The July Short-Term Energy Outlook (STEO) remains subject to heightened levels of uncertainty related to the ongoing economic recovery from the COVID-19 pandemic.

U.S. economic activity continues to rise after reaching multiyear lows in the second quarter of 2020 (2Q20). The increase in economic activity and easing of the COVID-19 pandemic have contributed to rising energy use. U.S. gross domestic product (GDP) declined by 3.5% in 2020 from 2019 levels. This STEO assumes U.S. GDP will grow by 7.4% in 2021 and by 5.0% in 2022. We based the U.S. macroeconomic assumptions in this outlook on forecasts by IHS Markit.

Brent crude oil spot prices averaged $73 per barrel (b) in June, up $5/b from May and $33/b higher than in June of last year. In the coming months, we expect that global oil production, largely from OPEC+ members (OPEC and partner nonmember countries), will increase by more than global oil consumption. We expect rising production will reduce the persistent global oil inventory draws that have occurred for much of the past year and keep prices similar to current levels, averaging $72/b during the second half of 2021 (2H21). However, in 2022, we expect that continuing growth in production from OPEC+ and accelerating growth in U.S. tight oil production, along with other supply growth, will outpace growth in global oil consumption and contribute to declining oil prices. Based on these factors, we expect Brent to average $67/b in 2022.

We estimate that global consumption of petroleum and liquid fuels averaged 92.3 million barrels per day (b/d) for all of 2020, down by 8.6 million b/d from 2019. We expect that global liquid fuels consumption will grow by 5.3 million b/d in 2021. In our forecast, global consumption of liquid fuels rises by an additional 3.7 million b/d in 2022 to 101.4 million b/d, which would surpass 2019 levels.

Based on our estimates, global liquid fuels inventories rose by 6.3 million b/d in 1H20 before declining at an average rate of 2.1 million b/d in 2H20 and 1H21. We forecast global inventories will continue to fall in the near term but at a slower rate, with global inventories falling by 0.2 million b/d in 2H21. We then expect inventories to rise by almost 0.5 million b/d in 2022.

U.S. regular gasoline retail prices averaged $2.78 per gallon (gal) in 1H21, compared with an average of $2.20/gal in 1H20. In June, monthly retail gasoline prices averaged $3.06/gal, the first time the monthly average was more than $3.00/gal since October
We forecast regular-grade gasoline prices to average $2.92/gal in 2H21 and $2.74/gal for all of 2022.

- U.S. liquid fuels consumption in 2020 averaged 18.1 million b/d, down 2.4 million b/d (12%) from 2019 consumption. We forecast U.S. liquid fuels consumption will rise to 19.6 million b/d in 2021 and then to 20.7 million b/d in 2022, which would surpass the 2019 level.

- Henry Hub natural gas spot prices averaged $2.03 per million British thermal units (MMBtu) in 2020. We expect Henry Hub prices will rise to an annual average of $3.22/MMBtu in 2021, and we forecast prices will then fall to an average of $3.00/MMBtu in 2022.

- We expect U.S. dry natural gas production to average 92.6 billion cubic feet per day (Bcf/d) in 2021, up by 1.3% from 2020, and then rise to 94.7 Bcf/d in 2022.

- U.S. natural gas consumption averaged 83.3 Bcf/d in 2020, down 2.2% from 2019. We expect that natural gas consumption will decline by 1.1% in 2021 and then grow by 0.7% in 2022. Most of the forecast decline in natural gas consumption this year is the result of less natural gas use in the electric power sector, which we expect to continue to decline because of rising natural gas prices.

- U.S. working natural gas in storage ended the winter withdrawal season in March 2021 at 1.8 trillion cubic feet (Tcf), slightly less than the five-year (2016–20) average. We forecast that flat U.S. natural gas production this summer combined with record U.S. natural gas exports will contribute to slightly lower-than-average inventory builds during the remainder of the summer build season, which ends in October. Forecast natural gas inventories end October 2021 at 3.6 Tcf, which is 3% lower than the five-year average.

- We forecast that U.S. retail sales of electricity will increase by 2.8% in 2021 after falling by 3.9% in 2020. The largest forecast increase in electricity consumption occurs in the industrial sector, driven by rising levels of economic output. We forecast U.S. retail sales of electricity to the industrial sector will grow by 5.1% this year. Retail sales of electricity to the commercial sector also grow in the forecast, but they grow at the slightly slower pace of 2.1% in 2021 as some workers continue working from home instead of in office buildings. We forecast U.S. residential electricity sales will grow by 1.9% in 2021, as a result of colder temperatures in 1Q21 compared with 1Q20 and a hot start to the summer.

- We expect the share of electric power generation produced by natural gas in the United States will average 36% in both 2021 and 2022, down from 39% in 2020. Our forecast for the natural gas share as a generation fuel declines because we expect a higher delivered natural gas price for electricity generators. Because we expect higher natural gas prices, we forecast coal’s generation share to rise from 20% in 2020 to 24% this year.
but to fall to 22% next year. New additions of solar and wind generating capacity support our expectation that the share of U.S. generation from these two energy sources will rise from 11% in 2020 to 15% by 2022. Extreme drought conditions in the West drive our expectation that the share of U.S. generation from hydropower will fall from 8% in 2020 to 6% in 2021 and 7% in 2022. The nuclear share of U.S. electricity generation declines from 21% in 2020 to 20% in 2021 and to 19% in 2022 as a result of retiring capacity at some nuclear power plants.

- The U.S. retail electricity price for the residential sector in our forecast averages 13.6 cents per kilowatthour in 2021, which is 2.8% higher than the average retail price in 2020. Forecast residential prices increase by an additional 1.8% in 2022.

- During the next 18 months, we expect electricity generation capacity from renewable energy sources to continue growing. Our forecast includes both wind and solar capacity growth, and solar capacity grows at a faster rate. Based on our survey data, large-scale solar capacity growth in gigawatts (GW) will exceed wind growth for the first time in 2022.

- We expect U.S. coal production to total 617 million short tons (MMst) in 2021, which is 78 MMst (15%) more than in 2020. Rising electricity demand for coal amid higher natural gas prices is driving this production increase. In 2022, we expect coal production to fall by 7 MMst (1%).

- We forecast that total energy-related carbon dioxide (CO$_2$) emissions will increase by 7.1% in 2021 and by 1.5% in 2022 after declining by 11.1% in 2020. Even with growth over the next two years, forecast emissions in 2022 remain 3.3% lower than in 2019.

**Global Liquid Fuels**

*Global Petroleum and Other Liquid Fuels Consumption.* Based on preliminary data and estimates from 1Q21, as well as our assumptions of continued economic recovery, we forecast consumption of global petroleum and other liquid fuels will grow by 5.3 million b/d in 2021. This growth follows a decline of 8.6 million b/d in 2020. Forecast growth in global oil consumption of 3.7 million b/d in 2022 would bring global oil consumption to 101.4 million b/d, which would be 0.4 million b/d higher than in 2019. Our global economic growth forecasts come from Oxford Economics, which forecasts GDP in 2021 will increase by 6.3% and by 4.8% in 2022, compared with a decline of 3.4% in 2020.

