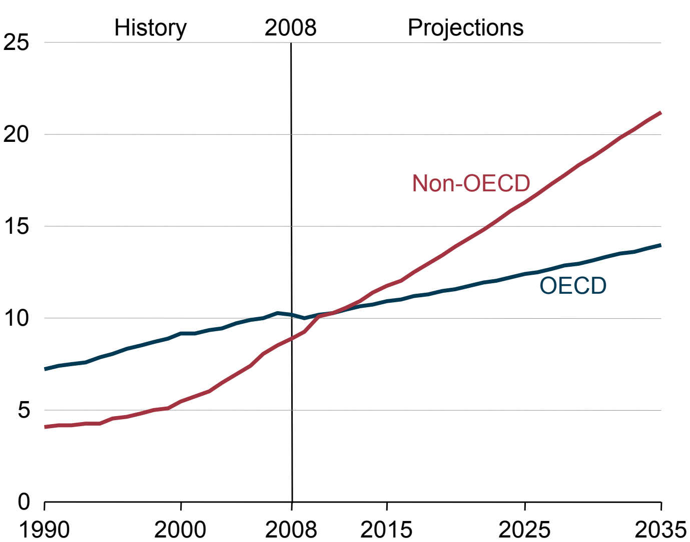
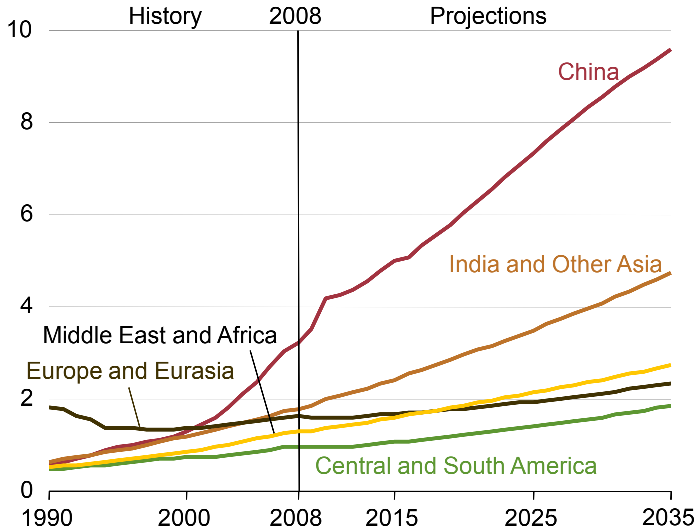


Figure 73. OECD and non-OECD net electricity generation, 1990-2035 (trillion kilowatthours)



The *IEO2011* projections do not incorporate assumptions related to limiting or reducing greenhouse gas emissions, such as caps on carbon dioxide emissions levels or taxes on carbon dioxide emissions. However, the Reference case does incorporate current national energy policies, such as the European Union's "20-20-20" plan and its member states' nuclear policies; China's wind capacity targets; and India's National Solar Mission.[28]

Figure 74. Non-OECD net electricity generation by region, 1990-2035 (trillion kilowatthours)



Electricity supply by energy source

The worldwide mix of primary fuels used to generate electricity has changed a great deal over the past four decades. Coal continues to be the fuel most widely used for electricity generation, although generation from nuclear power increased rapidly from the 1970s through the 1980s, and natural-gas-fired generation grew rapidly in the 1980s and 1990s. The use of oil for electricity generation has been declining since the mid-1970s, when oil prices rose sharply.

The high fossil fuel prices recorded between 2003 and 2008, combined with concerns about the environmental consequences of greenhouse gas emissions, have renewed interest in the development of alternatives to fossil fuels—specifically, nuclear power and renewable energy sources. In the *IEO2011* Reference case, long-term prospects continue to improve for generation from both nuclear and renewable energy sources—primarily supported by government incentives. Renewable energy sources are the fastest-growing sources of electricity generation in the *IEO2011* Reference case, with annual increases averaging 3.1 percent per year from 2008 to

Table 11. OECD and non-OECD net electricity generation by energy source, 2008-2035 (trillion kilowatthours)

Region	2008	2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
Liquids	0.4	0.3	0.3	0.3	0.3	0.3	-0.8
Natural gas	2.3	2.5	2.7	2.9	3.4	3.8	1.8
Coal	3.6	3.3	3.4	3.5	3.6	3.8	0.2
Nuclear	2.2	2.4	2.6	2.7	2.8	2.9	1.0
Renewables	1.8	2.3	2.7	2.9	3.1	3.2	2.2
Total OECD	**10.2**	**10.9**	**11.6**	**12.4**	**13.2**	**13.9**	**1.2**
Non-OECD							
Liquids	0.7	0.6	0.6	0.6	0.5	0.5	-1.0
Natural gas	1.8	2.4	3.0	3.5	4.1	4.6	3.4
Coal	4.1	5.2	5.6	6.7	7.9	9.1	3.0
Nuclear	0.4	0.7	1.2	1.5	1.7	2.0	6.0
Renewables	1.9	2.8	3.6	4.0	4.5	5.0	3.7
Total non-OECD	**8.9**	**11.8**	**13.9**	**16.3**	**18.8**	**21.2**	**3.3**
World							
Liquids	1.0	0.9	0.9	0.9	0.8	0.8	-0.9
Natural gas	4.2	4.9	5.6	6.5	7.5	8.4	2.6
Coal	7.7	8.5	8.9	10.2	11.5	12.9	1.9
Nuclear	2.6	3.2	3.7	4.2	4.5	4.9	2.4
Renewables	3.7	5.1	6.3	7.0	7.6	8.2	3.1
Total World	**19.1**	**22.7**	**25.5**	**28.7**	**31.9**	**35.2**	**2.3**

Note: Totals may not equal sum of components due to independent rounding.

[28]See the following sections on OECD Europe (pages 94-95) and non-OECD Asia (pages 97-99).

2035. Natural gas is the second fastest-growing generation source, increasing by 2.6 percent per year, followed by nuclear power at 2.4 percent per year. Although coal-fired generation increases by an annual average of only 1.9 percent over the projection period, it remains the largest source of generation through 2035. However, the outlook for coal, in particular, could be altered substantially by any future national policies or international agreements aimed at reducing or limiting the growth of greenhouse gas emissions.

Coal

In the *IEO2011* Reference case, coal continues to fuel the largest share of worldwide electric power production by a wide margin (Figure 75). In 2008, coal-fired generation accounted for 40 percent of world electricity supply; in 2035, its share decreases to 37 percent, as renewables, natural gas, and nuclear power all are expected to advance strongly during the projection and displace the need for coal-fired-generation in many parts of the world. World net coal-fired generation grows by 67 percent, from 7.7 trillion kilowatthours in 2008 to 12.9 trillion kilowatthours in 2035.

The electric power sector offers some of the most cost-effective opportunities for reducing carbon dioxide emissions in many countries. Coal is both the world's most widely used source of energy for power generation and also the most carbon-intensive energy source. If a cost, either implicit or explicit, is applied to carbon dioxide emissions in the future, there are several alternative technologies with no emissions or relatively low levels of emissions that currently are commercially proven or under development and could be used to displace coal-fired generation.

Natural gas

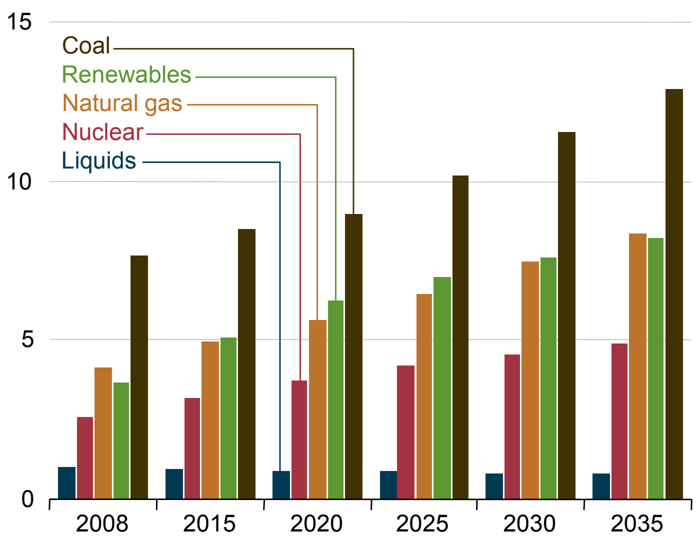
Over the 2008 to 2035 projection period, natural-gas-fired electricity generation increases by 2.6 percent per year. Generation from natural gas worldwide increases from 4.2 trillion kilowatthours in 2008 to 8.4 trillion kilowatthours in 2035, but the total amount of electricity generated from natural gas continues to be less than one-half the total for coal, even in 2035. Natural-gas-fired combined-cycle technology is an attractive choice for new power plants because of its fuel efficiency, operating flexibility (it can be brought online in minutes rather than the hours it takes for coal-fired and some other generating capacity), relatively short planning and construction times, relatively low emissions, and relatively low capital costs.

Prospects for natural gas have improved substantially relative to last year's outlook, in large part because of the revised expectations for unconventional sources of natural gas, especially shale gas,[29] both within the United States and globally. The additional resources will allow natural gas supplies outside North American to be used as LNG to supply markets that have few domestic resources. As a result, natural gas markets are expected to remain well supplied and prices relatively low in the mid-term, and many nations are expected to turn to natural gas, rather than more expensive or more carbon-intensive sources of electricity, to supply their future power needs.

Liquid fuels and other petroleum

With world oil prices projected to return to relatively high levels, reaching $125 per barrel (in real 2009 dollars) in 2035, liquid fuels are the only energy source for power generation that does not grow on a worldwide basis. Nations are expected to respond to higher oil prices by reducing or eliminating their use of oil for generation—opting instead for more economical sources of electricity, including natural gas and nuclear. Even in the resource-rich Middle East, there is an effort to reduce the use of petroleum liquids for generation in favor of natural gas and other resources, in order to maximize revenues from oil exports. Worldwide, generation from liquid fuels decreases by 0.9 percent per year, from 1.0 trillion kilowatthours in 2008 to 0.8 trillion kilowatthours in 2035.

Figure 75. World net electricity generation by fuel, 2008-2035 (trillion kilowatthours)



Nuclear power

Electricity generation from nuclear power worldwide increases from 2.6 trillion kilowatthours in 2008 to 4.9 trillion kilowatthours in 2035 in the *IEO2011* Reference case, as concerns about energy security and greenhouse gas emissions support the development of new nuclear generating capacity. In addition, world average capacity utilization rates have continued to rise over time, from about 65 percent in 1990 to about 80 percent today, with some increases still anticipated in the future. Finally, most older plants now operating in OECD countries and in non-OECD Eurasia probably will be granted extensions to their operating licenses.

While *IEO2011* was in preparation, a large earthquake and tsunami struck the northeast coast of Japan, severely damaging nuclear power plants at Fukushima Daiichi [*209*]. Although the full extent of the damage remains unclear, the event is almost certain to have a negative impact on Japan's nuclear power industry, at least in the short term, and it is

[29]Unconventional natural gas includes tight gas, shale gas, and coalbed methane.

also likely to reduce projected nuclear generation from both existing and new facilities as governments formulate their policy responses to the disaster. The *IEO2011* Reference case was not revised to take the March 2011 natural disaster into account, but the uncertainty associated with nuclear power projections for Japan and for the rest of the world has increased.

A number of issues could slow the development of new nuclear power plants. In many countries, concerns about plant safety, radioactive waste disposal, and nuclear material proliferation could hinder plans for new installations. Moreover, the explosions at Japan's Fukushima Daiichi nuclear power plant in the aftermath of the March 2011 earthquake and tsunami could have long-term implications for the future of world nuclear power development in general. Even China—where large increases in nuclear capacity have been announced and are anticipated in the *IEO2011* Reference case—has indicated that it will halt approval processes for all new reactors until the country's nuclear regulator completes a "thorough safety review"—a process that could last for as long as a year [*210*]. Germany, Switzerland, and Italy already have announced plans to phase out or cancel all their existing and future reactors, indicating that some slowdown in the growth of nuclear power should be expected. High capital and maintenance costs may also keep some countries from expanding their nuclear power programs. Finally, a lack of trained labor resources, as well as limited global capacity for the manufacture of technological components, could keep national nuclear programs from advancing quickly.

IEO2011 provides the status of international radioactive waste disposal programs in the box on page 89, which identifies the most common approaches to radioactive waste disposal and, where available, their costs and schedules. Storage and disposal costs remain an important life-cycle consideration in the decision to add nuclear generation capacity. Future *IEO*s will address supply chain uncertainties as well as uncertainties related to construction costs and uranium enrichment. Despite such uncertainties, the *IEO2011* Reference case projects continued growth in world nuclear power generation. The projection for nuclear electricity generation in 2035 is 9 percent higher than the projection published in last year's *IEO*.

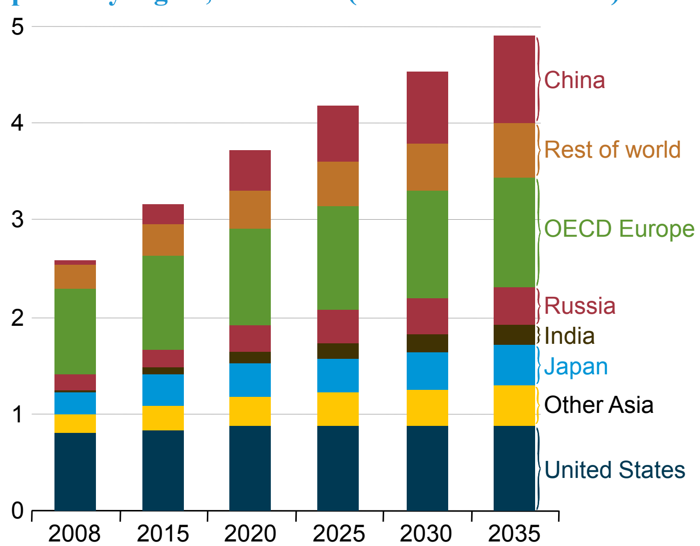
On a regional basis, the Reference case projects the strongest growth in nuclear power for the countries of non-OECD Asia (Figure 76), averaging 9.2 percent per year from 2008 to 2035, including increases of 10.3 percent per year in China and 10.8 percent per year in India. China leads the field with nearly 44 percent of the world's active reactor projects under construction in 2011 and is expected to install the most nuclear capacity over the period, building 106 gigawatts of net generation capacity by 2035 [*211*]. Outside Asia, nuclear generation grows the fastest in Central and South America, where it increases by an average of 4.2 percent per year. Nuclear generation worldwide increases by 2.4 percent per year in the Reference case.

To address the uncertainty inherent in projections of nuclear power growth over the long term, a two-step approach is used to formulate the outlook for nuclear power. In the short term (through 2020), projections are based primarily on the current activities of the nuclear power industry and national governments. Because of the long permitting and construction lead times associated with nuclear power plants, there is general agreement among analysts on which nuclear projects are likely to become operational in the short term. After 2020, the projections are based on a combination of announced plans or goals at the country and regional levels and consideration of other issues facing the development of nuclear power, including economics, geopolitical issues, technology advances, environmental policies, supply chain issues, and uranium availability.

Hydroelectric, wind, geothermal, and other renewable generation

Renewable energy is the fastest-growing source of electricity generation in the *IEO2011* Reference case. Total generation from renewable resources increases by 3.1 percent annually, and the renewable share of world electricity generation grows from 19 percent in 2008 to 23 percent in 2035. More than 82 percent of the increase is in hydroelectric power and wind power. The contribution of wind energy, in particular, has grown swiftly over the past decade, from 18 gigawatts of net installed capacity at the end of 2000 to 121 gigawatts at the end of 2008—a trend that continues into the future. Of the 4.6 trillion kilowatthours of new renewable generation added over the projection period, 2.5 trillion kilowatthours (55 percent) is attributed to hydroelectric power and 1.3 trillion kilowatthours (27 percent) to wind (Table 13).

Figure 76. World net electricity generation from nuclear power by region, 2008-2035 (trillion kilowatthours)



Although renewable energy sources have positive environmental and energy security attributes, most renewable technologies other than hydroelectricity are not able to compete economically with fossil fuels during the projection period except in a few regions or in niche markets. Solar power, for instance, is currently a "niche" source of renewable energy, but it can be economical where electricity prices are especially high, where peak load pricing occurs, or where government incentives are available. Government policies or incentives often provide the primary economic motivation for construction of renewable generation facilities.

Wind and solar are intermittent technologies that can be used only when resources are available. Once wind or solar facilities are built, however, their operating costs generally are much lower than the operating costs for fossil fuel-fired power plants. However, high construction costs can make the total cost to build and operate renewable generators higher than those for conventional plants. The intermittence of wind and solar can further hinder the economic competitiveness of those resources, because they are not operator-controlled and are not necessarily available when they would be of greatest value to the system. Although the technologies currently are not cost-effective, the use of energy storage (such as hydroelectric pumped storage, compressed air storage, and batteries) and the dispersal of wind and solar generating facilities over wide geographic areas could mitigate many of the problems associated with intermittency.

Changes in the mix of renewable fuels used for electricity generation differ between the OECD and non-OECD regions in the *IEO2011* Reference case. In the OECD nations, most of the hydroelectric resources that are both economical to develop and also meet environmental regulations already have been exploited. With the exceptions of Canada and Turkey, there are few large-scale hydroelectric projects planned for the future. As a result, most renewable energy growth in OECD countries comes from nonhydroelectric sources, especially wind and biomass. Many OECD countries, particularly those in Europe, have government policies, including feed-in tariffs (FITs),[30] tax incentives, and market share quotas, that encourage the construction of such renewable electricity facilities.

In non-OECD countries, hydroelectric power is expected to be the predominant source of renewable electricity growth. Strong growth in hydroelectric generation, primarily from mid- to large-scale power plants, is expected in China, India, Brazil, and a number of nations in Southeast Asia, including Malaysia and Vietnam. Growth rates for wind-powered generation also are high in non-OECD countries. The most substantial additions to electricity supply generated from wind power are expected for China.

The *IEO2011* projections for renewable energy sources include only marketed renewables. Non-marketed (noncommercial) biomass from plant and animal resources, while an important source of energy, particularly in the developing non-OECD economies, is not included in the projections, because comprehensive data on its use are not available. For the same reason, off-grid distributed renewables—renewable energy consumed at the site of production, such as off-grid photovoltaic (PV) panels—are not included in the projections.

Global efforts to manage radioactive waste from nuclear power plants

Prospects for nuclear power generation have improved in recent years, as many nations have attempted to diversify the fuel mix for their power generation sectors away from fossil fuels while also addressing concerns about greenhouse gas emissions. Nuclear power generators do not emit the greenhouse gases produced by fossil fuel generators. However, they do produce radioactive waste that must be managed.

In the *IEO2011* Reference case, nuclear electricity generation nearly doubles from 2008 to 2035. Such an increase would be accompanied by significant increases in the accumulation of spent fuel rods and other nuclear waste in countries with nuclear power plants. Managing nuclear waste is a long-term issue. Governments must protect the public and environment from exposure to highly radioactive materials for hundreds or thousands of years into the future. And although there is general international agreement about how waste disposal should be approached, implementing management plans has proven to be politically complicated. As a result, few of the countries that currently have nuclear generation programs in operation have solidified their long-term plans for managing nuclear waste.

There are two forms of nuclear waste: spent nuclear fuel (SNF) and high-level radioactive waste (HLW), which results from the processing of SNF for re-use in nuclear power reactors. If SNF is not reprocessed, the normal management approach is long-term storage, either on site at nuclear power stations or at centralized interim storage facilities followed by deep geological disposal in a repository. This approach to waste management is known as the "direct disposal option."

In the United States, SNF is stored at the country's 104 operating nuclear reactors. In Sweden it is stored at a single site, the Central Interim Storage Facility for Spent Nuclear Fuel at Oskarshamn. France reprocesses its spent nuclear fuel to recover plutonium and uranium for use in fabricating new mixed-oxide fuel for its nuclear power plants, and it has successfully commercialized the process. Reprocessing greatly reduces the volume of nuclear waste for which disposal is necessary, but some components of the HLW cannot be recycled and must be vitrified (solidified in a glass-like matrix), stored, and eventually placed in a repository.

In selecting a nuclear waste management approach, several countries, including the United States, have opted for direct disposal in order to reduce the risk of nuclear weapons proliferation that is associated with the reprocessing option. The International Atomic Energy Agency's (IAEA) Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which entered into force on June 18, 2001, recognizes that at the technical level disposal of nuclear waste in a deep geological repository ultimately represents the safest method of managing nuclear waste [*212*]. Many countries are investigating

(continued on page 90)

[30]A feed-in tariff is a financial incentive that encourages the adoption of renewable electricity. Under a feed-in tariff, government legislation requires electric utilities to purchase renewable electricity at a higher price than the wholesale price, allowing the renewable generator to achieve a positive return on investment despite higher costs.

geological disposal and are committed to the approach in principle, including the 13 countries that produce more than 80 percent of the world's nuclear power: Belgium, Canada, China, Finland, France, Germany, Japan, South Korea, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Only a few countries provide reliable data on the costs of geological disposal. Their estimates generally are contained in national reports to the IAEA under the provisions of the Joint Convention or, alternatively, in published accounts of total life-cycle costs for their nuclear power systems. Disposal costs are affected by such factors as the type and quantity of waste that requires disposal, the design of the waste repository and its period of operation, and the country's waste management strategy (direct disposal or reprocessing). National cost estimates for the management of spent nuclear fuel vary widely:

- In the United States, a facility with storage capacity for 70,000 metric tons of heavy metal (MTHM) is estimated to cost $96.18 billion (2007 dollars) or about $707 per kilogram of heavy metal [*213*].
- In Japan a 29,647 MTHM storage facility is estimated to cost $25 billion (2007 dollars) or about $851 per kilogram of heavy metal [*214*].
- In Sweden a 9,741 MTHM storage facility is estimated to cost $3.4 billion (2007 dollars) or about $350 per kilogram of heavy metal [*215*].

Nuclear energy remains a key component of the world's electric power mix in the IEO2011 Reference case. Countries with nuclear generation programs recognize the need for long-term planning for waste disposal, but the timing and costs of disposal are uncertain at best. Currently, no country has an operational disposal facility. With the United States recently having terminated its plan for disposal at Yucca Mountain in Nevada, the only countries likely to have operational deep geological repositories by 2025 are Finland, France, and Sweden. Others, including China and Spain, may not have established geological repositories until as late as 2050 (Table 12). Implementing timely nuclear waste management strategies will reduce uncertainties in the nuclear fuel cycle as well as the ultimate cost of disposal, but it remains to be seen how successful the international community will be in implementing such strategies.

Table 12. Approaches to nuclear waste management in selected countries

Waste management approach	Spent fuel in storage, 2008[a] (MTHM)	Centralized interim storage	Expected date for operation of geologic waste disposal site[b, c]
Direct disposal			
Belgium[d]	2,699	Yes	2040
Canada	40,054	No	2025
Finland	1,684	No	2020
South Korea[e]	10,185	Planned for 2016	Unknown
Spain	3,827	Planned for 2012	2050
Sweden	4,893	Yes	2022
United States[f, g]	62,400	No	Unknown
Reprocessing			
China[c]	1,532	No	2050
France[e]	12,400	No	2025
Germany[h]	12,788	Yes	2035
Japan[e]	12,585	No	2035
Switzerland[i]	1,040	Yes	2040
United Kingdom[j]	423	No	2025 (site selection)

[a]Organization for Economic Cooperation and Development/Nuclear Energy Agency, "Nuclear Energy Data 2009" (August 13, 2009), website www.oecd-ilibrary.org/nuclear-energy/nuclear-energy-data-2009_ned-2009-en-fr (subscription site).
[b]International Atomic Energy Agency, "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management," Registration No. 1729 (April 11, 2011), website www.iaea.org/Publications/Documents/Conventions/jointconv_status.pdf.
[c]International Atomic Energy Agency, "Net-Enabled Radioactive Waste Management Database," website http://newmdb.iaea.org/.
[d]Belgium ceased reprocessing in 1993. Direct disposal was adopted as the waste management approach.
[e]Provisional.
[f]The U.S. program for deep geologic disposal was terminated in 2010. A review is underway to determine the future approach.
[g]U.S. Energy Information Administration, Form RW-859, "Nuclear Fuel Data" (2002). Data for years after 2002 are projected.
[h]Once Germany's existing reprocessing contracts are fulfilled, no further reprocessing is expected.
[i]Switzerland's Nuclear Energy Act prohibits the reprocessing of spent nuclear fuel for a period of 10 years after July 1, 2006.
[j]All future reprocessing contracts in the United Kingdom will require government approval.

Regional electricity outlooks

In the *IEO2011* Reference case, the highest growth rates for electricity generation are in non-OECD nations, where strong economic growth and rising personal incomes drive the growth in demand for electric power. In OECD countries—where electric power infrastructures are relatively mature, national populations generally are expected to grow slowly or decline, and GDP growth is slower than in the developing nations—demand for electricity grows much more slowly. Electricity generation in non-OECD nations increases by 3.3 percent per year in the Reference case, as compared with 1.2 percent per year in OECD nations.

OECD electricity

Americas

The countries of the OECD Americas (the United States, Canada, Chile, and Mexico) currently account for the largest regional share of world electricity generation, with 26 percent of the total in 2008. That share declines as non-OECD nations experience fast-paced growth in demand for electric power. In 2035, the nations of the OECD Americas together account for only 19 percent of the world's net electric power generation.

The United States is by far the largest consumer of electricity in the region (Figure 77). U.S. electricity generation—including both generation by electric power producers and on-site generation—increases slowly, at an average annual rate of 0.8 percent from 2008 to 2035. Canada, like the United States, has a mature electricity market, and its generation increases by 1.4 percent per year over the same period. Mexico/Chile's electricity generation grows at a faster rate—averaging 3.2 percent per year through 2035—reflecting the current less-developed state of their electric power infrastructure (and thus the greater potential for expansion) relative to Canada and the United States.

There are large differences in the mix of energy sources used to generate electricity in the four countries that make up the OECD Americas, and those differences are likely to become more pronounced in the future (Figure 78). In the United States, coal is the leading source of energy for power generation, accounting for 48 percent of the 2008 total. In Canada, hydroelectricity provided 60 percent of the nation's electricity generation in 2008. Most of Mexico/Chile's electricity generation is currently

Table 13. OECD and non-OECD net renewable electricity generation by energy source, 2008-2035 (billion kilowatthours)

Region	2008	2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
Hydroelectric	1,329	1,418	1,520	1,600	1,668	1,717	1.0
Wind	181	492	689	806	852	898	6.1
Geothermal	38	56	67	79	93	104	3.8
Solar	12	68	86	95	105	120	8.8
Other	217	268	309	362	381	398	2.3
Total OECD	**1,778**	**2,302**	**2,670**	**2,941**	**3,099**	**3,236**	**2.2**
Non-OECD							
Hydroelectric	1,791	2,363	2,946	3,224	3,536	3,903	2.9
Wind	29	219	347	426	499	564	11.6
Geothermal	22	56	58	61	70	81	5.0
Solar	0	19	48	60	65	71	22.8
Other	41	132	186	252	321	375	8.5
Total non-OECD	**1,884**	**2,788**	**3,585**	**4,023**	**4,491**	**4,995**	**3.7**
World							
Hydroelectric	3,121	3,781	4,465	4,823	5,204	5,620	2.2
Wind	210	710	1,035	1,232	1,350	1,462	7.5
Geothermal	60	112	125	139	163	186	4.2
Solar	13	87	134	155	170	191	10.6
Other	258	400	496	614	702	772	4.1
Total World	**3,662**	**5,091**	**6,256**	**6,964**	**7,590**	**8,232**	**3.1**

Note: Totals may not equal sum of components due to independent rounding.

fueled by petroleum-based liquid fuels and natural gas, which together accounted for 66 percent of total generation in 2008. The predominant fuels for generation in the United States and Canada are expected to lose market share by 2035, although electricity generation continues to be added. Coal-fired generation declines to 43 percent of the U.S. total, and hydropower falls to 54 percent of Canada's total in 2035. In contrast, in Mexico/Chile, natural-gas-fired generation increases from 48 percent of the total in 2008 to 58 percent in 2035.

Generation from renewable energy sources in the United States increases in response to requirements in more than half of the 50 States for minimum renewable shares of electricity generation or capacity. Although renewable generation in 2035 in the *IEO2011* Reference case is 17 percent lower than in last year's outlook (due to a variety of factors, including lower electricity demand, a significant increase in the availability of shale gas, and revised technology and policy assumptions), the share of renewable-based generation is expected to grow from 9.7 percent in 2008 to 14.3 percent in 2035. The projection for electricity generation from other renewables sources also has dropped, as a result of lower expectations for biomass co-firing. U.S. Federal subsidies for renewable generation are assumed to expire as enacted. If those subsidies were extended, however, a larger increase in renewable generation would be expected.

Electricity generation from nuclear power plants accounts for 16.9 percent of total U.S. generation in 2035 in the *IEO2011* Reference case. Title XVII of the U.S. Energy Policy Act of 2005 (EPACT2005, Public Law 109-58) authorized the U.S. Department of Energy to issue loan guarantees for innovative technologies that "avoid, reduce, or sequester greenhouse gases." In addition, subsequent legislative provisions in the Consolidated Appropriation Act of 2008 (Public Law 110-161) allocated $18.5 billion in guarantees for nuclear power plants [*216*]. That legislation supports a net increase of about 10 gigawatts of nuclear power capacity, which grows from 101 gigawatts in 2008 to 111 gigawatts in 2035. The increase includes 3.8 gigawatts of expanded capacity at existing plants and 6.3 gigawatts of new capacity. The *IEO2011* Reference case includes completion of a second unit at the Watts Bar nuclear site in Tennessee, where construction was halted in 1988 when it was nearly 80 percent complete. Four new U.S. nuclear power plants are completed by 2035, all brought on before 2020 to take advantage of Federal financial incentives. One nuclear unit, Oyster Creek, is projected to be retired at the end of 2019, as announced by Exelon in December 2010. All other existing nuclear units continue to operate through 2035 in the Reference case.

In Canada, generation from natural gas increases by 3.8 percent per year from 2008 to 2035, nuclear by 2.2 percent per year, hydroelectricity by 0.9 percent per year, and wind by 9.9 percent per year. Oil-fired generation and coal-fired generation, on the other hand, decline by 1.0 percent per year and 0.6 percent per year, respectively.

In Ontario—Canada's largest provincial electricity consumer—the government plans to close its four remaining coal-fired plants (Atikokan, Lambton, Nanticoke, and Thunder Bay) by December 31, 2014, citing environmental and health concerns [*217*]. Units 1 and 2 of Lambton and units 3 and 4 of Nanticoke were decommissioned in 2010 [*218*]. The government plans to replace coal-fired generation with natural gas, nuclear, hydropower, and wind. It also plans to increase conservation measures. With the planned retirements in Ontario, Canada's coal-fired generation declines from about 104 billion kilowatthours in 2008 to 88 billion kilowatthours in 2035.

The renewable share of Canada's overall generation remains roughly constant throughout the projection. Hydroelectric power is, and is expected to remain, the primary source of electricity in Canada. From 60 percent of the country's total generation in 2008, hydropower falls to 54 percent in 2035. As one of the few OECD countries with large untapped hydroelectric potential, Canada currently has several large- and small-scale hydroelectric facilities either planned or under construction. Hydro-Québec is continuing the construction of a 768-megawatt facility near Eastmain and a smaller 150-megawatt facility at Sarcelle in

Figure 77. OECD Americas net electricity generation by region, 2008-2035 (trillion kilowatthours)

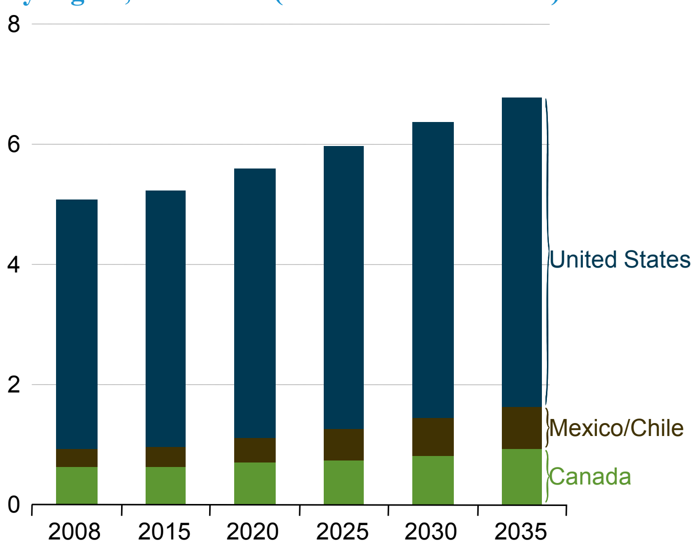
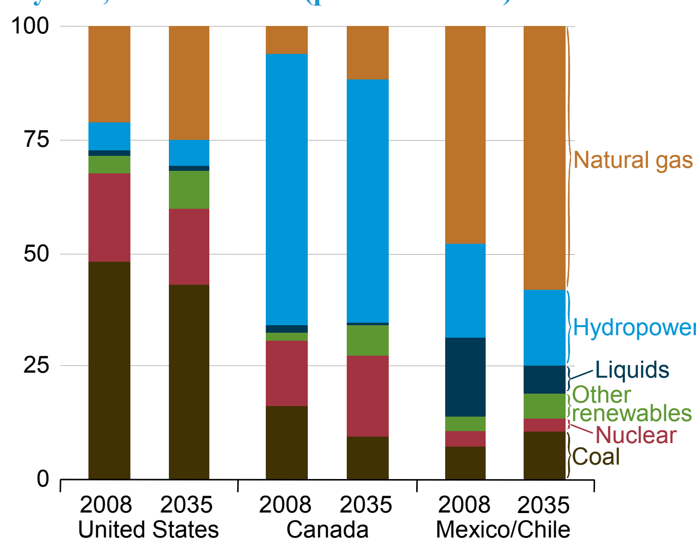


Figure 78. OECD Americas net electricity generation by fuel, 2008 and 2035 (percent of total)



Québec, both of which are expected to be fully commissioned by 2012 [*219*]. Other hydroelectric projects are under construction, including the 1,550-megawatt Romaine River project in Québec and the 200-megawatt Wuskwatim project in Manitoba [*220*]. The *IEO2011* Reference case does not anticipate that all planned projects will be constructed, but given Canada's past experience with hydropower and the commitments for construction, new hydroelectric capacity accounts for 25,563 megawatts of additional renewable capacity added in Canada between 2008 and 2035.

Wind-powered generation, in contrast, is the fastest-growing source of new energy in Canada, with its share of total generation increasing from less than 1 percent in 2008 to 5 percent in 2035. Canada has plans to continue expanding its wind power capacity, from 4.0 gigawatts of installed capacity at the end of 2010 [*221*] to nearly 16.6 gigawatts in 2035 in the Reference case. Growth in wind capacity has been so rapid that Canada's federal wind incentive program, "ecoENERGY for Renewable Power," which targeted the deployment of 4 gigawatts of renewable energy by 2011, allocated all of its funding and met its target by the end of 2009 [*222*].

In addition to the incentive programs of Canada's federal government, several provincial governments have instituted their own incentives to support the construction of new wind capacity. After the success of its Renewable Energy Standard Offer Program, Ontario enacted a feed-in-tariff that pays all sizes of renewable energy generators between 10 cents and 80 cents (Canadian) per kilowatthour, depending on project type, for electricity delivered to the grid [*223*]. The two programs have helped support robust growth in wind installations over the past several years, and installed wind capacity in the province has risen from 0.6 megawatts in 1995 to 1,457 megawatts in February 2011 [*224*]. Continued support from Canada's federal and provincial governments—along with the sustained higher fossil fuel prices in the *IEO2011* Reference case—is expected to provide momentum for the projected increase in the country's use of wind power for electricity generation.

The combined electricity generation of Mexico and Chile increases by an average of 3.2 percent annually from 2008 to 2035—more than double the rate for Canada and almost quadruple the rate for the United States. In Mexico, the government has recognized the need for the country's electricity infrastructure to keep pace with the fast-paced growth anticipated for electricity demand. In July 2007, the government unveiled its 2007-2012 National Infrastructure Program, which included plans to invest $25.3 billion to improve and expand electricity infrastructure [*225*]. As part of the program, the government has set a goal to increase installed generating capacity by 8.6 gigawatts from 2006 to 2012 [*226*].

Natural-gas-fired generation in Mexico and Chile more than doubles in the Reference case, from 147 billion kilowatthours in 2008 to 418 billion kilowatthours in 2035. With Mexico's government expected to implements plans to reduce the country's use of diesel and fuel oil for power generation [*227*], the country's demand for natural gas strongly outpaces growth in electricity production, leaving it dependent on pipeline imports from the United States and LNG from other countries. Currently, Mexico has one LNG import terminal, Altamira, operating on the Gulf Coast and another, Costa Azul, on the Pacific Coast. A contract tender for a third terminal at Manzanillo, also on the Pacific Coast, was awarded in March 2008, and the project is scheduled for completion by 2011 [*228*].

Chile also has been trying to increase natural gas use for electricity generation in order to diversify its fuel mix. In 2008, nearly 40 percent of the country's total generation came from hydropower, which can be problematic during times of drought. An unusually hot and dry summer in Chile in 2010-2011 has resulted in the country's worst drought in several decades and threatens power shortages [*229*]. The government has instituted emergency measures to ensure power supplies, launching a nationwide energy conservation program and also increasing imports of LNG through its two regasification terminals. Although Chile can import natural gas from Argentina through existing pipelines, supplies have not always been reliable. Beginning in 2004, Argentina began to restrict its gas exports to Chile because it was unable to meet its own domestic supplies, leading Chile to develop its LNG import capacity [*230*].

Most of the renewable generation in Chile and Mexico comes from hydroelectric dams. Hydroelectric resources provide about 85 percent of the region's current renewable generation mix, with another 9 percent coming from geothermal energy. There are plans to expand hydroelectric power in both countries in the future. In the *IEO2011* Reference case, hydroelectric power accounts for almost 75 percent of Mexico/Chile's total net generation from renewable energy sources in 2035. In Mexico, there are two major hydroelectric projects underway: the 750-megawatt La Yesca facility, scheduled for completion by 2012, and the planned 900-megawatt La Parota project, which has been delayed and may not be completed until 2018 [*231*].

In addition to efforts to diversify its electricity fuel mix, Chile has a number of new hydroelectric plants planned or under construction. In October 2010, the 150-megawatt La Higuera and 158-megawatt La Confluencia hydro projects on the Tinguiririca River were completed [*232*]. The two run-of-river projects were constructed in a joint venture by Australia's Pacific Hydro and Norway's SN Power Invest. Pacific Hydro also has plans to construct another 650 megawatts of hydroelectric capacity on Chile's Upper Cachapoal River. Construction on the first phase of the development began in 2009. The first hydro plant in the system, the 111-megawatt Chacayes power plant, is scheduled for completion in October 2011. The entire development should be completed in 2019, when the 78-megawatt Las Maravillas project is scheduled to begin operation [*233*].

There is virtually no wind or solar generation in Mexico at present, but the Mexican government's goal of installing 2.5 gigawatts of wind capacity on the Tehuantepec Isthmus by 2012 has encouraged wind development in the short term [*234*]. The 161-megawatt Los Vergeles project and the Oaxaca II, III, and IV projects—totaling more than 300 megawatts—are due for completion in 2011 and 2012, respectively. In Baja California even larger projects are under development, such as the 1,200-megawatt Sempra and the 400-megawatt Union Fenosa projects [*235*]. Further, Mexico's goal of reducing national greenhouse gas emissions to 50 percent of 2002 levels by 2050 is expected to spur wind and solar installations in the future [*236*].

Chile expanded its total installed wind capacity to 167 megawatts in early 2011 and has granted environmental approval to an additional 1,500 megawatts of wind projects [*237*]. Still, the penetration of wind and solar generating capacity in Chile remains modest throughout the projection, with their share of Mexico and Chile's combined total electricity generation rising from less than 0.1 percent in 2008 to 3 percent in 2035.

OECD Europe

Electricity generation in the nations of OECD Europe increases by an average of 1.2 percent per year in the *IEO2011* Reference case, from 3.4 trillion kilowatthours in 2008 to 4.8 trillion kilowatthours in 2035. Because most of the countries in OECD Europe have relatively stable populations and mature electricity markets, most of the region's growth in electricity demand is expected to come from those nations with more robust population growth (including Turkey, Ireland, and Spain) and from the newest OECD members (including the Czech Republic, Hungary, Poland, and Slovenia), whose projected economic growth rates exceed the OECD average. In addition, with environmental concerns remaining prominent in the region, there is a concerted effort in the industrial sector to switch from coal and liquid fuels to electricity.

Renewable energy is OECD Europe's fastest-growing source of electricity generation in the Reference case (Figure 79), increasing by 2.5 percent per year through 2035. The increase is almost entirely from wind and solar. OECD Europe's leading position worldwide in wind power capacity is maintained through 2035, with growth in generation from wind sources averaging 6.4 percent per year, even though the Reference case assumes no enactment of additional legislation to limit greenhouse gas emissions. Strong growth in offshore wind capacity is underway, with 883 megawatts added to the grid in 2010, representing a 51-percent increase over the amount of capacity added in 2009 [*238*].

The United Kingdom is expected to spearhead the growth in OECD Europe's offshore wind capacity. Although there is debate within the country over the costs and benefits of offshore wind power, the 300-megawatt Thanet Wind Farm, the world's largest, was completed in September 2010 [*239*]. Work is also continuing on other major projects, including the 1,000-megawatt London Array, for which the first foundation was laid in March 2011 [*240*].

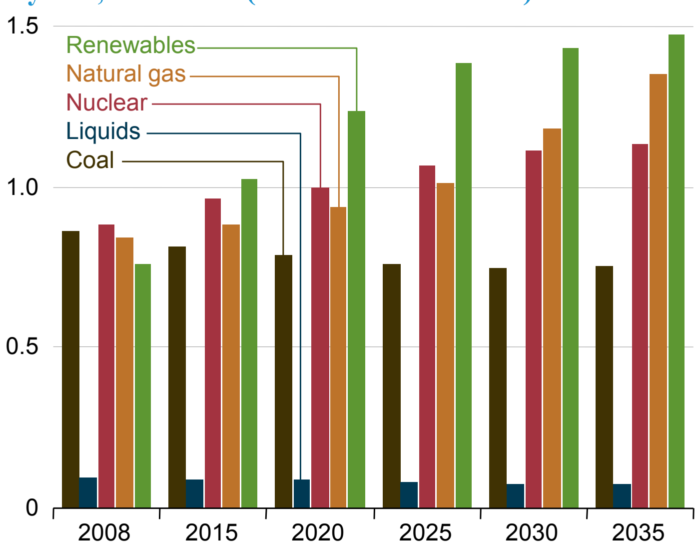
The growth of nonhydropower renewable energy sources in OECD Europe is encouraged by some of the world's most favorable renewable energy policies. The European Union set a binding target to produce 21 percent of electricity generation from renewable sources by 2010 [*241*] and reaffirmed the goal of increasing renewable energy use with its December 2008 "climate and energy policy," which mandates that 20 percent of total energy production must come from renewables by 2020 [*242*]. Approximately 18 percent of the European Union's electricity came from renewable sources in 2008.

The *IEO2011* Reference case does not anticipate that all future renewable energy targets in the European Union will be met on time. Nevertheless, current laws are expected to lead to the construction of more renewable capacity than would have occurred in their absence. In addition, some individual countries provide economic incentives to promote the expansion of renewable electricity. For example, Germany, Spain, and Denmark—the leaders in OECD Europe's installed wind capacity—have enacted feed-in tariffs that guarantee above-market rates for electricity generated from renewable sources and, typically, last for 20 years after a project's completion. As long as European governments support such price premiums for renewable electricity, robust growth in renewable generation is likely to continue.

Exceptionally generous feed-in tariffs have been falling out of favor in recent years, however. Before September 2008, Spain's solar subsidy led to an overabundance of solar PV projects. When the Spanish feed-in tariff was lowered after September 2008, a PV supply glut or "solar bubble" resulted, driving down the price of solar panels and lowering profits throughout the industry [*243*]. The Spanish government is now set to reduce its tariffs by a further 45 percent for large ground-based sites, in view of the country's large public deficit and the fear of creating another solar bubble [*244*]. Germany has taken a similar approach and will cut its feed-in tariff for ground PV units by 15 percent, effective in the summer of 2011 [*245*]. Italy, with the third-largest installed PV capacity in OECD Europe, is also lowering its solar feed-in tariff in June 2011, after experiencing a financially unsustainable 128-percent increase in solar PV output between November 2009 and November 2010 [*246*].

Natural gas is the second fastest-growing source of power generation after renewables in the outlook for OECD Europe, increasing at an average rate of 1.8 percent per year from 2008 to 2035. Growth is projected to be more robust than the 1.3-percent annual increase in last year's outlook, as prospects for the development of unconventional sources of natural gas in the United States and other parts of the world help to keep world markets well supplied and global prices relatively low. As a result, natural gas is more competitive in European markets in the *IEO2011* Reference case than it was in *IEO2010*.

Figure 79. OECD Europe net electricity generation by fuel, 2008-2035 (trillion kilowatthours)



Before the Fukushima disaster in Japan, prospects for nuclear power in OECD Europe had improved markedly in recent years, and many countries were reevaluating their programs to consider plant life extensions or construction of new nuclear generating capacity. In the aftermath of Fukushima, it appears that many OECD nations are reconsidering their plans. Although the full extent to which European governments might withdraw their support for nuclear power is uncertain, some countries already have reversed their nuclear policies. For example, the German government has announced plans to close all nuclear reactors in the country by 2022 [*247*]; the Swiss Cabinet has decided to phase out nuclear power by 2034 [*248*]; and Italian voters, in a country-wide referendum, have rejected plans to build nuclear power plants in Italy [*249*]. In addition, the European Commission has announced that it will conduct a program of stress tests on nuclear reactors operating in the European Union. (Turkey, in contrast, has announced that it will proceed with construction of the country's first nuclear power plant [*250*].) Still, environmental concerns and the importance of energy security provide support for future European nuclear generation. With no phaseout of nuclear power anticipated in the *IEO2011* Reference case, nuclear capacity in OECD Europe increases by a net 19 gigawatts from 2008 to 2035.

Coal accounted for 25 percent of OECD Europe's net electricity generation in 2008, but concerns about the contribution of carbon dioxide emissions to climate change could reduce that share in the future. In the *IEO2011* Reference case, electricity from coal slowly loses its prominence in OECD Europe, declining by 0.5 percent per year from 2008 to 2035 and ultimately falling behind renewables, natural gas, and nuclear energy as a source of electricity. Coal consumption in the electric power sector is not decreasing uniformly in all countries in OECD Europe, however. Spain's Coal Decree, which went into force in February 2011, subsidizes the use of domestic coal in Spanish power plants. The policy is expected to result in more electricity generation from coal-fired plants at least through 2014, when the subsidy is scheduled to expire [*251*].

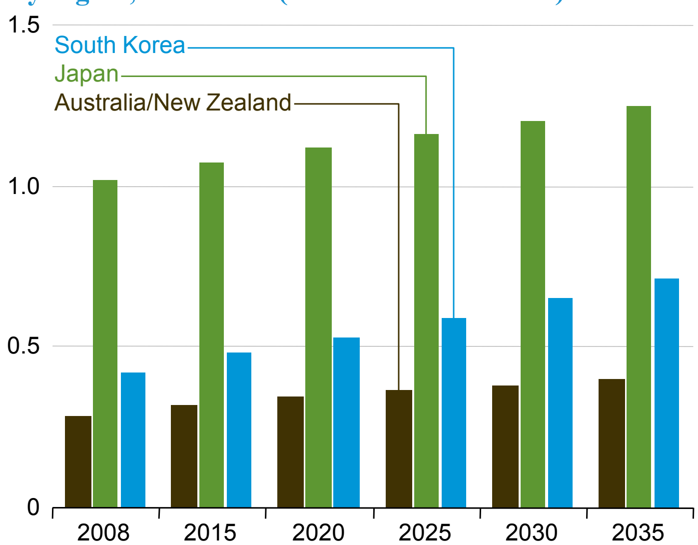
OECD Asia

Total electricity generation in OECD Asia increases by an average of 1.2 percent per year in the Reference case, from 1.7 trillion kilowatthours in 2008 to 2.4 trillion kilowatthours in 2035. Japan accounted for the largest share of electricity generation in the region in 2008 and continues to do so throughout the projection period, despite having the slowest-growing electricity market in the region and the slowest among all OECD countries, averaging 0.8 percent per year, as compared with 1.3 percent per year for Australia/New Zealand and 2.0 percent per year for South Korea (Figure 80). Japan's electricity markets are well established, and its aging population and relatively slow projected economic growth translate into slow growth in demand for electric power. In contrast, Australia/New Zealand and South Korea are expected to see more robust economic growth and population growth, leading to more rapid growth in demand for electricity.

The fuel mix for electricity generation varies widely among the three economies that make up the OECD Asia region. In Japan, natural gas, coal, and nuclear power make up the bulk of the current electric power mix, with natural gas and nuclear accounting for about 51 percent of total generation and coal another 26 percent. The remaining portion is split between renewables and petroleum-based liquid fuels. Japan's reliance on nuclear power increases over the projection period, from 24 percent of total generation in 2008 to 33 percent in 2035. The natural gas share of generation declines slightly over the same period, from 27 percent to 26 percent, and coal's share declines to 18 percent, being displaced by nuclear and renewable energy sources.

On March 11, 2011, a devastating, magnitude 9.0 earthquake, followed by a tsunami, struck northeastern Japan, resulting in extensive loss of life and triggering a nuclear disaster at the Fukushima Daiichi nuclear power plants. At present, it is impossible to assess the ultimate impact on Japan's nuclear program, and *IEO2011* makes no attempt to incorporate the ultimate effects of the earthquake in the Reference case. In the immediate aftermath of the earthquake, reactors at Japan's Fukushima Daini and Onagawa nuclear facilities were successfully shut down, and they will not be returned to operation until they have undergone stringent safety reviews [*252*]. The six reactors at Fukushima Daiichi were damaged beyond repair, removing of 4.7 gigawatts of generating capacity from the grid. Although power had been restored in most of the affected areas by June 2011, the temporary and permanent losses of nuclear power capacity from Japan's electricity grid (in addition to a substantial amount of coal-fired capacity that also remains shut down) will make it difficult for power generators to meet demand in the summer months of 2011 (June, July, and August), when electricity consumption typically is very high [*253*].

Figure 80. OECD Asia net electricity generation by region, 2008-2035 (trillion kilowatthours)



Currently, Japan is reconsidering its electricity supply policies. In May, Prime Minister Naoto Kan stated that the plan to increase the nuclear power share of the country's electricity supply, from about 26 percent at present to 50 percent by 2030, "will have to be set aside" [*254*]. Instead, the government plans to pursue an aggressive expansion of renewable energy capacity, especially solar power. Japan generates only about 6 percent of its primary energy from renewable energy sources (including hydroelectricity), but government policies and incentives to increase solar power will improve the growth of the energy source in the future. In the *IEO2011* Reference case, electricity generation from solar energy increases by 11.5 percent per year from 2008 to 2035, making solar power Japan's fastest-growing source of renewable energy (although it starts from a negligible amount in 2008). In November 2009, the government initiated a feed-in tariff incentive to favor the development of solar power [*255*]. Wind-powered generation in Japan also increases strongly in the Reference case, by an average of 8.1 percent per year. In the wake of the nuclear disaster, it is likely that additional government incentives for renewable energy sources will follow. Both solar and wind power, however, remain minor sources of electricity, supplying 3 percent and 2 percent of total generation in 2035, respectively, as compared with hydropower's 8-percent share of the total.

Australia and New Zealand, as a region, rely on coal for about 66 percent of electricity generation, based largely on Australia's rich coal resource base (9 percent of the world's total coal reserves). The remaining regional generation is supplied by natural gas and renewable energy sources—mostly hydropower, wind, and, in New Zealand, geothermal.

Australia continues to make advances in wind energy, with 1,712 megawatts of capacity installed at the end of 2009 and a further 588 megawatts under construction [*256*]. To help meet its 2025 goal of having 90 percent of electricity generation come from renewable sources, New Zealand is focusing on harnessing more of its geothermal potential [*257*]. Construction of the 250-megawatt Tauhara II project, currently under review by the country's Environmental Protection Authority, would alone power all the homes in the Wellington metro area [*258*]. The Australia/New Zealand region uses negligible amounts of oil for electricity generation and no nuclear power, and that is not expected to change over the projection period. Natural-gas-fired generation is expected to grow strongly in the region, at 4.0 percent per year from 2008 to 2035, reducing the coal share to 39 percent in 2035.

In South Korea, coal and nuclear power currently provide 42 percent and 34 percent of total electricity generation, respectively. Natural-gas-fired generation grows quickly in the Reference case, but despite a near doubling of electricity generation from natural gas, its share of total generation increases only slightly, from 19 percent in 2008 to 21 percent in 2035. Coal and nuclear power continue to provide most of South Korea's electricity generation, with a combined 73 percent of total electricity generation in 2035.

Non-OECD electricity

Non-OECD Europe and Eurasia

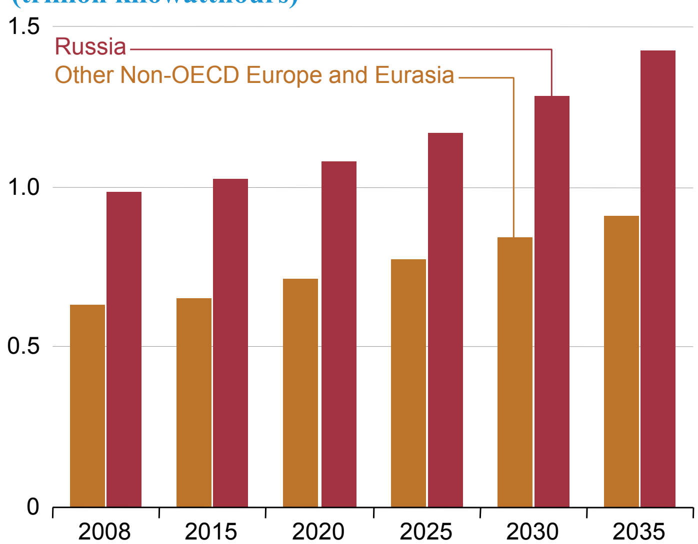
Total electricity generation in non-OECD Europe and Eurasia grows at an average rate of 1.4 percent per year in the *IEO2011* Reference case, from 1.6 trillion kilowatthours in 2008 to 2.3 trillion kilowatthours in 2035. Russia, with the largest economy in non-OECD Europe and Eurasia, accounted for about 60 percent of the region's total generation in 2008 and is expected to retain approximately that share throughout the period (Figure 81).

Natural gas and nuclear power supply much of the growth in electricity generation in the region. Although non-OECD Europe and Eurasia has nearly one-third of the world's total proved natural gas reserves, some countries (notably, Russia) plan to export natural gas instead of using it to fuel electricity generation. As a result, the region's natural-gas-fired generation grows modestly in the outlook, at an average rate of 0.7 percent from 2008 to 2035.

Generation from nuclear power grows strongly in the region, averaging 3.0 percent per year. Much of the increase is expected in Russia, which continues to shift generation from natural gas to nuclear, because natural gas exports are more profitable than the domestic use of natural gas for electricity generation.

In 2006, the Russian government released Resolution 605, which set a federal target program (FTP) for nuclear power development. Although the FTP was updated and scaled back in July 2009 as a result of the recession, 10 nuclear power reactors still are slated for completion by 2016, adding a potential 9 gigawatts of capacity. According to the Russian plan, another 44 reactors are to be constructed, increasing Russia's total nuclear generating capacity to 42 gigawatts by 2024. By 2030, the plan would bring the total to nearly 50 gigawatts and increase nuclear generation to 25 or 30 percent of total generation. In January 2010, the Russian government approved an FTP that would shift the focus of the nuclear power industry to fast reactors with a closed fuel cycle. Life extensions have been completed for roughly 30 percent of Russia's operating reactors, and the installed capacity of most reactors has been uprated [*259*]. In the *IEO2011* Reference case, Russia's existing 23 gigawatts of nuclear generating capacity is supplemented by a net total of 5 gigawatts in 2015 and another 23 gigawatts in 2035.

Figure 81. Non-OECD Europe and Eurasia net electricity generation by region, 2008-2035 (trillion kilowatthours)



Renewable generation in non-OECD Europe and Eurasia, almost entirely from hydropower facilities, increases by an average of 1.9 percent per year, largely as a result of repairs and expansions at existing sites. The repairs include reconstruction of turbines in the 6.4-gigawatt Sayano-Shushenskaya hydroelectric plant, which was damaged in an August 2009 accident [*260*]. Four of the plant's 640-megawatt generators are currently operational, and full restoration of the dam is expected to be completed by 2014 [*261*]. Notable new projects include the 3-gigawatt Boguchanskaya Hydroelectric Power Station in Russia and the 3.6-gigawatt Rogun Dam in Tajikistan. Construction of the Boguchanskaya station began in 1980, and work was started on Rogun in 1976. However, work on both projects ceased when the former Soviet Union experienced economic difficulties in the 1980s.

Despite the recent recession, construction continues on Boguchanskaya, which is on track for completion by 2012 [*262*]. Although Tajikistan's president announced in May 2008 that construction work on Rogun Dam had resumed, its prospects are less favorable [*263*]. Neighboring Uzbekistan strongly opposes the dam, fearing that it will reduce the water supply that supports the Uzbek cotton industry [*264*]. Furthermore, only $200 million of the $4 billion needed to complete the hydroelectric plant has been raised so far, enough to support the construction work for just 2 more years [*265*].

Other than increases in hydropower, only modest growth in renewable generation is projected for the nations of non-OECD Europe and Eurasia, given the region's access to fossil fuel resources and lack of financing available for relatively expensive renewable projects. In the *IEO2011* Reference case, nonhydropower renewable capacity in the region increases by only 5 gigawatts from 2008 to 2035. Although total growth in nonhydropower renewable generation is projected to be small, Romania is one nation in the region that is moving ahead with wind energy projects: its 348-megawatt Fantanele wind farm is on track to be completed in late 2010, and the nearby Cogealac wind farm (253 megawatts) is due for commissioning in 2011 [*266*].

Non-OECD Asia

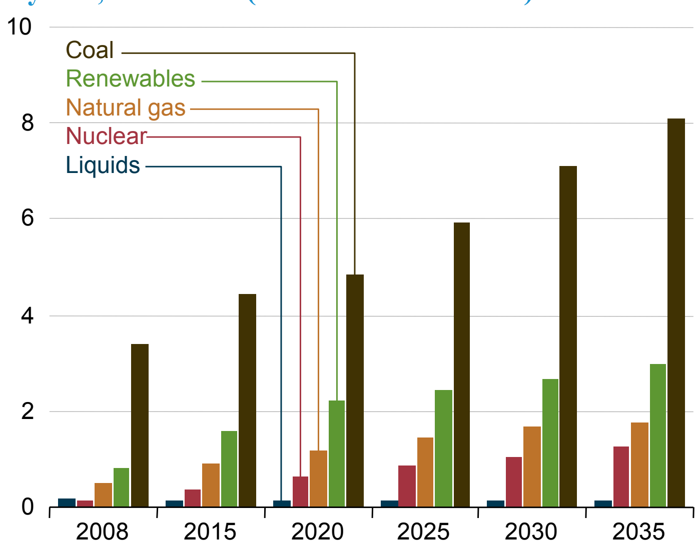
Non-OECD Asia—led by China and India—has the fastest projected growth rate for electric power generation worldwide, averaging 4.0 percent per year from 2008 to 2035 in the Reference case. Although the global economic recession had an impact on the region's short-term economic growth, the economies of non-OECD Asia have led the recovery and are projected to expand strongly in the long term, with corresponding increases in demand for electricity in both the building and industrial sectors. Total electricity generation in non-OECD Asia grows by 49 percent, from 5.0 trillion kilowatthours in 2008 to 14.3 trillion kilowatthours in 2035, with electricity demand increasing by 46 percent from 2015 to 2025 and by another 32 percent from 2025 to 2035. In 2035, net electricity generation in non-OECD Asia totals 14.3 trillion kilowatthours in the Reference case. Non-OECD Asia is the world's fastest-growing regional market for electricity in *IEO2011*, accounting for 41 percent of world electricity generation in 2035.

Coal is used to fuel more than two-thirds of electricity generation in non-OECD Asia (Figure 82), led by coal-fired generation in China and India. Both countries rely heavily on coal to produce electric power. In 2008, coal's share of generation was an estimated 80 percent in China and 68 percent in India. Under existing policies, it is likely that coal will remain the predominant source of power generation in both countries. In the *IEO2011* Reference case, coal's share of electricity generation declines to 66 percent in China and 51 percent in India in 2035.

At present, China is installing approximately 900 megawatts of coal-fired capacity (equivalent to one large coal-fired power plant) per week. However, it also has been retiring old, inefficient plants to help slow the rate of increase in the nation's carbon intensity. From 2006 to 2010, China retired almost 71 gigawatts of coal-fired capacity, including 11 gigawatts in 2010, and it plans to retire an additional 8 gigawatts in 2011 [*267*].

Non-OECD Asia leads the world in installing new nuclear capacity in the *IEO2011* Reference case, accounting for 54 percent of the net increment in nuclear capacity worldwide (or 144 gigawatts of the total 266-gigawatt increase). China, in particular, has ambitious plans for nuclear power, with more than 27 nuclear power plants currently under construction and a total of 106 gigawatts of new capacity expected to be installed by 2035.

Figure 82. Non-OECD Asia net electricity generation by fuel, 2008-2035 (trillion kilowatthours)



There is significant uncertainty in the *IEO2011* Reference case projections for China's nuclear capacity. Officially, China's nuclear capacity targets are 70 to 86 gigawatts by 2020 and 200 gigawatts by 2030—targets that the Chinese government has been increasing since 2008, when the target was 40 gigawatts by 2020 [*268*]. Factors that may cause China to undershoot its official targets include limited global capacity of heavy forging facilities required for the manufacture of Generation III reactor components and potential difficulties in training the large number of engineers and regulators needed to operate and monitor the planned power plants. On the other hand, an estimated 226 gigawatts of new capacity has advanced beyond the pre-feasibility study phase, including reactors in at least 20 provinces that are not approved for the national plan [*269*]. The impact of the March 2011 disaster at Japan's Fukushima Daishi nuclear power plant may also have a negative impact on the pace of China's nuclear power program. In the aftermath of the disaster, China announced it would halt approval processes for all new reactors until the country's nuclear regulator completes a "thorough safety review"—a process that could last for as long as a year [*270*].

The *IEO2011* Reference case assumes that the global lack of heavy forging facilities and the long lead times needed to build or upgrade forging facilities, build new nuclear power plants, and train new personnel will cause China's nuclear power industry to grow more slowly than in official government predictions. Nonetheless, the 115 gigawatts of nuclear capacity projected for 2035 is a 53-percent increase over last year's Reference case. In the *IEO2011* Reference case, the nuclear share of China's total electricity generation increases from 2 percent in 2008 to 10 percent in 2035.

India also has plans to boost its nuclear power generating capacity. From 4 gigawatts of installed nuclear power capacity in operation in 2011, India has set an ambitious goal of increasing its nuclear generating capacity to 20 gigawatts by 2020 and to as much as 63 gigawatts by 2032 [*271*]. Currently, five nuclear reactors are under construction, three of which are scheduled for completion by the end of 2011 [*272*]. The *IEO2011* Reference case assumes a slower increase in nuclear capacity than anticipated by India's government, to 16 gigawatts in 2020 and 28 gigawatts in 2035.

In addition to China and India, several other countries in non-OECD Asia are expected to begin or expand nuclear power programs. In the Reference case, new nuclear power capacity is installed in Taiwan, Vietnam, Indonesia, and Pakistan by 2020. Concerns about security of energy supplies and greenhouse gas emissions lead many nations in the region to diversify their fuel mix for power generation by adding a nuclear component.

Electricity generation from renewable energy sources in non-OECD Asia grows at an average annual rate of 4.9 percent, increasing the renewable share of the region's total generation from 17 percent in 2008 to 21 percent in 2035. Small-, mid-, and large-scale hydroelectric facilities all contribute to the projected growth. Several countries in non-OECD Asia have hydropower facilities either planned or under construction, including Vietnam, Malaysia, Pakistan, and Myanmar (the former Burma). Almost 50 hydropower facilities, with a combined 3,398 megawatts capacity, are under construction in Vietnam's Son La province, including the 2,400-megawatt Son La and 520-megawatt Houi Quang projects, both of which are scheduled for completion before 2015 [*273*]. The remaining facilities are primarily micro- and mini-hydroelectric power plants. Malaysia expects to complete its 2,400-megawatt Bakun Dam by the end of 2011, although the project has experienced delays and setbacks in the past [*274*].

Pakistan and Myanmar also have substantial hydropower development plans, but those plans have been discounted in the *IEO2011* Reference case to reflect the two countries' historical difficulties in acquiring foreign direct investment for infrastructure projects. Pakistan's electricity development plans have been further hampered by floods that occurred in 2010; power plants that had been in need of refurbishment are now severely damaged or destroyed [*275*]. Nearly 150 of the 200 small hydroelectric plants in the northern Khyber-Pakhtunkhwa province were destroyed by the floods and may take years to rebuild [*276*].

India has plans to more than double its installed hydropower capacity by 2030. In its Eleventh and Twelfth Five-Year Plans, which span 2008 through 2017, India's Central Electricity Authority has identified nearly 41 gigawatts of hydroelectric capacity that it intends to build. Nearly one-half of the planned capacity is to be built in the Uttarakhand region. However, environmental concerns recently led to the rejection of two proposed projects in the region, totaling 860 megawatts, which underscores the uncertainty associated with estimating India's future hydroelectric development. Despite $150 million already invested in the 600-megawatt Loharinag Pala project, construction on the project has also been halted, and its future is uncertain [*277*]. Although the *IEO2011* Reference case does not assume that all the planned capacity will be completed, more than one-third of the announced projects are under construction already and are expected to be completed by 2020 [*278*].

Like India, China has many large-scale hydroelectric projects under construction. The final generator for the 18.2-gigawatt Three Gorges Dam project went on line in October 2008, and the Three Gorges Project Development Corporation plans to increase the project's total installed capacity further, to 22.4 gigawatts by 2012 [*279*]. In addition, work continues on the 12.6-gigawatt Xiluodu project on the Jinsha River, which is scheduled for completion in 2015 as part of a 14-facility hydropower development plan [*280*]. China also has the world's second-tallest dam (at nearly 985 feet) currently under construction, as part of the 3.6-gigawatt Jinping I project on the Yalong River. The dam scheduled for completion in 2014 as part of a plan by the Ertan Hydropower Development Company to construct 21 facilities with 29.2 gigawatts of hydroelectric capacity on the Yalong [*281*].

The Chinese government has set a 300-gigawatt target for hydroelectric capacity in 2020. Including those mentioned above, the country has a sufficient number of projects under construction or in development to meet the target. China's aggressive hydropower development plan is expected to increase hydroelectricity generation by 3.2 percent per year, more than doubling the country's total hydroelectricity generation by 2035.

Although hydroelectric projects dominate the renewable energy mix in non-OECD Asia, generation from nonhydroelectric renewable energy sources, especially wind, also is expected to grow significantly. In the *IEO2011* Reference case, electricity generation from wind plants in China grows by 14.2 percent per year, from 12 billion kilowatthours in 2008 to 447 billion kilowatthours in 2035. In addition, government policies in China and India are encouraging the growth of solar generation. Under its "Golden Sun" program, announced in July 2009, the Chinese Ministry of Finance plans to subsidize 50 percent of the construction costs for grid-connected solar plants [*282*]. India's National Solar Mission, launched in November 2009, aims to have 20 gigawatts of installed solar capacity (both PV and solar thermal) by 2020, 100 gigawatts by 2030, and 200 gigawatts by 2050 [*283*]. India's targets have been discounted in the *IEO2011* Reference case because of the substantial uncertainty about the future of government-provided financial incentives [284]. However, the policies do support robust growth rates in solar generation for China and India, at 22 percent per year and 28 percent per year, respectively, in the Reference case.

Measuring the growth of China's wind capacity has proven difficult as the number of wind farms rapidly expands. According to the Chinese Renewable Energy Industry Association (CREIA), the country had 41.8 gigawatts of installed wind capacity at the end of 2010 [285]. The National Energy Administration and the Chinese Electricity Council, however, report only 31.1 gigawatts of wind capacity connected to the electricity grid at the end of 2010. The discrepancy between the two figures is a result of the inability of some local grids to absorb wind-generated electricity, a lack of long-distance transmission lines [286], and policies (now superseded) that encouraged construction of wind capacity instead of generation of electricity. The *IEO2011* Reference case assumes that China had 31.1 gigawatts of wind capacity installed at the end of 2010.

Although geothermal energy is a small contributor to non-OECD Asia's total electricity generation, it plays an important role in the Philippines and Indonesia. With the second-largest amount of installed geothermal capacity in the world, the Philippines generated almost 16 percent of its total electricity from geothermal sources in 2010 [287]. Indonesia, with the world's third-largest installed geothermal capacity, plans to have 3.9 gigawatts of capacity installed by 2014 [288] and 9.5 gigawatts by 2025 [289]. However, those goals are discounted in the Reference case in view of the long lead times and high exploration costs associated with geothermal energy.

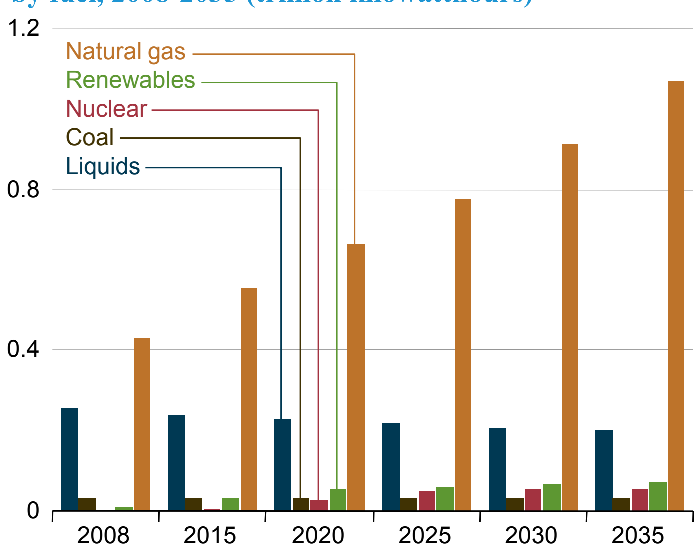
Middle East

Electricity generation in the Middle East region grows by 2.5 percent per year in the Reference case, from 0.7 trillion kilowatthours in 2008 to 1.4 trillion kilowatthours in 2035. The region's young and rapidly growing population, along with a strong increase in national income, is expected to result in rapid growth in demand for electric power. Iran, Saudi Arabia, and the United Arab Emirates (UAE) account for two-thirds of the region's demand for electricity, and demand has increased sharply over the past several years in each of those countries. From 2000 to 2008, Iran's net generation increased by an average of 7.5 percent per year, Saudi Arabia's by 6.2 percent per year, and the UAE's by 10.1 percent per year.

The Middle East depends on natural gas and petroleum liquid fuels to generate most of its electricity and is projected to continue that reliance through 2035, although liquids-fired generation declines over the projection period and thus loses market share to natural-gas-fired generation (Figure 83). In 2008, natural gas supplied 59 percent of electricity generation in the Middle East and liquid fuels 35 percent. In 2035, the natural gas share is projected to be 75 percent and the liquid fuels share 14 percent. There has been a concerted effort by many of the petroleum exporters in the region to develop their natural gas resources for use in domestic power generation. Petroleum is a valuable export commodity for many nations in the Middle East, and there is growing interest in the use of domestic natural gas for electricity generation in order to make more oil assets available for export.

Other energy sources make only minor contributions to electricity supply in the Middle East. Israel is the only country in the region that uses significant amounts of coal to generate electric power [290], and Iran and the UAE are the only ones projected to add nuclear capacity. Iran's 1,000-megawatt Bushehr reactor is scheduled to begin operating in 2011, although it has faced repeated delays, the latest being the detection of metal particles in the nuclear fuel rods, with the result that the fuel had to be unloaded and tested for possible contamination [291]. In December 2009, the Emirates Nuclear Energy Corporation (ENEC) in the UAE selected a South Korean consortium to build four nuclear reactors, with construction planned to begin in 2012 [292]. ENEC filed construction license applications for the first two units in December 2010, and it plans to have all four units operational by 2020 [293].

Figure 83. Middle East net electricity generation by fuel, 2008-2035 (trillion kilowatthours)



In addition to Iran and the UAE, several other Middle Eastern nations have announced intentions in recent years to pursue nuclear power programs. In 2010, the six-nation Gulf Cooperation Council[31] entered into a contract with U.S.-based Lightbridge Corporation to assess regional cooperation in the development of nuclear power and desalination programs [294]. Jordan also has announced its intention to add nuclear capacity [295], and in 2010 Kuwait's National Nuclear Energy Committee announced plans to build four reactors by 2022 [296]. Even given the considerable interest in nuclear power in the region, however, given the economic and political issues and long lead times usually associated with beginning a nuclear program, the only reactors projected to be built in the Middle East in the *IEO2011* Reference case are in Iran and the UAE.

Several Middle Eastern countries recently have expressed some interest in increasing coal-fired generation in response to concerns about diversifying the electricity fuel mix and

[31]Gulf Cooperation Council members are Saudi Arabia, Kuwait, Bahrain, the United Arab Emirates, Qatar, and Oman.

meeting the region's fast-paced growth in electricity demand. For example, Oman announced in 2008 that it would construct the Persian Gulf's first coal-fired power plant at Duqm [*297*]. According to the plan, the 1-gigawatt plant will be fully operational by 2016, powering a water desalinization facility [*298*]. The UAE, Saudi Arabia, and Bahrain also have considered building coal-fired capacity [*299*].

Although there is little economic incentive for countries in the Middle East to increase their use of renewable energy sources (the renewable share of the region's total electricity generation increases from only 1 percent in 2008 to 5 percent in 2035 in the Reference case), there have been some recent developments in renewable energy use in the region. Iran, which generated 10 percent of its electricity from hydropower in 2010, is adding approximately 4 gigawatts of new hydroelectric capacity, even after the droughts of 2007 and 2008 reduced available hydroelectric generation by nearly 75 percent [*300*]. Although development of Abu Dhabi's Masdar City project has been slowed by the current global economic environment [*301*], the government still plans to meet its 2020 goal of producing 7 percent of its energy from renewable sources. Solar power is expected to meet the vast majority of that goal, including two 100-megawatt solar power plants that Masdar Power plans to build [*302*].

Africa

Demand for electricity in Africa grows at an average annual rate of 3.0 percent in the *IEO2011* Reference case. Fossil-fuel-fired generation supplied 81 percent of the region's total electricity in 2008, and reliance on fossil fuels is expected to continue through 2035. Coal-fired power plants, which were the region's largest source of electricity in 2008, accounting for 41 percent of total generation, provide a 33-percent share in 2035; and natural-gas-fired generation expands strongly, from 29 percent of the total in 2008 to 45 percent in 2035 (Figure 84).

At present, South Africa's two nuclear reactors are the only commercial reactors operating in the region, accounting for about 2 percent of Africa's total electricity generation. Although the construction of a new Pebble Bed Modular Reactor in South Africa has been canceled, the South African government's Integrated Electricity Resource Plan calls for another 9.6 gigawatts of nuclear capacity to be built by 2030 [*303*]. In addition, in May 2009, Egypt's government awarded a contract to Worley Parsons for the construction of a 1,200-megawatt nuclear power plant. Although original plans were for one unit, current plans call for four units, with the first plant to be operational in 2019 and the others by 2025 [*304*]. In the Reference case, 2.3 gigawatts of net nuclear capacity becomes operational in Africa over the 2008-2035 period, although only South Africa is expected to complete construction of any reactors. The nuclear share of the region's total generation remains at 2 percent in 2035.

