The December Short-Term Energy Outlook (STEO) remains subject to heightened levels of uncertainty related to the ongoing recovery from the COVID-19 pandemic. Notably, the emergence of the SARS-CoV-2 Omicron variant raises uncertainty about the level of energy consumption throughout the world compared with last month’s forecast. U.S. gross domestic product (GDP) declined by 3.4% in 2020 from 2019 levels. This STEO assumes U.S. GDP will grow by 5.5% in 2021 and by 4.4% in 2022. The U.S. macroeconomic assumptions in this outlook are based on forecasts by IHS Markit. The U.S. macroeconomic forecast and the global macroeconomic forecast from Oxford Economics were completed in mid-November before the Omicron variant was identified. In addition to uncertainty about macroeconomic conditions, winter weather along with the evolving effects of consumer behavior on energy demand because of the pandemic present a wide range of potential outcomes for energy consumption. Supply uncertainty in the forecast results from the production decisions of OPEC+ and with the rate at which U.S. oil and natural gas producers increase drilling.

Brent crude oil spot prices averaged $81 per barrel (b) in November, a $3/b decrease from October 2021 but a $38/b increase from November 2020. Crude oil prices have risen over the past year as result of steady draws on global oil inventories, which averaged 1.4 million barrels per day (b/d) during the first three quarters of 2021. Crude oil prices fell significantly on November 26, and the Brent spot price began December below $70/b. The drop in prices followed the identification of the new COVID-19 Omicron variant, which raised the possibility that petroleum demand could decline in the near term.

We expect Brent prices will average $71/b in December and $73/b in the first quarter of 2022 (1Q22). For 2022 as a whole, we expect that growth in production from OPEC+, of U.S. tight oil, and from other non-OPEC countries will outpace slowing growth in global oil consumption, especially in light of renewed concerns about COVID-19 variants. We expect Brent prices will remain near current levels in 2022, averaging $70/b.

We estimate that 99.7 million b/d of petroleum and liquid fuels was consumed globally in November, a 4.9 million b/d increase from November 2020 but 1.1 million b/d less than in November 2019. We revised down our forecast of consumption of petroleum
and liquid fuels for 4Q21 and 1Q22, partly as a result of recently announced travel restrictions following reported outbreaks of the Omicron variant of COVID-19. The potential effects of the spread of this variant are uncertain, which introduces downside risks to the global oil consumption forecast, particularly for jet fuel. We forecast that global consumption of petroleum and liquid fuels will average 96.9 million b/d for all of 2021, which is a 5.1 million b/d increase from 2020. We forecast that global consumption of petroleum and liquid fuels will increase by 3.5 million b/d in 2022 to average 100.5 million b/d.

- U.S. regular gasoline retail prices averaged $3.39 per gallon (gal) in November, a 10 cents/gal increase from October and $1.29/gal higher than in November 2020. The November monthly average was the highest since September 2014. We forecast that retail gasoline prices will average $3.13/gal in December before falling to $3.01/gal in January and $2.88/gal on average in 2022.

- Total U.S. crude oil production was an estimated 11.7 million b/d in November. We forecast that it will rise to an average of 11.8 million b/d in 2022 and to an average of 12.1 million b/d in 4Q22.

**Natural Gas**

- In November, the natural gas spot price at Henry Hub averaged $5.05 per million British thermal units (MMBtu), down from the October average of $5.51/MMBtu but up from an average of $3.25/MMBtu in the first half of 2021 (1H21). After rising in recent months, natural gas prices declined in November amid mild weather across much of the country that resulted in less natural gas used for space heating than expected. Decreased demand for natural gas also contributed to inventory levels moving closer to the five-year (2016–20) average. Global demand for U.S. liquefied natural gas (LNG) has remained high, limiting some downward pressure on natural gas prices.

- The Henry Hub spot price averages $4.58/MMBtu from December 2021 through February 2022 in our forecast and then generally declines through 2022, averaging $3.98/MMBtu in 2022 amid rising U.S. natural gas production and slowing growth in LNG exports. We forecast that U.S. inventory draws will be similar to the five-year average this winter, and we expect that factor, along with rising U.S. natural gas exports and relatively flat production through March, will keep U.S. natural gas prices near recent levels before downward price pressures emerge. Because of uncertainty around seasonal demand, we expect natural gas prices to remain volatile over the coming months, and winter temperatures will be a key driver of natural gas consumption and prices.

