



Independent Statistics & Analysis
U.S. Energy Information
Administration

Trends and Expectations Surrounding the Outlook for Energy Markets

August 2020



This report was prepared by the U.S. Energy Information Administration (EIA), the statistical and analytical agency within the U.S. Department of Energy. By law, EIA's data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government. The views in this report should not be construed as representing those of the U.S. Department of Energy or other federal agencies.

Table of Contents

- Introduction and Overview 4
- Macroeconomic Sector 6
 - Short Term (2020–2021) 6
 - Medium to Long Term (2022–2050) 6
- Demand..... 7
 - Transportation 7
 - Short Term (2020–2021) 7
 - Medium to Long Term (2022–2050) 8
 - Buildings..... 9
 - Short Term (2020–2021) 9
 - Medium to Long Term (2022–2050) 9
 - Industrial..... 10
 - Short Term (2020–2021) 10
 - Medium to Long Term (2022–2050) 10
- Electric Power Sector 11
 - Short Term (2020–2021)..... 11
 - Medium to Long Term (2022–2050)..... 11
- Oil and Natural Gas Supply 12
 - Short Term (2020–2021)..... 12
 - Medium to Long Term (2022–2050)..... 13
 - Biofuel Supply 13
- Petroleum Trade 14
 - Short Term (2020–2021)..... 14
 - Medium to Long Term (2022–2050)..... 14
 - Refinery Runs 14
 - Net Imports 14
- Liquefied Natural Gas Exports 15
 - Short Term (2020–2021)..... 15
 - Medium to Long Term (2022–2050)..... 15
 - LNG Export Capacity..... 15

U.S. LNG Global Competitiveness	15
Expected LNG Export Volumes.....	15
Coal Supply, Consumption, Exports, and Prices.....	16
Short Term (2020–2021).....	16
Coal Supply and Consumption	16
Coal Trade	16
Coal Prices	16
Medium to Long Term (2022–2050).....	16
Coal Supply and Consumption	16
Coal Trade	17

Introduction and Overview

Creating energy market forecasts and projections for the short term, medium term, and long term is always a challenging task, and the current events caused by the global response to the COVID-19 pandemic are having broad impacts on macroeconomic activity, in general, and energy markets, in particular, that make creating these forecasts and projections all the more challenging. Some uncertainties are unavoidable in any forecast or projection, but the current environment heightens these uncertainties and creates additional issues that greatly complicate the analytic landscape.

To address these elevated challenges facing the upcoming *Annual Energy Outlook 2021* (AEO2021) cycle, the U.S. Energy Information Administration (EIA) conducted an intensive internal review to identify key issues to consider when developing the AEO2021 Reference case. One key aspect of this review was reconciling current and near-term market conditions, which directly affect EIA's *Short-Term Energy Outlook* (STEO) results, with the related uncertainty and modeling limitations in the long-term National Energy Modeling System (NEMS). This EIA document summarizes the issues identified in each time frame, and it places them into the context of energy sector analysis requirements. This framework forms the basis of EIA's developing analytic view of the potential impact that COVID-19 and its mitigation efforts may have on energy markets, and it represents a jumping-off point for upcoming EIA activities. It also serves to inform the public and EIA stakeholders and establish a common basis for analysis, discussion, and risk management.

COVID-19 and its mitigation efforts are significantly affecting energy demand in the short term and could continue to do so in the medium and even long term. Although many of the effects stem from a rapidly shifting economic situation, other non-macroeconomic energy sector specific factors are also changing. EIA assesses the impact and uncertainty of macroeconomic drivers on future energy market behavior, as well as mid- and long-term expectations of energy supply and demand in a post-pandemic world. Macroeconomic drivers do not always capture these expectations adequately, so specific NEMS modules may have to be modified to more fully represent longer-term energy market changes induced by COVID-19.

Macroeconomic activity is a critical driver of energy market dynamics; one of the largest sources of uncertainty in EIA's forecasts and projections is always related to the underlying macroeconomic assumptions that underpin EIA's energy market modeling efforts. Reconciling macroeconomic drivers with the deterministic behavior of the NEMS modules is often challenging even in normal business cycles, but the current economic impacts of the COVID-19 pandemic and the global response to it make this challenge far more pronounced. Since first-quarter 2020, when COVID-19 cases began spreading globally and governments began crafting various mitigation efforts to contain the pandemic, the understanding of how responses to the pandemic would impact global economic activity was changing far more rapidly than normal. This unprecedented volatility in macroeconomic activity and related forecasts is likely to continue. Further complicating matters is the issue of possible resurgences of the pandemic if a vaccine remains elusive or containment efforts prove inadequate.