We expect oil demand growth in 2021 to be fairly evenly split between the OECD and non-OECD. OECD oil demand grows by 2.5 million b/d, and non-OECD demand grows by 2.8 million b/d. Our forecast assumes that business activity and travel will continue to increase throughout 2021 and into 2022. For 2021, in addition to rising economic activity, oil consumption growth is driven by reopening economies and a return to travel patterns more similar to pre-pandemic norms. In 2022, economic growth alone becomes the main driver of oil consumption growth.
We expect U.S. liquid fuels consumption in 2021 to rise by 1.5 million b/d from 2020, making it the largest contributor to global consumption growth in the forecast. Since the beginning of 2021, some of the most significant increases in our expectations for oil demand have been for Europe. Strict travel restrictions imposed by many of the European OECD countries in 1Q21 gradually eased in the second quarter as a result of successful large-scale vaccination campaigns. As a result, Europe has experienced a significant increase in economic activity in 2Q21 as capacity limits and restrictions on mobility and non-essential business activity have either been reduced or eliminated. We estimate that 2Q21 liquid fuels consumption in OECD Europe was up 1.8 million b/d from the same period in 2020, contributing to our expectation that liquids consumption in OECD Europe will be up 0.5 million b/d for all 2021 compared with 2020.

Oil consumption growth in many of the non-OECD regions remains more uncertain. Large-scale vaccination campaigns in Asia, Latin America, the Middle East, and Africa have been relatively slower—with some exceptions—than in Europe and the United States. Outbreaks of COVID-19 infections and the re-imposition of restrictions on mobility and business activity still pose a significant downside risk in these regions. In 1H21, Malaysia, Thailand, and Vietnam, where a majority of the populations remain unvaccinated, imposed mobility and business activity restrictions after experiencing large outbreaks of COVID-19 infections.

In addition, the spread of COVID-19 variants and the effectiveness of the vaccines against these variants are significant risk factors to a full and sustained global recovery. India experienced its worst outbreak of COVID-19 infections in 2Q21 when the Delta variant spread, which is reportedly more virulent and contagious than other variants, and the outbreak led to a sharp reduction in economic activity from which the country is now slowly recovering. If the vaccines currently available are not effective against the Delta or other variants, countries will have to continue to rely on mobility and activity restrictions to mitigate the spread, which will lead to a longer, more drawn-out return in global oil demand.

For 2021, we forecast liquid fuels consumption in India to grow by 0.3 million b/d (6%), consumption in China to grow by 0.9 million b/d (6%), and consumption in the rest of non-OECD to grow by 1.7 million b/d (5%).

**Non-OPEC Production of Petroleum and Other Liquid Fuels.** Following a 2.5 million b/d decrease in 2020, with declines extending into 1Q21, we estimate that non-OPEC liquid fuels production increased by 2.6 million b/d in 2Q21 from 2Q20. Almost three quarters of this increase came from two non-OPEC producers: the United States and Russia. We expect non-OPEC production to rise by 1.1 million b/d in 2021 and by 3.1 million b/d in 2022. We expect Canada and Brazil to lead non-OPEC production growth in 2021 and the United States and Russia to lead growth in 2022.

We expect Canada’s production of petroleum and other liquid fuels to increase by more than 0.3 million b/d in 2021, which would make it the leading source of non-OPEC liquid fuels supply...
growth this year. Despite heavier-than-normal turnarounds at a number of oil sands projects in 1H21, we forecast Canada’s production to reach new record highs in 2H21. Output growth in 2021 is driven by increasing refinery demand for crude oil in the United States, the end of Canadian government-ordered curtailments, and the restart of oil sands expansion projects that were deferred during 2020. We do not expect any new upstream projects to come online in Canada during the forecast period. Forecast crude oil production growth comes from expansions or debottlenecking of existing projects.

In January 2021, President Biden revoked the presidential permit authorizing the construction of the Keystone XL pipeline, and in June 2021, owner TC Energy officially canceled the project. The pipeline would have expanded Canada’s crude oil export capacity to the United States by 830,000 b/d. The cancellation of the Keystone XL does not materially affect our production outlook for Canada, and we expect Canada’s pipeline export capacity will be adequate through the end of the forecast period. Enbridge’s Line 3 replacement (370,000 b/d) will come online at the end of 2021, the TransMountain expansion project (590,000 b/d) in 2022, and additional Enbridge expansion and optimizations to its existing pipeline system can bring more than 400,000 b/d of increased export capacity over the forecast period. Forecast production in Canada grows by 0.2 million b/d in 2022.

Even as production in most non-OPEC producers declined in 2020, Brazil’s liquid fuels supply grew by 0.1 million b/d during 2020. We expect Brazil’s production to grow by more than 0.2 million b/d in 2021. However, our current forecast is 0.1 million b/d lower on average compared with the January 2021 STEO and reflects the difficulties Brazil’s national oil company, Petrobras, experienced at the beginning of 2021 with restarting fields that had undergone heavy maintenance in 4Q20. Growth in 2021 is further limited as a result of delayed startups. Petrobras has postponed the start-up of the first phase of the Mero oil field development, the floating production storage and offloading vessel (FPSO) Guanabara, from 4Q21 to 1H22. The restart of the Equinor-operated Peregrino field has also been delayed to 2022. The current operational asset in the Peregrino field has been offline since 2019 because of technical issues and was delayed again in 2020 because of COVID-19 safety protocols. The startup of its second phase of development has also been delayed to 2022 because of work disruptions caused by the pandemic. Forecast production in Brazil will grow by 0.3 million b/d in 2022. We expect that five new FPSO units will ramp up through the forecast period and continue to drive growth, notably at the Sepia, Mero, and Buzios fields. Each of these FPSOs has a production capacity of 180,000 b/d.

Russia is the second-largest producer of liquid fuels among non-OPEC countries after the United States. Production in Russia grew by 0.5 million b/d in 1H21 from 2H20, as OPEC+ participants eased crude oil production cuts. We expect Russia’s liquid fuels production to increase by 0.2 million b/d for all of 2021 and by 0.8 million b/d in 2022. After the OPEC+ agreement ends in early 2022, we expect Russia’s production to rise above 11.5 million b/d during 2H22, with annual average production in 2022 equal to 2019 levels.
China’s liquid fuels production in our forecast increases by more than 0.1 million b/d in 2021. China’s government outlined its goals for national oil companies to increase upstream crude oil and natural gas production during the next few years to help meet its outlined energy security goals. We expect slight declines in crude oil production in 2022 will be offset by both increasing production of other liquids and by increasing refinery gains, resulting in a small increase in China’s overall production.