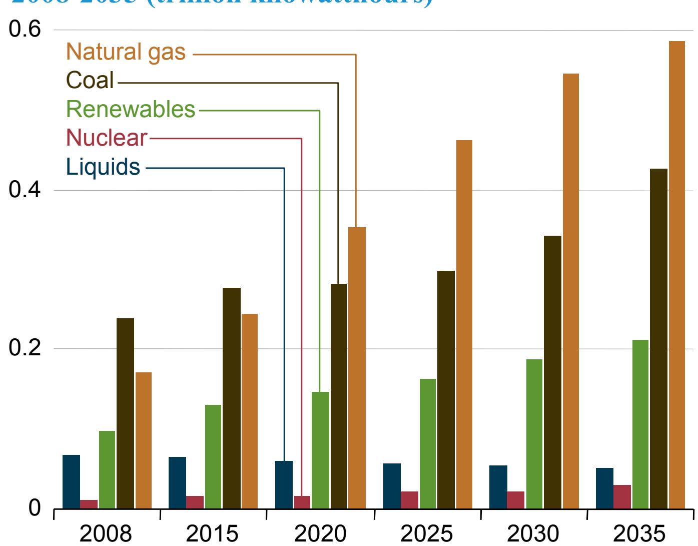
Generation from hydropower and other marketed renewable energy sources is expected to grow relatively slowly in Africa. Plans for several hydroelectric projects in the region have been advanced recently, and they may help to boost supplies of marketed renewable energy in the mid-term. Several (although not all) of the announced projects are expected to be completed by 2035, allowing the region's consumption of marketed renewable energy to grow by 2.9 percent per year from 2008 to 2035. For example, Ethiopia finished work on two hydroelectric facilities in 2009: the 300-megawatt Takeze power station and the 420-megawatt Gilgel Gibe II [*305*]. A third plant, the 460-megawatt Tana Beles, was completed in 2010 [*306*].

Central and South America

Electricity generation in Central and South America increases by 2.4 percent per year in the *IEO2011* Reference case, from 1.0 trillion kilowatthours in 2008 to 1.9 trillion kilowatthours in 2035. The fuel mix for electricity generation in Central and South America is dominated by hydroelectric power, which accounted for nearly two-thirds of the region's total net electricity generation in 2008. Of the top five electricity-generating countries in the region, three—Brazil, Venezuela, Paraguay—generate more than 70 percent of their total electricity from hydropower.

In Brazil, the region's largest economy, hydropower provided more than 80 percent of electricity generation in 2008 (Figure 85). The country has been trying to diversify its electricity generation fuel mix away from hydroelectric power because of the risk of power shortages during times of severe drought. In the Brazilian National Energy Plan for 2010-2019, the government set a goal to build 63 gigawatts of installed capacity, with nonhydroelectric capacity making up the majority of additions [*307*]. To help achieve that target, the government has announced plans to increase nuclear power capacity, beginning with the completion of the long-idled 1.3-gigawatt Angra-3 project [*308*]. Construction resumed in June 2010, and Angra-3 is expected to be operational at the end of 2015 [*309*]. Brazil also has plans to construct four new 1-gigawatt nuclear plants beginning in 2015. In the *IEO2011* Reference case, the Angra-3 project is completed by 2015, and three more planned nuclear projects are completed by 2035.

Figure 84. Net electricity generation in Africa by fuel, 2008-2035 (trillion kilowatthours)



In the past, the Brazilian government has tried (with relatively little success) to attract substantial investment in natural-gas-fired power plants. Its lack of success has been attributed mainly to the higher costs of natural-gas-fired generation relative to hydroelectric power, and to concerns about the security of natural gas supplies. Brazil has relied on imported Bolivian natural gas for much of its supply, but concerns about the impact of Bolivia's nationalization of its energy sector on foreign investment in the country's natural gas production has led Brazil to look toward LNG imports for secure supplies. Brazil has invested strongly in its LNG infrastructure, and its third LNG regasification plant is scheduled for completion in 2013 [*310*]. With Brazil diversifying its natural gas supplies, substantially increasing domestic production, and resolving to reduce the hydroelectric share of generation, natural gas is projected to be its fastest-growing source of electricity, increasing by 8.7 percent per year on average from 2008 to 2035.

Brazil still has plans to continue expanding its hydroelectric generation over the projection period, including the construction of two plants on the Rio Madeira in Rondonia—the 3.2-gigawatt Santo Antonio and the 3.3-gigawatt Jirau hydroelectric facilities. The two plants, with completion dates scheduled for 2012-2013, are expected to help Brazil meet electricity demand in the mid-term [*311*]. In the long term, electricity demand could be met in part by the proposed 11.2-gigawatt Belo Monte dam, which was given approval for construction in April 2010 [*312*]. Each of the three projects could, however, be subject to further delay as a result of legal challenges.

Brazil is also interested in increasing the use of other, nonhydroelectric renewable resources in the future—notably, wind. In December 2009, Brazil held its first supply tender exclusively for wind farms. At the event, 1.8 gigawatts of capacity were purchased, for development by mid-2012 [*313*]. The first signs of wind development are now taking place, with a purchase contract already signed for the 90-megawatt Brotas wind farm, which is scheduled for completion in 2011 [*314*]. In the *IEO2011* Reference case, wind power generation in Brazil grows by 10.8 percent per year, from 530 million kilowatthours in 2008 to 8,508 million kilowatthours in 2035. Despite that robust growth, however, wind remains a modest component of Brazil's renewable energy mix in the Reference case, as compared with the projected growth in hydroelectric generation to 792 billion kilowatthours in 2035.

In the *IEO2011* Reference case, natural-gas-fired generation and hydroelectric generation are expected to dominate the electric power sector in Central and South America (excluding Brazil), increasing from 73 percent of total electricity generation in 2008 to 79 percent in 2035 (Figure 86). However, some countries in the region have a more diverse fuel mix. Argentina, for example, generated 6 percent of its electricity from its two nuclear power plants in 2008. Although construction of a third reactor, Atucha 2, was suspended in 1994, the 692-megawatt facility is scheduled to be completed by the end of 2011 [*315*].

Many countries in Central and South America are continuing their attempts to increase the role of natural gas in the electricity mix to prevent blackouts, caused by a combination of surging electricity demand and droughts that decrease generation from hydroelectric sources. Argentina, which experienced repeated power outages from December 20 through 31 in the summer of 2010, continues to increase LNG imports. The Argentine government has announced plans to build an import terminal outside Buenos Aires by 2012 and has signed a deal to import up to 706 million cubic feet of LNG from Qatar through another new terminal in Rio Negro province [*316*]. Venezuela has also committed to increasing its use of natural gas for electricity generation to both reduce the nation's heavy reliance on hydroelectricity and to meet fast-paced growth in electricity demand. At present, hydroelectricity accounts for around 63 percent of Venezuela's total installed generating capacity. In 2010, an extremely hot and dry summer reduced available hydroelectric generation so much that the country was forced to ration electricity [*317*]. The rationing program was suspended on July 30, 2010 as rainfall returned reservoir levels at the Guri hydroelectric plant approached more normal levels. However, despite the government's aggressive investment in power sector infrastructure improvements over the past two years, electricity demand has continued to outpace the growth in generating capacity [*318*]. Venezuela once again began to experience widespread power outages beginning in March 2011 and in June the government announced it would reinstate electricity rationing in an attempt to reduce electricity demand in addition to continuing to invest in generating capacity increases.

Figure 85. Net electricity generation in Brazil by fuel, 2008-2035 (trillion kilowatthours)

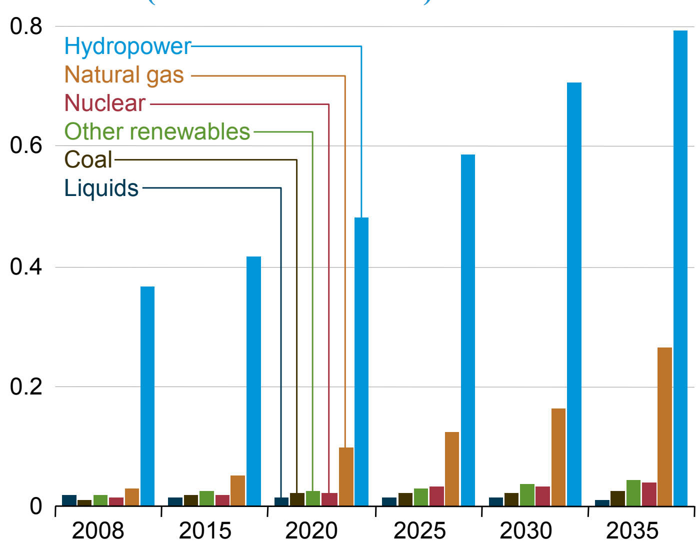
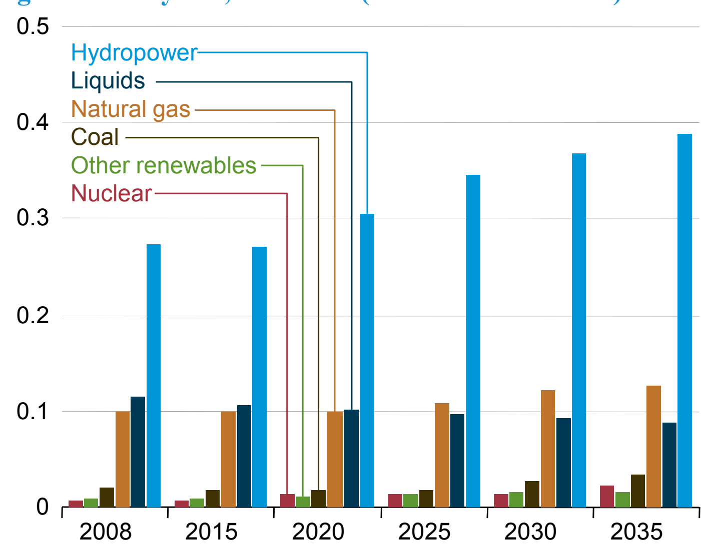


Figure 86. Other Central and South America net electricity generation by fuel, 2008-2035 (trillion kilowatthours)



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Industrial sector energy consumption

Overview

The world's industries make up a diverse sector that includes manufacturing industries (food, paper, chemicals, refining, iron and steel, nonferrous metals, and nonmetallic minerals, among others) and nonmanufacturing industries (agriculture, mining, and construction). Chemicals, iron and steel, nonmetallic minerals, paper, and nonferrous metal manufacturing account for the majority of all industrial energy consumption and thus are the main focus of this chapter. Industrial energy demand varies across regions and countries, depending on the level and mix of economic activity and technological development, among other factors. Energy is consumed in the industrial sector for a wide range of activities, such as processing and assembly, space conditioning, and lighting. Industrial energy use also includes natural gas and petroleum products (naphtha and natural gas liquids) used as feedstocks to produce non-energy products, such as plastics. In aggregate, the industrial sector uses more energy than any other end-use sector, consuming about one-half of the world's total delivered energy.

Over the projection period, worldwide industrial energy consumption grows from 191 quadrillion Btu in 2008 to 288 quadrillion Btu in 2035 (Table 14). In the *IEO2011* Reference case, world industrial energy demand increases by an average of 1.5 percent per year through 2035. The industrial sector accounts for a majority of the reduction in energy use in 2009 caused by the global economic recession that began in 2008 and deepened in 2009 (Figure 87), primarily because the impact of substantial cutbacks in manufacturing is more pronounced than the impact of marginal reductions in energy use in other sectors. In the long term, national economic growth rates and energy consumption patterns return to historical trends (Figure 88).

Most of the long-term growth in industrial sector energy demand occurs in non-OECD nations. Currently, non-OECD economies consume 62 percent of global delivered energy in the industrial sector. From 2008 to 2035, industrial energy use in non-OECD countries grows by an average of 2.0 percent per year, compared with 0.5 percent per year in OECD countries (Figure 89). Thus, 89 percent of the growth in industrial energy use from 2008 to 2035 in the *IEO2011* Reference case occurs in non-OECD countries, and non-OECD nations consume 71 percent of total delivered energy in the world's industrial sector in 2035.

Table 14. World industrial delivered energy use by region and energy source, 2008-2035 (quadrillion Btu)

Region	2008	2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
Petroleum and other liquids	28.1	26.2	27.0	27.4	27.6	28.0	0.0
Natural gas	19.1	20.2	21.2	21.9	22.9	24.0	0.9
Coal	9.2	8.6	8.6	8.8	9.0	9.2	0.0
Electricity	11.4	11.5	12.3	13.0	13.7	14.4	0.9
Renewables	5.3	5.4	6.1	7.0	7.6	8.0	1.5
Total OECD	**73.0**	**72.0**	**75.2**	**78.1**	**80.7**	**83.6**	**0.5**
Non-OECD							
Petroleum and other liquids	27.2	31.2	32.2	34.4	37.5	40.6	1.5
Natural gas	25.0	29.4	33.1	36.9	41.1	45.6	2.2
Coal	40.7	52.7	56.0	59.9	63.3	66.2	1.8
Electricity	16.5	20.9	24.0	28.1	32.5	37.0	3.0
Renewables	8.9	10.0	11.2	12.4	13.8	15.2	2.0
Total non-OECD	**118.3**	**144.2**	**156.3**	**171.8**	**188.1**	**204.5**	**2.0**
World							
Petroleum and other liquids	55.3	57.5	59.2	61.9	65.1	68.6	0.8
Natural gas	44.0	49.7	54.3	58.8	63.9	69.5	1.7
Coal	49.8	61.2	64.5	68.7	72.3	75.5	1.5
Electricity	27.9	32.4	36.3	41.1	46.1	51.4	2.3
Renewables	14.2	15.4	17.2	19.4	21.4	23.2	1.8
Total world	**191.3**	**216.2**	**231.5**	**249.9**	**268.8**	**288.2**	**1.5**

Note: Totals may not equal sum of components due to independent rounding.

Fuel prices shape the mix of fuel consumption in the industrial sector, as industrial enterprises choose the cheapest fuels available to them, subject to process constraints. Because liquids are more expensive than other primary fuels, the use of liquids in the world industrial sector increases at an average rate of only 0.8 percent per year (Figure 90), and the share of liquid fuels in the industrial fuel mix declines. Electricity can be generated from a wide variety of sources and used in a wide variety of industrial activities, and world industrial electricity use grows by an average of 2.3 percent per year from 2008 to 2035.

At present, the overall industrial fuel mix differs between OECD and non-OECD countries. In 2008, liquids made up 38 percent of industrial energy use in OECD countries, compared with 23 percent in non-OECD countries, and coal represented 13 percent of OECD industrial energy use, as compared with 34 percent of non-OECD industrial energy use.

Over the projection horizon, there are significant shifts in the industrial fuel mix in both OECD and non-OECD regions (Figures 91 and 92). From 2008 to 2035, as liquid prices continue to be sustained at relatively high levels, industrial liquids use in OECD countries stagnates and is displaced by growing industrial demand for natural gas, electricity, and especially renewables. As a result, the liquids share of OECD delivered industrial energy consumption falls from 38 percent in 2008 to 33 percent in 2035, while the natural gas share increases from 26 percent to 29 percent, the electricity share increases from 16 percent to 17 percent; and the renewable share increases from 7 percent to 10 percent. In non-OECD countries, there is a shift away from liquids and coal use in the industrial sector, but it is electricity that gains the largest portion of the fuel mix, increasing from 14 percent in 2008 to 18 percent in 2035.

In 2008, the industrial sector worldwide consumed 14 quadrillion Btu of energy from renewables for non-electricity uses, or about 7 percent of the sector's total delivered energy use [*319*]. From 2008 to 2035, renewable energy use in the industrial sector grows by an average of 1.8 percent per year. Biomass currently provides the vast majority of renewable energy consumed in the industrial sector and continues to do so throughout the projection period.

Industrial energy consumption in each region is a function of total industrial output and the energy intensity of the industrial sector, measured as energy consumed per unit of output. Energy-intensive industries consume about half the energy used in the industrial sector. For years, the energy-intensive industries have focused on reducing energy consumption, which represents a large portion of their costs [*320*]. Enterprises can reduce energy use in a number of ways. For example, industrial processes can be improved to reduce energy waste and recover energy, often process heat, which would otherwise be lost; and recycling of materials and fuel inputs can also improve efficiency.

Countries' development trajectories play a major role in industrial energy consumption. When economies initially begin to develop, industrial energy use rises as manufacturing output begins to take up a larger portion of GDP, as has occurred already in many non-OECD economies—most

Figure 87. Annual changes in world industrial and all other end-use energy consumption from previous year, 2007-2011 (quadrillion Btu)

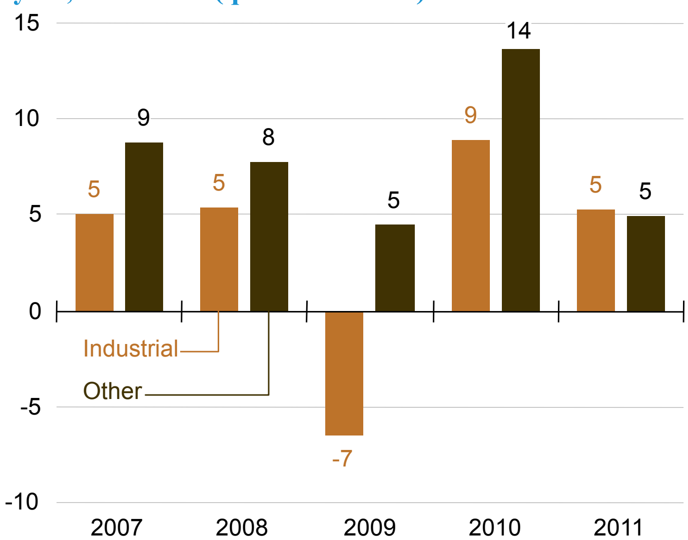


Figure 88. World delivered energy consumption in the industrial and all other end-use sectors, 2005-2035 (quadrillion Btu)

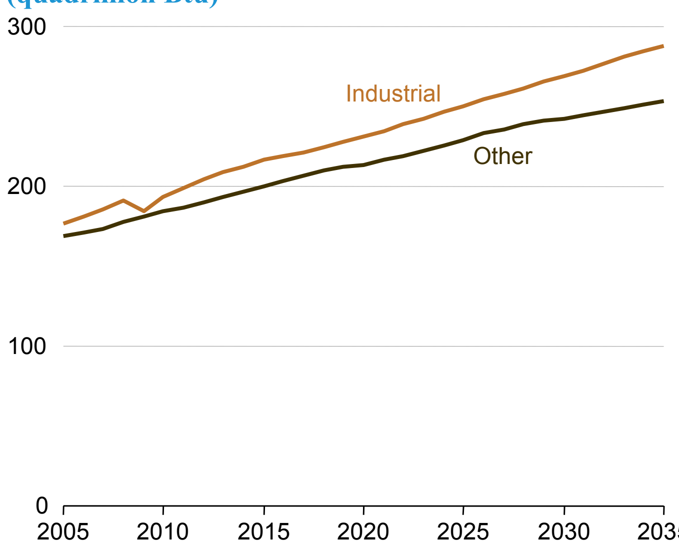
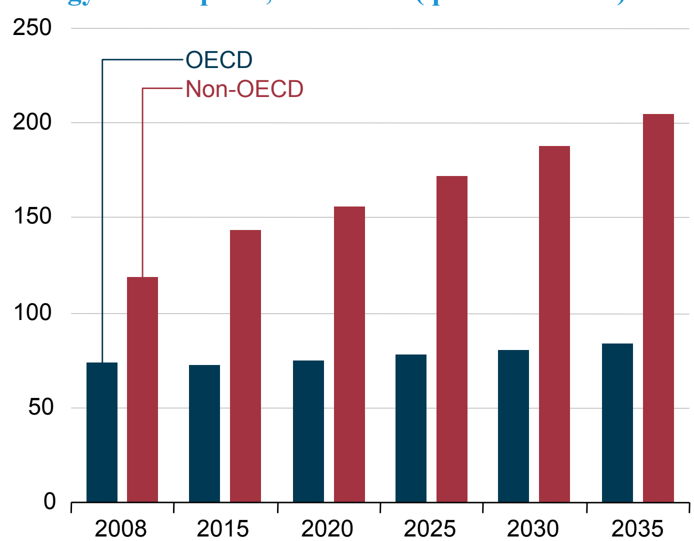


Figure 89. OECD and non-OECD industrial sector energy consumption, 2008-2035 (quadrillion Btu)



notably, China. When developing countries achieve higher levels of economic development, their economies tend to become more service-oriented, and their industrial energy use begins to level off, as can be seen currently in most OECD countries.

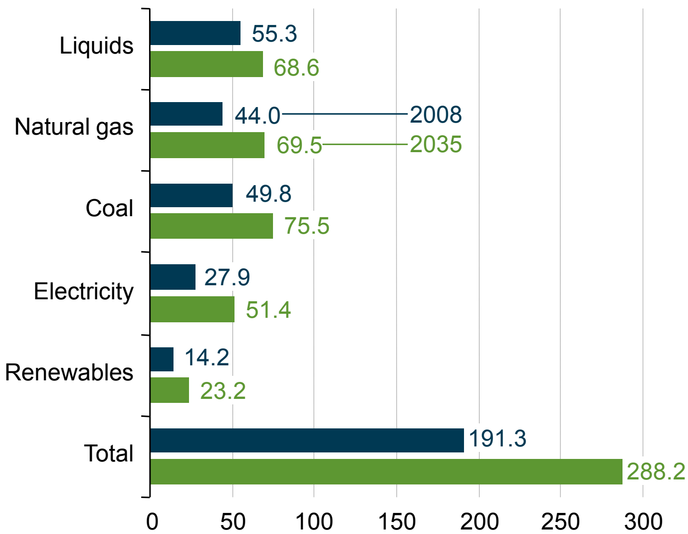
The following section describes patterns of energy use in the world's most energy-intensive industries. Subsequent sections examine specific patterns of industrial energy use in the major OECD and non-OECD regions.

Energy-intensive industries

Five industries account for more than 60 percent of all energy used in the industrial sector (Figure 93): chemicals (33 percent), iron and steel (14 percent), nonmetallic minerals (7 percent), pulp and paper (4 percent), and nonferrous metals (3 percent). Consequently, the quantity and fuel mix of future industrial energy consumption will be determined largely by energy use in those five industries. In addition, the same industries emit large quantities of carbon dioxide, related to both their energy use and their production processes.

The largest industrial consumer of energy is the chemical sector, which accounted for 22 percent of total world industrial energy consumption in 2008. Energy represents 60 percent of the industry's operating costs and an even higher percentage in the petrochemical subsector, which uses energy products as feedstocks. Petrochemical feedstocks account for 60 percent of the energy consumed in the chemicals sector. Intermediate petrochemical products, or "building blocks," which go into products such as plastics, require a fixed amount of hydrocarbon feedstock as input. In other words, for any given amount of chemical output, depending on the fundamental chemical process of production, a fixed amount of feedstock is required, which greatly reduces opportunities for decreasing fuel use [*321*].

Figure 90. World industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)



By volume, the most important "building block" in the petrochemical sector is ethylene, which can be produced by various chemical processes. In Europe and Asia, ethylene is produced primarily from naphtha, which is refined from crude oil. In North America and the Middle East, where domestic supplies of natural gas are more abundant, ethylene is produced from ethane, which typically is obtained from natural gas reservoirs. Because petrochemical feedstocks represent such a large share of industrial energy use, patterns of feedstock use play a substantial role in determining the industrial fuel mix in each region.

In recent years, most of the expansion of petrochemical production and consumption has taken place in non-OECD Asia. The combination of high energy prices in 2008 and the global recession in 2009 that reduced demand in client industries, such as construction, had a significant impact on the chemical industry, although demand for petrochemicals bounced back sharply in 2009 when oil prices declined significantly from their 2008 highs. Overall, with the exception of Japan, petrochemical production is projected to

Figure 91. OECD industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)

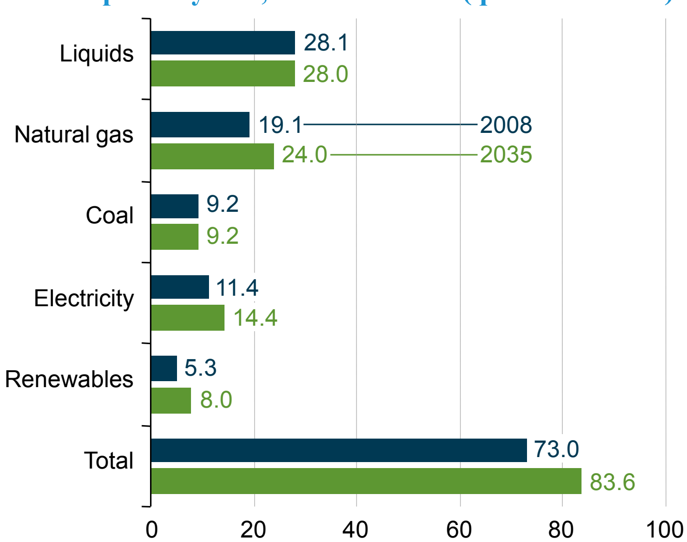
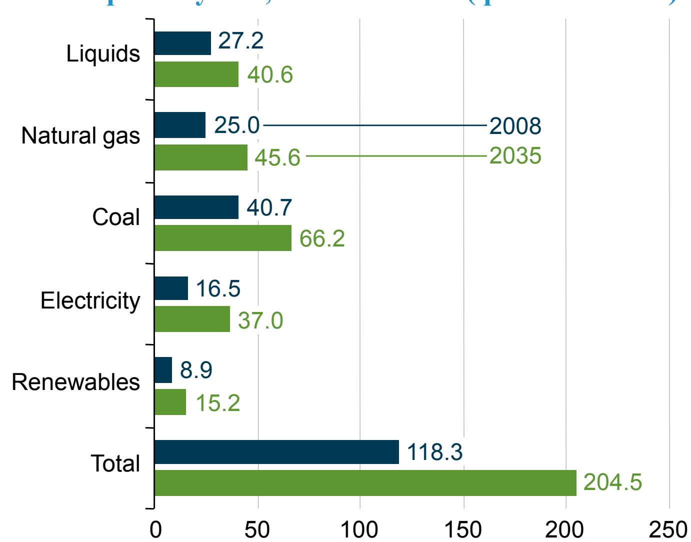


Figure 92. Non-OECD industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)



continue steady growth over the next few years [322]. Production growth in North America and Europe largely remains the same, whereas Asian, Middle Eastern, and Latin American markets largely outperform the global trend over the next five years. Capital expenditures in the chemical sector of the Asia-Pacific region have outpaced those in North America and Europe combined since 2005, and the trend is likely to continue through 2014 [323]. This growth is led by China, where the petrochemical operations of domestic firms, such as Sinopec and PetroChina, have expanded rapidly, and there has been an influx of petrochemical sector investment from multinational firms, such as ExxonMobil.

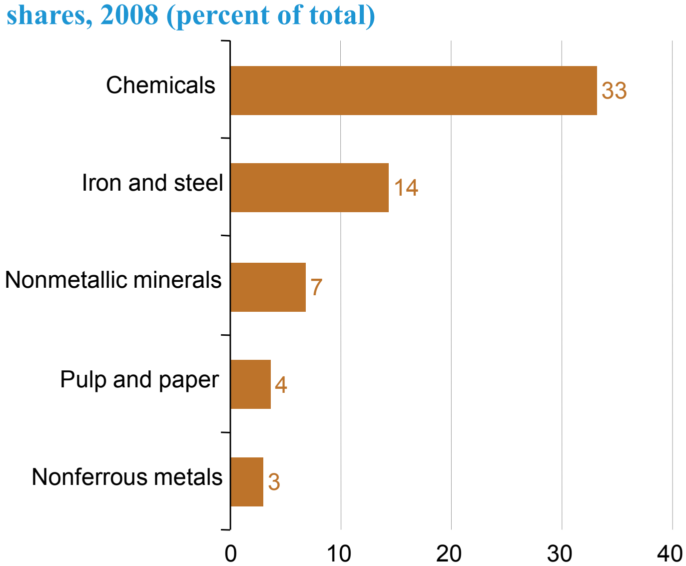
The next-largest industrial user of energy is iron and steel, which accounts for about 14 percent of industrial energy consumption. Across the iron and steel sector as a whole, energy represents roughly 15 percent of production costs [324]. The amount of energy used in the production of steel depends on the process used. In the blast furnace process, super-heated oxygen is blown into a furnace containing iron ore and coke. The iron ore is reduced (meaning that oxygen molecules in the ore bond with the carbon), leaving molten iron and carbon dioxide [325]. Coal use and heat generation make this process tremendously energy-intensive. In addition, it requires metallurgical coal, or coking coal, which is more costly than steam coal because of its lower ash and sulfur content.

Electric arc furnaces, the other major type of steel production process, produce steel by melting scrap metal using an electric current. The process is more energy-efficient and produces less carbon dioxide than the blast furnace process, but it depends on a reliable supply of scrap steel. Currently, two-thirds of global steel production uses the blast furnace process. The only major steel producers that make a majority of their steel with the electric arc furnace process are the United States (62 percent in 2009) and India (60 percent) [326]. More than 90 percent of steel production in China—by far the world's largest producer—employs the blast furnace method; and 78 percent of production in Japan, the world's second-largest steel producer, comes from blast furnaces [327].

Over the past decade, there has been a major expansion of steel consumption in non-OECD economies, with a corresponding increase in global production. Fueled by demand from the construction and manufacturing sectors, China has become the world's largest steel producer, with more steel output than the seven next-largest steel-producing nations combined (Figure 94). China's rapidly growing construction industry helped stabilize the steel industry throughout the economic downturn. Beginning in 2011, however, growth in construction slows as the government stimulus ends, and efforts are made to reduce energy use and rein in the pace of GDP growth to ensure that the nation's economy does not "overheat" and that inflation remains in check. In the medium term, world demand for steel grows steadily, spurred by infrastructure projects in non-OECD nations, with corresponding growth in energy use for steel production. Over the long term, however, the growth of energy use in the steel industry slows moderately, as increasing inventories of scrap iron drive down the price of inputs for the electric arc process, and the fuel mix shifts from coal to electricity.

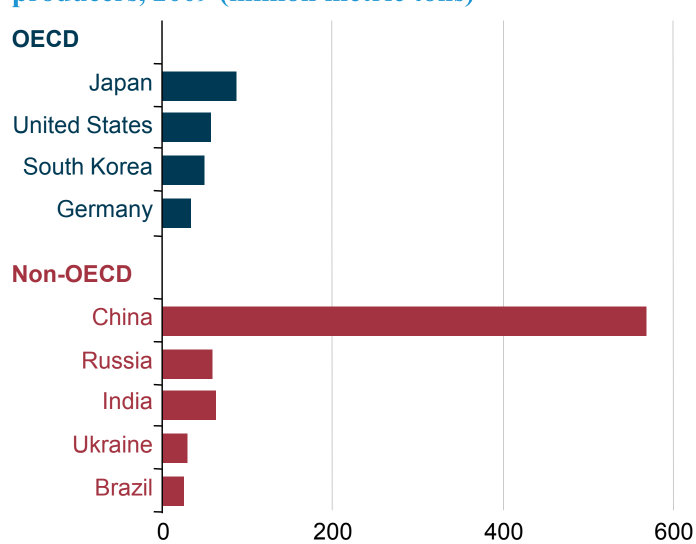
The third-largest energy-consuming industry is nonmetallic minerals, which includes cement, glass, brick, and ceramics. Production of those materials requires a substantial amount of heat and accounts for 7 percent of global industrial energy use. The most significant nonmetallic minerals industry is cement production, which accounts for 85 percent of energy use in the nonmetallic minerals sector. Although the cement industry has improved energy efficiency over the years by switching from the "wet kiln" production process to the "dry kiln" process, which requires less heat, energy costs still constitute between 20 and 40 percent of the total cost of cement production.

Figure 93. World industrial sector energy consumption by major energy-intensive industry shares, 2008 (percent of total)



Source: International Energy Agency

Figure 94. OECD and non-OECD major steel producers, 2009 (million metric tons)



Source: World Steel Association

The demand base for cement—the vast majority of which is used for construction—is less diversified than that for steel. Consequently, the impact of the 2008-2009 economic downturn on the cement industry was severe. Prices are expected to bottom out in early 2011, however, and to begin increasing at an annual rate of 1 to 2 percent [*328*]. The most significant growth in cement production over the next few years is expected to occur in non-OECD countries. Because the production of cement generates carbon dioxide directly, the industry has responded to pressure to address climate change impacts by focusing considerable attention on reducing fossil fuel use and improving energy efficiency. In the future, the energy efficiency of cement production is likely to improve as a result of continued improvements in kiln technology, the use of recycled materials and waste for heating fuels (known as "co-processing"), and increased use of additives to reduce the amount of clinker (the primary ingredient in marketed cement) needed to produce a given amount of cement [*329*].

Pulp and paper production accounts for 4 percent of global industrial energy use. Paper manufacturing is an energy-intensive process, but paper mills typically generate about one-half of the energy they use through cogeneration, primarily with black liquor and biomass from wood waste. In some cases, integrated paper mills generate more electricity than they need and are able to sell their excess power back to the grid. As is the case in other industries, recycling significantly reduces the energy intensity of production in the paper sector. The production of recycled paper produces more carbon dioxide, however, because the energy used in the process comes from fossil fuels rather than biomass[32] [*330*].

Many observers have suggested that electronic media and digital file storage will cause global demand for paper to contract over time. To date, such a trend is observable only in North America, where reduced demand for newsprint and an aging capital stock have led the industry to reduce capacity [*331*]. In the rest of the world, output from the paper industry expands steadily in the Reference case projection. Support for renewable energy in OECD countries could alter the cost structure of the paper sector in the future, however, if mandates for biomass use cause wood prices to escalate [*332*].

Production of nonferrous metals, which include aluminum, copper, lead, and zinc, consumed 3 percent of industrial delivered energy in 2008, mostly for aluminum production. Although aluminum is one of the most widely recycled materials on the planet, two-thirds of the aluminum industry's output still comes from primary production [*333*]. Energy accounts for about 30 percent of the total cost of primary aluminum manufacturing and is the second most expensive input after alumina ore. The impact of the 2008-2009 recession on client sectors, such as construction and automobile manufacturing, curtailed aluminum demand globally, but the trend was far less severe in non-OECD countries. Although some analysts expect a greater portion of OECD aluminum production to be exported to non-OECD countries in the future [*334*], non-OECD countries still are expected to increase their market share of global aluminum production.

To guard against electricity outages and fluctuations in electric power prices, many aluminum producers have turned to hydropower, going so far as to locate plants in areas where they can operate captive hydroelectric facilities. For example, Norway, which has considerable hydroelectric resources, hosts seven aluminum smelters. Today, more than one-half of the electricity used in primary aluminum production comes from hydropower [*335*].

Aluminum production from recycled materials uses only one-twentieth the energy of primary production [*336*]. Although aluminum recycling is encouraged both by the aluminum industry and by many governments, it is unlikely that the share of aluminum made from recycled product will increase much in the future, because most aluminum is used in the construction and manufacturing sectors and remains in place for long periods of time. Indeed, three-fourths of the aluminum ever produced still is in use [*337*]. Thus, it is expected that the aluminum industry will continue to consume large amounts of electricity.

Regional industrial energy outlooks

OECD countries

OECD countries have been transitioning in recent decades from manufacturing to more service-oriented economies. As a result, in the *IEO2011* Reference case, industrial energy use in OECD countries grows at an average annual rate of only 0.5 percent from 2008 to 2035, as compared with a rate of 0.8 percent per year for commercial energy use. In addition to the shift away from industry, slow growth in OECD industrial energy consumption can be attributed to relatively slow growth in overall economic output. With the OECD economies projected to grow by 2.1 percent per year on average from 2008 to 2035 in the *IEO2011* Reference case, their 65-percent share of global economic output in 2008 (as measured in purchasing power parity terms) falls to about 40 percent in 2035.

Rising oil prices in the Reference case lead to changes in industrial fuel mix for the OECD nations. OECD liquids use in the industrial sector stays constant, reducing the share of liquids in industrial energy use from 38 percent in 2008 to 33 percent in 2035. Coal use in the industrial sector also declines, and coal's share of OECD delivered industrial energy use falls from 13 percent to 11 percent, as industrial uses of natural gas, electricity, and renewables expand. Industrial consumption of renewables in OECD countries grows faster than the use of any other fuel, from 5.3 quadrillion Btu in 2008 to 8.0 quadrillion Btu in 2035. In the coming decades, patterns of industrial fuel use and trends in energy intensity in OECD countries are expected to be determined as much by policies regulating energy use as by economic and technological developments.

[32]This conclusion could change if assumptions about the life-cycle carbon dioxide output from biomass change.

OECD Americas

Currently, the U.S. industrial sector consumes more energy than that in any other OECD country, a position that is maintained through 2035 in the *IEO2011* Reference case. The overall increase in U.S. industrial energy use is minimal, however, from 25 quadrillion Btu in 2008 to 29 quadrillion Btu in 2035, or an average of 0.6 percent per year. The industrial share of total U.S. delivered energy consumption remains at approximately one-quarter through 2035. In contrast, U.S. commercial energy use increases 62 percent more rapidly, reflecting the continued U.S. transition to a service economy.

With oil prices rising steadily in the *IEO2011* Reference case, liquids consumption in the U.S. industrial sector remains flat throughout the projection, whereas the use of renewable fuels, such as waste and biomass, in the U.S. industrial sector grows faster than the use of any other energy source in the Reference case (Figure 95). Accordingly, the renewable share of U.S. industrial energy consumption rises from 10 percent in 2008 to 16 percent in 2035.

Growth in U.S. industrial energy also is expected to be moderated by legislation aimed at reducing the energy intensity of industrial processes. For example, the U.S. Department of Energy supports reductions in energy use through its Industrial Technologies Program, guided by the Energy Policy Act of 2005, which is working toward a 25-percent reduction in the energy intensity of U.S. industrial production by 2017 [*338*]. The Energy Independence and Security Act of 2007 also addresses energy-intensive industries, providing incentive programs for industries to recover additional waste heat and supporting research, development, and demonstration for efficiency-increasing technologies [*339*].

Industrial energy use in Canada grows by an average of 1.0 percent per year in the Reference case, continuing to constitute just under one-half of Canada's total delivered energy consumption. With world oil prices returning to sustained high levels, liquids use in Canada's industrial sector does not increase from current levels, while natural gas use increases by 1.7 percent per year (Figure 96). As a result, the share of liquids in the industrial fuel mix falls from 31 percent in 2008 to 25 percent in 2035, and the natural gas share increases from 38 percent to 46 percent. Increased production of unconventional liquids (oil sands) in western Canada, which requires large amounts of natural gas, contributes to the projected increase in industrial natural gas use.

Industrial energy efficiency in Canada has been increasing at an average rate of about 1.5 percent per year in recent decades, largely reflecting provisions in Canada's Energy Efficiency Act of 1992 [*340*]. The government increased those efforts in 2007, releasing its Regulatory Framework for Industrial Greenhouse Gas Emissions, which calls for a 20-percent reduction in greenhouse gas emissions by 2020. The plan stipulates that industrial enterprises must reduce the emissions intensity of their production by 18 percent between 2006 and 2010 and by 2 percent per year thereafter. The proposal exempts "fixed process emissions" from industrial processes in which carbon dioxide is a basic chemical byproduct of production. Therefore, most of the abatement will have to come from increased energy efficiency and fuel switching [*341*].

Mexico and Chile's combined GDP grows by 3.7 percent per year from 2008 to 2035 in the Reference case, which is the highest economic growth rate among all the OECD nations. Mexico and Chile also have the highest average annual rate of growth in industrial energy use, at 2.0 percent per year, to 5.6 quadrillion Btu in 2035 from 3.3 quadrillion Btu in 2008.

Chile, a new addition to the OECD in 2010, is the world's largest producer of copper, and the mining industry accounts for 16 percent of total fuel consumption within the country's industrial sector. In the mining industry, electricity accounts for 50 percent of energy use and oil 46 percent. In 2005, Chile's National Energy Efficiency Programme was passed. Together with the Chilean Economic Development Agency, the National Energy Efficiency Programme created an Energy Efficiency Pre-investment Programme, which allows large companies to hire consultants or conduct audits to develop plans for improving energy efficiency [*342*].

Figure 95. U.S. industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)

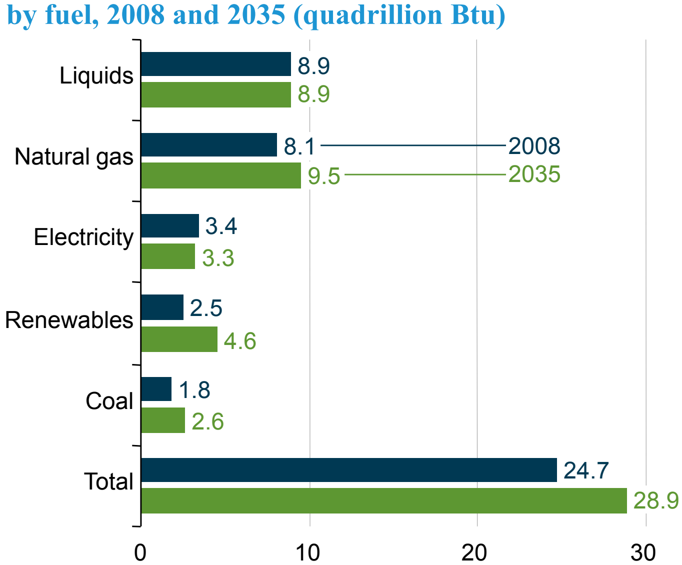
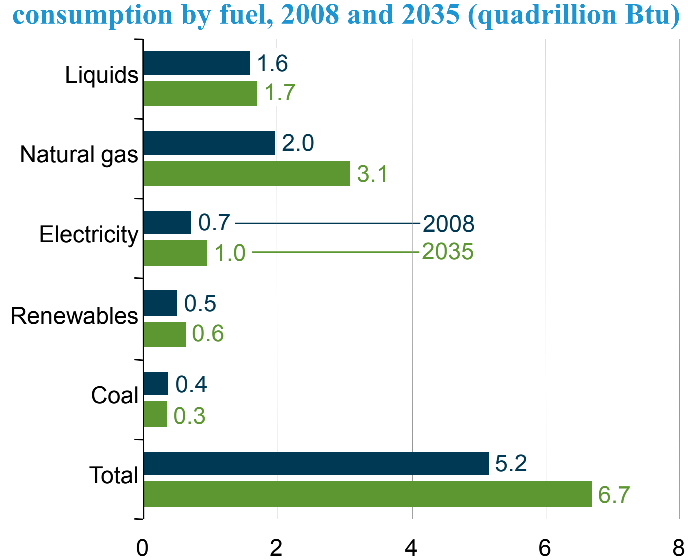


Figure 96. Canada industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)



Mexico's industrial sector continues to use oil and natural gas for most of its energy needs. In December 2009, the Mexican government introduced its Special Climate Change Program 2009-2012. The plan entails many industrial-sector initiatives, such as increasing the use of cogeneration and improving the operational efficiency of Petróleos Mexicanos (the state-owned oil company) and other Mexican industrial enterprises [*343*].

OECD Europe

In the *IEO2011* Reference case, OECD Europe continues its transition to a service economy, as its commercial sector energy use grows by 0.7 percent per year while industrial energy use grows by 0.1 percent per year. Climate change policy is expected to affect the mix of fuels consumed in OECD Europe's industrial sector, with coal use contracting at an average rate of 0.9 percent per year, while the use of renewables increases (Figure 97). The use of electric power in OECD Europe's industrial sector, increasingly generated from low-carbon sources, also rises.

Energy and environmental policies are significant factors behind the trends in industrial energy use in OECD Europe. In December 2008, the European Parliament passed the "20-20-20" plan, which stipulates a 20-percent reduction in greenhouse gas emissions, a 20-percent improvement in energy efficiency, and a 20-percent share for renewables in the fuel mix of European Union member countries by 2020 [*344*]. In debates on the plan, representatives of energy-intensive industries voiced concern about the price of carbon allocations. They argued that fully auctioning carbon dioxide permits to heavy industrial enterprises exposed to global competition would simply drive industrial production from Europe and slow carbon abatement efforts at the global level [*345*]. The resulting compromise was an agreement that 100 percent of carbon allowances would be given free of charge to industries that are exposed to such "carbon leakage," provided that they adhere to efficiency benchmarks [*346*]. As a result, the impact of the 20-20-20 plan on European Union industrial sector emissions may be somewhat limited relative to its original intention.

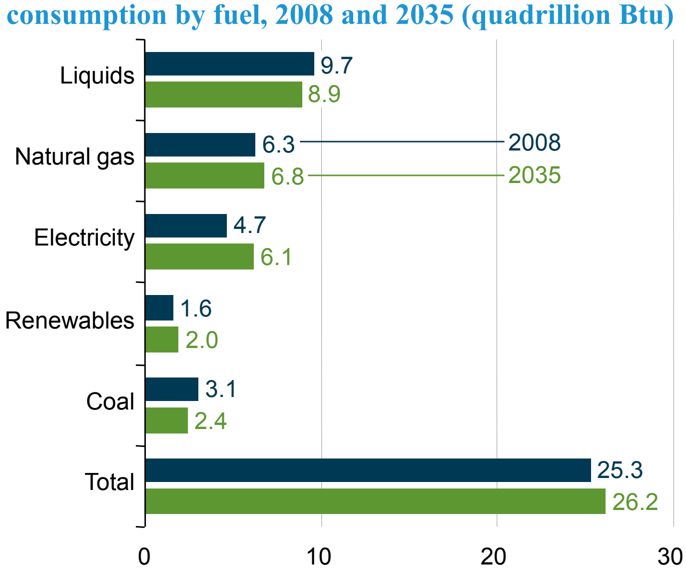
OECD Asia

The overall forecast for OECD Asia (Japan, South Korea, Australia, and New Zealand) is likely to be tempered in the future by the recent tragedy unfolding in Japan. Japan is the largest economy among the OECD Asian nations and the region's largest industrial energy consumer. The devastating earthquake and tsunami of 2011 have added enormous uncertainty to the country's short- and mid-term outlook, and as the events continue to unfold it is impossible to anticipate the timing and strength of the country's recovery. In the long term, the country is likely to recover to a normal economic growth path, but the projections presented here were made before the event and thus do not reflect its economic impact.

Along with slow economic growth, a major factor behind Japan's slowing industrial energy use is increasing efficiency. Already, the energy intensity of Japan's industrial production is among the lowest in the world. Since 1970, Japan has reduced the energy intensity of its manufacturing sector by 50 percent, mostly through efficiency improvements, along with a structural shift toward lighter manufacturing [*347*]. An amended version of Japan's Energy Conservation Law went into effect in April 2009, introducing sectoral efficiency benchmarks for energy-intensive sectors, including cement and steel [*348*].

South Korea, which experienced rapid industrial development during the later decades of the 20th century, is also beginning to make a transition to a service-oriented economy. In the *IEO2011* Reference case, South Korea's GDP grows at an average annual rate of 2.9 percent. South Korea is currently the sixth-largest steel producer in the world. A large portion of its steel (57 percent in 2009) is produced by electric arc furnaces [*349*], and that portion is projected to grow as inventories of discarded steel build up. As a result, coal consumption in South Korea's industrial sector increases slowly in the Reference case, and electricity is the fastest-growing source of energy for industrial uses. The largest consumer of industrial energy in South Korea is the chemical sector, and it is expected to remain in that position through 2035. Liquid fuel consumption, primarily for feedstock use, maintains a majority share of South Korea's industrial fuel mix through 2035.

Figure 97. OECD Europe industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)



In Australia and New Zealand, industrial delivered energy consumption grows by 1.1 percent per year in the Reference case, from 2.4 quadrillion Btu in 2008 to 3.3 quadrillion Btu in 2035. Industry's share of delivered energy consumption increases from 51 percent in 2008 to 54 percent in 2035. With liquids consumption in the industrial sector projected to remain flat throughout the projection period, natural gas and coal fuel much of the growth in industrial sector energy use (Figure 98). The natural gas share of industrial energy use in Australia and New Zealand rises from 33 percent in 2008 to 35 percent in 2035, and the coal share rises from 17 percent to 21 percent.

Non-OECD countries

Non-OECD industrial energy consumption grows at an average annual rate of 2.1 percent in the *IEO2011* Reference case—almost 10 times the average for OECD countries. The industrial sector accounted for about 45 percent of total non-OECD delivered energy use in 2008, and it continues to consume close to that share through 2035. With non-OECD economies expanding at an average annual rate of 4.5 percent in the Reference case, their share of global output increases from 35 percent in 2008 to 65 percent in 2035.

The key engines of non-OECD growth are the so-called "BRIC" countries (Brazil, Russia, India, and China). The four nations have accounted for 42 percent of global economic growth since 2007, and their share of growth is projected to continue unabated through 2035. Given the predominant role that heavy industry and manufacturing play in their dynamic economies, the BRIC countries account for more than 60 percent of non-OECD industrial energy use, and over two thirds of the growth in non-OECD industrial energy use from 2008 to 2035.

Non-OECD Asia

Non-OECD Asia is expected to be a major center of global economic growth in the coming decades. In the Reference case, the economies of non-OECD Asia, led by China, expand by an average of 5.3 percent per year, and industrial energy consumption increases across the region. China's industrial energy use nearly doubles from 2008 to 2035, averaging 2.4-percent annual growth over the period, and its growth rate is higher than the rate for any other major economy except India.

The industrial sector accounted for 74 percent of China's total delivered energy consumption in 2008, and its share remains above two-thirds through 2035. Since the beginning of economic reform in 1979, China's GDP growth has averaged 9.8 percent per year through 2007 [*350*]. Strong economic growth is anticipated through 2015 and beyond, and China still is expected to account for more than one-fourth of total global GDP growth from 2008 to 2035.

In addition to the impact of strong economic growth, continued rapid increases in industrial demand can be explained in part by the structure of the Chinese economy. Although the energy intensity of production in individual industries has improved over time, heavy industry still constitutes a major portion of China's total output. Patterns of energy use in China reflect its economy: iron and steel, nonmetallic minerals, and chemicals together account for about 60 percent of the country's industrial energy consumption. These sectors provide inputs to China's massive export and construction sectors, which continue to flourish in the *IEO2011* projection.

China's industrial fuel mix changes somewhat over the projection period. Despite its abundant coal reserves, direct use of coal in China's industrial sector grows by an average of only 1.9 percent per year in the Reference case, while industrial use of electricity (most of which is coal-fired) grows by 3.7 percent per year (Figure 99). As a result, coal's share in the industrial fuel mix falls from 63 percent in 2008 to 55 percent in 2035, while electricity's share increases from 18 percent to 26 percent due to increases in light manufacturing. At 4.1 percent per year, natural gas use is projected to grow faster than the use of any other fuel; however, it represents only 5.3 percent of China's industrial fuel mix in 2035.

In addition to its primary focus on economic development, the Chinese government also has introduced policy initiatives aimed at improving industrial energy efficiency. Its 12th Five Year Economic Plan, approved by China's National People's Congress on March 14, 2011 [*351*], included a goal of reducing energy intensity by 16 percent and carbon emissions per unit of GDP by 17 percent between 2011 and 2015. In addition, the government plans to target a slower, 7-percent rate of economic growth and a larger share of nonfossil fuels in its primary energy consumption (11.4 percent), opening up a market for clean technologies in China [*352*].

Figure 98. Australia/New Zealand industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)

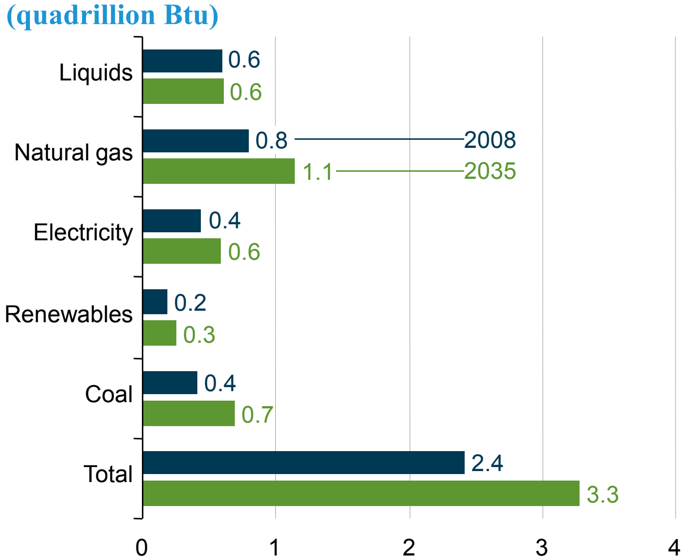
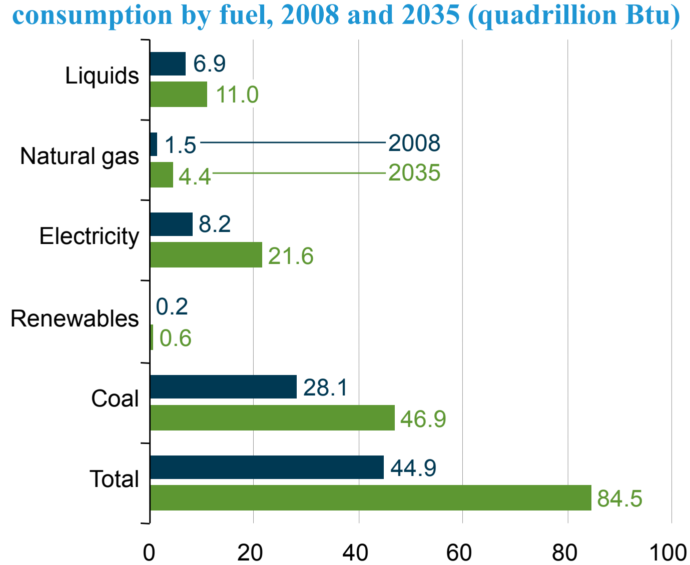


Figure 99. China industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)



In August 2010, the Chinese government announced that 2,087 steel mills, cement works, and other energy-intensive factories would be required to close by September 30 solely to meet its energy intensity reduction goal. Though the closure of these factories did not have a large effect on the industrial energy consumption, in that many of the targeted factories were older and inefficient, it may have a positive long-term effect on China's goals to update its factories and become less energy intensive [*353*]. The government is seeking further reductions in energy, between 40 and 45 percent by 2020 relative to 2005. In the *IEO2011* Reference case, China achieves a 39-percent improvement in energy intensity from 2005 to 2020. Over the projection period, China's energy intensity declines by an average of 2.5 percent per year from 2008 to 2035.

India has the world's second-highest rate of GDP growth among the *IEO2011* regions, averaging 5.5 percent per year from 2008 to 2035, contributing to a 2.6-percent average annual increase in delivered energy to the industrial sector. Although India's 2008-2035 economic growth rate is slightly slower than China's, its levels of GDP and energy consumption continue to be dwarfed by those of China throughout the projection. India's economic growth over the next 27 years is expected to derive more from light manufacturing and services than from heavy industry. As a result, the industrial share of total energy consumption in India falls from 48 percent in 2008 to 41 percent in 2035, and its commercial energy use grows more than twice as fast as its industrial energy use. Those changes are accompanied by shifts in India's industrial fuel mix: electricity use grows more rapidly than coal use, and natural gas use triples.

India has been successful in reducing the energy intensity of its industrial production over the past 20 years. A majority of its steel production comes from electric arc furnaces, and most of its cement production uses dry kiln technology [*354*]. A major reason for the intensity reductions is India's public policy, which provides subsidized fuel to citizens and farmers but requires industry to pay higher prices for fuel. In part because these market interventions have spurred industry to reduce energy costs, India is now one of the world's lowest cost producers of both aluminum and steel [*355*]. India is also the world's largest producer of pig iron, which can be used in place of scrap metal in the electric arc process [*356*].

The quality of India's indigenous coal supplies also has contributed to the steel industry's efforts to reduce its energy use. India's metallurgical coal is low in quality, forcing steel producers to import supplies [*357*]. As a result, producers have invested heavily in improving the efficiency of their capital stock to lower the amount of relatively expensive imported coal used in the production process.

The Indian government has facilitated further reductions in industrial energy use over the past decade by mandating industrial energy audits in the Energy Conservation Act of 2001 and by mandating specific consumption decreases for heavy industry as part of the 2008 National Action Plan on Climate Change. The new plan also calls for fiscal and tax incentives to promote efficiency, an energy-efficiency financing platform, and a trading market for energy savings certificates, wherein firms that have exceeded their required savings levels will be able to sell the certificates to firms that have not [*358*]. Those measures contribute to a reduction in the energy intensity of India's GDP, which declines by an average of 2.6 percent per year from 2008 to 2035 in the Reference case.

GDP growth in the other nations of non-OECD Asia is slower than in China and India, averaging 4.5 percent per year, and their industrial energy demand as a group grows from 13 quadrillion Btu in 2008 to 24 quadrillion Btu in 2035. The largest single energy-consuming industry in non-OECD Asia outside of China and India is the chemical sector, which accounts for more than 20 percent of industrial delivered energy use for the group. Malaysia, Taiwan, Singapore, and Indonesia account for the vast majority of the countries' chemical sector output. The most significant steel producer in the group is Taiwan, which produced about 16 million metric tons in 2009 [*359*].

Patterns of industrial energy use in the individual countries of non-OECD Asia follow diverse trajectories in the *IEO2011* Reference case projection. Mature economies, such as Taiwan, Hong Kong, and Singapore, follow patterns similar to those in OECD countries—transitioning away from energy-intensive industries to activities with higher added value. Much of the growth in commercial energy use occurs in those countries. Other regional economies, notably Vietnam, can be expected to expand manufacturing and increase industrial sector energy use.

Non-OECD Europe and Eurasia

In Russia, industrial energy consumption patterns are shaped largely by the country's role as a major energy producer. Russia's economy grows by 2.6 percent per year on average from 2008 to 2035, with industrial energy demand accounting for about 35 percent of total energy use throughout the period. The energy intensity of Russia's GDP is the highest in the world, and although its energy intensity declines in the Reference case, Russia remains among the world's least energy-efficient economies through 2035. The relative inefficiency of Russian industry can be attributed to Soviet-era capital stock and abundant and inexpensive domestic energy supplies. In the *IEO2011* Reference case, natural gas—Russia's most abundant domestic fuel—accounts for almost one-half of its industrial energy use. The share of electricity, most of which is provided by nuclear and natural-gas-fired generation, increases through 2035.

Industrial energy use in other parts of non-OECD Europe and Eurasia stays relatively constant through 2035. The iron and steel sector constitutes the largest single energy-consuming industry in the region, which consists primarily of states that were once part of the Soviet Union. Ukraine is the region's largest—and the world's eighth-largest—steel producer. Almost one-third of Ukraine's steel production uses open hearth furnaces, the least energy-efficient steelmaking process [*360*]. As in Russia, energy intensity in the remaining countries of non-OECD Europe and Eurasia remains very high, and despite average intensity reductions of 2.1 percent per year, the region remains one of the world's least energy-efficient through 2035.

Central and South America

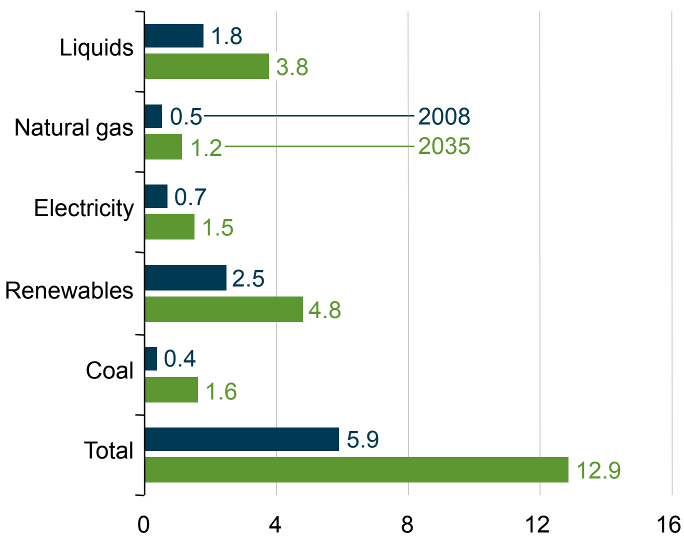
Brazil's industrial energy use grows by an average of 3.0 percent per year in the *IEO2011* Reference case, as its GDP expands by 4.6 percent per year. Industrial energy use accounted for 46 percent of total energy use in Brazil in 2008 and maintains that share through 2035. Unlike most other regions, more than 40 percent of delivered energy consumption in Brazil's industrial sector comes in the form of renewable energy (Figure 100). Biomass is often the fuel of choice for heat generation in industrial processes. Additionally, many Brazilian steel firms use charcoal (which is a wood-based renewable) instead of coking coal in the production of steel. The Brazilian government plans to support this practice as part of its National Plan on Climate Change [*361*]. Even with those efforts, however, coal use in the industrial sector—primarily for steelmaking—grows faster than the use of any other fuel.

Economic output in the other countries of Central and South America grows more slowly than in Brazil, averaging 3.0 percent per year, and their industrial energy consumption increases from 5.8 quadrillion Btu in 2008 to 7.2 quadrillion Btu in 2035. Chemicals and refining account for the largest shares of industrial energy use in this hydrocarbon-producing region. In the Reference case, natural gas displaces a large portion of liquids use in the industrial energy mix, fueled by growth in the region's domestic natural gas production. In 2008, liquids and natural gas accounted for 37 percent and 41 percent of industrial energy use, respectively. From 2008 to 2035, industrial sector natural gas consumption increases by an average of 1.9 percent per year, while liquids consumption decreases by 1.0 percent per year. As a result, the natural gas share of the region's industrial energy use increases to 54 percent, while the liquids share falls to 23 percent, in 2035.

Other Non-OECD regions

Industrial energy use in the Middle East grows on average by 2.6 percent per year from 2008 to 2035 in the *IEO2011* Reference case. In terms of energy consumption, the largest industry in the Middle East is the chemical sector. Higher world prices for oil and natural gas have spurred new investment in the region's petrochemical industry, where companies can rely on low-cost feedstocks, and the trend is expected to continue despite the current global slump in demand for chemicals. Numerous "mega" petrochemical projects currently are under construction in Saudi Arabia, Qatar, Kuwait, the UAE, and Iran, although many faced considerable delays in construction in 2008 to 2009 as a result of the economic downturn [*362*]. The Middle East is becoming a major manufacturer of the olefin building blocks that constitute a large share of global petrochemical output. The region's ethylene capacity is projected to double from 2008 to 2012. Liquids and natural gas combined maintain a 95-percent share of the Middle East's industrial fuel mix through 2035.

Figure 100. Brazil industrial sector energy consumption by fuel, 2008 and 2035 (quadrillion Btu)



Although 14 percent of the world's population lives in Africa, the continent's industrial energy use in 2008 was only 5 percent of the world total, and its share does not change in the Reference case. Africa's total industrial energy use grows at an average annual rate of 1.8 percent from 2008 to 2035 in the *IEO2011* Reference case. Although GDP for the sub-Saharan Africa region grows by an average of 3.7 percent per year, a substantial portion of the increase comes from primary commodities. Commodity extraction is an energy-intensive process, but it does not support the expansion of industrial energy use on the same scale as the development of a widespread manufacturing base. Without a substantial departure from historical patterns of governance and economic activity, low levels of industrial energy use in Africa are projected to persist.

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Links current as of July 2011

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Chapter 7

Transportation sector energy consumption

Overview

Energy use in the transportation sector includes energy consumed in moving people and goods by road, rail, air, water, and pipeline. The road transport component includes light-duty vehicles, such as automobiles, sport utility vehicles, minivans, small trucks, and motorbikes, as well as heavy-duty vehicles, such as large trucks used for moving freight and buses for passenger travel. Growth in economic activity and population are the key factors that determine transportation sector energy demand. In developing economies, increased economic activity leads to growing income per capita; and as standards of living rise, demand for personal transportation increases.

Over the next 25 years, demand for liquid fuels increases more rapidly in the transportation sector than in any other end-use sector, with most of the growth projected among the developing non-OECD nations and consumption among the developed OECD nations remaining relatively flat or declining in the *IEO2011* Reference case (Figure 101). In 2008, non-OECD countries as a group consumed 34 percent less energy for transportation than OECD countries. In 2035, non-OECD energy use for transportation exceeds that in the OECD countries by 19 percent (Figure 102 and Table 15).

A primary factor in the projected increase of energy demand for transportation is steadily rising demand for personal travel in both the developing and mature economies. In the developing economies, with gains in urbanization and personal incomes, demand for air travel and motorized personal vehicles increases. In addition, strong GDP growth in the non-OECD economies leads to modal shifts in the transport of goods, and freight transportation by trucks leads the growth in non-OECD demand for transportation fuels. In addition, as the volume of international trade grows, fuel use for freight transportation by air and marine vessels also increases in the projection.

World vehicle ownership is projected to grow rapidly, particularly in the non-OECD countries. In the industrialized OECD countries, growth in vehicle ownership per capita slows as saturation levels begin to be reached. In most of the non-OECD countries, growth in vehicle ownership is expected to continue at a rapid pace. In particular, the growth in China's vehicle ownership represents a key uncertainty in the *IEO2011* projections. With higher economic growth rates and higher energy intensities, the non-OECD countries' share of world transportation energy demand rises from 40 percent in 2008 to 54 percent in 2035.

In the *IEO2011* Reference case, the share of world transportation energy use attributed to petroleum-based liquids does not change significantly over the projection period, but oil's dominance may begin to be challenged by advancing technologies. Uncertainty about the security of oil supplies, the prospect of rising oil prices, and environmental concerns about emissions associated with the combustion of petroleum pose challenges to countries that are experiencing rapid motorization and have to import large portions of their transportation fuel supplies. As a result, future trends in transportation demand will be influenced by government policies directed at reducing emissions and congestion while promoting alternative fuels, new vehicle technologies, and mass transit.

Market forces and government policies could drive the development of highly efficient vehicle technologies, including hybrids, plug-in electric hybrids, and electric and fuel cell vehicles. The technologies are promising, with the potential to alter future demand for transportation fuels, reduce emissions, improve energy security, and provide significant energy savings. Widespread adoption of alternative vehicle technologies, combined with expansion of mass transit infrastructure, could be an attractive option for long-term development of the transportation sector in many developing countries.

Figure 101. World liquids consumption by end-use sector, 2008-2035 (quadrillion Btu)

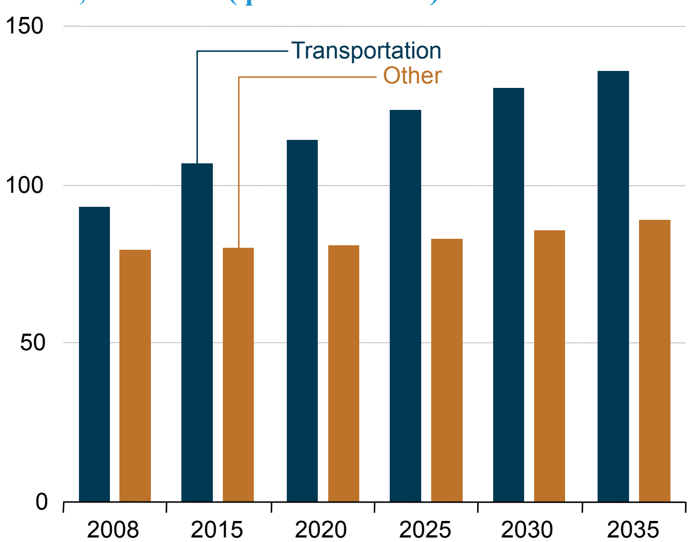
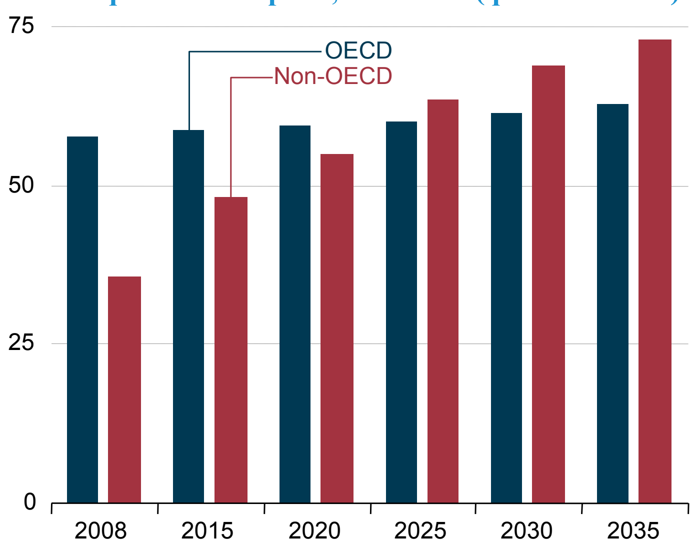


Figure 102. OECD and non-OECD transportation sector liquids consumption, 2008-2035 (quadrillion Btu)



OECD countries

The OECD countries generally have mature transportation sectors with fully established infrastructure networks and demand patterns, and transportation energy demand in OECD economies grows slowly in the Reference case as a result of high motorization levels, relatively slow growth of GDP and population, sustained high world oil prices, and continuing improvements in transportation energy efficiency. In the *IEO2011* Reference case, demand for transportation fuels in OECD countries grows by an average of 0.3 percent per year, from 59 quadrillion Btu in 2008 to 65 quadrillion Btu in 2035.

OECD Americas

The countries of the OECD Americas accounted for 34 percent of the world's fuel use for transportation in 2008, but their share is projected to decline to about 27 percent in 2035 as the transportation sectors of emerging economies expand. The region's total demand for transportation energy increases from 33 quadrillion Btu in 2008 to 38 quadrillion Btu in 2035 in the Reference case, and its share of the OECD total grows from 56 percent in 2008 to 59 percent in 2035 (Figure 103).

United States

The United States is the largest consumer of transportation energy among the OECD nations, accounting for 70 percent of the increase in OECD transportation energy use in the *IEO2011* Reference case. U.S. delivered energy consumption in the transportation sector grows from 28 quadrillion Btu in 2008 to almost 32 quadrillion Btu in 2035, an average annual increase of 0.5 percent.

The *IEO2011* Reference case assumes the adoption of Corporate Average Fuel Economy (CAFE) standards for light-duty vehicles[33] for model year 2011, as well as joint CAFE and greenhouse gas emissions standards set forth by the U.S. Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA) for model years 2012 through 2016. The Energy Independence and Security Act of 2007 further mandates an increase in light-duty vehicle fuel economy to an average of 35 miles per gallon by model year 2020. As a result of the more stringent standards, the average fuel economy of new light-duty vehicles in the United States (including credits for alternative-fuel vehicles and banked credits) rises from 29.7 miles per gallon in 2011 to 35.7 miles per gallon in 2020 and 37.6 miles per gallon in 2035. The *IEO2011* Reference case does not incorporate further increases in CAFE standards and greenhouse gas emissions standards for light-duty vehicles for model years 2017 through 2025, which currently are being developed.

Energy consumption for light-duty vehicles in the United States grows from 16.8 quadrillion Btu in 2008 to 18.4 quadrillion Btu in 2035, a 10-percent increase overall. The growth in U.S. energy demand for light-duty vehicles results mainly from a 17-percent increase in vehicle miles traveled per licensed driver, supported by higher levels of real disposable personal income and more moderate increases in fuel prices than have been seen in recent years. U.S. energy demand for heavy-duty vehicles[34] increases by 35 percent, from 5.0 quadrillion Btu in 2008 to 6.7 quadrillion Btu in 2035, representing the largest contribution to growth in total energy demand in the transportation sector. Fuel use for heavy-duty vehicles rises as industrial output increases and more high-value goods are carried by freight trucks, offset only partially by a small increase in heavy-duty vehicle fuel economy. The *IEO2011* Reference case does not incorporate fuel economy standards for heavy-duty vehicles that were issued in August 2011.

Table 15. Transportation energy use by region, 2008-2035 (quadrillion Btu)

Region	2008	2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD	**59.3**	**60.4**	**61.2**	**61.9**	**63.2**	**64.8**	**0.3**
Americas	33.2	34.1	34.6	35.3	36.4	38.0	0.5
Europe	18.8	18.7	18.8	18.7	18.9	18.9	0.0
Asia	7.4	7.5	7.8	7.9	7.9	7.9	0.3
Non-OECD	**38.9**	**51.6**	**58.7**	**67.2**	**73.3**	**77.3**	**2.6**
Europe and Eurasia	7.2	7.8	8.1	8.5	9.1	9.5	1.0
Asia	16.3	26.1	31.7	37.9	40.7	42.2	3.6
Middle East	5.4	6.1	6.3	7.2	8.7	9.5	2.2
Africa	3.6	3.8	4.0	4.4	4.8	5.3	1.5
Central and South America	6.4	7.7	8.6	9.2	10.0	10.7	1.9
World	**98.2**	**111.9**	**119.9**	**129.1**	**136.5**	**142.1**	**1.4**

Note: Totals may not equal sum of components due to independent rounding.

[33]Light-duty vehicles include passenger cars, pickup trucks, and light-duty commercial trucks with gross vehicle weight ratings of 8,500 to 10,000 pounds.
[34]Heavy-duty vehicles include trucks with gross vehicle weight ratings of 10,001 pounds and above, as well as intercity buses, school buses, and transit buses.

U.S. energy consumption for air travel grows by 14 percent in the Reference case, from 2.7 quadrillion Btu in 2008 to 3.1 quadrillion Btu in 2035, as increases in the cost of aviation fuel are moderate in comparison with recent increases and are accompanied by increases in aircraft fuel efficiency and load factors. Demand for air travel increases with rising personal incomes, and demand for air freight increases as U.S. exports rise. Those increases are tempered, however, by increases in aircraft fuel efficiency and load factors.[35] Energy consumption for marine and rail transportation also increases slightly, to 1.4 and 0.8 quadrillion Btu, respectively, in 2035 as a result of higher industrial output and the movement of bulk commodities such as corn and coal.

Canada

Canada's transportation sector is similar to that of the United States, with well developed infrastructure, high motor vehicle ownership rates per capita, and a similar mix of transportation fuel use. Personal motor vehicles in Canada are fueled largely by motor gasoline rather than diesel or alternative fuels. In the *IEO2011* Reference case, Canada's total transportation energy use increases by 0.2 percent per year, from 2.5 quadrillion Btu in 2008 to 2.6 quadrillion Btu in 2035.

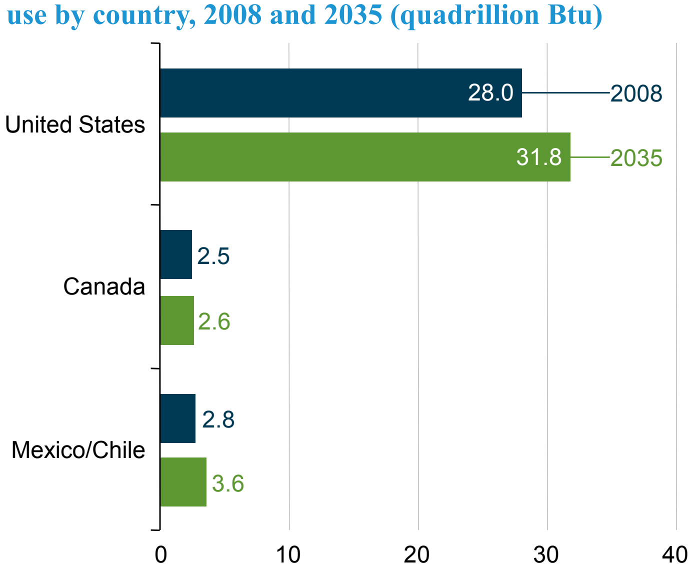
Petroleum products remain the dominant fuel in Canada's transportation fuel mix in the long term, although the share of alternative fuels increases moderately as a result of the Canadian government's commitment to reduce greenhouse gas emissions by 17 percent from 2005 levels by 2020 [*363*]. In December 2010, as part of its renewable fuels strategy, Canada adopted renewable fuels regulations requiring that gasoline contain 5 percent renewable fuel [*364*]. In addition, the government plans to implement a requirement for a 2-percent renewable content in diesel fuel and heating oil, subject to technical feasibility, as an amendment to the renewable fuels regulations [*365*]. In support of further development of transportation biofuel production facilities, the government extended the 4-year "ecoAgriculture Biofuels Capital Initiative" federal program—which provides repayable contributions to agricultural producers to stimulate participation in the biofuels industry—through September 2012 [*366*].