In addition to the underlying macroeconomic outlook's impact on energy market developments, questions are emerging about changing energy use patterns in reaction to COVID-19 in the short,

medium, and long term. The behavior of energy market participants during a transient market disruption is quite different than their response to a longer-run set of changes. Expectations play a crucial role in determining whether and to what degree energy market trends might change in the wake of the pandemic and recovery. EIA modeling and analysis in the longer term is structured around observed data on historic relationships between factors such as prices and income and the decisions that consumers and producers make. A disruption on the scale of the COVID-19 pandemic has no modern precedent. This factor renders energy market projections more vulnerable to unforeseen behavior changes than has ever been the case. Although scenario analysis can offer range estimates for behavioral change, EIA's AEO2021 Reference case remains dependent on assumptions rooted in experience to date. Use of the full range of AEO2021 scenarios has become more important than ever.

In conducting this intensive review of critical issues related to the impact of COVID-19 and its mitigation efforts on energy systems, EIA has worked to identify, categorize, and sort issues among both time frames and energy system elements. The data and assumptions required to quantify potential changes, formulate scenarios, and assess a range of outcomes remain in flux. The current set of key issues may continue to undergo changes as the next months and years play out. Nonetheless, at this juncture, an issue summary, including how the issues affect the energy sector and why they are important, provides a point of departure for EIA and others to evaluate analytic needs. Some of the key issues we considered include:

- Pandemic control measures, especially lockdowns; their duration; and their potential to extend the employment and demand impacts of the current situation
- Pace and level of economic recovery, both domestic and globally
- Effects of governmental stimulus and corporate-sector wage support on investment patterns
- Sector- and activity-specific demand changes across the entire energy system
- Potential persistence of people's behavioral changes, along with acceleration or deceleration of trends in employment, travel, trade, and consumption of goods and services
- Market pricing, from short-run shocks and disruptions through medium-term equilibration and long-term implications
- Changes to the U.S. energy import/export balance, including petroleum, other liquids, natural gas, electric power, and coal trade
- Impacts on the developing global and U.S. liquefied natural gas (LNG) markets
- Production responses, capital investment, and production trends for upstream oil and natural gas firms
- Changing refinery product demands and responses
- Electric power system operations, shifts in timing and levels of demand, and impacts on markets and rates
- Electric power generation decisions, including unit additions and retirements
- Environmental implications for system inputs, outputs, and regulatory requirements

The body of this report evaluates issues facing the major elements of the energy system through a short-, medium- and long-term lens, acknowledging the uncertainty for the outlook of these elements given the current environment.

Macroeconomic Sector

EIA uses IHS Markit's model of the U.S. economy to provide the major economic variables in the short term for the *Short-Term Energy Outlook* (STEO) and in the medium and long term for the *Annual Energy Outlook* (AEO). Both STEO's and AEO's energy modules are strongly linked to macroeconomic variables, and these variables are fundamental determinants of energy demand used by EIA's energy modules. EIA also has internal modules that produce industry output and employment by industry, tailored to the needs of EIA's long-term energy demand modules. In addition, EIA's model reflects EIA's analysis of energy market dynamics, such as world oil prices, which may differ from assumptions used by IHS Markit.

Short Term (2020–2021)

Response to the COVID-19 pandemic has caused a significant economic shock. Strict pandemic containment and social distancing measures curtailed consumer spending, and service sectors, which account for a large share of U.S. economic activity, were particularly affected as a result. Because economic production dropped sharply, many workers lost their jobs, pushing unemployment rates to high levels. The wide reach of the pandemic has disrupted global supply chains and trade and caused international financial market turbulence, leading to unprecedented fiscal and monetary policy actions. Considerable uncertainties still surround the pace, timing, and recovery from the COVID-19 virus and the future development of a vaccine and treatment. These uncertainties create challenges to developing a robust macroeconomic outlook. IHS Markit's economic forecasts have been subject to major updates in recent months as a result of the sudden and rapidly evolving COVID-19-related economic situation. Additional future revisions to monthly releases remain possible, depending on how efforts to reopen states proceed and the rate at which testing and reporting of new COVID-19 cases develop. Using IHS Markit's forecast in the July STEO, EIA assumes U.S. gross domestic product (GDP) will decline by 8.2% in 2020 before rising 5.1% in 2021.

Medium to Long Term (2022–2050)

The uncertainties surrounding the pace and timing of economic recovery associated with the trajectory of COVID-19 and the future development of a vaccine and treatment are perhaps most prominent in the short and medium term, but these pandemic-related variables may affect economic projections in the long term as well. If IHS Markit further revises its economic outlook, it could affect all time horizons.