Norway’s liquid fuels production rises in our forecast by about 0.1 million b/d in both 2021 and 2022. Norway’s Ministry of Petroleum and Energy enacted unilateral production limits on the Norwegian continental shelf from June 2020 to December 2020. When production limits expired, Norway’s liquid fuels production was up slightly in 1H21 compared with 1H20. We expect liquid fuels production to continue to grow in 2H21 and in 2022 as new fields come online and ramp up production, including the much-delayed Martin Linge field. The Johan Sverdrup field, which was the main driver of growth in Norway’s liquid fuels production in 2020, will also contribute to growth in 2021 and 2022.

Mexico’s forecast liquid fuels production averages 1.9 million b/d in 2021, almost unchanged from 2019 and 2020. We have revised our 2021 production forecast upwards from its January 2021 STEO estimate of 1.8 million b/d because private operators have surpassed our expectations regarding their ability to ramp up the Ixachi, Pokoch, and Hokchi fields. We expect Mexico’s oil production to fall to 1.8 million b/d on average in 2022, reflecting financial constraints at Mexico’s national oil company, PEMEX, and continued large declines in mature fields. New growth in foreign-operated fields in 2021 is insufficient to offset declines from PEMEX’s older fields, in particular the Maloob field.

We forecast that output across a number of other non-OPEC producers will decline in 2021 and 2022, notably Indonesia, the United Kingdom, and Colombia.

**OPEC Production of Petroleum and Other Liquid Fuels.** At the April 2021 OPEC+ meeting, the OPEC+ countries agreed to incrementally raise their production from May through July 2021, including a full reversal of Saudi Arabia’s voluntary production cut of 1 million b/d. They reaffirmed this agreement at their June meeting. This forecast was completed on July 1, prior to OPEC+ calling off its most recent meeting on July 5. However, we forecast that OPEC and its OPEC+ partners will continue to increase crude oil production beyond July in response to rising global oil consumption.

Although our forecast assumes current U.S. sanctions remain in place for Iran and Venezuela for the entire forecast period, we expect Iran will increase crude oil supply somewhat in the coming months. We also expect that OPEC+ will not implement further production cuts to accommodate any potential increases in oil output from Iran or Venezuela.

After holding crude oil production near 25 million b/d during the first four months of 2021, OPEC began increasing production in May based on its agreement with OPEC+ partners. We
expect OPEC will increase production by 2.4 million b/d from May through August, raising production in response to rising global oil consumption. In our forecast OPEC crude oil production averages 28.2 million b/d in 2H21, up 2.9 million b/d from 1H21 and up 4.0 million b/d from 2H20. For all of 2021, we forecast that OPEC crude oil production will average 26.8 million b/d, up 1.2 million b/d from 2020. We forecast OPEC will raise crude oil production by an additional 1.8 million b/d in 2022 to 28.6 million b/d.

Our OPEC crude oil production forecast is subject to considerable uncertainty. OPEC+ implemented monthly meetings to assess global oil market conditions, and the group’s production targets are potentially subject to regular adjustments. OPEC+ has indicated it will adjust production targets in response to changes in global oil demand, but the path of global oil demand in the coming months remains highly uncertain. Also, the manner in which OPEC+ would change production targets in response to higher production from Iran, or other changes in the oil market, is not clear. Finally, country compliance with existing production targets as the oil price rises is uncertain.

Even with increased OPEC crude oil production, remaining surplus production capacity will be more than sufficient to meet additional demand should consumption exceed our expectations. We expect that OPEC surplus crude oil production capacity, which averaged 6.2 million b/d in 2020, will average 6.7 million b/d in 2021 and 4.8 million b/d in 2022, compared with average surplus capacity of 2.2 million b/d from 2010–19. These estimates do not include additional capacity that may be available in Iran that is offline because of U.S. sanctions on Iran’s oil sales. All else equal, elevated levels of OPEC surplus production capacity tend to have a moderating effect on crude oil price increases.

Venezuela is not subject to the current OPEC+ production target, and in contrast to the rest of OPEC, we expect Venezuela’s crude oil production to continue to decline as a result of ongoing operational difficulties, lack of field and facility maintenance, and continuing sanctions. Venezuela’s production declines accelerated in 2020 after the United States government imposed new sanctions on its main oil trader, Rosneft Trading, in mid-February 2021. In addition, the decline in global oil demand following the onset of the COVID-19 pandemic further reduced the demand for Venezuela’s oil.

**OPEC Non-Crude Oil Liquids.** We estimate that OPEC production of other liquids declined to 5.1 million b/d on average in 2020, down from 5.4 million b/d in 2019. The 2020 production decrease was driven by reduced output of associated condensate stemming from reduced crude oil production. In the forecast, associated liquids production rises as OPEC relaxes its crude oil production cuts. We expect OPEC non-crude oil liquids production will rise to 5.3 million b/d in 2021 and to 5.5 million b/d in 2022.

**Global Oil Inventories.** We estimate global oil inventories increased by 1.2 billion barrels during the first five months of 2020. Inventories subsequently fell by 0.8 billion barrels from June 2020 through June 2021. However, we expect that markets will be much more balanced
during 2H21 and in 2022. Although global oil demand continues to rise, relaxed OPEC+ production targets during the second half of the year, rising oil supplies in Iran, and rising non-OPEC production will result in global oil inventory draws of 0.2 million b/d during 2H21, compared with our estimate that inventory draws were 1.7 million b/d in 1H21. We expect inventories to build at a rate of nearly 0.5 million b/d in 2022 as OPEC continues to raise production in response to rising demand and as non-OPEC production growth, particularly in the United States, accelerates.

**Crude Oil Prices.** Brent crude oil prices averaged $73/b in June 2021, up $5/b from May. June was the first month when Brent crude oil prices averaged more than $70/b since May 2019. The increase likely reflected market expectations of continuing near-term tightness in global oil markets, which were evident in ongoing declines in global oil inventories. As vaccination rollouts have continued to ramp up in parts of the world, personal travel and mobility have been rising during much of 2021. Increasing oil consumption combined with production restraint from OPEC+ and relatively flat crude oil output in the United States have kept global oil consumption above global oil supply, draining inventories. Although global oil inventories during May and June fell at a slower rate than earlier in the year, the inventory draws of 1.2 million b/d over the past two months indicate the oil market was still in a structural deficit. Crude oil prices received additional support from increasing global economic activity and decreasing global COVID-19 cases. These factors have also contributed to rising prices across a wide range of assets including equities and other commodities.

We expect that recent increases in crude oil prices along with the OPEC+ decision to raise production will help meet the expected increase in global oil demand and lead to relatively balanced global oil markets for the remainder of the forecast period. Despite strength in oil prices during 1H21, we expect moderate downward oil price pressures to emerge beginning in 2H21, when we forecast global oil production to rise and cause inventories to draw at a slower pace. We expect global oil inventories will fall by 0.2 million b/d in 2H21, compared with an average draw of 1.7 million b/d in 1H21. We forecast Brent spot prices to average $71/b during 4Q21 compared with the average of $73/b in June.

