

# **Executive Summary**

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The past year has been a tumultuous one for world energy markets, with oil prices soaring through the first half of 2008 and diving in its second half. The downturn in the world economy has had a significant impact on energy demand, and the near-term future of energy markets is tied to the downturn's uncertain depth and persistence. The recovery of the world's financial markets is especially important for the energy supply outlook, because the capital-intensive nature of most large energy projects makes access to financing a critical necessity.

The projections in *AEO2009* look beyond current economic and financial woes and focus on factors that drive U.S. energy markets in the longer term. Key issues highlighted in the *AEO2009* include higher but uncertain world oil prices, growing concern about greenhouse gas (GHG) emissions and its impacts on energy investment decisions, the increasing use of renewable fuels, the increasing production of unconventional natural gas, the shift in the transportation fleet to more efficient vehicles, and improved efficiency in end-use appliances. Using a reference case and a broad range of sensitivity cases, *AEO2009* illustrates these key energy market trends and explores important areas of uncertainty in the U.S. energy economy. The *AEO2009* cases, which were developed before enactment of the American Recovery and Reinvestment Act of 2009 (ARRA2009) in February 2009, reflect laws and policies in effect as of November 2008.

*AEO2009* also includes in-depth discussions on topics of special interest that may affect the energy market outlook, including changes in Federal and State laws and regulations and recent developments in technologies for energy production and consumption. Some of the highlights for selected topics are mentioned in this Executive Summary, but readers interested in other issues or a fuller discussion should look at the Legislation and Regulations and Issues in Focus sections.

Developments in technologies for energy production and consumption that are discussed and analyzed in this report include the impacts of growing concerns about GHG emissions on investment decisions and how those impacts are handled in the *AEO2009* projections; the impacts of extending the PTC for renewable fuels by 10 years; the impacts of uncertainty about construction costs for electric power plants; the relationship between natural gas prices and oil prices; the economics of bringing natural gas from Alaska's North Slope to U.S. markets; expectations for oil

shale production; the economics of plug-in electric hybrids; and trends in world oil prices and production.

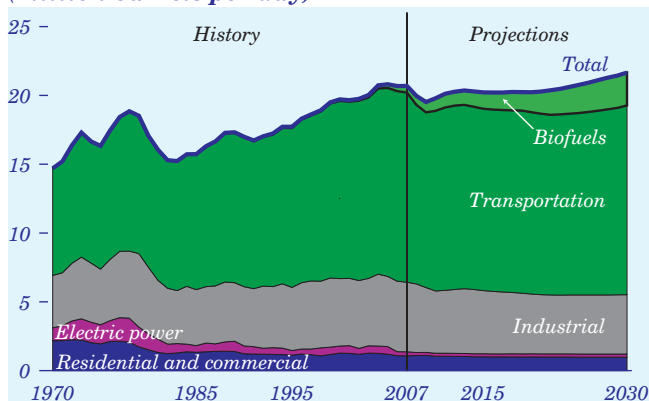
### World Oil Prices, Oil Use, and Import Dependence

Despite the recent economic downturn, growing demand for energy—particularly in China, India, and other developing countries—and efforts by many countries to limit access to oil resources in their territories that are relatively easy to develop are expected to lead to rising real oil prices over the long term. In the *AEO2009* reference case, world oil prices rise to \$130 per barrel (real 2007 dollars) in 2030; however, there is significant uncertainty in the projection, and 2030 oil prices range from \$50 to \$200 per barrel in alternative oil price cases. The low price case represents an environment in which many of the major oil-producing countries expand output more rapidly than in the reference case, increasing their share of world production beyond current levels. In contrast, the high price case represents an environment where the opposite would occur: major oil-producing countries choose to maintain tight control over access to their resources and develop them more slowly.

Total U.S. demand for liquid fuels grows by only 1 million barrels per day between 2007 and 2030 in the reference case, and there is no growth in oil consumption. Oil use is curbed in the projection by the combined effects of a rebounding oil price, more stringent corporate average fuel economy (CAFE) standards, and requirements for the increased use of renewable fuels (Figure 1).

Growth in the use of biofuels meets the small increase in demand for liquids in the projection. Further, with increased use of biofuels that are produced domestically and with rising domestic oil production spurred

**Figure 1. Total liquid fuels demand by sector (million barrels per day)**



by higher prices in the *AEO2009* reference case, the net import share of total liquid fuels supplied, including biofuels, declines from 58 percent in 2007 to less than 40 percent in 2025 before increasing to 41 percent in 2030. The net import share of total liquid fuels supplied in 2030 varies from 30 percent to 57 percent in the alternative oil price cases, with the lowest share in the high price case, where higher oil prices dampen liquids demand and at the same time stimulate more production of domestic petroleum and biofuels.

### Growing Concerns about Greenhouse Gas Emissions

Although no comprehensive Federal policy has been enacted, growing concerns about GHG emissions appear to be affecting investment decisions in energy markets, particularly in the electricity sector. In the United States, potential regulatory policies to address climate change are in various stages of development at the State, regional, and Federal levels. U.S. electric power companies are operating in an especially challenging environment. In addition to ongoing uncertainty with respect to future demand growth and the costs of fuel, labor, and new plant construction, it appears that capacity planning decisions for new generating plants already are being affected by the potential impacts of policy changes that could be made to limit or reduce GHG emissions.

