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U.S. DEPARTMENT OF ENERGY

before the

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

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Mr. Chairman and Members of the Committee:

I appreciate the opportunity to appear before you today to discuss the long-term outlook for energy markets in the United States.

The Energy Information Administration (EIA) is the independent statistical and analytical agency within the Department of Energy. We do not promote, formulate, or take positions on policy issues. Our mission is to produce objective, timely, and relevant data, projections, and analyses that are meant to assist policymakers, help markets function efficiently, and inform the public. The energy projections that I will discuss today are widely used by government agencies, the private sector, and academia as a starting point for their own energy analyses. However, our views are strictly those of EIA and should not be construed as representing those of the Department of Energy or the Administration.

The *Annual Energy Outlook 2008* (*AEO2008*) reference case discussed today includes the impact of the Energy Independence and Security Act of 2007 (EISA2007) that was enacted in December and replaces the early release version issued shortly before that enactment. The specific EISA2007 provisions that are modeled in *AEO2008* include updates to the renewable fuel standard (RFS) and to the corporate average fuel economy (CAFE) standard for new light-duty vehicles; updated and new appliance energy efficiency standards for boilers, dehumidifiers, dishwashers, clothes washers, and walk-in refrigerators and freezers; lighting energy efficiency standards; provisions to reduce energy consumption in Federal buildings; and industrial electric motor efficiency standards. Consistent with the general approach used in the *AEO*, the reference case does not consider those sections of EISA2007 that require appropriations for implementation or sections with highly uncertain impacts on energy markets. The updated reference case also includes additional revisions that reflect: historical data issued after the early release version of the *AEO2008* was completed, the EIA *Short-Term Energy Outlook* released in January 2008, a more current economic outlook, and updates to correct modeling problems in the early release version.

The *AEO2008* is intended to represent an energy future based on given technological and demographic trends, current laws and regulations, and consumer behavior as derived from known data. EIA recognizes that projections of energy markets are highly uncertain and subject to political disruptions, technological breakthroughs, and other unforeseeable events. In addition, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than expected in the projections. The complete *AEO2008*, which EIA will release in April, includes a large number of alternative cases intended to examine these uncertainties. The following discussion summarizes the highlights from the *AEO2008* reference case.

Energy Prices

EIA has raised the reference case path for world oil prices in *AEO2008*, although the upward adjustment is smaller than the last major adjustment, introduced in *AEO2006*. In the *AEO2008* reference case, real world crude oil prices (defined as the price of light,

low-sulfur crude oil delivered in Cushing, Oklahoma, in 2006 dollars) decline gradually from current levels to $57 per barrel in 2016 ($68 per barrel in nominal dollars), as expanded investment in exploration and development brings new supplies to the world market. After 2016, real prices begin to rise (**Figures 1 and 2**), as demand continues to grow and higher cost supplies are brought to market. In 2030, the average real price of crude oil is $70 per barrel in 2006 dollars, or about $113 per barrel in nominal dollars.

In developing its oil price outlook, EIA explicitly considered four factors: (1) growth in world liquids consumption, (2) the outlook for conventional oil production in countries outside the Organization of the Petroleum Exporting Countries (OPEC), (3) growth in unconventional liquids production, and (4) OPEC behavior. With the forces driving demand outside the United States as strong or stronger than previously expected and with global supply projections somewhat weaker, trends in total world liquids production are similar to those in the *Annual Energy Outlook 2007* (*AEO2007*) reference case but the oil prices are higher.

Current oil prices are above EIA's reference case estimate of the long-run equilibrium price, driven by recent strong global economic growth, shortages of experienced personnel, equipment, and construction materials in the oil industry, and political instability in some major producing regions. EIA's expectations regarding the ultimate size of both conventional and unconventional liquid resources have not changed since the *AEO2007*. Of course, geopolitical trends, the adequacy of investment and the availability of crude oil resources and the degree of access to them, and the market behavior of key OPEC producers are all inherently uncertain. To evaluate the implications of uncertainty about world crude oil prices, the *AEO2008* includes alternative high and low price cases (**Figure 2**).

The price of natural gas also is higher in the *AEO2008* reference case. The real wellhead price of natural gas (in 2006 dollars) declines from current levels through 2016, as new supplies enter the market. After 2016, real natural gas prices rise to $6.56 per thousand cubic feet ($10.52 per thousand cubic feet in nominal dollars) in 2030 (**Figure 1)**. The higher prices reflect an increase in production costs associated with trends that were discussed in *AEO2007* but not fully reflected in its reference case. The higher natural gas prices also are supported by higher oil prices.

Minemouth coal prices in the *AEO2008* reference case, both nationally and regionally, are generally similar to those in the *AEO2007* reference case. Average real minemouth coal prices (in 2006 dollars) fall from $1.21 per million British thermal unit (Btu) ($24.63 per short ton) in 2006 to $1.14 per million Btu ($22.51 per short ton) in 2020, as prices moderate following a substantial run-up over the past few years. After 2020, prices rise due to demand growth, reaching $1.19 per million Btu ($23.24 per short ton) in 2030 **(Figure 1)**. In nominal terms, the average minemouth price of coal in the *AEO2008* reference case is $1.91 per million Btu ($37.29 per ton) in 2030.

Electricity prices follow trends in the delivered prices of fuels to power plants. From a peak of 9.3 cents per kilowatthour (2006 dollars) in 2009, average delivered electricity prices in the *AEO2008* reference case decline to 8.5 cents per kilowatthour in 2016 and

then increase to 8.8 cents per kilowatthour in 2030. In nominal dollars, the average delivered electricity price reaches 14.1 cents per kilowatthour in 2030.

Energy Consumption

Total primary energy consumption grows by 19 percent between 2006 and 2030 (**Figure 3**), at a rate of 0.7 percent per year or less than one-third the rate of growth in gross domestic product (GDP) (2.4 percent per year). Energy intensity, as measured by primary energy use per dollar of GDP (2000 dollars), declines at an average annual rate of 1.7 percent from 2006 to 2030. Since 1992, the energy intensity of the U.S. economy has declined on average by 2.0 percent per year, in part because the share of industrial shipments accounted for by the energy-intensive industries has fallen from 30 percent in 1992 to 21 percent in 2006. In the *AEO2008* reference case, the energy-intensive industries' share of total industrial shipments continues to decline, although at a slower rate, to 18 percent in 2030.