- We estimate that U.S. LNG exports averaged 10.7 billion cubic feet per day (Bcf/d) in November 2021, a 0.8 Bcf/d increase from October, supported by large price differences
between the Henry Hub price in the United States and spot prices in Europe and Asia. LNG exports resumed from Cove Point LNG in late October after that facility’s annual maintenance was completed. In our forecast, LNG exports average 9.8 Bcf/d for all of 2021, a 50% increase from 2020. We expect that LNG exports will average 11.1 Bcf/d from December through March. We expect high levels of LNG exports to continue into 2022, averaging 11.5 Bcf/d for the year, a 17% increase from 2021. The forecast reflects our assumption that global natural gas demand remains high and U.S. LNG export capacity increases.

- U.S. natural gas inventories ended November 2021 at more than 3.5 trillion cubic feet (Tcf), 3% less than the five-year average for this time of year. Less natural gas was injected into storage this summer than the previous five-year average, largely as a result of more electricity consumption in June because of hot weather, and because of increased exports. However, storage levels moved closer to average as injections outpaced the five-year average in September, October, and early November. We expect natural gas inventories to fall by 2.0 Tcf during the November-to-March withdrawal season, ending March below 1.7 Tcf, which would be 2% less than the 2017–21 average for that time of year.

- We estimate dry U.S. natural gas production averaged 96.1 Bcf/d in the United States in November, up 1.0 Bcf/d from the average in October. Production in November was up from an average of 91.9 Bcf/d in 1H21. Natural gas production in the forecast rises to an average of 95.3 Bcf/d during the rest of this winter (December–March) and averages 96.0 Bcf/d for all of 2022, driven by natural gas and crude oil price levels that we expect will be sufficient to support enough drilling to sustain production growth.

**Electricity, coal, renewables, and emissions**

- We forecast that the share of electricity generation produced by natural gas in the United States will average 37% in 2021 and 35% in 2022, down from 39% in 2020. For 2021, the annual share for natural gas as a generation fuel declines in response to our expectation of a higher delivered natural gas price for electricity generators, which we forecast will average $4.99/MMBtu compared with $2.40/MMBtu in 2020. The natural gas share declines in 2022 as a result of continued high fuel costs and an increasing share of renewable generation. As a result of the higher expected natural gas prices, the annual forecast share of electricity generation from coal rises from 20% in 2020 to 23% in 2021 and then drops slightly to 22% in 2022. For renewable energy sources, new additions of solar and wind generating capacity have been offset somewhat by reduced generation from hydropower this year. As a result, we forecast that the share of all renewables in U.S. electricity generation will average 20% in 2021, about the same as last year, before rising to 22% in 2022. The nuclear share of U.S. electricity generation declines from 21% in 2020 to 20% in 2021 and 2022.
• We expect coal production to rise by 48 million short tons (MMst), or 9%, in 2021 and by an additional 38 MMst (6%) in 2022. The increase in production reflects more demand and higher prices for coal in the electric power sector because of higher natural gas prices this year compared with last year. Despite the increase in production, growth has not kept pace with rising domestic demand for steam coal in the electric power sector and export growth. As a result, coal inventories held by the electric power sector fall by an expected 51 MMst (38%) in 2021 and a further 10 MMst (13%) in 2022.

• Planned additions to U.S. wind and solar capacity in 2021 and 2022 increase electricity generation from those sources in our forecast. We estimate that the U.S. electric power sector added 14.6 gigawatts (GW) of new wind capacity in 2020. We expect 17.2 GW of new wind capacity will come online in 2021 and 7.1 GW in 2022. Utility-scale solar capacity rose by an estimated 10.4 GW in 2020. Our forecast for added utility-scale solar capacity is 16.2 GW for 2021 and 20.9 GW for 2022. We expect significant solar capacity additions in Texas during the forecast period. In addition, in 2020, small-scale solar capacity (systems less than 1 megawatt) increased by 4.4 GW to 27.6 GW. In particular, Texas and Florida had large increases of small-scale solar capacity in 2020. We project that small-scale solar capacity will grow by 5.1 GW in 2021 and by 5.0 GW in 2022.

