Global liquid fuels

- The May Short-Term Energy Outlook (STEO) is subject to heightened levels of uncertainty resulting from a variety of factors, including Russia’s full-scale invasion of Ukraine. This STEO assumes U.S. GDP will grow by 3.1% in both 2022 and 2023, following growth of 5.7% in 2021. We use the S&P Global macroeconomic model to generate our U.S. economic assumptions. Global macroeconomic assumptions in our forecast are from Oxford Economics and include global GDP growth of 3.4% in 2022 and 3.5% in 2023, compared with growth of 6.0% in 2021. A wide range of potential macroeconomic outcomes could significantly affect energy markets during the forecast period. Major factors driving energy supply uncertainty include how sanctions affect Russia’s oil production, the production decisions of OPEC+, and the rate at which U.S. oil and natural gas producers increase drilling.

- The Brent crude oil spot price averaged $105 per barrel (b) in April, a $13/b decrease from March. Although down from March, crude oil prices remain above $100/b following Russia’s full-scale invasion of Ukraine. Sanctions on Russia and other independent corporate actions contributed to falling oil production in Russia and continue to create significant market uncertainties about the potential for further oil supply disruptions. These events occurred against a backdrop of low oil inventories and persistent upward oil price pressures. Global oil inventory draws averaged 1.7 million barrels per day (b/d) from the third quarter of 2020 (3Q20) through the end of 2021. We estimate that commercial oil inventories in the OECD ended 1Q22 at 2.63 billion barrels, up slightly from February, which was the lowest level since April 2014.

- We expect the Brent price will average $107/b in 2Q22 and $103/b in the second half of 2022 (2H22). We expect the average price to fall to $97/b in 2023. However, this price forecast is highly uncertain. Actual price outcomes will largely depend on the degree to which existing sanctions imposed on Russia, any potential future sanctions, and independent corporate actions affect Russia’s oil production or the sale of Russia’s oil in the global market. We completed this outlook on May 5, therefore it does not include an EU ban on oil imports from Russia. However, the bans being reported at the time of writing would likely contribute to tighter oil balances and higher oil prices than our current forecast. In addition, the degree to which other oil producers respond to current oil prices and the effects macroeconomic developments might have on global oil
demand will be important for oil price formation in the coming months. We reduced Russia’s oil production in this month’s forecast compared with our April forecast, and we now expect oil markets to be mostly balanced from 2Q22 through the end of 2023. Because oil inventories are currently low, we expect downward oil price pressures will be limited and market conditions will exist for significant price volatility.

- We estimate that 97.4 million b/d of petroleum and liquid fuels was consumed globally in April 2022, an increase of 2.1 million b/d from April 2021. We forecast that global consumption of petroleum and liquid fuels will average 99.6 million b/d for all of 2022, which is a 2.2 million b/d increase from 2021. We revised down our forecast for 2022 global consumption of petroleum and liquid fuels by 0.2 million b/d from the April STEO, primarily as a result of downward revisions to consumption growth in China and the United States. We forecast that global consumption of petroleum and liquid fuels will increase by 1.9 million b/d in 2023 to average 101.5 million b/d.

- U.S. crude oil production in the forecast averages 11.9 million b/d in 2022, up 0.7 million b/d from 2021. We forecast that production will increase to more than 12.8 million b/d in 2023, surpassing the previous annual average record of 12.3 million b/d set in 2019.

**Natural gas**

- In April, the Henry Hub natural gas spot price averaged $6.59 per million British thermal units (MMBtu), which was up from the March average of $4.90/MMBtu and higher than the April 2021 average of $2.66/MMBtu. We expect the Henry Hub price to average $7.83/MMBtu in 2Q22 and average $8.59/MMBtu in 2H22. High forecast natural gas prices reflect our expectation that natural gas storage levels will remain less than the five-year (2017–2021) average this summer. Lower-than-average storage levels partly result from limited opportunities for natural gas-to-coal switching for power generation, which we forecast will keep the demand for natural gas for power generation high despite high prices. Natural gas prices could rise significantly above forecast levels if summer temperatures are hotter than assumed in this forecast and electricity demand is higher. In addition, we expect that U.S. liquefied natural gas exports (LNG) will remain high during the summer. We expect the Henry Hub spot price will average $4.74/MMBtu in 2023. The forecast drop in prices for 2023 reflects our expectation that the rate of natural gas production will increase next year while LNG export and demand growth slow, contributing to higher storage levels in 2023 than in 2022.

