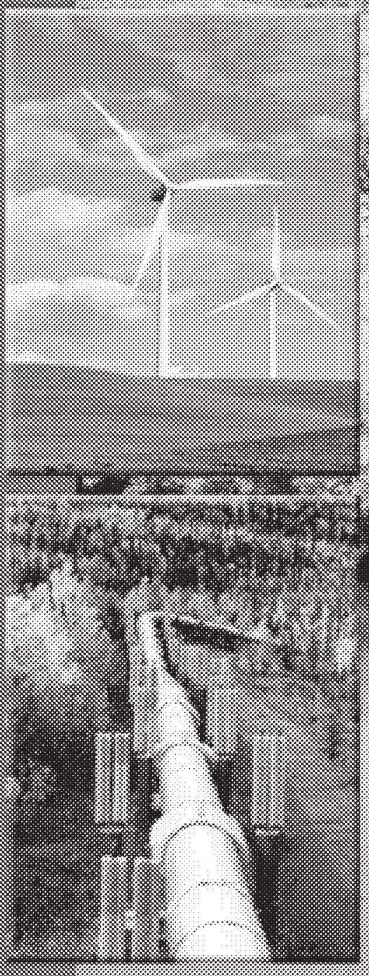
ANNUAL ENERGY OUTLOOK 2010 WITH PROJECTIONS TO 2035



U.S. Energy Information Administration

Executive Summary

In 2009, U.S. energy markets continued to show the impacts of the economic downturn that began in late 2007. After falling by 1 percent in 2008, total electricity generation dropped by another 3 percent in 2009. Although other factors, including weather, contributed to the decrease, it was the first time in the 60-year data series maintained by the EIA that electricity use fell in two consecutive years. Over the next few years, the key factors influencing U.S. energy markets will be the pace of the economic recovery, any lasting impacts on capital-intensive energy projects from the turmoil in financial markets, and the potential enactment of legislation related to energy and the environment.

The projections in *AEO2010* focus on the factors that shape U.S. energy markets in the long term. Under the assumption that current laws and regulations remain unchanged throughout the projections, the *AEO2010* Reference case provides the basis for examination and discussion of energy market trends and the direction they may take in the future. It also serves as a starting point for the analysis of potential changes in energy policies, rules, or regulations. Unless otherwise noted, results refer to the Reference case. But *AEO2010* is not limited to the Reference case. It also includes 38 sensitivity cases (see Appendix E, Table E1, on page 201), which explore important areas of market, technological, and policy uncertainty in the U.S. energy economy.

Key results highlighted in *AEO2010* include moderate growth in energy consumption, increased use of renewables, declining reliance on imported liquid fuels, strong growth in shale gas production, and projected slow growth in energy-related carbon dioxide (CO_2) emissions in the absence of new policies designed to mitigate greenhouse gas (GHG) emissions.

AEO2010 also includes in-depth discussions on topics of special interest that may affect the energy market outlook. They include: impacts of the continuing renewal and updating of Federal and State laws and regulations; end-use energy efficiency trends in the *AEO2010* Reference case; the sensitivity of projections to alternative assumptions about U.S. shale gas development; the implications of retiring nuclear plants after 60 years of operation; the relationship between natural gas and oil prices in U.S. markets; and the basis for world oil price and production trends in *AEO2010*. Some of the highlights from those discussions are mentioned in this Executive Summary. Readers interested in more detailed analyses and discussions should refer to the "Legislation and Regulations" and "Issues in Focus" sections of this report.

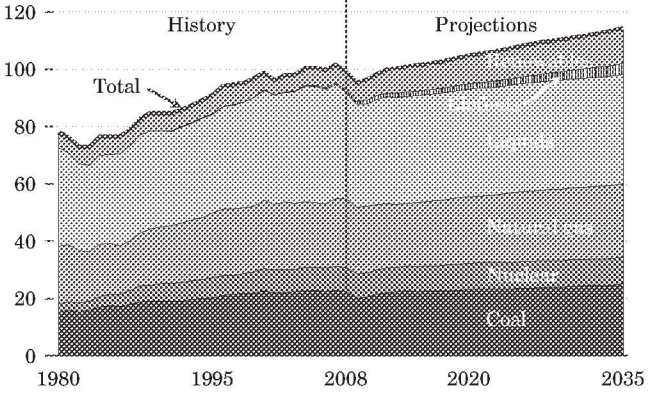
Moderate energy consumption growth and greater use of renewables