• U.S. energy-related carbon dioxide (CO₂) emissions decreased by 11% in 2020 as a result of less energy consumption due to reduced economic activity and to end user responses to the COVID-19 pandemic. For 2021, we forecast energy-related CO₂ emissions will increase about 7% from 2020 as economic activity increases and leads to rising energy use. We expect a 1% increase in energy-related CO₂ emissions in 2022. We forecast that after declining by 19% in 2020, coal-related CO₂ emissions will rise by 17% in 2021 and then fall by 3% in 2022.
Petroleum and natural gas markets review

Crude oil

Prices: The front-month futures price for Brent crude oil settled at $69.67 per barrel (b) on December 2, 2021, a decrease of $15.04/b from the November 1 price of $84.71/b. The front-month futures price for West Texas Intermediate (WTI) crude oil for delivery at Cushing, Oklahoma, decreased by $17.55/b during the same period, settling at $66.50/b on December 2 (Figure 1).

The front-month futures price for Brent crude oil decreased $9.50/b (11.6%) on November 26 after the World Health Organization designated the SARS-CoV-2 Omicron variant as a Variant of Concern. The price decline reflected market expectations that oil consumption might fall in the coming months as a result of the Omicron variant. The one-day percentage decrease for Brent crude oil on November 26 was the largest since April 21 2020, and larger percentage decreases have occurred on only four days since 2000 (three of which were in March and April 2020, the other in September 2001). In comparison, daily Brent crude oil prices typically change by less than 2%, and in 2021, prior to the price drop, the most the Brent crude oil price decreased in a single day was 6.9%.

Prior to the price decrease on November 26, crude oil prices were already lower than they were at the beginning of November, likely due to gradual increases in production from OPEC+ members and the United States and rising COVID-19 counts in Europe. These factors had already introduced additional uncertainty in oil demand forecasts, even before the Omicron variant was identified. High COVID-19 case counts in November have prompted renewed mobility restrictions in Austria, work-from-home mandates in Ireland and the Netherlands, and several other guidelines in the rest of Europe. Although COVID-related concerns may have placed some
downward pressure on prices earlier in the month, prices remained above $80/b throughout most of November as a result of the same trends that have caused prices to rise for much of 2021. Those trends include declining global petroleum stocks amid crude oil production restraint from OPEC+ and the potential for natural gas-to-oil fuel switching in parts of Asia and Europe.

Crude oil prices may have also experienced downward pressures in early November because of expectations that the United States and other countries would release strategic oil reserves. The United States announced the release of 50 million barrels of crude oil from the Strategic Petroleum Reserve (SPR) on November 23, and other nations also agreed to release reserves.

We estimate that world crude oil consumption has exceeded crude oil production for five consecutive quarters going back to the third quarter of 2020 (3Q20), which has resulted in persistent global petroleum stock withdrawals that have averaged 1.7 million barrels per day (b/d) over this period (Figure 2). These stock draws have contributed to consistent increases in crude oil prices in each of those quarters. We forecast stock draws will slow to 0.9 million b/d in 4Q21. With global oil stocks forecast to continue falling in December and with supply and demand moving into relative balance in 1Q22, we expect limited upward price pressure could emerge in the coming months. We forecast Brent spot prices will average $73/b in 1Q22. In our forecast, global oil stocks rise by an average of 0.5 million b/d from 2Q22 through 4Q22, as production begins to increase faster than global demand. These stock builds should contribute to downward pressure on crude oil prices, and our Brent forecast averages $71/b in 2Q22, $70/b in 3Q22, and $67/b in 4Q22.

The Omicron variant has introduced additional uncertainty into oil markets for the coming months, and this uncertainty is reflected in the recent increase in oil price volatility. It is not yet clear how Omicron will affect oil markets and the broader economy. One of the most likely markets to be affected is jet fuel, and some flights have already been canceled because of the
variant. We expect global oil demand to rise by 3.5 million b/d in 2022. The forecast is subject to significant revisions.