Although we expect oil markets to be fairly balanced in 2022, in our forecast, global oil production begins to outpace global oil demand in 2022, which we expect will continue to put moderate downward pressure on oil prices. Higher oil price levels realized in 2021 drive increases in U.S. tight oil production in 2022. In addition, we expect more barrels from OPEC+ members to reach the market. We expect U.S. crude oil production to increase by 0.8 million b/d in 2022 and OPEC crude oil production to increase by 1.8 million b/d in 2022. Paired with a forecast deceleration in global oil demand growth to 3.7 million b/d in 2022—compared with 5.3 million b/d in 2021—rising oil production contributes to our forecast that Brent crude oil spot prices will average $67/b next year.

Global economic developments and numerous uncertainties surrounding the ongoing COVID-19 pandemic in the coming months could push oil prices higher or lower than our current price
forecast. The current forecast price path reflects global oil consumption increasing by 6% from 2020 levels in 2021 and by an additional 4% in 2022. However, this forecast depends on the rate at which current vaccinations continue and the way oil consumption behavior changes once populations are widely vaccinated. The duration of, and compliance with, the latest OPEC+ production targets also remains uncertain. Lastly, the degree to which the U.S. shale industry responds to the recent relative strength in oil prices will affect the oil price path in the coming quarters.

We forecast West Texas Intermediate (WTI) crude oil prices will average about $3/b less than Brent prices in 2021 and $4/b less than Brent prices in 2022. This price discount is based on our assumption that the recent discount of WTI to Brent, which averaged less than $3/b in 2Q21, reflected low global demand for oil exports and relatively low levels of U.S. crude oil production. As global refinery demand for crude oil increase and U.S. crude oil supply also increases, we expect the WTI discount to return to $4/b by 2H22. This discount reflects the relative cost of exporting U.S. crude oil from the Cushing distribution hub to Asia, compared with the cost of exporting Brent crude oil from the North Sea to Asia.

### U.S. Liquid Fuels

**Consumption.** Although U.S. liquid fuels consumption has increased since reaching a recent low in 2Q20, lingering effects from COVID-19 continue to limit consumption. We estimate that in 1H21, U.S. consumption of liquids fuels averaged 19.1 million b/d, down 1.3 million b/d (6%) from 1H19. We expect the effects of the COVID-19 pandemic on liquid fuels consumption will continue to abate and liquids consumption will increase through the forecast period. Although we expect the direct effects from the pandemic on U.S. petroleum consumption to decrease, some consumption patterns may be more lasting, including increased working from home and changes in travel behavior, which could limit growth in gasoline and jet fuel consumption.

In 2021, we forecast that total U.S. liquids consumption will average 19.6 million b/d, down from 20.5 million b/d in 2019. Although we expect consumption of distillate fuel to be approximately equal to 2019 levels, we expect consumption of gasoline and jet fuel to remain below 2019 levels. We expect consumption of hydrocarbon gas liquids (HGL) to remain above 2019 levels in 2021, offsetting some of the declines in gasoline and jet fuel consumption.

In 2022, we expect distillate and HGL consumption to rise above 2019 levels, while gasoline and jet consumption will remain below 2019 levels. In the forecast, distillate and HGL consumption drive 2022 total liquids consumption to an average of 20.7 million b/d, surpassing 2019 consumption by about 0.1 million b/d.

In 1H21, we estimate U.S. gasoline consumption averaged 8.5 million b/d, down from 9.3 million b/d in 1H19 and the lowest level for the first half of a year since 2001 (except in 2020). Consumption in 1Q21 averaged 8.0 million b/d and increased to an estimated 9.0 million b/d in 2Q21 as the effects of COVID-19 decreased (driven by falling COVID-19 infections and increased...
vaccinations) and seasonal driving increased. We expect the effects of COVID-19 will continue to decrease and gasoline consumption will increase to an average of 8.9 million b/d in 2H21, up from 8.3 million b/d from 2H20, but still lower than the 9.3 million b/d consumed in the same period during 2019. For all of 2021, we forecast U.S. gasoline consumption to average 8.7 million b/d and increase to 9.0 million b/d in 2022, compared with 9.3 million b/d in 2019.

We do not expect U.S. gasoline consumption to exceed 2019 levels in the forecast period. In 2021, we forecast that U.S. vehicle miles traveled (VMT) will average 8.6 million miles per day, up from 7.7 million miles per day in 2020 but below the average of 8.9 million miles per day in 2019. In 2022, however, we expect VMT to average 9.0 million miles per day, slightly above the level seen in 2019. Increased vehicle efficiency, however, partly offsets the increases in VMT, keeping gasoline consumption below 2019 levels. We assume that work-from-home options in the future will remain more available than before the pandemic, limiting gasoline demand growth.

Responses to the COVID-19 pandemic affected distillate consumption in the United States in 2020 less than gasoline and jet fuel because it is driven more by economic activity and freight movement and less by reduced travel. In weekly data, distillate consumption recently returned to 2019 levels, and we estimate that distillate consumption in June 2021 surpassed distillate consumption in June 2019 by 70,000 b/d. For 1H21, distillate consumption averaged an estimated 4.0 million b/d, which is below the 1H19 average of 4.2 million b/d. However, we forecast distillate consumption to average 4.2 million b/d in 4Q21, surpassing the 4Q19 average by 0.1 million b/d. We forecast distillate consumption to average almost 4.3 million b/d in 2022, the highest level on record in our data, which dates back to 1945.

In 1H21, jet fuel consumption averaged 1.2 million b/d, up from 1.1 million b/d in 2020 but below 2019 consumption of 1.7 million b/d. We expect jet fuel consumption will average 1.4 million b/d in 2021, down from 1.7 million b/d in 2019. In 2022, forecast jet fuel consumption almost returns to 2019 levels, averaging 1.7 million b/d.

U.S. consumption of HGLs in our forecast increases by 0.1 million b/d to an average 3.3 million b/d in 2021 and then increase by 0.3 million b/d to 3.6 million b/d in 2022. The growth in HGL consumption in 2021 and 2022 reflects more demand for ethane as a petrochemical feedstock in the United States. We forecast ethane consumption will increase by 30,000 b/d in 2021 and by a further 300,000 b/d in 2022 with new demand coming from additional ethylene cracking capacity.

**Crude Oil Supply.** We forecast that annual U.S. crude oil production will average 11.1 million b/d in 2021, which is a 0.2 million b/d decrease from 2020 levels. However, annual average numbers somewhat obscure production trends. Production in 1Q21 was down by more than 2.0 million b/d from 1Q20, the quarter before 2Q20 when production fell sharply in response to falling oil prices. However, from 2Q21 through 4Q21, we forecast U.S. crude oil production will
be up 0.4 million b/d on average year over year. We forecast U.S. crude oil production will rise to an average of 11.9 million b/d in 2022.