Macroeconomic variables have large effects on domestic energy consumption in EIA's energy demand models (Commercial, Residential, Industrial, and Transportation). Some examples of important medium- and long-term variables for energy demand modules include commercial floorspace (Commercial sector); energy intensive sector gross output (Industrial sector); and disposable income, employment, new vehicle sales, and gross output (Transportation sector). Smaller effects for the supply and conversion models are also present; for example, lower interest rates may cause energy infrastructure to be constructed earlier than we previously projected.

Beyond simply using new macroeconomic projection data, several areas where a more fundamental change in modeling the relationships between economic activity and energy markets, such as consumer behaviors, could affect model outputs. For example, projected lower light-duty vehicle sales by the

macroeconomic module implies that scrappage rate assumptions may need to be adjusted in the Transportation model. Commercial floorspace is currently driven by factors such as consumer spending, disposable income, and population, among others, but we may need to adjust these relationships if consumer behaviors and preferences have changed.

Demand

Fuel consumption projections determined in the short term by STEO and in the medium and long term in the AEO NEMS demand models (Commercial, Residential, Industrial, and Transportation) depend heavily on the macroeconomic drivers, which in turn are derived from IHS Markit's macroeconomic forecast. Macroeconomic projections across all time horizons continue to be uncertain. In addition, fuel prices are also an important determinant of energy use in the demand models.

Projecting changes in fuel demand resulting from COVID-19 and its mitigation efforts beyond changes in macroeconomic variables or fuel prices requires implementing changes within the demand models, including updates to determinants, assumptions, and model structure. Describing the many factors that could be influenced by COVID-19 and its mitigation strategies allows the demand models to assess the need as well as the feasibility of implementing post-pandemic projected energy consumption changes in AEO2021.

The impact of COVID-19 and its mitigation efforts on fuel demand projections both in the medium and long term is highly uncertain. Uncertainties include the duration of COVID-19 health concerns, state and local safety restrictions, treatment effectiveness, and the timing of a potential vaccine. The impact of these factors on business and consumer's willingness and ability to resume pre-COVID-19 employment, shopping, and travel behaviors will largely determine the potential energy demand impacts. Resurgence of the pandemic could further erode confidence and begin to permanently change consumption patterns, employment, and travel behavior. In addition, the degree to which working from home, online shopping, and restaurant dining behaviors persist as the pandemic subsides will be key determinants of the long-term impacts. Behavior during market disruptions is a historically poor indicator of longer-term expectations, but the unprecedented scale of the pandemic-related disruptions increases the likelihood of permanent changes in people's behavior.

Transportation

Short Term (2020–2021)

In the short-term, STEO assumes significantly lower levels of U.S. liquid fuels consumption during much of 2020. COVID-19 and measures to contain it have disrupted economic and business activities and reduced all forms of travel. These impacts are likely to be most pronounced during the second quarter of 2020, when the most containment measures and wide-scale reductions in business and travel activity were in place. EIA expects negative demand impacts to persist through most of 2020, but in the second half of 2020, STEO forecasts liquid fuels consumption to gradually increase from second-quarter levels as some business activity resumes and stay-at-home orders gradually ease. EIA analyzes these short-term reductions in liquids demand by evaluating three main drivers: lower economic growth, less air travel, and other declines in demand not captured by these two categories, largely related to reductions in travel because of stay-at-home orders.

Medium to Long Term (2022–2050)

For the medium term, transportation energy consumption is likely to continue to be negatively affected by the pandemic, especially for light-duty vehicles (LDV), freight modes, and air passenger travel. In the long term, the continued effects of COVID-19 and its mitigation efforts on transportation energy demand are more uncertain.

Macroeconomic inputs are important drivers of transportation energy demand, especially travel demands. For example, vehicle miles traveled (VMT), freight movement, and air passenger miles traveled (PMT) are major determinants of LDVs, freight, and aircraft energy demand and are driven primarily by macroeconomic variables, although fuel prices are important as well.