**Crude oil prices and the U.S. dollar index:** The U.S. dollar index increased in November and developed a negative correlation with crude oil prices, which could reflect both reduced global economic growth expectations and financial flows from risky assets, such as commodities, into safer assets, such as U.S. Treasury bills. The U.S. dollar index measures the value of the U.S. dollar against the exchange rates of six currencies. The euro represents 58% of the currency weighting in the index, and the Japanese yen, British pound, Canadian dollar, Swiss franc, and Swedish krona make up the rest. The U.S. dollar index increased in November and reached 96.2 on December 2, which aside from a few days in late November was the highest since July 16, 2020 (Figure 3). The higher value of the U.S. dollar likely reflects increased demand for dollars as a financial safe haven as the euro has decreased in value, likely following increased COVID-19 case counts in Eurozone countries. The higher value of the dollar may also reflect expectations of higher U.S. interest rates, following announcements that the Federal Reserve will reduce its monthly asset purchases.

Because Brent crude oil is priced in dollars, oil-importing countries that use a currency that has depreciated relative to the dollar have not experienced the full extent of falling crude oil prices. From November 1 to December 2, the price of Brent crude oil decreased $15.04/b (17.8%). However, the euro fell by 2.6% compared with the U.S. dollar over the same period, meaning countries that use the euro have not experienced as steep of a relative price decrease in crude oil compared with countries that use the U.S. dollar or have currencies pegged to the dollar.

**High yield bonds:** Bond yields for companies with a credit rating lower than investment grade, called high yield bonds, were low for energy companies as well as broadly across all sectors in the first nine months of 2021. The lower yields reflected less default risk and reduced borrowing
costs for these companies. However, yields increased slightly in October and increased more substantially in November, particularly in the second half of the month, likely in response to some of the recent economic growth concerns and heightened market volatility. The Bloomberg Barclays Energy High Yield Corporate Bond Index’s yield-to-worst (YTW), which represents the minimum achievable yield on the bonds after accounting for early prepayment, increased to 5.43% as of December 2, 2021, and the broader high yield index increased to 4.71% (Figure 4). The low bond yields for exploration and production companies along with relatively high crude oil prices should result in an ample availability of funding to support the production increase in 2022. We forecast U.S. crude oil production will average 11.8 million b/d in 2022, a 0.7 million b/d increase from this year. Production in our forecast surpasses 12.0 million b/d in 4Q22.

![Figure 4. High yield bonds yield-to-worst percent](image)

Recent declines in crude oil prices and heightened volatility increase the risk of some oil producers’ ability to repay principal and interest on their debt. Furthermore, recent increases in interest rates likely reflect some market expectations for tighter monetary policy, which would also affect high yield bonds. Despite the recent increase in yields, the energy high yield bond index has narrowed to an average of 0.61% higher than the broad high yield index in November. Also, despite the recent increase in yields, bond yields for exploration and production companies remain relatively low.

**Petroleum products**

**Gasoline prices:** The front-month futures price of RBOB (the petroleum component of gasoline used in many parts of the country) settled at $1.97 per gallon (gal) on December 2, a 44 cents/gal decrease from November 1 (Figure 5). The RBOB–Brent crack spread (the difference between the price of RBOB and the price of Brent crude oil) decreased by 8 cents/gal to settle at 31 cents/gal during the same period. The average RBOB–Brent crack spread in November was 36 cents/gal, a 7 cents/gal decrease from October.
The front-month RBOB price in November averaged $2.28/gal for the month, a 14 cent/gal decrease from October. The decrease partly reflects a decline in U.S. gasoline consumption, which fell by 0.3 million barrels per day (b/d) from October to 8.9 million b/d in November. Lower demand, combined with increased refinery production, contributed to an overall increase in gasoline inventories in the United States of almost 3.4 million barrels from October. The RBOB price decreased to $1.98/gal at the end of November, a 43 cents/gal decrease from November 1, primarily reflecting lower crude oil prices. The gasoline crack spread in late November similarly decreased to just under 30 cents/gal, its lowest level since February 2021. The decrease in RBOB prices and the crack spread likely reflected market expectations that responses to the Omicron variant could reduce demand.