Population is another key determinant of energy consumption, influencing demand for travel, housing, consumer goods, and services. Since 1990, population has increased by about 20 percent and energy consumption by 18 percent. Population in the reference case increases by 22 percent from 2006 to 2030, compared to the aforementioned 19 percent growth in energy consumption. The rest of this section reviews consumption trends for each major energy source.

Total consumption of liquid fuels grows at an average annual rate of 0.4 percent in the *AEO2008* reference case, from 20.7 million barrels per day in 2006 to 22.8 million barrels per day in 2030 led by growth in transportation uses, which account for 68 percent of total liquid fuels demand in 2006, increasing to 73 percent in 2030 (**Figure 4**). Improvements in the efficiency of vehicles, planes, and ships are more than offset by growth in travel.

EISA2007 requires new light-duty vehicles, including both cars and trucks, to reach an average fuel economy of 35 miles per gallon (MPG) by 2020, based on the Environmental Protection Agency (EPA) test value used to measure compliance with the CAFE standard. The EPA CAFE test value generally differs from the estimated MPG value on the fuel economy label and typically exceeds the actual on-the-road fuel economy of a new vehicle by a significant margin. Despite these differences, the higher fuel economy standards in EISA2007 significantly improve the in-use fuel economy of the stock of light-duty vehicles. In the reference case, the average in-use fuel economy for the stock of light-duty vehicles in 2030 increases to 28.0 miles per gallon, 38 percent above its 2006 level. EISA2007 also results in a shift in the mix of transportation vehicle fuels. Total biofuel consumption reaches 2.8 quadrillion Btu (29.7 billion gallons) in 2030 in the revised *AEO2008* reference case, 2.3 quadrillion Btu (24.4 billion gallons) more than in 2006. This represents about 11.3 percent of total motor vehicle fuel, on a Btu basis, in 2030.

Total consumption of natural gas increases from 21.7 trillion cubic feet in 2006 to 23.9 trillion cubic feet in 2016, then declines to 22.7 trillion cubic feet in 2030 (**Figure 5**).

Industrial natural gas use is lower than in previous *AEO*s because of the higher delivered natural gas prices, lower economic growth, and a reassessment of natural gas use in the energy-intensive industries in *AEO2008*. Under current laws and regulations, natural gas is expected to lose market share to coal in the electric power sector as result of a continued increase in natural gas prices in the latter half of the projection and slower growth in electricity demand.

Total coal consumption increases from 22.5 quadrillion Btu (1,114 million short tons) in 2006 to 30.1 quadrillion Btu (1,557 million short tons) in 2030, growing by 1.2 percent per year. Coal consumption grows at a faster rate toward the end of the projection period, particularly after 2020, as coal use for new coal-fired generating capacity grows rapidly. About 91 percent of the coal is currently used for electricity generation. Coal remains the primary fuel for electricity generation and its share of generation (including end-use sector generation) is expected to increase from about 49 percent in 2006 to 54 percent in 2030. Growth in coal use by coal-to-liquids (CTL) plants is lower than in previous *AEO*s as a result of EISA2007. Investment dollars that would have previously gone into CTL capacity now flow to biomass-to-liquids (BTL) capacity. However, there is a great deal of uncertainty about this projection.

Total electricity consumption, including both purchases from electric power producers and on-site generation, grows from 3,814 billion kilowatthours in 2006 to 4,974 billion kilowatthours in 2030, increasing at an average annual rate of 1.1 percent (**Figure 6**). In comparison, electricity consumption grew by annual rates of 7.3 percent, 4.2 percent, 2.6 percent, and 2.3 percent in the 1960s, 1970s, 1980s, and 1990s, respectively. The most rapid growth (1.7 percent per year) occurs in the commercial sector, as building floorspace is expanded to accommodate growing service industries. Growing use of electricity for computers, office equipment, and small electrical appliances is partially offset in the *AEO2008* reference case by improved energy efficiency.

Total marketed renewable fuel consumption grows by an average of 3.0 percent per year in the reference case, from 6.8 quadrillion Btu in 2006 to 13.7 quadrillion Btu in 2030. About 45 percent of the demand for renewables in 2030 is for grid-related electricity generation (including combined heat and power), and the rest is for dispersed heating and cooling, industrial uses, or transportation uses.

The rapid growth in the use of renewable fuels for transportation in *AEO2008* reflects the updated RFS in Section 211(o) of the Clean Air Act as amended by EISA2007. The updated RFS sets a requirement for 36 billion gallons of total renewable fuels by 2022, including 21 billion gallons of advanced biofuels. Included are requirements for 1 billion gallons of biodiesel by 2012 and 16 billion gallons of cellulosic biofuels, both of which count toward the advanced biofuels requirement. The remaining 4 billion gallons of advanced biofuels may come from any source. The difference between advanced biofuels and total renewable fuels may be met by corn ethanol. Diesel fuels that are derived from biomass feedstocks count 1.5 times their physical volume as credits towards meeting the RFS requirements owing to diesel's higher energy content relative to ethanol.

While the situation is very uncertain, the current state of the industry and our present view of projected rates of technology development and market penetration of cellulosic biofuel technologies suggest that available quantities of cellulosic biofuels prior to 2022 will be insufficient to meet the new RFS targets for cellulosic biofuels, triggering both waivers and a modification of applicable volumes as provided for by paragraphs 7(D) and 7(F), respectively, of Section 211(o) of the Clean Air Act as amended by EISA2007. The modification of volumes reduces the overall target in 2022 from 36 billion gallons to 32.5 billion gallons. The modified cellulosic biofuel requirement is projected to be met by a combination of domestic cellulosic ethanol, imported cellulosic ethanol, and biomass-to-liquids diesel, but the specific mix is again highly uncertain.