Most crude oil production in the Lower 48 (L48) states, excluding the Federal Offshore Gulf of Mexico (GOM), is tight oil production, and we expect trends in L48 production to drive overall U.S. crude oil production levels. Our forecast crude oil production growth is based on WTI prices that indicate a favorable environment for drilling activity. In June, WTI prices averaged more than $70/b for the first time since October 2018, and we expect that through the end of 2022, WTI prices will remain above $60/b—a price that has signaled robust activity among U.S. operators in the past. Because changes in rig counts typically lag changes in the WTI price by three to six months and production changes typically occur about two months after rig deployment, current crude oil price levels will not likely affect production until late 2021. We forecast U.S. crude oil production to average about 11.2 million b/d in both 2Q21 and 3Q21 before beginning to rise more steadily. Forecast U.S. crude oil production reaches 11.3 million b/d in 4Q21 and increases to 12.2 million b/d by 4Q22.

Assuming that other factors remain constant, recent and forecast crude oil price levels will likely continue to drive rig deployments through the end of 2022. However, this forecast depends on the capital decisions of operators. The recent pace of rig deployment indicates that operators are adding rigs more slowly than during past periods when prices reached similar levels. If operators take a more cautious approach to rig deployment than we are expecting, crude oil production could be lower than in our forecast.

In the GOM, we expect crude oil production to average 1.8 million b/d in both 2021 and 2022. Ten new projects that will likely begin operations during the forecast period will help offset declines at existing GOM projects.

We expect little change in Alaska’s crude oil production, which will average more than 0.4 million b/d in both 2021 and 2022, down slightly from 2020 levels. We do not expect the U.S. federal moratorium on new federal oil and natural gas leases that occurred earlier this year to affect the short-term outlook for the GOM or Alaska.

**Hydrocarbon Gas Liquids Supply.** We forecast natural gas plant production of HGLs to increase by 0.1 million b/d in 2021 and by almost 0.5 million b/d in 2022. Rising HGL production in the forecast is mostly driven by increased ethane production. Higher rates of ethane recovery at natural gas processing plants occur in the forecast to meet growing demand for ethane as a petrochemical feedstock in the United States and abroad during both 2021 and 2022.

**Liquid Biofuels.** COVID-19-related reductions in economic activity in general, and decreased demand for liquid fuels in particular, significantly affected U.S. biofuels markets in 2020, and we expect some of these impacts to persist through the forecast period. The current forecast reflects the most recent 2020 targets in the Renewable Fuel Standard (RFS) program, and given the delays in finalizing 2021 RFS targets, we assume those 2020 target levels to remain
unchanged throughout the forecast period. In the forecast, these RFS targets primarily affect biomass-based diesel production and net imports, which help meet multiple RFS targets for biomass-based diesel, advanced biofuel, and total renewable fuel.

Because of sharp reductions in motor gasoline demand resulting from responses to COVID-19, U.S. fuel ethanol production was significantly lower in 2020 than in previous years. U.S. fuel ethanol production fell by 12% from 2019 to an average of 0.91 million b/d in 2020. As a result, we forecast that persistent reductions in domestic gasoline demand and limited higher-blend fuel ethanol growth potential will result in fuel ethanol production remaining lower than 2019 levels throughout the STEO forecast. We expect fuel ethanol production to average 0.97 million b/d in 2021, 7% more than in 2020, and to average 1.00 million b/d in 2022, 4% more than 2021, but still slightly below the 2019 level.

U.S. fuel ethanol consumption averaged 949,000 b/d in 2019, and we estimate fuel ethanol consumption fell by 13% to an average of 822,000 b/d in 2020. We forecast that fuel ethanol consumption will gradually rise during the forecast period, largely following the growth in domestic motor gasoline consumption with limited growth in any higher blending levels. In our forecast, U.S. fuel ethanol consumption averages 896,000 b/d in 2021 and 917,000 b/d in 2022. This level of consumption results in the fuel ethanol share of total gasoline, which was an estimated 10.2% in both 2019 and 2020, remaining near this level during 2021 and 2022. This stable fuel ethanol share assumes that growth in higher-level fuel ethanol blends is limited by a lack in consumer demand for higher levels of fuel ethanol blending beyond 10% of gasoline (E10) despite significantly elevated renewable identification number (RIN) prices which could incentivize increased fuel ethanol blending by some gasoline blenders and retailers.

We estimate that U.S. biodiesel production increased in 2020 and was less affected by COVID-19-related restrictions than many other fuels, despite production capacity that declined slightly. U.S. biodiesel production increased by an estimated 5% from 2019 to 2020, averaging an estimated 118,000 b/d last year. We expect biodiesel production will fall slightly to 117,000 b/d in 2021 before increasing by 10% to 129,000 b/d in 2022, driven largely by biodiesel’s role in meeting multiple RFS targets and the existence of the biodiesel production tax credit through 2022. Despite RIN prices that have recently been at all-time highs, record-high feedstock costs are expected to limit biodiesel production growth over the forecast period.

U.S. net imports of biomass-based diesel increased by an estimated 6% to an average of 22,000 b/d in 2020, and we expect net imports to increase to an average of 29,000 b/d in 2021 and 44,000 b/d in 2022. Increased net imports of biomass-based diesel primarily reflect increased volumes of renewable diesel imported to meet both California Low Carbon Fuel Standard requirements and RFS targets for biomass-based diesel and advanced biofuels.

*Product Prices.* Changes in travel patterns in response to COVID-19 resulted in significant reductions in crude oil prices and demand for liquid fuels in the United States during 2020, which significantly reduced prices for gasoline and diesel fuel during the same period. In 2021,
as vaccination levels have increased and general economic activity has begun to recover, personal mobility and seasonal driving demand has grown sharply year-over-year, leading to increasing prices for crude oil, gasoline, and diesel fuel compared with the same time last year.

Although much of the increase in U.S. gasoline and diesel prices so far in 2021 reflects rising crude oil prices, higher refinery margins have also contributed. Refinery margins (the difference between the wholesale price of gasoline and the price of Brent crude oil), which fell significantly along with gasoline and diesel demand in March and April 2020, returned to levels within their seasonal ranges in 4Q20. Since then, margins have increased significantly beyond their recent five-year averages, driven in part by significant increases in RIN prices, which are embedded to some degree in wholesale product prices. So, although refinery margins have increased beyond seasonal averages for both gasoline and diesel fuel, RIN costs have likely limited actual refinery profitability to some degree. This dynamic is reflected in refinery production of gasoline, which has not increased in line with growing gasoline demand, resulting in U.S. gasoline inventories that have been lower than in recent years and in upward pressure on prices.