**Gasoline price differentials to Europe:** In mid-November, U.S. gasoline spot price differentials to Europe narrowed to 17 cents/gal at New York Harbor (NYH) and 4 cents/gal at the U.S. Gulf Coast (USGC)—the smallest difference since 2020. Spreads in NYH narrowed further to 11 cents/gal at the end of November (Figure 6). The narrowing spreads occurred as a drop in U.S. gasoline demand coincided with increased petroleum product prices in Europe. Higher prices in Europe likely reflect increased refining costs because of higher natural gas prices, along with higher-than-average gasoline demand since July. Gasoline crack spreads in Europe have been increasing compared with the five-year average since early October, during a period when they would normally be decreasing because of colder weather and lower seasonal demand. The rising prices in Europe have contributed to the mid-November decline in differentials to U.S. prices and to decreased U.S. imports of gasoline. According to our Weekly Petroleum Status Report, the rolling four-week average of U.S. gasoline imports decreased from 949,000 b/d during the week ending October 1 to 588,000 b/d during the week ending November 5, a 38% decline.
After the U.S. gasoline premiums narrowed for much of the past month, they widened during early December amid market volatility and uncertainty over the demand impact from the Omicron variant.

**Ultra-low sulfur diesel prices**: The front-month futures price for ultra-low sulfur diesel (ULSD) for delivery in New York Harbor settled at $2.10/gal on December 2, a 40 cents/gal decrease from November 1 (Figure 7). The ULSD-Brent crack spread (the difference between the price of ULSD and the price of Brent crude oil) decreased 4 cents/gal during the same period and settled at 44 cents/gal on December 2.

The ULSD–Brent crack spread in November averaged 45 cents/gal, down 7 cents/gal from October’s average but up 25 cents/gal from November 2020. Recent changes in crude oil prices
caused by concerns about the Omicron variant increased volatility in the crack spread, which
decreased 6 cents/gal on November 26 (the largest single-day decrease since April 2020) and
then increased 7 cents/gal through December 1. We estimate that U.S. distillate consumption
increased by 0.1 million b/d (2.8%) from October to 4.2 million b/d in November, more than the
five-year average but just below 2019 levels. U.S. distillate production increased from October
as refineries came back from maintenance, but it remained below the five-year average.

Our recent *Weekly Petroleum Status Report* data show that lower-than-average distillate
production and relatively high distillate demand resulted in continued inventory drawdowns,
mainly in the Midwest (PADD 2). In the Northeast (PADDs 1A and 1B), where heating oil is used
as a primary source of home heating, inventories remained relatively flat, likely mild because of
temperatures in October and November. Inventories in the Northeast have been at least 20%
below average since mid-May.

**Retail diesel prices:** The average retail price for on-highway diesel in November was $3.73/gal,
$1.30/gal (53%) higher than in November 2020. Compared with levels before the COVID-19
pandemic, prices are 66 cents/gal (21%) higher than at the same time in 2019 (*Figure 8*). Rising
crude oil prices are the primary driver of U.S. diesel prices, making up 52% of the total cost to
produce a gallon of diesel in October 2021. Diesel serves as an input cost to other sectors of the
economy, such as trucking, where rising diesel prices have contributed to freight rates
increasing 36% year over year as of October. Although the November price was the highest since
September 2014 in nominal terms, adjusting for inflation shows that recent prices are nearly the
same in real terms as prices in 2018, but lower than prices in 2014. Compared with November
2014, November 2021 nominal prices are 2% higher, but in real terms they are 12% lower. We
forecast nominal diesel prices will decline from December 2021 and average $3.19/gal in 2022.

![Figure 8. U.S. monthly average retail diesel price](image)
Natural Gas

Prices: The front-month natural gas futures contract for delivery at the Henry Hub settled at $4.06 per million British thermal units (MMBtu) on December 2, 2021, down $1.13 cents/MMBtu from November 1, 2021 (Figure 9). The average closing price for front-month natural gas futures in November was $5.12/MMBtu, the highest November monthly average in real terms since November 2009.