Ethanol use grows from 5.6 billion gallons in 2006 to 24.3 billion gallons in 2030 (over 16 percent of total gasoline consumption by volume) (**Figure 7**). Ethanol use for gasoline blending grows to 13.3 billion gallons and E85 consumption to 11.0 billion gallons in 2030. The ethanol supply is expected to be produced from both corn and cellulosic feedstocks, with corn accounting for 15.0 billion gallons of ethanol production in 2030. The *AEO2008* reference case also expects strong growth in ethanol imports after 2010, reflecting the pending expiration of the tariff on imported ethanol in January 2009. Biodiesel use reaches 1.3 billion gallons in 2030 (about 1.6 percent of total diesel consumption by volume). Consumption of diesel liquids produced from biomass (BTL) grows to 4.2 billion gallons in 2030, 4.9 percent of total diesel consumption by volume.

Excluding hydroelectric power, renewable energy consumption for electric power generation grows from 0.9 quadrillion Btu in 2006 to 3.1 quadrillion Btu in 2030. The higher level of nonhydroelectric renewable energy consumption in the *AEO2008* reference case primarily reflects a revised representation of State renewable portfolio standard (RPS) programs, which require that specific and generally increasing shares of electricity sales be supplied by renewable resources such as wind, solar, geothermal, and sometimes biomass or hydropower. Previous *AEO*s placed more weight on the "escape clauses" incorporated in many State RPS programs, given that the consumer costs of these programs would increase significantly if the Federal production tax credit (PTC) for qualifying renewable energy expired as provided for under current law. The new representation, which assumes that the State RPS goals will be met absent a clear contrary indication, results in significant additional growth of renewable generation from wind, biomass, and geothermal resources.

Energy Production and Imports

Net imports of energy are expected to continue to meet a major share of total U.S. energy demand. The increased use of biofuels resulting from EISA2007, much of which is domestically produced, and the reduction in transportation fuel demand due to the new fuel economy standards both serve to moderate growth in energy imports. Higher fuel prices over the projection period also spur increased domestic energy production and moderate energy demand growth, also tempering growth in imports. Furthermore, the net import share of total U.S. energy consumption in 2030 is 27 percent, a decline from the 30-percent share in 2006.

Liquids and Other Petroleum Products. U.S. crude oil production grows from 5.1 million barrels per day in 2006 to a peak of 6.3 million barrels per day in 2018, primarily due to increased production from the deep waters of the Gulf of Mexico and from the expansion of enhanced oil recovery operations in onshore areas supported by higher crude oil prices. Domestic production subsequently declines to 5.6 million barrels per day in 2030, as increased production from new smaller discoveries is inadequate to offset the declines in large fields in Alaska and the Gulf of Mexico (**Figure 8**) Total domestic liquids supply, including crude oil, natural gas plant liquids, refinery processing gains, and other refinery inputs (e.g., ethanol, biodiesel, BTL, and liquids from coal) grows from 8.3 million barrels per day in 2006 to 10.5 million barrels per day in 2030.

The net import share of total liquids supplied, including crude oil and refined products, drops from 60 percent in 2006 to less than 51 percent in 2022, and then increases to 54 percent in 2030 as crude oil imports grow rapidly at the end of the projection to meet liquids demand (**Figure 9**). Net crude oil imports in 2030 are 11.1 million barrels per day in 2030 and net product imports (including net ethanol imports) are 1.3 million barrels per day in 2030.

Natural Gas. Total domestic natural gas production, including supplemental natural gas supplies, increases from 18.6 trillion cubic feet in 2006 to 20.1 trillion cubic feet in 2022 before declining to 19.6 trillion cubic feet in 2030 in the *AEO2008* reference case. While onshore conventional production declines steadily from 6.6 trillion cubic feet in 2006 to 4.4 trillion cubic feet in 2030, lower-48 offshore production grows from 3.1 trillion cubic feet in 2006 to a peak of 4.5 trillion cubic feet in 2017 as new resources come online in the Gulf of Mexico. After 2017, lower-48 offshore production declines to 3.5 trillion cubic feet in 2030. Lower-48 production of unconventional natural gas, particularly gas from shale, is expected to be a key contributor to growth in U.S. natural gas supplies, increasing from 8.5 trillion cubic feet in 2006 to 9.5 trillion cubic feet in 2030. The Alaska natural gas pipeline is expected to be completed in 2020, later than previously anticipated, because of delays in the resolution of issues between Alaska's State government and industry participants.

Net pipeline imports of natural gas fall from 2.9 trillion cubic feet in 2006 to 0.3 trillion cubic feet in 2030 in the *AEO2008* reference case (**Figure 10**), reflecting both resource depletion in Alberta and Canada's growing domestic demand. Total net imports of liquefied natural gas (LNG) to the United States increase from 0.5 trillion cubic feet in 2006 to 2.8 trillion cubic feet in 2030. U.S. LNG regasification capacity increases from 1.5 trillion cubic feet in 2006 to 5.7 trillion cubic feet in 2009 with the addition of six new regasification facilities that are currently under construction (four along the Gulf Coast and two off the coast of New England). Given global LNG supply constraints, overall capacity utilization at the U.S. LNG import facilities is expected to remain below 50 percent through 2030. The future direction of the global LNG market, with many new international players entering LNG markets and strong competition for available supply, is one of the key uncertainties in the *AEO2008* reference case.

Coal. As coal demand grows in the *AEO2008* reference case, U.S. coal production increases at an average rate of 1.0 percent per year (**Figure 11**). On a Btu basis, 60

percent of domestic coal production originates from States west of the Mississippi River in 2030, up from an estimated 49 percent in 2006.

Electricity Generation

Absent new environmental policy initiatives that would serve to accelerate the retirement of existing coal-fired power plants, the slowing rate of electricity growth reduces the need for new generating capacity. In the *AEO2008* reference case, the natural gas share of electricity generation (including generation in the end-use sectors) remains between 20 percent and 21 percent through 2017, before falling to 14 percent in 2030 (**Figure 12**). The coal share remains between 48 percent and 49 percent through 2018, before increasing to 54 percent in 2030. Net additions to coal-fired generating capacity in the *AEO2008* reference case total 103 gigawatts from 2006 to 2030, including 4 gigawatts at CTL plants and 30 gigawatts at integrated gasification combined-cycle plants. Given the assumed continuation of current energy and environmental policies in the reference case, carbon capture and sequestration (CCS) technology does not come into use during the projection period.