- We estimate that natural gas inventories ended April at 1.6 trillion cubic feet (Tcf), which is 17% below the five-year average. Inventories at the end of April were 190 billion cubic feet (Bcf) higher than at the end of March. This increase was below the five-year average as a result of below-normal temperatures that raised demand for natural gas for heating amid relatively flat production. We expect natural gas inventories to increase by 418 Bcf in May, ending the month at 2.0 Tcf, which would be 14% below the
five-year average for this time of year. We forecast that natural gas inventories will end the 2022 injection season (end of October) at almost 3.4 Tcf, which is 9% below the five-year average. However, summer temperatures will be key to storage, and a hotter-than-normal summer that results in high electricity demand could cause inventories to be lower than forecast and result in prices that are higher than forecast.

- In April, U.S. LNG exports averaged 11.6 billion cubic feet per day (Bcf/d), slightly below an all-time peak of almost 12.0 Bcf/d set in March. We forecast that U.S. LNG exports will average 12.1 Bcf/d from May through August, which is slightly lower than our previous forecast. This forecast reflects our assumption of slightly lower LNG demand in Asia and Europe this summer compared with our previous assumption, in part because of sustained high natural gas prices. We expect U.S. LNG exports to average 12.0 Bcf/d this year, a 23% increase from 2021. Growth in LNG exports in recent years has been driven by capacity expansions. However, we do not expect any new export facilities to come online in the forecast period, and as a result, forecast growth in LNG exports slows to 5% in 2023, with LNG exports averaging 12.6 Bcf/d for the year.

- We expect that U.S. consumption of natural gas will average 85.7 Bcf/d in 2022, up 3% from 2021. The increase in U.S. natural gas consumption is a result of colder temperatures and related higher consumption in the residential and commercial sectors in 2022 compared with 2021. We also expect the industrial sector to consume more natural gas in 2022 in response to expanding economic activity. In addition, forecast natural gas consumption in the electric power sector increases in 2022 because of limited natural gas-to-coal switching despite high natural gas prices. For 2023, we forecast natural gas consumption will average 85.3 Bcf/d, down 1%, mostly as a result of assumed milder winter temperatures (based on forecasts from the National Oceanic and Atmospheric Administration) that will reduce residential and commercial consumption.

- We estimate dry natural gas production averaged 95.5 Bcf/d in the United States in April, up 0.4 Bcf/d from March. Although production in April was lower than the recent peak in December 2021, it increased in each of the past two months. Periods of below-normal temperatures and snow in some producing regions, along with seasonal maintenance on pipelines, limited the production increases in April compared with March. We forecast dry natural gas production to average 95.8 Bcf/d in May. For all of 2022, we expect that dry natural gas production will average 96.7 Bcf/d, which would be 3.2 Bcf/d more than in 2021. We expect dry natural gas production to average 101.7 Bcf/d in 2023.