Our expectations of medium- and potentially even long-term transportation fuel demand may not be fully represented by changes in macroeconomic indicators alone and so would require, where possible, adjustments within the Transportation Demand Module. Some examples include:

- In the medium term, jet fuel will likely have a net negative adjustment because travelers are switching to light-duty vehicles when possible and because large events (conference, sporting, and educational events) will increasingly become virtual. In the longer term, EIA expects that air travel demand will be the slowest to recover and will take the longest to return to previous operations, which could reduce the long-term level of jet fuel demand. However, modified passenger air travel could increase the energy intensity of fuel use per passenger. For example, the load factor, a measure of the capacity utilization on an aircraft, could become lower in the long term, increasing the energy use per passenger mile traveled. Furthermore, lower oil prices reduce incentives for improving energy efficiency.
- Gasoline will likely see net decrease over the medium term, primarily as a result of the effect of increased working from home on VMT. However, gasoline consumption's net effect is the most uncertain because it also depends on mode switching as well as changes in people's behavior. Continuing the current level of working from home and online shopping behaviors, as well as overall employment growth, will significantly lower VMT and the rate and level of recovery and growth, but the duration of these factors is highly uncertain. Further, shifting from mass transit or other transportation modes to LDVs puts upward pressure on VMT. In the long term, the uncertainty of these factors is even more pronounced when additional factors affecting gasoline use come into play. For example, lower vehicle sales or changes in consumer preferences to keep existing vehicles longer (lower scrappage) could affect vehicle fleet composition and, therefore, fuel consumption. Lower scrappage rates would entail greater fuel consumption as consumers retain older, less fuel-efficient vehicles for longer instead of purchasing newer, more fuel-efficient vehicles. Rental car/truck fleet purchases and use may also decrease, generally reducing overall gasoline consumption.
- Freight fuel use by all transportation modes (trucking, rail, marine, and aircraft) has been hampered by reduced movement of goods and trade, lowering the demand for distillate, a trend that is likely to persist through the medium term. As economies worldwide recover, long-term freight mode energy use will likely rise again, but there may be permanent changes, including loss of investment in new railway equipment, disrupted supply chains that affect logistics, and a noticeable shift of freight truck to parcel movements. Any of these changes may affect long-

term freight mode fuel demand, but it is highly uncertain by how much or in which direction. For example, less investment in new railway infrastructure could mean less future rail energy demand. However, traffic may then shift to trucking, a more energy-intensive mode, which could increase demand. Further, the increase in parcel delivery shipments may result in reduced household LDV energy use, but it could also entail increased freight mode energy use, either gasoline or distillate, depending on the type of truck or the logistical energy tail of the relevant supply chain.

Buildings

Short Term (2020–2021)

The July STEO assumes minor shifts in residential and commercial energy demand as restrictions related to the COVID-19 pandemic result in more people staying at home rather than going to work, shopping at retail establishments, or attending entertainment venues. This shift increases residential heating and cooling demand for a given temperature level as thermostats are set to keep occupants comfortable, affecting both natural gas and electricity consumption. More people at home will lead to more electricity consumption for other uses as well, especially electronics. Forecast mild weather will offset many of these impacts in 2020. Anticipated increases in economic activity and a return to average temperatures in 2021 lead to increases in residential natural gas and electricity use, even with the easing of mitigation efforts.

With fewer people working in commercial buildings, we expect decreases in commercial sector natural gas and electricity demand. A drop in energy demand for lighting and HVAC needs will occur as a result of the effects of lower office occupancy and lower use of other commercial facilities such as restaurants, schools, and movie theaters. In addition, commercial natural gas demand will decrease further in the near term under the assumption that restaurants and other food establishments, which use more natural gas for cooking and for water heating compared with other segments of the commercial sector, will see a particularly high number of closings. In 2021, with the economy recovering and average temperatures expected, commercial electricity and natural gas demand will increase but not to 2019 levels.

Medium to Long Term (2022–2050)

For the medium- and long-term projections, important drivers of energy consumption in the Commercial Demand Module include commercial floorspace, provided by the Macroeconomic Activity Module based on the current IHS Markit forecast, and energy intensity measures. The fuels most affected by changes in buildings energy demands are natural gas and electricity.

Preliminary medium- and long-term projections of commercial floorspace show that it is mostly unaffected by COVID-19 mitigation efforts. However, continued work-from-home arrangements, as well as higher office vacancy rates, could change the relationship between macroeconomic variables and the demand for commercial floorspace (although some commercial buildings, such as hospitals, will be unaffected). Further, EIA expects energy intensities for services to be different in the short to medium term because of COVID-19 mitigation efforts, compared with historical values derived from the *Commercial Buildings Energy Consumption Survey (CBECS)* and *Residential Energy Consumption Survey*

(RECS) data. In the long term, EIA expects little change in residential energy consumption patterns because the COVID-19 mitigation efforts are unlikely to affect previous projections of demographic shifts and population trends.

Industrial

Short Term (2020–2021)

In the short term, among the demand sectors, EIA expects the most significant effects of COVID-19-related natural gas demand to occur in the industrial sector, both in relative and absolute terms. The STEO forecasts industrial demand for natural gas will decrease by 8% in 2020 compared with 2019. This decline reflects reduced economic activity (captured as a lower forecast natural gas-weighted manufacturing index through June 2020) and a slow recovery in natural gas-weighted manufacturing activity thereafter. Industrial demand for natural gas is particularly sensitive to macroeconomic conditions. The level and pace of the forecast economic contraction and the subsequent expected economic recovery significantly affect industrial demand for natural gas.