Nuclear generating capacity in the *AEO2008* reference case increases from 100.2 gigawatts in 2006 to 114.8 gigawatts in 2030. The increase includes 16.4 gigawatts of capacity at newly-built nuclear power plants and 2.7 gigawatts expected from uprates of existing plants, partially offset by 4.5 gigawatts of retirements. Total electricity generation from nuclear power plants grows from 787 billion kilowatthours in 2006 to 917 billion kilowatthours in 2030 in the *AEO2008* reference case, accounting for about 18 percent of total generation in 2030. Additional nuclear capacity is built in some of the alternative *AEO2008* cases, particularly those that project higher demand for electricity or even higher fossil fuel prices.

The use of renewable technologies for electricity generation is stimulated by improved technology, existing State RPS programs, the availability of the renewable production tax credit for eligible generation placed in service before the end of 2008, and higher fossil fuel prices. Total renewable generation in the *AEO2008* reference case, including combined heat and power (CHP) and end-use generation, grows by 2.2 percent per year, from 385 billion kilowatthours in 2006 to 654 billion kilowatthours in 2030 (**Figure 13**).

Energy-Related Carbon Dioxide Emissions

Carbon dioxide emissions from energy use in the *AEO2008* reference case increase from 5,890 million metric tons in 2006 to 6,859 million metric tons in 2030, an average annual increase of 0.6 percent **(Figure 14)**. The energy-related carbon dioxide emissions intensity of the U.S. economy falls from 520 metric tons per million dollars of GDP in 2006 to 339 metric tons per million dollars of GDP in 2030, an average decline of 1.8 percent per year. Increases in carbon dioxide emissions primarily result from a continued reliance on coal for electricity generation and on petroleum fuels in the transportation sector.

Conclusion

As I noted at the outset, while EIA does not take positions on policy issues, its data, analyses, and projections are meant to assist policymakers in their energy policy deliberations. In addition to the work on baseline projections that I have reviewed this morning, EIA has also recently responded to requests from this Committee and others for analyses of the energy and economic impacts of alternative proposals to limit greenhouse gas emissions and other policy proposals. We look forward to providing whatever further analytical support that you may require on energy-related topics. We believe that such analyses can help to identify both potential synergies and potential conflicts among different energy-related objectives that are currently under discussion in this Committee and elsewhere.

This concludes my testimony, Mr. Chairman and members of the Committee. I would be happy to answer any questions you may have.

Figure 1. Energy prices are expected to decline in near term, then rise.

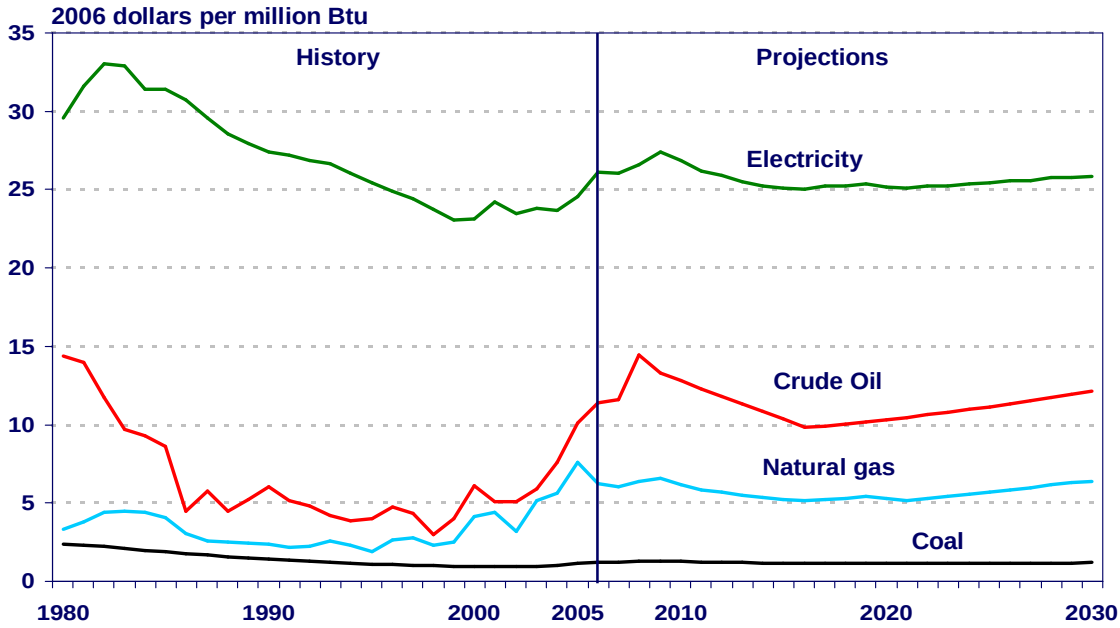

Figure 2. World oil prices are higher in all *AEO2008* cases.