Mild weather throughout November and forecasts for a warm start to December have contributed to a decline in natural gas futures prices. As weather gets colder, consumption of natural gas typically increases in the residential and commercial sectors for space heating. However, November 2021 was relatively warm; the United States experienced 479 heating degree days (HDDs), 38 fewer than the November 2011–20 average of 517 HDDs. Milder temperatures affected demand for natural gas in the residential and commercial sectors. We estimate that combined residential and commercial natural gas consumption was 26.7 billion cubic feet per day (Bcf/d) in November, 1.0 Bcf/d less than the five-year (2016–20) average.

Less-than-average natural gas consumption in the residential and commercial sectors in November resulted in natural gas storage levels increasing against their five-year average (Figure 10). U.S. natural gas storage typically experiences a net draw during November. Injections often continue through mid-November, but those injections are usually more than offset by draws in the second half of the month. We estimate that U.S. working natural gas inventories decreased by 103 Bcf during November, which was 3.5% less than the five-year average inventory change for that time. At the end of the month, we estimate that storage inventories totaled 3,540 Bcf, which was 3.0% below the five-year average.
The spread between international and domestic natural gas prices remained high in November and contributed to high demand for U.S. liquefied natural gas (LNG) exports. International LNG spot and forward prices established records during the first week of October in northern Asia and Europe. They remained high throughout November. U.S. LNG exports averaged 10.7 Bcf/d in November, or approximately 104% of total nameplate LNG export capacity. We forecast LNG exports will continue to increase between December 2021 and late 2022 as a result of the optimization of operations at Cheniere’s Sabine Pass and Corpus Christi terminals; the completion of Train 6 at Sabine Pass LNG, which started producing LNG in November; and the completion of a new LNG terminal at Calcasieu Pass, Louisiana. We forecast LNG exports will average 11.1 Bcf/d from December 2021 to February 2022, with exports above 11 Bcf/d in each month during that period. If those levels are reached, December would be the first month on record in which U.S. LNG exports are more than 11 Bcf/d.

**Historical volatility:** Volatility of U.S. natural gas futures prices has risen in the past three months (Figure 11). Historical volatility measures the magnitude of daily changes in closing prices for a commodity during a given time in the past. Based on rolling front-month contracts, the 30-day historical volatility of U.S. natural gas futures prices was 29.8% for April through August of this year. In September, volatility rose to 49.4%, compared with the 2015–19 September average of 30.6%. In October, volatility once again rose to 78.3%, compared with the 2015–19 October average of 32.7%. In November, historical volatility averaged 85.0%, compared with the 2015–19 November average of 53.7%. During November, daily front-month prices for intraday natural gas futures contracts ranged as high as $5.88/MMBtu on November 4, and as low as $4.48/MMBtu on November 30.
We forecast the Henry Hub spot price will average $4.50/MMBtu in December, $4.64/MMBtu in January, and $4.61/MMBtu in February. These prices are lower than we forecast last month. We expect U.S. working natural gas in storage to end March at 1,659 Bcf, which is 36 Bcf higher than forecast last month. However, this forecast is highly uncertain as reflected in the recent price volatility. Weather, which is a significant source of uncertainty in this forecast, will continue to be a key indicator of price formation this winter.

**Notable forecast changes**

- The December STEO forecast incorporates the latest updates to EIA’s *International Energy Statistics*, including historical petroleum consumption and production data for all non-OECD countries for 2019 and updated 2020 petroleum consumption data for several of the largest consuming countries. These historical data updates resulted in us lowering supply and consumption data for 2019 and 2020, and lowering total supply and consumption forecasts through 2022. We made the most significant revisions to data for Argentina, Brazil, Russia, and Hong Kong for 2019 and 2020. We also made additional revisions to a number of data series from 2000 to 2019 that resulted in lower values for consumption, which were offset by nearly equivalent reductions to refinery gains for most countries. These changes to historical data are reflected in our forecast.

- We forecast natural gas spot prices at Henry Hub will average $4.58/MMBtu in 1Q22, compared with a forecast of $5.24/MMBtu in the November STEO. The lower forecast reflects our expectation that U.S. natural gas inventories will finish the withdrawal season at the end of March at a higher level than previously expected.
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 therefore should not be construed as representing those of the U.S. Department of Energy or other federal agencies.