Demand for other fuels will also decrease in the short term in the industrial sector. Utilization in the primary metals industry declined sharply this spring, and as a result, EIA forecasts coal consumption and purchased electricity demand to decrease in 2020, with modest recovery in 2021. Declines in metal-based durables and cement production also affect electricity and coal demand in the short term. Chemicals production decreases as well in 2020, resulting in a decrease in feedstock consumption of hydrocarbon gas liquids (HGL).

Medium to Long Term (2022–2050)

For medium- and long-term projections, the major driver of industrial energy consumption in the Industrial Demand Module is the gross output (value of shipments) projection, which is provided by the Macroeconomic Activity Module. In particular, energy intensive industries have the greatest effect on industrial sector fuel consumption, and non-energy intensive industries (for example, transportation equipment and machinery) gross output has less influence on overall industrial energy consumption.

As with the other demand sectors, EIA expects energy consumption in the industrial sector to be influenced by forces beyond the macroeconomic drivers and fuel prices that are provided by other NEMS modules. In general, over the short to medium term, lower utilization in the industrial sector should increase energy intensity, but this factor is difficult to model explicitly. For more specific industries, EIA expects the response to the pandemic to further highlight the already existing overcapacity of crackers in the United States, which lowers liquid (feedstock) consumption in the medium and even long term, a factor we can model in the Industrial Demand Module. EIA also expects the primary metals industry, which have experienced heavy idling of capacity, to further accelerate its push toward using more recycled metals, away from the more energy-intensive virgin metal production. Shifting to more recycled-base metal production should lead to overall lower energy fuel consumption.

Electric Power Sector

Short Term (2020–2021)

Electricity supply in the short term is highly uncertain because of rapidly changing economic conditions. In the July STEO, total electric power generation declines 6% in 2020 compared with 2019 before rising modestly by less than 1% in 2021, which reflects the overall decline in power demand that remains lower than pre-COVID-19 levels.

In addition to the uncertainty in electricity demand, the status of component supply chains and the construction workforce are likely to affect the building of new generating capacity in the short term in many areas of the country. This uncertainty has fuel use implications because most of the generating capacity that had been scheduled to come online in 2020 is fueled by renewable energy sources—including solar and wind—and by natural gas. STEO represents these impacts on electricity supply by assuming that some of the generating capacity previously reported to EIA as planned to come online in the next six months will be postponed to sometime beyond the STEO forecast period. Most of these postponements are in solar and wind. As we continue to collect updates for project development activities reported on our surveys, we will revise these assumptions in future STEO forecasts. Natural gas prices also play a role in determining power supply fuel sources, and the short-term effect of the pandemic on prices is discussed under *Oil and Natural Gas Supply*.

Medium to Long Term (2022–2050)

In the medium to long term, utility sector models are affected by power demands and load shapes, macroeconomic variables (such as interest rates and future metals prices), and policy considerations such as the renewable tax credits.

The overall level of power consumption will be affected primarily by any demand changes related to COVID-19 mitigation efforts in the industrial and buildings sectors. The demand modules produce annual projections of electricity demand in NEMS, and assumptions regarding the load shape of specific applications or subsectors are static.

Working from home has already changed hourly consumption patterns, as seen in data from Form EIA-930, shifting the morning peak for the shoulder season lower and later. As we move toward a more single-peaked, summer consumption pattern, load shapes may continue to change. However, these changes in load shape are not likely to have major impacts on model behavior unless deployment of renewable energy and battery storage significantly accelerates in the medium term. A different load shape would change the operation of the system, so solar (and to a lesser extent, wind) might fit into a different operational niche. Plants being planned and built today based on historical consumption (and revenue) patterns might realize a different set of consumption patterns, with resulting differences in the value-of-energy as the system evolves.

Changes in projected macroeconomic conditions could also affect the power industry. Primary effects include interest rates and future metals prices and how they will change the cost of capital for new construction because lower interest rates over an extended period of time favor more capital-intensive investment projects. A possible additional effect is that, to take advantage of current tax credits,

renewable developers must partner with companies that have tax liability. A protracted recession may limit the ability of developers to take advantage of such partnerships.