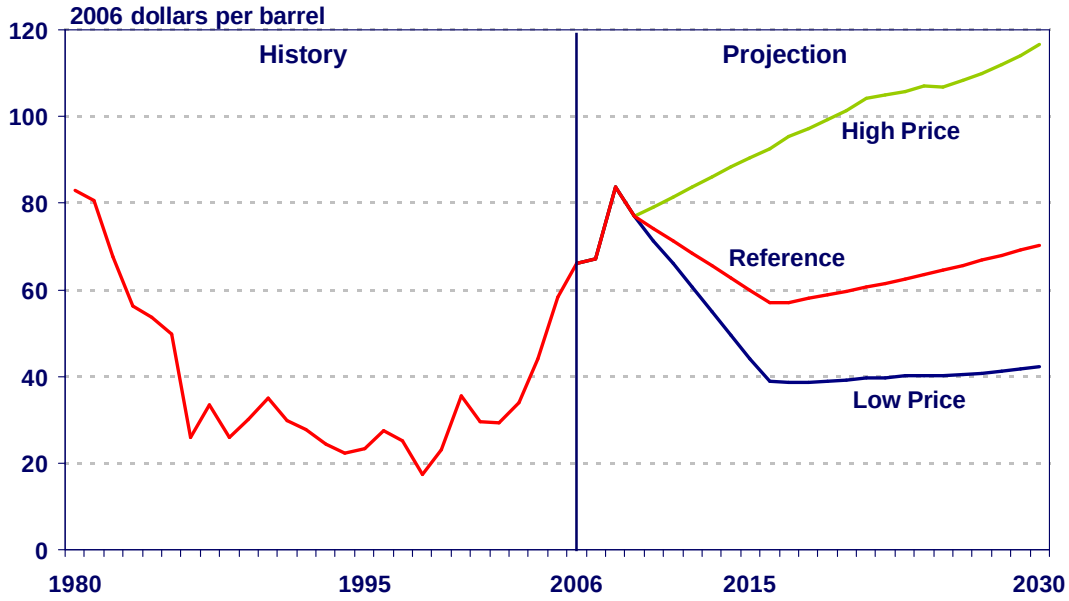

Figure 3. U.S. energy consumption grows slowly.

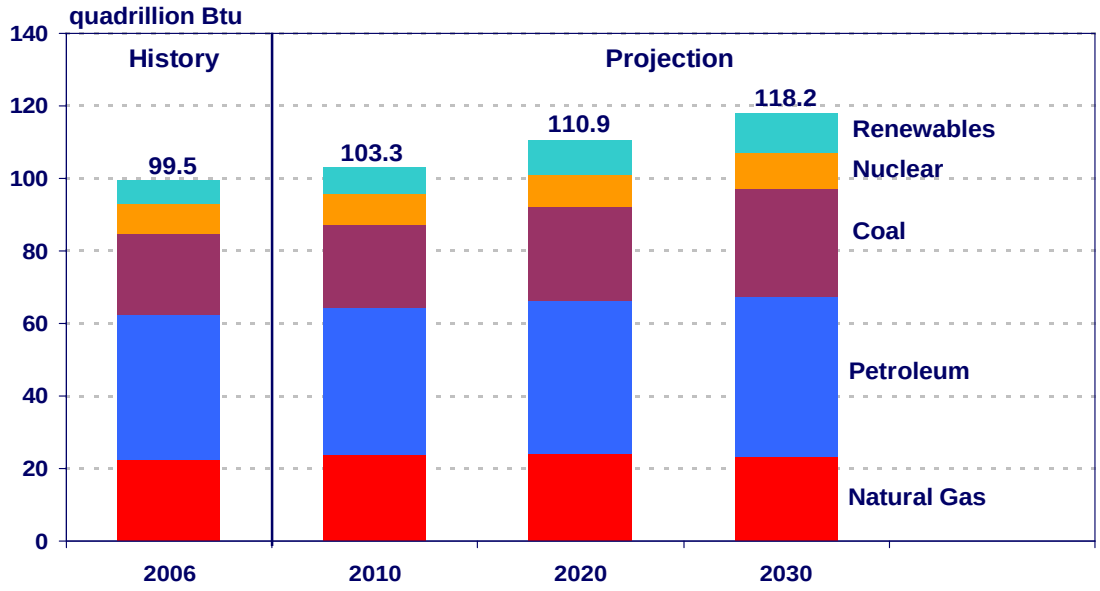

Figure 4. The transportation sector dominates liquid fuel consumption.

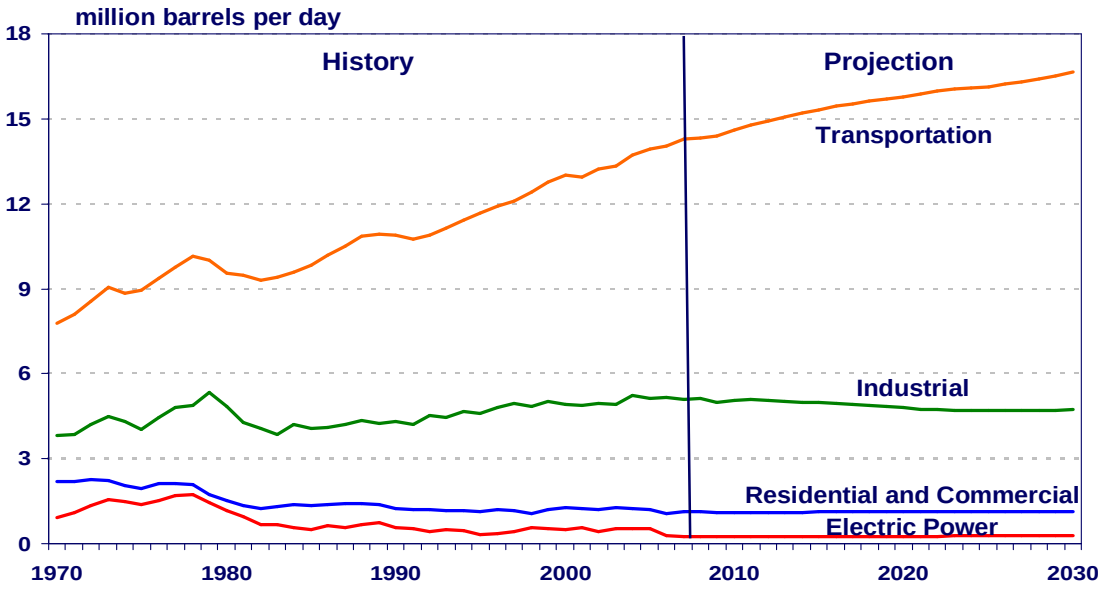

Figure 5. Natural gas consumption grows over the next decade, then declines slowly.