The transportation sector is Canada's largest source of greenhouse gas emissions, currently accounting for approximately one-quarter of total emissions, and the country is taking action to reduce the environmental impact of emissions from the transportation sector [*367*]. In October 2010, Canada adopted its first national greenhouse gas emissions standards for new passenger automobiles and light trucks, for the 2011-2016 model years, aligning them with U.S. national fuel economy standards [*368*]. The new regulations establish increasingly stringent greenhouse gas emissions standards for vehicle model years 2011 through 2016. Implementation of the standards is expected to reduce average greenhouse gas emissions from new passenger vehicles and light trucks manufactured in 2016 by approximately 25 percent compared with vehicles manufactured in 2008. Environment Canada is also developing amendments to regulations under Canada's Environmental Protection Act of 1999 to further limit greenhouse gas emissions from light-duty vehicles for 2017 and later model years, as well as regulations to reduce greenhouse gas emissions from new heavy-duty vehicles [*369*].

Mexico/Chile

In Mexico and Chile, transportation infrastructure is less developed than in the United States and Canada. With economic growth in the two countries from 2008 to 2035 projected to be stronger than in the United States and Canada, their transportation sectors are the fastest growing among all the OECD regions in the *IEO2011* Reference case. Demand for transportation fuels in Mexico and Chile combined increases by 0.9 percent per year, from 2.8 quadrillion Btu in 2008 to 3.6 quadrillion Btu in 2035. Relatively strong GDP growth (3.7 percent per year), rising income per capita, and increasing levels of motorization contribute to the growth in demand for transportation fuels. Expanding trade with countries of North and South America and improvements in overall standards of living also contribute to the growth in transportation energy use in the two countries. In 2035, fuel use for road transport accounts for 89 percent of total transportation energy demand in Mexico/Chile.

Figure 103. OECD Americas transportation energy use by country, 2008 and 2035 (quadrillion Btu)



Mexico will require major investments in infrastructure to support the growth of its transportation sector. The National Infrastructure Plan (NIP) envisions building some 300 infrastructure projects in multiple sectors to address current bottlenecks. In the transportation sector, the NIP proposes 100 new highway projects, including the development of an interstate highway system, 2,500 miles of new roads in rural areas, 3 new airports (with further expansion to 31), new intermodal railway corridors, 3 suburban passenger rail lines (to be built in the Mexico City area), 5 new seaports, and expansion of 22 existing ports [*370*]. Although the NIP has experienced some setbacks in recent years, with some projects being no longer economically viable and others having been restructured, the Mexican government is committed to moving the NIP forward until its expected completion in 2012 [*371*].

[35]The "load factor" represents the percentage of seats filled relative to total seating capacity on a given aircraft.

In the near term, sales of light-duty vehicles in Mexico continue to increase with the improving economic climate and rising consumer confidence. In 2010, light-duty vehicle sales continued a slow recovery from the economic downturn of 2008-2009, posting an 8.7-percent increase over 2009 sales to 820,406 units but still remaining 20 percent below sales in 2008 [*372*]. Imports of used cars from the United States may have contributed to the relatively slow growth of new vehicle sales. Since August 2005, when Mexico issued a decree in accordance with North American Free Trade Agreement provisions to allow imports of vehicles more than 10 years old, sales of used vehicles in Mexico have increased considerably [*373*]. In the period from 2005 to 2008, Mexico reportedly imported nearly 2.5 million used vehicles from the United States [*374*].

In Chile, much of the activity in the transportation sector has been in repairing the damage done to the infrastructure as a result of the massive February 2010 earthquake—the world's fifth most powerful ever—that affected about three-fourths of the population [*375*]. Approximately 965 miles of road, 212 bridges, and 9 airports were damaged by the earthquake. Overall, the cost to repair and rebuild the infrastructure has been estimated at $1.2 billion [*376*]. Before the earthquake, Chile's Ministry of Public Works had announced plans to spend some $5 billion on 38 large-scale infrastructure projects in advance of the country's 200th year of independence [*377*]. The plans included an expansion of Santiago International Airport, several reservoir and irrigation canal projects, shipping and coastal infrastructure improvements, and construction of a coastal road that would span two-thirds of the length of the country. The Ministry of Public Works has not yet announced whether those plans will be altered substantially as a result of the costs already incurred to repair the earthquake damage.

OECD Europe

Demand for transportation fuels in OECD Europe remains flat in the *IEO2011* Reference case, due to slow population growth, high transportation fuel costs, high vehicle saturation levels, fully established transportation networks with limited potential for growth, and continuous improvements in energy efficiency. Despite the slow population growth projected for OECD Europe, the region's economic growth continues at an average rate of 1.8 percent per year, and energy use for freight transportation grows by an average of 0.7 percent per year. With growth in fuel use for freight transport offsetting a projected decline in fuel use for passenger transport, total transportation energy use is projected to remain stable.

In 2010, sales of new vehicles in OECD Europe declined after government-sponsored vehicle scrappage schemes that were implemented as part of the monetary stimulus measures to combat the 2008–2009 recession came to an end in the second half of the year. Germany posted one of the highest reductions in new vehicle sales—a 23-percent decline from 2009 sales—among the countries of OECD Europe. Germany's vehicle scrappage scheme was the most far-reaching and the best-funded of any in the European Union, with a funding package worth about $7 billion supporting purchases of 2 million passenger cars in 2009. As a result, there was a marked correction in 2010 from the previous year's very high base [*378*]. Passenger vehicle sales also contracted in Italy by 9 percent and in Greece by 36 percent in 2010, again a result of the ending of subsidy schemes. In France, the vehicle scrappage scheme was gradually scaled down from $1,430 per vehicle in 2009 to $1,070 in the first half of 2010 and $715 in the second half of 2010, with overall vehicle sales declining by 2.2 percent from the 2009 total.

The United Kingdom and Spain were the only two countries among OECD Europe's major vehicle markets that recorded sales growth in 2010 (2 percent and 3 percent, respectively) despite the ending of their scrappage schemes in the first half of the year [*379*]. In the United Kingdom, the increase in vehicle sales was attributed primarily to large-scale orders from businesses as the scrappage scheme for private motorists ended [*380*]. In Spain, strong vehicle sales in the first half of 2010, consisting largely of vehicle purchases in advance of a 2-percent increase in the value-added tax and the end of the scrappage subsidy in the second half of the year, boosted overall growth in vehicle sales for the year [*381*]. In the short term, with an improving macroeconomic outlook and rising consumer confidence, sales of passenger vehicles in OECD Europe are expected to rebound.

Sustainable mobility remains the core strategy of transportation policy in OECD Europe. The strategy includes various policy measures aimed at improving the quality and efficiency of transportation systems. In the past few years, the European Commission has adopted several major initiatives promoting use of clean and energy-efficient vehicles, including the Commission's Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles, European Green Car Initiative, and Strategy for Clean and Energy Efficient Vehicles, among others [*382*]. As part of those initiatives, the countries of OECD Europe have introduced various tax incentives for purchases of hybrid and electric vehicles (Table 16).

OECD Europe's national governments have allocated significant funds to promote mass adoption of electric vehicle technology and have set ambitious targets for electric vehicle penetration in the next few years. The German government allocated $715 million toward its goal of having 1 million electric vehicles on the roads by 2020 as part of its "National Electro-Mobility Development Plan," and France plans to spend around $2.1 billion with a target of having 2 million electric and hybrid cars on the roads by 2020 [*383*]. In the United Kingdom, the government announced a new grant scheme for electric cars, which offers grants of up to $8,000 for nine models from January 1, 2011, reducing the cost of eligible cars by one-quarter. In addition, a new network of electric vehicle recharging points in streets, car parks, and commercial retail facilities is being developed [*384*].

Despite major government efforts to promote sales of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) in OECD Europe, sales of the vehicles remain very low. In Spain, the government set a target of selling 2,000 electric vehicles with lithium ion batteries in 2009-2010 and 20,000 electric and hybrid vehicles in 2011. However, as of December 2010, only 98 EV passenger cars and 778 EVs of other types had been sold, with an average subsidy amounting to $4,700 per vehicle [*385*]. In Germany, of the 49.6 million cars in operation, only 22,300 are hybrid vehicles and 1,500 vehicles are all-electric, comprising less than one-tenth of one percent of the country's total passenger vehicle fleet [*386*]. The main barriers to mass penetration of EVs and PHEVs are their

Table 16. Tax incentives for hybrid and electric vehicles in OECD Europe, 2010

Country	Tax Incentive
Austria	A fuel consumption tax is levied upon the first registration of a passenger car. It is calculated as follows: • Petrol cars: 2 percent of the purchase price × (fuel consumption in liters – 3 liters) • Diesel cars: 2 percent of the purchase price x (fuel consumption in liters – 2 liters). Cars emitting less than 120 grams carbon dioxide per kilometer receive a maximum bonus of $430. Alternative-fuel vehicles, including hybrid electric vehicles, receive an additional bonus of $715 maximum. The bonus regime is valid from July 1, 2008, until August 31, 2012. Electric vehicles are exempt from the fuel consumption tax[a] and from the monthly vehicle tax.[b] The Austrian automobile club ÖAMTC publishes the incentives granted by local authorities on its website (www.oeamtc.at/elektrofahrzeuge).
Belgium	Purchasers of electric cars receive a personal income tax reduction of 30 percent of the purchase price (with a maximum of $12,900).
Germany	Electric vehicles are exempt from the annual circulation tax[c] for a period of 5 years from the date of their first registration. Subsequently, they incur a tax amounting to $16.10 (up to 2,000 kilograms), $17.20 (up to 3,000 kilograms), or $18.29 (up to 3,500 kilograms), per 200 kilograms of vehicle weight or part thereof.
Spain	Various regional governments grant tax incentives for the purchase of alternative-fuel vehicles, including electric and hybrid vehicles: • Aragon, Asturias, Baleares, Madrid, Navarra, Valencia, Castilla la Mancha, Murcia, and Castilla y Léon allow $2,900 for hybrids and $8,600 for electric vehicles • Andalucia allows up to 70 percent of the investment.
France	A premium is granted for the purchase of a new car when its carbon dioxide emissions are 125 grams per kilometer or less. The maximum premium is $7,150 for vehicles emitting 60 grams per kilometer or less. This incentive will remain in place until 2012. For such vehicles, the amount of the incentive cannot exceed 20 percent of the vehicle purchase price, including the value added tax (VAT) and the cost of the battery if it is rented. Hybrid vehicles emitting 135 grams per kilometer or less receive an incentive of $2,860.
Greece	Electric and hybrid vehicles are exempt from the registration tax. If their engine capacity is 1,929 cubic centimeters (cc)or less, they are also exempt from the annual circulation tax. Above 1,929 cc, the exemption is limited to 50 percent.
Denmark	Electric vehicles weighing less than 2,000 kilograms are exempt from the registration tax. This exemption does not apply to hybrid vehicles. The registration tax is based on the price of the vehicle. It is calculated as follows: (105 percent of the vehicle price up to $15,160) + (180 percent of the vehicle price above $15,160).
Netherlands	Hybrid vehicles benefit from a reduction of the registration tax by a maximum of $9,160, depending on the efficiency rating of the vehicle. The incentives remained in place until July 1, 2010. The registration tax is based on price and carbon dioxide emissions.
Portugal	Electric vehicles are exempt from the registration tax. Hybrid vehicles benefit from a 50-percent reduction of the registration tax. The registration tax is based on engine capacity and carbon dioxide emissions.
Ireland	Electric and hybrid vehicles benefit from a reduction of the registration tax ($3,600 maximum). This benefit was valid from July 1, 2008, to December 31, 2010.
United Kingdom	Electric vehicles are exempt from the annual circulation tax, which is based on carbon dioxide emissions. All vehicles with emissions below 100 grams per kilometer are exempt from it. As of April 1, 2010, electric cars receive a 5-year exemption from company car tax,[d] and electric vans receive a 5-year exemption from the van benefit charge[e] ($4,800). As of 2011, purchasers of electric vehicles (including plug-in hybrids) will receive a discount of 25 percent of the vehicle's list price, up to a maximum of $8,000. The government has set aside 230 million British pounds for the incentive program.

[a]The fuel consumption tax (or "pollution tax") is levied on the purchase price or commercial leasing fee of new passenger cars and motorcycles.
[b]The monthly vehicle tax, levied on registered vehicles, is calculated on the basis of cylinder capacity for motorcycles and horsepower for all other vehicles.
[c]An annual circulation tax is levied on registered automobiles on the basis of carbon dioxide emitted according to engine capacity and vehicle weight.
[d]The company car tax is levied on persons when an employer makes a company-owned automobile available for private use to an employee earning more than $13,500 per year or to a member of that employee's family or household.
[e]The van benefit charge is an annual tax paid when a company has allowed private use of a van by a director or an employee (or an employee's family member) earning more than $13,500 per year.
Source: European Automobile Manufacturers' Association

relatively high prices and the lack of requisite charging infrastructure. Although sales of EVs and hybrids undoubtedly will increase in the future, mass adoption of the new technologies is likely to take many years.

OECD Asia

In the OECD Asia region, transportation energy use grows by a relatively modest average rate of 0.3 percent per year in the *IEO2011* Reference case, from 7.4 quadrillion Btu in 2008 to 7.9 quadrillion Btu in 2035. Fully established transportation infrastructures, projected population declines, high motorization levels, and continued improvement in transport energy efficiency are the main factors limiting the growth of transportation energy demand in the long term (Figure 104).

Japan

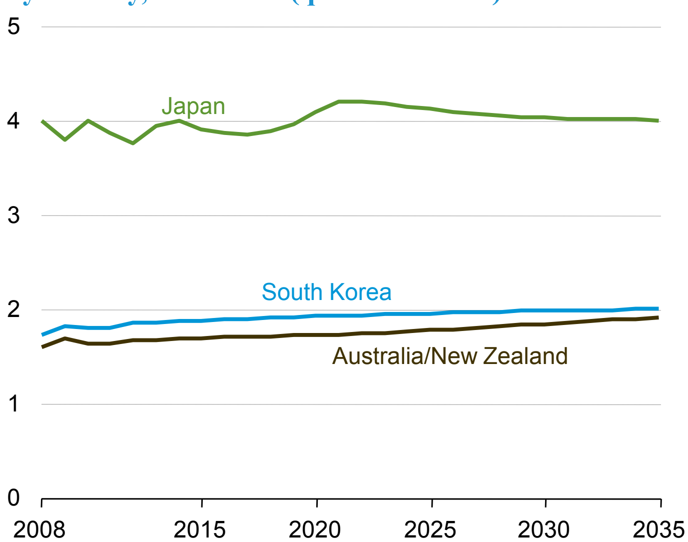
In Japan, the earthquake and tsunami that struck in March 2011 caused substantial damage to energy and transportation infrastructures, creating significant uncertainty around demand for transportation fuels in the short term. In the long term, as Japan rebuilds its infrastructure, transportation energy use remains essentially unchanged at 4.0 quadrillion Btu in 2035 in the Reference case. With a projected decline in population (averaging 0.3 percent per year from 2008 to 2035), demand for passenger transportation also decreases gradually. As a result, energy use for passenger transport in 2035 is 4 percent below the 2008 level. Although Japan's GDP growth averages 0.5 percent per year over the period, its energy use for freight transportation increases by an average of only 0.2 percent per year.

Fuel use for road transportation accounted for approximately three-quarters of Japan's transportation energy consumption in 2008. Continuous improvement in vehicle fuel efficiency (promoted by the "Top Runner Standards," which require new vehicles to at least meet the fuel efficiency level of the most efficient existing vehicles) accounts for significant energy savings and a reduction in transportation fuel use over the projection. Market penetration by alternative technologies (hybrid, electric, natural gas, and some diesel-powered models) continues with support from government incentives aimed at reducing the price differential between the new technologies and conventional vehicles. Starting in April 2009, "eco-cars" have been exempted from an acquisition and tonnage tax for 3 years, and subsidies are offered as buyer incentives [*387*].

In 2009 and 2010, Japan registered robust growth in sales of hybrid vehicles, in part as a result of the scrappage scheme that was implemented to provide subsidies for purchases of new fuel-efficient vehicles [*388*]. Toyota's hybrid Prius was Japan's best-selling vehicle in 2009 and 2010, breaking its annual sales record for a single model for the first time in 20 years with 315,669 units sold in 2010 [*389*]. In support of further penetration of EVs and PHEVs, manufacturers are developing advanced energy management systems to optimize efficient use of electricity during vehicle recharge times. Toyota plans to launch a smart-grid electric power system to optimize electricity use for charging EVs and PHEVs by 2012 [*390*].

Japan has a highly developed air transportation infrastructure, with 176 airports, including 144 with paved runways [*391*]. Japan's main airport is Narita International Airport, which serves Tokyo and its suburbs. The airport has recently completed the extension of its second runway [*392*]. However, Japanese authorities announced plans to make Haneda International Airport, which also serves the Tokyo area and is located 30 minutes from downtown Tokyo, the main international hub for air travel in the country [*393*]. In 2010, Haneda International Airport added a fourth runway, opened a new international terminal, and expanded flights to international destinations [*394*]. Narita International Airport is considering a new terminal for low-cost carriers to capitalize on the growing market, with plans to convert the airport's existing cargo facilities, which currently are not being used, into a terminal for low-cost carriers [*395*].

Figure 104. OECD Asia transportation energy use by country, 2008-2035 (quadrillion Btu)



South Korea

Transportation energy use in South Korea grows by 0.6 percent per year in the *IEO2011* Reference case. The country has OECD Asia's strongest projected GDP growth, averaging 2.9 percent per year from 2008 to 2035, and its transportation energy consumption per capita increases by an average rate of 0.5 percent per year while energy intensity per capita declines by 1.7 percent per year over the projection period, reflecting continuous gains in energy efficiency and South Korea's commitment to "green energy." In January 2009, the government launched a "Green New Deal" economic stimulus package, allocating $30.7 billion for renewable energy projects, energy-efficient buildings, low-carbon vehicles, and water and waste management [*396*]. In July 2009, the government adopted a "Five-Year Green Growth Plan" for implementing a "low carbon, green growth vision" and allocating $83.6 billion for initiatives on climate change and energy, sustainable transportation, and the development of green technologies, absorbing the "Green New Deal" into the Five-Year Plan for years 2009-2012 [*397*].

The Five-Year Plan includes initiatives for further expansion of South Korea's high-speed railway network in order to meet a goal of increasing the passenger transport load of trains[36] from 18 percent in 2009 to 26 percent in 2020, and the passenger transport load of metropolitan mass transit from 50 percent to 65 percent over that same time period [*398*]. The goal will be achieved by further expanding the high-speed train system, Korea Train eXpress (KTX), which started operation in 2004 and in 2008 accounted for more than 50 percent of all long-distance passenger rail travel [*399*]. In November 2010, an upgrade to the KTX high-speed line connecting Daegu and Busan in the southeast was completed. Another upgrade connecting Seoul to Mokpo in the southwest, which involves conversion of the conventional line to high-speed rail, is due for completion in 2014 [*400*]. Other upgrades to high-speed rail are in various stages of development.

Passenger air traffic in South Korea has expanded rapidly as business travel and tourism have increased. Incheon International Airport, which serves the capital city of Seoul and is the country's largest, is being expanded from a current capacity of 44 million passengers to 62 million passengers and a cargo handling capacity of 5.8 million metric tons [*401*]. The airport is a premier hub in northeast Asia and has received a designation as the "Best Airport Worldwide" by the Airports Council International for 6 years in a row [*402*].

Australia and New Zealand

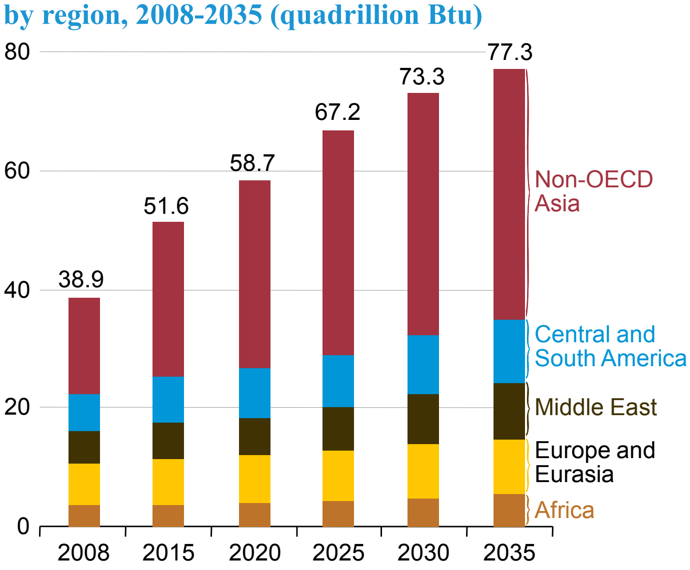
Transportation energy use in Australia and New Zealand grows by an average of 0.7 percent per year in the *IEO2011* Reference case, based on relatively moderate population growth and 2.7-percent average annual GDP growth over the projection period. Increasing freight transportation is the key factor behind the growth in demand for transportation fuels, with freight transportation accounting for 11 percent of the region's total transportation energy use in 2035, up from 8 percent in 2008.

In Australia, most of the projected increase in freight transportation sector is the result of growth in the country's mineral exports [*403*]. Significant investments have been made in port infrastructure and freight railways in Queensland, Western Australia, and New South Wales. Several ports have added coal terminals and are constructing freight railways to connect coal mines to ports. The government of Western Australia is conducting a feasibility study to assess development of the proposed Oakajee project, which will include an integrated iron ore port and freight railway network serving the state's iron ore industry [*404*]. In June 2010, the state government of New South Wales announced large investments in transportation infrastructure, including expansions and upgrades of marine ports, roads, mass transit systems, and high-speed rail, amounting to more than $60 billion over the next 4 years [*405*].

Non-OECD Countries

The projected average growth rate for transportation energy use in the non-OECD countries from 2008 to 2035 is 2.6 percent per year—almost 9 times the corresponding rate for OECD countries. The use of liquids in the non-OECD transportation sector doubles over the projection period in the *IEO2011* Reference case, as total transportation energy demand grows from 38.9 quadrillion Btu in 2008 to 77.3 quadrillion Btu in 2035 (Figure 105). The transportation sector accounts for about 75 percent of the increase in the total liquids consumption in non-OECD countries from 2008 to 2035. In 2008, non-OECD countries accounted for 40 percent of the world's energy use for transportation; in 2035, their share is 54 percent.

Figure 105. Non-OECD transportation energy use by region, 2008-2035 (quadrillion Btu)



Non-OECD Asia

Non-OECD Asia has the highest growth rate in transportation energy use among the regions in the *IEO2011* Reference case, exceeding transportation energy demand in the OECD Americas by 2025. Non-OECD Asia's economies account for 59 percent of the increase in world transportation energy demand from 2008 to 2035, with an annual average growth rate of 3.6 percent. Consumption of gasoline and diesel fuel in the region more than triples from 2008 to 2035. Over the same period, non-OECD Asia's share of world transportation liquids consumption increases from 17 percent to 30 percent. Large and growing populations, rising per-capita incomes, and rapid urbanization are the main contributors to growth in transportation energy use in non-OECD Asia, only somewhat moderated by government policies on fuel price subsidies, penetration rates of advanced and alternative-fuel vehicles, and the pace of development of public mass transit infrastructure.

[36] The passenger transport load of trains is a measure of how much of a train's passenger carrying capacity is used. It is usually calculated as passenger-miles traveled as a percentage of seat-miles available. Seat-miles are calculated as the number of seats available for each mile traveled by the train.

China

China has been, and continues to be, the fastest-growing economy among non-OECD countries and the fastest-growing consumer of transportation fuels (Figure 106). From 2008 to 2035, China's GDP increases by an average of 5.7 percent per year, and its use of liquid fuels for passenger and freight transportation increases by 4.4 and 4.5 percent per year, respectively. From 1998 to 2008, the combined length of all China's highways increased by an average of 11.3 percent per year, while growth in expressways averaged 21.4 percent per year. Over the same period, highway passenger travel (measured in passenger-miles) and highway freight travel (measured in ton-miles) increased by annual averages of 7.7 and 19.6 percent, respectively [*406*].

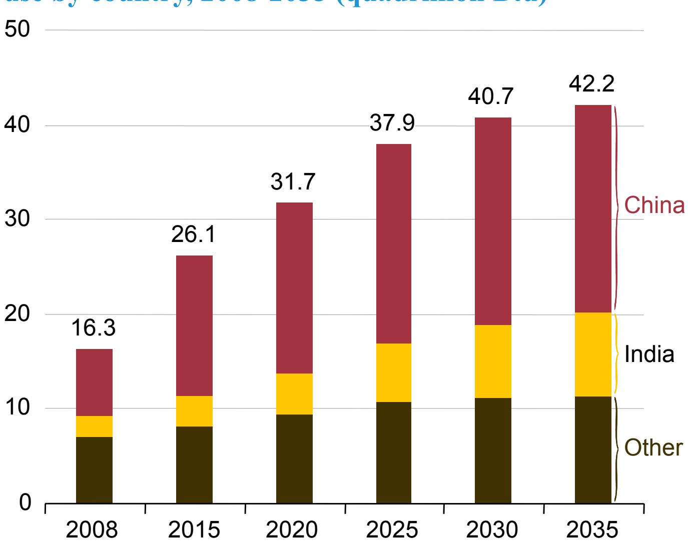
Much of the growth in China's transportation energy consumption is for road use. The number of light-duty vehicles in China grew by an average of 24 percent per year from 2000 to 2008, and the total number of vehicles nearly quadrupled, from 22.3 million in 2000 to 86 million in 2008 [*407*]. China's motorization level is estimated at 32 motor vehicles[37] per 1,000 people in 2007, as compared with 820 in the United States, 552 in Europe, 595 in Japan, and 338 in South Korea [*408*]. China's motorization is likely to increase strongly through 2035, although not to the levels seen in many OECD countries in the *IEO2011* Reference case. Although China's passenger transportation energy use per capita triples in the Reference case, in 2035 it still is only about one-third that of South Korea.

Growing demand for passenger vehicles in China is a result of increasing income per capita and lifestyle modernization that includes greater mobility. In 2010, China was the world's largest vehicle market for the second year in a row, registering 32-percent annual growth. Sales of passenger vehicles increased to 13.9 million units in 2010, and total vehicle sales, including heavy commercial vehicles, increased to 18.1 million units [*409*]. Strong sales in 2009 and 2010 were spurred by the government's numerous stimulus measures, including sales tax rebates for purchases of small cars (engine size 1.6 liters or less) and one-time subsidies for farmers who scrapped their three-wheel or low-speed trucks and replaced them with light trucks or minibuses with engine size less than 1.3 liters. In 2010, government incentives included a 7.5-percent tax break on small cars and subsidies of $750 to $2,700 in rural areas to promote sales of new fuel-efficient vehicles [*410*]. The program proved to be very successful, with small vehicles accounting for 70 percent of all passenger vehicle sales in 2009 [*411*]. Vehicles sales are expected to moderate somewhat in 2011 as government incentives are withdrawn, but the market for light-duty vehicles in China is expected to continue expanding strongly in the medium term as per-capita incomes continue to increase.

In addition to promoting fuel-efficient vehicles, China's government has made a commitment to increase sales of "new energy vehicles" through consumer subsidies, incentives for domestic auto manufacturers to develop local capacity to produce alternative-fuel vehicles, and development of recharging infrastructure for electric vehicles. Support for the development of "new energy" vehicles and the capability of the domestic automobile industry to produce them in large numbers is a key component of China's 12th Five-Year Plan, which identifies the alternative vehicle industry as one of seven strategic emerging industries. The government plans to invest an estimated $15 billion in alternative-energy vehicles over the next 10 years [*412*].

In 2010, China launched a pilot program in five cities (Shanghai, Changchun, Shenzhen, Hangzhou, and Hefei) that offers subsidies of $9,150 for purchases of EVs, up to $7,620 for PHEVs, and $460 for other hybrid vehicles (which is equivalent to the traditional subsidy for cars with small engines) [*413*]. The five cities were selected on the basis of their access to domestic car manufacturers with capabilities for mass production of EVs and PHEVs. The Chinese automobile industry views the government-mandated domestic electrification as an opportunity to build the capacity necessary for establishing itself as a global leader in the electric vehicle market. So far, most large Chinese manufacturers have announced plans to build alternative-fueled vehicles in response to government subsidies, with a few domestically produced vehicles already sold in the Chinese market, including the Besturn B70 by FAW Group Corporation and E6 electric vehicles and F3DM plug-in hybrids by BYD Company [*414*]. In addition to the central government's subsidies, local governments also offer subsidies for purchase of EVs and PHEVs. For example, electric vehicles receive local government subsidies of $1,525 to $3,050 per vehicle in Hefei and $6,100 to $7,620 per vehicle in Shanghai [*415*].

Figure 106. Non-OECD Asia transportation energy use by country, 2008-2035 (quadrillion Btu)



In addition to subsidies for private alternative vehicles, China launched a separate subsidy in 20 pilot cities for "new energy" public vehicle fleets, with the goal of speeding up structural transition of the automotive industry and increasing annual production capacity to 500,000 EVs and PHEVs, including light commercial vehicles and buses, in 2012 (from 2,100 in 2008). In comparison, Japan and South Korea combined are expected to produce a total of 1.1 million and North America

[37]Motor vehicles include cars, buses, and freight vehicles but do not include two-wheelers.

267,000 hybrid or all-electric light vehicles in 2012 [*416*]. The Chinese government has set an ambitious goal to have between 500,000 and 1 million electric vehicles by 2015 and 5 million by 2020 [*417*]. The government is also building charging stations and battery-swapping networks for alternative vehicles, with a goal of installing 75 charging stations and 6,000 charging poles in 27 cities by the end of 2010 and 10,000 charging stations by 2016 [*418*]. In addition to the central government's plans for infrastructure to support electric vehicles, provincial and local governments and power companies are joining forces to build charging networks in major cities, with the goal of building a nationwide charging network by 2020 [*419*].

The transition to electrification of the Chinese vehicle fleet may take time and concerted effort on the part of the government before mass adaptation of alternative-fueled vehicles technologies becomes a reality. Sales of alternative-fuel vehicles have been minimal to date, with BYD selling only 54 EVs and 290 PHEVs between January and October 2010, and Changan Auto discontinuing its hybrid Jiexun model because of poor sales [*420*]. Sales of Toyota's Prius model in China, at around 4,000 vehicles per year over the past 3 years, have been well below expectations.

The pace of motorization in China is raising concerns about oil supply security, increasing congestion in major cities, and high levels of air pollution in urban areas resulting from a rapidly expanding vehicle fleet. If China's motorization continues to follow its GDP growth, the total number of vehicles could expand by one-third, to around 290 million vehicles, by 2020 [*421*]. The growth of vehicle sales in China has been strong over the past 15 years. In Beijing, for example, there were only 1 million vehicles on the road in 1997 and 2 million in 2003, as compared with 4 million in 2008 [*422*]. Rapid motorization and high concentrations of vehicles have led to serious congestion problems in China's metropolitan areas. From 2000 to 2006, road density (measured as road space per car) fell from 52 to 33 miles in Beijing and from 998 to 262 miles in Shanghai, with a national average reduction of more than 50 percent. Over the same period, road space increased by 62 percent in Beijing and 120 percent in Shanghai, indicating that the number of vehicles is increasing faster than road space in most Chinese cities [*423*].

In Beijing, concerns about rising congestion have prompted municipal authorities to cap the number of new vehicle registrations at 240,000 per year, or about one-third of the city's total vehicle sales in 2010. Other large cities also are considering restrictions on new car registrations. Shanghai, which has been restricting new registrations for many years to protect the streets in its ancient historic district, has about one-third as many registered vehicles as Beijing, even though population levels in the two cities are similar. In comparison, other cities—such as Guangzhou in southern China, which has a well developed and expanding subway network—have not experienced traffic congestion problems as severe as those in Beijing and are not planning restrictive measures that may discourage vehicle sales or otherwise have negative impacts on local economic growth [*424*].

China is pursuing large-scale plans for expansion of high-speed rail and mass transit networks. Expenditure for railways was the single largest component of the government's economic stimulus package adopted in 2008 in the wake of the global economic downturn. From 2009 to 2012, the government plans to invest $303.7 billion in rail construction [*425*], with plans to extend the rail network by 24,900 miles to a total of 74,600 miles by 2020 [*426*]. The government expects to have some 8,100 miles of high-speed rail installed and 42 lines in operation by 2012 and 10,000 miles installed by 2020 [*427*].

China's current 4,680-mile high-speed rail network is the largest and fastest in the world [*428*]. Within the next decade, all provincial capitals and cities with more than 500,000 inhabitants will be connected by high-speed rail, providing rail access to 90 percent of the population. High-speed rail will reduce the travel times between Beijing and provincial capitals significantly. Travel time between Beijing and Tianjin will be reduced to 1 hour, and trips between Beijing and cities in western and southern China will be reduced to between 6 and 7 hours [*429*]. The world's longest high-speed rail line, stretching 819 miles between Beijing and Shanghai, will reduce travel time between the two cities from the current 10 hours to about 4 hours [*430*].

As China's intercity rail networks have expanded, its urban commuter railways have also proliferated in response to rapid urbanization. Currently, China is developing some 60 subway projects in more than 20 cities [*431*]. At the end of 2009, metro and light rail lines had a combined length of 617 miles. Shanghai and Beijing had the longest networks, at 186 miles and 155 miles, respectively. Both cities are expanding their rail systems, with Shanghai adding 75 miles in 2010 and Beijing extending lines to 229 miles by 2010 and 349 miles by 2015. Between 2011 and 2015, China plans annual expenditures of $88 billion on railway infrastructure, $37 billion on subway infrastructure, and $24 billion on rolling stock [*432*].

India

India's transportation energy use is projected to grow at the fastest rate in the world, averaging 5.5 percent per year in the *IEO2011* Reference case, compared with the world average of 1.4 percent per year. Transportation energy use in India more than quadruples, from 2.0 quadrillion Btu in 2008 to 8.7 quadrillion Btu in 2035. Road travel leads the expansion of transportation energy use, with energy use per capita for passenger vehicles increasing threefold. Demand for personal transportation is growing rapidly in India, with much of it being accounted for by small automobiles and vehicles with two or three wheels. In 2010, despite the end of economic stimulus measures introduced in 2008 in response to the global economic downturn, vehicle sales in India continued to expand strongly. Following a 19-percent increase from 2008 to 2009, sales of domestically manufactured vehicles increased to nearly 1.9 million units in 2010 (from 1.4 million in 2009), and total vehicle sales increased by almost 31 percent to 14.8 million units (from 11.3 million in 2009) [*433*]. The implementation of new emissions standards in 13 major cities contributed to higher vehicle prices in 2010, as manufacturers offered models with new engine options, but demand continued to increase [*434*]. In the next few years, robust GDP growth and rising per-capita income are expected to support continued strong sales growth in India's automobile market. The country's demographics, with 600 million people under 25 years old, offer some of the best prospects in the world for automobile market expansion.

Roads are India's predominant mode of travel, accounting for around 90 percent of total transportation energy use over the past 10 years [*435*]. India has the second-largest road network in the world after the United States [*436*]. The road network increased from around 1.2 million miles in 1990 to around 2 million miles in 2008, and the total number of registered motor vehicles increased from 2.1 million in 1991 to 72.7 million in 2004. National highways connecting different Indian states make up about 2 percent of the total road network and state highways about 4 percent. The remaining 94 percent consists of rural and district roads. National highways, many of which are not linked to major economic and population centers, carry about 40 percent of the total traffic.

In 1999, India's national government launched a $12 billion National Highway Development Project to increase the capacity of national highways, including the Golden Quadrilateral project connecting four major cities; North-South and East-West corridors; and additional roads connecting to ports. With public and private investment, the length of the national highway network has quadrupled over the past 20 years, from about 10,000 miles in the 1990s to 41,500 miles in 2008.

India's government is also investing in the development of rural and district roads. In its 11th five-year plan (2007-2012), the government planned to connect state and district roads to national highways and integrate rural and district roads with the state highways. In the 12th five-year plan (2013-2017), it has targeted an investment of $1 trillion for infrastructure projects, with a goal of raising at least $300 billion from private funds [*437*]. Development of the country's infrastructure is one of the key priorities for India's government, as the rapidly growing economy has been placing significant demand on its transportation system, and existing bottlenecks in both urban and rural infrastructure have been seen as eroding the country's competitiveness. Expansion of the nation's transportation infrastructure will be essential for future economic growth.

India's automobile producers manufactured 2.6 million vehicles in 2009, making it the world's seventh-largest producer of motor vehicles [*438*]. The vehicle market in India is supported by the country's strong economic growth: GDP grew by 7.6 percent in the 2009-2010 fiscal year and 8.9 percent in the first half of the 2010-2011 fiscal year [*439*]. India's motor vehicle manufacturers aspire to improve their market share of the world's automotive sector. Rising per-capita incomes are expected to support strong growth in motor vehicle sales over the next few years, with analysts projecting 16- to 20-percent growth in the light-vehicle segment for 2010 and 2011 and 19-percent growth in the commercial-vehicle segment.

In 2010, India launched a National Ethanol Blending Programme, establishing a 5-percent mandatory ethanol blending standard in 20 states, and started selling blended fuel in 14 of the Programme's states, while increasing regulated prices for ethanol [*440*]. Supply availability remains a key challenge to the program's success. The government announced a 5-percent mandatory ethanol blend in October 2006, which was delayed until October 2009 because of disappointing sugarcane production in that year, along with a molasses shortage. In addition to ethanol, Indian Railways plans to establish four biodiesel production plants. India will continue to pursue development of blended transportation fuels as crude oil prices rise while the country's dependence on imported oil increases. It appears unlikely that India will be able meet its 20-percent blending target by 2017, given its current level of ethanol production and the need for additional government incentives to stimulate further growth.

Other non-OECD Asia

In non-OECD Asia outside China and India, burgeoning demand for transportation has led some countries to plan ambitious infrastructure improvement projects. In the *IEO2011* Reference case, transportation energy use in the nations of non-OECD Asia, excluding China and India, grows by 1.8 percent per year from 2008 to 2035. In Indonesia, for example, the government's Medium-Term Development Plan calls for investment of some $140 billion in infrastructure projects between 2010 and 2014, including plans to build 14 new airports and 53 miles of railway and improve the capacity of 1,625 miles of roads [*441*]. The Indonesian government expects public-private partnerships to fund nearly 65 percent of the infrastructure projects [*442*].

Indonesia is the world's largest exporter of thermal coal, and there are plans to further expand freight railways and marine ports to increase export capacity in the coming years. Indonesia also plans to construct a 190-mile coal railway line in southern Sumatra, to be completed by 2014, with the capacity to transport 27 million metric tons of coal; an 80-mile coal railway in East Kalimantan connecting a coal mine in Muara Wahau to the coast; and a coal railway in Central Kalimantan, to be completed by 2013, with the capacity to transport 10 million metric tons for 10 years and then expanding to a capacity of 20 million metric tons [*443*].

Private vehicle ownership has expanded rapidly in Indonesia over the past few years, creating congestion problems and placing a significant burden on road infrastructure. To address the congestion, a mass rapid transport system is being developed in Jakarta's metropolitan area. It will consist of a 9-mile rail line with a capacity to carry 400,000 passengers daily. However, the project only recently entered the design stage, and it will not be operational until at least 2016 [*444*]. In August 2009, the Indonesian government approved a new bill designed to cut congestion and generate more income for local governments to use on transportation infrastructure projects. The bill calls for a tax of up to 2 percent for a first vehicle or motorcycle and a tax of 2 to 10 percent on a vehicle owner's second or subsequent vehicle, with a requirement that at least 10 percent of tax proceeds be used by local governments for transportation infrastructure projects [*445*].

In May 2010, plans were announced to build elevated roads in Jakarta, linking the south, central, and east parts of the city to help reduce congestion problems for commuters. Other proposed measures include a vehicle occupancy requirement that would increase the required number of occupants per passenger vehicle. Such congestion management measures may not be sufficient, however, given the rate of increase in the number of vehicles on the roads. Without an adequate mass transit system in Jakarta and other urban areas, Indonesia's serious traffic congestion problems are likely to remain unabated [*446*].

Another country in the non-OECD Asia region that is attempting to improve the operation of its transportation network is Malaysia. The country's New Economic Model, designed to foster a high-income economy by 2020, involves large investments in transportation infrastructure. Projects under consideration include development of Kuala Lumpur's mass rapid transit system—the largest infrastructure project in Malaysia—as well as expansion of the city's light rail transit system. Upgrades to rural road infrastructure and the connectivity of existing city clusters, among other projects, are also planned under the New Economic Model, which calls for the development of a multi-modal transport network to facilitate trade and enhance the country's productivity [*447*].

Non-OECD Europe and Eurasia

Transportation sector energy use in non-OECD Europe and Eurasia is projected to grow at an annual average rate of 1.0 percent, from 7.2 quadrillion Btu in 2008 to 9.5 quadrillion Btu in 2035 (Figure 107). Growth in the region's transportation energy use results primarily from increases in private vehicle ownership, particularly in the countries of the former Soviet Union, where rising per-capita incomes and higher levels of economic activity lead to higher demand for personal motorized vehicles.

In the countries of non-OECD Europe and Eurasia, GDP growth of 2.7 percent per year from 2008 to 2035 leads to higher transportation energy consumption per capita, increasing by an average of 1.2 percent per year over the projection period despite virtually flat population levels. Energy use for freight transportation grows more rapidly, by an average of 2.2 percent per year, reflecting increased trade and improvements in the countries' standards of living.

In Russia, transportation energy consumption increases on average by 0.6 percent per year from 2008 to 2035 in the *IEO2011* Reference case, even as the population declines by an average of 0.5 percent per year. The growth in transportation energy use results primarily from expanding private vehicle ownership and freight transportation. From 2003 through 2008, sales of light-duty vehicles in Russia registered strong growth. Vehicle sales fell by 49 percent in 2009, however, following the global recession and a severe economic downturn in Russia [*448*]. In response, in March 2010, the Russian government implemented a scrappage scheme that offered a subsidy of $1,665 to consumers who replaced vehicles more than 10 years old with new, domestically manufactured vehicles. The scrappage scheme provided a highly effective stimulus for the passenger car market, leading to a robust recovery in light-duty vehicle sales, which increased by 30 percent to 1.9 million units in 2010. Russia's largest car manufacturer, AvtoVAZ, with its best-selling model Lada, became the main beneficiary of the scheme, with full-year sales growing by 48 percent to 517,147 units [*449*]. The government extended funding for the scrappage scheme to 2011, and as a result further increases in passenger vehicle sales are expected.

Middle East

In the *IEO2011* Reference case, transportation energy consumption in the Middle East grows by an average of 2.2 percent per year from 2008 to 2035, to a total of 9.5 quadrillion Btu (Figure 108). Although the Middle East has a relatively small population, rapid population growth and continued urbanization are expected to increase demand for transportation. Sustained economic expansion, growing population, and continuous subsidies to end users, which are unlikely to be completely eliminated in some countries in the region, support strong increases in demand for transport fuels through the medium term.

Figure 107. Non-OECD Europe and Eurasia transportation energy use by country, 2008-2035 (quadrillion Btu)

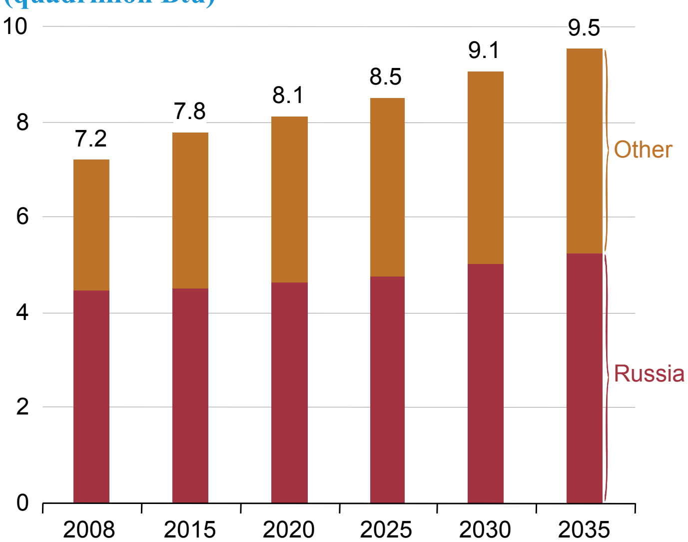
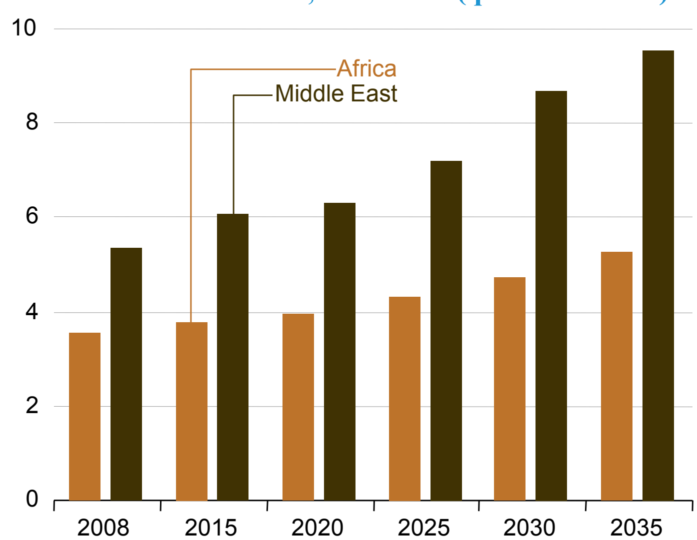


Figure 108. Transportation energy use in the Middle East and Africa, 2008-2035 (quadrillion Btu)



Oil and natural gas producing countries in the Middle East have seen some of the fastest growth in transportation energy demand in the world. From 2000 to 2008, demand for gasoline and diesel fuel increased by 5.2 percent per year in Iran, 6.2 percent per year in Saudi Arabia, 7.0 percent per year in the United Arab Emirates, and 17 percent per year in Qatar. One explanation for the rapid demand increases is the fact that governments have maintained end-user subsidies despite high world oil prices, and the subsidies have discouraged conservation and efficiency improvements [*450*]. Prices for transportation fuels in the Middle East are among the lowest in the world. For example, in mid-November 2010, retail prices for gasoline were $0.37 per gallon in Iran and $0.87 in Kuwait, and retail prices for diesel fuel were $0.06 per gallon in Iran, $0.25 in Saudi Arabia, $0.49 in Bahrain, and $0.72 in Qatar [*451*].

The *IEO2011* Reference case assumes gradual phasing out of the transportation fuel subsidies in Middle Eastern countries, although it may take some time for governments to implement such changes successfully. In addition, the social and political unrest that began in the region in December 2010 makes any efforts to remove subsidies in the short term even more unlikely. Iran offers a good example of the difficulties of removing subsidies.

Even before recent events, Iran had sought to reform its extremely costly subsidy system for some time, but concerns remained that significant subsidy reform could trigger civil unrest, as happened briefly in 2007 when fuel rationing was initially enacted. In 2010, in its fifth development plan (2010-2015), the government enacted a subsidy reform law, which calls for increases in petroleum product prices (including gasoline, gasoil, kerosene, and fuel oil) to 90 percent of free-on-board prices in the Persian Gulf. The subsidy reform is expected to have a more significant impact on demand for transportation fuels than previous consumption management plans, such as gasoline rationing, which began in 2007. Since 2007, the gasoline quota for private motorists has been reduced from 120 liters per month to the current 60 liters per month in 4 steps. Due to stepwise tightening of the quota over time, the impact on gasoline consumption has not been significant [*452*]. With the government reportedly enacting a plan to eliminate nearly all government subsidies by the end of 2014, transportation fuel prices are expected to continue rising in the coming years. However, the timing and scope of the subsidy cuts for transportation fuels remains unclear, because such measures are unpopular with consumers and could lead to civil unrest [*453*].

High world oil prices have increased revenues from oil exports in many of the exporting countries of the Middle East, and as a result several transportation infrastructure projects, including those for mass transit, are underway. In Saudi Arabia, plans for transportation infrastructure expansion are centered around the needs of its growing population, continuous urbanization, the growth of the tourist industry, and increasing trade. Under the Eighth Development Plan, several major infrastructure projects were implemented, including construction of new roads, rail networks, and airports. From 2004 to 2008, the length of the national road network increased by 11.5 percent, from 102.5 thousand miles to about 114 thousand miles, and the number of registered vehicles reached an estimated 5.4 million, with private cars and light trucks constituting 96 percent of the total [*454*].

Major railroad expansion is under way in Saudi Arabia, including three projects that will add 2,500 miles of railway lines as the country prepares to become part of the Gulf Cooperation Council's Gulf Railway Network. Rail expansion projects include a 600-mile line connecting the capital Riyadh to Jeddah; a 75-mile line from Dammam to Jubail; a 315-mile high-speed passenger railway connecting Mecca to Medina; and a 1,400-mile line, the North-South Railway, that will connect mines in northern Saudi Arabia with industrial facilities in Riyadh and in Ras al-Zour on the Persian Gulf [*455*].

Saudi Arabia's King Abdul-Aziz International Airport in Jeddah is being expanded to increase annual passenger capacity from 15 million to 80 million passengers by 2035. The Ninth Development Plan envisages construction of a Ras Al-Zour port, completion of the Phase 1 expansion of King Abdul-Aziz International Airport, construction of Prince Mohammed bin Abdul-Aziz Airport in Medina with an annual passenger handling capacity of 3 million, construction of new Taif and Tabuk regional airports that will serve millions of pilgrims visiting Saudi Arabia annually [*456*], and completion of three railway expansion projects [*457*]. The General Authority of Civil Aviation of Saudi Arabia plans to invest between $10 billion and $20 billion on developing and upgrading airports through 2020, with private investors set to contribute up to $10 billion [*458*].

Saudi Arabia remains the only country in the world where women are legally prohibited from driving a vehicle. Although women are allowed to own cars, they are required to have a chauffeur or a male family member drive their vehicles for them. Although social and economic pressure to resolve the issue has been significant, progress on lifting the ban has been slow [*459*]. Private vehicle ownership by women has been one of the fastest-growing consumer segments in Saudi Arabia in recent years [*460*], increasing by 60 percent from 2003 to 2006, with an estimated 75,522 women owning 120,334 vehicles at the end of 2006 [*461*]. In the medium term, lifting a ban on female driving is unlikely to increase passenger vehicle sales significantly, because the majority of women who have the means to purchase a vehicle already own one [*462*].

Rising fuel costs and increasing congestion have prompted many countries in the Middle East to take steps to develop urban mass transit systems, particularly metro rail systems. In 2009, Dubai launched metro and monorail networks. In November 2010, Saudi Arabia opened Al Mashaaer Al Mugaddassah Metro Line in Mecca, which connects the holy sites of Arafat, Muzdalifah, and Mina. The line provides transport for about 3.5 million pilgrims who arrive in Mecca annually to perform Hajj. The line from Mina to Arafat can transport 500,000 pilgrims in 6 to 8 hours and has been effective in helping to reduce from 70,000 to 25,000 the number of buses needed to transport pilgrims. The metro is expected to reach full capacity in 2011, carrying 72,000 passengers in each direction per hour [*463*].

In Amman, Jordan, construction of a Bus Rapid Transit (BRT) line is under way, scheduled for completion by 2012. The system will have a transport capacity of 6,000 passengers per hour per direction along three corridors and will link areas of high population density in the south and east with education and employment centers in the north and west [*464*]. Abu Dhabi is developing a tram and an 81-mile metro rail network, which are scheduled to be operational by 2014 and 2016, respectively [*465*]. This project is part of the Abu Dhabi Master Transport Plan 2030, which also includes development of 360 miles of high-speed rail and 217 miles of light rail tram network [*466*].

Oman plans to develop a 620-mile national railway system in four stages that will incorporate double tracks and trains operating at speeds up to 125 mile per hour and will include a provision to introduce high-speed trains in the future. Construction of the rail network is expected to commence in 2012 [*467*]. Finally, the Gulf Cooperation Council has announced plans to build a railway network to link Kuwait, Saudi Arabia, Bahrain, Qatar, UAE, and Oman by 2017. The $30 billion railway project will be approximately 1,370 miles long and will be connected to the planned Middle East rail network [*468*].

Africa

Transportation energy use in Africa grows by 1.5 percent per year in the Reference case, to 5.3 quadrillion Btu in 2035 (Figure 108). Transportation infrastructure is still in early development stages in most African countries, and major investments will be required to achieve the levels necessary to support economic growth. The Economic Commission for Africa has estimated that the continent needs to invest at least $20 billion per year in infrastructure development until 2015 in order to effectively integrate Africa with the global economy [*469*].

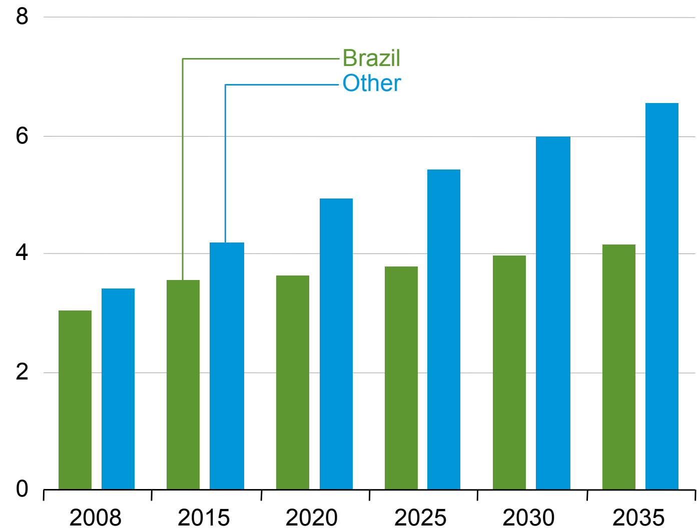
Central and South America

Transportation energy use in Central and South America grows by 1.9 percent per year in the Reference case, to 10.7 quadrillion Btu in 2035 (Figure 109). Brazil, the region's largest economy, continues to show strong growth in its transportation sector following its success in achieving economic stability. The country experienced only a mild impact from the global economic recession, and demand for transportation fuels has continued growing with the expansion of road and air travel as well as transport of freight and agricultural goods by rail.

The automotive market in Central and South America has been growing in recent years. In 2010, light-duty vehicle sales in Brazil increased by 10.6 percent, supported by the strong economic recovery and greater availability of consumer credit. December 2010 marked the best month for light-duty vehicle sales in Brazil's history, with a 30-percent increase in vehicle sales from December 2009, to 361,230 units [*470*]. Argentina's vehicle market also recovered strongly in 2010 after declining in 2009 as a result of the global recession. In 2010, motor vehicle sales in Argentina rose by 43 percent from the 2009 total, and vehicle production increased by 41 percent in response to an active local market and strong export demand [*471*].

Brazil is the world's second-largest producer of biofuels, after the United States [*472*]. Since the launch of a National Alcohol Program in 1975 to promote the use of ethanol in the transportation fuel mix, ethanol consumption in Brazil has been growing steadily, from 0.1 billion gallons in 1975 to 5.7 billion gallons in 2010 [*473*]. The increase in ethanol consumption was supported by the launch of flexible-fuel vehicle (FFV) production in 2003.[38] In 2009, FFVs accounted for 95 percent of all new vehicle sales in Brazil [*474*]. With a continuous increase in FFV sales, the ethanol share of Brazil's transportation fuel market is likely to expand.

Figure 109. Central and South America transportation energy use by country, 2008-2035 (quadrillion Btu)



[38]Flexible-fuel vehicles can operate using 100 percent ethanol, 100 percent motor gasoline, or any combination of the two fuels.

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Chapter 8
Energy-related carbon dioxide emissions

Overview

Because anthropogenic emissions of carbon dioxide result primarily from the combustion of fossil fuels, energy consumption is at the center of the climate change debate. In the *IEO2011* Reference case, world energy-related carbon dioxide emissions[39] increase from 30.2 billion metric tons in 2008 to 35.2 billion metric tons in 2020 and 43.2 billion metric tons in 2035. Much of the growth in emissions is attributed to developing, non-OECD nations that continue to rely heavily on fossil fuels to meet fast-paced growth in energy demand. Non-OECD emissions total 28.9 billion metric tons in 2035, or about 73 percent above the 2008 level. In comparison, OECD emissions total 14.3 billion metric tons in 2035—only about 6 percent above the level in 2008 (Figure 110).

High world oil prices in 2008, compounded by the 2008-2009 global recession, resulted in a decrease in fossil fuel consumption for the OECD regions, with carbon dioxide emissions declining by 2.0 percent in 2008 and an estimated 6.3 percent in 2009. Non-OECD emissions, however, continued to increase in 2008 and 2009. As a result, total world emissions increased by 2.2 percent in 2008 and an estimated 0.3 percent in 2009. In the *IEO2011* Reference case, the non-OECD share of overall energy-related carbon dioxide emissions increases from 55 percent in 2008 to about 67 percent in 2035.

The *IEO2011* Reference case projections are, to the extent possible, based on existing laws and policies. Projections for carbon dioxide emissions may change significantly if laws and policies aimed at reducing greenhouse gas emissions are changed or new ones are introduced. Many countries have submitted emission reduction goals under the United Nations Framework Convention on Climate Change in conjunction with the Conference of Parties meetings in Copenhagen and Cancun (see box on page 141); however, those goals are not considered in the *IEO2011* Reference case. In addition, beyond energy-related carbon dioxide there are other gases (e.g., methane) and sources (e.g., deforestation) that contribute to greenhouse gas emissions. Other sources are not considered in *IEO2011*, but they could have significant impacts on national or regional shares of total global greenhouse gas emissions.

Emissions by fuel

Worldwide energy-related carbon dioxide emissions from the use of liquid fuels, natural gas, and coal all increase in the Reference case projection, but the relative contributions of the individual fuels shift over time (Figure 111). Carbon dioxide emissions associated with the consumption of liquids accounted for the largest portion (43 percent) of global emissions in 1990. The liquids share fell to 37 percent in 2008, and it continues declining in the Reference case to 33 percent in 2035. The coal share follows an inverse pattern, accounting for 39 percent of total emissions in 1990, 43 percent in 2008, and 45 percent in 2035 in the *IEO2011* Reference case. Coal, the most carbon-intensive fossil fuel, became the leading source of world energy-related carbon dioxide emissions in 2004 and remains the leading source through 2035. The natural gas share of carbon dioxide emissions remains relatively small by comparison, at 19 percent of the total in 1990 and a projected 21 percent of the total in 2035.

Global carbon dioxide emissions from coal use show the largest absolute increase in the Reference case, from 13.0 billion metric tons in 2008 to 19.6 billion metric tons in 2035. Coal is the largest contributor to emissions growth in the non-OECD economies,

Figure 110. World energy-related carbon dioxide emissions, 1990-2035 (billion metric tons)

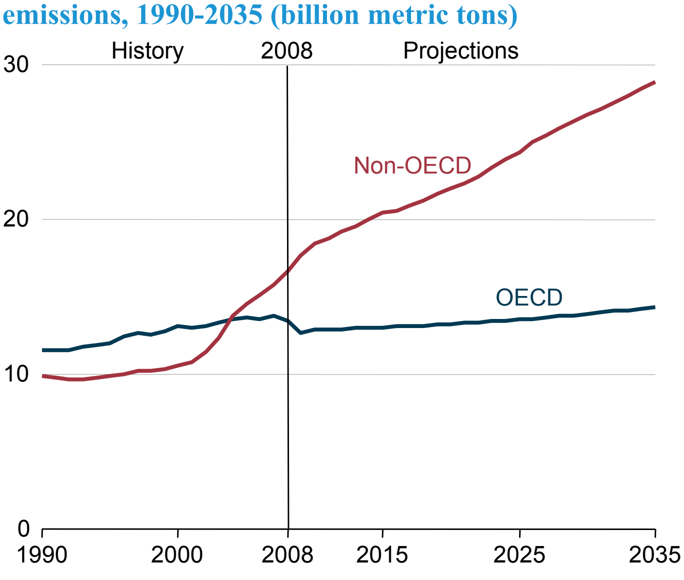
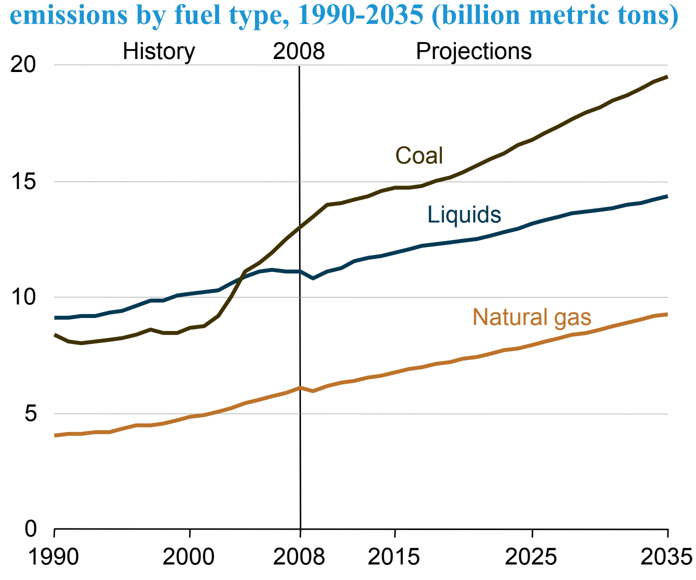


Figure 111. World energy-related carbon dioxide emissions by fuel type, 1990-2035 (billion metric tons)



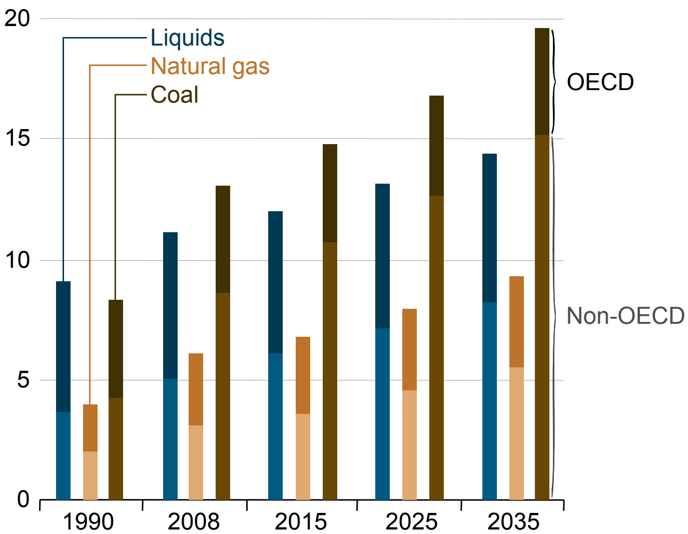
[39]In *IEO2011*, energy-related carbon dioxide emissions are defined as emissions related to the combustion of fossil fuels (liquid fuels, natural gas, and coal) and those associated with petroleum feedstocks. Emissions from the flaring of natural gas are not included.

accounting for 54 percent of the projected non-OECD increase in total energy-related emissions. World coal-related carbon dioxide emissions grow at an average annual rate of 1.5 percent over the 27-year projection period, and the non-OECD countries account for nearly all of the increase. Although there is virtually no change in OECD coal-related emissions from 2008 to 2035, non-OECD coal-related emissions increase by 76 percent over the period. The world's top three national sources of coal-related emissions are China, the United States, and India, which remain at the top throughout the projection and in combination account for three-quarters of world coal-related carbon dioxide emissions in 2035.

In percentage terms, natural gas is the world's fastest-growing fossil fuel in the *IEO2011* Reference case and, as a result, is also the world's fastest-growing source of energy-related carbon dioxide emissions. Nevertheless, emissions from natural gas combustion on a worldwide basis remain much smaller than emissions from combustion of coal or liquids. At an average annual growth rate of 1.6 percent, emissions from natural gas increase by more than 50 percent from 2008 to 2035 (Figure 112). Emissions from natural gas use account for about 90 percent of the projected increase in total OECD emissions. In contrast, only about 20 percent of the growth in total non-OECD emissions is expected to come from natural gas. Although non-OECD emissions from natural gas use grow by 79 percent from 2008 to 2035, the large absolute increases in non-OECD coal- and liquids-related emissions exceed the increase associated with natural gas.

Carbon dioxide emissions from the consumption of liquids worldwide show the slowest growth over the projection period, at an average annual rate of 1.0 percent—a comparatively low growth rate that still results in an absolute increase of 3.3 billion metric tons of liquids-related carbon dioxide emissions from 2008 to 2035. As in the case of coal and natural gas, increases in liquids-related emissions are not distributed evenly across regions. In the OECD countries, liquids-related carbon dioxide emissions in increase on average by less than 0.1 percent per year. In the non-OECD countries, rising demand for transportation and industrial uses of liquids contributes to a much higher growth rate of 1.8 percent per year. As a result, the OECD share of carbon dioxide emissions from liquids declines from 55 percent in 2008 to 43 percent in 2035.

Figure 112. OECD and non-OECD energy-related carbon dioxide emissions by fuel type, 1990-2035 (billion metric tons)



Emissions by region

World energy-related carbon dioxide emissions increase at an average annual rate of 1.3 percent from 2008 to 2035 in the *IEO2011* reference case. OECD emissions increase by only 0.2 percent per year on average, but non-OECD emissions increase at 10 times that rate (Figures 113 and 114). OECD emissions fell in 2008 and in 2009—primarily because of the global recession and high oil prices in 2008. In the *IEO2011* Reference case, OECD carbon dioxide emissions do not return to 2008 levels until after 2020.

Figure 113. Average annual growth of energy-related carbon dioxide emissions in OECD economies, 2008-2035 (percent per year)

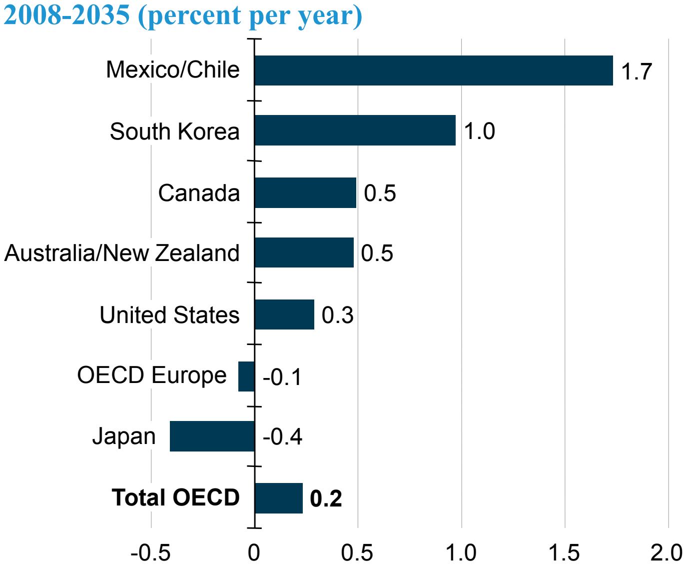
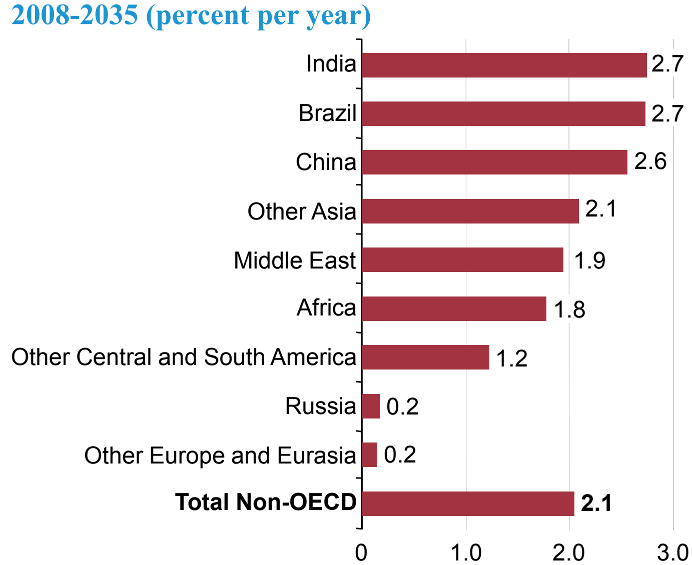


Figure 114. Average annual growth of energy-related carbon dioxide emissions in non-OECD economies, 2008-2035 (percent per year)



Among the OECD countries, Mexico/Chile and South Korea have the highest projected growth rates for energy-related carbon dioxide emissions, at 1.7 percent and 1.0 percent per year, respectively (Figure 113). From a combined 8 percent in 2008, their share of total OECD emissions increases to 10 percent in 2035. The two regions also have the highest projected rates of economic growth in the OECD over the period, with Mexico/Chile's GDP increasing by 3.7 percent per year in the *IEO2011* Reference case and South Korea's by 2.9 percent per year. For the OECD region as a whole GDP growth averages 2.1 percent per year.

In Japan and OECD Europe, carbon dioxide emissions decline from 2008 to 2035. Japan emits 1.1 billion metric tons of energy-related carbon dioxide in 2035, or 11 percent less than in 2008. OECD Europe's emissions decline by 0.1 percent per year over the projection period; Japan's by 0.4 percent per year. In 2035, OECD Europe accounts for less than 10 percent of world emissions, as compared with about 14 percent in 2008.

Among the OECD regions, the United States continues to be the largest source of energy-related carbon dioxide emissions through 2035. U.S. emissions grow by an average of 0.3 percent per year—a lower rate of growth than in Mexico/Chile, South Korea, Australia/New Zealand, and Canada. However, in terms of absolute increases across the OECD regions, the United States contributes the most additional metric tons of energy-related carbon dioxide emissions in 2035 compared with 2008 levels. Still, the U.S. share of world emissions falls from 19 percent in 2008 to 15 percent in 2035, as fast-paced expansion of fossil fuel use, and thus energy-related carbon dioxide emissions, in non-OECD countries displaces the U.S. share.

Non-OECD Asia accounts for about 74 percent of the growth in world carbon dioxide emissions from 2008 to 2035. China's emissions grow by an average of 2.6 percent per year (Figure 114) and account for more than two-thirds of the total increase in non-OECD Asia's emissions. India's carbon dioxide emissions increase by 2.7 percent per year, and emissions in the rest of non-OECD Asia increase by an average of 2.1 percent per year. In 2035, India is the fifth-highest emitter among the *IEO2011* regions, following China, the United States, OECD Europe, and "other" non-OECD Asia (i.e., non-OECD Asia excluding China and India). Emissions increases in non-OECD Asia, particularly China, are led by coal-related carbon dioxide emissions—but emissions from natural gas and liquids use also increase substantially (Figure 115).

Non-OECD Europe and Eurasia exhibits the slowest growth in carbon dioxide emissions among the non-OECD regions, at 0.2 percent per year in the *IEO2011* Reference case. Natural gas is the region's leading source of fuel emissions, accounting for 54 percent of total carbon dioxide emissions in Russia in 2008 and 39 percent in the other non-OECD Europe and Eurasia nations. Total carbon dioxide emissions in non-OECD Europe and Eurasia increase only slightly, from 2.8 billion metric tons in 2008 to 3.0 billion metric tons in 2035, in part because of Russia's projected population decline and increasing reliance on nuclear power to meet electricity demand in the future. Natural gas continues to be the region's leading source of energy-related carbon dioxide emissions throughout the projection, accounting for nearly 50 percent of total energy-related emissions in 2035.

The Copenhagen Accord

In December 2009, the fifteenth session of the Conference of Parties to the United Nations Framework Convention on Climate Change (COP-15) was held in Copenhagen, Denmark. Although COP-15 did not produce a legally binding agreement to cut emissions, key developed and developing countries negotiated a Copenhagen Accord that was noted by the COP in its final session. Under the Accord, a process was established for countries to enter specific mitigation pledges by January 31, 2010.

In addition to voluntary reduction goals, the developed countries at COP-15 pledged $30 billion in added resources in the 2010-2012 time frame to help developing countries reduce emissions, preserve and enhance forests, and adapt to climate change [*475*]. They also set a further goal of mobilizing $100 billion per year in public and private financing by 2020 to address the needs of developing countries [*476*].

The emissions mitigation pledges submitted by countries pursuant to the Copenhagen Accord fall into two general categories: absolute reductions and intensity reductions. Absolute reductions reduce greenhouse gas emissions independent of economic or material output. Japan, Russia, the European Union, the United States, and Brazil have announced absolute reduction goals, which are expressed as percentage reductions below historical base-year amounts. (For example, Japan has announced its goal to reduce carbon dioxide emissions to 25 percent below 1990 levels by 2020.) China and India have announced intensity reduction goals, which typically are expressed as reductions in emissions per unit of output as measured by GDP. (For example, China has announced its intention to reduce its carbon emissions intensity by 2020 to a level that is 40 to 45 percent below its emissions intensity in 2005.)

Some of the non-binding commitments submitted under COP-15 are shown in Table 17 to provide a comparison with *IEO2011* Reference case projections, which do not assume that greenhouse gas reduction goals will be met. For the United States, the European Union, Japan, and Brazil, further reductions in energy-related carbon dioxide emissions probably would be necessary to achieve the 2020 targets. Depending on the region, the required reductions range between 208 and 1,249 million metric tons in

(continued on page 142)

2020. For Russia, the Reference case projects emissions in 2020 that are 10 percent lower than the country's Copenhagen Accord goal. Similarly, the Copenhagen Accord goals for China and India in 2020 are higher than the 2020 projections in the *IEO2011* Reference case.

The sixteenth Conference of the Parties (COP-16) and sixth Meeting of the Parties (CMP-6) convened from November 29 through December 10, 2010, in Cancun, Mexico. The Parties adopted a package of agreements that reaffirmed and built upon the Copenhagen Accord. The Cancun Agreements reaffirm the Copenhagen Accord's goal to limit the global average temperature rise to 2 degrees Celsius above pre-industrial levels [*477*]. The Agreements also include formal recognition for the first time of the reduction pledges made in the Copenhagen Accord, by "taking note" of the pledges made by both developed and developing countries. They indicate that the Clean Development Mechanism (CDM), by which Annex I nations may use non-Annex I mitigation projects to offset their emissions, will continue beyond 2012. In addition, the Agreements create a new "standardized baseline" process for some types of CDM projects.

Other actions agreed to at Cancun include:

- Setting out a reporting framework that continues annual submission of inventories by developed nations, creates a new registry for developing nations to report on mitigation actions that receive international financing, and provides general guidelines for reporting
- Providing a framework to develop financing and other policies for the Reduce Emissions from Deforestation and Degradation (REDD+) program, and calling on developing nations to develop national strategies and reference levels for future efforts to reduce deforestation
- Establishing the World Bank as interim trustee of the Green Climate Fund, which seeks to raise $100 billion per year from public and private sources by 2020 to support greenhouse gas mitigation efforts in developing countries
- Setting up the Cancun Adaption Framework to formalize and outline efforts to enhance adaption activities by all UNFCCC members
- Establishing the Technology Mechanism to assist developing countries with identification, transfer, and application of appropriate low-carbon technologies.

Table 17. Emissions mitigation goals announced by selected countries (million metric tons carbon dioxide)

Country/region	Reduction goal	Carbon dioxide emissions goal for 2020[a]	*IEO2011* Reference case projection for 2020	2008 emissions	Emissions reduction needed to achieve goal	Average annual percent change from 2008 emissions needed to achieve goal
Countries with goals for total emissions reductions						
United States	To 17 percent below 2005 level by 2020	4,977	5,777	5,838	800	-1.3%
OECD Europe[b]	To 20 percent below 1990 level by 2020	3,301	4,147	4,345	846	-2.3%
	To 30 percent below 1990 level by 2020	2,889	4,147	4,345	1,249	-3.3%
Japan	To 25 percent below 1990 level by 2020	785	1,142	1,215	357	-3.6%
Brazil	By 36 to 39 percent relative to projected level in 2020	353-371	579	423	208-226	-1.1% – -1.5%
Russia	To between 15 and 25 percent below 1990 level by 2020	1,776-2,013	1,607	1,663	--	--
Countries with goals for carbon dioxide intensity reductions						
China	To between 40 and 45 percent below 2005 level by 2020	10,149-11,071[c]	10,128	6,801	--	--
India	To between 20 and 25 percent below 2005 level by 2020	2,512-2,679[c]	2,056	1,462	--	--

[a]It is assumed that country goals are applied proportionally to energy-related carbon dioxide emissions and other greenhouse gases.
[b]Because *IEO2011* does not model the European Union as a region, emissions and projections for OECD Europe are used as a proxy. The reduction goal is based on 20 percent of the 1990 level for OECD Europe. Although some countries in OECD Europe are not members of the European Union, the European Union also includes some countries that are not included in the OECD Europe region. On balance, OECD Europe's 1990 emissions were 2 percent higher than the European Union's emissions. In 2005 and 2008, OECD Europe's emissions were about 2 percent and 3 percent lower than the European Union's emissions, respectively. The difference could be more pronounced in future years, depending on emissions from the various countries. COP-16 omitted Turkey from the European Union's commitments; *IEO2011* includes Turkey as part of OECD Europe.
[c]Carbon dioxide intensity is defined as emissions per unit of output (as measured by GDP expressed in purchasing power parity). The carbon dioxide emissions goal is calculated by multiplying the 2020 carbon intensity goal by *IEO2011* GDP projections for 2020.
Source: United Nations Framework Convention on Climate Change.