This concern is recognized in the reference case and leads to limited additions of new coal-fired capacity—much less new coal capacity than projected in recent editions of the *Annual Energy Outlook (AEO)*. Instead of relying heavily on the construction of new coal-fired plants, the power industry constructs more new natural-gas-fired plants, which account for the largest share of new power plant additions, followed by smaller amounts of renewable, coal, and nuclear capacity. From 2007 to 2030, new natural-gas-fired plants account for 53 percent of new plant additions in the reference case, and coal plants account for only 18 percent.

Two alternative cases in *AEO2009* illustrate how uncertainty about the evolution of potential GHG policies could affect investment behavior in the electric power sector. In the no GHG concern case, it is assumed that concern about GHG emissions will not affect investment decisions in the electric power sector. In contrast, in the LW110 case, the GHG emissions reduction policy proposed by Senators Lieberman and Warner (S. 2191) in the 110th

Congress is incorporated to illustrate a future in which an explicit Federal policy is enacted to limit U.S. GHG emissions. The results in this case should be viewed as illustrative, because the projected impact of any policy to reduce GHG emissions will depend on its detailed specifications, which are likely to differ from those used in the LW110 case.

Projections in the two alternative cases illustrate the potential importance of GHG policy changes to the electric power industry and why uncertainty about such changes weighs heavily on planning and investment decisions. Relative to the reference case, new coal plants play a much larger role in meeting the growing demand for electricity in the no GHG concern case, and the role of natural gas and nuclear plants is diminished. In this case, new coal plants account for 38 percent of generating capacity additions between 2007 and 2030. In contrast, in the LW110 case there is a strong shift toward nuclear and renewable generation, as well as fossil technologies with carbon capture and storage (CCS) equipment.

There is also a wide divergence in electricity prices in the two alternative GHG cases. In the no GHG concern case, electricity prices are 3 percent lower in 2030 than in the reference case; in the LW110 case, they are 22 percent higher in 2030 than in the reference case.

### Increasing Use of Renewable Fuels

The use of renewable fuels grows strongly in *AEO-2009*, particularly in the liquid fuels and electricity markets. Overall consumption of marketed renewable fuels—including wood, municipal waste, and biomass in the end-use sectors; hydroelectricity, geothermal, municipal waste, biomass, solar, and wind for electric power generation; ethanol for gasoline blending; and biomass-based diesel—grows by 3.3 percent per year in the reference case, much faster than the 0.5-percent annual growth in total energy use. The rapid growth of renewable generation reflects the impacts of the renewable fuel standard in the Energy Independence and Security Act of 2007 (EISA2007) and strong growth in the use of renewables for electricity generation spurred by renewable portfolio standard (RPS) programs at the State level.

EISA2007 requires that 36 billion gallons of qualifying credits from biofuels be produced by 2022 (a credit is roughly one gallon, but some biofuels may receive

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more than one credit per gallon); and although the reference case does not show that credit level being achieved by the 2022 target date, it is exceeded by 2030. The volume of biofuels consumed is sensitive to the price of the petroleum-based products against which they compete. As a result, total liquid biofuel consumption varies significantly between the reference case projection and the low and high oil price cases. In the low oil price case, total liquid biofuel consumption reaches 27 billion gallons in 2030. In the high oil price case, where the price of oil approaches \$200 per barrel (real 2007 dollars) by 2030, it reaches 40 billion gallons.

As of November 2008, 28 States and the District of Columbia had enacted RPS requirements that a specified share of the electricity sold in the State come from various renewable sources. As a result, the share of electricity sales coming from nonhydroelectric renewables grows from 3 percent in 2007 to 9 percent in 2030, and 33 percent of the increase in total generation comes from nonhydroelectric renewable sources. The share of sales accounted for by nonhydroelectric renewables could grow further if more States adopted or strengthened existing RPS requirements. Moreover, the enactment of policies to reduce GHG emissions could stimulate additional growth. In the LW110 case, the share of electricity sales accounted for by nonhydroelectric renewable generation grows to 18 percent in 2030.

### Growing Production from Unconventional Natural Gas Resources

Relative to recent *AEOs*, the *AEO2009* reference case raises EIA's projection for U.S. production and consumption of natural gas, reflecting a larger resource base and higher demand for natural gas for electricity generation. Among the various sources of natural gas, the most rapid growth is in domestic production from unconventional resources, while the role played by pipeline imports and imports of liquefied natural gas (LNG) declines over the long term (Figure 2).