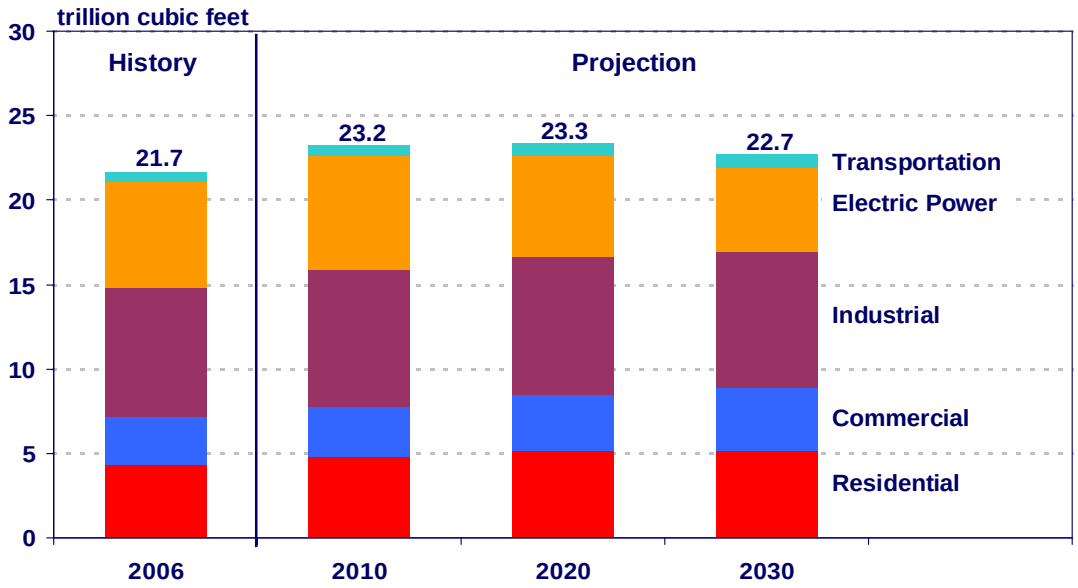

Figure 6. U.S. electricity consumption grows slowly in all sectors.

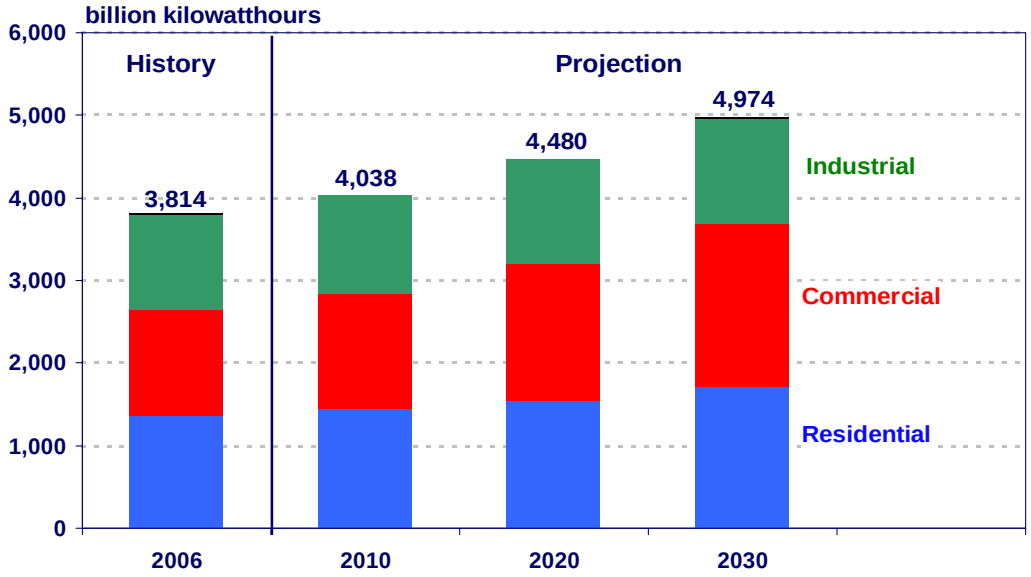

Figure 7. A variety of fuel sources support the renewable fuel standard in EISA2007.

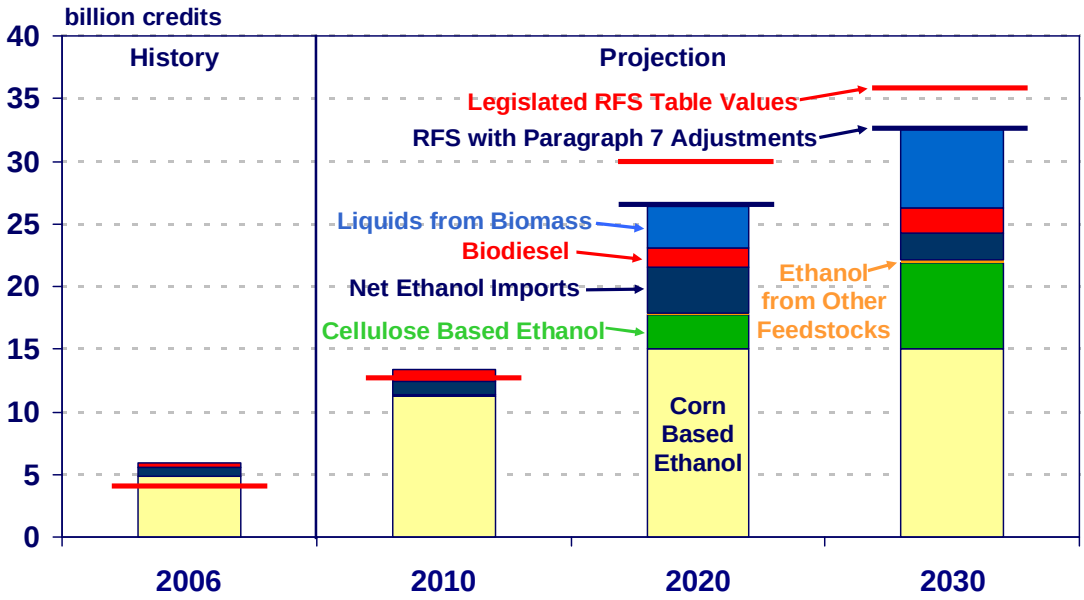

Figure 8. Domestic crude oil production grows in the near term.