Cumulative carbon dioxide emissions

The *IEO2011* Reference case projects about 1 trillion metric tons of additional cumulative energy-related carbon dioxide emissions between 2009 and 2035. The pace of carbon dioxide emissions growth slows in the *IEO2011* Reference case during the last 15 years of the projection period (2021-2035) in comparison with the previous 15 years (2006-2020). In the period from 2021 to 2035, cumulative emissions are 22 percent higher than those in the period from 2006 to 2020 (including historical emission years 2006-2008), and emissions in the period from 2006 to 2020 are 38 percent higher than the total from 1991 to 2005.

Non-OECD Asia is the dominant source of cumulative emissions growth in the 30 years preceding 2035 (Figure 116). In the last 15 years of the projection, cumulative emissions from non-OECD Asia are 44 percent of total cumulative emissions, up from a 38-percent share between 2006 and 2020 and a 23-percent share between 1991 and 2005. Cumulative emissions from the OECD Americas region also grow between 1991 and 2035, but in the 15 years ending in 2035, they are 13 percent higher than those from the earliest period shown in Figure 116 (1991-2005). In contrast, non-OECD Asia's cumulative emissions from 2021 to 2035 are more than three times its cumulative emissions between 1991 and 2005. The second-largest increase, after non-OECD Asia, is projected for the Middle East; but because it is starting from a much smaller total, its contribution to cumulative emissions between 2021 and 2035 remains small, at 6 percent of the total for the period.

Factors influencing trends in energy-related carbon dioxide emissions

There are many factors that influence a country's level of carbon dioxide emissions. Two key measures provide useful insights for the analysis of trends in energy-related emissions:

- The *carbon intensity of energy supply* is a measure of the amount of carbon dioxide associated with each unit of energy used. It directly links changes in carbon dioxide emissions levels with changes in energy usage. Carbon emissions vary by energy source, with coal being the most carbon-intensive fuel, followed by oil and natural gas. Nuclear power and some renewable energy sources (i.e., solar and wind) do not directly generate carbon dioxide emissions. Consequently, changes in the fuel mix therefore alter overall carbon intensity. Over time, declining carbon intensity can offset increasing energy consumption to some extent. If energy consumption increased and carbon intensity declined by a proportional factor, carbon dioxide emissions would remain constant. A decline in carbon intensity can indicate a shift away from fossil fuels, a shift towards less carbon-intensive fossil fuels, or both.
- The *energy intensity of economic activity* is a measure of energy consumption per unit of economic activity, as measured by GDP. It relates changes in energy consumption to economic output. Increased energy use and economic growth generally occur together, although the degree to which they are linked varies across regions and stages of economic development.

As with carbon intensity, regional energy intensities do not necessarily remain constant over time. Energy intensity can be indicative of the energy efficiency of an economy's capital stock (vehicles, appliances, manufacturing equipment, power plants, etc.). For example, if an old power plant is replaced with a more thermally efficient unit, then it is possible to meet the same level of electricity demand with a lower level of primary energy consumption, thereby decreasing energy intensity.

Energy intensity is acutely affected by structural changes within an economy—in particular, the relative shares of its output sectors (manufacturing versus service, for example) or its trade balance. Higher concentrations of energy-intensive industries, such as oil and gas extraction, will yield higher overall energy intensities, whereas countries with proportionately larger service sectors will tend to have lower energy intensities. For example, the Middle East had a relatively high energy intensity of 10.6

Figure 115. Increases in carbon dioxide emissions by fuel type for regions with highest absolute emissions growth, 2008-2035 (billion metric tons)

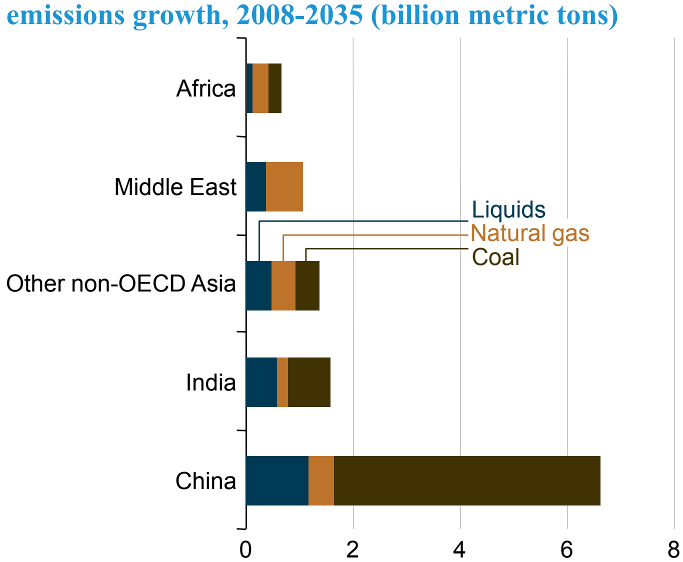
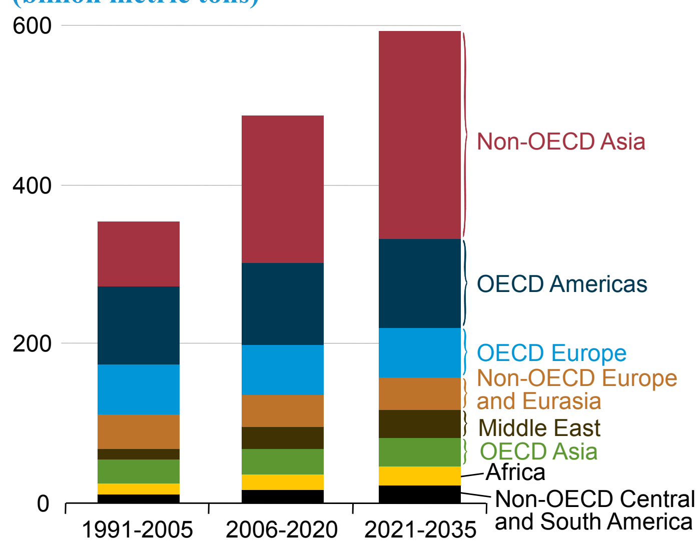


Figure 116. Cumulative carbon dioxide emissions by region, 1991-2005, 2006-2020, and 2021-2035 (billion metric tons)



thousand Btu per dollar of GDP in 2008, in part because of the important role played by hydrocarbon production and exports in most Middle East economies.

When carbon intensity and energy intensity components are multiplied together, the resulting measure is carbon dioxide emissions per dollar of GDP (CO_2/GDP)—that is, the *carbon intensity of economic output*. Carbon intensity of output is another common measure used in analysis of changes in carbon dioxide emissions, and it is sometimes used as a standalone measure for tracking progress in relative emissions reductions. However, when the goal is to determine the relative strengths of forces driving changes in carbon intensity, disaggregation of the components helps to determine whether a change in carbon intensity is the result of a change in the country's fuel mix or a change in the relative energy intensity of its economic activity.

The Kaya decomposition of emissions trends

The Kaya Identity provides an intuitive approach to the interpretation of historical trends and future projections of energy-related carbon dioxide emissions. It can be used to decompose total carbon dioxide emissions as the product of individual factors that explicitly link energy-related carbon dioxide emissions to energy consumption, the level of economic output as measured by gross domestic product (GDP), and population size.

The Kaya Identity expresses total carbon dioxide emissions as the product of (1) carbon intensity of energy supply (CO_2/E), (2) energy intensity of economic activity (E/GDP), (3) economic output per capita, and (4) population:

$$CO_2 = (CO_2 / E) \times (E / GDP) \times (GDP / POP) \times POP \quad .$$

Using 2008 data as an example, world energy-related carbon dioxide emissions totaled 30.2 billion metric tons in that year, world energy consumption totaled 505 quadrillion Btu, world GDP totaled $65.8 trillion, and the total world population was 6,731 million. Using those figures in the Kaya equation yields the following: 59.8 metric tons carbon dioxide per billion Btu of energy (CO_2/E), 7.7 thousand Btu of energy per dollar of GDP (E/GDP), and $9,773 of income per person (GDP/POP). Appendix H delineates the Kaya factors for all *IEO* regions over the projection period.

Of the four Kaya components, policymakers generally focus on the energy intensity of economic output (E/GDP) and carbon dioxide intensity of the energy supply (CO_2/E). Reducing growth in per-capita output may have a mitigating influence on emissions, but governments generally pursue policies to increase rather than reduce output per capita in order to advance objectives other than greenhouse gas mitigation.

Policies related to energy intensity of GDP typically involve improvements to energy efficiency. However, the measure is also sensitive to shifts in the energy-intensive portion of a country's trade balance, and improvements may simply reflect a greater reliance on imports of manufactured goods, which may decrease one country's energy intensity but, if the country producing the imported goods is less energy efficient, could lead to a worldwide increase in energy consumption and related carbon dioxide emissions. Policies related to the carbon dioxide intensity of energy supply typically focus on promotion of low-carbon or zero-carbon sources of energy.

Conveniently, the percentage rate of change in carbon dioxide emission levels over time approximates the sum of the percentage rate of change across the four Kaya components. Table 18 shows the average rate of change of total carbon dioxide emissions and each individual Kaya component from 2008 to 2035 in the *IEO2011* Reference case. The most significant driver of positive growth in energy-related carbon dioxide emissions is economic output per capita. The average annual growth rate of output per capita for non-OECD countries (3.6 percent from 2008 to 2035) in particular dominates all other Kaya components in the 27-year projection. For OECD countries, on the other hand, the 1.7-percent average annual increase in output per capita is nearly offset by the 1.5-percent annual decline in energy intensity.

Except for Japan and Russia—where population is expected to decline from 2008 to 2035—population growth is also an important determinant of emissions increases. However, the population effect is less pronounced than the effect of output per capita (Figure 117). For non-OECD countries, increases in output per capita coupled with population growth overwhelm the improvements in energy intensity and carbon intensity. Although the same was true for the OECD countries over the period from 1990 to 2008, the projection horizon shows OECD growth in output per capita and population balanced by improvements in energy intensity and carbon intensity (Figure 118).

Over the 2008-2035 projection period, energy intensity of economic output declines in all the *IEO2011* regions. The trend is particularly pronounced in the non-OECD countries, where energy intensity of output decreases on average by 2.2 percent per year, compared with 1.5 percent per year in the OECD countries. Worldwide, the most significant decline in energy intensity of output is projected for China, at 2.6 percent per year. However, that decline is offset by the projected increase in China's output per capita, which grows by an average of 5.4 percent per year over the same period.

Carbon intensity of energy supply is also projected to decline in all the *IEO2011* regions from 2008 to 2035, but to a lesser extent. The most significant declines in carbon intensity of energy supply are projected for Japan and OECD Europe, with annual decreases averaging 0.6 percent per year for both regions. Decreases in the consumption of liquids and coal (the most carbon-intensive fuels) in both regions, combined with increases in consumption of renewable energy, nuclear power, and natural gas, reduce the carbon intensity of the energy supply. For the OECD region as a whole, the average rate of decline in carbon intensity of energy supply over the 2008-2035 period is 0.4 percent per year, exceeding the non-OECD average of 0.2 percent per year. Still, the projected decrease in non-OECD carbon intensity would mark a departure from the 1990-2008 historical trend, when non-OECD carbon intensity remained nearly constant.

Table 18. Average annual changes in Kaya decomposition factors, 2008-2035 (percent per year)

	Carbon intensity of energy supply (CO_2/E)	Energy intensity of economic activity (E/GDP)	Income per person (GDP/POP)	Population (POP)	CO_2 emissions
OECD Americas	-0.3%	-1.9%	1.7%	0.9%	0.4%
United States	-0.2%	-2.0%	1.6%	0.9%	0.3%
Canada	-0.5%	-1.1%	1.1%	1.0%	0.5%
Mexico/Chile	-0.3%	-1.5%	3.0%	0.6%	1.7%
OECD Europe	-0.6%	-1.3%	1.6%	0.2%	-0.1%
OECD Asia	-0.5%	-0.8%	1.5%	-0.1%	0.2%
Japan	-0.6%	-0.3%	0.9%	-0.4%	-0.4%
South Korea	-0.3%	-1.6%	2.9%	0.0%	1.0%
Australia/New Zealand	-0.5%	-1.6%	1.8%	0.8%	0.5%
Total OECD	**-0.4%**	**-1.5%**	**1.7%**	**0.4%**	**0.2%**
Non-OECD Europe and Eurasia	-0.4%	-2.1%	2.9%	-0.2%	0.2%
Russia	-0.4%	-2.0%	3.1%	-0.4%	0.2%
Other	-0.4%	-2.2%	2.7%	0.0%	0.1%
Non-OECD Asia	-0.4%	-2.3%	4.5%	0.8%	2.5%
China	-0.4%	-2.6%	5.4%	0.3%	2.5%
India	-0.4%	-2.2%	4.5%	1.0%	2.7%
Other	-0.3%	-2.0%	3.3%	1.1%	2.1%
Middle East	-0.2%	-1.6%	2.2%	1.6%	1.9%
Africa	-0.1%	-1.7%	2.0%	1.7%	1.7%
Central and South America	-0.2%	-1.7%	2.9%	0.8%	1.9%
Brazil	-0.1%	-1.7%	4.1%	0.5%	2.8%
Other	0.0%	-1.7%	2.0%	1.0%	1.2%
Total non-OECD	**-0.2%**	**-2.2%**	**3.6%**	**0.9%**	**2.0%**
Total world	**-0.2%**	**-1.8%**	**2.5%**	**0.9%**	**1.3%**

*Note: Components will not sum exactly to total average annual growth rates; for all regions, the residual is less than .3 percent.

Figure 117. Average annual changes in Kaya decomposition components of non-OECD carbon dioxide emissions growth, 1990-2008 and 2008-2035 (percent per year)

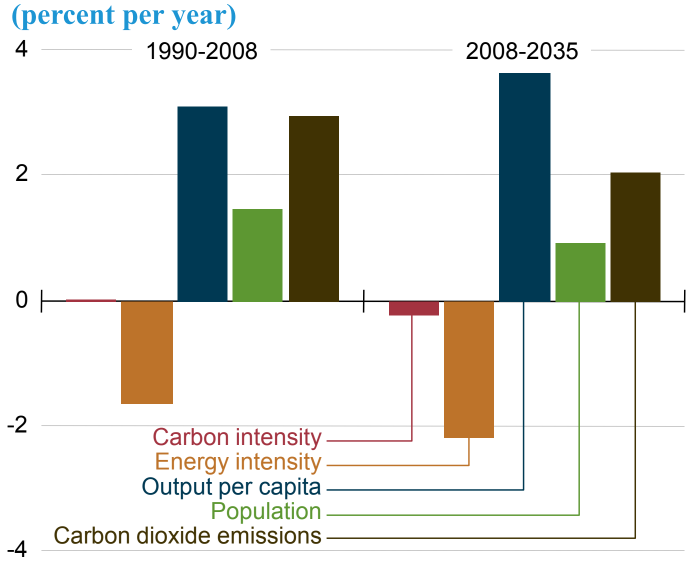
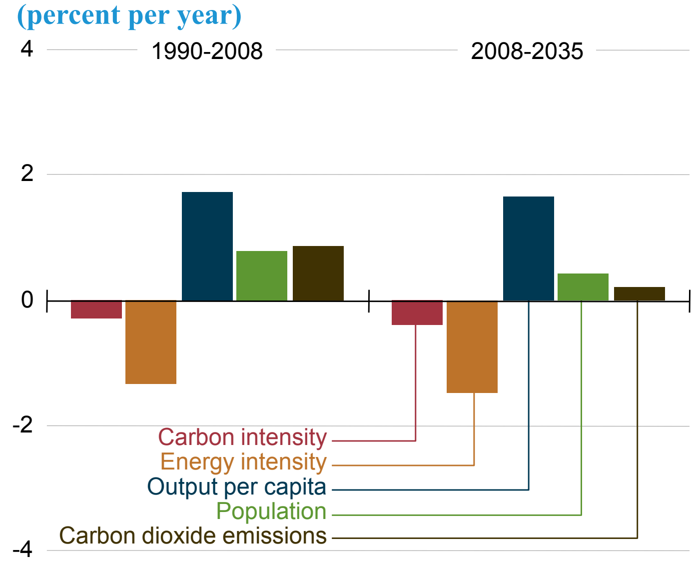


Figure 118. Average annual changes in Kaya decomposition components of OECD carbon dioxide emissions growth, 1990-2008 and 2008-2035 (percent per year)



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Highlights

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Figure 4. Natural gas production in China, Canada, and the United States, 2008 and 2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, International Natural Gas Model (2011).

Figure 5. World coal consumption by region, 1990–2035: ***History:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 6. World net electricity generation by fuel type, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

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Figure 11. World carbon dioxide emissions per capita, 1990-2035: ***History:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Chapter 1. World energy demand and economic outlook

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Figure 61. Non-OECD Asia net natural gas trade, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, International Natural Gas Model (2011).

Figure 62. Non-OECD Central and South America net natural gas trade, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, International Natural Gas Model (2011).

Figure 63. World natural gas reserves by region,1980-2011: ***1980-1993:*** "Worldwide Oil and Gas at a Glance," *International Petroleum Encyclopedia* (Tulsa, OK: PennWell Publishing, various issues). ***1994-2011:*** *Oil & Gas Journal* (various issues). Note that U.S. reserves for 2011 incorporate revisions released by EIA on December 30, 2010, after publication of the latest *Oil & Gas Journal.* See website www.eia.gov/dnav/ng/ng_enr_dry_a_EPG0_r11_bcf_a.htm.

Figure 64. World natural gas reserves by geographic region as of January 1, 2011: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 108, No. 46 (December 6, 2010), pp. 46-49. The estimates were adjusted to reflect the latest EIA natural gas reserve estimates for the United States (as of December 31, 2010). See website www.eia.gov/dnav/ng/ng_enr_dry_a_EPG0_r11_bcf_a.htm.

Table 7. World natural gas reserves by country as of January 1, 2011: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 108, No. 46 (December 6, 2010), pp. 46-49. The estimates were adjusted to reflect the latest EIA natural gas reserve estimates for the United States (as of December 31, 2010). See website www.eia.gov/dnav/ng/ng_enr_dry_a_EPG0_r11_bcf_a.htm.

Chapter 4. Coal

Figure 65. World coal consumption by region, 1980–2035: ***History:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 66. Coal share of world energy consumption by sector, 2008, 2020 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2020 and 2035:*** EIA, World Energy Projection System Plus (2011).

Figure 67. OECD coal consumption by region, 1980, 2008, 2020 and 2035: ***1980 and 2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2020 and 2035:*** EIA, World Energy Projection System Plus (2011).

Figure 68. Non-OECD coal consumption by region, 1980, 2008, 2020 and 2035: ***1980 and 2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2020 and 2035:*** EIA, World Energy Projection System Plus (2011).

Figure 69. Coal share of China's energy consumption by sector, 2008, 2020, and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2020 and 2035:*** EIA, World Energy Projection System Plus (2011).

Table 8. World coal production by region, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011) and IEO2011 National Energy Modeling System, run IEO2011.D050311A.

Figure 70. World coal imports by major importing region, 1995-2035: ***History:*** SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 18, No. 4 (London, United Kingdom, July 2010), and previous issues; International Energy Agency, *Coal Information 2010* (Paris, France, August 2010), and previous issues; and EIA, *Quarterly Coal Report*, October-December 2009, DOE/EIA-0121(2009/4Q) (Washington, DC, March 2010), and previous issues; Btu conversions from short tons are estimated by EIA's Office of Energy Analysis. ***Projections:*** EIA, IEO2011 National Energy Modeling System, run IEO2011.D050311A.

Figure 71. Coal imports to Asia by major importing region, 2008 and 2035: ***2008:*** SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 18, No. 4 (London, United Kingdom, July 2010). ***2035:*** EIA, IEO2011 National Energy Modeling System, run IEO2011.D050311A.

Table 9. World coal flows by importing and exporting regions, Reference case, 2009, 2020, and 2035*: 2009:* SSY Consultancy and Research Ltd, *SSY's Coal Trade Forecast*, Vol. 18, No. 4 (London, United Kingdom, July 2010); and EIA, *Quarterly Coal Report*, October-December 2009, DOE/EIA-0121(2009/4Q) (Washington, DC, March 2010). ***2020 and 2035:*** EIA, IEO2011 National Energy Modeling System, run IEO2011.D050311A.

Table 10. World recoverable coal reserves as of January 1, 2009: ***Reserves:*** *United States:* EIA, unpublished data from Coal Reserves Database (February 2011). *All Other Countries:* World Energy Council, Survey of Energy Resources 2010 (London, UK, November 2010). ***Production:*** EIA, International Energy Statistics Database (as of March 2011), website www.eia.gov/ies.

Chapter 5. Electricity

Figure 72. Growth in world electricity generation and total delivered energy consumption, 1990-2035: ***History:*** *Generation:* EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. *Delivered Energy Consumption:* Derived from

EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 73. OECD and non-OECD net electricity generation, 1990-2035: ***History:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 74. Non-OECD net electricity generation by region, 1990-2035: ***History:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Table 11. OECD and non-OECD net electricity generation by energy source, 2008-2035: ***History:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 75. World net electricity generation by fuel, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 76. World net electricity generation from nuclear power by region, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Table 12. Approaches to nuclear waste management in selected countries: *Spent fuel in storage, 2008:* Organization for Economic Cooperation and Development/Nuclear Energy Agency, "Nuclear Energy Data 2009" (August 13, 2009), website www.oecd-ilibrary.org/nuclear-energy/nuclear-energy-data-2009_ned-2009-en-fr (subscription site). *Expected date for operation of geologic waste disposal site: China:* International Atomic Energy Agency, "Net-Enabled Radioactive Waste Management Database," website http://newmdb.iaea.org/. *All Other Countries:* International Atomic Energy Agency, "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management," Registration No. 1729 (April 11, 2011), website www.iaea.org/Publications/Documents/Conventions/jointconv_status.pdf.

Table 13. OECD and non-OECD net renewable electricity generation by energy source, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 77. OECD Americas net electricity generation by region, 1990-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011) and *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo.

Figure 78. OECD Americas net electricity generation by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011) and *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo.

Figure 79. OECD Europe net electricity generation by fuel, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 80. OECD Asia net electricity generation by region, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 81. Non-OECD Europe and Eurasia net electricity generation by region, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 82. Non-OECD Asia net electricity generation by fuel, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 83. Middle East net electricity generation by fuel, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 84. Net electricity generation in Africa by fuel, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 85. Net electricity generation in Brazil by fuel, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 86. Other Central and South America net electricity generation by fuel, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Chapter 6. Industrial sector energy consumption

Table 14. World industrial delivered energy use by region and energy source, 2008-2035: ***2008:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies , and International Energy Agency, "Balances of OECD and Non-OECD Statistics," (2010), website www.iea.org (subscription site). ***Projections:*** EIA, World Energy Projection System Plus (2011) and *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo.

Figure 87. Annual changes in world industrial and all other end-use energy consumption from previous year, 2007-2011: ***2007 and 2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2009-2011:*** EIA, World Energy Projection System Plus (2011).

Figure 88. World delivered energy consumption in the industrial and all other end-use sectors, 2005-2035: ***2005-2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 89. OECD and Non-OECD industrial sector energy consumption, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 90. World industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Figure 91. OECD industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Figure 92. Non-OECD industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Figure 93. World industrial sector energy consumption by major energy-intensive industry shares, 2008: International Energy Agency Data Services, *World Energy Balances* (2010), website www.iea.org (subscription site).

Figure 94. OECD and Non-OECD major steel producers, 2009: World Steel Association, "World Steel in Figures 2010," (October 2010), website www.worldsteel.org.

Figure 95. U.S. industrial sector energy consumption by fuel, 2008 and 2035: *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo.

Figure 96. Canada industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Figure 97. OECD Europe industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Figure 98. Australia/New Zealand industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Figure 99. China industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Figure 100. Brazil industrial sector energy consumption by fuel, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***2035:*** EIA, World Energy Projection System Plus (2011).

Chapter 7. Transportation energy consumption

Figure 101. World liquids consumption by end-use sector, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 102. OECD and non-OECD transportation sector liquids consumption, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Table 15. Transportation energy use by region, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 103. OECD Americas transportation energy use by country, 2008 and 2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011) and *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo.

Table 16. Tax incentives for hybrid and electric vehicles in OECD Europe, 2010: European Automobile Manufacturers' Association, "Overview of Tax Incentives for Electric Vehicles in the EU" (April 20. 2010), website www.acea.be/index.php/news/news_detail/increasing_number_of_incentives_for_buying_electric_vehicles/.

Figure 104. OECD Asia transportation energy use by country, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 105. Non-OECD transportation energy use by region, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 106. Non-OECD Asia transportation energy use by country, 2008-2035: ***2008:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 107. Non-OECD Europe and Eurasia transportation energy use by country, 2008-2035: *2008:* Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 108. Transportation energy use in the Middle East and Africa, 2008-2035: *2008:* Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 109. Central and South America transportation energy use by country, 2008-2035: *2008:* Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Chapter 8. Energy-related carbon dioxide emissions

Figure 110. World energy-related carbon dioxide emissions, 1990-2035: *History:* EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Table 17. Emissions mitigation goals announced by selected countries: ***Reduction goals:*** United Nations Framework Convention on Climate Change, National Reports, Appendix I—Quantified Economy-wide Emissions Targets for 2020, website http://unfccc.int/home/items/5265.php. ***Reduction goal targets:*** Estimated based on announced targets, and EIA, estimates. ***2008 emissions:*** EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Goal year projected Reference case carbon dioxide emissions:*** EIA, World Energy Projection System Plus (2011).

Figure 111. World energy-related carbon dioxide emissions by fuel type, 1990-2035: *History:* EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 112. OECD and non-OECD energy-related carbon dioxide emissions by fuel type, 1990-2035: *1990 and 2008:* EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Figure 113. Average annual growth of energy-related carbon dioxide emissions in OECD economies, 2008–2035: EIA, World Energy Projection System Plus (2011).

Figure 114. Average annual growth of energy-related carbon dioxide emissions in non-OECD economies, 2008-2035: EIA, World Energy Projection System Plus (2011).

Figure 115. Increases in carbon dioxide emissions by fuel type for regions with highest absolute emissions growth, 2008-2035: EIA, World Energy Projection System Plus (2011).

Figure 116. Cumulative carbon dioxide emissions by region, 1991-2005, 2006-2020, and 2021-2035: *History:* Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011).

Table 18. Average annual changes in Kaya decomposition factors, 2008-2035: Calculated based on projections from EIA, World Energy Projection System Plus (2011).

Figure 117. Average annual change in Kaya decomposition components of non–OECD carbon dioxide emissions growth, 1990–2008 and 2008-2035: ***History:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011). *Population (history and projections):* IHS Global Insight, *World Overview* (Lexington, MA, various issues). *GDP (history and projections):* Derived from IHS Global Insight, *World Overview* (Lexington, MA, various issues).

Figure 118. Average annual change in Kaya decomposition components of OECD carbon dioxide emissions growth, 1990–2008 and 2008-2035: ***History:*** Derived from EIA, International Energy Statistics database (as of March 2011), website www.eia.gov/ies. ***Projections:*** EIA, World Energy Projection System Plus (2011) and *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo. ***Population (history and projections):*** *United States:* EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo. *Other Countries:* IHS Global Insight, *World Overview* (Lexington, MA, various issues). ***GDP (history and projections):*** *United States:* EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo. *Other Countries:* Derived from IHS Global Insight, *World Overview* (Lexington, MA, various issues).

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Appendix A

Reference case projections

- *World energy consumption*
- *Gross domestic product*
- *Carbon dioxide emissions*
- *World population*

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Table A1. World total primary energy consumption by region, Reference case, 2006-2035
(Quadrillion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**122.3**	**124.3**	**122.9**	**126.1**	**131.0**	**135.9**	**141.6**	**147.7**	**0.7**
United States[a]	99.8	101.7	100.1	102.0	104.9	108.0	111.0	114.2	0.5
Canada	14.0	14.3	14.3	14.6	15.7	16.4	17.6	18.8	1.0
Mexico/Chile	8.5	8.3	8.5	9.5	10.4	11.5	13.0	14.7	2.1
OECD Europe	**82.8**	**82.3**	**82.2**	**83.6**	**86.9**	**89.7**	**91.8**	**93.8**	**0.5**
OECD Asia	**39.2**	**39.4**	**39.2**	**40.7**	**42.7**	**44.2**	**45.4**	**46.7**	**0.7**
Japan	23.3	23.0	22.4	22.2	23.2	23.7	23.7	23.8	0.2
South Korea	9.4	9.8	10.0	11.1	11.6	12.4	13.1	13.9	1.2
Australia/NewZealand	6.5	6.6	6.8	7.4	7.8	8.1	8.5	8.9	1.0
Total OECD	**244.3**	**246.1**	**244.3**	**250.4**	**260.6**	**269.8**	**278.7**	**288.2**	**0.6**
Non-OECD									
Non-OECD Europe and Eurasia	**48.9**	**49.6**	**50.5**	**51.4**	**52.3**	**54.0**	**56.0**	**58.4**	**0.5**
Russia	29.1	29.7	30.6	31.1	31.3	32.3	33.7	35.5	0.6
Other	19.8	19.9	19.9	20.4	21.0	21.7	22.3	22.9	0.5
Non-OECD Asia	**121.0**	**128.6**	**137.9**	**188.1**	**215.0**	**246.4**	**274.3**	**298.8**	**2.9**
China	73.4	78.9	86.2	124.2	140.6	160.9	177.9	191.4	3.0
India	18.8	20.0	21.1	27.8	33.1	38.9	44.3	49.2	3.2
Other	28.8	29.7	30.7	36.2	41.3	46.7	52.1	58.2	2.4
Middle East	**24.0**	**24.0**	**25.6**	**31.0**	**33.9**	**37.3**	**41.3**	**45.3**	**2.1**
Africa	**17.2**	**17.8**	**18.8**	**21.5**	**23.6**	**25.9**	**28.5**	**31.4**	**1.9**
Central and South America	**25.9**	**26.5**	**27.7**	**31.0**	**34.2**	**38.0**	**42.6**	**47.8**	**2.0**
Brazil	11.5	12.1	12.7	15.5	17.3	19.9	23.2	26.9	2.8
Other	14.4	14.5	15.0	15.6	16.9	18.1	19.5	20.8	1.2
Total Non-OECD	**237.0**	**246.5**	**260.5**	**323.1**	**358.9**	**401.7**	**442.8**	**481.6**	**2.3**
Total World	**481.3**	**492.6**	**504.7**	**573.5**	**619.5**	**671.5**	**721.5**	**769.8**	**1.6**

[a]Includes the 50 States and the District of Columbia.
Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run REF2011. D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A2. World total energy consumption by region and fuel, Reference case, 2006-2035
(Quadrillion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas									
Liquids	49.6	49.9	47.7	48.6	48.9	49.4	50.5	52.1	0.3
Natural gas	28.2	29.5	29.6	31.9	33.1	34.1	36.1	38.1	0.9
Coal	24.4	24.7	24.3	21.3	22.5	24.3	25.2	26.5	0.3
Nuclear	9.4	9.6	9.5	10.1	10.7	10.7	11.0	11.1	0.6
Other	10.7	10.7	11.8	14.2	15.8	17.3	18.8	19.9	2.0
Total	**122.3**	**124.3**	**122.9**	**126.1**	**131.0**	**135.9**	**141.6**	**147.7**	**0.7**
OECD Europe									
Liquids	32.5	32.1	32.0	29.7	30.1	30.4	30.5	30.6	-0.2
Natural gas	19.7	19.6	20.1	20.4	21.0	21.6	22.7	23.9	0.7
Coal	13.2	13.5	12.5	11.5	11.2	10.8	10.5	10.4	-0.7
Nuclear	9.7	9.2	9.1	10.0	10.3	11.1	11.5	11.8	1.0
Other	7.6	8.1	8.4	12.0	14.2	15.8	16.5	17.1	2.7
Total	**82.8**	**82.3**	**82.2**	**83.6**	**86.9**	**89.7**	**91.8**	**93.8**	**0.5**
OECD Asia									
Liquids	17.5	17.3	16.8	15.9	16.6	16.9	16.9	17.0	0.1
Natural gas	6.2	6.6	6.6	6.9	7.3	7.9	8.4	8.6	1.0
Coal	9.2	9.6	9.9	9.7	9.5	9.4	9.5	9.7	-0.1
Nuclear	4.3	3.9	3.9	5.1	5.7	6.0	6.5	7.0	2.2
Other	2.0	1.9	1.9	3.1	3.6	3.9	4.1	4.3	3.1
Total	**39.2**	**39.4**	**39.2**	**40.7**	**42.7**	**44.2**	**45.4**	**46.7**	**0.7**
Total OECD									
Liquids	99.6	99.3	96.5	94.1	95.6	96.7	97.9	99.7	0.1
Natural gas	54.1	55.7	56.3	59.2	61.4	63.6	67.1	70.6	0.8
Coal	46.8	47.8	46.8	42.6	43.1	44.6	45.3	46.7	0.0
Nuclear	23.4	22.6	22.6	25.2	26.7	27.8	29.1	29.8	1.0
Other	20.4	20.7	22.1	29.3	33.6	37.1	39.4	41.4	2.4
Total	**244.3**	**246.1**	**244.3**	**250.4**	**260.6**	**269.8**	**278.7**	**288.2**	**0.6**
Non-OECD									
Non-OECD Europe and Eurasia									
Liquids	8.8	9.5	10.1	10.7	10.5	10.6	11.0	11.3	0.4
Natural gas	25.2	25.4	25.4	24.8	24.9	25.3	26.2	27.0	0.2
Coal	8.8	8.6	8.9	8.5	8.2	8.0	8.1	8.5	-0.2
Nuclear	2.9	3.0	3.0	3.7	4.8	5.8	6.1	6.5	2.9
Other	3.3	3.1	3.0	3.6	3.9	4.2	4.6	5.0	1.9
Total	**48.9**	**49.6**	**50.5**	**51.4**	**52.3**	**54.0**	**56.0**	**58.4**	**0.5**
Non-OECD Asia									
Liquids	33.4	34.0	35.0	47.0	53.5	61.7	66.6	70.2	2.6
Natural gas	9.8	10.8	11.6	17.6	21.4	25.9	29.8	32.9	3.9
Coal	66.3	71.4	77.5	99.6	106.2	119.5	132.8	144.1	2.3
Nuclear	1.1	1.2	1.2	3.7	6.5	8.9	11.0	13.3	9.2
Other	10.5	11.2	12.6	20.3	27.3	30.5	34.1	38.2	4.2
Total	**121.0**	**128.6**	**137.9**	**188.1**	**215.0**	**246.4**	**274.3**	**298.8**	**2.9**

See notes at end ot table.

(continued on page 159)

Table A2. World total energy consumption by region and fuel, Reference case, 2006-2035 (continued)
(Quadrillion Btu)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
Middle East									
Liquids	12.5	12.1	12.8	14.8	14.8	15.7	17.3	18.3	1.4
Natural gas	10.8	11.2	12.2	15.4	17.8	20.0	22.4	25.2	2.7
Coal	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
Nuclear	0.0	0.0	0.0	0.1	0.3	0.5	0.5	0.6	--
Other	0.3	0.3	0.1	0.4	0.6	0.6	0.7	0.8	6.6
Total	**24.0**	**24.0**	**25.6**	**31.0**	**33.9**	**37.3**	**41.3**	**45.3**	**2.1**
Africa									
Liquids	6.2	6.4	6.5	6.8	6.9	7.2	7.6	8.2	0.9
Natural gas	3.1	3.3	3.9	5.1	6.4	7.7	8.8	9.8	3.5
Coal	4.2	4.4	4.6	5.1	5.4	5.7	6.2	7.1	1.6
Nuclear	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	3.8
Other	3.5	3.6	3.7	4.3	4.7	5.1	5.6	6.0	1.9
Total	**17.2**	**17.8**	**18.8**	**21.5**	**23.6**	**25.9**	**28.5**	**31.4**	**1.9**
Central and South America									
Liquids	11.2	11.5	12.1	13.8	14.4	15.1	16.2	17.4	1.4
Natural gas	4.5	4.5	4.8	5.2	6.1	6.9	7.9	9.3	2.5
Coal	0.7	0.8	0.8	1.1	1.2	1.4	1.8	2.3	4.0
Nuclear	0.2	0.2	0.2	0.3	0.4	0.5	0.5	0.7	4.1
Other	9.2	9.6	9.8	10.7	12.1	14.1	16.3	18.1	2.3
Total	**25.9**	**26.5**	**27.7**	**31.0**	**34.2**	**38.0**	**42.6**	**47.8**	**2.0**
Total Non-OECD									
Liquids	72.1	73.4	76.4	93.1	100.1	110.3	118.7	125.5	1.9
Natural gas	53.4	55.2	58.0	68.1	76.6	85.9	95.2	104.1	2.2
Coal	80.4	85.6	92.2	114.7	121.4	135.1	149.4	162.5	2.1
Nuclear	4.4	4.5	4.6	7.9	12.2	15.8	18.3	21.4	5.9
Other	26.8	27.8	29.2	39.3	48.6	54.6	61.2	68.1	3.2
Total	**237.0**	**246.5**	**260.5**	**323.1**	**358.9**	**401.7**	**442.8**	**481.6**	**2.3**
Total World									
Liquids	171.7	172.7	173.0	187.2	195.8	207.0	216.6	225.2	1.0
Natural gas	107.5	110.9	114.3	127.3	138.0	149.4	162.3	174.7	1.6
Coal	127.2	133.3	139.0	157.3	164.6	179.7	194.7	209.1	1.5
Nuclear	27.8	27.1	27.2	33.2	38.9	43.7	47.4	51.2	2.4
Other	47.1	48.5	51.3	68.5	82.2	91.7	100.6	109.5	2.9
Total	**481.3**	**492.6**	**504.7**	**573.5**	**619.5**	**671.5**	**721.5**	**769.8**	**1.6**

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run REF2011. D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A3. World gross domestic product (GDP) by region expressed in purchasing power parity, Reference case, 2006-2035
(Billion 2005 dollars)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**15,755**	**16,090**	**16,125**	**18,759**	**21,457**	**24,759**	**28,305**	**32,246**	**2.6**
United States[a]	12,976	13,229	13,229	15,336	17,421	20,020	22,731	25,692	2.5
Canada	1,200	1,226	1,233	1,408	1,572	1,741	1,942	2,167	2.1
Mexico/Chile	1,579	1,634	1,664	2,015	2,463	2,998	3,632	4,387	3.7
OECD Europe	**14,469**	**14,924**	**15,007**	**16,378**	**18,241**	**20,150**	**22,126**	**24,222**	**1.8**
OECD Asia	**5,706**	**5,883**	**5,873**	**6,565**	**7,124**	**7,596**	**8,086**	**8,584**	**1.4**
Japan	3,952	4,043	3,995	4,235	4,405	4,483	4,558	4,624	0.5
South Korea	938	986	1,009	1,274	1,506	1,737	1,969	2,196	2.9
Australia/NewZealand	816	853	869	1,055	1,213	1,375	1,559	1,764	2.7
Total OECD	**35,929**	**36,897**	**37,005**	**41,701**	**46,822**	**52,506**	**58,517**	**65,052**	**2.1**
Non-OECD									
Non-OECD Europe and Eurasia	**3,171**	**3,431**	**3,612**	**4,191**	**4,847**	**5,557**	**6,418**	**7,349**	**2.7**
Russia	1,835	1,984	2,094	2,377	2,681	3,055	3,589	4,197	2.6
Other	1,336	1,447	1,518	1,814	2,166	2,502	2,829	3,152	2.7
Non-OECD Asia	**13,349**	**14,779**	**15,783**	**25,488**	**34,084**	**43,465**	**53,455**	**63,853**	**5.3**
China	6,130	7,000	7,672	13,358	18,206	23,550	28,953	34,366	5.7
India	2,759	3,025	3,180	5,207	7,147	9,121	11,255	13,433	5.5
Other	4,460	4,753	4,931	6,924	8,730	10,794	13,247	16,054	4.5
Middle East	**2,183**	**2,306**	**2,415**	**3,229**	**3,924**	**4,682**	**5,569**	**6,577**	**3.8**
Africa	**2,587**	**2,743**	**2,891**	**3,906**	**4,744**	**5,646**	**6,631**	**7,776**	**3.7**
Central and South America	**3,633**	**3,872**	**4,073**	**5,317**	**6,454**	**7,757**	**9,272**	**11,041**	**3.8**
Brazil	1,594	1,692	1,778	2,452	3,079	3,840	4,784	5,951	4.6
Other	2,039	2,181	2,295	2,865	3,375	3,916	4,488	5,091	3.0
Total Non-OECD	**24,924**	**27,131**	**28,774**	**42,131**	**54,052**	**67,107**	**81,345**	**96,596**	**4.6**
Total World	**60,853**	**64,028**	**65,779**	**83,832**	**100,874**	**119,612**	**139,862**	**161,648**	**3.4**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for non-OECD Europe and Eurasia (excluding Russia). China, India, Africa, and Central and South America (excluding Brazil) were adjusted, based on the analyst's judgment.
Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA: various issues). **Projections:** IHS Global Insight, *World Overview,* Third Quarter 2010 (Lexington, MA: November 2010); and U.S. Energy Information Administration (EIA), *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo.

Table A4. World gross domestic product (GDP) by region expressed in market exchange rates, Reference case, 2006-2035
(Billion 2005 dollars)

	History			Projections					Average annual percent change, 2008-2035
Region	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**15,157**	**15,471**	**15,496**	**17,974**	**20,587**	**23,596**	**26,940**	**30,646**	**2.6**
United States[a]	12,976	13,229	13,229	15,313	17,479	19,982	22,726	25,731	2.5
Canada	1,166	1,192	1,198	1,368	1,528	1,692	1,887	2,106	2.1
Mexico/Chile	1,015	1,050	1,069	1,293	1,580	1,922	2,328	2,809	3.6
OECD Europe	**15,207**	**15,664**	**15,728**	**17,028**	**18,836**	**20,685**	**22,604**	**24,637**	**1.7**
OECD Asia	**6,408**	**6,601**	**6,583**	**7,315**	**7,903**	**8,387**	**8,890**	**9,401**	**1.3**
Japan	4,650	4,758	4,701	4,984	5,184	5,276	5,364	5,441	0.5
South Korea	888	934	955	1,206	1,426	1,645	1,864	2,080	2.9
Australia/NewZealand	869	909	926	1,125	1,293	1,465	1,661	1,880	2.7
Total OECD	**36,772**	**37,736**	**37,806**	**42,317**	**47,326**	**52,667**	**58,434**	**64,684**	**2.0**
Non-OECD									
Non-OECD Europe and Eurasia	**1,419**	**1,533**	**1,613**	**1,867**	**2,157**	**2,473**	**2,854**	**3,268**	**2.7**
Russia	824	890	940	1,067	1,204	1,371	1,611	1,884	2.6
Other	595	642	673	801	954	1,101	1,243	1,384	2.7
Non-OECD Asia	**5,280**	**5,846**	**6,240**	**10,052**	**13,394**	**17,033**	**20,883**	**24,869**	**5.3**
China	2,544	2,905	3,184	5,543	7,555	9,772	12,015	14,261	5.7
India	920	1,008	1,060	1,736	2,382	3,040	3,752	4,478	5.5
Other	1,817	1,933	1,997	2,774	3,457	4,220	5,117	6,130	4.2
Middle East	**1,166**	**1,231**	**1,302**	**1,748**	**2,127**	**2,544**	**3,031**	**3,584**	**3.8**
Africa	**1,054**	**1,118**	**1,175**	**1,557**	**1,880**	**2,235**	**2,626**	**3,086**	**3.6**
Central and South America	**1,947**	**2,070**	**2,172**	**2,838**	**3,464**	**4,185**	**5,031**	**6,029**	**3.9**
Brazil	917	972	1,022	1,410	1,770	2,208	2,750	3,421	4.6
Other	1,030	1,097	1,149	1,429	1,694	1,977	2,281	2,608	3.1
Total Non-OECD	**10,865**	**11,798**	**12,502**	**18,062**	**23,022**	**28,469**	**34,426**	**40,836**	**4.5**
Total World	**47,637**	**49,534**	**50,308**	**60,380**	**70,348**	**81,136**	**92,860**	**105,520**	**2.8**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for non-OECD Europe and Eurasia (excluding Russia). China, India, Africa, and Central and South America (excluding Brazil) were adjusted, based on the analyst's judgment.
Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA: various issues). **Projections:** IHS Global Insight, *World Overview,* Third Quarter 2010 (Lexington, MA: November 2010); and U.S. Energy Information Administration (EIA), *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo.

Table A5. World liquids consumption by region, Reference case, 2006-2035
(Million barrels per day)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**25.3**	**25.4**	**24.2**	**25.2**	**25.5**	**25.8**	**26.4**	**27.2**	**0.4**
United States[a]	20.7	20.6	19.5	20.4	20.7	21.0	21.4	21.9	0.4
Canada	2.3	2.3	2.2	2.3	2.3	2.3	2.3	2.4	0.2
Mexico/Chile	2.4	2.5	2.4	2.5	2.6	2.6	2.7	2.9	0.7
OECD Europe	**15.7**	**15.6**	**15.6**	**14.4**	**14.6**	**14.8**	**14.8**	**14.9**	**-0.2**
OECD Asia	**8.6**	**8.5**	**8.3**	**7.8**	**8.2**	**8.3**	**8.3**	**8.4**	**0.1**
Japan	5.3	5.2	5.0	4.3	4.6	4.7	4.6	4.5	-0.4
South Korea	2.2	2.2	2.1	2.3	2.4	2.4	2.5	2.6	0.7
Australia/NewZealand	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.3	0.5
Total OECD	**49.6**	**49.6**	**48.0**	**47.5**	**48.3**	**48.9**	**49.5**	**50.4**	**0.2**
Non-OECD									
Non-OECD Europe and Eurasia	**4.9**	**4.6**	**5.0**	**5.3**	**5.2**	**5.2**	**5.4**	**5.6**	**0.4**
Russia	2.8	2.6	2.8	2.9	2.8	2.7	2.8	2.9	0.1
Other	2.1	2.1	2.1	2.3	2.4	2.5	2.6	2.6	0.8
Non-OECD Asia	**16.2**	**16.6**	**17.1**	**23.0**	**26.2**	**30.2**	**32.6**	**34.4**	**2.6**
China	7.3	7.5	7.8	12.1	13.6	15.6	16.4	16.9	2.9
India	2.7	2.8	3.0	3.8	4.6	5.7	6.8	7.5	3.5
Other	6.2	6.3	6.3	7.1	7.9	8.8	9.4	9.9	1.7
Middle East	**6.0**	**6.3**	**6.6**	**7.7**	**7.7**	**8.1**	**9.0**	**9.5**	**1.4**
Africa	**3.0**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.7**	**4.0**	**0.9**
Central and South America	**5.5**	**5.6**	**5.8**	**6.6**	**6.9**	**7.2**	**7.8**	**8.3**	**1.4**
Brazil	2.3	2.4	2.5	2.9	3.1	3.3	3.6	3.9	1.7
Other	3.2	3.3	3.3	3.7	3.9	4.0	4.2	4.4	1.1
Total Non-OECD	**35.7**	**36.3**	**37.7**	**45.9**	**49.3**	**54.3**	**58.4**	**61.8**	**1.9**
Total World	**85.3**	**85.9**	**85.7**	**93.3**	**97.6**	**103.2**	**108.0**	**112.2**	**1.0**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A6. World natural gas consumption by region, Reference case, 2006-2035
(Trillion cubic feet)

	History			Projections					Average annual percent change,
Region	2006	2007	2008	2015	2020	2025	2030	2035	2008-2035
OECD									
OECD Americas	**27.4**	**28.7**	**28.8**	**31.1**	**32.2**	**33.2**	**35.2**	**37.1**	**0.9**
United States[a]	21.7	23.1	23.2	25.1	25.3	25.1	25.9	26.5	0.5
Canada	3.3	3.4	3.4	3.5	3.7	4.2	4.6	5.0	1.5
Mexico/Chile	2.5	2.2	2.2	2.5	3.2	4.0	4.7	5.5	3.4
OECD Europe	**19.2**	**19.0**	**19.5**	**19.8**	**20.4**	**20.9**	**22.0**	**23.2**	**0.7**
OECD Asia	**5.8**	**6.2**	**6.2**	**6.5**	**6.8**	**7.4**	**7.8**	**8.0**	**1.0**
Japan	3.4	3.7	3.7	3.7	3.7	3.9	4.0	4.0	0.3
South Korea	1.1	1.2	1.3	1.5	1.6	1.8	1.9	1.9	1.5
Australia/NewZealand	1.2	1.2	1.3	1.3	1.5	1.8	2.0	2.2	2.1
Total OECD	**52.4**	**53.9**	**54.5**	**57.4**	**59.5**	**61.6**	**65.0**	**68.4**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia	**24.8**	**25.0**	**25.0**	**24.4**	**24.4**	**24.9**	**25.8**	**26.6**	**0.2**
Russia	16.6	16.7	16.8	16.2	16.1	16.2	16.8	17.4	0.1
Other	8.2	8.3	8.2	8.1	8.4	8.7	9.0	9.1	0.4
Non-OECD Asia	**9.5**	**10.5**	**11.3**	**17.1**	**20.8**	**25.2**	**28.9**	**31.9**	**3.9**
China	2.0	2.5	2.7	5.3	6.8	8.6	10.2	11.5	5.5
India	1.4	1.5	1.5	3.3	3.9	4.5	4.9	5.1	4.6
Other	6.2	6.6	7.1	8.5	10.0	12.0	13.9	15.3	2.9
Middle East	**10.3**	**10.7**	**11.7**	**14.7**	**17.0**	**19.1**	**21.3**	**24.0**	**2.7**
Africa	**2.9**	**3.1**	**3.6**	**4.7**	**5.9**	**7.1**	**8.3**	**9.1**	**3.5**
Central and South America	**4.3**	**4.2**	**4.6**	**5.0**	**5.7**	**6.5**	**7.5**	**8.8**	**2.5**
Brazil	0.7	0.7	0.8	1.1	1.5	1.8	2.3	3.2	5.1
Other	3.6	3.5	3.7	3.8	4.2	4.7	5.2	5.7	1.6
Total Non-OECD	**51.8**	**53.5**	**56.2**	**65.8**	**73.9**	**82.8**	**91.7**	**100.4**	**2.2**
Total World	**104.1**	**107.4**	**110.7**	**123.1**	**133.4**	**144.4**	**156.8**	**168.7**	**1.6**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A7. World coal consumption by region, Reference case, 2006-2035
(Quadrillion Btu)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**24.4**	**24.7**	**24.3**	**21.3**	**22.5**	**24.3**	**25.2**	**26.5**	**0.3**
United States[a]	22.5	22.7	22.4	19.7	20.8	22.6	23.4	24.3	0.3
Canada	1.4	1.4	1.4	1.0	1.0	1.0	1.0	1.1	-0.7
Mexico/Chile	0.6	0.6	0.5	0.6	0.6	0.7	0.8	1.1	2.6
OECD Europe	**13.2**	**13.5**	**12.5**	**11.5**	**11.2**	**10.8**	**10.5**	**10.4**	**-0.7**
OECD Asia	**9.2**	**9.6**	**9.9**	**9.7**	**9.5**	**9.4**	**9.5**	**9.7**	**-0.1**
Japan	4.6	4.9	4.8	4.6	4.4	4.2	4.0	3.8	-0.8
South Korea	2.1	2.3	2.6	2.6	2.6	2.8	3.1	3.4	1.0
Australia/NewZealand	2.4	2.5	2.6	2.5	2.5	2.5	2.5	2.5	-0.1
Total OECD	**46.8**	**47.8**	**46.8**	**42.6**	**43.1**	**44.6**	**45.3**	**46.7**	**0.0**
Non-OECD									
Non-OECD Europe and Eurasia	**8.8**	**8.6**	**8.9**	**8.5**	**8.2**	**8.0**	**8.1**	**8.5**	**-0.2**
Russia	4.4	4.2	4.5	4.5	4.3	4.3	4.5	4.9	0.3
Other	4.4	4.5	4.5	4.0	3.9	3.8	3.7	3.7	-0.7
Non-OECD Asia	**66.3**	**71.4**	**77.5**	**99.6**	**106.2**	**119.5**	**132.8**	**144.1**	**2.3**
China	51.2	55.2	60.4	80.7	85.5	96.4	106.5	113.6	2.4
India	9.2	10.1	10.9	12.4	13.6	15.3	17.3	19.5	2.2
Other	5.8	6.1	6.3	6.5	7.0	7.7	9.1	11.0	2.1
Middle East	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.3**
Africa	**4.2**	**4.4**	**4.6**	**5.1**	**5.4**	**5.7**	**6.2**	**7.1**	**1.6**
Central and South America	**0.7**	**0.8**	**0.8**	**1.1**	**1.2**	**1.4**	**1.8**	**2.3**	**4.0**
Brazil	0.4	0.5	0.5	0.8	0.9	1.1	1.4	1.9	5.2
Other	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	1.1
Total Non-OECD	**80.4**	**85.6**	**92.2**	**114.7**	**121.4**	**135.1**	**149.4**	**162.5**	**2.1**
Total World	**127.2**	**133.3**	**139.0**	**157.3**	**164.6**	**179.7**	**194.7**	**209.1**	**1.5**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A8. World nuclear energy consumption by region, Reference case, 2006-2035
(Billion kilowatthours)

	History			Projections					Average annual percent change,
Region	2006	2007	2008	2015	2020	2025	2030	2035	2008-2035
OECD									
OECD Americas	**891**	**905**	**905**	**963**	**1,018**	**1,021**	**1,047**	**1,054**	**0.6**
United States[a]	787	806	806	839	877	877	877	874	0.3
Canada	93	89	89	113	131	134	152	162	2.2
Mexico/Chile	10	10	9	10	10	10	18	18	2.4
OECD Europe	**935**	**884**	**882**	**965**	**998**	**1,067**	**1,111**	**1,136**	**0.9**
OECD Asia	**430**	**386**	**389**	**502**	**560**	**591**	**641**	**683**	**2.1**
Japan	288	251	245	319	342	358	388	417	2.0
South Korea	141	136	143	183	218	233	253	266	2.3
Australia/NewZealand	0	0	0	0	0	0	0	0	0.0
Total OECD	**2,255**	**2,176**	**2,175**	**2,430**	**2,576**	**2,680**	**2,799**	**2,873**	**1.0**
Non-OECD									
Non-OECD Europe and Eurasia	**263**	**272**	**276**	**342**	**449**	**538**	**567**	**614**	**3.0**
Russia	144	152	154	197	275	342	366	388	3.5
Other	119	120	121	145	174	196	201	225	2.3
Non-OECD Asia	**111**	**119**	**119**	**360**	**631**	**855**	**1,063**	**1,281**	**9.2**
China	55	63	65	223	419	585	749	916	10.3
India	16	16	13	66	119	157	187	211	10.8
Other	40	41	41	71	92	113	127	153	5.0
Middle East	**0**	**0**	**0**	**6**	**24**	**51**	**52**	**54**	**0.0**
Africa	**10**	**12**	**11**	**15**	**15**	**21**	**21**	**31**	**3.8**
Central and South America	**21**	**19**	**21**	**25**	**35**	**44**	**44**	**63**	**4.2**
Brazil	14	12	14	18	22	31	31	41	4.1
Other	7	7	7	7	13	13	13	22	4.4
Total Non-OECD	**405**	**422**	**427**	**748**	**1,154**	**1,508**	**1,747**	**2,043**	**6.0**
Total World	**2,660**	**2,598**	**2,602**	**3,178**	**3,731**	**4,188**	**4,546**	**4,916**	**2.4**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A9. World consumption of hydroelectricity and other renewable energy by region, Reference case, 2006-2035
(Quadrillion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**10.7**	**10.7**	**11.8**	**14.2**	**15.8**	**17.3**	**18.8**	**19.9**	**2.0**
United States[a]	6.4	6.2	7.0	8.6	9.5	10.6	11.3	11.8	1.9
Canada	3.7	3.9	4.0	4.3	4.9	5.2	5.7	6.0	1.5
Mexico/Chile	0.6	0.6	0.7	1.3	1.4	1.5	1.8	2.1	4.0
OECD Europe	**7.6**	**8.1**	**8.4**	**12.0**	**14.2**	**15.8**	**16.5**	**17.1**	**2.7**
OECD Asia	**2.0**	**1.9**	**1.9**	**3.1**	**3.6**	**3.9**	**4.1**	**4.3**	**3.1**
Japan	1.2	1.1	1.1	1.6	2.0	2.2	2.3	2.4	2.9
South Korea	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	3.0
Australia/NewZealand	0.7	0.7	0.7	1.2	1.4	1.4	1.5	1.6	3.3
Total OECD	**20.4**	**20.7**	**22.1**	**29.3**	**33.6**	**37.1**	**39.4**	**41.4**	**2.4**
Non-OECD									
Non-OECD Europe and Eurasia	**3.3**	**3.1**	**3.0**	**3.6**	**3.9**	**4.2**	**4.6**	**5.0**	**1.9**
Russia	1.9	1.9	1.7	2.1	2.2	2.5	2.8	3.1	2.1
Other	1.4	1.2	1.3	1.5	1.7	1.7	1.8	1.9	1.6
Non-OECD Asia	**10.5**	**11.2**	**12.6**	**20.3**	**27.3**	**30.5**	**34.1**	**38.2**	**4.2**
China	4.7	5.3	6.4	11.2	15.8	17.8	19.7	21.8	4.6
India	2.4	2.5	2.4	3.5	4.7	5.3	6.0	6.7	3.9
Other	3.5	3.5	3.7	5.6	6.8	7.4	8.4	9.7	3.6
Middle East	**0.3**	**0.3**	**0.1**	**0.4**	**0.6**	**0.6**	**0.7**	**0.8**	**6.6**
Africa	**3.5**	**3.6**	**3.7**	**4.3**	**4.7**	**5.1**	**5.6**	**6.0**	**1.9**
Central and South America	**9.2**	**9.6**	**9.8**	**10.7**	**12.1**	**14.1**	**16.3**	**18.1**	**2.3**
Brazil	5.5	5.9	6.0	7.2	8.2	9.7	11.5	13.1	2.9
Other	3.7	3.7	3.8	3.5	3.9	4.4	4.7	5.0	1.0
Total Non-OECD	**26.8**	**27.8**	**29.2**	**39.3**	**48.6**	**54.6**	**61.2**	**68.1**	**3.2**
Total World	**47.1**	**48.5**	**51.3**	**68.5**	**82.2**	**91.7**	**100.6**	**109.5**	**2.9**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A10. World carbon dioxide emissions by region, Reference case, 2006-2035
(Million metric tons carbon dioxide)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**7,014**	**7,123**	**6,926**	**6,773**	**6,924**	**7,169**	**7,431**	**7,772**	**0.4**
United States[a]	5,918	6,022	5,838	5,680	5,777	5,938	6,108	6,311	0.3
Canada	594	607	595	569	582	608	635	679	0.5
Mexico/Chile	502	494	493	524	565	623	688	782	1.7
OECD Europe	**4,428**	**4,413**	**4,345**	**4,115**	**4,147**	**4,156**	**4,198**	**4,257**	**-0.1**
OECD Asia	**2,165**	**2,206**	**2,201**	**2,143**	**2,181**	**2,224**	**2,253**	**2,294**	**0.2**
Japan	1,240	1,254	1,215	1,125	1,142	1,136	1,110	1,087	-0.4
South Korea	484	503	522	553	562	597	634	678	1.0
Australia/NewZealand	440	449	464	466	477	492	509	528	0.5
Total OECD	**13,606**	**13,742**	**13,472**	**13,031**	**13,252**	**13,549**	**13,882**	**14,323**	**0.2**
Non-OECD									
Non-OECD Europe and Eurasia	**2,823**	**2,790**	**2,832**	**2,803**	**2,767**	**2,782**	**2,863**	**2,964**	**0.2**
Russia	1,668	1,618	1,663	1,648	1,607	1,603	1,659	1,747	0.2
Other	1,155	1,172	1,169	1,154	1,159	1,179	1,204	1,217	0.2
Non-OECD Asia	**8,835**	**9,416**	**10,100**	**13,238**	**14,475**	**16,475**	**18,238**	**19,688**	**2.5**
China	5,817	6,257	6,801	9,386	10,128	11,492	12,626	13,441	2.6
India	1,281	1,367	1,462	1,802	2,056	2,398	2,728	3,036	2.7
Other	1,737	1,793	1,838	2,050	2,291	2,585	2,884	3,211	2.1
Middle East	**1,446**	**1,479**	**1,581**	**1,889**	**2,019**	**2,199**	**2,435**	**2,659**	**1.9**
Africa	**984**	**1,016**	**1,078**	**1,209**	**1,311**	**1,430**	**1,568**	**1,735**	**1.8**
Central and South America	**1,064**	**1,085**	**1,128**	**1,287**	**1,386**	**1,497**	**1,654**	**1,852**	**1.9**
Brazil	380	397	423	528	579	644	739	874	2.7
Other	684	688	705	759	807	853	916	978	1.2
Total Non-OECD	**15,152**	**15,786**	**16,718**	**20,426**	**21,958**	**24,383**	**26,758**	**28,897**	**2.1**
Total World	**28,758**	**29,529**	**30,190**	**33,457**	**35,210**	**37,932**	**40,640**	**43,220**	**1.3**

[a]Includes the 50 States and the District of Columbia.

Notes: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A11. World carbon dioxide emissions from liquids use by region, Reference case, 2006-2035
(Million metric tons carbon dioxide)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**3,198**	**3,219**	**3,050**	**3,053**	**3,044**	**3,059**	**3,128**	**3,245**	**0.2**
United States[a]	2,603	2,603	2,444	2,434	2,423	2,430	2,479	2,561	0.2
Canada	281	292	283	286	285	285	290	299	0.2
Mexico/Chile	314	325	323	333	336	344	359	385	0.7
OECD Europe	**2,135**	**2,090**	**2,076**	**1,924**	**1,954**	**1,969**	**1,980**	**1,984**	**-0.2**
OECD Asia	**993**	**966**	**934**	**880**	**921**	**936**	**935**	**941**	**0.0**
Japan	622	599	574	498	534	538	524	516	-0.4
South Korea	221	216	206	223	227	235	243	251	0.7
Australia/NewZealand	149	152	153	159	160	163	169	174	0.5
Total OECD	**6,326**	**6,276**	**6,059**	**5,857**	**5,918**	**5,965**	**6,043**	**6,169**	**0.1**
Non-OECD									
Non-OECD Europe and Eurasia	**670**	**624**	**637**	**678**	**666**	**674**	**697**	**720**	**0.5**
Russia	368	328	340	352	335	331	340	351	0.1
Other	302	296	297	325	331	343	357	368	0.8
Non-OECD Asia	**2,147**	**2,185**	**2,242**	**2,999**	**3,415**	**3,931**	**4,242**	**4,473**	**2.6**
China	928	959	995	1,533	1,736	1,982	2,087	2,154	2.9
India	349	354	372	478	580	725	857	948	3.5
Other	870	872	874	988	1,099	1,224	1,298	1,370	1.7
Middle East	**839**	**845**	**894**	**1,034**	**1,035**	**1,098**	**1,210**	**1,283**	**1.4**
Africa	**428**	**437**	**447**	**469**	**473**	**496**	**524**	**563**	**0.9**
Central and South America	**757**	**777**	**799**	**910**	**953**	**997**	**1,069**	**1,146**	**1.3**
Brazil	301	315	332	394	408	435	478	525	1.7
Other	456	462	467	516	544	562	590	621	1.1
Total Non-OECD	**4,841**	**4,868**	**5,018**	**6,089**	**6,541**	**7,196**	**7,741**	**8,185**	**1.8**
Total World	**11,167**	**11,144**	**11,077**	**11,946**	**12,460**	**13,161**	**13,784**	**14,354**	**1.0**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A12. World carbon dioxide emissions from natural gas use by region, Reference case, 2006-2035
(Million metric tons carbon dioxide)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**1,473**	**1,540**	**1,549**	**1,678**	**1,740**	**1,794**	**1,902**	**2,008**	**1.0**
United States[a]	1,157	1,235	1,243	1,352	1,365	1,351	1,398	1,434	0.5
Canada	180	187	186	191	204	228	249	275	1.5
Mexico/Chile	136	118	120	135	171	215	256	299	3.4
OECD Europe	**1,047**	**1,045**	**1,070**	**1,088**	**1,123**	**1,150**	**1,210**	**1,275**	**0.7**
OECD Asia	**326**	**352**	**351**	**367**	**388**	**420**	**443**	**456**	**1.0**
Japan	193	210	205	204	208	216	221	221	0.3
South Korea	68	74	75	88	94	105	110	112	1.5
Australia/NewZealand	66	68	71	74	86	99	112	123	2.1
Total OECD	**2,847**	**2,937**	**2,970**	**3,132**	**3,250**	**3,364**	**3,555**	**3,739**	**0.9**
Non-OECD									
Non-OECD Europe and Eurasia	**1,332**	**1,353**	**1,354**	**1,319**	**1,324**	**1,349**	**1,397**	**1,438**	**0.2**
Russia	889	897	899	867	860	864	895	932	0.1
Other	443	456	454	452	464	485	502	506	0.4
Non-OECD Asia	**518**	**573**	**617**	**934**	**1,138**	**1,377**	**1,584**	**1,746**	**3.9**
China	111	138	151	297	378	477	566	641	5.5
India	78	83	86	184	223	257	276	288	4.6
Other	330	352	380	453	537	643	742	818	2.9
Middle East	**572**	**595**	**650**	**817**	**946**	**1,063**	**1,186**	**1,335**	**2.7**
Africa	**166**	**176**	**206**	**268**	**338**	**406**	**469**	**517**	**3.5**
Central and South America	**241**	**238**	**256**	**278**	**321**	**366**	**419**	**494**	**2.5**
Brazil	38	39	46	62	85	102	126	175	5.1
Other	203	199	210	217	236	264	293	320	1.6
Total Non-OECD	**2,829**	**2,934**	**3,083**	**3,616**	**4,068**	**4,561**	**5,055**	**5,531**	**2.2**
Total World	**5,675**	**5,870**	**6,052**	**6,748**	**7,318**	**7,925**	**8,611**	**9,270**	**1.6**

[a]Includes the 50 States and the District of Columbia.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A13. World carbon dioxide emissions from coal use by region, Reference case, 2006-2035
(Million metric tons carbon dioxide)

	History			Projections					Average annual percent change,
Region	2006	2007	2008	2015	2020	2025	2030	2035	2008-2035
OECD									
OECD Americas	**2,331**	**2,352**	**2,315**	**2,030**	**2,128**	**2,304**	**2,389**	**2,507**	**0.3**
United States[a]	2,147	2,172	2,139	1,882	1,977	2,145	2,219	2,304	0.3
Canada	132	128	126	92	93	96	96	105	-0.7
Mexico/Chile	53	51	50	55	58	63	74	98	2.6
OECD Europe	**1,245**	**1,279**	**1,200**	**1,103**	**1,071**	**1,036**	**1,008**	**999**	**-0.7**
OECD Asia	**846**	**888**	**917**	**896**	**872**	**868**	**875**	**897**	**-0.1**
Japan	425	446	436	422	400	382	364	350	-0.8
South Korea	195	213	240	242	241	257	281	316	1.0
Australia/NewZealand	226	229	240	232	230	229	229	231	-0.1
Total OECD	**4,422**	**4,518**	**4,431**	**4,029**	**4,071**	**4,208**	**4,272**	**4,403**	**0.0**
Non-OECD									
Non-OECD Europe and Eurasia	**821**	**813**	**841**	**806**	**777**	**759**	**769**	**806**	**-0.2**
Russia	412	393	424	429	413	408	424	464	0.3
Other	410	420	417	378	364	351	344	342	-0.7
Non-OECD Asia	**6,170**	**6,659**	**7,241**	**9,306**	**9,922**	**11,167**	**12,412**	**13,468**	**2.3**
China	4,779	5,160	5,654	7,556	8,013	9,033	9,973	10,646	2.4
India	854	931	1,003	1,140	1,254	1,416	1,595	1,800	2.2
Other	537	569	583	609	655	718	843	1,023	2.1
Middle East	**36**	**39**	**37**	**38**	**38**	**38**	**39**	**41**	**0.3**
Africa	**390**	**403**	**426**	**472**	**500**	**528**	**575**	**655**	**1.6**
Central and South America	**65**	**70**	**72**	**99**	**112**	**134**	**167**	**211**	**4.1**
Brazil	41	43	44	72	86	107	134	174	5.2
Other	25	27	28	27	26	27	33	37	1.1
Total Non-OECD	**7,482**	**7,985**	**8,618**	**10,721**	**11,349**	**12,626**	**13,961**	**15,181**	**2.1**
Total World	**11,904**	**12,503**	**13,049**	**14,750**	**15,420**	**16,834**	**18,234**	**19,584**	**1.5**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table A14. World population by region, Reference case, 2006-2035
(Millions)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**455**	**459**	**464**	**495**	**518**	**540**	**562**	**582**	**0.9**
United States[a]	299	302	305	326	342	358	374	390	0.9
Canada	33	33	33	36	38	40	42	43	1.0
Mexico/Chile	123	124	125	133	138	142	146	149	0.6
OECD Europe	**538**	**541**	**544**	**560**	**567**	**573**	**577**	**580**	**0.2**
OECD Asia	**200**	**201**	**201**	**203**	**202**	**201**	**199**	**196**	**-0.1**
Japan	128	128	128	126	124	122	119	116	-0.4
South Korea	48	48	48	49	49	49	49	48	0.0
Australia/NewZealand	25	25	25	27	28	30	31	32	0.8
Total OECD	**1,193**	**1,201**	**1,209**	**1,257**	**1,287**	**1,314**	**1,338**	**1,358**	**0.4**
Non-OECD									
Non-OECD Europe and Eurasia	**341**	**340**	**340**	**338**	**336**	**333**	**329**	**324**	**-0.2**
Russia	143	142	141	138	135	132	129	125	-0.4
Other	198	198	199	200	200	201	200	198	0.0
Non-OECD Asia	**3,487**	**3,526**	**3,565**	**3,840**	**4,021**	**4,175**	**4,300**	**4,400**	**0.8**
China	1,314	1,321	1,328	1,385	1,419	1,441	1,451	1,450	0.3
India	1,148	1,165	1,181	1,294	1,367	1,431	1,485	1,528	1.0
Other	1,025	1,040	1,055	1,162	1,234	1,302	1,365	1,422	1.1
Middle East	**196**	**200**	**205**	**234**	**255**	**275**	**293**	**311**	**1.6**
Africa	**921**	**941**	**961**	**1,101**	**1,202**	**1,302**	**1,401**	**1,501**	**1.7**
Central and South America	**441**	**446**	**451**	**486**	**509**	**528**	**545**	**559**	**0.8**
Brazil	188	190	192	203	209	214	217	219	0.5
Other	253	256	259	283	299	315	328	340	1.0
Total Non-OECD	**5,385**	**5,454**	**5,522**	**5,999**	**6,321**	**6,613**	**6,869**	**7,095**	**0.9**
Total World	**6,579**	**6,655**	**6,731**	**7,257**	**7,609**	**7,927**	**8,207**	**8,453**	**0.9**

[a]Includes the 50 States and the District of Columbia.
Sources: **United States:** U.S. Energy Information Administration (EIA), *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo. **Other Countries:** IHS Global Insight, *World Overview* (Lexington, MA: various issues).

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Appendix B

High Oil Price case projections

- *World energy consumption*
- *Gross domestic product*
- *Carbon dioxide emissions*

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Table B1. World total primary energy consumption by region, High Oil Price case, 2006-2035
(Quadrillion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**122.3**	**124.3**	**122.9**	**124.2**	**129.0**	**134.4**	**141.0**	**148.1**	**0.7**
United States[a]	99.8	101.7	100.1	100.7	103.7	107.3	111.3	115.2	0.5
Canada	14.0	14.3	14.3	14.4	15.5	16.3	17.4	18.5	1.0
Mexico/Chile	8.5	8.3	8.5	9.1	9.8	10.9	12.4	14.3	2.0
OECD Europe	**82.8**	**82.3**	**82.2**	**82.0**	**84.5**	**86.9**	**88.9**	**90.9**	**0.4**
OECD Asia	**39.2**	**39.4**	**39.2**	**39.7**	**41.4**	**42.8**	**44.1**	**45.4**	**0.6**
Japan	23.3	23.0	22.4	21.6	22.5	23.0	23.0	23.2	0.1
South Korea	9.4	9.8	10.0	10.8	11.3	12.0	12.7	13.5	1.1
Australia/NewZealand	6.5	6.6	6.8	7.3	7.6	7.9	8.3	8.7	0.9
Total OECD	**244.3**	**246.1**	**244.3**	**245.8**	**254.9**	**264.2**	**274.1**	**284.4**	**0.6**
Non-OECD									
Non-OECD Europe and Eurasia	**48.9**	**49.6**	**50.5**	**50.6**	**52.8**	**55.6**	**59.4**	**64.2**	**0.9**
Russia	29.1	29.7	30.6	30.7	31.7	33.2	35.6	38.8	0.9
Other	19.8	19.9	19.9	20.0	21.1	22.4	23.8	25.4	0.9
Non-OECD Asia	**121.0**	**128.6**	**137.9**	**185.9**	**224.1**	**269.5**	**314.9**	**359.0**	**3.6**
China	73.4	78.9	86.2	122.9	147.1	176.7	205.3	230.9	3.7
India	18.8	20.0	21.1	27.4	34.2	42.3	50.6	59.2	3.9
Other	28.8	29.7	30.7	35.7	42.8	50.5	58.9	68.9	3.1
Middle East	**24.0**	**24.0**	**25.6**	**30.6**	**35.0**	**40.2**	**46.5**	**53.2**	**2.8**
Africa	**17.2**	**17.8**	**18.8**	**21.0**	**24.4**	**28.2**	**32.5**	**37.4**	**2.6**
Central and South America	**25.9**	**26.5**	**27.7**	**30.2**	**33.9**	**39.4**	**46.4**	**54.0**	**2.5**
Brazil	11.5	12.1	12.7	15.1	17.7	21.3	26.0	31.4	3.4
Other	14.4	14.5	15.0	15.1	16.2	18.1	20.3	22.6	1.5
Total Non-OECD	**237.0**	**246.5**	**260.5**	**318.4**	**370.2**	**432.9**	**499.7**	**567.8**	**2.9**
Total World	**481.3**	**492.6**	**504.7**	**564.2**	**625.1**	**697.1**	**773.8**	**852.2**	**2.0**

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B2. World total energy consumption by region and fuel, High Oil Price case, 2006-2035
(Quadrillion Btu)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas									
Liquids	49.6	49.9	47.7	46.8	46.7	46.9	47.6	49.0	0.1
Natural gas	28.2	29.5	29.6	31.9	33.0	34.0	35.8	37.9	0.9
Coal	24.4	24.7	24.3	21.2	22.6	24.8	26.8	28.7	0.6
Nuclear	9.4	9.6	9.5	10.1	10.7	10.7	11.0	11.1	0.6
Other	10.7	10.7	11.8	14.2	16.0	17.9	19.7	21.4	2.2
Total	**122.3**	**124.3**	**122.9**	**124.2**	**129.0**	**134.4**	**141.0**	**148.1**	**0.7**
OECD Europe									
Liquids	32.5	32.1	32.0	28.8	28.7	28.7	28.9	29.0	-0.4
Natural gas	19.7	19.6	20.1	19.8	20.3	20.6	21.6	22.6	0.5
Coal	13.2	13.5	12.5	11.5	11.1	10.7	10.5	10.5	-0.7
Nuclear	9.7	9.2	9.1	10.0	10.3	11.1	11.5	11.8	1.0
Other	7.6	8.1	8.4	11.9	14.1	15.8	16.4	17.0	2.6
Total	**82.8**	**82.3**	**82.2**	**82.0**	**84.5**	**86.9**	**88.9**	**90.9**	**0.4**
OECD Asia									
Liquids	17.5	17.3	16.8	15.4	15.8	16.0	16.0	16.2	-0.1
Natural gas	6.2	6.6	6.6	6.7	7.0	7.5	7.9	8.0	0.7
Coal	9.2	9.6	9.9	9.6	9.4	9.4	9.6	9.9	0.0
Nuclear	4.3	3.9	3.9	5.1	5.7	6.0	6.5	7.0	2.2
Other	2.0	1.9	1.9	2.9	3.6	3.9	4.1	4.3	3.1
Total	**39.2**	**39.4**	**39.2**	**39.7**	**41.4**	**42.8**	**44.1**	**45.4**	**0.6**
Total OECD									
Liquids	99.6	99.3	96.5	90.9	91.2	91.7	92.6	94.1	-0.1
Natural gas	54.1	55.7	56.3	58.4	60.3	62.2	65.3	68.6	0.7
Coal	46.8	47.8	46.8	42.3	43.0	44.9	46.9	49.1	0.2
Nuclear	23.4	22.6	22.6	25.2	26.7	27.8	29.1	29.8	1.0
Other	20.4	20.7	22.1	29.0	33.7	37.6	40.2	42.7	2.5
Total	**244.3**	**246.1**	**244.3**	**245.8**	**254.9**	**264.2**	**274.1**	**284.4**	**0.6**
Non-OECD									
Non-OECD Europe and Eurasia									
Liquids	8.8	9.5	10.1	10.5	10.5	10.9	11.7	12.7	0.8
Natural gas	25.2	25.4	25.4	24.5	25.1	26.3	28.0	29.4	0.5
Coal	8.8	8.6	8.9	8.5	8.3	8.3	8.9	10.1	0.5
Nuclear	2.9	3.0	3.0	3.7	4.8	5.8	6.1	6.5	2.9
Other	3.3	3.1	3.0	3.4	4.1	4.3	4.8	5.5	2.2
Total	**48.9**	**49.6**	**50.5**	**50.6**	**52.8**	**55.6**	**59.4**	**64.2**	**0.9**
Non-OECD Asia									
Liquids	33.4	34.0	35.0	46.4	56.0	68.3	78.0	86.8	3.4
Natural gas	9.8	10.8	11.6	17.4	22.8	28.5	33.3	37.4	4.4
Coal	66.3	71.4	77.5	98.2	111.3	132.9	157.4	180.5	3.2
Nuclear	1.1	1.2	1.2	3.7	6.5	8.9	11.0	13.3	9.2
Other	10.5	11.2	12.6	20.2	27.5	30.9	35.2	40.9	4.5
Total	**121.0**	**128.6**	**137.9**	**185.9**	**224.1**	**269.5**	**314.9**	**359.0**	**3.6**

See notes at end ot table.