In 2009, Congress passed a stimulus package (ARRA) that included new incentives for renewable generation. Depending on the length and depth of the current recession, Congress may choose to modify or create new incentives for renewable or other types of electric generation, which would change the incentives to build different types of generation. More broadly, a long-term shift in the electric industry away from less flexible resources (such as coal and nuclear plants that cannot respond quickly to changes in demand) has occurred. The loss in demand and other changes associated with the pandemic may be a precipitating event that triggers large changes in the electric sector that would have otherwise occurred over a longer timescale.

Even after taking into account the impacts discussed above, the U.S. electric power sector is resilient and will not likely fundamentally change operations in the long term. The pandemic does add another layer of uncertainty and risk, and the lack of information and data make it difficult to understand the impacts of COVID-19 mitigation efforts on power generation in the years to come.

Oil and Natural Gas Supply

For both liquids and natural gas, the effects of COVID-19 mitigation efforts are primarily a demand-side shock, with higher impacts for liquids than for natural gas. However, uncertainty surrounding post-pandemic demand expectations for oil and natural gas certainly translates into uncertainties in supply.

The oil and natural gas industry was already headed toward relying on capital from cash flow instead of debt and equity, and it was capital constrained even before the current market turbulence. The current economic downturn has accelerated and exacerbated this trend, leaving producers much more dependent on internal sources of capital because outside sources are less available or may require higher rates of return.

Short Term (2020–2021)

EIA's model for crude oil and natural gas production in the Lower 48 states includes structural parameters that reduce the forecast for rigs and wells when the West Texas Intermediate crude oil price falls lower than \$45 per barrel (b) or the Henry Hub natural gas price falls lower than \$2 per million British thermal units, based on historical trends in each region. In addition to this model-based drop, EIA assumes a further 30% reduction in drilling activity, on average, in the second quarter of 2020 and a 6% reduction in the third quarter of 2020 as a result of low oil prices related to the unprecedented effects of restrictions as a result of COVID-19. Many producers have already announced plans to reduce capital spending and drilling levels.

In the July STEO, EIA expects that the steepest declines in U.S. crude oil production will be in the second quarter of 2020, with forecast month-over-month declines averaging 0.5 million barrels per day (b/d) during those three months. EIA expects production to continue declining, albeit at a slower rate, through March 2021, when production bottoms out at 10.7 million b/d, which would be a 2.1 million b/d decline from the record monthly production reached in November 2019. EIA expects production to rise modestly through the end 2021 in response to rising crude oil prices. EIA forecasts annual average

crude oil production to be 11.7 million b/d in 2020 and 10.9 million b/d in 2021, both of which are about 0.1 million b/d lower than forecast in the April STEO.

Medium to Long Term (2022–2050)

Unlike natural gas prices, oil prices are exogenous to NEMS and are contained within EIA's separately developed world oil price paths, making the AEO2021 Reference case oil price path the primary mechanism representing the expected pace of global demand recovery in the future. This oil price path, along with modeling changes to medium- and long-term demand-side behavior within NEMS, will dictate projected well drilling activity and accompanying U.S. crude oil production rates. In general, EIA expects a lower price path in the short- and medium-term to decrease U.S. oil production rates in that time frame. Overall, if global oil prices are lower in AEO2021, EIA would expect to see lower U.S. domestic production of crude oil.

In the short to medium term, low oil prices may induce less petroleum product demand growth than might be expected, given the potential for longer lasting behavioral changes as well as a large global petroleum inventory. In the medium to long term, if global demand does not recover, the marginal U.S.-produced barrel from new investment is not needed and global demand can be met either by lower cost barrels produced outside the United States or by putting investment dollars back into U.S. wells currently curtailed, which also cost less than new investment projects. Depending on the demand outlook, U.S. oil (and natural gas) investment and production could remain subdued even beyond 2025.

With respect to natural gas, prices could actually increase because, although demand will decline over the short to medium term, associated gas production will also decline with lower oil output. However, the net production effect may be fairly limited because any increase from pure play natural gas regions in response to higher prices will be offset from the declines in associated gas. In addition, the demand concerns that affect oil are just as prevalent for natural gas—international demand for LNG is highly uncertain both in the medium and long term and was even before the effects of COVID-19 containment measures.

In addition, setting aside any resource availability concerns, U.S. natural gas volumes will be determined by future natural gas prices based on the demand for natural gas within the Buildings, Industrial, and Power sectors. Because all three of these consumption sectors may change as a result of COVID-19 mitigation efforts in the short, medium, and long term, the consequences for natural gas prices, and by extension domestic natural gas consumption, are uncertain.