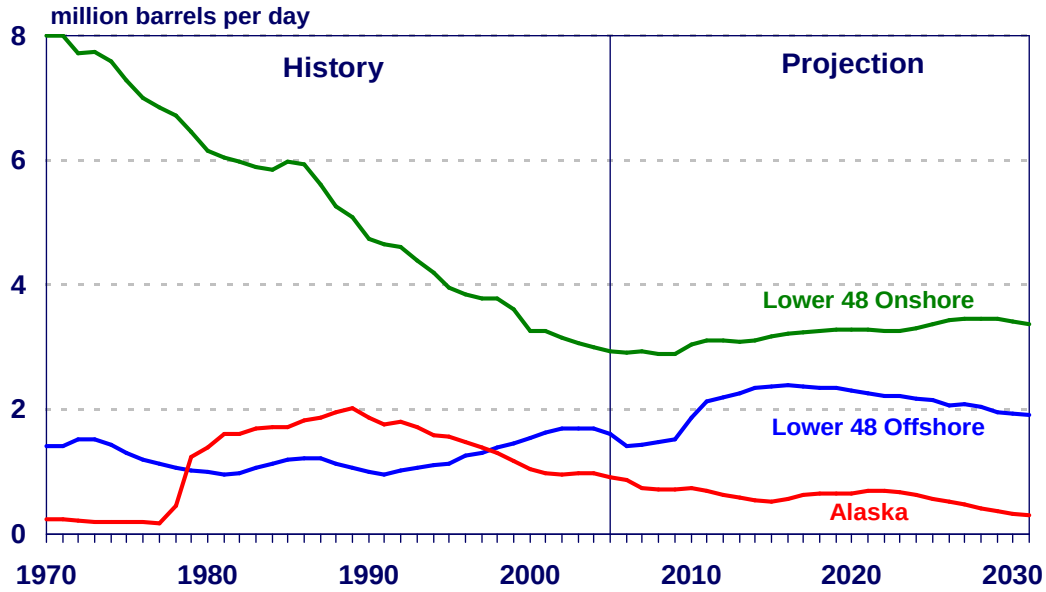

Figure 9. The import share of net liquids use falls from it current level.

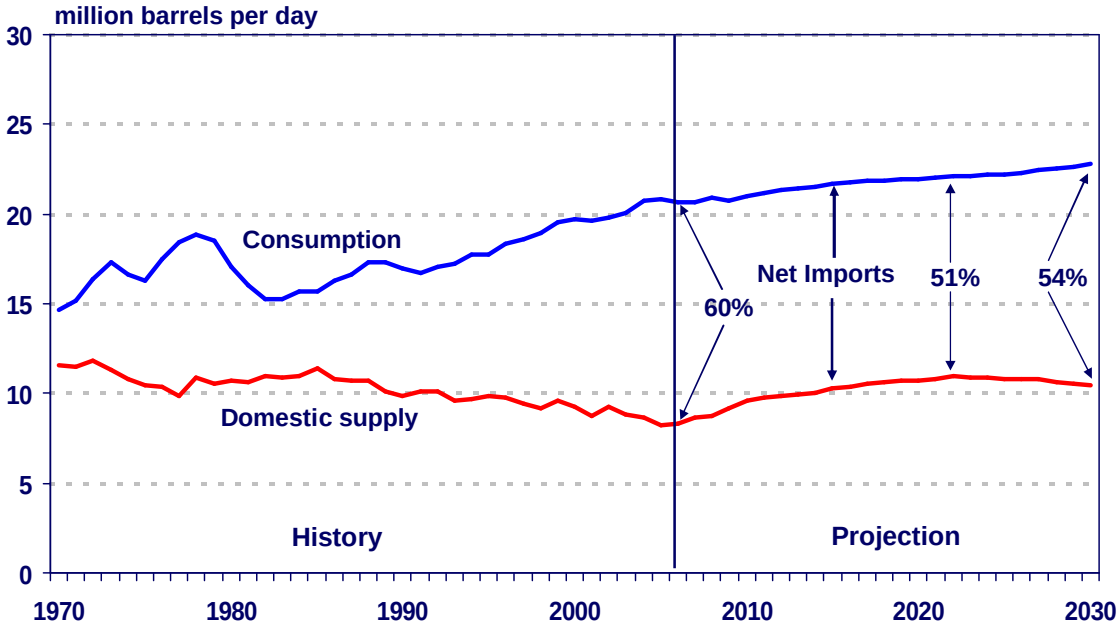

Figure 10. Net pipeline imports decline and LNG imports grow.

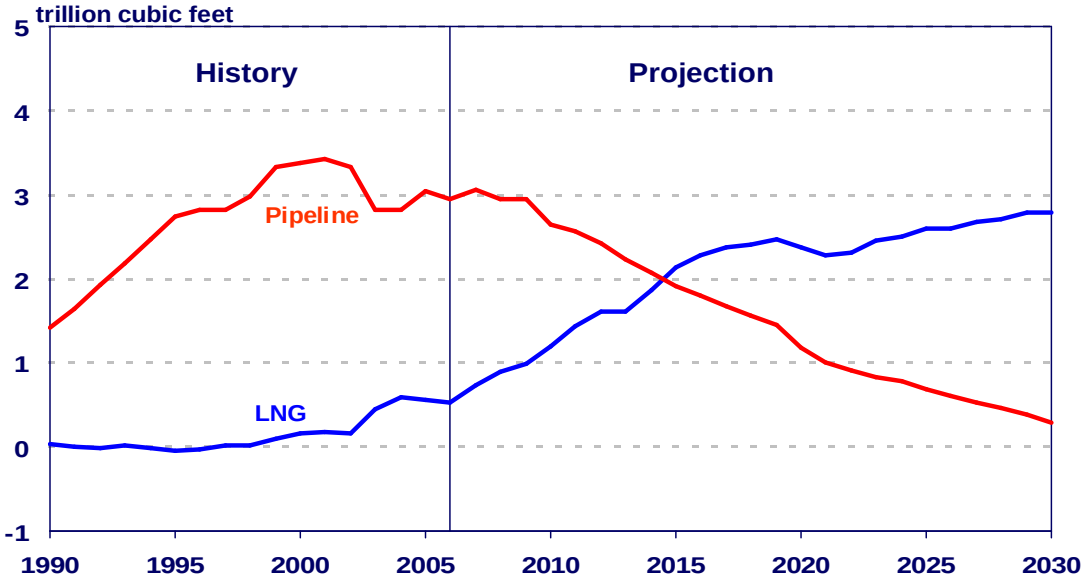

Figure 11. U.S. coal production continues to shift to the West.