Total U.S. primary energy consumption increases by 14 percent from 2008 to 2035 in the Reference case (Figure 1), representing an average annual growth rate of 0.5 percent—only one-fifth of the projected 2.4-percent annual growth rate of the Nation's economic output. The difference between the two rates is the result of continuing improvement in the energy intensity of the U.S. economy, measured as the amount of energy consumed per dollar of gross domestic product (GDP). From 2008 to 2035, energy intensity falls by 1.9 percent per year in the Reference case, as the most rapid growth in the U.S. economy occurs in the less energy-intensive service sectors, and as the efficiency of energy-consuming appliances, vehicles, and structures improves.

EIA projects the strongest growth in fuel use for the renewable fuels used to generate electricity and to produce liquid fuels for the transportation sector. The growth in consumption of renewable fuels is primarily a result of Federal and State programs—including the Federal renewable fuels standard (RFS), various State renewable portfolio standard (RPS) programs, and funds in ARRA—together with rising fossil fuel prices. Although fossil fuels continue to provide most of the energy consumed in the United States over the next 25 years in the Reference case, their share of overall energy use falls from 84 percent in 2008 to 78 percent in 2035.

The role of renewables could grow still further if current policies that support renewable fuels are

Figure 1. U.S. primary energy consumption, 1980-2035 (quadrillion Btu)



extended. For example, the Reference case assumes that the PTC available for electricity generation from renewables sunsets in 2012 (wind) or 2013 (other technologies) as specified in current law, but it has a history of being renewed and could be extended again. In the Reference case, renewable generation accounts for 45 percent of the increase in total generation from 2008 to 2035. In alternative cases assuming the PTC for renewable generation is extended through 2035, the share of growth in total generation accounted for by renewables is between 61 and 65 percent.

Declining reliance on imported liquid fuels

Although U.S. consumption of liquid fuels continues to grow over the next 25 years in the *AEO2010* Reference case, reliance on petroleum imports decreases (Figure 2). With government policies and rising oil prices providing incentives for the continued development and use of alternatives to fossil fuels, biofuels account for all the growth in liquid fuel consumption in the United States over the next 25 years, while consumption of petroleum-based liquids is essentially flat. Total U.S. consumption of liquid fuels, including both fossil fuels and biofuels, rises from about 20 million barrels per day in 2008 to 22 million barrels per day in 2035 in the Reference case.

The role played by petroleum-based liquids could be further challenged if electric or natural-gas-fueled vehicles begin to enter the market in significant numbers. Rising oil prices, together with growing concerns about climate change and energy security, are leading to increased interest in alternative-fuel vehicles (AFVs), but both electric and natural gas vehicles face significant challenges. Alternative cases in this report examine the possible impacts of policies aimed at increasing natural gas use in heavy trucks and identify some of the key factors that will determine the potential for petroleum displacement.

Shale gas drives growth in natural gas production, offsetting declines in other sources

The growth in shale gas production in recent years is one of the most dynamic stories in U.S. energy markets. A few years ago, most analysts foresaw a growing U.S. reliance on imported sources of natural gas, and significant investments were being made in regasification facilities for imports of liquefied natural gas (LNG). Today, the biggest questions are the size of the shale gas resource base (which by most estimates is vast), the price level required to sustain its development, and whether there are technical or environmental factors that might dampen its development. Beyond those questions, the level of future domestic natural gas production will also depend on the level of natural gas demand in key consuming sectors, which will be shaped by prices, economic growth, and policies affecting fuel choice.

In the Reference case, total domestic natural gas production grows from 20.6 trillion cubic feet in 2008 to 23.3 trillion cubic feet in 2035. With technology improvements and rising natural gas prices, natural gas production from shale formations grows to 6 trillion cubic feet in 2035, more than offsetting declines in other production. In 2035, shale gas provides 24 percent of the natural gas consumed in the United States, up from 6 percent in 2008 (Figure 3).