Biofuel Supply

In general, we expect impacts on ethanol demand will be similar to those on gasoline demand in the medium to long term. So, E10 and E85 consumption will track VMT in the Transportation Demand Module. However, in the medium term, EIA expects E15 consumption to remain low as a result of a lack of capital to make the necessary infrastructure investments. Biodiesel and renewable diesel should, for the most part, track overall diesel demand and are likely to continue to gain market share.

Petroleum Trade

The COVID-19 outbreak has had an unprecedented effect on global oil demand as people stay home and avoid nonessential travel. Although it remains to be seen how persistent these effects are, worldwide refinery throughput and international oil petroleum trade has been affected by the containment efforts of the pandemic.

Short Term (2020–2021)

In the July STEO, EIA assumes that the decline in U.S. crude oil production in 2020 and 2021, combined with rising U.S. liquid fuels consumption in 2021, results in the United States returning to being a net importer (when a country imports more than it exports) of crude oil and petroleum products in the third quarter of 2020 and remaining a net importer in most months through the end of the forecast period. Petroleum trade in the STEO model is done on a net basis.

Medium to Long Term (2022–2050)

Refinery Runs

Worldwide demand recovery will be the major driver in the medium-term modeling period as a result of the close correlation between finished product demand and refinery throughput. In mid-May, global distillation unit outages were higher than 22 million b/d, and U.S. refinery utilization was approximately 70%. Some refineries determined it was more economic to shut down completely than run at reduced throughput. In weaker refining markets such as Europe, Central America, and the eastern United States, a period of sustained reduction in global demand could result in refinery rationalizations over the next few years. Any changes to the regional refining capacity in Europe or Central America, two of the largest export markets for the United States, could have significant impacts on U.S. petroleum export volumes and compositions in both the medium and long term.

Net Imports

The status of the United States as a net exporter of petroleum products has also been significantly affected by reduced global oil demand and prices. Domestic crude oil production is down 12% since the beginning of the year, and export volumes have remained relatively constant to date, although it remains to be seen whether or not this trend will change because the volumes that are currently in floating storage or en route to a destination are unclear. The number of horizontal shale oil rigs in the United States is down 67% since mid-March. U.S. finished petroleum product exports are also down 23% from mid-March. Although refinery runs have started to recover in recent weeks, the full impact of U.S. crude oil production decreases is not yet known; if refinery throughput recovers before domestic crude oil production, EIA expects downward market pressure on the net import/export balance as refiners adjust.

Finally, with respect to biofuels, the medium- and long-term effects on demand for liquid fuels in the United States' major export markets (Brazil and Europe) are unclear. Any contraction of demand for ethanol in Brazil will affect U.S. ethanol export volumes. European regulators may slow down implementation of higher biofuel requirements, which would further slow down U.S. biofuel exports, at least in the medium term.

Liquefied Natural Gas Exports

Short Term (2020–2021)

Domestic and global impacts from the response to COVID-19 are currently affecting liquefied natural gas (LNG) exports from the United States. The large drop in crude oil prices, reduced international demand for natural gas, the abundance of new LNG supply on the international market, and a drop in domestic associated gas production have resulted in canceled LNG shipments from the United States. These cancellations result in an expected drop in LNG exports from 8.1 billion cubic feet per day (Bcf/d) in January to 4.6 Bcf/d in September 2020. Although EIA expects U.S. LNG exports to reach pre-COVID-19 levels in the second half of 2021, lasting market effects could reduce LNG exports in the medium term compared with the projection in AEO2020.

The July STEO forecast assumes that a combination of lower global natural gas demand as a result of responses to the COVID-19 pandemic and an unfavorable LNG pricing environment will lower U.S. LNG exports, primarily in the second and third quarters of 2020. The declines in forecast LNG exports are largely based on announced and anticipated cargo cancellations: 30–33 cargoes were reportedly canceled in June and 45 in August, with current global natural gas forward pricing suggesting additional continued weakness into the fall. We used an average cargo capacity size of about 3.4 Bcf to determine reductions in exports based on cargo cancellations.

Medium to Long Term (2022–2050)

LNG Export Capacity

From 2022 to 2025, projected levels of U.S. LNG exports are governed by total available export capacity and international oil prices. Because of the long lead times to construct an LNG export facility, we do not expect any unplanned export capacity to be added before 2025, and most planned capacity additions should be completed by the end of 2021. Several proposed LNG export projects have already been canceled or announced delays, and this factor will likely lower the total projected export capacity through 2025.

U.S. LNG Global Competitiveness

EIA expects the world oil price to be lower from 2022 to 2025, which would likely affect the competitiveness of U.S. LNG exports and decrease capacity utilization. A sizeable portion of global LNG shipments are tied to global oil prices on long-term contracts, but U.S. LNG exports are linked to domestic natural gas prices and are traded on the spot market. As oil and non-U.S. LNG prices drop, U.S. LNG exports will face steeper price competition on the global market.