(continued on page 177)

Table B2. World total energy consumption by region and fuel, High Oil Price case, 2006-2035 (continued)
(Quadrillion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
Middle East									
Liquids	12.5	12.1	12.8	14.6	15.3	17.0	19.7	21.9	2.0
Natural gas	10.8	11.2	12.2	15.1	18.4	21.6	25.1	29.3	3.3
Coal	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	1.1
Nuclear	0.0	0.0	0.0	0.1	0.3	0.5	0.5	0.6	0
Other	0.3	0.3	0.1	0.4	0.6	0.6	0.7	0.8	6.9
Total	**24.0**	**24.0**	**25.6**	**30.6**	**35.0**	**40.2**	**46.5**	**53.2**	**2.8**
Africa									
Liquids	6.2	6.4	6.5	6.7	7.1	7.9	8.7	9.8	1.5
Natural gas	3.1	3.3	3.9	4.9	6.7	8.5	10.2	11.5	4.1
Coal	4.2	4.4	4.6	5.1	5.6	6.1	7.1	8.8	2.4
Nuclear	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	3.8
Other	3.5	3.6	3.7	4.1	4.8	5.5	6.3	7.1	2.5
Total	**17.2**	**17.8**	**18.8**	**21.0**	**24.4**	**28.2**	**32.5**	**37.4**	**2.6**
Central and South America									
Liquids	11.2	11.5	12.1	13.4	14.2	15.4	17.4	19.6	1.8
Natural gas	4.5	4.5	4.8	5.0	6.1	7.2	8.6	10.7	3.0
Coal	0.7	0.8	0.8	1.0	1.2	1.5	2.1	3.4	5.6
Nuclear	0.2	0.2	0.2	0.3	0.4	0.5	0.5	0.7	4.1
Other	9.2	9.6	9.8	10.5	12.0	14.8	17.9	19.7	2.6
Total	**25.9**	**26.5**	**27.7**	**30.2**	**33.9**	**39.4**	**46.4**	**54.0**	**2.5**
Total Non-OECD									
Liquids	72.1	73.4	76.4	91.6	103.1	119.5	135.5	150.7	2.6
Natural gas	53.4	55.2	58.0	66.9	79.2	92.1	105.2	118.3	2.7
Coal	80.4	85.6	92.2	113.2	126.8	149.3	175.9	203.3	3.0
Nuclear	4.4	4.5	4.6	7.9	12.2	15.8	18.3	21.4	5.9
Other	26.8	27.8	29.2	38.7	48.9	56.2	64.9	74.1	3.5
Total	**237.0**	**246.5**	**260.5**	**318.4**	**370.2**	**432.9**	**499.7**	**567.8**	**2.9**
Total World									
Liquids	171.7	172.7	173.0	182.5	194.3	211.2	228.1	244.9	1.3
Natural gas	107.5	110.9	114.3	125.4	139.5	154.3	170.5	186.9	1.8
Coal	127.2	133.3	139.0	155.5	169.8	194.2	222.8	252.5	2.2
Nuclear	27.8	27.1	27.2	33.1	38.9	43.7	47.4	51.2	2.4
Other	47.1	48.5	51.3	67.7	82.6	93.8	105.1	116.8	3.1
Total	**481.3**	**492.6**	**504.7**	**564.2**	**625.1**	**697.1**	**773.8**	**852.2**	**2.0**

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run HP2011HNO. D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B3. World gross domestic product (GDP) by region expressed in purchasing power parity, High Oil Price case, 2006-2035
(Billion 2005 dollars)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**15,536**	**15,864**	**15,889**	**18,319**	**21,037**	**24,343**	**27,785**	**31,677**	**2.6**
United States[a]	12,976	13,229	13,229	15,260	17,441	20,122	22,816	25,813	2.5
Canada	1,200	1,231	1,236	1,436	1,606	1,779	1,975	2,192	2.2
Mexico/Chile	1,359	1,405	1,424	1,624	1,990	2,442	2,994	3,672	3.6
OECD Europe	**14,412**	**14,849**	**14,969**	**16,208**	**18,035**	**19,864**	**21,771**	**23,807**	**1.7**
OECD Asia	**5,681**	**5,850**	**5,861**	**6,530**	**7,089**	**7,557**	**8,044**	**8,531**	**1.4**
Japan	3,951	4,041	4,014	4,258	4,437	4,520	4,601	4,665	0.6
South Korea	938	986	1,008	1,263	1,494	1,725	1,958	2,189	2.9
Australia/NewZealand	792	823	839	1,009	1,157	1,311	1,485	1,677	2.6
Total OECD	**35,629**	**36,563**	**36,718**	**41,057**	**46,160**	**51,763**	**57,601**	**64,015**	**2.1**
Non-OECD									
Non-OECD Europe and Eurasia	**3,218**	**3,481**	**3,664**	**4,243**	**5,178**	**6,212**	**7,542**	**9,079**	**3.4**
Russia	1,834	1,982	2,093	2,408	2,860	3,387	4,176	5,131	3.4
Other	1,384	1,499	1,571	1,835	2,319	2,825	3,366	3,948	3.5
Non-OECD Asia	**13,013**	**14,323**	**15,281**	**25,779**	**36,519**	**49,230**	**63,988**	**80,540**	**6.4**
China	6,035	6,820	7,431	13,529	19,592	26,803	34,949	43,699	6.8
India	2,676	2,918	3,096	5,259	7,621	10,341	13,447	16,977	6.5
Other	4,302	4,585	4,754	6,990	9,306	12,085	15,592	19,865	5.4
Middle East	**2,145**	**2,261**	**2,357**	**3,266**	**4,197**	**5,258**	**6,569**	**8,153**	**4.7**
Africa	**2,494**	**2,638**	**2,775**	**3,945**	**5,054**	**6,350**	**7,827**	**9,620**	**4.7**
Central and South America	**3,822**	**4,066**	**4,271**	**5,387**	**6,870**	**8,679**	**10,900**	**13,630**	**4.4**
Brazil	1,595	1,685	1,771	2,493	3,288	4,303	5,623	7,337	5.4
Other	2,227	2,381	2,500	2,894	3,583	4,376	5,277	6,293	3.5
Total Non-OECD	**24,692**	**26,769**	**28,348**	**42,619**	**57,819**	**75,729**	**96,825**	**121,022**	**5.5**
Total World	**60,321**	**63,333**	**65,066**	**83,676**	**103,979**	**127,492**	**154,426**	**185,037**	**4.0**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for non-OECD Europe and Eurasia (excluding Russia). China, India, Africa, and Central and South America (excluding Brazil) were adjusted, based on the analyst's judgment.

Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA: various issues). **Projections:** IHS Global Insight, *World Overview,* Third Quarter 2010 (Lexington, MA: November 2010); and U.S. Energy Information Administration (EIA), *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo.

Table B4. World liquids consumption by region, High Oil Price case, 2006-2035
(Million barrels per day)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**25.3**	**25.4**	**24.2**	**24.4**	**24.5**	**24.8**	**25.2**	**25.9**	**0.3**
United States[a]	20.7	20.6	19.5	19.7	19.9	20.2	20.5	20.9	0.3
Canada	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.3	0.1
Mexico/Chile	2.4	2.5	2.4	2.4	2.4	2.4	2.5	2.7	0.4
OECD Europe	**15.7**	**15.6**	**15.6**	**14.0**	**13.9**	**14.0**	**14.0**	**14.1**	**-0.4**
OECD Asia	**8.6**	**8.5**	**8.3**	**7.5**	**7.8**	**7.9**	**7.9**	**7.9**	**-0.1**
Japan	5.3	5.2	5.0	4.2	4.4	4.4	4.3	4.3	-0.6
South Korea	2.2	2.2	2.1	2.2	2.2	2.3	2.4	2.5	0.6
Australia/NewZealand	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	0.3
Total OECD	**49.6**	**49.6**	**48.0**	**45.9**	**46.2**	**46.6**	**47.1**	**47.9**	**0.0**
Non-OECD									
Non-OECD Europe and Eurasia	**4.9**	**4.6**	**5.0**	**5.1**	**5.1**	**5.3**	**5.7**	**6.2**	**0.8**
Russia	2.8	2.6	2.8	2.9	2.8	2.8	3.0	3.2	0.5
Other	2.1	2.1	2.1	2.3	2.4	2.5	2.8	3.0	1.3
Non-OECD Asia	**16.2**	**16.6**	**17.1**	**22.7**	**27.4**	**33.4**	**38.2**	**42.5**	**3.4**
China	7.3	7.5	7.8	11.9	14.4	17.4	19.4	21.2	3.8
India	2.7	2.8	3.0	3.7	4.7	6.3	8.0	9.4	4.4
Other	6.2	6.3	6.3	7.1	8.3	9.7	10.8	12.0	2.4
Middle East	**6.0**	**6.3**	**6.6**	**7.6**	**8.0**	**8.8**	**10.2**	**11.4**	**2.0**
Africa	**3.0**	**3.1**	**3.2**	**3.3**	**3.5**	**3.9**	**4.3**	**4.8**	**1.5**
Central and South America	**5.5**	**5.6**	**5.8**	**6.4**	**6.8**	**7.4**	**8.3**	**9.4**	**1.8**
Brazil	2.3	2.4	2.5	2.9	3.1	3.5	4.0	4.7	2.4
Other	3.2	3.3	3.3	3.5	3.7	3.9	4.3	4.7	1.3
Total Non-OECD	**35.7**	**36.3**	**37.7**	**45.1**	**50.8**	**58.8**	**66.7**	**74.2**	**2.6**
Total World	**85.3**	**85.9**	**85.7**	**91.0**	**96.9**	**105.4**	**113.8**	**122.2**	**1.3**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B5. World natural gas consumption by region, High Oil Price case, 2006-2035
(Trillion cubic feet)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**27.4**	**28.7**	**28.8**	**31.1**	**32.2**	**33.2**	**35.1**	**37.2**	**0.9**
United States[a]	21.7	23.1	23.2	25.3	25.6	25.3	26.0	26.8	0.5
Canada	3.3	3.4	3.4	3.4	3.7	4.1	4.5	5.0	1.4
Mexico/Chile	2.5	2.2	2.2	2.3	2.9	3.8	4.5	5.4	3.3
OECD Europe	**19.2**	**19.0**	**19.5**	**19.2**	**19.7**	**20.0**	**21.0**	**22.0**	**0.5**
OECD Asia	**5.8**	**6.2**	**6.2**	**6.3**	**6.5**	**7.0**	**7.4**	**7.5**	**0.7**
Japan	3.4	3.7	3.7	3.6	3.6	3.7	3.8	3.7	0.1
South Korea	1.1	1.2	1.3	1.4	1.5	1.6	1.6	1.6	1.0
Australia/NewZealand	1.2	1.2	1.3	1.3	1.5	1.7	1.9	2.1	2.0
Total OECD	**52.4**	**53.9**	**54.5**	**56.6**	**58.4**	**60.2**	**63.4**	**66.7**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia	**24.8**	**25.0**	**25.0**	**24.1**	**24.7**	**25.9**	**27.5**	**28.9**	**0.5**
Russia	16.6	16.7	16.8	16.1	16.2	16.7	17.7	18.7	0.4
Other	8.2	8.3	8.2	8.0	8.4	9.1	9.8	10.2	0.8
Non-OECD Asia	**9.5**	**10.5**	**11.3**	**16.9**	**22.1**	**27.6**	**32.3**	**36.3**	**4.4**
China	2.0	2.5	2.7	5.3	7.4	9.5	11.5	13.4	6.1
India	1.4	1.5	1.5	3.2	4.2	5.0	5.5	5.8	5.1
Other	6.2	6.6	7.1	8.3	10.6	13.1	15.3	17.1	3.3
Middle East	**10.3**	**10.7**	**11.7**	**14.4**	**17.5**	**20.6**	**23.9**	**27.9**	**3.3**
Africa	**2.9**	**3.1**	**3.6**	**4.6**	**6.3**	**7.9**	**9.5**	**10.7**	**4.1**
Central and South America	**4.3**	**4.2**	**4.6**	**4.7**	**5.8**	**6.8**	**8.2**	**10.1**	**3.0**
Brazil	0.7	0.7	0.8	1.0	1.7	2.1	2.8	4.1	6.1
Other	3.6	3.5	3.7	3.7	4.1	4.7	5.4	6.1	1.8
Total Non-OECD	**51.8**	**53.5**	**56.2**	**64.7**	**76.4**	**88.8**	**101.3**	**114.0**	**2.7**
Total World	**104.1**	**107.4**	**110.7**	**121.3**	**134.8**	**149.0**	**164.8**	**180.6**	**1.8**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B6. World coal consumption by region, High Oil Price case, 2006-2035
(Quadrillion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**24.4**	**24.7**	**24.3**	**21.2**	**22.6**	**24.8**	**26.8**	**28.7**	**0.6**
United States[a]	22.5	22.7	22.4	19.6	21.0	23.1	25.0	26.5	0.6
Canada	1.4	1.4	1.4	1.0	1.0	1.0	1.0	1.1	-0.7
Mexico/Chile	0.6	0.6	0.5	0.6	0.6	0.7	0.8	1.1	2.8
OECD Europe	**13.2**	**13.5**	**12.5**	**11.5**	**11.1**	**10.7**	**10.5**	**10.5**	**-0.7**
OECD Asia	**9.2**	**9.6**	**9.9**	**9.6**	**9.4**	**9.4**	**9.6**	**9.9**	**0.0**
Japan	4.6	4.9	4.8	4.5	4.3	4.1	4.0	3.9	-0.8
South Korea	2.1	2.3	2.6	2.6	2.6	2.8	3.1	3.6	1.2
Australia/NewZealand	2.4	2.5	2.6	2.5	2.5	2.4	2.4	2.5	-0.2
Total OECD	**46.8**	**47.8**	**46.8**	**42.3**	**43.0**	**44.9**	**46.9**	**49.1**	**0.2**
Non-OECD									
Non-OECD Europe and Eurasia	**8.8**	**8.6**	**8.9**	**8.5**	**8.3**	**8.3**	**8.9**	**10.1**	**0.5**
Russia	4.4	4.2	4.5	4.5	4.4	4.5	4.9	5.9	1.1
Other	4.4	4.5	4.5	4.0	3.9	3.9	4.0	4.2	-0.2
Non-OECD Asia	**66.3**	**71.4**	**77.5**	**98.2**	**111.3**	**132.9**	**157.4**	**180.5**	**3.2**
China	51.2	55.2	60.4	79.6	90.0	107.6	126.3	141.9	3.2
India	9.2	10.1	10.9	12.2	14.0	16.8	20.1	24.0	3.0
Other	5.8	6.1	6.3	6.4	7.2	8.5	11.0	14.5	3.2
Middle East	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**1.1**
Africa	**4.2**	**4.4**	**4.6**	**5.1**	**5.6**	**6.1**	**7.1**	**8.8**	**2.4**
Central and South America	**0.7**	**0.8**	**0.8**	**1.0**	**1.2**	**1.5**	**2.1**	**3.4**	**5.6**
Brazil	0.4	0.5	0.5	0.8	1.0	1.2	1.7	2.8	6.9
Other	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	2.1
Total Non-OECD	**80.4**	**85.6**	**92.2**	**113.2**	**126.8**	**149.3**	**175.9**	**203.3**	**3.0**
Total World	**127.2**	**133.3**	**139.0**	**155.5**	**169.8**	**194.2**	**222.8**	**252.5**	**2.2**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B7. World nuclear energy consumption by region, High Oil Price case, 2006-2035
(Billion kilowatthours)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**891**	**905**	**905**	**962**	**1,018**	**1,021**	**1,047**	**1,054**	**0.6**
United States[a]	787	806	806	839	877	877	877	874	0.3
Canada	93	89	89	112	131	134	152	162	2.2
Mexico/Chile	10	10	9	10	10	10	18	18	2.4
OECD Europe	**935**	**884**	**882**	**965**	**998**	**1,067**	**1,111**	**1,136**	**0.9**
OECD Asia	**430**	**386**	**389**	**502**	**560**	**591**	**641**	**683**	**2.1**
Japan	288	251	245	319	342	358	388	417	2.0
South Korea	141	136	143	183	218	233	253	266	2.3
Australia/NewZealand	0	0	0	0	0	0	0	0	--
Total OECD	**2,255**	**2,176**	**2,175**	**2,429**	**2,576**	**2,680**	**2,799**	**2,873**	**1.0**
Non-OECD									
Non-OECD Europe and Eurasia	**263**	**272**	**276**	**342**	**449**	**538**	**567**	**614**	**3.0**
Russia	144	152	154	197	275	342	366	388	3.5
Other	119	120	121	145	174	196	201	225	2.3
Non-OECD Asia	**111**	**119**	**119**	**360**	**631**	**855**	**1,063**	**1,281**	**9.2**
China	55	63	65	223	419	585	749	916	10.3
India	16	16	13	66	119	157	187	211	10.8
Other	40	41	41	71	92	113	127	153	5.0
Middle East	**0**	**0**	**0**	**6**	**24**	**51**	**52**	**54**	**--**
Africa	**10**	**12**	**11**	**15**	**15**	**21**	**21**	**31**	**3.8**
Central and South America	**21**	**19**	**21**	**25**	**35**	**44**	**44**	**63**	**4.2**
Brazil	14	12	14	18	22	31	31	41	4.1
Other	7	7	7	7	13	13	13	22	4.4
Total Non-OECD	**405**	**422**	**427**	**748**	**1,154**	**1,508**	**1,747**	**2,043**	**6.0**
Total World	**2,660**	**2,598**	**2,602**	**3,177**	**3,731**	**4,188**	**4,546**	**4,916**	**2.4**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B8. World consumption of hydroelectricity and other renewable energy by region, High Oil Price case, 2006-2035
(Quadrillion Btu)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**10.7**	**10.7**	**11.8**	**14.2**	**16.0**	**17.9**	**19.7**	**21.4**	**2.2**
United States[a]	6.4	6.2	7.0	8.7	9.7	11.2	12.2	13.2	2.4
Canada	3.7	3.9	4.0	4.3	4.9	5.2	5.7	6.0	1.5
Mexico/Chile	0.6	0.6	0.7	1.3	1.4	1.5	1.8	2.2	4.1
OECD Europe	**7.6**	**8.1**	**8.4**	**11.9**	**14.1**	**15.8**	**16.4**	**17.0**	**2.6**
OECD Asia	**2.0**	**1.9**	**1.9**	**2.9**	**3.6**	**3.9**	**4.1**	**4.3**	**3.1**
Japan	1.2	1.1	1.1	1.5	2.0	2.2	2.3	2.4	2.9
South Korea	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	3.0
Australia/NewZealand	0.7	0.7	0.7	1.2	1.4	1.4	1.5	1.6	3.3
Total OECD	**20.4**	**20.7**	**22.1**	**29.0**	**33.7**	**37.6**	**40.2**	**42.7**	**2.5**
Non-OECD									
Non-OECD Europe and Eurasia	**3.3**	**3.1**	**3.0**	**3.4**	**4.1**	**4.3**	**4.8**	**5.5**	**2.2**
Russia	1.9	1.9	1.7	2.1	2.4	2.6	3.0	3.4	2.5
Other	1.4	1.2	1.3	1.4	1.7	1.7	1.9	2.1	1.8
Non-OECD Asia	**10.5**	**11.2**	**12.6**	**20.2**	**27.5**	**30.9**	**35.2**	**40.9**	**4.5**
China	4.7	5.3	6.4	11.2	15.9	17.8	19.8	22.5	4.8
India	2.4	2.5	2.4	3.5	4.8	5.5	6.5	7.6	4.4
Other	3.5	3.5	3.7	5.5	6.8	7.6	8.9	10.8	4.0
Middle East	**0.3**	**0.3**	**0.1**	**0.4**	**0.6**	**0.6**	**0.7**	**0.8**	**6.9**
Africa	**3.5**	**3.6**	**3.7**	**4.1**	**4.8**	**5.5**	**6.3**	**7.1**	**2.5**
Central and South America	**9.2**	**9.6**	**9.8**	**10.5**	**12.0**	**14.8**	**17.9**	**19.7**	**2.6**
Brazil	5.5	5.9	6.0	7.1	8.3	10.3	12.8	14.1	3.2
Other	3.7	3.7	3.8	3.5	3.7	4.5	5.1	5.6	1.5
Total Non-OECD	**26.8**	**27.8**	**29.2**	**38.7**	**48.9**	**56.2**	**64.9**	**74.1**	**3.5**
Total World	**47.1**	**48.5**	**51.3**	**67.7**	**82.6**	**93.8**	**105.1**	**116.8**	**3.1**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B9. World carbon dioxide emissions by region, High Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

	History			Projections					Average annual percent change,
Region	2006	2007	2008	2015	2020	2025	2030	2035	2008-2035
OECD									
OECD Americas	**7,014**	**7,123**	**6,926**	**6,617**	**6,745**	**6,980**	**7,292**	**7,663**	**0.4**
United States[a]	5,918	6,022	5,838	5,558	5,646	5,800	6,019	6,244	0.3
Canada	594	607	595	558	570	596	622	664	0.4
Mexico/Chile	502	494	493	502	530	584	651	755	1.6
OECD Europe	**4,428**	**4,413**	**4,345**	**4,019**	**4,002**	**3,990**	**4,029**	**4,092**	**-0.2**
OECD Asia	**2,165**	**2,206**	**2,201**	**2,095**	**2,109**	**2,151**	**2,186**	**2,231**	**0.1**
Japan	1,240	1,254	1,215	1,101	1,104	1,096	1,074	1,053	-0.5
South Korea	484	503	522	538	542	578	617	664	0.9
Australia/NewZealand	440	449	464	456	463	477	495	514	0.4
Total OECD	**13,606**	**13,742**	**13,472**	**12,731**	**12,856**	**13,121**	**13,507**	**13,986**	**0.1**
Non-OECD									
Non-OECD Europe and Eurasia	**2,823**	**2,790**	**2,832**	**2,767**	**2,783**	**2,877**	**3,072**	**3,325**	**0.6**
Russia	1,668	1,618	1,663	1,628	1,620	1,654	1,772	1,949	0.6
Other	1,155	1,172	1,169	1,139	1,162	1,223	1,300	1,376	0.6
Non-OECD Asia	**8,835**	**9,416**	**10,100**	**13,065**	**15,183**	**18,284**	**21,444**	**24,383**	**3.3**
China	5,817	6,257	6,801	9,270	10,671	12,820	14,943	16,730	3.4
India	1,281	1,367	1,462	1,776	2,129	2,639	3,168	3,728	3.5
Other	1,737	1,793	1,838	2,020	2,382	2,825	3,333	3,924	2.9
Middle East	**1,446**	**1,479**	**1,581**	**1,864**	**2,090**	**2,375**	**2,753**	**3,140**	**2.6**
Africa	**984**	**1,016**	**1,078**	**1,188**	**1,360**	**1,556**	**1,791**	**2,085**	**2.5**
Central and South America	**1,064**	**1,085**	**1,128**	**1,246**	**1,375**	**1,543**	**1,793**	**2,171**	**2.5**
Brazil	380	397	423	513	599	700	846	1,113	3.7
Other	684	688	705	733	777	843	947	1,058	1.5
Total Non-OECD	**15,152**	**15,786**	**16,718**	**20,130**	**22,791**	**26,635**	**30,854**	**35,105**	**2.8**
Total World	**28,758**	**29,529**	**30,190**	**32,860**	**35,646**	**39,757**	**44,361**	**49,091**	**1.8**

[a]Includes the 50 States and the District of Columbia.

Notes: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B10. World carbon dioxide emissions from liquids use by region, High Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**3,198**	**3,219**	**3,050**	**2,914**	**2,862**	**2,831**	**2,855**	**2,939**	**-0.1**
United States[a]	2,603	2,603	2,444	2,315	2,273	2,238	2,244	2,293	-0.2
Canada	281	292	283	278	275	275	280	288	0.1
Mexico/Chile	314	325	323	321	314	318	331	358	0.4
OECD Europe	**2,135**	**2,090**	**2,076**	**1,866**	**1,858**	**1,863**	**1,873**	**1,878**	**-0.4**
OECD Asia	**993**	**966**	**934**	**852**	**875**	**887**	**888**	**895**	**-0.2**
Japan	622	599	574	482	507	510	498	491	-0.6
South Korea	221	216	206	216	216	222	230	239	0.6
Australia/NewZealand	149	152	153	154	152	154	159	164	0.3
Total OECD	**6,326**	**6,276**	**6,059**	**5,631**	**5,595**	**5,581**	**5,616**	**5,712**	**-0.2**
Non-OECD									
Non-OECD Europe and Eurasia	**670**	**624**	**637**	**662**	**663**	**691**	**744**	**803**	**0.9**
Russia	368	328	340	344	333	337	358	386	0.5
Other	302	296	297	318	330	355	386	417	1.3
Non-OECD Asia	**2,147**	**2,185**	**2,242**	**2,962**	**3,573**	**4,352**	**4,968**	**5,529**	**3.4**
China	928	959	995	1,518	1,828	2,213	2,472	2,691	3.8
India	349	354	372	468	599	801	1,004	1,182	4.4
Other	870	872	874	975	1,145	1,338	1,492	1,656	2.4
Middle East	**839**	**845**	**894**	**1,025**	**1,074**	**1,190**	**1,379**	**1,533**	**2.0**
Africa	**428**	**437**	**447**	**462**	**490**	**540**	**597**	**671**	**1.5**
Central and South America	**757**	**777**	**799**	**883**	**936**	**1,018**	**1,146**	**1,290**	**1.8**
Brazil	301	315	332	386	417	465	539	624	2.4
Other	456	462	467	497	519	553	607	666	1.3
Total Non-OECD	**4,841**	**4,868**	**5,018**	**5,993**	**6,735**	**7,792**	**8,833**	**9,826**	**2.5**
Total World	**11,167**	**11,144**	**11,077**	**11,624**	**12,330**	**13,373**	**14,449**	**15,537**	**1.3**

[a]Includes the 50 States and the District of Columbia.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B11. World carbon dioxide emissions from natural gas use by region, High Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

	History			Projections					Average annual percent change,
Region	2006	2007	2008	2015	2020	2025	2030	2035	2008-2035
OECD									
OECD Americas	**1,473**	**1,540**	**1,549**	**1,676**	**1,737**	**1,791**	**1,885**	**1,995**	**0.9**
United States[a]	1,157	1,235	1,243	1,362	1,377	1,362	1,393	1,433	0.5
Canada	180	187	186	188	202	226	246	272	1.4
Mexico/Chile	136	118	120	126	159	203	245	291	3.3
OECD Europe	**1,047**	**1,045**	**1,070**	**1,057**	**1,080**	**1,100**	**1,153**	**1,207**	**0.5**
OECD Asia	**326**	**352**	**351**	**357**	**371**	**399**	**417**	**425**	**0.7**
Japan	193	210	205	203	201	208	212	208	0.1
South Korea	68	74	75	83	88	96	97	97	1.0
Australia/NewZealand	66	68	71	71	82	95	108	119	2.0
Total OECD	**2,847**	**2,937**	**2,970**	**3,090**	**3,188**	**3,289**	**3,455**	**3,627**	**0.7**
Non-OECD									
Non-OECD Europe and Eurasia	**1,332**	**1,353**	**1,354**	**1,303**	**1,335**	**1,401**	**1,489**	**1,564**	**0.5**
Russia	889	897	899	858	867	894	945	1,001	0.4
Other	443	456	454	446	467	508	544	564	0.8
Non-OECD Asia	**518**	**573**	**617**	**926**	**1,212**	**1,511**	**1,770**	**1,987**	**4.4**
China	111	138	151	297	409	526	640	743	6.1
India	78	83	86	183	239	284	310	329	5.1
Other	330	352	380	446	565	701	820	915	3.3
Middle East	**572**	**595**	**650**	**801**	**977**	**1,145**	**1,332**	**1,557**	**3.3**
Africa	**166**	**176**	**206**	**260**	**357**	**451**	**539**	**608**	**4.1**
Central and South America	**241**	**238**	**256**	**266**	**325**	**383**	**457**	**567**	**3.0**
Brazil	38	39	46	57	93	118	153	225	6.1
Other	203	199	210	210	232	265	304	342	1.8
Total Non-OECD	**2,829**	**2,934**	**3,083**	**3,556**	**4,206**	**4,892**	**5,586**	**6,283**	**2.7**
Total World	**5,675**	**5,870**	**6,052**	**6,646**	**7,394**	**8,181**	**9,041**	**9,911**	**1.8**

[a]Includes the 50 States and the District of Columbia.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table B12. World carbon dioxide emissions from coal use by region, High Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**2,331**	**2,352**	**2,315**	**2,015**	**2,134**	**2,346**	**2,540**	**2,718**	**0.6**
United States[a]	2,147	2,172	2,139	1,868	1,984	2,188	2,370	2,506	0.6
Canada	132	128	126	92	93	96	96	105	-0.7
Mexico/Chile	53	51	50	55	57	62	74	106	2.8
OECD Europe	**1,245**	**1,279**	**1,200**	**1,097**	**1,063**	**1,028**	**1,004**	**1,006**	**-0.7**
OECD Asia	**846**	**888**	**917**	**886**	**863**	**865**	**881**	**912**	**0.0**
Japan	425	446	436	416	395	378	364	354	-0.8
South Korea	195	213	240	239	239	260	290	327	1.2
Australia/NewZealand	226	229	240	231	229	227	227	230	-0.2
Total OECD	**4,422**	**4,518**	**4,431**	**3,998**	**4,061**	**4,239**	**4,424**	**4,636**	**0.2**
Non-OECD									
Non-OECD Europe and Eurasia	**821**	**813**	**841**	**802**	**785**	**784**	**839**	**958**	**0.5**
Russia	412	393	424	426	420	424	468	562	1.1
Other	410	420	417	376	365	360	371	396	-0.2
Non-OECD Asia	**6,170**	**6,659**	**7,241**	**9,178**	**10,398**	**12,421**	**14,707**	**16,867**	**3.2**
China	4,779	5,160	5,654	7,455	8,435	10,081	11,831	13,297	3.2
India	854	931	1,003	1,125	1,291	1,554	1,855	2,217	3.0
Other	537	569	583	598	672	786	1,021	1,353	3.2
Middle East	**36**	**39**	**37**	**38**	**39**	**40**	**42**	**50**	**1.1**
Africa	**390**	**403**	**426**	**466**	**513**	**565**	**655**	**807**	**2.4**
Central and South America	**65**	**70**	**72**	**97**	**115**	**142**	**191**	**314**	**5.6**
Brazil	41	43	44	70	89	116	154	264	6.9
Other	25	27	28	27	26	26	36	50	2.1
Total Non-OECD	**7,482**	**7,985**	**8,618**	**10,581**	**11,850**	**13,952**	**16,435**	**18,996**	**3.0**
Total World	**11,904**	**12,503**	**13,049**	**14,579**	**15,910**	**18,191**	**20,859**	**23,631**	**2.2**

[a]Includes the 50 States and the District of Columbia.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run HP2011HNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Appendix C

Low Oil Price case projections

- *World energy consumption*
- *Gross domestic product*
- *Carbon dioxide emissions*

Table C1. World total primary energy consumption by region, Low Oil Price case, 2006-2035
(Quadrillion Btu)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**122.3**	**124.3**	**122.9**	**128.4**	**133.6**	**139.4**	**145.1**	**151.6**	**0.8**
United States[a]	99.8	101.7	100.2	103.5	106.5	110.0	112.8	116.2	0.6
Canada	14.0	14.3	14.3	15.0	16.4	17.3	18.6	19.7	1.2
Mexico/Chile	8.5	8.3	8.5	9.8	10.7	12.1	13.7	15.7	2.3
OECD Europe	**82.8**	**82.3**	**82.2**	**85.4**	**90.2**	**93.6**	**96.0**	**98.1**	**0.7**
OECD Asia	**39.2**	**39.4**	**39.2**	**41.9**	**45.0**	**47.1**	**48.5**	**49.8**	**0.9**
Japan	23.3	23.0	22.4	22.9	24.6	25.4	25.6	25.7	0.5
South Korea	9.4	9.8	10.0	11.4	12.3	13.2	14.1	14.9	1.5
Australia/NewZealand	6.5	6.6	6.8	7.6	8.1	8.4	8.9	9.2	1.1
Total OECD	**244.3**	**246.1**	**244.3**	**255.7**	**268.8**	**280.1**	**289.6**	**299.5**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia	**48.9**	**49.6**	**50.5**	**52.0**	**51.3**	**51.2**	**51.6**	**51.8**	**0.1**
Russia	29.1	29.7	30.6	31.5	30.8	30.7	31.3	31.8	0.2
Other	19.8	19.9	19.9	20.5	20.5	20.5	20.3	20.0	0.0
Non-OECD Asia	**121.0**	**128.6**	**137.9**	**192.0**	**214.2**	**235.3**	**249.4**	**257.3**	**2.3**
China	73.4	78.9	86.2	126.5	139.6	152.8	161.2	164.5	2.4
India	18.8	20.0	21.1	28.4	33.1	37.4	40.4	42.5	2.6
Other	28.8	29.7	30.7	37.1	41.6	45.1	47.8	50.4	1.9
Middle East	**24.0**	**24.0**	**25.6**	**31.5**	**33.8**	**35.7**	**37.5**	**39.0**	**1.6**
Africa	**17.2**	**17.8**	**18.8**	**22.2**	**23.8**	**25.0**	**26.0**	**26.9**	**1.3**
Central and South America	**25.9**	**26.5**	**27.7**	**31.8**	**33.4**	**35.3**	**37.3**	**39.5**	**1.3**
Brazil	11.5	12.1	12.7	16.0	17.3	18.8	20.6	22.5	2.1
Other	14.4	14.5	15.0	15.8	16.0	16.4	16.8	17.0	0.5
Total Non-OECD	**237.0**	**246.5**	**260.5**	**329.5**	**356.4**	**382.5**	**401.8**	**414.6**	**1.7**
Total World	**481.3**	**492.6**	**504.7**	**585.2**	**625.2**	**662.6**	**691.5**	**714.1**	**1.3**

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C2. World total energy consumption by region and fuel, Low Oil Price case, 2006-2035
(Quadrillion Btu)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas									
Liquids	49.6	49.9	47.7	50.6	51.8	53.4	55.2	58.1	0.7
Natural gas	28.2	29.5	29.6	32.3	33.5	34.3	35.9	38.1	0.9
Coal	24.4	24.7	24.3	21.0	22.2	24.1	24.7	24.9	0.1
Nuclear	9.4	9.6	9.5	10.1	10.6	10.7	10.9	11.0	0.5
Other	10.7	10.7	11.8	14.3	15.6	16.9	18.4	19.5	1.9
Total	**122.3**	**124.3**	**122.9**	**128.4**	**133.6**	**139.4**	**145.1**	**151.6**	**0.8**
OECD Europe									
Liquids	32.5	32.1	32.0	30.9	32.4	33.2	33.6	34.1	0.2
Natural gas	19.7	19.6	20.1	20.9	21.8	22.5	23.8	24.8	0.8
Coal	13.2	13.5	12.5	11.6	11.3	10.9	10.6	10.3	-0.7
Nuclear	9.7	9.2	9.1	10.0	10.3	11.1	11.5	11.8	1.0
Other	7.6	8.1	8.4	12.0	14.3	15.9	16.6	17.1	2.7
Total	**82.8**	**82.3**	**82.2**	**85.4**	**90.2**	**93.6**	**96.0**	**98.1**	**0.7**
OECD Asia									
Liquids	17.5	17.3	16.8	16.7	18.2	19.0	19.3	19.7	0.6
Natural gas	6.2	6.6	6.6	7.1	7.8	8.5	9.1	9.4	1.3
Coal	9.2	9.6	9.9	9.8	9.6	9.6	9.4	9.4	-0.2
Nuclear	4.3	3.9	3.9	5.1	5.7	6.0	6.5	7.0	2.2
Other	2.0	1.9	1.9	3.2	3.6	4.0	4.1	4.4	3.1
Total	**39.2**	**39.4**	**39.2**	**41.9**	**45.0**	**47.1**	**48.5**	**49.8**	**0.9**
Total OECD									
Liquids	99.6	99.3	96.5	98.1	102.4	105.6	108.1	111.9	0.6
Natural gas	54.1	55.7	56.3	60.3	63.1	65.4	68.8	72.2	0.9
Coal	46.8	47.8	46.8	42.5	43.1	44.6	44.7	44.6	-0.2
Nuclear	23.4	22.6	22.6	25.2	26.7	27.7	29.0	29.7	1.0
Other	20.4	20.7	22.1	29.6	33.6	36.8	39.1	41.1	2.3
Total	**244.3**	**246.1**	**244.3**	**255.7**	**268.8**	**280.1**	**289.6**	**299.5**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia									
Liquids	8.8	9.5	10.1	11.0	10.6	10.4	10.4	10.3	0.1
Natural gas	25.2	25.4	25.4	25.0	24.4	23.9	23.6	23.5	-0.3
Coal	8.8	8.6	8.9	8.6	8.1	7.7	7.4	7.1	-0.8
Nuclear	2.9	3.0	3.0	3.7	4.5	5.4	6.1	6.5	2.9
Other	3.3	3.1	3.0	3.7	3.8	3.8	4.1	4.4	1.4
Total	**48.9**	**49.6**	**50.5**	**52.0**	**51.3**	**51.2**	**51.6**	**51.8**	**0.1**
Non-OECD Asia									
Liquids	33.4	34.0	35.0	48.6	55.0	61.5	64.1	64.4	2.3
Natural gas	9.8	10.8	11.6	18.1	21.1	24.4	27.0	28.8	3.4
Coal	66.3	71.4	77.5	101.3	104.4	110.3	114.2	115.2	1.5
Nuclear	1.1	1.2	1.2	3.7	6.5	8.9	11.0	13.3	9.2
Other	10.5	11.2	12.6	20.3	27.2	30.2	33.1	35.6	3.9
Total	**121.0**	**128.6**	**137.9**	**192.0**	**214.2**	**235.3**	**249.4**	**257.3**	**2.3**

See notes at end ot table.

(continued on page 193)

Table C2. World total energy consumption by region and fuel, Low Oil Price case, 2006-2035 (continued)
(Quadrillion Btu)

	History			Projections					Average annual percent change,
Region	2006	2007	2008	2015	2020	2025	2030	2035	2008-2035
Middle East									
Liquids	12.5	12.1	12.8	15.7	16.2	16.9	18.2	18.9	1.5
Natural gas	10.8	11.2	12.2	15.0	16.4	17.3	17.8	18.5	1.5
Coal	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-0.3
Nuclear	0.0	0.0	0.0	0.1	0.3	0.5	0.5	0.6	0
Other	0.3	0.3	0.1	0.4	0.6	0.6	0.7	0.7	6.2
Total	**24.0**	**24.0**	**25.6**	**31.5**	**33.8**	**35.7**	**37.5**	**39.0**	**1.6**
Africa									
Liquids	6.2	6.4	6.5	7.1	7.2	7.3	7.3	7.5	0.5
Natural gas	3.1	3.3	3.9	5.3	6.4	7.2	8.0	8.4	2.9
Coal	4.2	4.4	4.6	5.2	5.4	5.5	5.5	5.6	0.7
Nuclear	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	3.8
Other	3.5	3.6	3.7	4.4	4.7	4.9	5.0	5.1	1.2
Total	**17.2**	**17.8**	**18.8**	**22.2**	**23.8**	**25.0**	**26.0**	**26.9**	**1.3**
Central and South America									
Liquids	11.2	11.5	12.1	14.1	14.2	14.2	14.4	14.5	0.7
Natural gas	4.5	4.5	4.8	5.5	5.8	6.3	6.7	7.2	1.5
Coal	0.7	0.8	0.8	1.1	1.2	1.3	1.5	1.7	2.9
Nuclear	0.2	0.2	0.2	0.3	0.4	0.5	0.5	0.7	4.1
Other	9.2	9.6	9.8	10.8	11.8	13.0	14.3	15.5	1.7
Total	**25.9**	**26.5**	**27.7**	**31.8**	**33.4**	**35.3**	**37.3**	**39.5**	**1.3**
Total Non-OECD									
Liquids	72.1	73.4	76.4	96.6	103.1	110.2	114.3	115.5	1.5
Natural gas	53.4	55.2	58.0	68.8	74.0	79.1	83.1	86.4	1.5
Coal	80.4	85.6	92.2	116.5	119.4	125.2	129.0	130.0	1.3
Nuclear	4.4	4.5	4.6	7.9	11.8	15.5	18.3	21.4	5.9
Other	26.8	27.8	29.2	39.7	48.1	52.5	57.1	61.3	2.8
Total	**237.0**	**246.5**	**260.5**	**329.5**	**356.4**	**382.5**	**401.8**	**414.6**	**1.7**
Total World									
Liquids	171.7	172.7	173.0	194.7	205.5	215.8	222.4	227.5	1.0
Natural gas	107.5	110.9	114.3	129.1	137.1	144.5	151.9	158.6	1.2
Coal	127.2	133.3	139.0	159.0	162.5	169.8	173.7	174.6	0.9
Nuclear	27.8	27.1	27.2	33.2	38.5	43.2	47.3	51.1	2.4
Other	47.1	48.5	51.3	69.2	81.7	89.3	96.2	102.3	2.6
Total	**481.3**	**492.6**	**504.7**	**585.2**	**625.2**	**662.6**	**691.5**	**714.1**	**1.3**

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C3. World gross domestic product (GDP) by region expressed in purchasing power parity, Low Oil Price case, 2006-2035
(Billion 2005 dollars)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**15,536**	**15,864**	**15,889**	**18,470**	**21,071**	**24,250**	**27,705**	**31,599**	**2.6**
United States[a]	12,976	13,229	13,229	15,411	17,475	20,029	22,736	25,735	2.5
Canada	1,200	1,231	1,236	1,436	1,606	1,779	1,975	2,192	2.2
Mexico/Chile	1,359	1,405	1,424	1,624	1,990	2,442	2,994	3,672	3.6
OECD Europe	**14,412**	**14,849**	**14,969**	**16,208**	**18,035**	**19,864**	**21,771**	**23,807**	**1.7**
OECD Asia	**5,681**	**5,850**	**5,861**	**6,530**	**7,089**	**7,557**	**8,044**	**8,531**	**1.4**
Japan	3,951	4,041	4,014	4,258	4,437	4,520	4,601	4,665	0.6
South Korea	938	986	1,008	1,263	1,494	1,725	1,958	2,189	2.9
Australia/NewZealand	792	823	839	1,009	1,157	1,311	1,485	1,677	2.6
Total OECD	**35,629**	**36,563**	**36,718**	**41,208**	**46,195**	**51,671**	**57,521**	**63,937**	**2.1**
Non-OECD									
Non-OECD Europe and Eurasia	**3,218**	**3,481**	**3,664**	**4,141**	**4,476**	**4,753**	**5,109**	**5,444**	**1.5**
Russia	1,834	1,982	2,093	2,350	2,470	2,588	2,827	3,076	1.4
Other	1,384	1,499	1,571	1,791	2,006	2,165	2,283	2,368	1.5
Non-OECD Asia	**13,013**	**14,323**	**15,281**	**25,182**	**31,704**	**37,939**	**43,734**	**48,781**	**4.4**
China	6,035	6,820	7,431	13,218	17,021	20,677	23,912	26,492	4.8
India	2,676	2,918	3,096	5,137	6,619	7,975	9,197	10,290	4.6
Other	4,302	4,585	4,754	6,826	8,064	9,287	10,625	11,999	3.5
Middle East	**2,145**	**2,261**	**2,357**	**3,189**	**3,633**	**4,033**	**4,464**	**4,909**	**2.8**
Africa	**2,494**	**2,638**	**2,775**	**3,851**	**4,375**	**4,871**	**5,317**	**5,788**	**2.8**
Central and South America	**3,822**	**4,066**	**4,271**	**5,259**	**5,946**	**6,657**	**7,409**	**8,211**	**2.5**
Brazil	1,595	1,685	1,771	2,435	2,848	3,307	3,833	4,436	3.5
Other	2,227	2,381	2,500	2,824	3,098	3,350	3,577	3,775	1.5
Total Non-OECD	**24,692**	**26,769**	**28,348**	**41,622**	**50,133**	**58,253**	**66,034**	**73,134**	**3.6**
Total World	**60,321**	**63,333**	**65,066**	**82,830**	**96,328**	**109,923**	**123,555**	**137,071**	**2.8**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for non-OECD Europe and Eurasia (excluding Russia). China, India, Africa, and Central and South America (excluding Brazil) were adjusted, based on the analyst's judgment.
Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA: various issues). **Projections:** IHS Global Insight, *World Overview,* Third Quarter 2010 (Lexington, MA: November 2010); and U.S. Energy Information Administration (EIA), *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo.

Table C4. World liquids consumption by region, Low Oil Price case, 2006-2035
(Million barrels per day)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**25.3**	**25.4**	**24.2**	**26.3**	**26.9**	**27.8**	**28.7**	**30.1**	**0.8**
United States[a]	20.7	20.6	19.5	21.3	21.7	22.3	22.9	23.8	0.7
Canada	2.3	2.3	2.2	2.4	2.5	2.5	2.6	2.7	0.7
Mexico/Chile	2.4	2.5	2.4	2.6	2.7	2.9	3.2	3.6	1.4
OECD Europe	**15.7**	**15.6**	**15.6**	**15.0**	**15.8**	**16.1**	**16.3**	**16.6**	**0.2**
OECD Asia	**8.6**	**8.5**	**8.3**	**8.2**	**9.0**	**9.3**	**9.5**	**9.7**	**0.6**
Japan	5.3	5.2	5.0	4.6	5.1	5.3	5.2	5.2	0.1
South Korea	2.2	2.2	2.1	2.4	2.6	2.7	2.9	3.1	1.4
Australia/NewZealand	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	0.8
Total OECD	**49.6**	**49.6**	**48.0**	**49.4**	**51.6**	**53.2**	**54.5**	**56.3**	**0.6**
Non-OECD									
Non-OECD Europe and Eurasia	**4.9**	**4.6**	**5.0**	**5.4**	**5.2**	**5.1**	**5.1**	**5.0**	**0.1**
Russia	2.8	2.6	2.8	3.0	2.8	2.7	2.7	2.7	-0.2
Other	2.1	2.1	2.1	2.4	2.3	2.4	2.4	2.4	0.4
Non-OECD Asia	**16.2**	**16.6**	**17.1**	**23.8**	**26.9**	**30.1**	**31.4**	**31.5**	**2.3**
China	7.3	7.5	7.8	12.5	14.0	15.7	16.1	15.7	2.6
India	2.7	2.8	3.0	3.9	4.7	5.7	6.3	6.5	3.0
Other	6.2	6.3	6.3	7.4	8.2	8.7	9.0	9.3	1.4
Middle East	**6.0**	**6.3**	**6.6**	**8.2**	**8.4**	**8.8**	**9.4**	**9.8**	**1.5**
Africa	**3.0**	**3.1**	**3.2**	**3.5**	**3.5**	**3.6**	**3.6**	**3.7**	**0.5**
Central and South America	**5.5**	**5.6**	**5.8**	**6.8**	**6.8**	**6.8**	**6.9**	**6.9**	**0.7**
Brazil	2.3	2.4	2.5	3.1	3.1	3.2	3.3	3.3	1.1
Other	3.2	3.3	3.3	3.7	3.7	3.6	3.6	3.6	0.3
Total Non-OECD	**35.7**	**36.3**	**37.7**	**47.6**	**50.8**	**54.3**	**56.3**	**57.0**	**1.5**
Total World	**85.3**	**85.9**	**85.7**	**97.0**	**102.4**	**107.5**	**110.8**	**113.3**	**1.0**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C5. World natural gas consumption by region, Low Oil Price case, 2006-2035
(Trillion cubic feet)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**27.4**	**28.7**	**28.8**	**31.5**	**32.6**	**33.5**	**35.0**	**37.1**	**0.9**
United States[a]	21.7	23.1	23.2	25.3	25.4	25.0	25.6	26.5	0.5
Canada	3.3	3.4	3.4	3.6	4.0	4.5	4.9	5.3	1.6
Mexico/Chile	2.5	2.2	2.2	2.6	3.2	4.0	4.6	5.3	3.3
OECD Europe	**19.2**	**19.0**	**19.5**	**20.3**	**21.2**	**21.9**	**23.1**	**24.1**	**0.8**
OECD Asia	**5.8**	**6.2**	**6.2**	**6.6**	**7.3**	**8.0**	**8.5**	**8.8**	**1.3**
Japan	3.4	3.7	3.7	3.7	3.9	4.2	4.3	4.4	0.7
South Korea	1.1	1.2	1.3	1.6	1.7	2.0	2.1	2.1	2.0
Australia/NewZealand	1.2	1.2	1.3	1.4	1.6	1.8	2.1	2.2	2.1
Total OECD	**52.4**	**53.9**	**54.5**	**58.5**	**61.1**	**63.3**	**66.6**	**70.0**	**0.9**
Non-OECD									
Non-OECD Europe and Eurasia	**24.8**	**25.0**	**25.0**	**24.6**	**24.0**	**23.5**	**23.2**	**23.1**	**-0.3**
Russia	16.6	16.7	16.8	16.4	16.0	15.6	15.5	15.6	-0.3
Other	8.2	8.3	8.2	8.1	8.0	7.9	7.8	7.5	-0.3
Non-OECD Asia	**9.5**	**10.5**	**11.3**	**17.5**	**20.4**	**23.7**	**26.2**	**27.9**	**3.4**
China	2.0	2.5	2.7	5.5	6.7	8.1	9.4	10.3	5.1
India	1.4	1.5	1.5	3.3	3.8	4.3	4.5	4.6	4.2
Other	6.2	6.6	7.1	8.7	10.0	11.3	12.3	13.0	2.3
Middle East	**10.3**	**10.7**	**11.7**	**14.2**	**15.6**	**16.4**	**16.9**	**17.6**	**1.5**
Africa	**2.9**	**3.1**	**3.6**	**5.0**	**5.9**	**6.7**	**7.4**	**7.9**	**2.9**
Central and South America	**4.3**	**4.2**	**4.6**	**5.2**	**5.5**	**5.9**	**6.4**	**6.8**	**1.5**
Brazil	0.7	0.7	0.8	1.2	1.4	1.6	1.9	2.1	3.5
Other	3.6	3.5	3.7	3.9	4.1	4.3	4.5	4.7	0.9
Total Non-OECD	**51.8**	**53.5**	**56.2**	**66.5**	**71.4**	**76.3**	**80.1**	**83.3**	**1.5**
Total World	**104.1**	**107.4**	**110.7**	**124.9**	**132.5**	**139.6**	**146.7**	**153.3**	**1.2**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C6. World coal consumption by region, Low Oil Price case, 2006-2035
(Quadrillion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**24.4**	**24.7**	**24.3**	**21.0**	**22.2**	**24.1**	**24.7**	**24.9**	**0.1**
United States[a]	22.5	22.7	22.4	19.4	20.5	22.3	22.8	23.0	0.1
Canada	1.4	1.4	1.4	1.0	1.0	1.1	1.1	1.1	-0.8
Mexico/Chile	0.6	0.6	0.5	0.6	0.6	0.7	0.7	0.9	1.8
OECD Europe	**13.2**	**13.5**	**12.5**	**11.6**	**11.3**	**10.9**	**10.6**	**10.3**	**-0.7**
OECD Asia	**9.2**	**9.6**	**9.9**	**9.8**	**9.6**	**9.6**	**9.4**	**9.4**	**-0.2**
Japan	4.6	4.9	4.8	4.7	4.5	4.3	4.1	3.9	-0.8
South Korea	2.1	2.3	2.6	2.7	2.7	2.8	2.9	3.0	0.5
Australia/NewZealand	2.4	2.5	2.6	2.5	2.5	2.5	2.5	2.5	-0.1
Total OECD	**46.8**	**47.8**	**46.8**	**42.5**	**43.1**	**44.6**	**44.7**	**44.6**	**-0.2**
Non-OECD									
Non-OECD Europe and Eurasia	**8.8**	**8.6**	**8.9**	**8.6**	**8.1**	**7.7**	**7.4**	**7.1**	**-0.8**
Russia	4.4	4.2	4.5	4.5	4.3	4.1	4.0	3.9	-0.5
Other	4.4	4.5	4.5	4.0	3.8	3.6	3.4	3.2	-1.2
Non-OECD Asia	**66.3**	**71.4**	**77.5**	**101.3**	**104.4**	**110.3**	**114.2**	**115.2**	**1.5**
China	51.2	55.2	60.4	82.0	84.0	88.7	91.4	91.3	1.5
India	9.2	10.1	10.9	12.6	13.4	14.4	15.2	16.1	1.5
Other	5.8	6.1	6.3	6.7	7.0	7.3	7.5	7.8	0.8
Middle East	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**-0.3**
Africa	**4.2**	**4.4**	**4.6**	**5.2**	**5.4**	**5.5**	**5.5**	**5.6**	**0.7**
Central and South America	**0.7**	**0.8**	**0.8**	**1.1**	**1.2**	**1.3**	**1.5**	**1.7**	**2.9**
Brazil	0.4	0.5	0.5	0.8	0.9	1.1	1.2	1.5	4.2
Other	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	-0.8
Total Non-OECD	**80.4**	**85.6**	**92.2**	**116.5**	**119.4**	**125.2**	**129.0**	**130.0**	**1.3**
Total World	**127.2**	**133.3**	**139.0**	**159.0**	**162.5**	**169.8**	**173.7**	**174.6**	**0.9**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C7. World nuclear energy consumption by region, Low Oil Price case, 2006-2035
(Billion kilowatthours)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**891**	**905**	**905**	**963**	**1,010**	**1,013**	**1,039**	**1,046**	**0.5**
United States[a]	787	806	806	839	869	869	869	866	0.3
Canada	93	89	89	113	131	134	152	162	2.2
Mexico/Chile	10	10	9	10	10	10	18	18	2.4
OECD Europe	**935**	**884**	**882**	**965**	**998**	**1,067**	**1,111**	**1,136**	**0.9**
OECD Asia	**430**	**386**	**389**	**502**	**560**	**591**	**641**	**683**	**2.1**
Japan	288	251	245	319	342	358	388	417	2.0
South Korea	141	136	143	183	218	233	253	266	2.3
Australia/NewZealand	0	0	0	0	0	0	0	0	--
Total OECD	**2,255**	**2,176**	**2,175**	**2,430**	**2,568**	**2,672**	**2,791**	**2,865**	**1.0**
Non-OECD									
Non-OECD Europe and Eurasia	**263**	**272**	**276**	**342**	**416**	**504**	**567**	**614**	**3.0**
Russia	144	152	154	197	242	308	366	388	3.5
Other	119	120	121	145	174	196	201	225	2.3
Non-OECD Asia	**111**	**119**	**119**	**360**	**631**	**855**	**1,063**	**1,281**	**9.2**
China	55	63	65	223	419	585	749	916	10.3
India	16	16	13	66	119	157	187	211	10.8
Other	40	41	41	71	92	113	127	153	5.0
Middle East	**0**	**0**	**0**	**6**	**24**	**51**	**52**	**54**	**--**
Africa	**10**	**12**	**11**	**15**	**15**	**21**	**21**	**31**	**3.8**
Central and South America	**21**	**19**	**21**	**25**	**35**	**44**	**44**	**63**	**4.2**
Brazil	14	12	14	18	22	31	31	41	4.1
Other	7	7	7	7	13	13	13	22	4.4
Total Non-OECD	**405**	**422**	**427**	**748**	**1,121**	**1,474**	**1,747**	**2,043**	**6.0**
Total World	**2,660**	**2,598**	**2,602**	**3,178**	**3,690**	**4,146**	**4,538**	**4,908**	**2.4**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C8. World consumption of hydroelectricity and other renewable energy by region, Low Oil Price case, 2006-2035
(Quadrillion Btu)

	History			Projections					Average annual
Region	2006	2007	2008	2015	2020	2025	2030	2035	percent change, 2008-2035
OECD									
OECD Americas	**10.7**	**10.7**	**11.8**	**14.3**	**15.6**	**16.9**	**18.4**	**19.5**	**1.9**
United States[a]	6.4	6.2	7.1	8.6	9.3	10.2	10.9	11.4	1.8
Canada	3.7	3.9	4.0	4.4	4.9	5.2	5.7	6.0	1.5
Mexico/Chile	0.6	0.6	0.7	1.3	1.4	1.5	1.8	2.1	4.1
OECD Europe	**7.6**	**8.1**	**8.4**	**12.0**	**14.3**	**15.9**	**16.6**	**17.1**	**2.7**
OECD Asia	**2.0**	**1.9**	**1.9**	**3.2**	**3.6**	**4.0**	**4.1**	**4.4**	**3.1**
Japan	1.2	1.1	1.1	1.8	2.0	2.3	2.3	2.5	3.0
South Korea	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	3.1
Australia/NewZealand	0.7	0.7	0.7	1.2	1.4	1.4	1.5	1.6	3.3
Total OECD	**20.4**	**20.7**	**22.1**	**29.6**	**33.6**	**36.8**	**39.1**	**41.1**	**2.3**
Non-OECD									
Non-OECD Europe and Eurasia	**3.3**	**3.1**	**3.0**	**3.7**	**3.8**	**3.8**	**4.1**	**4.4**	**1.4**
Russia	1.9	1.9	1.7	2.1	2.1	2.1	2.4	2.6	1.6
Other	1.4	1.2	1.3	1.5	1.7	1.7	1.8	1.8	1.3
Non-OECD Asia	**10.5**	**11.2**	**12.6**	**20.3**	**27.2**	**30.2**	**33.1**	**35.6**	**3.9**
China	4.7	5.3	6.4	11.2	15.8	17.7	19.6	21.0	4.5
India	2.4	2.5	2.4	3.6	4.7	5.2	5.6	5.9	3.4
Other	3.5	3.5	3.7	5.6	6.7	7.3	7.9	8.8	3.2
Middle East	**0.3**	**0.3**	**0.1**	**0.4**	**0.6**	**0.6**	**0.7**	**0.7**	**6.2**
Africa	**3.5**	**3.6**	**3.7**	**4.4**	**4.7**	**4.9**	**5.0**	**5.1**	**1.2**
Central and South America	**9.2**	**9.6**	**9.8**	**10.8**	**11.8**	**13.0**	**14.3**	**15.5**	**1.7**
Brazil	5.5	5.9	6.0	7.3	8.2	9.1	10.2	11.4	2.4
Other	3.7	3.7	3.8	3.5	3.6	3.9	4.0	4.0	0.3
Total Non-OECD	**26.8**	**27.8**	**29.2**	**39.7**	**48.1**	**52.5**	**57.1**	**61.3**	**2.8**
Total World	**47.1**	**48.5**	**51.3**	**69.2**	**81.7**	**89.3**	**96.2**	**102.3**	**2.6**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C9. World carbon dioxide emissions by region, Low Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**7,014**	**7,123**	**6,926**	**6,907**	**7,127**	**7,457**	**7,733**	**8,074**	**0.6**
United States[a]	5,918	6,022	5,838	5,778	5,913	6,136	6,304	6,497	0.4
Canada	594	607	595	588	625	662	692	733	0.8
Mexico/Chile	502	494	493	541	589	659	737	844	2.0
OECD Europe	**4,428**	**4,413**	**4,345**	**4,226**	**4,346**	**4,400**	**4,459**	**4,518**	**0.2**
OECD Asia	**2,165**	**2,206**	**2,201**	**2,206**	**2,310**	**2,384**	**2,418**	**2,446**	**0.4**
Japan	1,240	1,254	1,215	1,159	1,223	1,237	1,218	1,195	-0.1
South Korea	484	503	522	571	595	637	670	705	1.1
Australia/NewZealand	440	449	464	476	493	511	530	546	0.6
Total OECD	**13,606**	**13,742**	**13,472**	**13,339**	**13,784**	**14,241**	**14,610**	**15,038**	**0.4**
Non-OECD									
Non-OECD Europe and Eurasia	**2,823**	**2,790**	**2,832**	**2,834**	**2,730**	**2,656**	**2,612**	**2,571**	**-0.4**
Russia	1,668	1,618	1,663	1,672	1,600	1,550	1,529	1,530	-0.3
Other	1,155	1,172	1,169	1,162	1,130	1,106	1,083	1,041	-0.4
Non-OECD Asia	**8,835**	**9,416**	**10,100**	**13,529**	**14,381**	**15,528**	**16,187**	**16,398**	**1.8**
China	5,817	6,257	6,801	9,572	10,018	10,753	11,125	11,126	1.8
India	1,281	1,367	1,462	1,846	2,049	2,289	2,457	2,573	2.1
Other	1,737	1,793	1,838	2,111	2,314	2,486	2,605	2,699	1.4
Middle East	**1,446**	**1,479**	**1,581**	**1,931**	**2,038**	**2,135**	**2,251**	**2,339**	**1.5**
Africa	**984**	**1,016**	**1,078**	**1,249**	**1,324**	**1,384**	**1,433**	**1,479**	**1.2**
Central and South America	**1,064**	**1,085**	**1,128**	**1,324**	**1,356**	**1,392**	**1,445**	**1,494**	**1.1**
Brazil	380	397	423	553	581	611	655	699	1.9
Other	684	688	705	771	775	781	789	795	0.4
Total Non-OECD	**15,152**	**15,786**	**16,718**	**20,867**	**21,829**	**23,095**	**23,928**	**24,281**	**1.4**
Total World	**28,758**	**29,529**	**30,190**	**34,206**	**35,613**	**37,336**	**38,538**	**39,319**	**1.0**

[a]Includes the 50 States and the District of Columbia.
Notes: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C10. World carbon dioxide emissions from liquids use by region, Low Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**3,198**	**3,219**	**3,050**	**3,191**	**3,257**	**3,355**	**3,489**	**3,690**	**0.7**
United States[a]	2,603	2,603	2,444	2,548	2,587	2,653	2,743	2,872	0.6
Canada	281	292	283	300	313	320	328	342	0.7
Mexico/Chile	314	325	323	344	358	382	418	475	1.4
OECD Europe	**2,135**	**2,090**	**2,076**	**2,001**	**2,102**	**2,153**	**2,178**	**2,214**	**0.2**
OECD Asia	**993**	**966**	**934**	**924**	**1,010**	**1,051**	**1,068**	**1,084**	**0.6**
Japan	622	599	574	525	590	610	601	593	0.1
South Korea	221	216	206	234	249	264	282	301	1.4
Australia/NewZealand	149	152	153	165	171	178	184	190	0.8
Total OECD	**6,326**	**6,276**	**6,059**	**6,116**	**6,369**	**6,560**	**6,734**	**6,987**	**0.5**
Non-OECD									
Non-OECD Europe and Eurasia	**670**	**624**	**637**	**694**	**669**	**656**	**658**	**651**	**0.1**
Russia	368	328	340	363	343	328	325	324	-0.2
Other	302	296	297	331	326	328	334	328	0.4
Non-OECD Asia	**2,147**	**2,185**	**2,242**	**3,105**	**3,507**	**3,919**	**4,082**	**4,107**	**2.3**
China	928	959	995	1,585	1,782	1,998	2,042	2,002	2.6
India	349	354	372	497	596	716	794	824	3.0
Other	870	872	874	1,022	1,129	1,205	1,246	1,282	1.4
Middle East	**839**	**845**	**894**	**1,100**	**1,133**	**1,182**	**1,273**	**1,323**	**1.5**
Africa	**428**	**437**	**447**	**487**	**491**	**499**	**501**	**513**	**0.5**
Central and South America	**757**	**777**	**799**	**933**	**937**	**936**	**947**	**953**	**0.7**
Brazil	301	315	332	411	418	424	437	446	1.1
Other	456	462	467	522	520	513	511	507	0.3
Total Non-OECD	**4,841**	**4,868**	**5,018**	**6,320**	**6,737**	**7,192**	**7,462**	**7,547**	**1.5**
Total World	**11,167**	**11,144**	**11,077**	**12,435**	**13,107**	**13,752**	**14,196**	**14,534**	**1.0**

[a]Includes the 50 States and the District of Columbia.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C11. World carbon dioxide emissions from natural gas use by region, Low Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

Region	History 2006	History 2007	History 2008	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD									
OECD Americas	**1,473**	**1,540**	**1,549**	**1,701**	**1,760**	**1,807**	**1,894**	**2,009**	**1.0**
United States[a]	1,157	1,235	1,243	1,364	1,370	1,350	1,379	1,432	0.5
Canada	180	187	186	196	217	243	265	288	1.6
Mexico/Chile	136	118	120	141	174	214	250	288	3.3
OECD Europe	**1,047**	**1,045**	**1,070**	**1,115**	**1,164**	**1,202**	**1,268**	**1,322**	**0.8**
OECD Asia	**326**	**352**	**351**	**376**	**412**	**452**	**480**	**497**	**1.3**
Japan	193	210	205	206	221	233	242	245	0.7
South Korea	68	74	75	92	101	116	123	127	2.0
Australia/NewZealand	66	68	71	78	90	103	115	125	2.1
Total OECD	**2,847**	**2,937**	**2,970**	**3,192**	**3,337**	**3,461**	**3,642**	**3,828**	**1.0**
Non-OECD									
Non-OECD Europe and Eurasia	**1,332**	**1,353**	**1,354**	**1,330**	**1,297**	**1,273**	**1,257**	**1,248**	**-0.3**
Russia	889	897	899	878	853	833	826	833	-0.3
Other	443	456	454	453	445	440	431	416	-0.3
Non-OECD Asia	**518**	**573**	**617**	**959**	**1,119**	**1,297**	**1,433**	**1,528**	**3.4**
China	111	138	151	303	370	450	520	572	5.1
India	78	83	86	189	216	242	256	263	4.2
Other	330	352	380	467	532	604	657	693	2.3
Middle East	**572**	**595**	**650**	**793**	**868**	**916**	**943**	**982**	**1.5**
Africa	**166**	**176**	**206**	**282**	**338**	**383**	**423**	**448**	**2.9**
Central and South America	**241**	**238**	**256**	**290**	**309**	**333**	**358**	**383**	**1.5**
Brazil	38	39	46	68	80	89	103	117	3.5
Other	203	199	210	222	230	244	255	265	0.9
Total Non-OECD	**2,829**	**2,934**	**3,083**	**3,655**	**3,931**	**4,203**	**4,414**	**4,589**	**1.5**
Total World	**5,675**	**5,870**	**6,052**	**6,846**	**7,268**	**7,664**	**8,057**	**8,417**	**1.2**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table C12. World carbon dioxide emissions from coal use by region, Low Oil Price case, 2006-2035
(Million metric tons carbon dioxide)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**2,331**	**2,352**	**2,315**	**2,003**	**2,098**	**2,283**	**2,338**	**2,363**	**0.1**
United States[a]	2,147	2,172	2,139	1,855	1,944	2,121	2,170	2,181	0.1
Canada	132	128	126	92	95	99	99	102	-0.8
Mexico/Chile	53	51	50	56	58	63	70	81	1.8
OECD Europe	**1,245**	**1,279**	**1,200**	**1,110**	**1,080**	**1,045**	**1,013**	**983**	**-0.7**
OECD Asia	**846**	**888**	**917**	**907**	**888**	**881**	**871**	**864**	**-0.2**
Japan	425	446	436	429	411	394	375	356	-0.8
South Korea	195	213	240	244	245	257	265	277	0.5
Australia/NewZealand	226	229	240	233	232	230	230	231	-0.1
Total OECD	**4,422**	**4,518**	**4,431**	**4,020**	**4,066**	**4,208**	**4,222**	**4,210**	**-0.2**
Non-OECD									
Non-OECD Europe and Eurasia	**821**	**813**	**841**	**810**	**764**	**728**	**697**	**672**	**-0.8**
Russia	412	393	424	431	405	389	378	374	-0.5
Other	410	420	417	379	359	339	319	298	-1.2
Non-OECD Asia	**6,170**	**6,659**	**7,241**	**9,465**	**9,755**	**10,311**	**10,672**	**10,764**	**1.5**
China	4,779	5,160	5,654	7,684	7,865	8,305	8,563	8,553	1.5
India	854	931	1,003	1,160	1,237	1,330	1,407	1,487	1.5
Other	537	569	583	622	652	677	702	724	0.8
Middle East	**36**	**39**	**37**	**38**	**37**	**36**	**35**	**34**	**-0.3**
Africa	**390**	**403**	**426**	**480**	**496**	**502**	**510**	**518**	**0.7**
Central and South America	**65**	**70**	**72**	**101**	**109**	**123**	**139**	**158**	**2.9**
Brazil	41	43	44	74	84	98	115	135	4.2
Other	25	27	28	27	26	25	24	23	-0.8
Total Non-OECD	**7,482**	**7,985**	**8,618**	**10,893**	**11,161**	**11,700**	**12,052**	**12,145**	**1.3**
Total World	**11,904**	**12,503**	**13,049**	**14,913**	**15,227**	**15,909**	**16,274**	**16,356**	**0.8**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011,* DOE/EIA-0383(2011), AEO2011 National Energy Modeling System, run LP20011LNO.D022511A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

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Appendix D

Reference case projections by end-use sector and country grouping

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Table D1. Total world delivered energy consumption by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
		Projections					
Residential							
Liquids	9.8	9.7	9.1	8.9	8.8	8.8	-0.4
Natural gas	20.8	22.3	23.3	24.3	24.8	25.4	0.8
Coal	4.4	4.5	4.6	4.6	4.5	4.4	0.0
Electricity	16.2	19.4	22.0	24.7	27.5	30.3	2.3
Renewables	0.4	0.4	0.4	0.4	0.4	0.4	-0.2
Total	**51.7**	**56.2**	**59.4**	**62.9**	**66.1**	**69.3**	**1.1**
Commercial							
Liquids	4.6	4.3	4.2	4.1	4.1	4.1	-0.4
Natural gas	8.3	9.2	9.6	10.0	10.3	10.6	0.9
Coal	1.2	1.3	1.3	1.4	1.4	1.5	0.7
Electricity	13.8	17.0	19.3	21.7	23.9	25.8	2.3
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	**28.1**	**31.9**	**34.6**	**37.3**	**39.9**	**42.1**	**1.5**
Industrial							
Liquids	55.3	57.5	59.2	61.9	65.1	68.6	0.8
Natural gas	44.0	49.7	54.3	58.8	63.9	69.5	1.7
Coal	49.8	61.2	64.5	68.7	72.3	75.5	1.6
Electricity	27.9	32.4	36.3	41.1	46.1	51.4	2.3
Renewables	14.2	15.4	17.2	19.4	21.4	23.2	1.8
Total	**191.3**	**216.2**	**231.5**	**249.9**	**268.8**	**288.2**	**1.5**
Transportation							
Liquids	93.5	106.8	114.6	123.9	130.7	136.1	1.4
Natural gas	3.6	3.7	3.8	3.9	4.2	4.6	0.9
Coal	0.2	0.2	0.1	0.0	0.0	0.0	--
Electricity	0.9	1.2	1.2	1.3	1.5	1.4	1.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**98.2**	**111.9**	**119.9**	**129.1**	**136.5**	**142.1**	**1.4**
All end-use sectors							
Liquids	163.3	178.2	187.1	198.8	208.7	217.7	1.1
Natural gas	76.8	84.8	91.0	96.9	103.3	110.1	1.3
Coal	55.6	67.3	70.6	74.7	78.2	81.3	1.4
Electricity	58.9	70.1	78.9	88.9	99.1	108.9	2.3
Renewables	14.8	15.9	17.7	19.9	21.9	23.7	1.8
Delivered energy	**369.4**	**416.3**	**445.4**	**479.2**	**511.3**	**541.7**	**1.4**
Electricity-related losses	135.3	157.2	174.1	192.3	210.2	228.1	2.0
Total	**504.7**	**573.5**	**619.5**	**671.5**	**721.5**	**769.8**	**1.6**
Electric power[a]							
Liquids	9.7	9.0	8.6	8.2	7.8	7.5	-0.9
Natural gas	37.5	42.5	47.0	52.5	59.0	64.6	2.0
Coal	83.4	90.0	94.0	105.0	116.4	127.8	1.6
Nuclear	27.2	33.1	38.9	43.7	47.4	51.2	2.4
Renewables	36.5	52.6	64.5	71.7	78.7	85.8	3.2
Total	**194.3**	**227.3**	**253.0**	**281.1**	**309.3**	**337.0**	**2.1**
Total energy consumption							
Liquids	173.0	187.2	195.8	207.0	216.6	225.2	1.0
Natural gas	114.3	127.3	138.0	149.4	162.3	174.7	1.6
Coal	139.0	157.3	164.6	179.7	194.7	209.1	1.5
Nuclear	27.2	33.1	38.9	43.7	47.4	51.2	2.4
Renewables	51.3	68.5	82.2	91.7	100.6	109.5	2.9
Total	**504.7**	**573.5**	**619.5**	**671.5**	**721.5**	**769.8**	**1.6**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table D2. Total OECD delivered energy consumption by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	4.5	3.9	3.8	3.7	3.6	3.6	-0.8
Natural gas	12.0	12.3	12.4	12.3	12.1	11.9	0.0
Coal	0.7	0.6	0.6	0.5	0.5	0.4	-1.4
Electricity	10.1	10.8	11.5	12.1	12.7	13.3	1.0
Renewables	0.4	0.4	0.4	0.4	0.4	0.4	-0.2
Total	**27.7**	**28.0**	**28.6**	**29.1**	**29.4**	**29.7**	**0.3**
Commercial							
Liquids	3.0	2.5	2.5	2.5	2.5	2.5	-0.7
Natural gas	6.6	7.1	7.3	7.3	7.3	7.4	0.4
Coal	0.2	0.2	0.2	0.2	0.2	0.2	-1.0
Electricity	10.0	11.2	12.1	13.0	14.0	15.0	1.5
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	**20.0**	**21.1**	**22.2**	**23.1**	**24.1**	**25.1**	**0.8**
Industrial							
Liquids	28.1	26.2	27.0	27.4	27.6	28.0	0.0
Natural gas	19.1	20.2	21.2	21.9	22.9	24.0	0.9
Coal	9.2	8.6	8.6	8.8	9.0	9.2	0.0
Electricity	11.4	11.5	12.3	13.0	13.7	14.4	0.9
Renewables	5.3	5.4	6.1	7.0	7.6	8.0	1.6
Total	**73.0**	**72.0**	**75.2**	**78.1**	**80.7**	**83.6**	**0.5**
Transportation							
Liquids	57.9	58.7	59.6	60.5	61.7	63.3	0.3
Natural gas	1.0	1.2	1.1	1.0	1.1	1.1	0.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.4	0.5	0.4	0.4	0.5	0.5	0.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**59.3**	**60.4**	**61.2**	**61.9**	**63.2**	**64.8**	**0.3**
All end-use sectors							
Liquids	93.5	91.3	92.9	94.1	95.4	97.3	0.2
Natural gas	38.6	40.8	42.0	42.5	43.4	44.3	0.5
Coal	10.0	9.4	9.3	9.5	9.6	9.9	-0.1
Electricity	32.0	34.1	36.3	38.6	40.9	43.2	1.1
Renewables	5.8	5.9	6.6	7.5	8.1	8.5	1.4
Delivered energy	**180.0**	**181.5**	**187.1**	**192.2**	**197.4**	**203.2**	**0.5**
Electricity-related losses	64.2	68.9	73.4	77.5	81.3	85.0	1.0
Total	**244.3**	**250.4**	**260.6**	**269.8**	**278.7**	**288.2**	**0.6**
Electric power[a]							
Liquids	3.0	2.8	2.7	2.6	2.5	2.4	-0.8
Natural gas	17.6	18.4	19.5	21.0	23.7	26.2	1.5
Coal	36.7	33.2	33.8	35.1	35.6	36.8	0.0
Nuclear	22.6	25.2	26.7	27.8	29.1	29.8	1.0
Renewables	16.3	23.4	27.1	29.6	31.3	32.9	2.6
Total	**96.2**	**103.0**	**109.8**	**116.1**	**122.2**	**128.1**	**1.1**
Total energy consumption							
Liquids	96.5	94.1	95.6	96.7	97.9	99.7	0.1
Natural gas	56.3	59.2	61.4	63.6	67.1	70.6	0.8
Coal	46.8	42.6	43.1	44.6	45.3	46.7	0.0
Nuclear	22.6	25.2	26.7	27.8	29.1	29.8	1.0
Renewables	22.1	29.3	33.6	37.1	39.4	41.4	2.4
Total	**244.3**	**250.4**	**260.6**	**269.8**	**278.7**	**288.2**	**0.6**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table D3. Delivered energy consumption in the United States by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections: 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	1.2	1.1	1.0	0.9	0.9	0.9	-1.2
Natural gas	5.0	4.9	5.0	5.0	5.0	4.9	-0.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-1.6
Electricity	4.7	4.6	4.8	5.0	5.2	5.5	0.6
Renewables	0.4	0.4	0.4	0.4	0.4	0.4	-0.2
Total	**11.4**	**11.0**	**11.2**	**11.3**	**11.5**	**11.7**	**0.1**
Commercial							
Liquids	0.6	0.5	0.5	0.5	0.5	0.5	-0.7
Natural gas	3.2	3.5	3.6	3.7	3.8	3.9	0.7
Coal	0.1	0.1	0.1	0.1	0.1	0.1	-0.6
Electricity	4.6	4.8	5.2	5.6	6.0	6.4	1.3
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	**8.6**	**9.0**	**9.5**	**9.9**	**10.5**	**11.1**	**0.9**
Industrial							
Liquids	8.9	9.3	9.2	9.2	9.0	8.9	0.0
Natural gas	8.1	9.5	9.7	9.5	9.5	9.5	0.6
Coal	1.8	1.7	1.7	1.9	2.2	2.6	1.4
Electricity	3.4	3.5	3.6	3.5	3.4	3.3	-0.2
Renewables	2.5	2.7	3.2	4.0	4.4	4.6	2.3
Total	**24.7**	**26.7**	**27.3**	**28.1**	**28.5**	**28.9**	**0.6**
Transportation							
Liquids	27.2	27.8	28.2	28.8	29.7	30.9	0.5
Natural gas	0.7	0.7	0.7	0.7	0.8	0.8	0.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.0	0.0	0.1	0.1	4.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**28.0**	**28.5**	**29.0**	**29.6**	**30.5**	**31.8**	**0.5**
All end-use sectors							
Liquids	38.0	38.7	38.9	39.4	40.1	41.2	0.3
Natural gas	17.0	18.6	19.0	18.9	19.1	19.2	0.5
Coal	1.9	1.7	1.8	2.0	2.3	2.7	1.3
Electricity	12.7	13.0	13.6	14.1	14.7	15.3	0.7
Renewables	3.0	3.3	3.7	4.5	4.9	5.1	1.9
Delivered energy	**72.6**	**75.3**	**77.0**	**78.9**	**81.1**	**83.5**	**0.5**
Electricity-related losses	27.5	26.7	28.0	29.0	29.9	30.7	0.4
Total	**100.1**	**102.0**	**104.9**	**108.0**	**111.0**	**114.2**	**0.5**
Electric power[a]							
Liquids	0.5	0.4	0.4	0.5	0.5	0.5	0.0
Natural gas	6.8	7.2	7.0	6.8	7.5	8.1	0.6
Coal	20.5	18.0	19.1	20.6	21.1	21.6	0.2
Nuclear	8.4	8.8	9.2	9.2	9.2	9.1	0.3
Renewables	4.0	5.4	5.8	6.1	6.4	6.7	2.0
Total	**40.2**	**39.7**	**41.5**	**43.2**	**44.6**	**46.0**	**0.5**
Total energy consumption							
Liquids	38.5	39.1	39.4	39.8	40.6	41.7	0.3
Natural gas	23.8	25.8	26.0	25.7	26.6	27.2	0.5
Coal	22.4	19.7	20.8	22.6	23.4	24.3	0.3
Nuclear	8.4	8.8	9.2	9.2	9.2	9.1	0.3
Renewables	7.0	8.6	9.5	10.6	11.3	11.8	1.9
Total	**100.1**	**102.0**	**104.9**	**108.0**	**111.0**	**114.2**	**0.5**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC: May 2011); AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo, and World Energy Projection System Plus (2011).