The U.S. refinery wholesale gasoline margin averaged 30 cents/gal in February 2021. It then increased to an average of 52 cents/gal in June, which was 17 cents/gal higher than at the same time last year and 11 cents/gal higher than the recent five-year average. We expect the U.S. refinery wholesale gasoline margin will average 42 cents/gal in 2021 and 36 cents/gal in 2022, compared with a five-year (2016–20) average of 35 cents/gal. Because some of the strength in margins is attributable to elevated RIN costs, the margins remain uncertain throughout the year because RIN markets can be highly volatile and are currently driven by both agricultural commodity markets as well as uncertainty around future RFS rulemakings. Our forecast assumes current elevated agricultural commodity prices will not persist to the same degree, and future RFS rulemakings will add clarity and reduce some tightness in RIN markets.

In addition to elevated refinery margins, supply disruptions as a result of the Colonial Pipeline Cyberattack added upward retail gasoline price pressure in May, when the U.S. weekly average gasoline retail prices surpassed $3.00/gal for the first time since late 2014. Since then, U.S. regular gasoline retail prices have remained above $3.00/gal, averaging $3.06/gal in June. We expect that gradual reductions in U.S. refinery margins, driven partially by increased refinery output along with falling crude oil prices, will result in lower retail gasoline prices for the remainder of the year. We forecast the retail price of regular gasoline in the United States will average $3.04/gal during 3Q21, 85 cents/gal higher than at the same time last year. We expect the U.S. monthly regular retail gasoline price will fall from an average of $3.11/gal in July 2021 to $2.93/gal in September before falling to $2.76/gal in December 2021. We forecast the U.S. regular gasoline retail price, which averaged $2.18/gal in 2020, to average $2.85/gal in 2021 and $2.74/gal in 2022.

Regional annual average forecast prices for 2021 range from a low of $2.56/gal in the Gulf Coast region (PADD 3) to a high of $3.51/gal in the West Coast region (PADD 5).
The retail price of diesel fuel in the United States averaged $2.55/gal in 2020, which was 50 cents/gal lower than in 2019. We forecast that the diesel price will average $3.16/gal in 2021 and $3.09/gal in 2022. We expect that global economic activity returning to pre-pandemic levels will help drive diesel refinery margins higher during the forecast period than their multiyear lows in 2020. Diesel refinery margins based on the Brent crude oil price averaged 30 cents/gal in 2020, which was 11 cents/gal lower than the 2015–19 average and the lowest annual average since 2009. We expect diesel refinery margins will average 40 cents/gal in 2021 and 44 cents/gal in 2022.

Natural Gas

Natural Gas Consumption. U.S. consumption of natural gas averaged 83.3 billion cubic feet per day (Bcf/d) in 2020, and we expect consumption will decrease by 0.9 Bcf/d (1.1%) in 2021 and then increase by 0.6 Bcf/d (0.7%) 2022 to average 82.9 Bcf/d for the year.

The largest natural gas-consuming sector in the United States is the electric power sector. We estimate that the electric power sector will consume an average of 29.3 Bcf/d in 2021, which is 7.7% less than in 2020. We forecast that higher prices for natural gas (compared with coal prices) for power generation and rising electricity generation capacity from renewable energy will likely cause natural gas consumption in the electric power sector to decline in 2021. We forecast electric power sector consumption of natural gas will increase by 1.3% in 2022, based on an expected decline in natural gas prices next year.

We expect combined U.S. residential and commercial natural gas consumption will average 22.6 Bcf/d in 2021, up 6.0% from 2020. Compared with 1Q20, colder temperatures and people spending more time at home because of the COVID-19 pandemic led to increases in heating demand in 1Q21. Based on forecasts by the National Oceanic and Atmospheric Administration (NOAA), we assume colder temperatures with 7.0% more heating degree days (HDD) across the United States in 2021 compared with 2020. We expect natural gas consumption in the U.S. residential and commercial sectors to decline by 0.4% in 2022.

We forecast U.S. consumption of natural gas in the industrial sector will increase 1.2% in 2021 to 22.8 Bcf/d and an additional 0.9% to 23.0 Bcf/d in 2022. Our natural gas-weighted manufacturing index, based on forecasts from IHS Markit, has steadily increased after falling in 2Q20, and our forecast assumes that the natural gas-weighted manufacturing index will reach 2019 levels in 2H21.

Natural Gas Production. We forecast that U.S. dry natural gas production will average 92.6 Bcf/d in 2021, which would be up 1.3% from 2020. Natural gas production rises in response to higher crude oil and natural gas prices. We forecast Henry Hub spot prices in 2021 will average more than $1 per million British thermal units (MMBtu), or 58%, higher than the average in 2020. In addition, we expect associated natural gas production from oil directed rigs in the Permian Basin to increase in 2021 as WTI prices average almost $27/b (68%) more than in 2020.
In 2022, we expect dry natural gas production to average 94.7 Bcf/d, which would be up 2.3% from 2021.

**Natural Gas Trade.** We forecast U.S. liquefied natural gas (LNG) exports to average 9.6 Bcf/d in 2021 and 10.2 Bcf/d in 2022, surpassing pipeline exports for the first time on an annual basis in both years. Several factors support this forecast: gradual recovery in global LNG demand, high winter LNG demand, particularly in Asia, and expansions in global LNG regasification capacity in both existing and new markets in the next two years. U.S. LNG exports are projected to increase in 2022 because of commissioning of additional LNG trains at Sabine Pass and Calcasieu Pass.

U.S. LNG exports have reached record high levels this spring, averaging 10.3 Bcf/d from March through May, supported by high spot LNG prices in Asia and Europe, and a continuous recovery in global LNG demand. We estimate that U.S. LNG exports declined to 9.0 Bcf/d in June, likely because of planned and unplanned outages at several U.S. liquefaction facilities.

Pipeline exports of U.S. natural gas have also increased as more infrastructure has been built to transport natural gas both to and within Mexico. U.S. pipeline exports averaged 7.9 Bcf/d in 2020, an increase of 1.7% compared with 2019. We expect pipeline exports to increase as more natural gas-fired power plants come online in Mexico and more pipeline infrastructure is built within Mexico and the United States. We expect gross U.S. pipeline exports to Mexico and Canada to average 9.0 Bcf/d in 2021 and 9.2 Bcf/d in 2022.

U.S. natural gas pipeline imports (almost all of which come from Canada) decreased from 2019 to 2020, continuing a trend that began in 2008. We forecast natural gas pipeline imports to increase 5.7% in 2021 because the United States will import more natural gas amid relatively flat U.S. natural gas production along with record U.S. exports of natural gas. However, pipeline imports will likely decline in 2022 in response to an increase in U.S. natural gas production in 2022.

**Natural Gas Inventories.** Storage withdrawals in 1Q21 were 14% higher than the five-year average because severely cold temperatures in February caused near-record storage withdrawals and because of declines in natural gas production. Total inventories were 1.8 trillion cubic feet (Tcf) at the end of March, about 2% lower than the five-year average for that time of year. For the 2021 April–October storage injection season, we expect injections will be 5% below the five-year average rate because record exports outpace increases in natural gas production. We expect that inventories will reach more than 3.6 Tcf at the end of October 2021, which would be 3% lower than the previous five-year average for the end of October and 8% lower than at the end of October 2020.