Expected LNG Export Volumes

In AEO2020, EIA projected that LNG net exports would average 9.5 Bcf/d. The combination of lower capacity and lower utilization of existing or planned capacity will result in reduced LNG export levels from 2022 to 2025 in AEO2021 compared with last year. Over the long term, with lower international oil prices, EIA expects LNG exports to be lower, but the other major driver of LNG exports is international demand for natural gas, which remains very uncertain.

Coal Supply, Consumption, Exports, and Prices

Short Term (2020–2021)

Coal Supply and Consumption

U.S. coal production has continued to slow, primarily because of lower demand from coal-fired electric power generation. Some large producers have announced that they will shut down their mines permanently or idle them for periods ranging from 14 to 30 days, while others have not given a date they will resume normal operations. EIA expects that these decreases in overall production will have a noticeable effect on supply, contributing to a steeper decline than would have occurred without these measures.

EIA expects coal consumption to decline in 2020 as a result of an overall decline in coal-fired electricity generation. However, the STEO forecasts that coal consumption will rise in 2021 because of a general economic recovery that will increase overall electricity generation and an expected increase in natural gas prices that will cause some coal-fired generation units to become more economic to dispatch. Secondary stocks (at power plants) remain high, and even with decreased production, coal plants do not expect shortfalls in the next few months. EIA forecasts that industrial consumption will also decline as coal coke demand is slowed by unfavorable market conditions and by significantly decreased raw steel production.

Coal Trade

EIA estimates that U.S. coal exports will decrease through 2020. Atlantic markets, which are the primary outlet for U.S. coal exports, are showing considerably decreased demand because of the global economic slowdown. India, the top destination for U.S. exports, has lowered its demand for both steam and coking coals as a result of nationwide lockdowns. Japan, a large consumer of U.S. coking coal, idled many blast furnaces in the beginning of the second quarter of 2020. COVID-19-related lockdowns affecting large seaborne market suppliers, including Colombia and Indonesia, have dampened global supply, providing some support to international prices but not enough to overcome the decreased demand.

Coal Prices

EIA estimates the delivered coal price to U.S. electricity generators averaged \$2.02 per million British thermal units (MMBtu) in 2019, which was 4 cents/MMBtu lower than in 2018. EIA forecasts that coal prices will decrease in 2020 to \$1.99/MMBtu and increase in 2021 to \$2.04/MMBtu.

Medium to Long Term (2022–2050)

Coal Supply and Consumption

In the electricity market, coal often competes with natural gas as the fuel of choice for incremental electricity production. As EIA looks forward and attempts to model market behavior in the medium-term period (2022–2025), domestic coal consumption and the position of the United States in the global coal market will be highly dependent on how the natural gas market recovers from the demand events of 2020. If natural gas prices return to late-2018 to early-2019 levels, the coal marketplace may benefit as coal-based electricity generation becomes more economically feasible at that time. However, if natural

gas prices stay depressed in the medium term, we expect lower utilization at coal-fired generating plants, further eroding the profitability of these plants.

In the longer term, another challenge facing the coal industry is the recent number of closures; a significant number of coal-fired plants have recently retired. The large change in electricity demand because of COVID-19-related disruptions, as well as increasing economic and environmental pressures, could result in additional coal-fired plant retirements, especially if natural gas prices remain low.

Coal use also depends on the industrial sector, in particular the steel sector, for both metallurgical and thermal coal. Over the medium term as the steel industry recovers, we expect the use of industrial coal to recover as well. However, the closures of blast furnaces could possibly lead to a permanent reduction in industrial coal use because some of these idled blast furnaces may not be restarted again given the uncertainty in future steel demand and recycled steel capacity.

Coal Trade

The viability of U.S. coal exports will largely depend on the response of the natural gas market to recent demand events as well as the demands of the international power market. If natural gas prices recover to earlier levels, U.S. coal consumption would increase, strengthening prices and potentially reducing volumes available for export at competitive prices. Decreased international electric power demand as a result of COVID-19 associated mitigation measures would also result in a decreased demand for exported U.S. coal to the extent that the demand decrease translates to lower netback prices to U.S. coal producers. For example, the U.S. price can be quite high, but if transport rates and destination prices internationally are sufficient, U.S. mining companies will come online to meet the demand, given the role of the United States as a swing provider in global coal markets. However, if natural gas prices stay depressed or international power demand recovers faster than U.S. demand, we would expect relatively lower domestic consumption; in this case, more volume may be available for export, assuming it is still profitable to maintain the production sites.