*Electricity, coal, renewables, and emissions*

- We forecast that the annual share of U.S. electricity generation from renewable energy sources will rise from 20% in 2021 to 22% in 2022 and to 23% in 2023 because of continuing increases in solar and wind generating capacity. We forecast that natural gas
will provide almost 37% of generation in 2022, which is similar to the level in 2021, and we forecast natural gas generation will provide 36% of generation in 2023. Despite significantly higher natural gas fuel costs this year compared with last year, we do not expect an increase in electricity generation from coal-fired power plants, which have in the past acted as a primary substitute for natural gas in the power industry. Along with the continued retirement of coal-fired generating capacity, the remaining coal fleet has been facing constraints in regard to fuel delivery and coal stocks. We forecast coal will provide 21% of total U.S. generation 2022 and 20% in 2023, compared with a share of 23% last year. Nuclear generation remains relatively constant in the forecast at an average share between 19% and 20%. One nuclear reactor will retire during 2022, and two reactors at the Vogtle nuclear power plant are scheduled to come online in 2023, the first new nuclear units to open in the United States since 2016.

- Planned additions to U.S. wind capacity increase wind electricity generation in our forecast. We estimate that the U.S. electric power sector added 14 GW of wind capacity in 2021. Wind capacity additions in the forecast total 10 GW in 2022 and 4 GW in 2023. The electric power sector added 13 GW of utility-scale solar capacity in 2021, and forecast solar capacity additions in the power sector total 20 GW for 2022 and 23 GW for 2023. We expect additions to solar capacity and batteries to account for more than half of new electric sector capacity in 2022 and 2023. In addition, in 2021 small-scale solar (systems less than 1 megawatt) rose by 5 GW to 33 GW. We expect that small-scale solar capacity will grow by 5 GW in 2022 and 6 GW in 2023.

- U.S. coal production in the forecast increases by 20 million short tons (MMst) (3%) in 2022 to 598 MMst and by 7 MMst (1%) in 2023. We expect production in the Western region to drive the forecast increases. The forecast increase occurs despite our expectation that coal use in the power sector will decline. We expect rising coal production will replenish electric power sector inventories in 2023 that were depleted during 2021. We also expect coal exports will remain at high levels during the forecast period as a result of high global coal prices. Although exports and inventory builds contribute to rising coal production in the forecast, labor shortages, rail congestion, and challenges obtaining equipment are expected to limit production gains.

- U.S. energy-related carbon dioxide (CO₂) emissions increased by more than 6% in 2021 as a result of rising energy use. We expect a 2% increase in energy-related CO₂ emissions in 2022, primarily from growing transportation-related petroleum consumption. Forecast energy-related CO₂ emissions remain relatively unchanged in 2023. We expect petroleum emissions to increase by 3% in 2022 compared with 2021 before growth slows to 1% in 2023. Natural gas emissions rise by 3% in our forecast for 2022, then remain unchanged in 2023. We forecast that coal-related CO₂ emissions will fall by 2% in 2022 and by 5% in 2023.
Prices: The front-month futures price for Brent crude oil settled at $110.90 per barrel (b) on May 5, 2022, an increase of $6.51/b from the April 1, 2022, price of $104.39/b. The front-month futures price for West Texas Intermediate (WTI) crude oil for delivery at Cushing, Oklahoma, increased by $8.99/b during the same period, settling at $108.26/b on May 5 (Figure 1).

![Figure 1. Crude oil front-month futures prices](image)

The April monthly average front-month Brent crude oil price was $106/b, $7/b less than the March 2022 average but $41/b more than April 2021. The monthly average WTI crude oil price was $102/b, similarly $7/b less than March 2021 and $40/b more than April 2021. Monthly average crude oil prices in April decreased slightly from March levels but remained near the highest prices since 2014 on an inflation-adjusted basis. The possibility of oil supply disruptions resulting from Russia’s full-scale invasion of Ukraine and associated sanctions on Russia continue to contribute to the Brent crude oil price remaining above $100/b. This uncertainty is occurring amid low inventory levels globally. Relatively slow increases in global oil production amid more rapid increases in consumption contributed to global inventories declining for six consecutive quarters from the third quarter of 2020 to the fourth quarter of 2021 (3Q20 through 4Q21). Global inventories increased in 1Q22 as a result of reduced January consumption related to COVID-19 measures, reduced March consumption related to COVID-19 responses in China, and relatively steady global production increases; declines in Russia’s oil production were not substantial until April. At the same time, potential decreases in demand from factors including the ongoing severe COVID-19 containment measures in China, particularly in Shanghai, as well as a decrease in the reported first-quarter U.S. GDP estimate contributed to lower crude oil prices relative to March.
In addition to the decrease in monthly average prices in April, crude oil price volatility declined compared with the high level of volatility in March. The Brent crude oil price range in April was $17/b, down from a $42/b range in March. Although narrower than in March, the range in prices remains wider than in any month during 2021. Many of the key uncertainties that we noted in last month’s STEO remain, including:

- The impact of sanctions on Russia in relation to its full-scale invasion of Ukraine and the ongoing effect of current sanctions and private sector actions
- The potential for new sanctions on Russia, including the discussion of an EU-wide ban on energy imports from Russia, and the pace of its implementation
- The pace of petroleum demand growth through the summer and the potential for demand destruction because of high retail fuel prices
- The volume of new crude oil production that will come online at price levels near or above $100/b
- The potential for renewed resurgences in COVID-19 cases and the nature of government responses
- The ongoing impact of the coordinated release of petroleum supplies from strategic reserves in the United States and in Europe
- Other geopolitical uncertainties related to Libya, the ceasefire in Yemen, or potential new developments on an Iran deal

In this month’s STEO, we expect lower global crude oil and other liquid fuels production in the forecast compared with last month’s outlook, contributing to relatively balanced oil markets through the end of 2023. We estimate that OECD commercial liquid inventories in April were 315 million barrels below their five-year (2017–2021) April average, the lowest amount relative to the five-year average in our data going back to 2004. We expect some builds in global oil inventories will allow OECD inventories to move closer to the five-year average, particularly in the second half of 2022, which could contribute to limited downward pressure on crude oil prices. We expect the monthly average Brent price to remain above $100/b for the rest of 2022, but we forecast the Brent crude oil spot price will decrease to an average of $102/b in 4Q22 and $97/b by 4Q23 (Figure 2). Although we forecast some price declines, the possibility for significant crude oil price increases and high volatility remains, given low inventory levels and the wide range of possible outcomes for oil supply, particularly from Russia.
Our Brent crude oil price forecast of $97/b in 2023 is up $5/b compared with our forecast from the April 2022 *Short-Term Energy Outlook*. The higher forecast price reflects our expectation that oil markets will be relatively balanced in the forecast compared with our expectation of inventory builds last month, and we now forecast OECD commercial inventories to remain below their five-year average throughout the forecast period. This downward revision in OECD inventories is a result of our forecast for lower supply growth because we expect production declines in Russia to persist throughout the forecast period. Our forecast for total liquid fuels production in Russia from 2Q22 through the end of 2023 is 0.6 million b/d lower in this month’s outlook compared with last month. This forecast assumes existing sanctions as of May 5. Actual price outcomes will be affected by the degree to which existing sanctions imposed on Russia, any potential future sanctions, and independent corporate actions affect Russia’s oil production or the sale of Russia’s oil in the global market. We expect this supply reduction to only partially be offset by lower consumption expectations in China as well as the effect of lower global economic growth on global oil consumption.

**Crude oil and inflation expectations:** The spread between five-year treasury bonds and Treasury Inflation-Protected Securities (TIPS) is one indicator of financial market expectations of inflation because it measures the difference in yields between Treasury bonds that adjust their yield with the Consumer Price Index (CPI) and those that do not. In March 2022, the spread reached 3.6%, its highest level since at least 2003, and averaged 3.4% throughout the month (*Figure 3*).
The spread decreased sharply during the onset of the COVID-19 pandemic in 2020 but has increased since mid-2020 and had risen above pre-COVID levels by the end 1Q21. Inflationary concerns can encourage market participants to invest in commodities and commodity-derived assets, such as crude oil or precious metals, which tend to increase in value in highly inflationary environments. As a result, higher inflationary expectations can contribute to increased demand for crude oil-backed contracts, which can contribute to higher commodity prices and associated securities. At the same time, higher energy prices can contribute to increased inflation and inflationary concerns, either directly—through increased consumer fuel prices—or indirectly—through higher transportation costs for finished goods. These interrelated effects tend to result in a high correlation between crude oil prices and the TIPS-Treasury spread.