The larger natural gas resource in the reference case results primarily from a larger estimate for natural gas shales, with some additional impact from the 2008 lifting of the Executive and Congressional moratoria on leasing and development of crude oil and natural gas resources in the OCS. From 2007 to 2030, domestic production of natural gas increases by 4.3 trillion cubic feet (22 percent), while net imports fall by 3.1 trillion cubic feet (83 percent). Although average real U.S. wellhead prices for natural gas increase from \$6.39

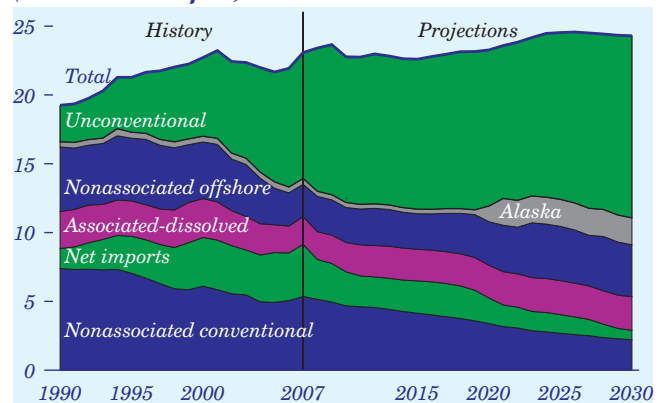
per thousand cubic feet in 2007 to \$8.40 per thousand cubic feet in 2030, stimulating production from domestic resources, the prices are not high enough to attract large imports of LNG, in a setting where world LNG prices respond to the rise of oil prices in the *AEO2009* reference case. One result of the growing production of natural gas from unconventional onshore sources, together with increases from the OCS and Alaska, is that the net import share of U.S. total natural gas use also declines, from 16 percent in 2007 to less than 3 percent in 2030.

In addition to concerns and/or policies regarding GHG emissions, the overall level of natural gas consumption that supply must meet is sensitive to many other factors, including the pace of economic growth. In the *AEO2009* alternative economic growth cases, consumption of natural gas in 2030 varies from 22.7 trillion cubic feet to 26.0 trillion cubic feet, roughly 7 percent below and above the reference case level.

### Shifting Mix of Unconventional Technologies in Cars and Light Trucks

Higher fuel prices, coupled with significant increases in fuel economy standards for light-duty vehicles (LDVs) and investments in alternative fuels infrastructure, have a dramatic impact on development and sales of alternative-fuel and advanced-technology LDVs. The *AEO2009* reference case includes a sharp increase in sales of unconventional vehicle technologies, such as flex-fuel, hybrid, and diesel vehicles. Hybrid vehicle sales of all varieties increase from 2 percent of new LDV sales in 2007 to 40 percent in 2030. Sales of plug-in hybrid electric vehicles (PHEVs) grow to almost 140,000 vehicles annually by 2015, supported by tax credits enacted in 2008, and they account for 2 percent of all new LDV sales in

**Figure 2. Total natural gas supply by source (trillion cubic feet)**



2030. Diesel vehicles account for 10 percent of new LDV sales in 2030 in the reference case, and flex-fuel vehicles (FFVs) account for 13 percent.

In addition to the shift to unconventional vehicle technologies, the *AEO2009* reference case shows a shift in the LDV sales mix between cars and light trucks (Figure 3). Driven by rising fuel prices and the cost of CAFE compliance, the sales share of new light trucks declines. In 2007, light-duty truck sales accounted for approximately 50 percent of new LDV sales. In 2030, their share is down to 36 percent, mostly as a result of a shift in LDV sales from sport utility vehicles to mid-size and large cars.

### Slower Growth in Overall Energy Use and Greenhouse Gas Emissions

The combination of recently enacted energy efficiency policies and rising energy prices in the *AEO-2009* reference case slows the growth in U.S. consumption of primary energy relative to history: from 101.9 quadrillion British thermal units (Btu) in 2007, energy consumption grows to 113.6 quadrillion Btu in 2030, a rate of increase of 0.5 percent per year. Further, when slower demand growth is combined with increased use of renewables and a reduction in additions of new coal-fired conventional power plants, growth in energy-related GHG emissions also is slowed relative to historical experience. Energy-related emissions of carbon dioxide (CO<sub>2</sub>) grow at a rate of 0.3 percent per year from 2007 to 2030 in the *AEO2009* reference case, to 6,414 million metric tons in 2030, compared with the *Annual Energy Outlook*

2008 (*AEO2008*) reference case projection of 6,851 million metric tons in 2030.

One key factor that drives growth in both total energy consumption and GHG emissions is the rate of overall economic growth. In the *AEO2009* reference case, the U.S. economy grows by an average of 2.5 percent per year. In comparison, in alternative low and high economic growth cases, the average annual growth rates from 2007 to 2030 are 1.8 percent and 3.0 percent. In the two cases, total primary energy consumption in 2030 ranges from 104 quadrillion Btu (8.2 percent below the reference case) to 123 quadrillion Btu (8.6 percent above the reference case). Energy-related CO<sub>2</sub> emissions in 2030 range from 5,898 million metric tons (8.1 percent below the reference case) in the low economic growth case to 6,886 million metric tons (7.3 percent above the reference case) in the high economic growth case.

**Figure 3. New light-duty vehicle sales shares by type (percent of total)**