Table D4. Delivered energy consumption in Canada by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-0.3
Natural gas	0.7	0.7	0.7	0.7	0.7	0.7	0.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-1.4
Electricity	0.6	0.6	0.7	0.7	0.8	0.8	1.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.3**	**1.4**	**1.4**	**1.5**	**1.6**	**1.6**	**0.7**
Commercial							
Liquids	0.3	0.3	0.3	0.3	0.3	0.3	-0.1
Natural gas	0.5	0.5	0.5	0.5	0.6	0.6	0.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Electricity	0.6	0.6	0.7	0.8	0.9	1.0	2.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.3**
Industrial							
Liquids	1.6	1.5	1.5	1.5	1.6	1.7	0.2
Natural gas	2.0	2.1	2.3	2.5	2.8	3.1	1.7
Coal	0.4	0.3	0.3	0.3	0.3	0.3	-0.5
Electricity	0.7	0.6	0.7	0.8	0.9	1.0	1.1
Renewables	0.5	0.5	0.5	0.6	0.6	0.6	0.9
Total	**5.2**	**5.0**	**5.5**	**5.8**	**6.2**	**6.7**	**1.0**
Transportation							
Liquids	2.3	2.5	2.4	2.4	2.5	2.5	0.3
Natural gas	0.1	0.1	0.1	0.1	0.1	0.1	-0.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	-2.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.5**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**0.2**
All end-use sectors							
Liquids	4.3	4.4	4.4	4.4	4.5	4.6	0.2
Natural gas	3.3	3.4	3.6	3.8	4.2	4.5	1.2
Coal	0.4	0.3	0.3	0.3	0.3	0.3	-0.5
Electricity	1.9	1.9	2.2	2.4	2.6	2.8	1.6
Renewables	0.5	0.5	0.5	0.6	0.6	0.6	0.9
Delivered energy	**10.4**	**10.5**	**11.0**	**11.5**	**12.2**	**12.9**	**0.8**
Electricity-related losses	3.9	4.1	4.6	5.0	5.4	5.9	1.5
Total	**14.3**	**14.6**	**15.7**	**16.4**	**17.6**	**18.8**	**1.0**
Electric power[a]							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-1.0
Natural gas	0.3	0.2	0.2	0.5	0.5	0.7	4.0
Coal	1.0	0.7	0.7	0.7	0.7	0.8	-0.7
Nuclear	1.0	1.3	1.4	1.5	1.7	1.8	2.1
Renewables	3.5	3.8	4.4	4.6	5.1	5.4	1.6
Total	**5.8**	**6.1**	**6.8**	**7.3**	**8.0**	**8.7**	**1.5**
Total energy consumption							
Liquids	4.4	4.5	4.4	4.4	4.5	4.7	0.2
Natural gas	3.5	3.6	3.8	4.3	4.7	5.2	1.5
Coal	1.4	1.0	1.0	1.0	1.0	1.1	-0.7
Nuclear	1.0	1.3	1.4	1.5	1.7	1.8	2.1
Renewables	4.0	4.3	4.9	5.2	5.7	6.0	1.5
Total	**14.3**	**14.6**	**15.7**	**16.4**	**17.6**	**18.8**	**1.0**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D5. Delivered energy consumption in Mexico and Chile by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.3	0.3	0.3	0.3	0.3	0.3	0.1
Natural gas	0.0	0.0	0.0	0.0	0.1	0.1	2.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.2	0.3	0.4	0.5	0.5	0.6	3.9
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.6**	**0.7**	**0.7**	**0.8**	**0.9**	**1.0**	**2.1**
Commercial							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.1	0.2	0.2	0.3	0.3	0.4	5.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.2**	**0.2**	**0.3**	**0.3**	**0.4**	**0.5**	**3.6**
Industrial							
Liquids	1.2	1.2	1.2	1.3	1.3	1.4	0.6
Natural gas	1.1	1.2	1.4	1.7	2.1	2.5	3.0
Coal	0.3	0.3	0.3	0.3	0.4	0.4	0.8
Electricity	0.6	0.6	0.7	0.8	1.0	1.2	2.7
Renewables	0.1	0.1	0.1	0.1	0.1	0.2	1.6
Total	**3.3**	**3.4**	**3.8**	**4.3**	**4.9**	**5.6**	**2.0**
Transportation							
Liquids	2.8	3.0	3.1	3.2	3.3	3.6	0.9
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	3.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	2.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.8**	**3.0**	**3.1**	**3.2**	**3.3**	**3.6**	**0.9**
All end-use sectors							
Liquids	4.4	4.6	4.7	4.8	5.0	5.4	0.8
Natural gas	1.2	1.3	1.5	1.8	2.1	2.6	3.0
Coal	0.3	0.3	0.3	0.3	0.4	0.4	0.8
Electricity	0.9	1.1	1.3	1.5	1.8	2.2	3.4
Renewables	0.1	0.1	0.1	0.1	0.1	0.2	1.6
Delivered energy	**6.9**	**7.3**	**7.9**	**8.6**	**9.5**	**10.7**	**1.7**
Electricity-related losses	1.6	2.2	2.5	2.9	3.4	4.1	3.6
Total	**8.5**	**9.5**	**10.4**	**11.5**	**13.0**	**14.7**	**2.1**
Electric power[a]							
Liquids	0.4	0.4	0.4	0.4	0.3	0.3	-0.7
Natural gas	1.1	1.3	1.7	2.3	2.7	3.1	3.9
Coal	0.2	0.3	0.3	0.3	0.4	0.7	4.2
Nuclear	0.1	0.1	0.1	0.1	0.2	0.2	2.5
Renewables	0.6	1.2	1.3	1.4	1.7	1.9	4.3
Total	**2.5**	**3.2**	**3.8**	**4.5**	**5.3**	**6.2**	**3.5**
Total energy consumption							
Liquids	4.8	5.0	5.0	5.2	5.4	5.8	0.7
Natural gas	2.3	2.5	3.2	4.1	4.8	5.6	3.4
Coal	0.5	0.6	0.6	0.7	0.8	1.1	2.6
Nuclear	0.1	0.1	0.1	0.1	0.2	0.2	2.5
Renewables	0.7	1.3	1.4	1.5	1.8	2.1	4.0
Total	**8.5**	**9.5**	**10.4**	**11.5**	**13.0**	**14.7**	**2.1**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D6. Delivered energy consumption in OECD Europe by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	2.1	1.8	1.8	1.8	1.8	1.7	-0.7
Natural gas	5.4	5.6	5.7	5.6	5.5	5.3	0.0
Coal	0.6	0.5	0.5	0.5	0.4	0.4	-1.4
Electricity	3.1	3.7	3.9	4.2	4.3	4.5	1.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**11.2**	**11.7**	**12.0**	**12.1**	**12.0**	**12.0**	**0.2**
Commercial							
Liquids	1.0	0.8	0.8	0.8	0.8	0.8	-0.9
Natural gas	2.0	2.1	2.1	2.1	2.0	2.0	-0.1
Coal	0.1	0.1	0.1	0.1	0.1	0.1	-1.4
Electricity	2.9	3.4	3.7	3.9	4.2	4.4	1.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**6.0**	**6.5**	**6.7**	**7.0**	**7.1**	**7.2**	**0.7**
Industrial							
Liquids	9.7	8.1	8.5	8.7	8.8	8.9	-0.3
Natural gas	6.3	5.8	6.0	6.3	6.5	6.8	0.3
Coal	3.1	2.6	2.6	2.6	2.5	2.4	-0.9
Electricity	4.7	4.5	5.0	5.3	5.7	6.1	1.0
Renewables	1.6	1.5	1.6	1.7	1.8	2.0	0.8
Total	**25.3**	**22.6**	**23.7**	**24.6**	**25.3**	**26.2**	**0.1**
Transportation							
Liquids	18.4	18.1	18.3	18.4	18.6	18.5	0.0
Natural gas	0.1	0.3	0.2	0.1	0.1	0.1	-1.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.3	0.4	0.3	0.3	0.3	0.3	0.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**18.8**	**18.7**	**18.8**	**18.7**	**18.9**	**18.9**	**0.0**
All end-use sectors							
Liquids	31.2	28.9	29.4	29.7	29.9	30.0	-0.2
Natural gas	13.8	13.8	14.1	14.1	14.1	14.1	0.1
Coal	3.8	3.3	3.2	3.1	3.0	2.9	-1.0
Electricity	10.9	12.0	12.8	13.7	14.5	15.2	1.2
Renewables	1.6	1.5	1.6	1.7	1.8	2.0	0.8
Delivered energy	**61.3**	**59.5**	**61.2**	**62.3**	**63.3**	**64.2**	**0.2**
Electricity-related losses	20.9	24.1	25.7	27.3	28.5	29.6	1.3
Total	**82.2**	**83.6**	**86.9**	**89.7**	**91.8**	**93.8**	**0.5**
Electric power[a]							
Liquids	0.8	0.8	0.7	0.7	0.7	0.6	-1.0
Natural gas	6.3	6.6	7.0	7.5	8.6	9.8	1.6
Coal	8.7	8.3	8.0	7.7	7.5	7.5	-0.5
Nuclear	9.1	10.0	10.3	11.1	11.5	11.8	1.0
Renewables	6.8	10.5	12.6	14.1	14.7	15.1	3.0
Total	**31.8**	**36.1**	**38.6**	**41.0**	**43.0**	**44.9**	**1.3**
Total energy consumption							
Liquids	32.0	29.7	30.1	30.4	30.5	30.6	-0.2
Natural gas	20.1	20.4	21.0	21.6	22.7	23.9	0.7
Coal	12.5	11.5	11.2	10.8	10.5	10.4	-0.7
Nuclear	9.1	10.0	10.3	11.1	11.5	11.8	1.0
Renewables	8.4	12.0	14.2	15.8	16.5	17.1	2.7
Total	**82.2**	**83.6**	**86.9**	**89.7**	**91.8**	**93.8**	**0.5**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D7. Delivered energy consumption in Japan by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.6	0.4	0.5	0.5	0.4	0.4	-1.2
Natural gas	0.4	0.5	0.4	0.4	0.4	0.4	-0.2
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	1.1	1.1	1.1	1.2	1.2	1.2	0.5
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.1**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**-0.1**
Commercial							
Liquids	0.8	0.6	0.6	0.6	0.6	0.6	-0.9
Natural gas	0.7	0.8	0.8	0.8	0.7	0.7	-0.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.8
Electricity	1.3	1.3	1.4	1.5	1.5	1.6	0.7
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.8**	**2.7**	**2.8**	**2.9**	**2.9**	**2.9**	**0.1**
Industrial							
Liquids	3.7	3.0	3.3	3.4	3.4	3.3	-0.5
Natural gas	0.5	0.5	0.6	0.6	0.6	0.6	0.7
Coal	2.2	2.2	2.1	1.9	1.8	1.7	-1.0
Electricity	0.9	1.0	1.0	1.1	1.1	1.2	1.2
Renewables	0.3	0.3	0.3	0.3	0.3	0.3	-0.4
Total	**7.7**	**7.0**	**7.3**	**7.3**	**7.2**	**7.1**	**-0.3**
Transportation							
Liquids	3.9	3.8	4.0	4.1	4.0	3.9	0.0
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**4.0**	**3.9**	**4.1**	**4.1**	**4.0**	**4.0**	**0.0**
All end-use sectors							
Liquids	9.0	7.8	8.4	8.6	8.4	8.3	-0.3
Natural gas	1.7	1.8	1.8	1.8	1.8	1.7	0.1
Coal	2.3	2.2	2.1	2.0	1.8	1.7	-1.0
Electricity	3.3	3.5	3.6	3.8	3.9	4.0	0.8
Renewables	0.3	0.3	0.3	0.3	0.3	0.3	-0.4
Delivered energy	**16.5**	**15.6**	**16.2**	**16.4**	**16.1**	**16.0**	**-0.1**
Electricity-related losses	5.8	6.6	7.0	7.3	7.6	7.8	1.1
Total	**22.4**	**22.2**	**23.2**	**23.7**	**23.7**	**23.8**	**0.2**
Electric power[a]							
Liquids	1.1	1.0	1.0	0.9	0.9	0.8	
Natural gas	2.2	2.0	2.1	2.3	2.4	2.5	0.5
Coal	2.5	2.4	2.3	2.2	2.1	2.1	-0.6
Nuclear	2.5	3.3	3.5	3.7	4.0	4.3	2.0
Renewables	0.8	1.4	1.7	2.0	2.0	2.2	3.7
Total	**9.1**	**10.1**	**10.6**	**11.1**	**11.5**	**11.9**	**1.0**
Total energy consumption							
Liquids	10.1	8.8	9.4	9.5	9.3	9.1	-0.4
Natural gas	3.9	3.9	3.9	4.1	4.2	4.2	0.3
Coal	4.8	4.6	4.4	4.2	4.0	3.8	-0.8
Nuclear	2.5	3.3	3.5	3.7	4.0	4.3	2.0
Renewables	1.1	1.6	2.0	2.2	2.3	2.4	2.9
Total	**22.4**	**22.2**	**23.2**	**23.7**	**23.7**	**23.8**	**0.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D8. Delivered energy consumption in South Korea by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-0.4
Natural gas	0.4	0.4	0.4	0.4	0.4	0.4	0.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-2.1
Electricity	0.2	0.2	0.3	0.3	0.3	0.3	2.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.7**	**0.8**	**0.8**	**0.9**	**0.9**	**0.9**	**0.6**
Commercial							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-0.6
Natural gas	0.1	0.2	0.2	0.2	0.2	0.2	1.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.5	0.5	0.6	0.7	0.8	0.9	2.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.7**	**0.8**	**0.9**	**1.0**	**1.1**	**1.2**	**1.7**
Industrial							
Liquids	2.3	2.6	2.6	2.8	2.9	3.1	1.0
Natural gas	0.3	0.3	0.3	0.3	0.3	0.3	0.9
Coal	1.0	1.0	1.1	1.1	1.1	1.2	0.7
Electricity	0.7	0.8	0.9	1.0	1.0	1.1	1.7
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	1.5
Total	**4.4**	**4.8**	**5.0**	**5.3**	**5.5**	**5.8**	**1.1**
Transportation							
Liquids	1.7	1.8	1.9	1.9	1.9	1.9	0.5
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.7**	**1.9**	**1.9**	**2.0**	**2.0**	**2.0**	**0.6**
All end-use sectors							
Liquids	4.3	4.7	4.8	4.9	5.1	5.3	0.8
Natural gas	0.8	0.9	0.9	1.0	1.0	1.0	0.7
Coal	1.0	1.1	1.1	1.1	1.2	1.2	0.6
Electricity	1.4	1.6	1.7	1.9	2.1	2.3	2.0
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	1.5
Delivered energy	**7.6**	**8.3**	**8.6**	**9.0**	**9.5**	**9.9**	**1.0**
Electricity-related losses	2.4	2.7	3.0	3.3	3.7	4.0	1.9
Total	**10.0**	**11.1**	**11.6**	**12.4**	**13.1**	**13.9**	**1.2**
Electric power[a]							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-1.0
Natural gas	0.6	0.8	0.8	1.0	1.1	1.1	2.4
Coal	1.6	1.5	1.5	1.7	1.9	2.3	1.2
Nuclear	1.4	1.8	2.2	2.4	2.6	2.7	2.4
Renewables	0.1	0.1	0.1	0.1	0.1	0.2	4.7
Total	**3.8**	**4.3**	**4.8**	**5.3**	**5.8**	**6.3**	**1.9**
Total energy consumption							
Liquids	4.4	4.8	4.8	5.0	5.2	5.3	0.7
Natural gas	1.4	1.7	1.8	2.0	2.1	2.1	1.5
Coal	2.6	2.6	2.6	2.8	3.1	3.4	1.0
Nuclear	1.4	1.8	2.2	2.4	2.6	2.7	2.4
Renewables	0.1	0.2	0.2	0.2	0.3	0.3	3.0
Total	**10.0**	**11.1**	**11.6**	**12.4**	**13.1**	**13.9**	**1.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D9. Delivered energy consumption in Australia/New Zealand by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.0	0.0	0.0	0.0	0.0	0.0	-0.5
Natural gas	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.8
Electricity	0.2	0.3	0.3	0.3	0.3	0.3	1.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**0.5**	**0.8**
Commercial							
Liquids	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	-1.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.4
Electricity	0.2	0.3	0.3	0.3	0.3	0.3	1.7
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.3**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**1.1**
Industrial							
Liquids	0.6	0.6	0.6	0.6	0.6	0.6	0.1
Natural gas	0.8	0.8	0.9	1.0	1.0	1.1	1.3
Coal	0.4	0.4	0.5	0.6	0.6	0.7	2.0
Electricity	0.4	0.4	0.5	0.5	0.6	0.6	1.1
Renewables	0.2	0.2	0.2	0.2	0.2	0.3	1.2
Total	**2.4**	**2.5**	**2.7**	**2.8**	**3.1**	**3.3**	**1.1**
Transportation							
Liquids	1.6	1.7	1.7	1.7	1.8	1.9	0.6
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.6**	**1.7**	**1.7**	**1.8**	**1.9**	**1.9**	**0.7**
All end-use sectors							
Liquids	2.2	2.3	2.3	2.4	2.4	2.5	0.5
Natural gas	1.0	1.0	1.1	1.2	1.3	1.4	1.1
Coal	0.4	0.5	0.5	0.6	0.6	0.7	1.9
Electricity	0.9	1.0	1.1	1.1	1.2	1.3	1.3
Renewables	0.2	0.2	0.2	0.2	0.2	0.3	1.2
Delivered energy	**4.7**	**5.0**	**5.2**	**5.5**	**5.8**	**6.1**	**1.0**
Electricity-related losses	2.1	2.5	2.6	2.7	2.8	2.8	1.1
Total	**6.8**	**7.4**	**7.8**	**8.1**	**8.5**	**8.9**	**1.0**
Electric power[a]							
Liquids	0.0	0.0	0.0	0.0	0.0	0.0	-1.0
Natural gas	0.3	0.4	0.5	0.7	0.9	1.0	3.9
Coal	2.1	2.0	2.0	1.9	1.8	1.8	-0.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	--
Renewables	0.5	1.0	1.2	1.2	1.3	1.3	3.9
Total	**3.0**	**3.5**	**3.7**	**3.8**	**4.0**	**4.1**	**1.2**
Total energy consumption							
Liquids	2.2	2.3	2.3	2.4	2.5	2.5	0.5
Natural gas	1.3	1.4	1.6	1.9	2.1	2.3	2.1
Coal	2.6	2.5	2.5	2.5	2.5	2.5	-0.1
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Renewables	0.7	1.2	1.4	1.4	1.5	1.6	3.3
Total	**6.8**	**7.4**	**7.8**	**8.1**	**8.5**	**8.9**	**1.0**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D10. Total Non-OECD delivered energy consumption by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	5.3	5.8	5.3	5.2	5.2	5.2	-0.1
Natural gas	8.8	10.0	10.9	11.9	12.7	13.5	1.6
Coal	3.8	3.9	4.0	4.0	4.0	3.9	0.2
Electricity	6.1	8.6	10.6	12.7	14.8	16.9	3.9
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**24.0**	**28.3**	**30.8**	**33.8**	**36.7**	**39.6**	**1.9**
Commercial							
Liquids	1.7	1.8	1.7	1.6	1.6	1.6	0.0
Natural gas	1.7	2.1	2.3	2.7	3.0	3.2	2.4
Coal	1.0	1.1	1.1	1.2	1.2	1.3	1.0
Electricity	3.8	5.9	7.2	8.6	9.9	10.9	4.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**8.1**	**10.8**	**12.4**	**14.2**	**15.8**	**17.1**	**2.8**
Industrial							
Liquids	27.2	31.2	32.2	34.4	37.5	40.6	1.5
Natural gas	25.0	29.4	33.1	36.9	41.1	45.6	2.3
Coal	40.7	52.7	56.0	59.9	63.3	66.2	1.8
Electricity	16.5	20.9	24.0	28.1	32.5	37.0	3.0
Renewables	8.9	10.0	11.2	12.4	13.8	15.2	2.0
Total	**118.3**	**144.2**	**156.3**	**171.8**	**188.1**	**204.5**	**2.1**
Transportation							
Liquids	35.6	48.1	55.1	63.4	69.0	72.9	2.7
Natural gas	2.6	2.5	2.7	2.9	3.2	3.4	1.0
Coal	0.1	0.2	0.1	0.0	0.0	0.0	-21.5
Electricity	0.5	0.7	0.8	0.9	1.1	1.0	2.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**38.9**	**51.6**	**58.7**	**67.2**	**73.3**	**77.3**	**2.6**
All end-use sectors							
Liquids	69.8	86.9	94.2	104.7	113.3	120.4	2.0
Natural gas	38.1	44.0	49.1	54.4	59.9	65.7	2.0
Coal	45.6	57.9	61.3	65.2	68.6	71.4	1.7
Electricity	26.9	36.0	42.5	50.3	58.2	65.8	3.4
Renewables	8.9	10.0	11.2	12.4	13.8	15.2	2.0
Delivered energy	**189.4**	**234.8**	**258.3**	**287.0**	**313.8**	**338.5**	**2.2**
Electricity-related losses	71.1	88.2	100.6	114.7	128.9	143.1	2.6
Total	**260.5**	**323.1**	**358.9**	**401.7**	**442.8**	**481.6**	**2.3**
Electric power[a]							
Liquids	6.7	6.2	5.9	5.6	5.3	5.1	-1.0
Natural gas	19.9	24.0	27.5	31.5	35.3	38.4	2.5
Coal	46.6	56.8	60.2	69.9	80.8	91.1	2.5
Nuclear	4.6	7.9	12.2	15.8	18.3	21.4	5.9
Renewables	20.2	29.3	37.4	42.2	47.4	52.9	3.6
Total	**98.0**	**124.2**	**143.2**	**165.0**	**187.2**	**208.9**	**2.8**
Total energy consumption							
Liquids	76.4	93.1	100.1	110.3	118.7	125.5	1.9
Natural gas	58.0	68.1	76.6	85.9	95.2	104.1	2.2
Coal	92.2	114.7	121.4	135.1	149.4	162.5	2.1
Nuclear	4.6	7.9	12.2	15.8	18.3	21.4	5.9
Renewables	29.2	39.3	48.6	54.6	61.2	68.1	3.2
Total	**260.5**	**323.1**	**358.9**	**401.7**	**442.8**	**481.6**	**2.3**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D11. Delivered energy consumption in Russia by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.4	0.4	0.4	0.4	0.4	0.4	-0.6
Natural gas	3.2	3.1	3.2	3.3	3.4	3.5	0.4
Coal	0.3	0.4	0.4	0.3	0.3	0.3	-0.5
Electricity	0.4	0.5	0.5	0.6	0.7	0.8	2.5
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**4.4**	**4.4**	**4.5**	**4.6**	**4.7**	**5.0**	**0.5**
Commercial							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-1.7
Natural gas	0.6	0.6	0.7	0.7	0.7	0.7	0.3
Coal	0.2	0.2	0.2	0.2	0.2	0.2	-0.6
Electricity	0.5	0.6	0.6	0.7	0.8	1.0	2.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.5**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**0.9**
Industrial							
Liquids	2.5	2.7	2.5	2.4	2.5	2.7	0.2
Natural gas	5.5	5.3	5.2	5.3	5.3	5.5	0.0
Coal	1.6	1.8	1.7	1.7	1.8	1.9	0.5
Electricity	1.7	1.8	1.8	1.9	2.1	2.3	1.1
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.8
Total	**11.5**	**11.7**	**11.3**	**11.5**	**11.9**	**12.5**	**0.3**
Transportation							
Liquids	2.4	2.6	2.5	2.5	2.6	2.6	0.3
Natural gas	1.7	1.7	1.8	1.9	2.1	2.3	1.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.3	0.3	0.3	0.3	0.3	0.3	0.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**4.4**	**4.5**	**4.6**	**4.8**	**5.0**	**5.2**	**0.6**
All end-use sectors							
Liquids	5.5	5.8	5.5	5.4	5.6	5.8	0.2
Natural gas	11.0	10.8	10.9	11.2	11.5	12.0	0.3
Coal	2.2	2.3	2.3	2.3	2.3	2.3	0.3
Electricity	2.9	3.1	3.3	3.6	4.0	4.4	1.5
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.8
Delivered energy	**21.7**	**22.1**	**22.0**	**22.5**	**23.4**	**24.6**	**0.5**
Electricity-related losses	8.8	8.9	9.3	9.8	10.3	10.9	0.8
Total	**30.6**	**31.1**	**31.3**	**32.3**	**33.7**	**35.5**	**0.6**
Electric power[a]							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-1.0
Natural gas	6.0	5.6	5.3	5.1	5.4	5.6	-0.3
Coal	2.3	2.2	2.1	2.0	2.2	2.5	0.4
Nuclear	1.7	2.1	2.9	3.6	3.9	4.1	3.3
Renewables	1.6	2.0	2.1	2.4	2.7	2.9	2.2
Total	**11.7**	**12.1**	**12.6**	**13.3**	**14.2**	**15.3**	**1.0**
Total energy consumption							
Liquids	5.7	5.9	5.6	5.5	5.7	5.9	0.1
Natural gas	17.0	16.4	16.2	16.3	16.9	17.6	0.1
Coal	4.5	4.5	4.3	4.3	4.5	4.9	0.3
Nuclear	1.7	2.1	2.9	3.6	3.9	4.1	3.3
Renewables	1.7	2.1	2.2	2.5	2.8	3.1	2.1
Total	**30.6**	**31.1**	**31.3**	**32.3**	**33.7**	**35.5**	**0.6**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D12. Delivered energy consumption in Other Non-OECD Europe and Eurasia by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.2	0.2	0.2	0.2	0.2	0.2	-0.7
Natural gas	2.4	2.5	2.5	2.5	2.4	2.3	-0.1
Coal	0.1	0.1	0.1	0.1	0.1	0.1	-1.8
Electricity	0.4	0.5	0.5	0.6	0.6	0.7	1.5
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**3.2**	**3.2**	**3.3**	**3.3**	**3.3**	**3.2**	**0.1**
Commercial							
Liquids	0.1	0.0	0.0	0.0	0.0	0.0	-0.9
Natural gas	0.4	0.4	0.4	0.4	0.3	0.3	-0.2
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.6
Electricity	0.3	0.3	0.3	0.4	0.4	0.5	2.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.7**	**0.7**	**0.8**	**0.8**	**0.8**	**0.9**	**0.9**
Industrial							
Liquids	1.6	1.5	1.4	1.3	1.3	1.2	-0.9
Natural gas	3.4	3.4	3.5	3.6	3.7	3.8	0.4
Coal	1.5	1.3	1.2	1.1	1.0	0.9	-1.9
Electricity	1.1	1.1	1.2	1.3	1.4	1.6	1.4
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.8
Total	**7.6**	**7.4**	**7.4**	**7.5**	**7.6**	**7.6**	**0.0**
Transportation							
Liquids	2.4	2.9	3.1	3.4	3.6	3.9	1.8
Natural gas	0.3	0.3	0.3	0.3	0.4	0.4	1.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.1	0.1	0.1	0.0	0.0	0.0	-1.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.8**	**3.2**	**3.5**	**3.8**	**4.0**	**4.3**	**1.7**
All end-use sectors							
Liquids	4.2	4.6	4.7	4.9	5.1	5.3	0.9
Natural gas	6.4	6.5	6.7	6.8	6.8	6.8	0.2
Coal	1.6	1.4	1.3	1.2	1.1	1.0	-1.9
Electricity	1.9	2.0	2.1	2.3	2.6	2.8	1.5
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.8
Delivered energy	**14.2**	**14.6**	**15.0**	**15.4**	**15.7**	**16.0**	**0.4**
Electricity-related losses	5.7	5.8	6.1	6.3	6.6	6.9	0.7
Total	**19.9**	**20.4**	**21.0**	**21.7**	**22.3**	**22.9**	**0.5**
Electric power[a]							
Liquids	0.2	0.2	0.2	0.2	0.2	0.2	-1.0
Natural gas	2.0	1.9	2.0	2.2	2.5	2.6	0.9
Coal	2.8	2.7	2.6	2.5	2.6	2.7	-0.2
Nuclear	1.3	1.6	1.9	2.1	2.2	2.4	2.2
Renewables	1.2	1.4	1.6	1.6	1.7	1.9	1.6
Total	**7.6**	**7.7**	**8.2**	**8.7**	**9.1**	**9.7**	**0.9**
Total energy consumption							
Liquids	4.4	4.8	4.9	5.1	5.3	5.5	0.8
Natural gas	8.4	8.4	8.6	9.0	9.3	9.4	0.4
Coal	4.5	4.0	3.9	3.7	3.7	3.7	-0.7
Nuclear	1.3	1.6	1.9	2.1	2.2	2.4	2.2
Renewables	1.3	1.5	1.7	1.7	1.8	1.9	1.6
Total	**19.9**	**20.4**	**21.0**	**21.7**	**22.3**	**22.9**	**0.5**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D13. Delivered energy consumption in China by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	1.0	1.1	1.0	0.9	0.9	0.8	-1.0
Natural gas	0.7	1.4	1.9	2.5	3.1	3.5	6.3
Coal	2.9	3.0	3.0	3.0	3.0	2.9	-0.1
Electricity	1.5	2.5	3.3	4.2	5.2	6.2	5.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**6.1**	**8.0**	**9.2**	**10.7**	**12.1**	**13.4**	**2.9**
Commercial							
Liquids	0.9	1.0	0.9	0.8	0.8	0.8	-0.7
Natural gas	0.4	0.7	0.9	1.2	1.4	1.7	5.8
Coal	0.5	0.5	0.5	0.5	0.5	0.5	0.2
Electricity	0.5	1.8	2.3	2.8	2.9	2.6	6.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.3**	**4.0**	**4.6**	**5.3**	**5.6**	**5.5**	**3.4**
Industrial							
Liquids	6.9	7.9	8.2	9.1	10.1	11.0	1.7
Natural gas	1.5	2.0	2.5	3.1	3.8	4.4	4.1
Coal	28.1	39.1	41.0	43.6	45.5	46.9	1.9
Electricity	8.2	11.6	13.4	16.1	18.9	21.6	3.7
Renewables	0.2	0.3	0.4	0.4	0.5	0.6	3.1
Total	**44.9**	**60.9**	**65.4**	**72.4**	**78.8**	**84.5**	**2.4**
Transportation							
Liquids	6.8	14.3	17.5	20.7	21.4	21.7	4.4
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	5.6
Coal	0.1	0.2	0.1	0.0	0.0	0.0	--
Electricity	0.1	0.2	0.3	0.3	0.4	0.3	4.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**7.1**	**14.8**	**18.0**	**21.1**	**21.9**	**22.1**	**4.3**
All end-use sectors							
Liquids	15.7	24.3	27.6	31.5	33.2	34.3	2.9
Natural gas	2.5	4.2	5.3	6.8	8.3	9.7	5.1
Coal	31.6	42.8	44.6	47.1	49.0	50.2	1.7
Electricity	10.3	16.1	19.4	23.5	27.4	30.7	4.1
Renewables	0.2	0.3	0.4	0.4	0.5	0.6	3.1
Delivered energy	**60.4**	**87.7**	**97.2**	**109.4**	**118.4**	**125.4**	**2.7**
Electricity-related losses	25.7	36.5	43.3	51.5	59.4	65.9	3.6
Total	**86.2**	**124.2**	**140.6**	**160.9**	**177.9**	**191.4**	**3.0**
Electric power[a]							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-0.8
Natural gas	0.3	1.4	1.8	2.1	2.3	2.4	7.9
Coal	28.7	37.9	40.9	49.3	57.5	63.4	3.0
Nuclear	0.7	2.3	4.3	6.1	7.8	9.5	10.4
Renewables	6.2	10.9	15.5	17.3	19.2	21.2	4.7
Total	**36.0**	**52.6**	**62.7**	**74.9**	**86.8**	**96.6**	**3.7**
Total energy consumption							
Liquids	15.9	24.5	27.7	31.6	33.3	34.4	2.9
Natural gas	2.8	5.6	7.1	9.0	10.6	12.1	5.5
Coal	60.4	80.7	85.5	96.4	106.5	113.6	2.4
Nuclear	0.7	2.3	4.3	6.1	7.8	9.5	10.4
Renewables	6.4	11.2	15.8	17.8	19.7	21.8	4.6
Total	**86.2**	**124.2**	**140.6**	**160.9**	**177.9**	**191.4**	**3.0**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D14. Delivered energy consumption in India by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.9	1.1	1.0	1.0	0.9	0.9	-0.2
Natural gas	0.0	0.0	0.0	0.1	0.1	0.1	3.1
Coal	0.2	0.2	0.2	0.2	0.3	0.3	2.3
Electricity	0.5	1.2	1.5	1.8	2.1	2.4	6.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.6**	**2.4**	**2.8**	**3.1**	**3.4**	**3.6**	**3.1**
Commercial							
Liquids	0.0	0.0	0.0	0.0	0.0	0.0	--
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal	0.2	0.2	0.3	0.3	0.4	0.4	2.9
Electricity	0.2	0.4	0.5	0.6	0.8	0.9	6.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.4**	**0.6**	**0.8**	**0.9**	**1.1**	**1.3**	**4.8**
Industrial							
Liquids	3.0	3.4	4.0	4.6	5.3	5.9	2.6
Natural gas	0.9	1.4	1.6	1.8	1.9	2.0	3.2
Coal	3.8	4.4	5.2	5.9	6.7	7.4	2.5
Electricity	1.3	1.5	1.8	2.1	2.4	2.7	2.7
Renewables	1.2	1.4	1.6	1.8	2.0	2.2	2.3
Total	**10.2**	**12.2**	**14.2**	**16.2**	**18.3**	**20.3**	**2.6**
Transportation							
Liquids	1.9	3.0	4.1	6.0	7.4	8.3	5.6
Natural gas	0.1	0.1	0.1	0.1	0.2	0.2	2.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.0	0.1	0.1	0.1	0.2	0.2	5.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.0**	**3.2**	**4.4**	**6.2**	**7.8**	**8.7**	**5.5**
All end-use sectors							
Liquids	5.8	7.5	9.2	11.5	13.6	15.1	3.6
Natural gas	1.0	1.6	1.8	1.9	2.1	2.3	3.2
Coal	4.2	4.8	5.7	6.5	7.3	8.1	2.5
Electricity	2.0	3.1	3.9	4.7	5.5	6.2	4.2
Renewables	1.2	1.4	1.6	1.8	2.0	2.2	2.3
Delivered energy	**14.2**	**18.4**	**22.1**	**26.4**	**30.6**	**33.9**	**3.3**
Electricity-related losses	6.9	9.4	11.0	12.4	13.7	15.3	3.0
Total	**21.1**	**27.8**	**33.1**	**38.9**	**44.3**	**49.2**	**3.2**
Electric power[a]							
Liquids	0.2	0.2	0.2	0.2	0.2	0.2	-1.0
Natural gas	0.7	1.9	2.4	2.9	3.1	3.2	6.0
Coal	6.7	7.5	7.9	8.9	10.0	11.4	2.0
Nuclear	0.2	0.7	1.3	1.7	2.0	2.2	10.2
Renewables	1.2	2.2	3.1	3.5	4.0	4.5	5.0
Total	**9.0**	**12.5**	**14.9**	**17.1**	**19.2**	**21.5**	**3.3**
Total energy consumption							
Liquids	6.0	7.7	9.4	11.7	13.8	15.3	3.5
Natural gas	1.6	3.5	4.2	4.8	5.2	5.4	4.6
Coal	10.9	12.4	13.6	15.3	17.3	19.5	2.2
Nuclear	0.2	0.7	1.3	1.7	2.0	2.2	10.2
Renewables	2.4	3.5	4.7	5.3	6.0	6.7	3.9
Total	**21.1**	**27.8**	**33.1**	**38.9**	**44.3**	**49.2**	**3.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D15. Delivered energy consumption in Other Non-OECD Asia by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	2015 (Projections)	2020 (Projections)	2025 (Projections)	2030 (Projections)	2035 (Projections)	Average annual percent change, 2008-2035
Residential							
Liquids	0.7	0.7	0.7	0.7	0.7	0.8	0.5
Natural gas	0.3	0.5	0.6	0.7	0.8	0.8	3.5
Coal	0.1	0.1	0.1	0.1	0.1	0.1	0.6
Electricity	0.9	1.2	1.4	1.6	1.9	2.2	3.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**2.0**	**2.4**	**2.7**	**3.0**	**3.4**	**3.9**	**2.5**
Commercial							
Liquids	0.2	0.2	0.2	0.2	0.2	0.3	1.0
Natural gas	0.1	0.1	0.1	0.1	0.1	0.1	2.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Electricity	0.8	1.0	1.2	1.5	1.8	2.2	3.9
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.1**	**1.3**	**1.5**	**1.9**	**2.2**	**2.6**	**3.4**
Industrial							
Liquids	4.0	4.7	5.2	5.8	6.4	7.2	2.1
Natural gas	3.3	3.8	4.4	5.0	5.6	6.3	2.5
Coal	3.1	3.3	3.7	4.0	4.4	4.7	1.5
Electricity	1.4	1.7	2.1	2.5	2.9	3.5	3.5
Renewables	1.5	1.7	1.9	2.1	2.4	2.7	2.2
Total	**13.3**	**15.2**	**17.2**	**19.3**	**21.7**	**24.4**	**2.3**
Transportation							
Liquids	7.0	8.1	9.3	10.6	11.1	11.4	1.8
Natural gas	0.1	0.1	0.1	0.0	0.0	0.0	-8.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	-1.9
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**7.1**	**8.2**	**9.4**	**10.6**	**11.1**	**11.4**	**1.8**
All end-use sectors							
Liquids	11.9	13.7	15.4	17.3	18.5	19.6	1.9
Natural gas	3.8	4.5	5.1	5.7	6.5	7.3	2.4
Coal	3.2	3.4	3.8	4.1	4.5	4.8	1.5
Electricity	3.1	3.9	4.7	5.6	6.7	7.9	3.5
Renewables	1.5	1.7	1.9	2.1	2.4	2.7	2.2
Delivered energy	**23.5**	**27.1**	**30.9**	**34.9**	**38.5**	**42.3**	**2.2**
Electricity-related losses	7.2	9.1	10.4	11.8	13.7	16.0	3.0
Total	**30.7**	**36.2**	**41.3**	**46.7**	**52.1**	**58.2**	**2.4**
Electric power[a]							
Liquids	1.2	1.1	1.0	1.0	0.9	0.9	-1.0
Natural gas	3.4	4.1	5.0	6.4	7.5	8.1	3.3
Coal	3.1	3.1	3.2	3.6	4.6	6.2	2.6
Nuclear	0.4	0.7	0.9	1.2	1.3	1.6	5.2
Renewables	2.3	3.9	4.9	5.3	6.0	7.1	4.3
Total	**10.3**	**12.9**	**15.1**	**17.4**	**20.3**	**23.8**	**3.2**
Total energy consumption							
Liquids	13.1	14.8	16.4	18.3	19.4	20.5	1.7
Natural gas	7.2	8.5	10.1	12.1	14.0	15.4	2.9
Coal	6.3	6.5	7.0	7.7	9.1	11.0	2.1
Nuclear	0.4	0.7	0.9	1.2	1.3	1.6	5.2
Renewables	3.7	5.6	6.8	7.4	8.4	9.7	3.6
Total	**30.7**	**36.2**	**41.3**	**46.7**	**52.1**	**58.2**	**2.4**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D16. Delivered energy consumption in the Middle East by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.7	0.9	0.8	0.8	0.8	0.8	0.5
Natural gas	1.5	1.7	1.8	1.9	1.9	1.9	0.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-1.7
Electricity	1.0	1.2	1.4	1.6	1.8	2.0	2.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**3.2**	**3.8**	**4.0**	**4.3**	**4.4**	**4.7**	**1.5**
Commercial							
Liquids	0.2	0.2	0.2	0.2	0.2	0.2	1.8
Natural gas	0.2	0.3	0.3	0.3	0.3	0.3	1.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.6	0.7	0.8	1.0	1.1	1.3	3.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.9**	**1.2**	**1.3**	**1.5**	**1.7**	**1.9**	**2.8**
Industrial							
Liquids	3.8	5.0	5.0	5.2	5.4	5.7	1.5
Natural gas	5.8	7.9	9.5	10.8	12.3	14.0	3.3
Coal	0.1	0.1	0.1	0.1	0.1	0.1	1.7
Electricity	0.6	0.7	0.8	0.8	0.9	1.0	2.0
Renewables	0.0	0.1	0.1	0.1	0.1	0.1	0.7
Total	**10.3**	**13.8**	**15.5**	**17.0**	**18.7**	**20.8**	**2.6**
Transportation							
Liquids	5.3	6.0	6.2	7.1	8.6	9.4	2.2
Natural gas	0.1	0.1	0.1	0.1	0.1	0.1	1.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	12.9
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**5.4**	**6.1**	**6.3**	**7.2**	**8.7**	**9.5**	**2.2**
All end-use sectors							
Liquids	9.9	12.1	12.2	13.3	15.0	16.1	1.8
Natural gas	7.6	9.9	11.7	13.1	14.6	16.3	2.9
Coal	0.1	0.1	0.1	0.1	0.1	0.1	1.7
Electricity	2.1	2.6	3.0	3.4	3.8	4.3	2.6
Renewables	0.0	0.1	0.1	0.1	0.1	0.1	0.7
Delivered energy	**19.8**	**24.8**	**27.1**	**30.0**	**33.6**	**37.0**	**2.3**
Electricity-related losses	5.7	6.3	6.8	7.3	7.7	8.3	1.4
Total	**25.5**	**31.0**	**33.9**	**37.3**	**41.3**	**45.3**	**2.1**
Electric power[a]							
Liquids	2.9	2.7	2.5	2.4	2.3	2.2	-1.0
Natural gas	4.6	5.5	6.2	6.9	7.8	8.8	2.4
Coal	0.3	0.3	0.3	0.3	0.3	0.3	-0.2
Nuclear	0.0	0.1	0.3	0.5	0.5	0.6	--
Renewables	0.1	0.3	0.5	0.6	0.6	0.7	8.0
Total	**7.9**	**8.8**	**9.8**	**10.7**	**11.5**	**12.6**	**1.8**
Total energy consumption							
Liquids	12.8	14.8	14.8	15.7	17.3	18.3	1.4
Natural gas	12.2	15.4	17.8	20.0	22.4	25.2	2.7
Coal	0.4	0.4	0.4	0.4	0.4	0.4	0.3
Nuclear	0.0	0.1	0.3	0.5	0.5	0.6	--
Renewables	0.1	0.4	0.6	0.6	0.7	0.8	6.6
Total	**25.5**	**31.0**	**33.9**	**37.3**	**41.3**	**45.3**	**2.1**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D17. Delivered energy consumption in Africa by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.7	0.8	0.7	0.7	0.8	0.8	0.3
Natural gas	0.2	0.3	0.4	0.5	0.5	0.6	3.1
Coal	0.2	0.2	0.3	0.3	0.3	0.3	2.4
Electricity	0.6	0.7	0.8	1.0	1.1	1.2	3.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.7**	**2.0**	**2.2**	**2.4**	**2.7**	**2.9**	**2.0**
Commercial							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	1.1
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Coal	0.1	0.1	0.1	0.1	0.2	0.2	2.1
Electricity	0.3	0.3	0.4	0.5	0.6	0.7	3.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**1.0**	**3.0**
Industrial							
Liquids	1.5	1.6	1.5	1.5	1.5	1.5	0.2
Natural gas	1.8	2.4	2.9	3.3	3.9	4.4	3.3
Coal	1.9	2.0	2.3	2.4	2.5	2.6	1.1
Electricity	0.9	1.1	1.4	1.6	1.8	2.0	2.9
Renewables	2.7	2.9	3.2	3.4	3.6	3.8	1.3
Total	**8.9**	**10.1**	**11.2**	**12.3**	**13.4**	**14.4**	**1.8**
Transportation							
Liquids	3.5	3.7	3.9	4.3	4.7	5.2	1.5
Natural gas	0.1	0.1	0.1	0.1	0.1	0.1	1.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	2.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**3.6**	**3.8**	**4.0**	**4.4**	**4.8**	**5.3**	**1.5**
All end-use sectors							
Liquids	5.8	6.2	6.3	6.6	7.1	7.7	1.0
Natural gas	2.1	2.8	3.3	3.9	4.5	5.1	3.3
Coal	2.2	2.4	2.6	2.8	3.0	3.1	1.2
Electricity	1.8	2.2	2.6	3.1	3.5	4.0	3.0
Renewables	2.7	2.9	3.2	3.4	3.6	3.8	1.3
Delivered energy	**14.6**	**16.5**	**18.0**	**19.8**	**21.7**	**23.7**	**1.8**
Electricity-related losses	4.2	5.0	5.5	6.1	6.8	7.7	2.3
Total	**18.8**	**21.5**	**23.6**	**25.9**	**28.5**	**31.4**	**1.9**
Electric power[a]							
Liquids	0.7	0.7	0.6	0.6	0.6	0.6	-1.0
Natural gas	1.7	2.3	3.0	3.8	4.4	4.7	3.7
Coal	2.4	2.8	2.8	2.9	3.3	4.0	1.9
Nuclear	0.1	0.2	0.2	0.2	0.2	0.3	3.8
Renewables	1.0	1.3	1.5	1.7	1.9	2.2	3.0
Total	**5.9**	**7.2**	**8.1**	**9.2**	**10.4**	**11.7**	**2.5**
Total energy consumption							
Liquids	6.5	6.8	6.9	7.2	7.6	8.2	0.9
Natural gas	3.9	5.1	6.4	7.7	8.8	9.8	3.5
Coal	4.6	5.1	5.4	5.7	6.2	7.1	1.6
Nuclear	0.1	0.2	0.2	0.2	0.2	0.3	3.8
Renewables	3.7	4.3	4.7	5.1	5.6	6.0	1.9
Total	**18.8**	**21.5**	**23.6**	**25.9**	**28.5**	**31.4**	**1.9**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D18. Delivered energy consumption in Brazil by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

		Projections					Average annual percent change,
Sector/fuel	2008	2015	2020	2025	2030	2035	2008-2035
Residential							
Liquids	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	6.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.4	0.4	0.5	0.6	0.7	0.9	3.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**1.2**	**2.4**
Commercial							
Liquids	0.0	0.1	0.0	0.0	0.1	0.1	0.6
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.4	0.4	0.5	0.7	0.9	1.1	4.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.4**	**0.5**	**0.6**	**0.8**	**0.9**	**1.2**	**3.8**
Industrial							
Liquids	1.8	2.3	2.4	2.8	3.2	3.8	2.8
Natural gas	0.5	0.6	0.7	0.8	1.0	1.2	2.9
Coal	0.4	0.6	0.7	1.0	1.3	1.6	5.6
Electricity	0.7	0.7	0.9	1.0	1.3	1.5	3.0
Renewables	2.5	2.8	3.2	3.6	4.2	4.8	2.5
Total	**5.9**	**7.1**	**7.9**	**9.2**	**10.9**	**12.9**	**3.0**
Transportation							
Liquids	3.0	3.4	3.5	3.6	3.8	4.0	1.1
Natural gas	0.1	0.1	0.1	0.1	0.1	0.2	2.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**3.0**	**3.5**	**3.6**	**3.8**	**4.0**	**4.2**	**1.2**
All end-use sectors							
Liquids	5.1	6.0	6.3	6.7	7.4	8.1	1.8
Natural gas	0.6	0.8	0.9	1.0	1.2	1.4	2.9
Coal	0.4	0.6	0.7	1.0	1.3	1.6	5.6
Electricity	1.4	1.6	1.9	2.4	2.9	3.5	3.4
Renewables	2.5	2.8	3.2	3.6	4.2	4.8	2.5
Delivered energy	**10.0**	**11.8**	**13.0**	**14.6**	**16.9**	**19.4**	**2.5**
Electricity-related losses	2.7	3.7	4.4	5.3	6.3	7.5	3.8
Total	**12.7**	**15.5**	**17.3**	**19.9**	**23.2**	**26.9**	**2.8**
Electric power[a]							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	-1.0
Natural gas	0.2	0.4	0.7	0.9	1.2	1.9	8.1
Coal	0.1	0.2	0.2	0.2	0.2	0.2	3.2
Nuclear	0.1	0.2	0.2	0.3	0.3	0.4	4.1
Renewables	3.5	4.4	5.0	6.1	7.4	8.3	3.2
Total	**4.1**	**5.2**	**6.3**	**7.6**	**9.2**	**11.0**	**3.7**
Total energy consumption							
Liquids	5.2	6.2	6.4	6.8	7.5	8.2	1.7
Natural gas	0.9	1.2	1.6	1.9	2.4	3.3	5.1
Coal	0.5	0.8	0.9	1.1	1.4	1.9	5.2
Nuclear	0.1	0.2	0.2	0.3	0.3	0.4	4.1
Renewables	6.0	7.2	8.2	9.7	11.5	13.1	2.9
Total	**12.7**	**15.5**	**17.3**	**19.9**	**23.2**	**26.9**	**2.8**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.
Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

Table D19. Delivered energy consumption in Other Central and South America by end-use sector and fuel, 2008-2035
(Quadrillion Btu)

Sector/fuel	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Residential							
Liquids	0.4	0.4	0.3	0.3	0.3	0.4	-0.2
Natural gas	0.4	0.4	0.5	0.5	0.6	0.6	1.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Electricity	0.4	0.5	0.6	0.6	0.7	0.7	1.7
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.2**
Commercial							
Liquids	0.1	0.1	0.1	0.1	0.1	0.1	0.6
Natural gas	0.1	0.1	0.1	0.1	0.1	0.1	0.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.3	0.4	0.4	0.5	0.5	0.6	2.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**0.5**	**0.5**	**0.6**	**0.6**	**0.7**	**0.7**	**1.6**
Industrial							
Liquids	2.1	2.1	1.9	1.7	1.7	1.6	-1.0
Natural gas	2.3	2.5	2.8	3.2	3.5	3.9	1.9
Coal	0.1	0.1	0.1	0.1	0.1	0.1	-0.1
Electricity	0.6	0.6	0.6	0.7	0.7	0.7	0.9
Renewables	0.7	0.7	0.7	0.8	0.8	0.9	1.0
Total	**5.8**	**5.9**	**6.1**	**6.4**	**6.8**	**7.2**	**0.8**
Transportation							
Liquids	3.3	4.1	4.8	5.3	5.8	6.3	2.5
Natural gas	0.2	0.1	0.1	0.2	0.2	0.2	1.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	--
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	--
Total	**3.4**	**4.2**	**4.9**	**5.4**	**6.0**	**6.5**	**2.4**
All end-use sectors							
Liquids	5.8	6.6	7.1	7.4	7.9	8.4	1.3
Natural gas	3.0	3.1	3.5	3.9	4.4	4.8	1.8
Coal	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Electricity	1.4	1.5	1.6	1.8	1.9	2.0	1.5
Renewables	0.7	0.7	0.7	0.8	0.8	0.9	1.0
Delivered energy	**10.9**	**11.9**	**13.0**	**13.9**	**15.0**	**16.1**	**1.5**
Electricity-related losses	4.1	3.6	3.9	4.2	4.4	4.7	0.5
Total	**15.0**	**15.6**	**16.9**	**18.1**	**19.5**	**20.8**	**1.2**
Electric power[a]							
Liquids	1.0	1.0	0.9	0.9	0.8	0.8	-1.0
Natural gas	1.0	1.0	1.0	1.1	1.2	1.2	0.7
Coal	0.2	0.2	0.2	0.2	0.3	0.3	1.4
Nuclear	0.1	0.1	0.1	0.1	0.1	0.2	4.1
Renewables	3.1	2.8	3.2	3.7	3.9	4.1	1.1
Total	**5.5**	**5.1**	**5.5**	**6.0**	**6.3**	**6.7**	**0.8**
Total energy consumption							
Liquids	6.9	7.6	8.0	8.3	8.7	9.2	1.1
Natural gas	4.0	4.1	4.5	5.0	5.5	6.0	1.6
Coal	0.3	0.3	0.3	0.3	0.4	0.4	1.1
Nuclear	0.1	0.1	0.1	0.1	0.1	0.2	4.1
Renewables	3.8	3.5	3.9	4.4	4.7	5.0	1.0
Total	**15.0**	**15.6**	**16.9**	**18.1**	**19.5**	**20.8**	**1.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2008:** Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), website www.eia.gov/ies; and International Energy Agency, "Balances of OECD and Non-OECD Statistics" (2010), website www.iea.org (subscription site). **Projections:** EIA, World Energy Projection System Plus (2011).

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Appendix E

Projections of liquid fuels and other petroleum production in five cases

- *Reference*
- *High Oil Price*
- *Low Oil Price*
- *Traditional High Oil Price*
- *Traditional Low Oil Price*

Table E1. World total liquids production by region and country, Reference case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**34.4**	**35.6**	**33.4**	**38.6**	**40.8**	**43.1**	**45.0**	**46.9**	**1.0**
Middle East	**23.1**	**24.2**	**22.5**	**27.0**	**28.9**	**31.2**	**33.3**	**35.2**	**1.4**
Iran	4.0	4.2	4.1	4.0	3.8	3.7	3.8	3.9	-0.3
Iraq	2.1	2.4	2.4	2.9	3.6	4.5	5.5	6.3	3.7
Kuwait	2.6	2.7	2.5	3.0	3.1	3.3	3.7	4.0	1.4
Qatar	1.1	1.2	1.2	1.9	2.1	2.3	2.5	2.5	2.7
Saudi Arabia	10.2	10.7	9.6	11.6	12.8	13.9	14.6	15.4	1.4
United Arab Emirates	2.9	3.0	2.8	3.6	3.5	3.5	3.3	3.2	0.2
North Africa	**4.0**	**4.1**	**3.9**	**3.5**	**3.4**	**3.4**	**3.3**	**3.2**	**-0.9**
Algeria	2.2	2.2	2.1	2.6	2.7	2.6	2.5	2.3	0.3
Libya	1.8	1.9	1.8	0.9	0.7	0.7	0.8	0.8	-3.0
West Africa	**4.1**	**4.2**	**4.1**	**5.3**	**5.5**	**5.5**	**5.4**	**5.4**	**1.0**
Angola	1.8	2.0	1.9	2.2	2.3	2.2	2.1	2.0	0.0
Nigeria	2.4	2.2	2.2	3.0	3.2	3.3	3.3	3.4	1.7
South America	**3.2**	**3.1**	**2.9**	**2.9**	**3.0**	**3.0**	**3.0**	**3.1**	**-0.1**
Ecuador	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.5	-0.3
Venezuela	2.7	2.6	2.4	2.4	2.5	2.5	2.5	2.6	0.0
Non-OPEC	**50.5**	**50.0**	**50.5**	**54.7**	**56.8**	**60.1**	**63.0**	**65.3**	**1.0**
OECD	**21.6**	**21.0**	**21.3**	**21.5**	**21.7**	**22.4**	**23.5**	**24.9**	**0.6**
OECD Americas	**15.4**	**15.0**	**15.6**	**16.9**	**17.7**	**18.5**	**19.7**	**21.1**	**1.3**
United States	8.5	8.5	9.1	10.4	11.2	11.7	12.2	12.8	1.5
Canada	3.4	3.4	3.6	4.2	4.7	5.4	6.0	6.6	2.6
Mexico	3.5	3.2	3.0	2.3	1.8	1.4	1.5	1.7	-2.4
OECD Europe	**5.4**	**5.1**	**4.8**	**3.8**	**3.3**	**3.2**	**3.1**	**3.0**	**-2.0**
OECD Asia	**0.8**	**0.8**	**0.8**	**0.8**	**0.7**	**0.8**	**0.8**	**0.8**	**-0.3**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.6
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.5	-0.6
Non-OECD	**28.9**	**29.0**	**29.2**	**33.2**	**35.1**	**37.6**	**39.5**	**40.4**	**1.2**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**14.6**	**15.5**	**16.6**	**17.4**	**18.0**	**1.3**
Russia	9.9	9.8	9.8	10.8	11.4	12.2	12.8	13.3	1.1
Caspian Area	2.6	2.6	2.8	3.5	3.8	4.2	4.4	4.5	2.1
Other	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	-1.2
Non-OECD Asia	**7.9**	**7.9**	**7.7**	**7.8**	**7.8**	**8.3**	**8.6**	**8.5**	**0.3**
China	4.1	4.0	4.0	4.0	4.2	4.8	5.2	5.3	1.0
India	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.1	0.8
Other	2.9	2.9	2.8	2.8	2.6	2.4	2.2	2.0	-1.3
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.3**	**1.1**	**1.1**	**-1.3**
Africa	**2.7**	**2.7**	**2.6**	**3.0**	**3.2**	**3.4**	**3.5**	**3.5**	**1.0**
Central and South America	**4.1**	**4.3**	**4.5**	**6.2**	**7.2**	**8.1**	**8.9**	**9.4**	**3.0**
Brazil	2.3	2.4	2.6	3.8	4.7	5.5	6.0	6.5	3.7
Other	1.8	1.9	1.9	2.5	2.5	2.7	2.9	2.9	1.7
Total world	**84.9**	**85.7**	**83.9**	**93.3**	**97.6**	**103.2**	**108.0**	**112.2**	**1.0**
OPEC share of world production	40%	42%	40%	41%	42%	42%	42%	42%	
Persian Gulf share of world production	27%	28%	27%	29%	30%	30%	31%	31%	

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E2. World conventional liquids production by region and country, Reference case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**33.8**	**35.0**	**32.8**	**37.6**	**39.5**	**41.7**	**43.4**	**45.2**	**1.0**
Middle East	**23.1**	**24.2**	**22.5**	**26.8**	**28.7**	**31.0**	**33.0**	**35.0**	**1.4**
Iran	4.0	4.2	4.1	4.0	3.8	3.7	3.8	3.9	-0.3
Iraq	2.1	2.4	2.4	2.9	3.6	4.5	5.5	6.3	3.7
Kuwait	2.6	2.7	2.5	3.0	3.1	3.3	3.7	4.0	1.4
Qatar	1.1	1.2	1.2	1.7	1.9	2.1	2.2	2.2	2.3
Saudi Arabia	10.2	10.7	9.6	11.6	12.8	13.9	14.6	15.4	1.4
United Arab Emirates	2.9	3.0	2.8	3.6	3.5	3.5	3.3	3.2	0.2
North Africa	**4.0**	**4.1**	**3.9**	**3.5**	**3.4**	**3.4**	**3.3**	**3.2**	**-0.9**
Algeria	2.2	2.2	2.1	2.6	2.7	2.6	2.5	2.3	0.3
Libya	1.8	1.9	1.8	0.9	0.7	0.7	0.8	0.8	-3.0
West Africa	**4.1**	**4.2**	**4.1**	**5.2**	**5.5**	**5.5**	**5.4**	**5.4**	**0.9**
Angola	1.8	2.0	1.9	2.2	2.3	2.2	2.1	2.0	0.0
Nigeria	2.4	2.2	2.2	3.0	3.2	3.3	3.3	3.4	1.6
South America	**2.6**	**2.5**	**2.4**	**2.1**	**1.9**	**1.8**	**1.7**	**1.7**	**-1.5**
Ecuador	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.5	-0.3
Venezuela	2.1	2.0	1.9	1.6	1.5	1.4	1.3	1.2	-1.9
Non-OPEC	**47.8**	**46.8**	**46.9**	**49.6**	**50.3**	**51.9**	**53.1**	**53.9**	**0.5**
OECD	**19.6**	**18.6**	**18.6**	**17.7**	**17.1**	**16.7**	**16.5**	**16.8**	**-0.4**
OECD Americas	**13.6**	**12.8**	**13.2**	**13.4**	**13.3**	**13.0**	**13.0**	**13.3**	**0.1**
United States	8.0	7.8	8.3	9.3	9.8	9.8	9.7	9.9	0.9
Canada	2.1	1.8	1.9	1.8	1.8	1.8	1.8	1.8	0.0
Mexico	3.5	3.2	3.0	2.3	1.7	1.4	1.5	1.6	-2.5
OECD Europe	**5.2**	**5.0**	**4.6**	**3.6**	**3.1**	**2.9**	**2.8**	**2.8**	**-2.1**
Denmark	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	-1.5
Norway	2.6	2.5	2.3	1.9	1.6	1.5	1.4	1.3	-2.2
United Kingdom	1.7	1.6	1.5	0.9	0.7	0.6	0.6	0.6	-3.4
Other	0.7	0.6	0.6	0.5	0.5	0.6	0.6	0.6	-0.1
OECD Asia	**0.8**	**0.8**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**-0.3**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.6
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.5	-0.7

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).

(continued on page 231)

Table E2. World conventional liquids production by region and country, Reference case, 2007-2035 (continued)
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Non-OECD	**28.2**	**28.2**	**28.3**	**31.8**	**33.2**	**35.2**	**36.5**	**37.1**	**1.0**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**14.6**	**15.5**	**16.6**	**17.4**	**18.0**	**1.3**
Russia	**9.9**	**9.8**	**9.8**	**10.8**	**11.4**	**12.2**	**12.8**	**13.3**	**1.1**
Caspian Area	**2.6**	**2.6**	**2.8**	**3.5**	**3.8**	**4.2**	**4.4**	**4.5**	**2.1**
Azerbaijan	0.8	0.9	1.0	1.3	1.3	1.2	1.1	0.9	0.3
Kazakhstan	1.4	1.4	1.5	2.0	2.2	2.6	2.9	3.1	2.9
Turkmenistan	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	3.2
Uzbekistan	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-5.0
Other	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**-1.3**
Non-OECD Asia	**7.7**	**7.7**	**7.6**	**7.6**	**7.5**	**7.6**	**7.6**	**7.3**	**-0.2**
China	3.9	4.0	3.9	4.0	4.1	4.3	4.5	4.3	0.3
India	0.9	0.9	0.9	1.0	0.9	1.0	1.0	1.0	0.5
Brunei	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	-1.1
Malaysia	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	-0.7
Thailand	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5
Vietnam	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.2	-1.3
Other	1.3	1.3	1.3	1.0	0.9	0.8	0.7	0.6	-2.7
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.3**	**1.1**	**1.1**	**-1.3**
Oman	0.7	0.8	0.8	1.0	0.8	0.7	0.6	0.6	-1.1
Syria	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	-1.9
Yemen	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	-3.3
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.6
Africa	**2.5**	**2.5**	**2.4**	**2.8**	**2.9**	**3.0**	**3.1**	**3.1**	**0.9**
Chad	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-3.0
Congo (Brazzaville)	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	-0.5
Egypt	0.8	0.7	0.7	0.6	0.7	0.7	0.8	0.8	0.2
Equatorial Guinea	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	-0.1
Gabon	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	-2.5
Sao Tome and Principe	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Sudan	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.8	2.1
Other	0.3	0.3	0.3	0.7	0.8	0.8	0.8	0.7	3.4
Central and South America	**3.7**	**3.8**	**3.9**	**5.3**	**5.9**	**6.7**	**7.3**	**7.6**	**2.7**
Brazil	1.9	2.0	2.0	2.9	3.5	4.1	4.5	4.8	3.4
Argentina	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	-1.2
Colombia	0.5	0.6	0.7	1.1	1.0	0.9	0.9	0.8	1.3
Peru	0.1	0.1	0.1	0.3	0.3	0.4	0.4	0.4	4.5
Trinidad and Tobago	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.6
Other	0.2	0.2	0.2	0.2	0.3	0.5	0.8	0.8	6.0
Total world	**81.5**	**81.7**	**79.7**	**87.2**	**89.8**	**93.6**	**96.5**	**99.1**	**0.7**
OPEC share of world production	41%	43%	41%	43%	44%	45%	45%	46%	
Persian Gulf share of world production	28%	30%	28%	31%	32%	33%	34%	35%	

Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E3.World unconventional liquids production by region and country, Reference case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**0.6**	**0.7**	**0.5**	**1.0**	**1.3**	**1.4**	**1.6**	**1.7**	**3.6**
Biofuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Extra-heavy oil (Venezuela)	0.6	0.7	0.5	0.8	1.1	1.2	1.3	1.4	3.0
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Gas-to-liquids (primarily Qatar)	0.0	0.0	0.0	0.2	0.2	0.3	0.3	0.3	16.0
Non-OPEC	**2.8**	**3.2**	**3.6**	**5.1**	**6.5**	**8.2**	**9.9**	**11.4**	**4.8**
OECD	**2.0**	**2.4**	**2.7**	**3.7**	**4.6**	**5.8**	**7.0**	**8.1**	**4.6**
Biofuels	0.6	0.9	1.0	1.3	1.6	2.0	2.4	2.5	4.1
Oil sands/bitumen (Canada)	1.4	1.5	1.7	2.3	2.9	3.5	4.1	4.8	4.4
Extra-heavy oil (Mexico)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	8.5
Coal-to-liquids	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.6	26.3
Gas-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	--
Non-OECD	**0.7**	**0.9**	**0.9**	**1.4**	**1.9**	**2.4**	**3.0**	**3.3**	**5.2**
Biofuels	0.5	0.6	0.7	1.1	1.4	1.7	2.0	2.1	4.6
Extra-heavy oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal-to-liquids	0.2	0.2	0.2	0.2	0.4	0.7	0.9	1.1	7.5
Gas-to-liquids	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.3
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
World									
Biofuels	1.2	1.5	1.7	2.4	3.0	3.8	4.4	4.7	4.3
Oil sands/bitumen	1.4	1.5	1.7	2.3	2.9	3.5	4.1	4.8	4.4
Extra-heavy oil	0.6	0.7	0.5	0.8	1.1	1.2	1.4	1.5	3.1
Coal-to-liquids	0.2	0.2	0.2	0.3	0.5	0.8	1.3	1.7	9.0
Gas-to-liquids	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.3	7.4
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	12.1
World total	**3.4**	**3.9**	**4.1**	**6.1**	**7.8**	**9.7**	**11.5**	**13.1**	**4.6**
Selected country highlights									
Biofuels									
Brazil	0.3	0.5	0.5	0.9	1.1	1.4	1.5	1.7	4.8
China	0.2	0.0	0.0	0.0	0.1	0.1	0.2	0.3	7.4
India	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
United States	0.5	0.7	0.8	1.1	1.4	1.8	2.1	2.2	4.6
Coal-to-liquids									
Australia and New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
China	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.7	--
Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
India	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	--
South Africa	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	2.0
United States	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.5	--
Gas-to-liquids									
Qatar	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	15.5
South Africa	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.0

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E4. World total liquids production by region and country, High Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**34.4**	**35.6**	**33.3**	**34.9**	**38.2**	**42.1**	**44.2**	**45.7**	**0.9**
Middle East	**23.1**	**24.2**	**22.5**	**24.3**	**26.9**	**30.4**	**32.6**	**34.1**	**1.3**
Iran	4.0	4.2	4.1	3.6	3.5	3.6	3.7	3.8	-0.4
Iraq	2.1	2.4	2.4	2.6	3.4	4.4	5.5	6.5	3.8
Kuwait	2.6	2.7	2.5	2.7	2.8	3.2	3.6	3.9	1.3
Qatar	1.1	1.2	1.2	1.7	2.0	2.2	2.4	2.4	2.6
Saudi Arabia	10.2	10.7	9.6	10.5	12.0	13.7	14.2	14.5	1.1
United Arab Emirates	2.9	3.0	2.8	3.2	3.3	3.4	3.2	3.1	0.1
North Africa	**4.0**	**4.1**	**3.9**	**3.2**	**3.2**	**3.3**	**3.2**	**3.1**	**-1.0**
Algeria	2.2	2.2	2.1	2.4	2.5	2.5	2.4	2.3	0.2
Libya	1.8	1.9	1.8	0.8	0.7	0.7	0.8	0.8	-3.0
West Africa	**4.1**	**4.2**	**4.1**	**4.7**	**5.0**	**5.3**	**5.3**	**5.3**	**0.8**
Angola	1.8	2.0	1.9	2.0	2.1	2.1	2.0	2.0	-0.1
Nigeria	2.4	2.2	2.2	2.7	2.9	3.2	3.3	3.3	1.6
South America	**3.2**	**3.1**	**2.9**	**2.8**	**3.0**	**3.1**	**3.1**	**3.2**	**0.1**
Ecuador	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.5	-0.4
Venezuela	2.7	2.6	2.4	2.4	2.6	2.7	2.7	2.7	0.1
Non-OPEC	**50.5**	**50.0**	**50.5**	**56.1**	**58.7**	**63.3**	**69.6**	**76.5**	**1.6**
OECD	**21.6**	**21.0**	**21.3**	**23.1**	**24.3**	**26.4**	**28.3**	**30.6**	**1.4**
OECD North America	**15.4**	**15.0**	**15.7**	**18.6**	**20.3**	**22.5**	**24.4**	**26.6**	**2.1**
United States	8.5	8.5	9.1	10.8	12.2	13.9	14.8	16.2	2.4
Canada	3.4	3.4	3.6	5.5	6.4	7.2	8.0	8.6	3.5
Mexico	3.5	3.2	3.0	2.3	1.7	1.4	1.6	1.8	-2.0
OECD Europe	**5.4**	**5.1**	**4.8**	**3.8**	**3.3**	**3.1**	**3.2**	**3.3**	**-1.7**
OECD Asia	**0.8**	**0.8**	**0.8**	**0.7**	**0.7**	**0.7**	**0.8**	**0.8**	**-0.1**
Japan	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.4
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.5	0.6	0.6	-0.3
Non-OECD	**28.9**	**29.0**	**29.2**	**33.0**	**34.4**	**36.9**	**41.3**	**45.8**	**1.7**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**14.4**	**15.0**	**16.0**	**17.8**	**19.8**	**1.7**
Russia	9.9	9.8	9.8	10.7	11.1	11.7	13.0	14.7	1.5
Caspian area	2.6	2.6	2.8	3.5	3.7	4.0	4.5	4.9	2.4
Other	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3	-1.0
Non-OECD Asia	**7.9**	**7.9**	**7.7**	**7.8**	**7.7**	**8.3**	**9.4**	**10.6**	**1.1**
China	4.1	4.0	4.0	4.0	4.2	4.9	6.0	7.1	2.1
India	0.9	0.9	0.9	1.0	1.0	1.1	1.2	1.2	1.0
Other	2.9	2.9	2.8	2.7	2.5	2.3	2.3	2.2	-1.0
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.2**	**1.2**	**1.2**	**-0.9**
Africa	**2.7**	**2.7**	**2.6**	**3.0**	**3.2**	**3.3**	**3.6**	**3.9**	**1.4**
Central and South America	**4.1**	**4.3**	**4.5**	**6.2**	**7.1**	**8.1**	**9.4**	**10.4**	**3.4**
Brazil	2.3	2.4	2.6	3.7	4.7	5.5	6.4	7.2	4.1
Other	1.8	1.9	1.9	2.5	2.5	2.6	3.0	3.2	2.0
Total world	**84.9**	**85.7**	**83.9**	**91.0**	**96.9**	**105.4**	**113.8**	**122.2**	**1.3**
OPEC share of world production	40%	42%	40%	38%	39%	40%	39%	37%	
Persian Gulf share of world production	27%	28%	27%	27%	28%	29%	29%	28%	

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E5. World conventional liquids production by region and country, High Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**33.8**	**35.0**	**32.8**	**33.8**	**36.8**	**40.6**	**42.6**	**43.9**	**0.8**
Middle East	**23.1**	**24.2**	**22.4**	**24.2**	**26.8**	**30.2**	**32.4**	**33.9**	**1.3**
Iran	4.0	4.2	4.1	3.6	3.5	3.6	3.7	3.8	-0.4
Iraq	2.1	2.4	2.4	2.6	3.4	4.4	5.5	6.5	3.8
Kuwait	2.6	2.7	2.5	2.7	2.8	3.2	3.6	3.9	1.3
Qatar	1.1	1.2	1.2	1.5	1.8	2.0	2.2	2.2	2.3
Saudi Arabia	10.2	10.7	9.6	10.5	12.0	13.7	14.2	14.5	1.1
United Arab Emirates	2.9	3.0	2.8	3.2	3.3	3.4	3.2	3.1	0.1
North Africa	**4.0**	**4.1**	**3.9**	**3.2**	**3.2**	**3.3**	**3.2**	**3.1**	**-1.0**
Algeria	2.2	2.2	2.1	2.4	2.5	2.5	2.4	2.3	0.2
Libya	1.8	1.9	1.8	0.8	0.7	0.7	0.8	0.8	-3.0
West Africa	**4.1**	**4.2**	**4.1**	**4.6**	**5.0**	**5.3**	**5.3**	**5.2**	**0.8**
Angola	1.8	2.0	1.9	2.0	2.1	2.1	2.0	2.0	-0.1
Nigeria	2.4	2.2	2.2	2.7	2.9	3.1	3.2	3.3	1.5
South America	**2.6**	**2.5**	**2.4**	**1.9**	**1.8**	**1.8**	**1.7**	**1.6**	**-1.6**
Ecuador	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.5	-0.4
Venezuela	2.1	2.0	1.9	1.5	1.4	1.3	1.2	1.2	-1.9
Non-OPEC	**47.8**	**46.8**	**46.9**	**49.6**	**50.0**	**51.7**	**55.0**	**59.1**	**0.9**
OECD	**19.6**	**18.6**	**18.6**	**18.0**	**17.6**	**17.7**	**17.6**	**18.3**	**-0.1**
OECD Americas	**13.6**	**12.8**	**13.2**	**13.7**	**13.9**	**14.1**	**14.0**	**14.5**	**0.5**
United States	8.0	7.8	8.3	9.5	10.4	10.9	10.5	10.8	1.2
Canada	2.1	1.8	1.9	1.9	1.9	1.9	2.0	2.0	0.4
Mexico	3.5	3.2	3.0	2.3	1.7	1.3	1.5	1.7	-2.2
OECD Europe	**5.2**	**5.0**	**4.6**	**3.6**	**3.0**	**2.9**	**2.9**	**3.0**	**-1.9**
Denmark	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	-1.1
Norway	2.6	2.5	2.3	1.9	1.6	1.5	1.4	1.5	-1.9
United Kingdom	1.7	1.6	1.5	0.9	0.7	0.6	0.7	0.7	-3.1
Other	0.7	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.0
OECD Asia	**0.8**	**0.8**	**0.8**	**0.7**	**0.7**	**0.7**	**0.8**	**0.8**	**-0.2**
Japan	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.4
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Australia and New Zealand	0.6	0.7	0.6	0.6	0.5	0.5	0.6	0.6	-0.4

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).