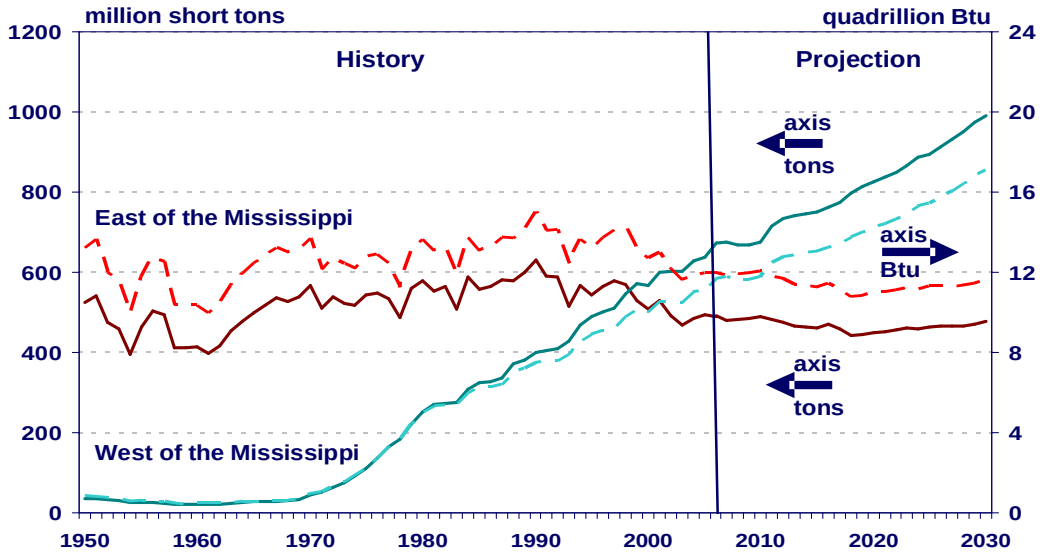

Figure 12. Natural gas generation offset by growth in coal, nuclear and renewables.

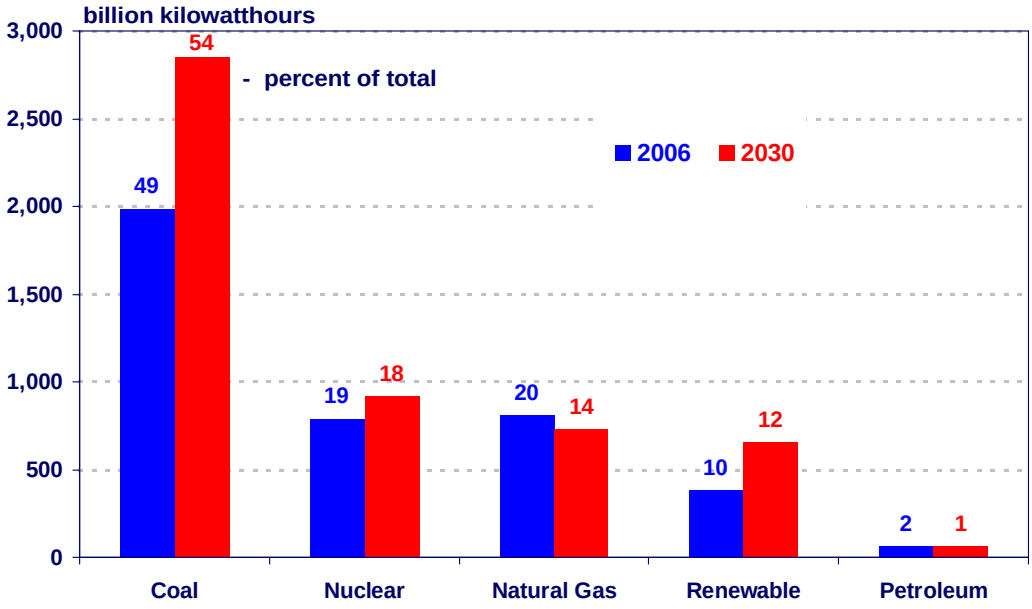

Figure 13. The strongest growth in renewable generation is in biomass and wind.

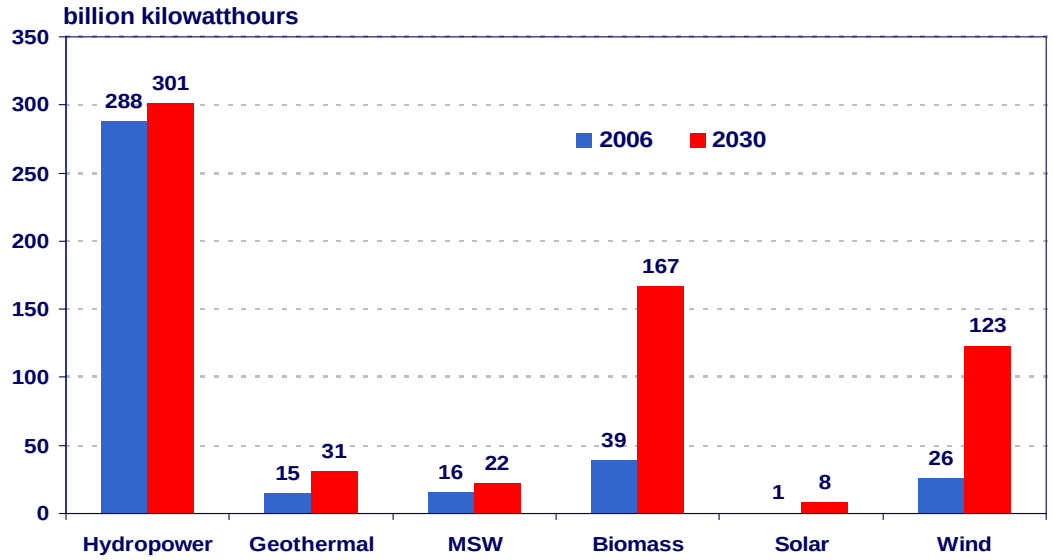

Figure 14. Total CO_2 emissions grow at slower rate.