**Natural Gas Prices.** The Henry Hub spot price averaged $2.03/MMBtu in 2020. Natural gas prices fell through much of 2020 as U.S. natural gas consumption outside of the electric power sector declined and LNG exports also dropped. These declines outpaced declines in production and contributed to inventories building at a faster rate than the five-year average.
The Henry Hub spot price rose to an average of $3.25/MMBtu in 1H21, somewhat elevated by the February monthly average price of $5.35/MMBtu, which was strongly influenced by cold weather. More recently, the daily spot price reached $3.79/MMBtu on June 30. U.S. natural gas prices rose in 1H21 as growth in demand for natural gas outpaced supply. The combination of U.S. consumption of natural gas outside of the power sector and exports together were up almost 6 Bcf/d in 1H21 compared with the same period in 2020. At the same time, domestic dry natural gas production plus imports were almost unchanged in 1H21 compared in 1H20.

We expect the Henry Hub spot price to fall from recent highs and average $3.22/MMBtu in 3Q21 and also average $3.22/MMBtu for all of 2021. For the remaining months in 2021, we expect prices to remain more than $3.00/MMBtu, driven by continuing record natural gas exports and rising demand for natural gas outside of the electric power sector amid relatively flat natural gas production. We expect downward price pressure to emerge in 2022 as U.S. natural gas production increases and export growth slows. We forecast the Henry Hub spot price to average $3.00/MMBtu in 2022.

**Coal**

**Coal Production.** We forecast U.S. coal production will increase by 78 million short tons (MMst) (15%) in 2021 to total 617 MMst for the year. The expected increase in production reflects greater electric power sector demand for coal. Higher natural gas prices make coal more economically competitive relative to natural gas for electricity generation dispatch. In the forecast, coal production increases by 13 MMst (9%) in the Appalachia region, 14 MMst (16%) in the Interior region, and 51 MMst (17%) in the Western region.

Coal production in the forecast falls by 7 MMst (1%) in 2022 to 610 MMst. The decline is in response to falling natural gas prices in our forecast, which tends to reduce coal use for power generation. Western region production is expected to decline by 6% in 2022, offsetting gains in the Interior (7%) and Appalachia (5%) regions.

Overall production capacity decreased in 2020, and the lost capacity is unlikely to come back online. We expect an increased draw on electric power sector coal inventories in 2021 (25 MMst) and 2022 (23 MMst).

**Coal Consumption.** We expect a 92 MMst (19%) increase in U.S. coal consumption in 2021. Rising consumption is largely driven by an increase in demand from the electric power sector, which is expected to consume 522 MMst of coal in 2021, 20% more than 2020. We forecast total U.S. coal consumption to decrease 32 MMst (6%), in 2022 to 537 MMst.

**Coal Trade.** Annual U.S. coal exports dropped 26% between 2019 and 2020, from 94 MMst to 69 MMst. Metallurgical coal exports were 42 MMst in 2020, 20% lower than the previous year, and steam coal exports were 27 MMst, 34% lower than in 2019.
Four of the top 10 U.S. coal export destinations—Brazil, Turkey, the Dominican Republic, and China—increased their imports of U.S. coal in 2020. Exports to the Dominican Republic increased by 1.3 MMst, more than double its 2019 imports of U.S. coal. In particular, an ongoing trade dispute between Australia and China has opened up opportunities for swing suppliers, such as the United States, to gain market share and increase overall exports especially for steam coal.

In our forecast, we assume the seaborne steam coal market in 2021 will be more robust with higher demand for U.S. coal. Forecast U.S. steam coal exports reach 37 MMst in 2021, which is a 37% increase from 2020. Rising U.S. exports in the forecast reflect smaller export volumes from other global suppliers and seaborne coal prices that are supportive of U.S. exports. We expect total U.S. coal exports to increase by 15 MMst (21%) in 2021 as a result of economic growth for major coal importers that are emerging from a lower demand market because of the pandemic in 2020. Steel production, which was limited by pandemic shutdowns, is expected to return to average levels during the remainder of 2021 and bring U.S. metallurgical coal exports to 47 MMst. We expect coal exports to increase by 15 MMst (18%) in 2022 as overall seaborne supply comes back into line with 2019 levels. We expect that U.S. coal exports will total 99 MMst in 2022.

**Coal Prices.** The delivered coal price to U.S. electricity generators averaged $1.92/MMBtu in 2020, which was 10 cents/MMBtu lower than the 2019 price. We forecast that coal prices will decrease to $1.88/MMBtu in 2021 and $1.85/MMBtu in 2022.

**Electricity**

**Electricity Consumption.** We forecast total retail sales of electricity by U.S. utilities and electricity suppliers will increase by 2.8% in 2021 and by 1.0% in 2022. So far this year, estimated U.S. retail electricity sales during 1H21 were 4.5% more than for the same period of 2020. We forecast that electricity sales during 2H21 will grow by 1.2% compared with 2H20.

The relaxing of social distancing guidelines and growing COVID-19 vaccinations have led to increased economic activity compared with last year, especially in restaurants and retail stores, which were most affected by pandemic-related restrictions in 2020. Residential electricity consumption in 2020 noticeably increased because people were staying at home for longer periods during the day and because many were working from home. Residential electricity use is likely to remain elevated as work-from-home arrangements continue for some workers.

Year-to-year changes in residential electricity consumption are most related to changes in temperature, often measured using heating degree days (HDD) and cooling degree days (CDD). We estimate residential electricity sales during 1H21 to be 5.7% more than during the same period in 2020. Much of this increase reflected colder winter temperatures compared with last year’s mild winter and a hot June across much of the country. HDDs in the United States during 1H21 were 6.9% more than in 2020. Based on forecasts from NOAA, our forecast assumes U.S.
HDDs to be higher than last year during 2H21, but the effect on electricity consumption is offset by CDDs in the forecast that are 9.7% lower than in 2H20. We forecast residential electricity sales during 2H21 will be 1.4% lower than residential sales in 2020. Forecast annual residential electricity use grows by 1.9% in 2021 and falls by 0.5% in 2022.

Weather and overall economic activity affect electricity consumption in the commercial sector. Although the colder winter weather earlier this year supported electricity consumption in the commercial sector, economic activity and growth in private-sector jobs were still restrained, especially during 1Q21 compared with the same period in 2020, before the pandemic-related lockdowns began. Nonfarm employment during 1Q21 was 5.6% lower during the same period in 2020, while retail electricity sales to the commercial sector were 2.9% lower. For 2H21, we forecast commercial sector retail electricity sales will grow by 1.7% compared with last year, driven in part by an expected 4.8% increase in nonfarm employment. For 2022, forecast commercial sector electricity use grows by 1.4% on an annual basis.