(continued on page 235)

Table E5. World conventional liquids production by region and country, High Oil Price case, 2007-2035 (continued)
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Non-OECD	**28.2**	**28.2**	**28.3**	**31.6**	**32.4**	**34.0**	**37.4**	**40.8**	**1.4**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**14.4**	**15.0**	**15.9**	**17.7**	**19.8**	**1.7**
Russia	**9.9**	**9.8**	**9.8**	**10.7**	**11.1**	**11.7**	**13.0**	**14.7**	**1.5**
Caspian Area	**2.6**	**2.6**	**2.8**	**3.5**	**3.7**	**4.0**	**4.5**	**4.9**	**2.4**
Azerbaijan	0.8	0.9	1.0	1.3	1.3	1.2	1.1	1.0	0.7
Kazakhstan	1.4	1.4	1.5	2.0	2.2	2.5	2.9	3.3	3.2
Turkmenistan	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	3.5
Uzbekistan	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-4.7
Other	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**-1.1**
Non-OECD Asia	**7.7**	**7.7**	**7.6**	**7.6**	**7.3**	**7.4**	**7.8**	**8.0**	**0.1**
China	3.9	4.0	3.9	3.9	4.0	4.2	4.6	4.7	0.7
India	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.1	0.7
Brunei	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	-0.8
Malaysia	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	-0.4
Thailand	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.8
Vietnam	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3	-1.0
Other	1.3	1.3	1.3	1.0	0.9	0.8	0.7	0.7	-2.4
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.2**	**1.2**	**1.2**	**-0.9**
Oman	0.7	0.8	0.8	1.0	0.8	0.7	0.6	0.6	-0.7
Syria	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	-1.5
Yemen	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	-2.9
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.9
Africa	**2.5**	**2.5**	**2.4**	**2.8**	**2.8**	**3.0**	**3.2**	**3.5**	**1.3**
Chad	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-2.6
Congo (Brazzaville)	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	-0.1
Egypt	0.8	0.7	0.7	0.6	0.7	0.7	0.8	0.8	0.5
Equatorial Guinea	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.3
Gabon	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	-2.1
Sao Tome and Principe	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Sudan	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.9	2.5
Other	0.3	0.3	0.3	0.7	0.7	0.8	0.8	0.8	3.8
Central and South America	**3.7**	**3.8**	**3.9**	**5.2**	**5.8**	**6.5**	**7.5**	**8.4**	**3.0**
Brazil	1.9	2.0	2.0	2.8	3.4	4.0	4.6	5.3	3.8
Argentina	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.6	-0.9
Colombia	0.5	0.6	0.7	1.1	1.0	0.9	0.9	0.9	1.7
Peru	0.1	0.1	0.1	0.3	0.3	0.3	0.4	0.4	4.8
Trinidad and Tobago	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.8
Other	0.2	0.2	0.2	0.2	0.3	0.5	0.8	0.9	6.5
Total world	**81.5**	**81.7**	**79.7**	**83.4**	**86.8**	**92.3**	**97.5**	**103.0**	**0.9**
OPEC share of world production	41%	43%	41%	41%	42%	44%	44%	43%	
Persian Gulf share of world production	28%	30%	28%	29%	31%	33%	33%	33%	

Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E6. World unconventional liquids production by region and country, High Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**0.6**	**0.7**	**0.5**	**1.1**	**1.4**	**1.6**	**1.7**	**1.8**	**3.8**
Biofuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Extra-heavy oil (Venezuela)	0.6	0.7	0.5	0.9	1.2	1.3	1.4	1.6	3.3
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Gas-to-liquids (primarily Qatar)	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	15.3
Non-OPEC	**2.8**	**3.2**	**3.6**	**6.5**	**8.7**	**11.6**	**14.6**	**17.4**	**6.4**
OECD	**2.0**	**2.4**	**2.7**	**5.1**	**6.7**	**8.7**	**10.7**	**12.4**	**6.3**
Biofuels	0.6	0.9	1.0	1.4	1.9	2.6	3.2	3.7	5.5
Oil sands/bitumen (Canada)	1.4	1.5	1.7	3.6	4.5	5.3	6.0	6.5	5.5
Extra-heavy oil (Mexico)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	9.5
Coal-to-liquids	0.0	0.0	0.0	0.1	0.3	0.6	1.1	1.6	31.4
Gas-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Shale oil	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	--
Non-OECD	**0.7**	**0.9**	**1.0**	**1.4**	**2.1**	**2.9**	**3.9**	**5.0**	**6.8**
Biofuels	0.5	0.6	0.8	1.1	1.5	2.0	2.3	2.5	5.1
Extra-heavy oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal-to-liquids	0.2	0.2	0.2	0.2	0.4	0.9	1.6	2.5	10.6
Gas-to-liquids	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.4
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
World									
Biofuels	1.2	1.5	1.8	2.5	3.4	4.6	5.5	6.2	5.4
Oil sands/bitumen	1.4	1.5	1.7	3.6	4.5	5.3	6.0	6.5	5.5
Extra-heavy oil	0.6	0.7	0.5	1.0	1.3	1.4	1.5	1.7	3.5
Coal-to-liquids	0.2	0.2	0.2	0.3	0.7	1.5	2.7	4.1	12.7
Gas-to-liquids	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.4	8.0
Shale oil	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	16.3
World total	**3.4**	**3.9**	**4.2**	**7.6**	**10.2**	**13.1**	**16.3**	**19.2**	**6.1**
Selected country highlights									
Biofuels									
Brazil	0.3	0.5	0.6	0.9	1.3	1.6	1.8	1.9	5.3
China	0.2	0.0	0.0	0.0	0.1	0.2	0.3	0.3	7.9
India	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.8
United States	0.5	0.7	0.8	1.2	1.6	2.3	2.9	3.3	6.3
Coal-to-liquids									
Australia and New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
China	0.0	0.0	0.0	0.0	0.1	0.5	1.2	2.1	32.7
Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
India	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	--
South Africa	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	2.1
United States	0.0	0.0	0.0	0.1	0.3	0.6	1.1	1.6	--
Gas-to-liquids									
Qatar	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	14.8
South Africa	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.1

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E7. World total liquids production by region and country, Low Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**34.4**	**35.6**	**33.3**	**42.2**	**46.0**	**49.0**	**51.4**	**53.7**	**1.5**
Middle East	**23.1**	**24.2**	**22.4**	**29.0**	**31.8**	**34.1**	**36.1**	**38.1**	**1.7**
Iran	4.0	4.2	4.1	4.3	4.1	3.9	4.0	4.0	-0.1
Iraq	2.1	2.4	2.4	3.3	4.4	5.8	7.1	8.1	4.6
Kuwait	2.6	2.7	2.5	3.2	3.4	3.6	3.9	4.2	1.6
Qatar	1.1	1.2	1.2	1.9	2.2	2.3	2.4	2.4	2.6
Saudi Arabia	10.2	10.7	9.6	12.3	13.8	14.7	15.3	16.0	1.5
United Arab Emirates	2.9	3.0	2.8	3.9	3.9	3.7	3.4	3.3	0.3
North Africa	**4.0**	**4.1**	**3.9**	**3.7**	**3.7**	**3.5**	**3.3**	**3.2**	**-0.8**
Algeria	2.2	2.2	2.1	2.8	2.9	2.8	2.5	2.4	0.3
Libya	1.8	1.9	1.8	0.9	0.8	0.8	0.8	0.8	-2.9
West Africa	**4.1**	**4.2**	**4.1**	**5.9**	**6.3**	**6.8**	**7.0**	**7.2**	**2.0**
Angola	1.8	2.0	1.9	2.6	2.8	2.8	2.7	2.6	0.9
Nigeria	2.4	2.2	2.2	3.3	3.6	4.0	4.3	4.6	2.8
South America	**3.2**	**3.1**	**2.9**	**3.6**	**4.3**	**4.6**	**4.9**	**5.2**	**1.9**
Ecuador	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-0.1
Venezuela	2.7	2.6	2.4	3.1	3.8	4.1	4.4	4.8	2.2
Non-OPEC	**50.5**	**50.0**	**50.6**	**54.9**	**56.4**	**58.5**	**59.4**	**59.6**	**0.6**
OECD	**21.6**	**21.0**	**21.3**	**21.3**	**20.6**	**20.4**	**20.3**	**20.5**	**-0.1**
OECD North America	**15.4**	**15.0**	**15.7**	**16.8**	**16.7**	**16.6**	**16.7**	**16.9**	**0.4**
United States	8.5	8.5	9.1	10.3	10.5	10.6	10.4	10.4	0.8
Canada	3.4	3.4	3.6	4.1	4.3	4.5	4.7	4.8	1.4
Mexico	3.5	3.2	3.0	2.4	1.8	1.5	1.6	1.7	-2.3
OECD Europe	**5.4**	**5.1**	**4.8**	**3.8**	**3.2**	**3.0**	**2.9**	**2.8**	**-2.2**
OECD Asia	**0.8**	**0.8**	**0.8**	**0.8**	**0.7**	**0.8**	**0.7**	**0.7**	**-0.4**
Japan	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.8
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.6	0.5	0.5	-0.9
Non-OECD	**28.9**	**29.0**	**29.2**	**33.6**	**35.8**	**38.1**	**39.1**	**39.1**	**1.1**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**15.3**	**16.8**	**18.3**	**18.8**	**18.9**	**1.5**
Russia	9.9	9.8	9.8	11.3	12.4	13.5	13.9	14.1	1.3
Caspian area	2.6	2.6	2.8	3.7	4.2	4.6	4.7	4.6	2.2
Other	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	-1.5
Non-OECD Asia	**7.9**	**7.9**	**7.7**	**7.9**	**7.6**	**7.8**	**7.7**	**7.3**	**-0.3**
China	4.1	4.0	4.0	4.1	4.1	4.5	4.6	4.4	0.3
India	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.4
Other	2.9	2.9	2.8	2.8	2.5	2.3	2.1	1.9	-1.6
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.3**	**1.1**	**1.0**	**-1.6**
Africa	**2.7**	**2.7**	**2.6**	**3.0**	**3.0**	**3.1**	**3.1**	**3.0**	**0.5**
Central and South America	**4.1**	**4.3**	**4.6**	**5.9**	**6.9**	**7.7**	**8.4**	**8.8**	**2.7**
Brazil	2.3	2.4	2.6	3.4	4.4	5.1	5.7	6.2	3.5
Other	1.8	1.9	1.9	2.5	2.5	2.6	2.7	2.7	1.4
Total world	**84.9**	**85.7**	**83.9**	**97.0**	**102.4**	**107.5**	**110.8**	**113.3**	**1.0**
OPEC share of world production	40%	42%	40%	43%	45%	46%	46%	47%	
Persian Gulf share of world production	27%	28%	27%	30%	31%	32%	33%	34%	

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E8. World conventional liquids production by region and country, Low Oil Price case, 2007-2035
(Million barrels per day)

	History (estimates)			Projections					Average annual percent change,
Region/country	2007	2008	2009	2015	2020	2025	2030	2035	2008-2035
OPEC[a]	**33.8**	**35.0**	**32.8**	**40.6**	**43.6**	**46.1**	**48.0**	**49.9**	**1.3**
Middle East	**23.1**	**24.2**	**22.4**	**28.8**	**31.6**	**33.9**	**35.9**	**37.9**	**1.7**
Iran	4.0	4.2	4.1	4.3	4.1	3.9	4.0	4.0	-0.1
Iraq	2.1	2.4	2.4	3.3	4.4	5.8	7.1	8.1	4.6
Kuwait	2.6	2.7	2.5	3.2	3.4	3.6	3.9	4.2	1.6
Qatar	1.1	1.2	1.2	1.8	2.0	2.1	2.3	2.2	2.4
Saudi Arabia	10.2	10.7	9.6	12.3	13.8	14.7	15.3	16.0	1.5
United Arab Emirates	2.9	3.0	2.8	3.9	3.9	3.7	3.4	3.3	0.3
North Africa	**4.0**	**4.1**	**3.9**	**3.7**	**3.7**	**3.5**	**3.3**	**3.2**	**-0.8**
Algeria	2.2	2.2	2.1	2.8	2.9	2.8	2.5	2.4	0.3
Libya	1.8	1.9	1.8	0.9	0.8	0.8	0.8	0.8	-2.9
West Africa	**4.1**	**4.2**	**4.1**	**5.8**	**6.3**	**6.8**	**7.0**	**7.2**	**2.0**
Angola	1.8	2.0	1.9	2.6	2.8	2.8	2.7	2.6	0.9
Nigeria	2.4	2.2	2.2	3.3	3.5	3.9	4.3	4.6	2.8
South America	**2.6**	**2.5**	**2.4**	**2.2**	**2.0**	**1.9**	**1.8**	**1.7**	**-1.4**
Ecuador	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-0.1
Venezuela	2.1	2.0	1.9	1.8	1.5	1.4	1.3	1.2	-1.9
Non-OPEC	**47.8**	**46.8**	**46.9**	**50.8**	**51.7**	**53.2**	**53.2**	**52.6**	**0.4**
OECD	**19.6**	**18.6**	**18.6**	**17.9**	**16.8**	**16.0**	**15.4**	**15.2**	**-0.7**
OECD Americas	**13.6**	**12.8**	**13.2**	**13.5**	**13.0**	**12.4**	**11.9**	**11.9**	**-0.3**
United States	8.0	7.8	8.3	9.2	9.3	9.1	8.6	8.5	0.3
Canada	2.1	1.8	1.9	1.9	1.8	1.8	1.8	1.7	-0.2
Mexico	3.5	3.2	3.0	2.4	1.8	1.5	1.6	1.7	-2.3
OECD Europe	**5.2**	**5.0**	**4.6**	**3.7**	**3.1**	**2.9**	**2.7**	**2.6**	**-2.3**
Denmark	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	-1.8
Norway	2.6	2.5	2.3	1.9	1.6	1.5	1.3	1.2	-2.5
United Kingdom	1.7	1.6	1.5	0.9	0.7	0.6	0.6	0.6	-3.6
Other	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.0
OECD Asia	**0.8**	**0.8**	**0.8**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**-0.4**
Japan	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.8
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.6	0.5	0.5	-0.9

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).

(continued on page 239)

Table E8. World conventional liquids production by region and country, Low Oil Price case, 2007-2035 (continued)
(Million barrels per day)

	History (estimates)			Projections					Average annual percent change,
Region/country	2007	2008	2009	2015	2020	2025	2030	2035	2008-2035
Non-OECD	**28.2**	**28.2**	**28.2**	**32.9**	**34.9**	**37.1**	**37.8**	**37.3**	**1.0**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.8**	**15.2**	**16.8**	**18.3**	**18.8**	**18.9**	**1.5**
Russia	**9.9**	**9.8**	**9.8**	**11.3**	**12.4**	**13.5**	**13.9**	**14.0**	**1.3**
Caspian Area	**2.6**	**2.6**	**2.8**	**3.7**	**4.2**	**4.6**	**4.7**	**4.6**	**2.2**
Azerbaijan	0.8	0.9	1.0	1.3	1.4	1.4	1.2	1.0	0.5
Kazakhstan	1.4	1.4	1.5	2.1	2.4	2.9	3.1	3.2	3.0
Turkmenistan	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	2.9
Uzbekistan	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-5.3
Other	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**-1.5**
Non-OECD Asia	**7.7**	**7.7**	**7.5**	**7.8**	**7.5**	**7.5**	**7.3**	**6.8**	**-0.5**
China	3.9	4.0	3.9	4.0	4.1	4.3	4.3	4.0	0.0
India	0.9	0.9	0.9	1.0	0.9	1.0	1.0	1.0	0.3
Brunei	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	-1.4
Malaysia	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	-0.9
Thailand	0.3	0.3	0.3	0.5	0.4	0.4	0.4	0.4	0.3
Vietnam	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.2	-1.5
Other	1.3	1.3	1.3	1.1	0.9	0.8	0.7	0.6	-2.9
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.3**	**1.1**	**1.0**	**-1.6**
Oman	0.7	0.8	0.8	1.0	0.8	0.7	0.6	0.5	-1.4
Syria	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	-2.1
Yemen	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	-3.6
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.3
Africa	**2.5**	**2.5**	**2.4**	**2.8**	**2.9**	**3.0**	**3.0**	**2.9**	**0.6**
Chad	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-3.3
Congo (Brazzaville)	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	-0.8
Egypt	0.8	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.0
Equatorial Guinea	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.3	-0.3
Gabon	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	-2.8
Sao Tome and Principe	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Sudan	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.8	1.8
Other	0.3	0.3	0.3	0.7	0.8	0.8	0.8	0.7	3.1
Central and South America	**3.7**	**3.8**	**3.9**	**5.4**	**6.2**	**7.1**	**7.6**	**7.7**	**2.7**
Brazil	1.9	2.0	2.0	3.0	3.8	4.5	4.9	5.1	3.6
Argentina	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	-1.4
Colombia	0.5	0.6	0.7	1.1	1.0	0.9	0.9	0.8	1.0
Peru	0.1	0.1	0.1	0.3	0.3	0.3	0.4	0.4	4.3
Trinidad and Tobago	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.4
Other	0.2	0.2	0.2	0.2	0.3	0.5	0.7	0.8	5.8
Total world	**81.5**	**81.7**	**79.6**	**91.4**	**95.3**	**99.3**	**101.2**	**102.5**	**0.8**
OPEC share of world production	41%	43%	41%	44%	46%	46%	47%	49%	
Persian Gulf share of world production	28%	30%	28%	32%	33%	34%	36%	37%	

Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E9. World unconventional liquids production by region and country, Low Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**0.6**	**0.7**	**0.5**	**1.5**	**2.4**	**2.9**	**3.4**	**3.8**	**6.7**
Biofuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Extra-heavy oil (Venezuela)	0.6	0.7	0.5	1.4	2.2	2.7	3.2	3.6	6.5
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Gas-to-liquids (primarily Qatar)	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	14.9
Non-OPEC	**2.8**	**3.2**	**3.7**	**4.1**	**4.7**	**5.3**	**6.2**	**7.0**	**2.9**
OECD	**2.0**	**2.4**	**2.7**	**3.4**	**3.8**	**4.3**	**4.9**	**5.2**	**2.9**
Biofuels	0.6	0.9	1.0	1.2	1.3	1.6	1.9	2.1	3.3
Oil sands/bitumen (Canada)	1.4	1.5	1.7	2.2	2.4	2.7	2.9	3.1	2.6
Extra-heavy oil (Mexico)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Coal-to-liquids	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	18.7
Gas-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Non-OECD	**0.7**	**0.9**	**1.0**	**0.7**	**0.9**	**1.0**	**1.4**	**1.8**	**2.7**
Biofuels	0.5	0.6	0.8	0.5	0.7	0.7	1.0	1.4	2.9
Extra-heavy oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal-to-liquids	0.2	0.2	0.2	0.1	0.2	0.2	0.3	0.3	2.8
Gas-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.0
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.8
World									
Biofuels	1.2	1.5	1.8	1.7	2.0	2.3	2.9	3.5	3.1
Oil sands/bitumen	1.4	1.5	1.7	2.2	2.4	2.7	2.9	3.1	2.6
Extra-heavy oil	0.6	0.7	0.5	1.4	2.2	2.7	3.2	3.6	6.5
Coal-to-liquids	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.4	3.8
Gas-to-liquids	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	5.8
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.8
World total	**3.4**	**3.9**	**4.2**	**5.6**	**7.1**	**8.2**	**9.6**	**10.8**	**3.8**
Selected country highlights									
Biofuels									
Brazil	0.3	0.5	0.6	0.4	0.6	0.6	0.8	1.1	3.1
China	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.2	5.7
India	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
United States	0.5	0.7	0.8	1.1	1.1	1.5	1.7	1.9	4.0
Coal-to-liquids									
Australia and New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
China	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	22.2
Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.0
India	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
South Africa	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	-2.4
United States	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	--
Gas-to-liquids									
Qatar	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	14.3
South Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.3

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E10. World total liquids production by region and country, Traditional High Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**34.4**	**35.6**	**33.3**	**32.7**	**34.0**	**34.8**	**34.5**	**34.1**	**-0.2**
Middle East	**23.1**	**24.2**	**22.5**	**22.8**	**23.9**	**24.9**	**25.2**	**25.1**	**0.1**
Iran	4.0	4.2	4.1	3.3	3.1	2.9	2.8	2.7	-1.6
Iraq	2.1	2.4	2.4	2.6	3.0	3.5	4.0	4.3	2.2
Kuwait	2.6	2.7	2.5	2.5	2.5	2.6	2.7	2.8	0.1
Qatar	1.1	1.2	1.2	1.6	1.8	1.9	2.0	1.9	1.7
Saudi Arabia	10.2	10.7	9.6	9.7	10.6	11.2	11.2	11.1	0.1
United Arab Emirates	2.9	3.0	2.8	3.0	2.9	2.8	2.5	2.3	-1.0
North Africa	**4.0**	**4.1**	**3.9**	**3.0**	**2.9**	**2.8**	**2.6**	**2.4**	**-1.9**
Algeria	2.2	2.2	2.1	2.2	2.2	2.1	1.9	1.8	-0.8
Libya	1.8	1.9	1.8	0.8	0.6	0.6	0.6	0.6	-3.9
West Africa	**4.1**	**4.2**	**4.1**	**4.3**	**4.4**	**4.3**	**4.0**	**3.7**	**-0.4**
Angola	1.8	2.0	1.9	1.8	1.9	1.7	1.6	1.4	-1.3
Nigeria	2.4	2.2	2.2	2.5	2.5	2.5	2.4	2.3	0.2
South America	**3.2**	**3.1**	**2.9**	**2.7**	**2.8**	**2.8**	**2.8**	**2.8**	**-0.4**
Ecuador	0.5	0.5	0.5	0.3	0.4	0.4	0.3	0.3	-1.7
Venezuela	2.7	2.6	2.4	2.3	2.5	2.5	2.5	2.5	-0.2
Non-OPEC	**50.5**	**50.0**	**50.5**	**57.9**	**59.5**	**63.9**	**68.7**	**73.3**	**1.4**
OECD	**21.6**	**21.0**	**21.3**	**23.4**	**24.4**	**26.4**	**28.1**	**30.2**	**1.4**
OECD North America	**15.4**	**15.0**	**15.7**	**18.8**	**20.4**	**22.5**	**24.3**	**26.4**	**2.1**
United States	8.5	8.5	9.1	10.8	12.2	13.9	14.8	16.2	2.4
Canada	3.4	3.4	3.6	5.6	6.4	7.2	8.0	8.5	3.5
Mexico	3.5	3.2	3.0	2.4	1.8	1.4	1.5	1.7	-2.2
OECD Europe	**5.4**	**5.1**	**4.8**	**3.9**	**3.3**	**3.1**	**3.1**	**3.1**	**-1.9**
OECD Asia	**0.8**	**0.8**	**0.8**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**-0.4**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	-0.6
Non-OECD	**28.9**	**29.0**	**29.2**	**34.5**	**35.1**	**37.5**	**40.6**	**43.1**	**1.5**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**15.1**	**15.3**	**16.2**	**17.4**	**18.5**	**1.4**
Russia	9.9	9.8	9.8	11.2	11.3	11.9	12.8	13.7	1.2
Caspian area	2.6	2.6	2.8	3.7	3.8	4.1	4.4	4.6	2.2
Other	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	-1.2
Non-OECD Asia	**7.9**	**7.9**	**7.7**	**8.1**	**7.8**	**8.4**	**9.2**	**10.0**	**0.9**
China	4.1	4.0	4.0	4.2	4.2	4.9	5.9	6.8	1.9
India	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	0.8
Other	2.9	2.9	2.8	2.9	2.6	2.4	2.2	2.1	-1.2
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.3**	**1.2**	**1.1**	**-1.2**
Africa	**2.7**	**2.7**	**2.6**	**3.1**	**3.2**	**3.4**	**3.5**	**3.6**	**1.1**
Central and South America	**4.1**	**4.3**	**4.5**	**6.4**	**7.3**	**8.2**	**9.2**	**9.9**	**3.1**
Brazil	2.3	2.4	2.6	3.8	4.7	5.6	6.3	6.9	3.9
Other	1.8	1.9	1.9	2.6	2.5	2.7	2.9	3.0	1.8
Total world	**84.9**	**85.7**	**83.9**	**90.6**	**93.5**	**98.6**	**103.2**	**107.4**	**0.8**
OPEC share of world production	40%	42%	40%	36%	36%	35%	33%	32%	
Persian Gulf share of world production	27%	28%	27%	25%	26%	25%	24%	23%	

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E11. World conventional liquids production by region and country, Traditional High Oil Price case, 2007-2035
(Million barrels per day)

	History (estimates)			Projections					Average annual percent change,
Region/country	2007	2008	2009	2015	2020	2025	2030	2035	2008-2035
OPEC[a]	**33.8**	**35.0**	**32.8**	**31.6**	**32.6**	**33.2**	**32.8**	**32.3**	**-0.3**
Middle East	**23.1**	**24.2**	**22.4**	**22.6**	**23.8**	**24.7**	**25.0**	**24.9**	**0.1**
Iran	4.0	4.2	4.1	3.3	3.1	2.9	2.8	2.7	-1.6
Iraq	2.1	2.4	2.4	2.6	3.0	3.5	4.0	4.3	2.2
Kuwait	2.6	2.7	2.5	2.5	2.5	2.6	2.7	2.8	0.1
Qatar	1.1	1.2	1.2	1.5	1.6	1.7	1.8	1.7	1.3
Saudi Arabia	10.2	10.7	9.6	9.7	10.6	11.2	11.2	11.1	0.1
United Arab Emirates	2.9	3.0	2.8	3.0	2.9	2.8	2.5	2.3	-1.0
North Africa	**4.0**	**4.1**	**3.9**	**3.0**	**2.9**	**2.8**	**2.6**	**2.4**	**-1.9**
Algeria	2.2	2.2	2.1	2.2	2.2	2.1	1.9	1.8	-0.8
Libya	1.8	1.9	1.8	0.8	0.6	0.6	0.6	0.6	-3.9
West Africa	**4.1**	**4.2**	**4.1**	**4.3**	**4.4**	**4.2**	**4.0**	**3.7**	**-0.4**
Angola	1.8	2.0	1.9	1.8	1.9	1.7	1.6	1.4	-1.3
Nigeria	2.4	2.2	2.2	2.5	2.5	2.5	2.4	2.3	0.2
South America	**2.6**	**2.5**	**2.4**	**1.7**	**1.6**	**1.5**	**1.4**	**1.3**	**-2.5**
Ecuador	0.5	0.5	0.5	0.3	0.4	0.4	0.3	0.3	-1.7
Venezuela	2.1	2.0	1.9	1.4	1.2	1.2	1.0	0.9	-2.7
Non-OPEC	**47.8**	**46.8**	**46.9**	**51.4**	**50.7**	**52.3**	**54.1**	**55.9**	**0.7**
OECD	**19.6**	**18.6**	**18.6**	**18.3**	**17.7**	**17.7**	**17.4**	**17.8**	**-0.2**
OECD Americas	**13.6**	**12.8**	**13.2**	**13.8**	**14.0**	**14.2**	**13.9**	**14.4**	**0.4**
United States	8.0	7.8	8.3	9.5	10.4	10.9	10.5	10.8	1.2
Canada	2.1	1.8	1.9	1.9	1.9	1.9	1.9	1.9	0.3
Mexico	3.5	3.2	3.0	2.4	1.7	1.4	1.5	1.6	-2.4
OECD Europe	**5.2**	**5.0**	**4.6**	**3.7**	**3.0**	**2.9**	**2.8**	**2.8**	**-2.1**
Denmark	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	-1.4
Norway	2.6	2.5	2.3	2.0	1.6	1.5	1.4	1.4	-2.1
United Kingdom	1.7	1.6	1.5	0.9	0.7	0.6	0.6	0.6	-3.3
Other	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.6	-0.4
OECD Asia	**0.8**	**0.8**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**-0.4**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.5	0.5	0.6	-0.6

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).

(continued on page 243)

Table E11. World conventional liquids production by region and country, Traditional High Oil Price case, 2007-2035 (continued)
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
Non-OECD	**28.2**	**28.2**	**28.3**	**33.1**	**33.0**	**34.5**	**36.7**	**38.1**	**1.1**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**15.1**	**15.3**	**16.2**	**17.4**	**18.5**	**1.4**
Russia	**9.9**	**9.8**	**9.8**	**11.2**	**11.3**	**11.9**	**12.8**	**13.7**	**1.2**
Caspian Area	**2.6**	**2.6**	**2.8**	**3.7**	**3.8**	**4.1**	**4.4**	**4.6**	**2.2**
Azerbaijan	0.8	0.9	1.0	1.3	1.3	1.2	1.1	1.0	0.4
Kazakhstan	1.4	1.4	1.5	2.1	2.2	2.5	2.9	3.1	3.0
Turkmenistan	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	3.3
Uzbekistan	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-4.9
Other	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**-1.4**
Non-OECD Asia	**7.7**	**7.7**	**7.6**	**8.0**	**7.5**	**7.5**	**7.6**	**7.4**	**-0.2**
China	3.9	4.0	3.9	4.1	4.0	4.3	4.5	4.4	0.4
India	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.0	0.5
Brunei	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	-1.0
Malaysia	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	-0.6
Thailand	0.3	0.3	0.3	0.5	0.4	0.4	0.4	0.4	0.6
Vietnam	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.2	-1.2
Other	1.3	1.3	1.3	1.1	0.9	0.8	0.7	0.6	-2.6
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.3**	**1.2**	**1.1**	**-1.2**
Oman	0.7	0.8	0.8	1.0	0.8	0.7	0.6	0.6	-1.0
Syria	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	-1.7
Yemen	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	-3.2
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.7
Africa	**2.5**	**2.5**	**2.4**	**2.9**	**2.9**	**3.0**	**3.1**	**3.3**	**1.0**
Chad	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-2.9
Congo (Brazzaville)	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	-0.4
Egypt	0.8	0.7	0.7	0.6	0.7	0.7	0.8	0.8	0.3
Equatorial Guinea	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.1
Gabon	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	-2.3
Sao Tome and Principe	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Sudan	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.9	2.2
Other	0.3	0.3	0.3	0.7	0.8	0.8	0.8	0.8	3.6
Central and South America	**3.7**	**3.8**	**3.9**	**5.5**	**5.9**	**6.6**	**7.4**	**7.8**	**2.8**
Brazil	1.9	2.0	2.0	3.0	3.5	4.0	4.5	5.0	3.5
Argentina	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.6	-1.1
Colombia	0.5	0.6	0.7	1.1	1.0	0.9	0.9	0.9	1.4
Peru	0.1	0.1	0.1	0.3	0.3	0.4	0.4	0.4	4.6
Trinidad and Tobago	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.7
Other	0.2	0.2	0.2	0.2	0.3	0.5	0.8	0.9	6.2
Total world	**81.5**	**81.7**	**79.7**	**83.0**	**83.3**	**85.5**	**86.9**	**88.2**	**0.3**
OPEC share of world production	41%	43%	41%	38%	39%	39%	38%	37%	
Persian Gulf share of world production	28%	30%	28%	27%	29%	29%	29%	28%	

Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E12. World unconventional liquids production by region and country, Traditional High Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**0.6**	**0.7**	**0.5**	**1.1**	**1.4**	**1.6**	**1.7**	**1.8**	**3.8**
Biofuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Extra-heavy oil (Venezuela)	0.6	0.7	0.5	0.9	1.2	1.3	1.4	1.6	3.3
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Gas-to-liquids (primarily Qatar)	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	15.3
Non-OPEC	**2.8**	**3.2**	**3.6**	**6.5**	**8.7**	**11.6**	**14.6**	**17.4**	**6.4**
OECD	**2.0**	**2.4**	**2.7**	**5.1**	**6.7**	**8.7**	**10.7**	**12.4**	**6.3**
Biofuels	0.6	0.9	1.0	1.4	1.9	2.6	3.2	3.7	5.5
Oil sands/bitumen (Canada)	1.4	1.5	1.7	3.6	4.5	5.3	6.0	6.5	5.5
Extra-heavy oil (Mexico)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	9.5
Coal-to-liquids	0.0	0.0	0.0	0.1	0.3	0.6	1.1	1.6	31.4
Gas-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Shale oil	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	--
Non-OECD	**0.7**	**0.9**	**1.0**	**1.4**	**2.1**	**2.9**	**3.9**	**5.0**	**6.8**
Biofuels	0.5	0.6	0.8	1.1	1.5	2.0	2.3	2.5	5.1
Extra-heavy oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal-to-liquids	0.2	0.2	0.2	0.2	0.4	0.9	1.6	2.5	10.6
Gas-to-liquids	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.4
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
World									
Biofuels	1.2	1.5	1.8	2.5	3.4	4.6	5.5	6.2	5.4
Oil sands/bitumen	1.4	1.5	1.7	3.6	4.5	5.3	6.0	6.5	5.5
Extra-heavy oil	0.6	0.7	0.5	1.0	1.3	1.4	1.5	1.7	3.5
Coal-to-liquids	0.2	0.2	0.2	0.3	0.7	1.5	2.7	4.1	12.7
Gas-to-liquids	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.4	8.0
Shale oil	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	16.3
World total	**3.4**	**3.9**	**4.2**	**7.6**	**10.2**	**13.1**	**16.3**	**19.2**	**6.1**
Selected country highlights									
Biofuels									
Brazil	0.3	0.5	0.6	0.9	1.3	1.6	1.8	1.9	5.3
China	0.2	0.0	0.0	0.0	0.1	0.2	0.3	0.3	7.9
India	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.8
United States	0.5	0.7	0.8	1.2	1.6	2.3	2.9	3.3	6.3
Coal-to-liquids									
Australia and New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
China	0.0	0.0	0.0	0.0	0.1	0.5	1.2	2.1	32.7
Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
India	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	--
South Africa	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	2.1
United States	0.0	0.0	0.0	0.1	0.3	0.6	1.1	1.6	--
Gas-to-liquids									
Qatar	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	14.8
South Africa	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.1

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E13. World total liquids production by region and country, Traditional Low Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**34.4**	**35.6**	**33.3**	**43.4**	**49.4**	**56.4**	**62.3**	**68.0**	**2.4**
Middle East	**23.1**	**24.2**	**22.4**	**29.9**	**34.4**	**39.9**	**44.8**	**49.3**	**2.7**
Iran	4.0	4.2	4.1	4.7	4.8	5.2	5.7	6.3	1.5
Iraq	2.1	2.4	2.4	3.2	4.3	5.8	7.4	8.9	5.0
Kuwait	2.6	2.7	2.5	3.5	4.0	4.8	5.8	6.6	3.3
Qatar	1.1	1.2	1.2	2.0	2.4	2.9	3.3	3.4	4.0
Saudi Arabia	10.2	10.7	9.6	12.4	14.4	16.4	17.8	19.1	2.2
United Arab Emirates	2.9	3.0	2.8	4.2	4.5	4.9	4.9	5.0	1.8
North Africa	**4.0**	**4.1**	**3.9**	**4.0**	**4.2**	**4.5**	**4.6**	**4.8**	**0.6**
Algeria	2.2	2.2	2.1	3.0	3.3	3.5	3.6	3.5	1.8
Libya	1.8	1.9	1.8	1.0	0.9	1.0	1.1	1.2	-1.5
West Africa	**4.1**	**4.2**	**4.1**	**5.7**	**6.3**	**6.8**	**7.2**	**7.9**	**2.4**
Angola	1.8	2.0	1.9	2.5	2.7	2.8	2.8	2.8	1.2
Nigeria	2.4	2.2	2.2	3.2	3.5	4.0	4.4	5.1	3.2
South America	**3.2**	**3.1**	**2.9**	**3.8**	**4.6**	**5.1**	**5.6**	**6.0**	**2.4**
Ecuador	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.8	1.7
Venezuela	2.7	2.6	2.4	3.3	4.0	4.5	4.9	5.2	2.6
Non-OPEC	**50.5**	**50.0**	**50.6**	**53.9**	**56.1**	**58.5**	**61.0**	**63.5**	**0.9**
OECD	**21.6**	**21.0**	**21.3**	**21.1**	**20.6**	**20.4**	**20.5**	**21.0**	**0.0**
OECD North America	**15.4**	**15.0**	**15.7**	**16.7**	**16.7**	**16.6**	**16.7**	**17.1**	**0.5**
United States	8.5	8.5	9.1	10.3	10.5	10.6	10.4	10.4	0.8
Canada	3.4	3.4	3.6	4.0	4.3	4.5	4.7	4.9	1.4
Mexico	3.5	3.2	3.0	2.3	1.8	1.5	1.6	1.8	-2.0
OECD Europe	**5.4**	**5.1**	**4.8**	**3.7**	**3.2**	**3.0**	**3.0**	**3.0**	**-1.9**
OECD Asia	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**-0.1**
Japan	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	1.1
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	-0.6
Non-OECD	**28.9**	**29.0**	**29.2**	**32.8**	**35.5**	**38.1**	**40.5**	**42.5**	**1.4**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.9**	**14.9**	**16.6**	**18.2**	**19.4**	**20.6**	**1.8**
Russia	9.9	9.8	9.8	11.0	12.3	13.4	14.4	15.3	1.7
Caspian area	2.6	2.6	2.8	3.6	4.1	4.6	4.9	5.1	2.5
Other	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	-1.2
Non-OECD Asia	**7.9**	**7.9**	**7.7**	**7.7**	**7.6**	**7.8**	**8.0**	**8.0**	**0.1**
China	4.1	4.0	4.0	4.0	4.1	4.5	4.8	4.8	0.7
India	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	0.7
Other	2.9	2.9	2.8	2.7	2.5	2.3	2.1	2.0	-1.3
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.2**	**1.1**	**1.1**	**-1.3**
Africa	**2.7**	**2.7**	**2.6**	**2.9**	**3.0**	**3.1**	**3.2**	**3.3**	**0.8**
Central and South America	**4.1**	**4.3**	**4.6**	**5.8**	**6.8**	**7.7**	**8.7**	**9.5**	**3.0**
Brazil	2.3	2.4	2.6	3.3	4.4	5.1	5.9	6.6	3.8
Other	1.8	1.9	1.9	2.4	2.4	2.6	2.8	2.9	1.7
Total world	**84.9**	**85.7**	**83.9**	**97.3**	**105.5**	**114.9**	**123.3**	**131.5**	**1.6**
OPEC share of world production	40%	42%	40%	45%	47%	49%	51%	52%	
Persian Gulf share of world production	27%	28%	27%	31%	33%	35%	36%	38%	

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E14. World conventional liquids production by region and country, Traditional Low Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**33.8**	**35.0**	**32.8**	**41.8**	**47.0**	**53.5**	**58.9**	**64.2**	**2.3**
Middle East	**23.1**	**24.2**	**22.4**	**29.8**	**34.2**	**39.7**	**44.6**	**49.2**	**2.7**
Iran	4.0	4.2	4.1	4.7	4.8	5.2	5.7	6.3	1.5
Iraq	2.1	2.4	2.4	3.2	4.3	5.8	7.4	8.9	5.0
Kuwait	2.6	2.7	2.5	3.5	4.0	4.8	5.8	6.6	3.3
Qatar	1.1	1.2	1.2	1.9	2.3	2.7	3.1	3.2	3.8
Saudi Arabia	10.2	10.7	9.6	12.4	14.4	16.4	17.8	19.1	2.2
United Arab Emirates	2.9	3.0	2.8	4.2	4.5	4.9	4.9	5.0	1.8
North Africa	**4.0**	**4.1**	**3.9**	**4.0**	**4.2**	**4.5**	**4.6**	**4.8**	**0.6**
Algeria	2.2	2.2	2.1	3.0	3.3	3.5	3.6	3.5	1.8
Libya	1.8	1.9	1.8	1.0	0.9	1.0	1.1	1.2	-1.5
West Africa	**4.1**	**4.2**	**4.1**	**5.7**	**6.2**	**6.7**	**7.2**	**7.9**	**2.4**
Angola	1.8	2.0	1.9	2.5	2.7	2.8	2.8	2.8	1.2
Nigeria	2.4	2.2	2.2	3.2	3.5	3.9	4.4	5.0	3.2
South America	**2.6**	**2.5**	**2.4**	**2.4**	**2.4**	**2.5**	**2.4**	**2.5**	**0.0**
Ecuador	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.8	1.7
Venezuela	2.1	2.0	1.9	1.9	1.8	1.8	1.7	1.7	-0.6
Non-OPEC	**47.8**	**46.8**	**46.9**	**49.8**	**51.4**	**53.2**	**54.8**	**56.5**	**0.7**
OECD	**19.6**	**18.6**	**18.6**	**17.7**	**16.8**	**16.1**	**15.7**	**15.7**	**-0.6**
OECD Americas	**13.6**	**12.8**	**13.2**	**13.4**	**13.0**	**12.4**	**12.0**	**12.1**	**-0.2**
United States	8.0	7.8	8.3	9.2	9.3	9.1	8.6	8.5	0.3
Canada	2.1	1.8	1.9	1.8	1.8	1.8	1.8	1.8	0.0
Mexico	3.5	3.2	3.0	2.3	1.8	1.5	1.6	1.8	-2.1
OECD Europe	**5.2**	**5.0**	**4.6**	**3.6**	**3.1**	**2.9**	**2.9**	**2.9**	**-2.0**
Denmark	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	-1.5
Norway	2.6	2.5	2.3	1.9	1.6	1.5	1.4	1.3	-2.2
United Kingdom	1.7	1.6	1.5	0.9	0.7	0.6	0.6	0.6	-3.3
Other	0.7	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.4
OECD Asia	**0.8**	**0.8**	**0.8**	**0.8**	**0.7**	**0.8**	**0.8**	**0.8**	**-0.1**
Japan	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	1.1
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Australia and New Zealand	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	-0.6

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).

(continued on page 247)

Table E14. World conventional liquids production by region and country, Traditional Low Oil Price case, 2007-2035 (continued)
(Million barrels per day)

	History (estimates)			Projections					Average annual percent change,
Region/country	2007	2008	2009	2015	2020	2025	2030	2035	2008-2035
Non-OECD	**28.2**	**28.2**	**28.2**	**32.1**	**34.6**	**37.1**	**39.1**	**40.8**	**1.4**
Non-OECD Europe and Eurasia	**12.8**	**12.7**	**12.8**	**14.9**	**16.6**	**18.2**	**19.4**	**20.6**	**1.8**
Russia	**9.9**	**9.8**	**9.8**	**11.0**	**12.3**	**13.4**	**14.4**	**15.3**	**1.7**
Caspian Area	**2.6**	**2.6**	**2.8**	**3.6**	**4.1**	**4.6**	**4.9**	**5.1**	**2.5**
Azerbaijan	0.8	0.9	1.0	1.3	1.4	1.4	1.2	1.1	0.9
Kazakhstan	1.4	1.4	1.5	2.0	2.4	2.8	3.2	3.5	3.4
Turkmenistan	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	3.2
Uzbekistan	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-4.9
Other	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**-1.2**
Non-OECD Asia	**7.7**	**7.7**	**7.5**	**7.6**	**7.5**	**7.6**	**7.6**	**7.5**	**-0.1**
China	3.9	4.0	3.9	3.9	4.0	4.3	4.5	4.4	0.4
India	0.9	0.9	0.9	1.0	0.9	1.0	1.0	1.1	0.6
Brunei	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	-1.1
Malaysia	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	-0.6
Thailand	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5
Vietnam	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.2	-1.2
Other	1.3	1.3	1.3	1.0	0.9	0.8	0.7	0.7	-2.6
Middle East (Non-OPEC)	**1.5**	**1.5**	**1.5**	**1.6**	**1.4**	**1.2**	**1.1**	**1.1**	**-1.3**
Oman	0.7	0.8	0.8	0.9	0.8	0.7	0.6	0.6	-1.1
Syria	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	-1.8
Yemen	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	-3.3
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.7
Africa	**2.5**	**2.5**	**2.4**	**2.7**	**2.9**	**3.0**	**3.1**	**3.2**	**0.9**
Chad	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-3.0
Congo (Brazzaville)	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	-0.5
Egypt	0.8	0.7	0.7	0.6	0.7	0.7	0.7	0.8	0.2
Equatorial Guinea	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.0
Gabon	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	-2.4
Sao Tome and Principe	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Sudan	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.9	2.1
Other	0.3	0.3	0.3	0.7	0.8	0.8	0.8	0.8	3.5
Central and South America	**3.7**	**3.8**	**3.9**	**5.3**	**6.2**	**7.1**	**7.9**	**8.4**	**3.0**
Brazil	1.9	2.0	2.0	2.9	3.8	4.5	5.1	5.6	4.0
Argentina	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.6	-1.1
Colombia	0.5	0.6	0.7	1.1	1.0	0.9	0.9	0.9	1.3
Peru	0.1	0.1	0.1	0.3	0.3	0.3	0.4	0.4	4.5
Trinidad and Tobago	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.6
Other	0.2	0.2	0.2	0.2	0.3	0.5	0.8	0.8	6.1
Total world	**81.5**	**81.7**	**79.6**	**91.7**	**98.4**	**106.7**	**113.7**	**120.7**	**1.5**
OPEC share of world production	41%	43%	41%	46%	48%	50%	52%	53%	
Persian Gulf share of world production	28%	30%	28%	32%	35%	37%	39%	41%	

Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Table E15. World unconventional liquids production by region and country, Traditional Low Oil Price case, 2007-2035
(Million barrels per day)

Region/country	History (estimates) 2007	2008	2009	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OPEC[a]	**0.6**	**0.7**	**0.5**	**1.5**	**2.4**	**2.9**	**3.4**	**3.8**	**6.7**
Biofuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Extra-heavy oil (Venezuela)	0.6	0.7	0.5	1.4	2.2	2.7	3.2	3.6	6.5
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Gas-to-liquids (primarily Qatar)	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	14.9
Non-OPEC	**2.8**	**3.2**	**3.7**	**4.1**	**4.7**	**5.3**	**6.2**	**7.0**	**2.9**
OECD	**2.0**	**2.4**	**2.7**	**3.4**	**3.8**	**4.3**	**4.9**	**5.2**	**2.9**
Biofuels	0.6	0.9	1.0	1.2	1.3	1.6	1.9	2.1	3.3
Oil sands/bitumen (Canada)	1.4	1.5	1.7	2.2	2.4	2.7	2.9	3.1	2.6
Extra-heavy oil (Mexico)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Coal-to-liquids	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	18.7
Gas-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Non-OECD	**0.7**	**0.9**	**1.0**	**0.7**	**0.9**	**1.0**	**1.4**	**1.8**	**2.7**
Biofuels	0.5	0.6	0.8	0.5	0.7	0.7	1.0	1.4	2.9
Extra-heavy oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Coal-to-liquids	0.2	0.2	0.2	0.1	0.2	0.2	0.3	0.3	2.8
Gas-to-liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.0
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.8
World									
Biofuels	1.2	1.5	1.8	1.7	2.0	2.3	2.9	3.5	3.1
Oil sands/bitumen	1.4	1.5	1.7	2.2	2.4	2.7	2.9	3.1	2.6
Extra-heavy oil	0.6	0.7	0.5	1.4	2.2	2.7	3.2	3.6	6.5
Coal-to-liquids	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.4	3.8
Gas-to-liquids	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	5.8
Shale oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.8
World total	**3.4**	**3.9**	**4.2**	**5.6**	**7.1**	**8.2**	**9.6**	**10.8**	**3.8**
Selected country highlights									
Biofuels									
Brazil	0.3	0.5	0.6	0.4	0.6	0.6	0.8	1.1	3.1
China	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.2	5.7
India	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
United States	0.5	0.7	0.8	1.1	1.1	1.5	1.7	1.9	4.0
Coal-to-liquids									
Australia and New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
China	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	22.2
Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.0
India	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
South Africa	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	-2.4
United States	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	--
Gas-to-liquids									
Qatar	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	14.3
South Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.3

[a]OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).
Sources: **History:** U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. **Projections:** EIA, Generate World Oil Balance Model (2011).

Appendix F

Reference case projections for electricity capacity and generation by fuel

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Table F1. World total installed generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**1,207**	**1,293**	**1,320**	**1,378**	**1,457**	**1,539**	**0.9**
United States[a]	1,009	1,075	1,085	1,119	1,170	1,221	0.7
Canada	128	136	143	153	167	180	1.3
Mexico/Chile	70	82	92	105	120	137	2.5
OECD Europe	**864**	**946**	**1,018**	**1,063**	**1,098**	**1,133**	**1.0**
OECD Asia	**425**	**444**	**460**	**476**	**492**	**510**	**0.7**
Japan	281	283	288	294	299	306	0.3
South Korea	80	89	95	103	111	119	1.5
Australia/New Zealand	65	72	77	79	82	85	1.0
Total OECD	**2,495**	**2,684**	**2,798**	**2,917**	**3,047**	**3,181**	**0.9**
Non-OECD							
Non-OECD Europe and Eurasia	**405**	**408**	**423**	**437**	**460**	**487**	**0.7**
Russia	224	227	235	242	258	277	0.8
Other	181	181	188	194	202	210	0.6
Non-OECD Asia	**1,207**	**1,633**	**1,920**	**2,184**	**2,446**	**2,695**	**3.0**
China	797	1,118	1,313	1,492	1,666	1,817	3.1
India	177	240	290	332	371	411	3.2
Other	233	275	317	360	408	466	2.6
Middle East	**165**	**182**	**202**	**221**	**240**	**264**	**1.8**
Africa	**123**	**149**	**169**	**191**	**214**	**238**	**2.5**
Central and South America	**228**	**256**	**284**	**320**	**363**	**408**	**2.2**
Brazil	104	122	144	172	205	242	3.2
Other	124	134	141	148	158	165	1.1
Total non-OECD	**2,128**	**2,628**	**2,998**	**3,352**	**3,722**	**4,091**	**2.5**
Total world	**4,623**	**5,312**	**5,796**	**6,269**	**6,769**	**7,272**	**1.7**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F2. World installed liquids-fired generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**137**	**120**	**113**	**112**	**111**	**106**	**-0.9**
United States[a]	116	101	94	94	94	90	-0.9
Canada	4	4	3	3	3	3	-1.0
Mexico/Chile	17	16	15	14	14	14	-0.8
OECD Europe	**48**	**44**	**42**	**40**	**38**	**36**	**-1.0**
OECD Asia	**58**	**54**	**51**	**49**	**46**	**44**	**-1.0**
Japan	52	49	46	44	42	40	-1.0
South Korea	4	4	4	4	4	3	-1.0
Australia/New Zealand	1	1	1	1	1	1	-1.0
Total OECD	**242**	**219**	**206**	**201**	**195**	**187**	**-1.0**
Non-OECD							
Non-OECD Europe and Eurasia	**27**	**25**	**24**	**23**	**22**	**21**	**-1.0**
Russia	5	5	5	4	4	4	-1.0
Other	22	20	19	18	18	17	-1.0
Non-OECD Asia	**46**	**43**	**41**	**39**	**37**	**35**	**-1.0**
China	12	12	11	10	10	10	-0.9
India	4	4	3	3	3	3	-1.0
Other	30	28	26	25	24	23	-1.0
Middle East	**35**	**33**	**31**	**30**	**28**	**27**	**-0.9**
Africa	**14**	**13**	**13**	**12**	**11**	**11**	**-1.0**
Central and South America	**26**	**25**	**23**	**22**	**21**	**20**	**-1.0**
Brazil	5	5	5	4	4	4	-1.0
Other	21	20	19	18	17	16	-1.0
Total non-OECD	**148**	**139**	**132**	**125**	**119**	**114**	**-1.0**
Total world	**391**	**357**	**338**	**326**	**315**	**301**	**-1.0**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F3. World installed natural-gas-fired generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**382**	**414**	**428**	**464**	**515**	**573**	**1.5**
United States[a]	338	368	373	395	436	482	1.3
Canada	16	15	14	18	20	24	1.5
Mexico/Chile	29	31	40	51	60	68	3.3
OECD Europe	**190**	**191**	**196**	**205**	**228**	**251**	**1.0**
OECD Asia	**118**	**115**	**119**	**128**	**133**	**135**	**0.5**
Japan	79	74	74	76	78	78	-0.1
South Korea	24	26	28	31	33	33	1.1
Australia/New Zealand	14	15	17	20	23	25	2.3
Total OECD	**690**	**720**	**744**	**797**	**876**	**959**	**1.2**
Non-OECD							
Non-OECD Europe and Eurasia	**141**	**132**	**129**	**132**	**143**	**150**	**0.2**
Russia	97	91	87	84	91	96	-0.1
Other	43	40	42	47	53	54	0.9
Non-OECD Asia	**153**	**208**	**242**	**284**	**312**	**327**	**2.9**
China	31	52	58	64	67	68	2.9
India	19	42	52	62	65	67	4.9
Other	103	114	132	158	180	192	2.4
Middle East	**113**	**129**	**144**	**159**	**178**	**200**	**2.1**
Africa	**42**	**51**	**66**	**81**	**94**	**99**	**3.3**
Central and South America	**51**	**54**	**61**	**66**	**73**	**89**	**2.1**
Brazil	9	12	19	23	28	43	6.0
Other	42	42	42	43	45	46	0.3
Total non-OECD	**499**	**575**	**642**	**722**	**800**	**866**	**2.1**
Total world	**1,189**	**1,295**	**1,386**	**1,519**	**1,676**	**1,825**	**1.6**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F4. World installed coal-fired generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**334**	**342**	**342**	**346**	**351**	**360**	**0.3**
United States[a]	313	322	323	326	329	334	0.2
Canada	16	12	12	12	12	13	-0.8
Mexico/Chile	6	8	8	8	10	14	3.3
OECD Europe	**200**	**189**	**182**	**176**	**171**	**169**	**-0.6**
OECD Asia	**106**	**101**	**98**	**97**	**99**	**103**	**-0.1**
Japan	48	45	44	42	41	40	-0.7
South Korea	27	26	26	28	31	37	1.2
Australia/New Zealand	31	30	28	27	27	26	-0.7
Total OECD	**641**	**632**	**622**	**618**	**620**	**633**	**0.0**
Non-OECD							
Non-OECD Europe and Eurasia	**104**	**98**	**95**	**92**	**95**	**102**	**-0.1**
Russia	50	47	46	44	46	52	0.1
Other	54	51	49	48	49	50	-0.3
Non-OECD Asia	**707**	**857**	**902**	**1,038**	**1,185**	**1,314**	**2.3**
China	557	695	733	848	962	1,043	2.4
India	99	111	116	131	149	171	2.0
Other	50	51	53	58	75	100	2.6
Middle East	**4**	**4**	**4**	**4**	**4**	**4**	**-0.1**
Africa	**40**	**47**	**47**	**49**	**54**	**65**	**1.8**
Central and South America	**7**	**8**	**8**	**8**	**9**	**11**	**1.6**
Brazil	2	3	4	4	4	4	2.8
Other	5	4	4	4	5	6	1.0
Total non-OECD	**862**	**1,014**	**1,056**	**1,191**	**1,347**	**1,496**	**2.1**
Total world	**1,503**	**1,646**	**1,677**	**1,810**	**1,968**	**2,129**	**1.3**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F5. World installed nuclear generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**115**	**122**	**129**	**130**	**133**	**134**	**0.6**
United States[a]	101	106	111	111	111	111	0.4
Canada	13	15	18	18	20	22	1.8
Mexico/Chile	1	1	1	1	2	2	2.0
OECD Europe	**132**	**134**	**137**	**145**	**149**	**151**	**0.5**
OECD Asia	**66**	**75**	**82**	**85**	**90**	**94**	**1.3**
Japan	48	52	55	56	59	61	0.9
South Korea	18	23	27	29	31	33	2.3
Australia/New Zealand	0	0	0	0	0	0	0.0
Total OECD	**313**	**331**	**349**	**360**	**373**	**379**	**0.7**
Non-OECD							
Non-OECD Europe and Eurasia	**42**	**49**	**63**	**74**	**77**	**82**	**2.5**
Russia	23	28	39	47	49	52	3.0
Other	19	20	24	27	28	31	1.9
Non-OECD Asia	**19**	**49**	**83**	**111**	**137**	**163**	**8.4**
China	9	30	55	75	95	115	9.9
India	4	9	16	21	25	28	7.4
Other	6	9	12	15	17	20	4.8
Middle East	**0**	**1**	**4**	**7**	**7**	**7**	**0.0**
Africa	**2**	**2**	**2**	**3**	**3**	**4**	**3.1**
Central and South America	**3**	**4**	**5**	**6**	**6**	**8**	**3.8**
Brazil	2	3	3	4	4	5	3.7
Other	1	2	2	2	2	3	4.0
Total non-OECD	**65**	**104**	**157**	**201**	**230**	**265**	**5.3**
Total world	**378**	**436**	**505**	**561**	**603**	**644**	**2.0**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F6. World installed hydroelectric and other renewable generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**238**	**295**	**307**	**326**	**348**	**365**	**1.6**
United States[a]	141	179	184	194	201	205	1.4
Canada	79	91	96	102	112	119	1.6
Mexico/Chile	18	26	28	30	35	40	3.1
OECD Europe	**294**	**387**	**460**	**497**	**512**	**525**	**2.2**
OECD Asia	**78**	**100**	**110**	**118**	**123**	**133**	**2.0**
Japan	53	63	69	76	80	88	1.9
South Korea	6	10	11	11	12	13	2.7
Australia/New Zealand	18	27	30	31	31	32	2.1
Total OECD	**610**	**783**	**878**	**941**	**983**	**1,023**	**1.9**
Non-OECD							
Non-OECD Europe and Eurasia	**92**	**104**	**112**	**116**	**123**	**132**	**1.4**
Russia	48	54	59	63	68	74	1.6
Other	43	49	53	53	55	58	1.1
Non-OECD Asia	**283**	**476**	**652**	**712**	**774**	**855**	**4.2**
China	187	330	456	494	532	581	4.3
India	51	74	102	115	129	142	3.9
Other	45	72	94	103	113	131	4.1
Middle East	**12**	**15**	**20**	**21**	**23**	**24**	**2.7**
Africa	**25**	**36**	**41**	**45**	**52**	**58**	**3.2**
Central and South America	**141**	**165**	**187**	**218**	**254**	**280**	**2.6**
Brazil	86	99	113	137	165	186	2.9
Other	55	66	74	81	88	94	2.0
Total non-OECD	**552**	**796**	**1,012**	**1,113**	**1,225**	**1,349**	**3.4**
Total world	**1,163**	**1,578**	**1,890**	**2,054**	**2,209**	**2,372**	**2.7**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F7. World installed hydroelectric generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**168**	**175**	**180**	**188**	**201**	**211**	**0.9**
United States[a]	78	78	78	79	80	81	0.1
Canada	74	78	81	86	95	100	1.1
Mexico/Chile	16	19	21	23	27	31	2.4
OECD Europe	**150**	**157**	**170**	**178**	**180**	**180**	**0.7**
OECD Asia	**37**	**39**	**39**	**39**	**39**	**40**	**0.3**
Japan	22	24	24	24	24	24	0.4
South Korea	2	2	2	2	2	2	0.1
Australia/New Zealand	13	13	13	13	14	14	0.3
Total OECD	**355**	**371**	**389**	**406**	**421**	**432**	**0.7**
Non-OECD							
Non-OECD Europe and Eurasia	**87**	**95**	**103**	**107**	**114**	**122**	**1.3**
Russia	47	53	57	61	66	72	1.6
Other	40	42	46	46	47	50	0.8
Non-OECD Asia	**249**	**364**	**479**	**501**	**529**	**580**	**3.2**
China	172	247	318	327	335	360	2.8
India	39	56	80	85	96	106	3.8
Other	39	61	81	89	98	114	4.1
Middle East	**12**	**14**	**17**	**18**	**19**	**21**	**2.0**
Africa	**22**	**28**	**32**	**35**	**40**	**45**	**2.7**
Central and South America	**132**	**153**	**175**	**205**	**239**	**264**	**2.6**
Brazil	78	89	104	127	154	173	3.0
Other	53	63	71	78	85	91	2.0
Total non-OECD	**502**	**654**	**806**	**866**	**941**	**1,031**	**2.7**
Total world	**857**	**1,025**	**1,195**	**1,272**	**1,362**	**1,463**	**2.0**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F8. World installed wind-powered generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**27**	**66**	**69**	**73**	**76**	**80**	**4.1**
United States[a]	25	51	51	54	55	57	3.1
Canada	2	11	13	14	15	17	7.5
Mexico/Chile	0	5	5	5	6	7	16.8
OECD Europe	**65**	**126**	**181**	**207**	**217**	**227**	**4.8**
OECD Asia	**4**	**13**	**18**	**20**	**21**	**23**	**6.4**
Japan	2	4	5	8	8	8	5.6
South Korea	0	1	2	2	3	4	9.9
Australia/New Zealand	2	8	11	11	11	11	6.2
Total OECD	**97**	**204**	**267**	**300**	**315**	**330**	**4.7**
Non-OECD							
Non-OECD Europe and Eurasia	**0**	**4**	**4**	**4**	**5**	**5**	**9.8**
Russia	0	0	0	0	0	0	0.1
Other	0	4	4	4	5	5	10.0
Non-OECD Asia	**23**	**77**	**117**	**143**	**165**	**185**	**8.1**
China	12	62	99	119	139	156	9.9
India	10	14	16	20	22	24	3.3
Other	0	1	3	3	4	4	10.5
Middle East	**0**	**1**	**1**	**1**	**1**	**2**	**11.3**
Africa	**0**	**4**	**5**	**5**	**6**	**6**	**10.3**
Central and South America	**1**	**3**	**3**	**3**	**4**	**4**	**7.7**
Brazil	0	2	2	3	3	4	8.5
Other	0	1	1	1	1	1	5.0
Total non-OECD	**24**	**88**	**130**	**157**	**181**	**203**	**8.2**
Total world	**121**	**293**	**398**	**456**	**496**	**533**	**5.7**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F9. World installed geothermal generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**3**	**4**	**5**	**6**	**7**	**8**	**3.4**
United States[a]	2	3	3	4	6	6	3.7
Canada	0	0	0	0	0	0	0.0
Mexico/Chile	1	1	1	1	2	2	2.4
OECD Europe	**1**	**2**	**2**	**2**	**2**	**2**	**1.6**
OECD Asia	**1**	**2**	**3**	**3**	**3**	**4**	**4.4**
Japan	1	1	1	2	2	2	4.0
South Korea	0	0	0	0	0	0	0.0
Australia/New Zealand	1	1	2	2	2	2	4.7
Total OECD	**6**	**8**	**9**	**11**	**13**	**14**	**3.3**
Non-OECD							
Non-OECD Europe and Eurasia	**0**	**0**	**0**	**0**	**1**	**1**	**7.3**
Russia	0	0	0	0	0	0	4.4
Other	0	0	0	0	0	0	--
Non-OECD Asia	**3**	**7**	**7**	**7**	**8**	**9**	**4.4**
China	0	0	0	0	0	0	--
India	0	0	0	0	0	0	--
Other	3	7	7	7	8	9	4.3
Middle East	**0**	**0**	**0**	**0**	**0**	**0**	**--**
Africa	**0**	**0**	**0**	**0**	**0**	**0**	**4.6**
Central and South America	**0**	**1**	**1**	**1**	**1**	**1**	**2.0**
Brazil	0	0	0	0	0	0	--
Other	0	1	1	1	1	1	2.0
Total non-OECD	**4**	**8**	**8**	**9**	**10**	**11**	**4.3**
Total world	**9**	**16**	**17**	**19**	**22**	**25**	**3.7**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F10. World installed solar generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**1**	**10**	**11**	**12**	**12**	**13**	**8.7**
United States[a]	1	9	11	11	12	13	8.8
Canada	0	0	0	0	0	0	7.7
Mexico/Chile	0	0	0	0	0	0	8.0
OECD Europe	**10**	**32**	**35**	**37**	**38**	**40**	**5.4**
OECD Asia	**3**	**10**	**14**	**18**	**23**	**30**	**9.4**
Japan	2	8	12	16	20	27	9.8
South Korea	0	1	1	1	1	1	4.7
Australia/New Zealand	0	1	1	1	1	1	9.6
Total OECD	**14**	**52**	**61**	**67**	**73**	**83**	**6.9**
Non-OECD							
Non-OECD Europe and Eurasia	**0**	**0**	**0**	**0**	**0**	**0**	**22.3**
Russia	0	0	0	0	0	0	—
Other	0	0	0	0	0	0	22.3
Non-OECD Asia	**0**	**8**	**21**	**25**	**27**	**29**	**21.3**
China	0	7	18	19	20	21	20.2
India	0	1	3	6	7	8	35.6
Other	0	0	0	0	0	0	13.7
Middle East	**0**	**1**	**2**	**2**	**2**	**2**	**--**
Africa	**0**	**1**	**2**	**3**	**4**	**4**	**25.4**
Central and South America	**0**	**0**	**0**	**0**	**0**	**0**	**12.3**
Brazil	0	0	0	0	0	0	--
Other	0	0	0	0	0	0	12.3
Total non-OECD	**0**	**10**	**25**	**31**	**33**	**36**	**21.6**
Total world	**14**	**62**	**86**	**97**	**106**	**119**	**8.3**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F11. World installed other renewable generating capacity by region and country, 2008-2035
(Gigawatts)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**37**	**41**	**43**	**48**	**51**	**52**	**1.2**
United States[a]	35	38	41	46	49	49	1.3
Canada	2	2	2	2	2	2	0.6
Mexico/Chile	0	0	0	1	1	1	1.4
OECD Europe	**69**	**71**	**72**	**73**	**74**	**75**	**0.3**
OECD Asia	**33**	**36**	**37**	**37**	**37**	**37**	**0.4**
Japan	27	27	27	27	27	27	0.0
South Korea	4	6	6	6	6	6	1.7
Australia/New Zealand	2	3	4	4	4	4	1.7
Total OECD	**139**	**148**	**151**	**158**	**162**	**164**	**0.6**
Non-OECD							
Non-OECD Europe and Eurasia	**4**	**4**	**4**	**4**	**4**	**4**	**0.2**
Russia	1	1	1	1	1	1	0.3
Other	3	3	3	3	3	3	0.1
Non-OECD Asia	**8**	**21**	**28**	**36**	**45**	**52**	**7.2**
China	3	14	22	30	38	44	10.5
India	2	3	3	3	3	4	2.6
Other	3	3	3	3	4	4	0.7
Middle East	**0**	**0**	**0**	**0**	**0**	**0**	**7.0**
Africa	**2**	**2**	**2**	**2**	**2**	**2**	**0.2**
Central and South America	**8**	**8**	**8**	**9**	**10**	**10**	**0.9**
Brazil	7	7	7	8	8	9	0.9
Other	1	1	1	1	1	1	0.6
Total non-OECD	**22**	**35**	**42**	**51**	**61**	**68**	**4.3**
Total world	**161**	**183**	**194**	**209**	**223**	**232**	**1.4**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F12. World total net electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**5,060**	**5,231**	**5,576**	**5,951**	**6,368**	**6,792**	**1.1**
United States[a]	4,122	4,253	4,453	4,682	4,930	5,167	0.8
Canada	632	622	695	756	828	908	1.4
Mexico/Chile	306	357	428	514	610	718	3.2
OECD Europe	**3,440**	**3,776**	**4,040**	**4,305**	**4,550**	**4,793**	**1.2**
OECD Asia	**1,721**	**1,873**	**1,992**	**2,114**	**2,238**	**2,363**	**1.2**
Japan	1,017	1,072	1,117	1,160	1,204	1,248	0.8
South Korea	419	482	530	590	651	714	2.0
Australia/New Zealand	285	319	345	364	383	401	1.3
Total OECD	**10,220**	**10,880**	**11,609**	**12,371**	**13,157**	**13,948**	**1.2**
Non-OECD							
Non-OECD Europe and Eurasia	**1,615**	**1,681**	**1,792**	**1,940**	**2,124**	**2,330**	**1.4**
Russia	985	1,028	1,080	1,166	1,284	1,423	1.4
Other	630	653	712	774	840	907	1.4
Non-OECD Asia	**4,995**	**7,436**	**8,989**	**10,822**	**12,640**	**14,305**	**4.0**
China	3,221	5,011	6,041	7,322	8,562	9,583	4.1
India	786	1,181	1,444	1,701	1,942	2,196	3.9
Other	988	1,244	1,504	1,798	2,136	2,526	3.5
Middle East	**726**	**866**	**1,000**	**1,134**	**1,265**	**1,430**	**2.5**
Africa	**587**	**733**	**860**	**1,001**	**1,149**	**1,308**	**3.0**
Central and South America	**981**	**1,056**	**1,211**	**1,397**	**1,607**	**1,853**	**2.4**
Brazil	455	544	661	801	969	1,178	3.6
Other	526	512	550	595	638	675	0.9
Total non-OECD	**8,904**	**11,772**	**13,852**	**16,294**	**18,786**	**21,227**	**3.3**
Total world	**19,125**	**22,652**	**25,462**	**28,665**	**31,943**	**35,175**	**2.3**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F13. World net liquids-fired electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**109**	**101**	**100**	**97**	**95**	**98**	**-0.4**
United States[a]	46	43	44	44	45	46	0.0
Canada	9	9	8	8	7	7	-1.0
Mexico/Chile	53	50	47	45	43	44	-0.7
OECD Europe	**97**	**90**	**86**	**82**	**78**	**74**	**-1.0**
OECD Asia	**147**	**137**	**130**	**124**	**118**	**112**	**-1.0**
Japan	130	121	115	109	104	99	-1.0
South Korea	14	13	13	12	11	11	-1.0
Australia/New Zealand	3	3	2	2	2	2	-1.0
Total OECD	**352**	**328**	**316**	**303**	**290**	**283**	**-0.8**
Non-OECD							
Non-OECD Europe and Eurasia	**37**	**34**	**33**	**31**	**30**	**28**	**-1.0**
Russia	15	14	13	12	12	11	-1.0
Other	22	21	20	19	18	17	-1.0
Non-OECD Asia	**164**	**153**	**146**	**139**	**132**	**126**	**-1.0**
China	22	21	20	19	18	18	-0.8
India	26	24	23	22	21	20	-1.0
Other	116	108	103	98	93	89	-1.0
Middle East	**257**	**241**	**229**	**218**	**208**	**200**	**-0.9**
Africa	**69**	**64**	**61**	**58**	**55**	**52**	**-1.0**
Central and South America	**131**	**122**	**116**	**110**	**105**	**100**	**-1.0**
Brazil	16	15	14	14	13	12	-1.0
Other	115	107	102	97	92	87	-1.0
Total non-OECD	**658**	**615**	**585**	**556**	**529**	**507**	**-1.0**
Total world	**1,010**	**943**	**901**	**859**	**820**	**790**	**-0.9**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F14. World net natural-gas-fired electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**1,069**	**1,208**	**1,275**	**1,379**	**1,596**	**1,814**	**2.0**
United States[a]	882	1,000	1,002	1,003	1,152	1,288	1.4
Canada	40	37	39	69	79	108	3.8
Mexico/Chile	147	171	234	307	365	418	4.0
OECD Europe	**841**	**883**	**936**	**1,012**	**1,180**	**1,352**	**1.8**
OECD Asia	**401**	**410**	**456**	**531**	**583**	**611**	**1.6**
Japan	273	255	268	292	311	320	0.6
South Korea	79	99	112	137	149	153	2.5
Australia/New Zealand	48	57	77	102	123	139	4.0
Total OECD	**2,310**	**2,501**	**2,668**	**2,922**	**3,359**	**3,777**	**1.8**
Non-OECD							
Non-OECD Europe and Eurasia	**627**	**590**	**584**	**617**	**710**	**766**	**0.7**
Russia	472	445	424	414	463	504	0.2
Other	155	145	160	203	246	262	2.0
Non-OECD Asia	**495**	**908**	**1,162**	**1,462**	**1,666**	**1,779**	**4.9**
China	31	182	234	281	305	315	9.0
India	81	242	311	374	399	410	6.2
Other	384	484	618	807	963	1,054	3.8
Middle East	**428**	**553**	**663**	**778**	**912**	**1,072**	**3.5**
Africa	**170**	**245**	**354**	**460**	**545**	**587**	**4.7**
Central and South America	**128**	**151**	**198**	**231**	**284**	**391**	**4.2**
Brazil	28	51	98	123	163	264	8.7
Other	100	100	100	108	122	127	0.9
Total non-OECD	**1,848**	**2,448**	**2,961**	**3,548**	**4,117**	**4,594**	**3.4**
Total world	**4,158**	**4,948**	**5,629**	**6,470**	**7,476**	**8,371**	**2.6**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F15. World net coal-fired electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**2,114**	**1,907**	**2,013**	**2,182**	**2,262**	**2,383**	**0.4**
United States[a]	1,987	1,799	1,907	2,069	2,138	2,218	0.4
Canada	104	76	73	76	76	88	-0.6
Mexico/Chile	23	32	33	37	48	78	4.6
OECD Europe	**860**	**815**	**786**	**759**	**746**	**756**	**-0.5**
OECD Asia	**631**	**598**	**581**	**584**	**601**	**640**	**0.1**
Japan	265	250	241	233	227	225	-0.6
South Korea	178	170	169	186	214	257	1.4
Australia/New Zealand	188	178	171	166	160	158	-0.7
Total OECD	**3,605**	**3,320**	**3,379**	**3,525**	**3,609**	**3,779**	**0.2**
Non-OECD							
Non-OECD Europe and Eurasia	**393**	**372**	**359**	**354**	**385**	**449**	**0.5**
Russia	179	169	163	158	180	229	0.9
Other	214	202	196	195	205	220	0.1
Non-OECD Asia	**3,391**	**4,454**	**4,855**	**5,937**	**7,098**	**8,121**	**3.3**
China	2,566	3,518	3,858	4,775	5,674	6,330	3.4
India	537	637	681	800	938	1,111	2.7
Other	288	299	315	362	486	679	3.2
Middle East	**33**	**31**	**31**	**30**	**30**	**32**	**-0.1**
Africa	**239**	**278**	**284**	**299**	**341**	**426**	**2.2**
Central and South America	**31**	**38**	**38**	**39**	**47**	**60**	**2.5**
Brazil	12	20	20	20	20	27	3.2
Other	20	19	18	19	27	33	2.0
Total non-OECD	**4,087**	**5,173**	**5,566**	**6,659**	**7,901**	**9,088**	**3.0**
Total world	**7,692**	**8,492**	**8,946**	**10,184**	**11,510**	**12,867**	**1.9**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F16. World net nuclear electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**905**	**963**	**1,018**	**1,021**	**1,047**	**1,054**	**0.6**
United States[a]	806	839	877	877	877	874	0.3
Canada	89	113	131	134	152	162	2.2
Mexico/Chile	9	10	10	10	18	18	2.4
OECD Europe	**882**	**965**	**998**	**1,067**	**1,111**	**1,136**	**0.9**
OECD Asia	**389**	**502**	**560**	**591**	**641**	**683**	**2.1**
Japan	245	319	342	358	388	417	2.0
South Korea	143	183	218	233	253	266	2.3
Australia/New Zealand	0	0	0	0	0	0	--
Total OECD	**2,175**	**2,430**	**2,576**	**2,680**	**2,799**	**2,873**	**1.0**
Non-OECD							
Non-OECD Europe and Eurasia	**276**	**342**	**449**	**538**	**567**	**614**	**3.0**
Russia	154	197	275	342	366	388	3.5
Other	122	145	174	196	201	225	2.3
Non-OECD Asia	**120**	**360**	**631**	**855**	**1,063**	**1,281**	**9.2**
China	65	223	419	585	749	916	10.3
India	13	66	119	157	187	211	10.8
Other	41	71	92	113	127	153	5.0
Middle East	**0**	**6**	**24**	**51**	**52**	**54**	**--**
Africa	**11**	**15**	**15**	**21**	**21**	**31**	**3.8**
Central and South America	**21**	**25**	**35**	**44**	**44**	**63**	**4.2**
Brazil	14	18	22	31	31	41	4.0
Other	7	7	13	13	13	22	4.4
Total non-OECD	**428**	**748**	**1,154**	**1,508**	**1,747**	**2,043**	**6.0**
Total world	**2,602**	**3,178**	**3,731**	**4,188**	**4,546**	**4,916**	**2.4**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F17. World net hydroelectric and other renewable generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**864**	**1,054**	**1,171**	**1,273**	**1,369**	**1,443**	**1.9**
United States[a]	401	572	623	689	719	740	2.3
Canada	390	388	443	469	514	543	1.2
Mexico/Chile	73	94	104	115	136	160	3.0
OECD Europe	**760**	**1,023**	**1,235**	**1,385**	**1,434**	**1,476**	**2.5**
OECD Asia	**154**	**226**	**265**	**284**	**296**	**317**	**2.7**
Japan	104	127	152	168	174	188	2.2
South Korea	4	17	20	21	23	27	7.0
Australia/New Zealand	45	82	94	94	98	103	3.1
Total OECD	**1,778**	**2,302**	**2,670**	**2,941**	**3,099**	**3,236**	**2.2**
Non-OECD							
Non-OECD Europe and Eurasia	**283**	**343**	**367**	**401**	**433**	**474**	**1.9**
Russia	166	202	206	240	264	291	2.1
Other	117	141	161	161	169	182	1.7
Non-OECD Asia	**825**	**1,562**	**2,195**	**2,430**	**2,682**	**2,999**	**4.9**
China	537	1,067	1,510	1,663	1,816	2,003	5.0
India	128	212	310	349	398	445	4.7
Other	159	282	376	418	467	552	4.7
Middle East	**9**	**35**	**52**	**57**	**64**	**72**	**8.0**
Africa	**98**	**130**	**146**	**163**	**187**	**212**	**2.9**
Central and South America	**670**	**720**	**825**	**973**	**1,127**	**1,239**	**2.3**
Brazil	385	440	507	613	742	834	2.9
Other	284	280	318	359	385	405	1.3
Total non-OECD	**1,884**	**2,788**	**3,585**	**4,023**	**4,491**	**4,995**	**3.7**
Total world	**3,662**	**5,091**	**6,256**	**6,964**	**7,590**	**8,232**	**3.1**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F18. World net hydroelectric generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**697**	**739**	**779**	**816**	**875**	**920**	**1.0**
United States[a]	256	297	305	309	312	314	0.8
Canada	379	374	398	421	462	486	0.9
Mexico/Chile	62	68	76	86	102	120	2.5
OECD Europe	**519**	**548**	**603**	**646**	**653**	**653**	**0.9**
OECD Asia	**112**	**132**	**138**	**138**	**139**	**143**	**0.9**
Japan	75	88	93	93	93	95	0.9
South Korea	3	4	4	4	4	4	1.2
Australia/New Zealand	34	40	41	41	42	44	1.0
Total OECD	**1,329**	**1,418**	**1,520**	**1,600**	**1,668**	**1,717**	**1.0**
Non-OECD							
Non-OECD Europe and Eurasia	**279**	**327**	**347**	**381**	**412**	**451**	**1.8**
Russia	163	199	202	235	259	286	2.1
Other	116	128	145	145	153	164	1.3
Non-OECD Asia	**769**	**1,207**	**1,639**	**1,726**	**1,835**	**2,031**	**3.7**
China	522	810	1,067	1,097	1,127	1,215	3.2
India	113	174	260	279	319	356	4.3
Other	133	223	312	350	389	460	4.7
Middle East	**9**	**31**	**46**	**49**	**55**	**62**	**7.6**
Africa	**94**	**112**	**125**	**138**	**158**	**179**	**2.4**
Central and South America	**640**	**687**	**789**	**930**	**1,077**	**1,181**	**2.3**
Brazil	366	416	483	585	707	792	2.9
Other	275	271	306	345	369	389	1.3
Total non-OECD	**1,791**	**2,363**	**2,946**	**3,224**	**3,536**	**3,903**	**2.9**
Total world	**3,121**	**3,781**	**4,465**	**4,823**	**5,204**	**5,620**	**2.2**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F19. World net wind-powered electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**59**	**164**	**196**	**208**	**219**	**231**	**5.2**
United States[a]	56	145	145	154	159	163	4.1
Canada	4	6	37	39	42	46	9.9
Mexico/Chile	0	14	14	15	18	21	17.2
OECD Europe	**114**	**297**	**444**	**543**	**573**	**604**	**6.4**
OECD Asia	**8**	**31**	**48**	**56**	**59**	**63**	**8.2**
Japan	2	7	13	20	20	20	8.1
South Korea	0	3	5	6	8	11	12.9
Australia/New Zealand	5	21	30	30	31	32	7.3
Total OECD	**181**	**492**	**689**	**806**	**852**	**898**	**6.1**
Non-OECD							
Non-OECD Europe and Eurasia	**1**	**10**	**13**	**13**	**13**	**14**	**13.1**
Russia	0	0	0	0	0	0	1.1
Other	1	10	13	13	13	14	13.1
Non-OECD Asia	**26**	**189**	**312**	**387**	**455**	**515**	**11.7**
China	12	161	273	334	394	447	14.2
India	13	24	31	44	50	56	5.5
Other	1	4	8	10	11	13	11.9
Middle East	**0**	**2**	**3**	**4**	**4**	**5**	**12.5**
Africa	**1**	**13**	**14**	**15**	**17**	**19**	**10.7**
Central and South America	**1**	**5**	**6**	**8**	**9**	**10**	**9.7**
Brazil	1	5	5	6	7	9	10.8
Other	0	0	1	2	2	2	6.8
Total non-OECD	**29**	**219**	**347**	**426**	**499**	**564**	**11.6**
Total world	**210**	**710**	**1,035**	**1,232**	**1,350**	**1,462**	**7.5**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F20. World net geothermal electricity generation from central producers by region and country, 2008-2035 (Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**22**	**28**	**34**	**41**	**54**	**63**	**4.0**
United States[a]	15	20	25	31	42	49	4.5
Canada	0	0	0	0	0	0	--
Mexico/Chile	7	9	9	10	12	14	2.6
OECD Europe	**10**	**13**	**13**	**14**	**15**	**15**	**1.6**
OECD Asia	**7**	**14**	**19**	**24**	**25**	**26**	**5.2**
Japan	3	4	6	10	10	10	5.3
South Korea	0	0	0	0	0	0	--
Australia/New Zealand	4	11	13	13	15	15	5.1
Total OECD	**38**	**56**	**67**	**79**	**93**	**104**	**3.8**
Non-OECD							
Non-OECD Europe and Eurasia	**0**	**3**	**3**	**4**	**4**	**4**	**8.7**
Russia	0	1	1	2	2	2	5.5
Other	0	2	2	2	2	2	--
Non-OECD Asia	**18**	**47**	**48**	**49**	**58**	**68**	**5.1**
China	0	0	0	0	0	0	--
India	0	1	1	1	1	1	--
Other	18	46	47	48	56	66	5.0
Middle East	**0**	**0**	**0**	**0**	**0**	**0**	**--**
Africa	**1**	**2**	**2**	**3**	**3**	**3**	**4.2**
Central and South America	**3**	**3**	**4**	**5**	**5**	**5**	**2.4**
Brazil	0	0	0	0	0	0	--
Other	3	3	4	5	5	5	2.4
Total non-OECD	**22**	**56**	**58**	**61**	**70**	**81**	**5.0**
Total world	**60**	**112**	**125**	**139**	**163**	**186**	**4.2**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F21. World net solar electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**2**	**15**	**18**	**19**	**20**	**22**	**8.9**
United States[a]	2	15	17	18	19	21	8.9
Canada	0	0	0	0	1	1	8.6
Mexico/Chile	0	0	0	0	0	0	13.5
OECD Europe	**8**	**41**	**47**	**48**	**51**	**54**	**7.5**
OECD Asia	**3**	**12**	**21**	**28**	**34**	**45**	**11.2**
Japan	2	8	17	23	30	40	11.5
South Korea	0	2	2	2	2	2	7.5
Australia/New Zealand	0	2	2	2	3	3	11.1
Total OECD	**12**	**68**	**86**	**95**	**105**	**120**	**8.8**
Non-OECD							
Non-OECD Europe and Eurasia	**0**	**0**	**0**	**0**	**0**	**0**	**19.3**
Russia	0	0	0	0	0	0	--
Other	0	0	0	0	0	0	19.3
Non-OECD Asia	**0**	**15**	**40**	**49**	**52**	**57**	**22.2**
China	0	13	34	36	37	40	21.5
India	0	2	6	13	15	16	28.5
Other	0	0	0	0	0	0	10.8
Middle East	**0**	**1**	**3**	**4**	**4**	**5**	**--**
Africa	**0**	**2**	**4**	**7**	**8**	**9**	**24.2**
Central and South America	**0**	**0**	**0**	**1**	**1**	**1**	**--**
Brazil	0	0	0	0	0	0	--
Other	0	0	0	1	1	1	--
Total non-OECD	**0**	**19**	**48**	**60**	**65**	**71**	**22.8**
Total world	**13**	**87**	**134**	**155**	**170**	**191**	**10.6**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Table F22. World net other renewable electricity generation from central producers by region and country, 2008-2035
(Billion kilowatthours)