Alternative cases in *AEO2010* examine the potential impacts of more limited shale gas development and of more extensive development of a larger resource base. In those cases, overall domestic natural gas production varies from 17.4 trillion cubic feet to 25.9 trillion

Figure 2. U.S. liquid fuels supply, 1970-2035 (million barrels per day)

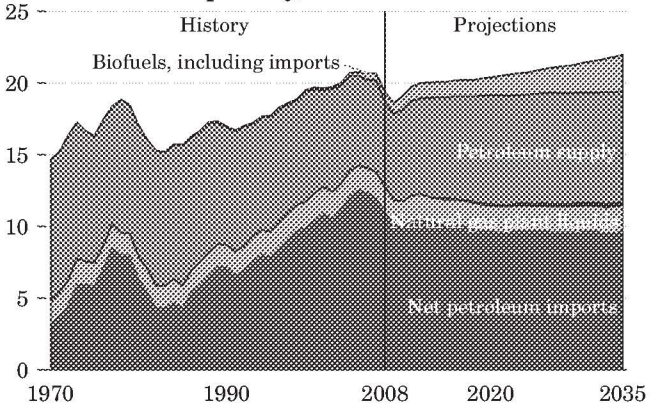
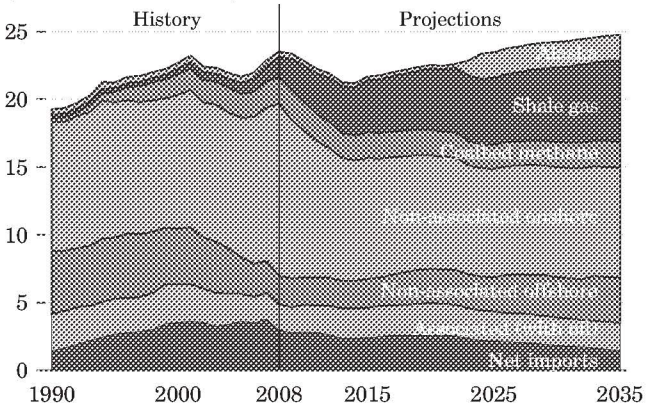


Figure 3. U.S. natural gas supply, 1990-2035 (trillion cubic feet)



cubic feet in 2035, compared with 23.3 trillion cubic feet in the Reference case. The wellhead price of natural gas in 2035 ranges from $6.92 per thousand cubic feet to $9.87 per thousand cubic feet in the alternative cases, compared with $8.06 per thousand cubic feet in the Reference case.

There also are uncertainties about the potential role of natural gas in various sectors of the economy. In recent years, total natural gas use has been increasing, with a decline in the industrial sector more than offset by growing use for electricity generation. In the long run, the use of natural gas for electricity generation continues growing in the Reference case. However, over the next few years the combination of relatively slow growth in total demand for electricity, strong growth in generation from renewable sources, and the completion of a number of coal-fired power plants already under construction limits the potential for increased use of natural gas in the electric power sector. The near- to mid-term downturn could be offset, of course, if policies were enacted that made the use of coal for electricity generation less attractive, if the recent growth in renewable electricity slowed, or if policies were enacted to make the use of natural gas in other sectors, such as transportation, more attractive.

Increases in energy-related carbon dioxide emissions slow

The combination of modest growth in energy consumption and increasing reliance on renewable fuels contributes to slow projected growth in U.S. CO_2 emissions. (For purposes of the *AEO2010* analysis, biomass energy consumption is assumed to be CO_2 neutral.) In the Reference case, which assumes no explicit regulations to limit GHG emissions beyond the recent vehicle GHG standards, CO_2 emissions from energy grow on average by 0.3 percent per year from 2008 to 2035, or a total of about 9 percent. To put the numbers in perspective, population growth is projected to average 0.9 percent per year, overall economic growth 2.4 percent per year, and growth in energy use 0.5 percent per year over the same period. Although total energy-related CO_2 emissions increase from 5,814 million metric tons in 2008 to 6,320 million metric tons in 2035 in the Reference case, emissions per capita fall by 0.6 percent per year. Most of the growth in CO_2 emissions in the *AEO2010* Reference case is accounted for by the electric power and transportation sectors (Figure 4).

The projections for CO_2 emissions are sensitive to many factors, including economic growth, policies aimed at stimulating renewable fuel use or low-carbon power sources, and any policies that may be enacted to reduce GHG emissions. In the *AEO2010* Low and High Economic Growth cases, projections for total primary energy consumption in 2035 are 104 quadrillion British thermal units (Btu) (9.5 percent below the Reference case) and 127 quadrillion Btu (10.7 percent above the Reference case), and projections for energy-related CO_2 emissions in 2035 are 5,768 million metric tons (8.7 percent below the Reference case) and 6,865 million metric tons (8.6 percent above the Reference case), respectively.

Figure 4. U.S. energy-related carbon dioxide emissions, 2008 and 2035