Improving economic conditions will also likely increase electricity demand in the industrial sector. The U.S. industrial production index for electricity-intensive industries in the forecast increases by 6.5% in 2021 after declining by a similar percentage in 2020. This expected increase in industrial production contributes to our forecast that retail sales of electricity to the industrial sector will rise by 5.1% in 2021. In 2022, we forecast retail sales of electricity to the industrial sector will increase by 2.6%.

**Electricity Generation.** We expect the U.S. electric power sector will generate 2.1% more power during 2021 than in 2020. Electric power sector generation in the forecast grows by an additional 0.7% in 2022.

One of the largest shifts in fuels for electricity generation in recent years has been the industry’s reduced use of coal and increased use of natural gas. Coal-fired electricity generation in the United States has declined almost every year over the past decade. The amount of U.S. coal generation in 2020 was 62% below its high in 2007. In contrast, natural gas generation grew by 86% between 2007 and 2020.

Both regulatory and economic factors are driving this trend of declining coal use and rising natural gas use. One of the most important drivers has been the sustained low cost of natural gas, which reached the lowest level in decades last year. In 2020, the price of natural gas delivered to electric generators averaged $2.39/MMBtu. However, natural gas prices have been rising in recent months now that the economy is beginning to recover from the effects of the pandemic, but U.S. production of natural gas is growing at a slower pace. In April 2021, the most recent available history, the delivered natural gas price to electricity generators averaged $3.04/MMBtu. Expected natural gas costs remain relatively elevated through the forecast and delivered prices average $3.44/MMBtu in 2H21.
These expected changes in the costs of fuels used for generating power will likely reverse some of the recent trends in the use of coal and natural gas for electricity generation, at least temporarily. We forecast that the natural gas-fired share of total U.S. generation will decline from 39% in 2020 to 36% in both 2021 and 2022, which would be close to what the natural gas share was in 2019. The expected rise in natural gas costs make coal more economical for electricity generation. The forecast share of generation from coal-fired power plants rises from 20% last year to 24% in 2021 and 22% in 2022.

We forecast the share of generation from renewable sources will increase from 20% in 2020 to 21% in 2021 and to 23% in 2022. Most of this increase will come from new solar and wind generating capacity expansions in the electric power sector. The current drought in the West has restrained electricity generation by hydropower. U.S. hydropower generation contributes about 6.5% of total generation in the 2021 forecast, which would be the lowest share since 2015. In 2022, the forecast hydropower share rises to 6.8% but is still below the 7.5% share last year.

The forecast nuclear share of total electricity generation, which averaged nearly 21% in 2020 will fall to 20% by 2021 and to 19% in 2022. The declining share partly reflects retirements of nuclear capacity. In April, New York’s Indian Point nuclear power plant retired. Reactors at three other nuclear plants in the Midwest are scheduled to retire in either 2021 or 2022. The retirements are partly offset by two reactors at the Vogtle plant in Georgia that are scheduled to come online next year.

**Renewable Capacity.** We expect that generating capacity from renewable energy sources will continue to grow through the STEO forecast horizon. By the end of 2022, electric power sector total renewables capacity increases by 81 gigawatts (GW) from 2019. An additional 15 GW in all other sectors brings the total to 96 GW.

We forecast that in 2022 large-scale solar capacity growth will exceed wind growth for the first time. We forecast that 16 GW of solar photovoltaic (PV) generating capacity in the electric power sector will be added in 2021 and an additional 17 GW is forecast for 2022. We forecast small-scale solar PV capacity to increase by about 5 GW per year through the STEO forecast period. Residential PV accounts for most of this additional small-scale generating capacity for both 2021 and 2022. Solar capacity growth in the forecast reflects various state and federal policies that support renewable energy.

We forecast generating capacity from wind turbines in the electric power sector to grow by 17 GW in 2021 and by 6 GW in 2022. Because wind capacity is often added at the end of the calendar year, increases in wind generation frequently lag behind increases in capacity for the year they occur in, and they are reflected in the generation for the next year.

Much of this slowing growth in wind capacity can be attributed to the expiration of the production tax credit. The credit, which at the end of 2019 was extended through 2020,
provided a 2.5 cents per kilowatthour (kWh) benefit for facilities entering service or securing 5% safe harbor (spending at least 5% of total estimated project cost) through the 2020 calendar year. The effect of the tax credit extension included in the Consolidated Appropriation Act 2021, enacted in late-December 2020, is now reflected in this forecast. This extension caused capacity additions to move from 2020 to 2021 and the slowing wind growth in 2022.

**Electricity Prices.** Wholesale electricity prices throughout the country so far in 2021 have been higher than last year, reflecting the increased cost of natural gas for power generation. During 2Q21, wholesale prices ranged from $31 per megawatthour (MWh) in the Central region, which is 58% higher than 2Q20, to $52/MWh in the Northwest region, which is 256% higher than in 2020. Wholesale prices are likely to remain relatively volatile over the next few months. Forecast prices during 2H21 average from a low of $24/MWh in Texas to a high of $46/MWh in California.

We forecast the U.S. retail electricity price for the residential sector will average 13.6 cents/kWh in 2021, which is 2.8% higher than the average retail price in 2020. Forecast residential prices increase by an additional 1.8% in 2022.

**U.S. Economic Assumptions and Energy-Related Carbon Dioxide Emissions**

**U.S. Economy.** We base the STEO on macroeconomic forecasts for the United States by IHS Markit. We used the June 2021 version of the IHS Markit macroeconomic model with our own energy price forecasts as model assumptions to develop the economic forecasts in the STEO.

Using the IHS Markit model, we assume U.S. real GDP will grow by 7.4% in 2021 and by 5.0% in 2022. These rates compare with a 3.5% decline in annual GDP growth in 2020. We assume that total U.S. industrial production will increase 6.5% in 2021 and 4.8% in 2022. This growth contrasts with the 7.2% decline in annual growth in 2020. In the forecast, U.S. nonfarm employment, which decreased by 5.7% in 2020, will increase by 2.9% in 2021 and 3.8% in 2022.

**Energy-Related Carbon Dioxide Emissions.** Energy-related carbon dioxide (CO₂) emissions in the United States fell by 11.1% in 2020 relative to 2019. We expect CO₂ emissions to rise by 7.1% in 2021 and by 1.5% in 2022. We forecast an increase in coal CO₂ emissions and a decrease in natural gas CO₂ emissions because higher natural gas prices make coal more economically competitive for electric power generation. We expect CO₂ emissions from coal to rise by 18.5% in 2021 and to decline by 4.9% in 2022. We expect CO₂ emissions from natural gas to fall by 1.3% from 2020 to 2021 and then increase by less than 1% in 2022. Petroleum-related CO₂ emissions increase 9.0% in 2021 and 5.2% in 2022 as transportation patterns begin to return to normal. Energy-related CO₂ emissions are sensitive to changes in weather, economic growth, energy prices, and fuel mix.
Notable forecast changes

- For more information, see the detailed table of forecast changes.