Region/country	2008	Projections 2015	2020	2025	2030	2035	Average annual percent change, 2008-2035
OECD							
OECD Americas	**83**	**107**	**143**	**189**	**200**	**208**	**3.5**
United States[a]	72	96	131	177	187	193	3.7
Canada	8	8	8	8	9	10	0.9
Mexico/Chile	4	4	4	4	5	5	1.4
OECD Europe	**109**	**124**	**128**	**134**	**142**	**149**	**1.2**
OECD Asia	**25**	**37**	**38**	**38**	**39**	**40**	**1.8**
Japan	21	21	21	21	21	22	0.1
South Korea	1	9	9	9	9	10	10.6
Australia/New Zealand	3	7	8	8	8	9	4.5
Total OECD	**217**	**268**	**309**	**362**	**381**	**398**	**2.3**
Non-OECD							
Non-OECD Europe and Eurasia	**3**	**3**	**3**	**3**	**4**	**4**	**1.6**
Russia	2	2	2	3	3	3	1.1
Other	0	1	1	1	1	1	4.3
Non-OECD Asia	**12**	**103**	**157**	**218**	**281**	**327**	**13.0**
China	2	82	136	197	257	300	19.9
India	2	11	11	12	14	15	8.0
Other	8	9	9	9	10	12	1.6
Middle East	**0**	**0**	**0**	**0**	**0**	**0**	**1.1**
Africa	**1**	**1**	**1**	**1**	**1**	**1**	**2.6**
Central and South America	**25**	**25**	**25**	**30**	**35**	**41**	**1.8**
Brazil	19	19	19	23	28	33	2.1
Other	7	6	6	7	8	8	0.7
Total non-OECD	**41**	**132**	**186**	**252**	**321**	**375**	**8.5**
Total world	**258**	**400**	**496**	**614**	**702**	**772**	**4.1**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. Projections: EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Appendix G

Reference case projections for natural gas production

Table G1. World total natural gas production by region, Reference case, 2008-2035
(Trillion cubic feet)

Region	History 2008	History 2009	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD								
OECD Americas	**28.0**	**27.5**	**31.3**	**33.0**	**34.0**	**35.8**	**37.6**	**1.1**
United States[a]	20.2	20.1	22.4	23.4	24.0	25.1	26.4	1.0
Canada	6.0	5.6	7.0	7.7	8.3	8.7	9.0	1.5
Mexico	1.7	1.8	1.9	1.7	1.7	1.8	2.1	0.8
Chile	0.1	0.0	0.1	0.1	0.1	0.1	0.1	2.9
OECD Europe	**10.6**	**10.1**	**8.1**	**7.5**	**7.5**	**7.9**	**8.3**	**-0.9**
North Europe	**10.3**	**9.7**	**7.7**	**7.0**	**7.0**	**7.3**	**7.6**	**-1.1**
South Europe	**0.3**	**0.3**	**0.4**	**0.4**	**0.5**	**0.5**	**0.6**	**2.2**
Southwest Europe	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**19.4**
Turkey	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.0**
OECD Asia	**1.9**	**2.0**	**2.8**	**3.3**	**4.0**	**5.0**	**5.9**	**4.3**
Japan	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Australia/NewZealand	1.7	1.8	2.6	3.1	3.8	4.8	5.7	4.5
Total OECD	**40.6**	**39.6**	**42.3**	**43.7**	**45.5**	**48.7**	**51.8**	**0.9**
Non-OECD								
Non-OECD Europe and Eurasia	**30.4**	**26.3**	**30.5**	**32.6**	**35.4**	**38.3**	**40.4**	**1.1**
Russia	23.4	20.6	23.0	24.9	27.3	29.6	31.2	1.1
Central Asia	5.9	4.5	6.4	6.7	7.0	7.5	7.9	1.1
Non-OECD Europe	1.2	1.2	1.1	1.0	1.1	1.2	1.4	0.5
Non-OECD Asia	**12.7**	**13.3**	**15.6**	**17.4**	**19.7**	**22.2**	**24.5**	**2.5**
China	2.7	2.9	3.1	3.7	4.7	6.0	7.3	3.8
India	1.1	1.4	2.5	3.0	3.3	3.6	3.9	4.6
LNG exporters	5.1	5.0	5.5	6.1	6.8	7.6	8.2	1.8
Other	3.8	3.9	4.5	4.6	4.8	5.0	5.2	1.2
Middle East	**13.5**	**14.3**	**19.7**	**22.3**	**24.6**	**26.7**	**28.8**	**2.8**
Arabian producers	3.5	3.5	3.7	3.7	3.8	3.9	4.1	0.5
Iran	4.1	4.6	5.7	6.9	7.8	8.6	9.4	3.1
Iraq	0.1	0.0	0.1	0.2	0.4	0.7	0.8	9.8
Qatar	2.7	3.2	6.3	7.0	7.4	7.8	8.1	4.1
Saudi Arabia	2.8	2.8	3.3	3.7	4.2	4.6	5.2	2.3
Other	0.3	0.3	0.6	0.9	1.0	1.1	1.2	5.8
Africa	**7.5**	**7.1**	**9.7**	**11.1**	**12.2**	**13.3**	**14.1**	**2.4**
North Africa	5.8	5.8	7.4	8.5	9.3	10.0	10.4	2.2
West Africa	1.5	1.1	2.1	2.3	2.6	2.9	3.3	3.1
South Africa	0.1	0.1	0.1	0.1	0.2	0.2	0.2	5.1
Other	0.1	0.2	0.1	0.2	0.1	0.2	0.2	1.1
Central and South America	**5.1**	**4.9**	**5.8**	**6.6**	**7.5**	**8.5**	**9.5**	**2.3**
Brazil	0.4	0.4	1.0	1.4	1.8	2.3	2.7	6.9
Northern producers	2.4	2.5	2.7	2.9	3.1	3.4	3.7	1.5
Southern Cone	1.6	1.5	1.3	1.3	1.5	1.8	1.9	0.8
Andean	0.7	0.6	0.8	0.8	0.9	1.0	1.0	1.7
Central America and Caribbean	0.0	0.0	0.1	0.1	0.1	0.1	0.2	5.0
Total non-OECD	**69.3**	**66.0**	**81.3**	**90.0**	**99.4**	**109.1**	**117.4**	**2.0**
Total world	**109.9**	**105.6**	**123.6**	**133.8**	**145.0**	**157.8**	**169.2**	**1.6**
Discrepancy[b]	**-1.0**	**-1.2**	**0.4**	**0.3**	**0.6**	**1.0**	**0.5**	

[a]Includes the 50 States and the District of Columbia. Production includes supplemental production, less any forecast discrepancy.
[b]Balancing item. Differences between global production and consumption totals results from independent rounding and differences in conversion factors derived from heat contents of natural gas that is produced and consumed regionally.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and International Natural Gas Model (2011).

Table G2. World tight gas, shale gas and coalbed methane production by region, Reference case, 2008-2035
(Trillion cubic feet)

Region	History 2008	History 2009	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD								
OECD Americas	**12.9**	**13.7**	**17.5**	**19.0**	**21.1**	**22.9**	**24.9**	**2.5**
United States[a]	10.9	11.7	14.8	15.6	17.1	18.4	19.8	2.3
Canada	2.1	2.0	2.7	3.4	3.9	4.3	4.6	3.0
Mexico	0.0	0.0	0.0	0.0	0.0	0.2	0.4	--
Chile	0.0	0.0	0.0	0.0	0.0	0.0	0.1	--
OECD Europe	**0.0**	**0.0**	**0.1**	**0.3**	**0.9**	**1.7**	**2.3**	**19.1**
North Europe	**0.0**	**0.0**	**0.1**	**0.3**	**0.9**	**1.6**	**2.1**	**18.7**
South Europe	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**	**--**
Southwest Europe	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**--**
Turkey	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**--**
OECD Asia	**0.1**	**0.1**	**0.5**	**1.0**	**1.6**	**2.5**	**3.3**	**13.3**
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Australia/NewZealand	0.1	0.1	0.5	1.0	1.6	2.5	3.3	13.3
Total OECD	**13.1**	**13.8**	**18.1**	**20.3**	**23.7**	**27.1**	**30.5**	**3.2**
Non-OECD								
Non-OECD Europe and Eurasia	**0.0**	**0.0**	**0.2**	**0.7**	**1.3**	**2.1**	**3.0**	**--**
Russia	0.0	0.0	0.2	0.7	1.1	1.5	2.0	--
Central Asia	0.0	0.0	0.0	0.0	0.1	0.4	0.7	--
Non-OECD Europe	0.0	0.0	0.0	0.0	0.1	0.2	0.4	--
Non-OECD Asia	**0.0**	**0.0**	**0.6**	**1.5**	**2.8**	**4.3**	**5.8**	**--**
China	0.0	0.0	0.5	1.4	2.6	3.9	5.2	--
India	0.0	0.0	0.0	0.1	0.1	0.2	0.2	--
LNG exporters	0.0	0.0	0.0	0.0	0.0	0.0	0.1	--
Other	0.0	0.0	0.0	0.0	0.0	0.1	0.2	--
Middle East	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.3**	**0.7**	**--**
Arabian producers	0.0	0.0	0.0	0.0	0.0	0.1	0.2	--
Iran	0.0	0.0	0.0	0.0	0.0	0.1	0.3	--
Iraq	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Qatar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Saudi Arabia	0.0	0.0	0.0	0.0	0.0	0.1	0.1	--
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Africa	**0.0**	**0.0**	**0.0**	**0.1**	**0.3**	**0.7**	**1.0**	**--**
North Africa	0.0	0.0	0.0	0.1	0.2	0.3	0.4	--
West Africa	0.0	0.0	0.0	0.0	0.0	0.2	0.4	--
South Africa	0.0	0.0	0.0	0.0	0.1	0.2	0.2	--
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Central and South America	**0.0**	**0.0**	**0.2**	**0.4**	**0.9**	**1.5**	**2.0**	**--**
Brazil	0.0	0.0	0.0	0.0	0.2	0.4	0.6	--
Northern producers	0.0	0.0	0.0	0.0	0.1	0.2	0.3	--
Southern Cone	0.0	0.0	0.2	0.4	0.6	0.9	1.1	--
Andean	0.0	0.0	0.0	0.0	0.0	0.0	0.1	--
Central America and Caribbean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Total non-OECD	**0.0**	**0.0**	**1.0**	**2.8**	**5.3**	**8.7**	**12.5**	**--**
Total world	**13.1**	**13.8**	**19.0**	**23.1**	**28.9**	**35.8**	**43.0**	**4.5**

[a]Includes the 50 States and the District of Columbia. Production includes supplemental production, less any forecast discrepancy.
Sources: **History:** *United States:* U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. *Canada:* National Energy Board, *Short-term Canadian Natural Gas Deliverability, 2010-2012*, Appendix C.1. Canadian Gas Deliverability by Area/Resource--Mid-Price Scenario (March 2010), p. 63, website www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/ntrlgs/ntrlgs-eng.html. *Australia:* Australian Bureau of Agricultural and Resource Economics (ABARE), *Energy in Australia 2010* (Canberra, Australia, April 2010), Table 22, "Australian Gas Production by State," p. 44. *Note:* The 2008 number in this table is ABARE's 2007-2008 number (Australia's fiscal year is from July 1, 2007, to June 30, 2008); and the 2009 number is ABARE's 2008-2009 number. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, website www.eia.gov/aeo; and International Natural Gas Model (2011).

Table G3. World other natural gas production by region, Reference case, 2008-2035
(Trillion cubic feet)

Region	History 2008	History 2009	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD								
OECD Americas	**15.1**	**13.8**	**13.9**	**14.0**	**12.9**	**12.9**	**12.7**	**-0.6**
United States[a]	9.4	8.4	7.7	7.8	6.8	6.8	6.6	-1.3
Canada	4.0	3.6	4.3	4.3	4.4	4.4	4.4	0.4
Mexico	1.7	1.8	1.9	1.7	1.7	1.7	1.7	0.0
Chile	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.9
OECD Europe	**10.6**	**10.1**	**8.1**	**7.1**	**6.6**	**6.2**	**6.0**	**-2.1**
North Europe	**10.2**	**9.7**	**7.7**	**6.7**	**6.1**	**5.7**	**5.5**	**-2.3**
South Europe	**0.3**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**1.2**
Southwest Europe	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**18.7**
Turkey	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-10.9**
OECD Asia	**1.8**	**1.9**	**2.3**	**2.3**	**2.4**	**2.5**	**2.6**	**1.3**
Japan	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-0.1
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Australia/NewZealand	1.6	1.7	2.1	2.1	2.2	2.3	2.4	1.5
Total OECD	**27.5**	**25.8**	**24.2**	**23.4**	**21.9**	**21.6**	**21.3**	**-0.9**
Non-OECD								
Non-OECD Europe and Eurasia	**30.4**	**26.3**	**30.2**	**31.9**	**34.1**	**36.2**	**37.4**	**0.8**
Russia	23.4	20.6	22.8	24.2	26.2	28.1	29.2	0.8
Central Asia	5.9	4.5	6.4	6.7	7.0	7.1	7.2	0.8
Non-OECD Europe	1.2	1.2	1.1	1.0	1.0	1.0	1.0	-0.6
Non-OECD Asia	**12.7**	**13.3**	**15.0**	**15.9**	**16.9**	**18.0**	**18.8**	**1.5**
China	2.7	2.9	2.6	2.3	2.2	2.1	2.0	-1.0
India	1.1	1.4	2.5	2.9	3.2	3.5	3.6	4.4
LNG exporters	5.1	5.0	5.5	6.1	6.8	7.6	8.2	1.7
Other	3.8	3.9	4.5	4.6	4.7	4.9	4.9	1.0
Middle East	**13.5**	**14.3**	**19.7**	**22.3**	**24.5**	**26.5**	**28.1**	**2.8**
Arabian producers	3.5	3.5	3.7	3.7	3.7	3.8	3.9	0.4
Iran	4.1	4.6	5.7	6.9	7.8	8.5	9.1	3.0
Iraq	0.1	0.0	0.1	0.2	0.4	0.7	0.8	9.6
Qatar	2.7	3.2	6.3	7.0	7.4	7.8	8.1	4.1
Saudi Arabia	2.8	2.8	3.3	3.7	4.2	4.6	5.0	2.1
Other	0.3	0.3	0.6	0.9	1.0	1.1	1.2	5.8
Africa	**7.5**	**7.1**	**9.7**	**11.0**	**11.9**	**12.6**	**13.1**	**2.1**
North Africa	5.8	5.8	7.3	8.4	9.2	9.7	10.0	2.0
West Africa	1.5	1.1	2.1	2.3	2.5	2.7	2.9	2.6
South Africa	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-0.7
Other	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.4
Central and South America	**5.1**	**4.9**	**5.7**	**6.1**	**6.6**	**7.1**	**7.5**	**1.4**
Brazil	0.4	0.4	1.0	1.4	1.7	1.9	2.1	5.9
Northern producers	2.4	2.5	2.7	2.9	3.1	3.2	3.4	1.2
Southern Cone	1.6	1.5	1.1	1.0	0.9	0.9	0.9	-2.0
Andean	0.7	0.6	0.8	0.8	0.9	0.9	1.0	1.5
Central America and Caribbean	0.0	0.0	0.1	0.1	0.1	0.1	0.1	4.6
Total non-OECD	**69.3**	**66.0**	**80.3**	**87.3**	**94.1**	**100.4**	**104.9**	**1.5**
Total world	**96.8**	**91.8**	**104.5**	**110.7**	**116.0**	**122.0**	**126.2**	**1.0**

[a]Includes the 50 States and the District of Columbia. Production includes supplemental production, less any forecast discrepancy.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and International Natural Gas Model (2011).

Table G4. World net trade in natural gas by region, Reference case, 2008-2035
(Trillion cubic feet)

Region	History 2008	History 2009	Projections 2015	Projections 2020	Projections 2025	Projections 2030	Projections 2035	Average annual percent change, 2008-2035
OECD								
OECD Americas	**0.8**	**0.5**	**-0.2**	**-0.6**	**-0.6**	**-0.3**	**-0.3**	**--**
United States[a]	3.0	2.6	2.7	1.9	1.1	0.8	0.2	-9.8
Canada	-2.6	-2.6	-3.5	-3.9	-3.9	-3.9	-3.8	1.3
Mexico	0.4	0.4	0.5	1.3	2.0	2.6	2.9	7.3
Chile	0.0	0.1	0.1	0.1	0.2	0.3	0.4	10.3
OECD Europe	**9.0**	**8.5**	**12.1**	**13.4**	**14.0**	**14.8**	**15.6**	**2.1**
North Europe	**3.4**	**3.4**	**6.4**	**7.5**	**7.9**	**8.3**	**8.6**	**3.5**
South Europe	**2.8**	**2.6**	**2.5**	**2.6**	**2.7**	**3.0**	**3.2**	**0.5**
Southwest Europe	**1.5**	**1.4**	**1.7**	**1.8**	**1.8**	**1.9**	**2.0**	**1.0**
Turkey	**1.3**	**1.2**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.2**
OECD Asia	**4.3**	**4.0**	**3.5**	**3.4**	**3.3**	**2.8**	**2.1**	**-2.6**
Japan	3.5	3.4	3.4	3.5	3.7	3.8	3.8	0.3
South Korea	1.2	1.2	1.5	1.6	1.8	1.8	1.9	1.5
Australia/NewZealand	-0.5	-0.6	-1.3	-1.6	-2.1	-2.8	-3.5	7.9
Total OECD	**14.0**	**13.0**	**15.5**	**16.3**	**16.7**	**17.3**	**17.4**	**0.8**
Non-OECD								
Non-OECD Europe and Eurasia	**-5.3**	**-4.4**	**-6.0**	**-8.3**	**-10.7**	**-12.7**	**-14.2**	**3.7**
Russia	-6.6	-5.1	-6.6	-8.9	-11.3	-13.1	-14.0	2.8
Central Asia	-2.4	-1.3	-2.7	-3.0	-3.1	-3.4	-3.7	1.7
Non-OECD Europe	3.6	2.0	3.3	3.5	3.7	3.7	3.5	-0.1
Non-OECD Asia	**-1.4**	**-1.1**	**1.5**	**3.6**	**5.8**	**7.1**	**7.6**	**--**
China	0.0	0.1	2.4	3.3	4.1	4.5	4.6	19.2
India	0.4	0.4	0.8	1.1	1.3	1.4	1.4	5.0
LNG exporters	-2.6	-2.6	-2.9	-2.9	-2.9	-2.9	-2.9	0.4
Other	0.8	0.9	1.1	2.2	3.3	4.1	4.5	6.4
Middle East	**-1.8**	**-2.2**	**-5.0**	**-5.5**	**-5.5**	**-5.4**	**-4.8**	**3.6**
Arabian producers	0.0	0.0	0.2	0.8	1.4	2.2	3.0	--
Iran	0.1	0.0	-0.6	-1.1	-1.3	-1.4	-1.4	--
Iraq	0.0	0.0	0.0	0.0	-0.2	-0.4	-0.6	--
Qatar	-2.0	-2.4	-4.6	-4.9	-5.1	-5.3	-5.5	3.8
Saudi Arabia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Other	0.1	0.2	-0.1	-0.3	-0.3	-0.3	-0.3	--
Africa	**-3.9**	**-3.5**	**-5.1**	**-5.2**	**-5.1**	**-5.0**	**-5.1**	**1.0**
North Africa	-3.0	-2.8	-3.8	-3.9	-3.8	-3.6	-3.5	0.6
West Africa	-0.9	-0.7	-1.3	-1.3	-1.3	-1.4	-1.6	2.2
South Africa	0.1	0.1	0.1	0.1	0.0	0.0	0.0	-155.5
Other	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	-42.6
Central and South America	**-0.6**	**-0.6**	**-0.9**	**-0.8**	**-0.9**	**-1.0**	**-0.9**	**1.6**
Brazil	0.4	0.3	0.1	0.1	0.0	0.0	0.2	-2.5
Northern producers	-0.6	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6	0.0
Southern Cone	0.0	0.1	0.3	0.4	0.4	0.3	0.3	12.3
Andean	-0.4	-0.3	-0.6	-0.7	-0.7	-0.8	-0.8	2.6
Central America and Caribbean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Total non-OECD	**-13.0**	**-11.9**	**-15.5**	**-16.2**	**-16.5**	**-17.0**	**-17.4**	**1.1**
Total world	**1.0**	**1.1**	**0.0**	**0.1**	**0.3**	**0.2**	**0.1**	**--**

[a]Includes the 50 States and the District of Columbia. Production includes supplemental production, less any forecast discrepancy.
Sources: **History:** U.S. Energy Information Administration (EIA), International Energy Statistics database (as of March 2011), web site www.eia.gov/ies. **Projections:** EIA, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, April 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and International Natural Gas Model (2011).

Appendix H

Kaya Identity factor projections

- *Population*
- *GDP per capita*
- *Energy intensity*
- *Carbon dioxide intensity*

Table H1. World population by region, Reference case, 2006-2035
(Millions)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**455**	**459**	**464**	**495**	**518**	**540**	**562**	**582**	**0.9**
United States[a]	299	302	305	326	342	358	374	390	0.9
Canada	33	33	33	36	38	40	42	43	1.0
Mexico/Chile	123	124	125	133	138	142	146	149	0.7
OECD Europe	**538**	**541**	**544**	**560**	**567**	**573**	**577**	**580**	**0.3**
OECD Asia	**200**	**201**	**201**	**203**	**202**	**201**	**199**	**196**	**-0.1**
Japan	128	128	128	126	124	122	119	116	-0.3
South Korea	48	48	48	49	49	49	49	48	0.0
Australia/NewZealand	25	25	25	27	28	30	31	32	0.9
Total OECD	**1,193**	**1,201**	**1,209**	**1,257**	**1,287**	**1,314**	**1,338**	**1,358**	**0.5**
Non-OECD									
Non-OECD Europe and Eurasia	**341**	**340**	**340**	**338**	**336**	**333**	**329**	**324**	**-0.2**
Russia	143	142	141	138	135	132	129	125	-0.5
Other	198	198	199	200	200	201	200	198	0.0
Non-OECD Asia	**3,487**	**3,526**	**3,565**	**3,840**	**4,021**	**4,175**	**4,300**	**4,400**	**0.8**
China	1,314	1,321	1,328	1,385	1,419	1,441	1,451	1,450	0.3
India	1,148	1,165	1,181	1,294	1,367	1,431	1,485	1,528	1.0
Other	1,025	1,040	1,055	1,162	1,234	1,302	1,365	1,422	1.2
Middle East	**196**	**200**	**205**	**234**	**255**	**275**	**293**	**311**	**1.6**
Africa	**921**	**941**	**961**	**1,101**	**1,202**	**1,302**	**1,401**	**1,501**	**1.7**
Central and South America	**441**	**446**	**451**	**486**	**509**	**528**	**545**	**559**	**0.8**
Brazil	188	190	192	203	209	214	217	219	0.5
Other	253	256	259	283	299	315	328	340	1.1
Total non-OECD	**5,385**	**5,454**	**5,522**	**5,999**	**6,321**	**6,613**	**6,869**	**7,095**	**1.0**
Total world	**6,579**	**6,655**	**6,731**	**7,257**	**7,609**	**7,927**	**8,207**	**8,453**	**0.9**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: **United States:** U.S. Energy Information Administration, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo. **Other countries:** IHS Global Insight, *World Overview* (Lexington, MA, various issues).

Table H2. World gross domestic product (GDP) per capita by region expressed in purchasing power parity, Reference case, 2006-2035
(2005 dollars per person)

	History			Projections					Average annual percent change, 2008-2035
Region	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**34,641**	**35,026**	**34,771**	**37,876**	**41,427**	**45,826**	**50,391**	**55,391**	**1.7**
United States[a]	43,338	43,748	43,349	47,020	50,938	55,913	60,765	65,862	1.5
Canada	36,888	37,287	37,041	39,430	41,641	43,760	46,584	49,833	1.1
Mexico/Chile	12,852	13,172	13,275	15,102	17,829	21,046	24,888	29,527	3.0
OECD Europe	**26,893**	**27,588**	**27,568**	**29,268**	**32,158**	**35,152**	**38,320**	**41,762**	**1.5**
OECD Asia	**28,486**	**29,300**	**29,196**	**32,395**	**35,251**	**37,862**	**40,693**	**43,732**	**1.5**
Japan	30,932	31,647	31,284	33,510	35,446	36,869	38,328	39,771	0.8
South Korea	19,640	20,561	20,950	25,913	30,438	35,115	40,054	45,359	3.0
Australia/NewZealand	32,919	34,067	34,360	38,948	42,812	46,565	50,892	55,807	1.8
Total OECD	**30,114**	**30,719**	**30,601**	**33,162**	**36,373**	**39,954**	**43,741**	**47,887**	**1.7**
Non-OECD									
Non-OECD Europe and Eurasia	**9,303**	**10,079**	**10,622**	**12,404**	**14,434**	**16,674**	**19,516**	**22,697**	**3.1**
Russia	12,873	13,977	14,813	17,224	19,802	23,082	27,853	33,470	3.3
Other	6,737	7,291	7,639	9,077	10,807	12,452	14,144	15,889	2.9
Non-OECD Asia	**3,828**	**4,191**	**4,427**	**6,637**	**8,477**	**10,411**	**12,431**	**14,512**	**4.7**
China	4,663	5,298	5,777	9,647	12,826	16,340	19,961	23,694	5.7
India	2,404	2,597	2,692	4,023	5,227	6,373	7,581	8,792	4.6
Other	4,351	4,570	4,672	5,961	7,075	8,289	9,704	11,292	3.4
Middle East	**11,157**	**11,523**	**11,797**	**13,789**	**15,411**	**17,054**	**18,990**	**21,145**	**2.3**
Africa	**2,809**	**2,916**	**3,009**	**3,548**	**3,948**	**4,338**	**4,731**	**5,181**	**2.2**
Central and South America	**8,242**	**8,679**	**9,023**	**10,938**	**12,691**	**14,680**	**17,005**	**19,749**	**3.1**
Brazil	8,474	8,897	9,264	12,086	14,726	17,963	22,029	27,134	4.2
Other	8,069	8,517	8,845	10,115	11,271	12,450	13,679	14,983	2.1
Total non-OECD	**4,628**	**4,975**	**5,211**	**7,023**	**8,551**	**10,148**	**11,842**	**13,615**	**3.8**
Total world	**9,250**	**9,621**	**9,773**	**11,552**	**13,258**	**15,090**	**17,042**	**19,123**	**2.6**

[a]Includes the 50 States and the District of Columbia.
Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for non-OECD Europe and Eurasia (excluding Russia), China, India, Africa, and Central and South America (excluding Brazil) were adjusted, based on the analyst's judgment.
Sources: **History:** IHS Global Insight, *World Overview* (Lexington, MA, various issues). **Projections:** IHS Global Insight, *World Overview*, Third Quarter 2010 (Lexington, MA, November 2010); and U.S. Energy Information Administration, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo.

Table H3. World energy intensity by region, Reference case, 2006-2035
(Thousand Btu per 2005 dollar of GDP)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**7.8**	**7.7**	**7.6**	**6.7**	**6.1**	**5.5**	**5.0**	**4.6**	**-1.9**
United States[a]	7.7	7.7	7.6	6.7	6.0	5.4	4.9	4.4	-2.0
Canada	11.7	11.7	11.6	10.4	10.0	9.4	9.1	8.7	-1.1
Mexico/Chile	5.4	5.1	5.1	4.7	4.2	3.8	3.6	3.4	-1.5
OECD Europe	**5.7**	**5.5**	**5.5**	**5.1**	**4.8**	**4.4**	**4.1**	**3.9**	**-1.3**
OECD Asia	**6.9**	**6.7**	**6.7**	**6.2**	**6.0**	**5.8**	**5.6**	**5.4**	**-0.8**
Japan	5.9	5.7	5.6	5.2	5.3	5.3	5.2	5.2	-0.4
South Korea	10.1	9.9	9.9	8.7	7.7	7.1	6.7	6.3	-1.7
Australia/NewZealand	8.0	7.8	7.8	7.0	6.5	5.9	5.5	5.1	-1.6
Total OECD	**6.8**	**6.7**	**6.6**	**6.0**	**5.6**	**5.1**	**4.8**	**4.4**	**-1.5**
Non-OECD									
Non-OECD Europe and Eurasia	**15.4**	**14.5**	**14.0**	**12.3**	**10.8**	**9.7**	**8.7**	**8.0**	**-2.2**
Russia	15.8	15.0	14.6	13.1	11.7	10.6	9.4	8.5	-2.1
Other	14.9	13.7	13.1	11.2	9.7	8.7	7.9	7.3	-2.3
Non-OECD Asia	**9.1**	**8.7**	**8.7**	**7.4**	**6.3**	**5.7**	**5.1**	**4.7**	**-2.3**
China	12.0	11.3	11.2	9.3	7.7	6.8	6.1	5.6	-2.6
India	6.8	6.6	6.6	5.3	4.6	4.3	3.9	3.7	-2.2
Other	6.5	6.3	6.2	5.2	4.7	4.3	3.9	3.6	-2.0
Middle East	**11.0**	**10.4**	**10.6**	**9.6**	**8.6**	**8.0**	**7.4**	**6.9**	**-1.5**
Africa	**6.6**	**6.5**	**6.5**	**5.5**	**5.0**	**4.6**	**4.3**	**4.0**	**-1.7**
Central and South America	**7.1**	**6.8**	**6.8**	**5.8**	**5.3**	**4.9**	**4.6**	**4.3**	**-1.7**
Brazil	7.2	7.1	7.1	6.3	5.6	5.2	4.8	4.5	-1.7
Other	7.1	6.6	6.5	5.4	5.0	4.6	4.3	4.1	-1.8
Total non-OECD	**9.5**	**9.1**	**9.1**	**7.7**	**6.6**	**6.0**	**5.4**	**5.0**	**-2.2**
Total world	**7.9**	**7.7**	**7.7**	**6.8**	**6.1**	**5.6**	**5.2**	**4.8**	**-1.8**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Sources: United States: U.S. Energy Information Administration, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo. Other countries: IHS Global Insight, *World Overview* (Lexington, MA, various issues).

Table H4. World carbon dioxide intensity of energy use by region, Reference case, 2006-2035
(Metric tons per billion Btu)

Region	History			Projections					Average annual percent change, 2008-2035
	2006	2007	2008	2015	2020	2025	2030	2035	
OECD									
OECD Americas	**57.3**	**57.3**	**56.4**	**53.7**	**52.9**	**52.7**	**52.5**	**52.6**	**-0.3**
United States[a]	59.3	59.2	58.3	55.7	55.1	55.0	55.0	55.3	-0.2
Canada	42.3	42.3	41.6	38.9	37.2	37.0	36.1	36.2	-0.5
Mexico/Chile	58.8	59.7	58.2	55.1	54.5	54.1	53.1	53.1	-0.3
OECD Europe	**53.5**	**53.6**	**52.9**	**49.2**	**47.7**	**46.3**	**45.7**	**45.4**	**-0.6**
OECD Asia	**55.2**	**56.3**	**56.5**	**53.0**	**51.4**	**50.6**	**50.0**	**49.5**	**-0.5**
Japan	53.3	54.7	54.2	50.7	49.2	48.0	46.8	45.6	-0.6
South Korea	51.3	52.6	53.6	51.3	49.6	49.5	49.5	50.0	-0.3
Australia/NewZealand	67.4	67.5	68.0	62.4	60.6	60.1	59.4	59.0	-0.5
Total OECD	**55.7**	**55.9**	**55.2**	**52.1**	**50.9**	**50.3**	**49.9**	**49.8**	**-0.4**
Non-OECD									
Non-OECD Europe and Eurasia	**57.7**	**56.2**	**56.1**	**54.5**	**52.9**	**51.5**	**51.1**	**50.7**	**-0.4**
Russia	57.4	54.4	54.4	53.1	51.4	49.6	49.2	49.2	-0.4
Other	58.2	58.9	58.6	56.7	55.1	54.3	54.0	53.1	-0.4
Non-OECD Asia	**73.0**	**73.1**	**73.2**	**70.3**	**67.3**	**66.8**	**66.5**	**65.9**	**-0.4**
China	79.3	79.4	79.0	75.6	72.1	71.5	71.0	70.3	-0.4
India	68.1	69.2	69.9	65.4	62.6	62.3	62.2	62.4	-0.4
Other	60.3	59.0	59.0	55.8	54.6	54.5	54.5	54.4	-0.3
Middle East	**60.3**	**61.7**	**61.9**	**60.9**	**59.6**	**59.0**	**59.0**	**58.7**	**-0.2**
Africa	**57.3**	**57.2**	**57.4**	**56.4**	**55.7**	**55.1**	**55.0**	**55.3**	**-0.1**
Central and South America	**41.1**	**40.9**	**40.7**	**41.5**	**40.5**	**39.3**	**38.8**	**38.8**	**-0.2**
Brazil	33.1	32.9	33.3	34.1	33.4	32.3	31.9	32.4	-0.1
Other	47.4	47.5	47.0	48.8	47.9	47.0	47.0	46.9	0.0
Total non-OECD	**63.9**	**64.0**	**64.1**	**63.2**	**61.2**	**60.7**	**60.4**	**60.0**	**-0.2**
Total world	**59.8**	**59.9**	**59.8**	**58.3**	**56.8**	**56.5**	**56.3**	**56.2**	**-0.2**

[a]Includes the 50 States and the District of Columbia.
Note: Totals may not equal sum of components due to independent rounding.
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2011*, DOE/EIA-0383(2011) (Washington, DC, May 2011), AEO2011 National Energy Modeling System, run REF2011.D020911A, web site www.eia.gov/aeo; and World Energy Projection System Plus (2011).

Appendix I

Comparisons with International Energy Agency and *IEO2010* projections

Comparisons with IEA's *World Energy Outlook 2010*

The International Energy Agency (IEA) in its *World Energy Outlook 2010* provides projections comparable with those in *IEO2011*. In both reports, the latest historical year of data upon which the projections are based is 2008, and the projections extend to 2035. As a result, two time periods can be compared—2008 to 2020 and 2020 to 2035.

IEA's *World Energy Outlook 2010* presents three scenario cases: Current Policies Scenario (formerly the Reference Scenario), New Policies Scenario, and 450 Scenario. Much of the text of the report concentrates on the New Policies Scenario, which "takes account of the broad policy commitments and plans that have been announced by countries around the world, including the national pledges to reduce greenhouse gas emissions and plans to phase out fossil-energy subsidies even where the measures to implement these commitments have yet to be identified or announced."[40] The *IEO2011* Reference case is most directly comparable with the World Energy Outlook 2010 Current Policies Scenario.

The IEA Current Policies Scenario has a world oil price trajectory similar to that in the *IEO2011* Reference case, with the IEA oil price projections for 2035 about 8 percent higher than those in the *IEO2011* Reference case. The resulting projections of demand for liquid fuels are similar in the two outlooks. In the *IEO2011* Reference case, projected demand for liquid fuels in 2035 is 107.5 million barrels per day (plus another 4.7 million barrels per day of biofuels), compared with the IEA Current Policies Scenario projection of 107.4 million barrels per day of liquids in 2035 in (plus another 5.3 million barrels per day of biofuels).[41]

One noteworthy difference between the two cases is in their projections for the natural gas market in North America and, in particular, the United States. In the *IEO2011* Reference case, the average price for U.S. imports of natural gas is relatively flat from 2009 to 2018 and increases slowly thereafter to $6.83 per million Btu (real 2009 dollars) in 2035. In the IEA Current Policies Scenario, however, the price for U.S. imports of natural gas increases by 70 percent from 2009 to 2015 and then rises to $11.20 per million Btu in 2035. This could explain why U.S. natural gas consumption in the *IEO2011* Reference case increases by an average of 0.5 percent per year from 2008 to 2035, but in the IEA Current Policies Scenario it does not increase at all over the same period.

For the period from 2008 to 2020, world energy consumption in the IEA Current Policies Scenario increases by an average of 1.5 percent per year, compared with 1.7 percent per year in the *IEO2011* Reference case (Table I1). The slower near-term growth in *IEO2011* may reflect, in part, the different release dates for *IEO2011* and IEA's World Energy Outlook 2010. The *IEO2011* projections were prepared when preliminary assessments of the global recession were becoming available (specifically, as reflected in the near-term estimates of gross domestic product [GDP] in IHS Global Insight's November 2010 release), whereas the World Energy Outlook 2010 was released in November 2010, and its projections were formulated several months in advance of the report's release date. Thus, the IEA report may not have fully anticipated the faster-than-expected economic recovery in many key non-OECD countries. In fact, *IEO2011* projects faster demand growth than IEA over the 2008 to 2020 period in both China and India, which are the two economies least affected by the economic downturn of 2008-2009.

By OECD region, the largest differences between the *IEO2011* and IEA projections are for Europe and the United States. IEA projects a 0.1-percent average yearly increase in OECD Europe's total energy consumption from 2008 to 2020, compared with a 0.5-percent average increase in the *IEO2011* Reference case. For the United States, IEA also projects a 0.1-percent average yearly increase from 2008 to 2020, compared with a 0.4-percent average increase over the same period in the *IEO2011* Reference case.

In some of the near-term projections for the non-OECD regions, there is wider variation between the IEA and *IEO2011* reports. For the entire group of non-OECD countries, the IEA projections for total energy consumption are the same as those in the *IEO2011* Reference case, with total energy consumption growing by 2.7 percent per year from 2008 to 2020. On a regional basis, projected growth rates in the IEA report exceed those in *IEO2011* for non-OECD Europe and Eurasia, the Middle

Table I1. Comparison of *IEO2011* and IEA world energy consumption growth rates by region, 2008-2020 (average annual percent growth)

Region	*IEO2011*	IEA
OECD	**0.6**	**0.3**
Americas	0.5	0.3
United States	0.4	0.1
Europe	0.5	0.1
Asia	0.7	0.6
Non-OECD	**2.7**	**2.7**
Europe and Eurasia	0.3	0.9
China	4.2	3.7
India	3.8	3.5
Other non-OECD Asia	2.5	2.5
Middle East	2.4	2.8
Africa	1.9	1.6
Central & South America	1.8	2.2
World	**1.7**	**1.5**

Sources: ***IEO2011*:** U.S. Energy Information Administration, World Energy Projection System Plus (2011). **IEA:** International Energy Agency, *World Energy Outlook 2010* (Paris, France, November 2010), pp. 617-693, Current Policies Scenario.

[40]International Energy Agency, *World Energy Outlook 2010: Executive Summary* (Paris, France, November 2010), p. 46.
[41]IEA reported energy-equivalent biofuels consumption of 3.5 million barrels per day, which has been converted to volumetric terms for purposes of comparison.

East, and Central and South America. For non-OECD Europe and Eurasia, IEA projects annual increases in energy consumption averaging 0.9 percent per year from 2008 to 2020, whereas *IEO2011* projects average increases of 0.3 percent per year. For the Middle East, IEA projects a 2.8-percent average annual increase in total energy use, compared with 2.4 percent in *IEO2011*. For non-OECD Central and South America, IEA and *IEO2011* project average increases of 2.2 percent and 1.8 percent, respectively; however, *IEO2011* includes Chile in OECD Americas, whereas IEA includes Chile in non-OECD Central and South America.

For non-OECD Asia and Africa, *IEO2011* projects more rapid growth in energy consumption than IEA over the 2008-2020. In the *IEO2011* Reference case, China's energy use increases by 4.2 percent per year over, compared with 3.7 percent per year in the IEA projection. Similarly, *IEO2011* projects 3.8-percent average annual growth in India's energy consumption, compared with 3.5 percent in the IEA projection; and for Africa, *IEO2011* projects 1.9-percent average annual growth in energy use, compared with 1.6 percent in the IEA projection.

For the period from 2020 to 2035, the overall differences between the *IEO2011* and IEA projections narrow, with worldwide energy demand growing by 1.5 percent per year in both outlooks (Table I2). At the regional level, however, there are some substantial differences between the outlooks. For example, total OECD energy demand increases more than twice as fast in the *IEO2011* Reference case, with the largest differences for the OECD Americas and OECD Asia regions. Again, the difference for OECD Americas may be explained in part by the inclusion of Chile in the OECD Americas region in *IEO2011*, as well as much stronger demand growth in the United States—by far the region's largest energy consumer—toward the end of the projection. In *IEO2011*, energy demand in the OECD Americas region increase by 0.8 percent per year on average from 2020 to 2035, with U.S. energy consumption growing by 0.6 percent per year. In contrast, IEA's Current Policies Scenario shows U.S. energy use rising by an anemic 0.2 percent per year and OECD North America's energy use rising by only 0.3 percent per year.

In the projections for non-OECD energy consumption, the largest differences are for India, Africa, and Central and South America. The *IEO2011* Reference case projects annual growth rates of energy consumption averaging 2.7 percent for India, 1.9 percent for Africa, and 2.3 percent for Central and South America from 2020 to 2035. In comparison, IEA projects average annual growth rates of 3.4 percent for India, 1.2 percent for Africa, and 1.4 percent for Central and South America. In each case, the likely explanation is different GDP growth assumptions. IEA assumes that India's GDP will expand by 5.6 percent per year on average from 2020 to 2035, whereas the *IEO2011* Reference case assumes a 4.3-percent average. On the other hand, the *IEO2011* Reference case assumes that Africa's GDP will expand by 3.3 percent per year, compared with 2.8 percent per year in the IEA Current Policies Scenario; and *IEO2011* assumes GDP growth averaging 3.6 percent per year in Central and South America, compared with IEA's assumption of 2.7 percent per year.

The projections vary not only with respect to levels of energy demand but also with respect to the mix of primary energy inputs. For the 2008-2020 period, IEA expects much faster growth in the use of coal and slower growth in the use of nuclear and renewable energy sources than does *IEO2011* (Table I3). The IEA projection shows world coal consumption increasing by an annual average of 2.2 percent from 2008 to 2020, compared with 1.4 percent in the *IEO2011* Reference case. The IEA renewables projections were adjusted for this comparison by removing biofuels from the totals; but there are still other differences between the projections for consumption of renewables, because IEA includes an estimate for traditional, nonmarketed biomass in its renewable energy projections, whereas the *IEO2011* projections do not attempt to estimate

Table I2. Comparison of *IEO2011* and IEA world energy consumption growth rates by region, 2020-2035 (average annual percent growth)

Region	*IEO2011*	IEA
OECD	**0.8**	**0.3**
Americas	0.8	0.3
United States	0.6	0.2
Europe	0.5	0.4
Asia	0.6	0.2
Non-OECD	**2.0**	**1.8**
Europe and Eurasia	0.7	1.0
China	2.1	1.7
India	2.7	3.4
Other non-OECD Asia	2.3	2.3
Middle East	2.0	2.0
Africa	1.9	1.2
Central & South America	2.3	1.4
World	**1.5**	**1.5**

Sources: ***IEO2011*:** U.S. Energy Information Administration, World Energy Projection System Plus (2011). **IEA:** International Energy Agency, *World Energy Outlook 2010* (Paris, France, November 2010), pp. 617-693, Current Policies Scenario.

Table I3. Comparison of *IEO2011* and IEA world energy consumption growth rates by fuel, 2008-2020 (average annual percent growth)

Fuel	*IEO2011*	IEA
Liquids	**1.0**	**0.9**
Natural gas	1.6	1.7
Coal	1.4	2.2
Nuclear	3.0	2.1
Renewables/Other	4.0	2.0
Total	**2.0**	**1.6**

Sources: ***IEO2011*:** U.S. Energy Information Administration, World Energy Projection System Plus (2011). **IEA:** International Energy Agency, *World Energy Outlook 2010* (Paris, France, November 2010), pp. 617-693, Current Policies Scenario.

the use of nonmarketed renewable fuels (which, in fact, is not likely to expand significantly, because developing countries tend to move away from traditional fuels to commercial fuels as their energy infrastructures and standards of living increase). Still, consumption of traditional fuels in some developing countries is estimated to be quite large, with effects on total renewable energy use that would tend to mask any growth in the consumption of energy from marketed, commercial renewable sources—particularly, wind and other nonhydroelectric renewables.

Differences between the IEA and *IEO2011* projections for nuclear energy are explained in part by different expectations for the OECD region, which accounted for 84 percent of the world's total nuclear power use in 2008. Neither the IEA or *IEO2011* projections reflect consideration of policy responses to Japan's Fukushima Daiichi nuclear disaster on nuclear generation from existing or new facilities. Although the IEA Current Policies Scenario projects more rapid growth for nuclear power in the OECD Asia region than is projected in the *IEO2011* Reference case, it also projects a decline in OECD Europe's nuclear power demand. In contrast, in the *IEO2011* Reference case, nuclear power use in OECD Europe rises by 1.4 percent per year through 2020. Because OECD Europe consumes twice as much nuclear electricity as OECD Asia, the 1.4-percent per year decline projected by IEA for OECD Europe offsets the projected increases for other OECD regions that are larger than those in the *IEO2011* Reference case.

IEO2011 also projects higher growth in non-OECD nuclear power demand than does the IEA Current Policies Scenario over the 2008-2020 period. In this case, the *IEO2011* nuclear growth projections are higher than the IEA projections for every region except China and Central and South America. However, IEA's higher growth rates for nuclear power in China and Central and South America are not sufficient to offset the more robust growth rates for the rest of the non-OECD regions in the *IEO2011* projections.

For the period from 2020 to 2035, the most noticeable differences between the *IEO2011* Reference case and IEA projections are for nuclear power and renewable energy sources (Table I4). In the IEA projection, the average annual growth rate for world nuclear electricity consumption slows from 2.1 percent in the 2008-2020 period to 1.1 percent in the 2020-2035 period; *IEO2011* projects average annual increases of 2.2 percent from 2008 to 2020 and 2.1 percent from 2020 to 2035. In the IEA Current Policies Scenario, renewable energy use increases by 2.0 percent per year over the 2008-2020 period and by 1.5 percent per year from 2020 to 2035; in the *IEO2011* Reference case, renewable energy use increases by 4.0 percent per year from 2008 to 2020 and 1.9 percent per year from 2020 to 2035.

Comparisons with *IEO2010*

The *IEO2011* outlook for total energy consumption in 2020 is 29 quadrillion Btu (about 5 percent) higher than the outlook that was published in *IEO2010*. A faster economic recovery from the global downturn in 2008 and 2009 resulted in faster than expected growth in the developing world, particularly China and India. As a result, total marketed energy consumption in 2020 in the *IEO2011* Reference case is 619 quadrillion Btu, as compared with 590 quadrillion Btu in *IEO2010* (Table I5). China accounts for 19 quadrillion Btu (or about 65 percent) of the net difference in world energy use between the two outlooks in 2020, and India adds another 5 quadrillion Btu (17 percent).

The near-term differences between the *IEO2011* and *IEO2010* projections continue throughout the projection. *IEO2011* projects total world energy use in 2035 that is 31 quadrillion Btu (about 4 percent) higher than the *IEO2010* projection for 2035. Again, higher demand in China and India explains much of the difference, with the two countries accounting for the largest upward revisions in *IEO2011* relative to last year's report. The two countries combined account for about 70 percent of the net difference between the two outlooks for 2035, with most of the remainder attributed to OECD Europe. Projections for marketed energy use in every other region are nearly the same in *IEO2011* and *IEO2010*.

Along with regional differences between the *IEO2011* and *IEO2010* projections, there are some differences in the projected mix of energy resources consumed (Table I6). The largest difference is in the 2020 projection for world coal consumption, which in the *IEO2011* Reference case is 12 quadrillion Btu higher than projected in *IEO2010*. In 2020, demand for every type of energy except natural gas is higher in *IEO2011* than in *IEO2010*, reflecting somewhat lower oil prices, increased demand for coal in China, and additional plans to increase the use of energy sources that do not emit greenhouse gases—notably, nuclear power and renewables.

In 2035, demand for all energy sources is higher in *IEO2011* than in *IEO2010*, but the largest increases relative to last year's report are for natural gas and renewable energy. The upward revision of natural gas use in *IEO2011* reflects the expectation that, in the long term, new sources of unconventional natural gas worldwide will keep markets well supplied and prices economically competitive with other fuel sources. The increase in renewable energy use relative to *IEO2010* is for the most part a continuation of the mid-term upward revision in 2020, carried through the end of the projection period.

Table I4. Comparison of *IEO2011* and IEA world energy consumption growth rates by fuel, 2020-2035 (average annual percent growth)

Fuel	*IEO2011*	IEA
Liquids	**0.9**	**0.9**
Natural gas	1.6	1.6
Coal	1.6	1.4
Nuclear	1.9	1.1
Renewables/Other	1.9	1.5
Total	**1.5**	**1.3**

Sources: ***IEO2011***: U.S. Energy Information Administration, World Energy Projection System Plus (2011). **IEA**: International Energy Agency, *World Energy Outlook 2010* (Paris, France, November 2010), pp. 617-693, Current Policies Scenario.

Table I5. Total Reference Case energy consumption in *IEO2011* and *IEO2010*, 2020 and 2035 (quadrillion Btu)

Region	2020		2035		Difference between *IEO2011* and *IEO2010*	
	IEO2011	*IEO2010*	*IEO2011*	*IEO2010*	2020	2035
OECD	**287**	**254**	**322**	**281**	**32**	**41**
United States	105	105	114	115	0	0
Canada	16	15	19	18	0	1
Mexico/Chile[a]	10	9	15	14	1	1
OECD Europe[b]	87	83	94	88	4	6
OECD Asia	43	42	47	46	1	0
Japan	23	22	24	22	1	2
South Korea	12	12	14	15	0	-1
Australia/NewZealand	8	8	9	9	0	0
Non-OECD	**359**	**336**	**482**	**458**	**23**	**24**
Non-OECD Europe and Eurasia[b]	52	54	58	60	-2	-2
Russia	31	32	36	36	0	0
Other	21	23	23	25	-1	-2
China	141	121	191	182	19	10
India	33	28	49	38	5	12
Other Asia	41	38	58	58	3	0
Middle East	34	36	45	46	-3	0
Africa	24	22	31	29	1	2
Central and South America[a]	34	35	48	46	-1	2
Total world	**619**	**590**	**770**	**739**	**29**	**31**

[a]Chile was included in Central and South America in *IEO2010*.
[b]Slovenia was included in non-OECD Europe/Eurasia in IEO2010; in IEO2011 it is in OECD Europe.
Sources: ***IEO2010***: U.S. Energy Information Administration, *International Energy Outlook 2010*, DOE/EIA-0484(2010) (Washington, DC, July 2010).
IEO2011: U.S. Energy Information Administration, World Energy Projection System Plus (2011).

Table I6. Reference Case energy consumption by energy source in *IEO2010* and *IEO2011*, 2020 and 2035 (quadrillion Btu)

Fuel	2020		2035		Difference between *IEO2011* and *IEO2010*	
	IEO2011	*IEO2010*	*IEO2011*	*IEO2010*	2020	2035
Liquids	196	186	225	224	10	2
Natural gas	138	141	175	162	-3	13
Coal	165	152	209	206	12	3
Nuclear	39	37	51	47	1	4
Renewables/Other	82	73	110	100	9	10
Total	**619**	**590**	**770**	**739**	**29**	**31**

Sources: ***IEO2010***: U.S. Energy Information Administration, *International Energy Outlook 2010*, DOE/EIA-0484(2010) (Washington, DC, July 2010).
IEO2011: U.S. Energy Information Administration, World Energy Projection System Plus (2011).

Appendix J

Models used to generate the *IEO2011* projections

The *IEO2011* projections of world energy consumption and supply were generated from EIA's World Energy Projections Plus (WEPS+) model. WEPS+ consists of a system of individual sectoral energy models, using an integrated iterative solution process that allows for convergence of consumption and prices to an equilibrium solution. It is used to build the Reference case energy projections, as well as alternative energy projections based on different assumptions for GDP growth and fossil fuel prices. It can also be used to perform other analyses.

WEPS+ produces projections for 16 regions or countries of the world, including OECD Americas (United States, Canada, and Mexico/Chile), OECD Europe, OECD Asia (Japan, South Korea, and Australia/New Zealand), Russia, other non-OECD Europe and Eurasia, China, India, other non-OECD Asia, Brazil, and other Central and South America. Currently, the projections extend to 2035.

The WEPS+ platform allows the various individual models to communicate through a common, shared database and provides a comprehensive, central series of output reports for analysis. In the individual models, the detail also extends to the subsector level. In WEPS+, the end-use demand models (residential, commercial, industrial, and transportation) project consumption of the key primary energy sources: several petroleum products, other liquids, natural gas, coal, nuclear power, hydropower, wind, geothermal, and other renewable sources. These models also provide intermediate consumption projections for electricity in the end-use demand sectors.

The end-use model projections generally depend on retail supply prices, economic activity as represented by GDP (or gross output in the industrial sector), and population. The transformation models (power generation and district heat) satisfy electricity and heat requirements and also project consumption of primary energy sources at resulting price levels. The supply models (petroleum, natural gas, and coal) generate supply and wholesale price projections for the key supply sources corresponding to the primary consumption sources. The refinery model makes retail price projections for a variety of petroleum products corresponding to the world oil price. The main model in the WEPS+ system monitors the convergence sequence for all the models and projects energy-related carbon dioxide emissions from fossil fuels (including emissions from the use of petrochemical feedstocks but excluding flared natural gas) at the regional level.

Small improvements were made throughout the WEPS+ modeling system, but the models themselves are essentially unchanged from those used for *IEO2010*. The model enhancements implemented in this year's version of the WEPS+ model include improvements to the modeling platform and improvements in the individual models. In addition, the following minor changes were implemented:

- After joining the OECD, Chile has been combined with Mexico to create the region Mexico/Chile. Slovenia, which also joined the OECD, is now part of OECD Europe.
- The electricity model now uses learning algorithms for power plant costs and efficiency, a new input file for power plants under construction, and updated historical power plant capacities.
- The model reports now link directly to output reports from EIA's National Energy Modeling System (NEMS), so that U.S. projections match those published in the *Annual Energy Outlook* precisely. In past years, the WEPS+ model attempted to recalculate U.S. projections.
- Four types of crude oil have been added to the Refinery model, to better model refined product prices based on the different grades of crude.
- The graphical user interface for the system has been recoded from Visual Basic 6 to Python.

The Reference case reflects the underlying relationships incorporated in the complete set of models interacting with each other in supply/demand relationships communicated through macroeconomic variables, prices, and consumption. The system of models is run iteratively to a point at which prices and consumption have converged to a reasonable equilibrium. Accumulated knowledge from the results of other complex models that focus on specific supply or demand issues and analysts' expert judgments also are taken into account and incorporated into the final projections. After the Reference case has been established, WEPS+ is used to run alternative cases that reflect different assumptions about future economic growth and energy prices. WEPS+ also can be used for other analyses, such as the effects of carbon prices.

The Generate World Oil Balance (GWOB) application is used to create a "bottom up" projection of world liquids supply—based on current production capacity, planned future additions to capacity, resource data, geopolitical constraints, and prices—and to generate conventional crude oil production cases. The scenarios (Oil Price cases) are developed through an iterative process of examining demand levels at given prices and considering price and income sensitivity on both the demand and supply sides of the equation. Projections of conventional liquids production for 2009 through 2015 are based on analysis of investment and development trends around the globe. Data from EIA's *Short-Term Energy Outlook* are integrated to ensure consistency between short- and long-term modeling efforts. Projections of unconventional liquids production are based on exogenous analysis.

Ten major streams of liquids production are tracked on a volume basis: (1) crude oil and lease condensate, (2) natural gas plant liquids, (3) refinery gains, (4) Canadian oil sands, (5) extra-heavy oils, (6) coal-to-liquids, (7) gas-to-liquids, (8) shale oils, (9) ethanol, and (10) biodiesel. Biofuels are tracked on both a volume basis and an oil equivalent basis. All liquid fuels are reported in physical volumes, unless otherwise stated.

The *IEO2011* projections of global natural gas production and trade were generated from EIA's International Natural Gas Model (INGM), a tool that estimates natural gas production, demand, and international trade. It combines estimates of natural gas reserves, natural gas resources and resource extraction costs, energy demand, and transportation costs and capacity in order to estimate future production, consumption, and prices of natural gas.

INGM incorporates regional energy consumption projections by fuel from the WEPS+ model, as well as more detailed U.S. projections from NEMS, which is used to generate U.S. energy projections for the *Annual Energy Outlook*. An iterative process between INGM and WEPS+ is used to balance world natural gas markets, with INGM providing supply curves to WEPS+ and receiving demand estimates developed by WEPS+. INGM uses regional natural gas demand estimates from NEMS for the United States rather than those computed as part of the WEPS+ output, so that the final output for the United States is consistent with *AEO* projections.

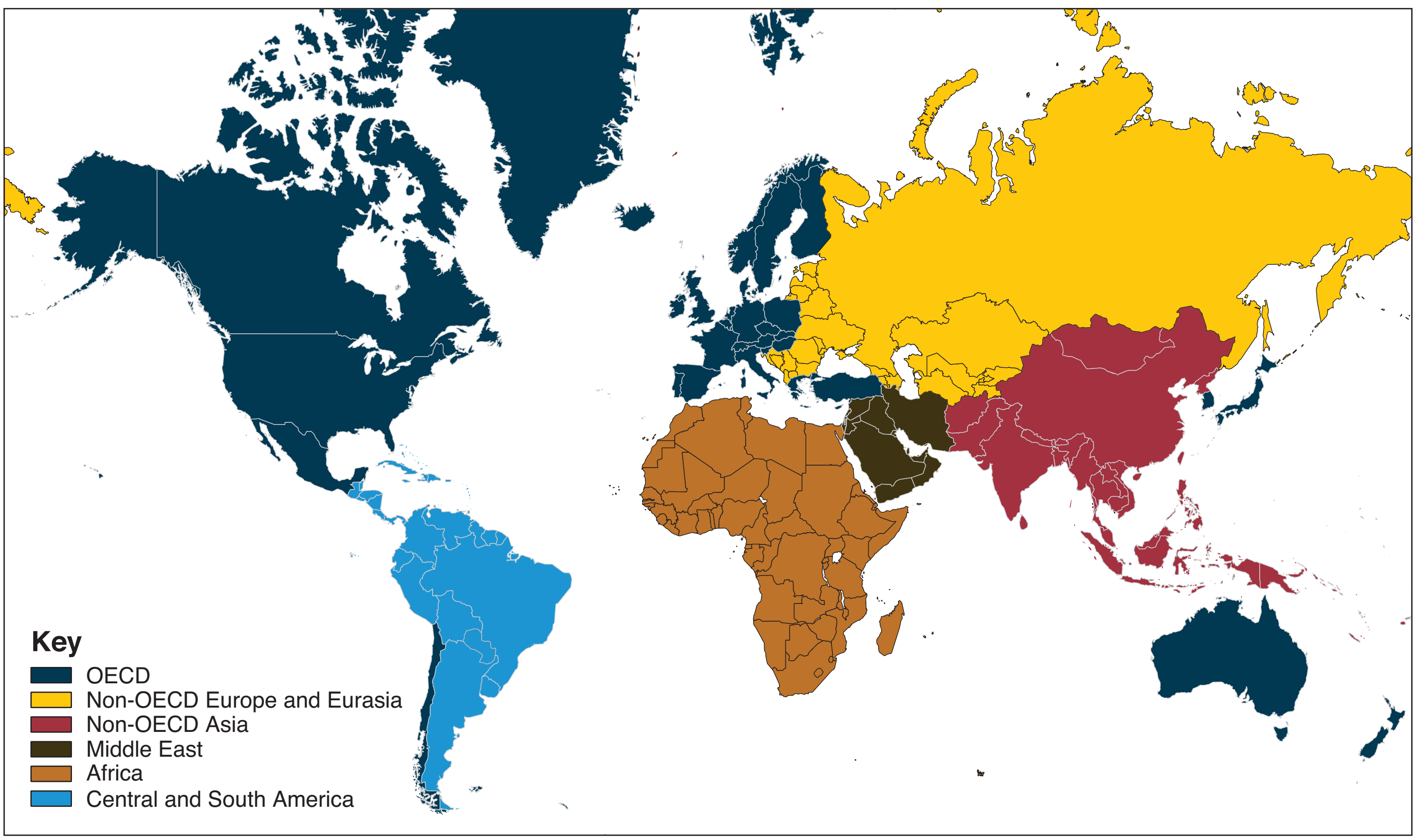
Appendix K

Regional definitions

The six basic country groupings used in this report (Figure M1) are defined as follows:

- OECD (18 percent of the 2011 world population): OECD Americas—United States, Canada, Chile, and Mexico; OECD Europe—Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom; OECD Asia—Japan, South Korea, Australia, and New Zealand.
- Non-OECD (82 percent of the 2011 world population):
  - Non-OECD Europe and Eurasia (5 percent of the 2011 world population)—Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Malta, Moldova, Montenegro, Romania, Russia, Serbia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.
  - Non-OECD Asia (53 percent of the 2011 world population)—Afghanistan, American Samoa, Bangladesh, Bhutan, Brunei, Cambodia (Kampuchea), China, Cook Islands, Fiji, French Polynesia, Guam, Hong Kong, India, Indonesia, Kiribati, Laos, Macau, Malaysia, Maldives, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, Niue, North Korea, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Timor-Leste (East Timor), Tonga, U.S. Pacific Islands, Vanuatu, Vietnam, and Wake Islands.
  - Middle East (3 percent of the 2011 world population)—Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, the United Arab Emirates, and Yemen.
  - Africa (15 percent of the 2011 world population)—Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Congo (Kinshasa), Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, St. Helena, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Western Sahara, Zambia, and Zimbabwe.
  - Central and South America (7 percent of the 2011 world population)—Antarctica, Antigua and Barbuda, Argentina, Aruba, The Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti,

Figure K1. Map of the six basic country groupings



Source: Energy Information Administration, Office of Energy Analysis.

Honduras, Jamaica, Martinique, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Kitts-Nevis, St. Lucia, St. Vincent/Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, U.S. Virgin Islands, and Venezuela.

In addition, the following commonly used country groupings are referenced in this report:

- **Annex I Countries participating in the Kyoto Climate Change Protocol on Greenhouse Gas Emissions:** Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, European Community, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and the United Kingdom.[42]
- **European Union (EU):** Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.
- **Organization of the Petroleum Exporting Countries (OPEC):** Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.
- **Persian Gulf Countries:** Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.
- **Natural Gas Arabian Producers:** Bahrain, Kuwait, Oman, United Arab Emirates, and Yemen.

[42]Turkey is an Annex I nation that has not ratified the Framework Convention on Climate Change and did not commit to quantifiable emissions targets under the Kyoto Protocol. In 2001, the United States withdrew from the Protocol.