The March TIPS-Treasury spread increased by 0.5 percentage points compared with the February monthly average, and like crude oil prices, the TIPS-Treasury spread decreased slightly in April, falling 0.1 percentage points from March to average 3.3%. The April average spread was 0.8 percentage points higher than the April 2021 level and still 0.4 percentage points higher than February 2022. Sustained higher crude oil prices as a result of market fundamentals discussed previously are likely to continue contributing to inflationary concerns. At the same time, the TIPS-Treasury spread and inflationary concerns can also result from other macroeconomic indicators as well as the prices of other staple commodities that comprise a significant share of the CPI.

**Crude oil price differentials:** In April, the differential between crude oil grades with high API gravity and low sulfur content (sweet) and those with medium API gravity and higher sulfur contents (sour) narrowed compared with March (Figure 4). In the crude oil markets review in last month’s STEO, we noted the widening of the spread between Houston-based Mars medium sour crude oil prices and the price of Brent and Light Louisiana Sweet (LLS) crude oil grades, despite the impact of sanctions on the availability of Russia’s medium sour Urals grade crude oil.
Mars crude oil has an API gravity of 28 and a sulfur content of 1.93%, making it more comparable to Russia’s Urals grade (API gravity of 30.6, sulfur content of 1.48%) than LLS (API gravity of 38.5, sulfur content of 0.39) or Brent (API gravity of 37.9, sulfur content of 0.45%). In April, both the Mars-Brent and Mars-LLS spreads have contracted sharply, suggesting that the effect of sanctions and self-sanctioning by many crude oil buyers has contributed to less availability of medium sour crude oil, contributing to higher prices for medium sour grades such as Mars relative to lighter grades such as Brent or LLS.

In April, the five-day moving average of the Mars-Brent spread narrowed by $3.87/b from April 1 to May 5, while the Mars-LLS spread narrowed by $1.17/b compared with April 1. Both spreads are still wider than they were around the same time last year; the Mars-Brent spread widened by $1.14/b and the Mars-LLS spread widened by $1.34/b compared with May 5, 2021. Although trade press reports indicate Russia’s medium sour crude oil grades have been selling at a substantial discount to other benchmark grades because of sanctions and private company boycotts, the increasing shipping prices and associated insurance prices needed to take possession of Russia’s crude oil are likely contributing to increased end-user prices for buyers still willing to purchase Russia’s crude oil. These increased delivered prices may be mitigating the value of the wholesale discount that is captured by potential buyers. Given the narrowing of light-medium crude oil quality spreads in April, it is unlikely that discounts on Russia’s crude oil are effectively pulling down medium sour crude oil prices globally, while higher prices associated with less availability of medium sour crude grades from outside of Russia—such as Mars—are now becoming apparent.

The narrowing Mars-Brent spread also reflects regional effects, primarily a narrowing spread between crude oils from Europe such as Brent with U.S.-based crude oils such as WTI, Mars, and LLS. Although the impact of sanctions on Russia initially manifested predominately in the Brent price—a global benchmark linked geographically to Europe—the call on global crude oil supplies
by European refiners has begun to affect other regional markets as global refiners make crude oil purchases and reroute ships. As a result, the difference between the Mars-LLS spread and the Mars-Brent spread, which incorporates this global dynamic, has decreased considerably. As of May 5, the difference between the Mars-Brent spread and the Mars-LLS spread decreased to $1.06/b, compared with a monthly average of $4.67/b in March.

**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 $3.66 per gallon (gal) on May 5, up 51 cents/gal from April 1 (Figure 5). The RBOB–Brent crack spread (the difference between the price of RBOB and the price of Brent crude oil) settled at $1.02/gal on May 5, up 35 cents/gal during the same period. The RBOB–Brent crack spread increased by 11 cents/gal (13%) on April 27, the third-highest daily percentage increase in 2022 (March 1 marked the highest increase when the RBOB futures contract rolled to a new month reflecting more expensive summer grade gasoline).

April’s increasing RBOB–Brent crack spread was likely due to decreasing gasoline inventories. We estimate that U.S. gasoline inventories decreased from March to April by 8.2 million barrels (3.5%). One reason for this inventory decrease was increased driving. We estimate that gasoline consumption increased to 8.7 million barrels per day (b/d) in April, a 0.1 million b/d (1%) increase from March. Gasoline inventories have been particularly low on the East Coast where, according to our *Weekly Petroleum Status Report* (WPSR), inventories on April 22 were at their lowest levels since November 2014. The RBOB futures contract is for delivery in New York Harbor (NYH), and particularly low inventories in that region could be contributing to higher RBOB-Brent crack spreads. Gasoline inventories in the Northeast (PADD 1A and 1B) were 28 million barrels on April 22, according to WPSR data, the lowest level for April since 2011. Low inventories and high RBOB prices likely supported imports from international markets in late
April. Gasoline imports to the East Coast in the week ending April 29 were 812,000 b/d, the highest since the week ending October 1, 2021, according to WPSR data.

*Ultra-low sulfur diesel prices:* The front-month futures price for ultra-low sulfur diesel (ULSD) for delivery in New York Harbor settled at $4.04/gal on May 5, a 62 cents/gal increase from April 1 (Figure 6). The ULSD-Brent crack spread (the difference between the price of ULSD and the price of Brent crude oil) increased by 46 cents/gal during the same period and settled at $1.40/gal on May 5. The ULSD-Brent average crack spread in April was the highest recorded in real terms in data going back to July 1988. The ULSD front-month futures average price in April was the highest in real terms since February 2013.

![Figure 6. Historical ULSD front-month futures prices and crack spreads](image)

High global demand and low inventories continued to support higher distillate prices and crack spreads in April. Distillate exports from Russia have declined as a result of sanctions. This drop in global supply combined with refinery closures over the past few years has produced a tight U.S. distillate market. U.S. distillate stocks declined by 9.4 million barrels (8%) from March, falling to 24% below the five-year average. Increased *trucking activity* and increased distillate demand for oil and natural gas drilling could be contributing to higher domestic diesel demand and supporting ULSD prices. In addition, distillate exports are contributing to lower stock levels. Our estimate for April net distillate exports of 1.3 million b/d, if confirmed in monthly data, would be the highest amount of net distillate exports since September 2019.

Front-month ULSD prices increased significantly in the last week of April and may have been the result of reduced liquidity in the expiring May ULSD futures contract. *Liquidity* in financial markets refers to the ease of buyers and sellers to make trades at stable, transparent prices. During periods of low liquidity, market participants may need to bid at price levels higher or lower than during periods of ample liquidity to transact in the market. From April 25 to April 28, the May ULSD futures contract increased $1.04/gal (26%), and the June ULSD futures contract
increased 35 cents/gal (10%), suggesting low liquidity ahead of expiration may have added price volatility. This volatility was also evident when comparing the May ULSD futures price with Brent crude oil. ULSD futures prices usually follow movements in the underlying price of crude oil because it makes up the largest part of the overall cost to produce diesel fuel. However, between April 25 and April 28 when ULSD futures prices increased by 26%, Brent crude oil futures prices increased by just 5%.

**International distillate crack spreads:** Global spot distillate crack spreads at the major global trading hubs in Amsterdam, Rotterdam, and Antwerp (ARA); Singapore; and NYH increased substantially in April. The ARA ULSD-Brent crack spread averaged $1.07/gal, the Singapore-Dubai crack spread averaged 83 cents/gal, and the NYH ULSD-Brent crack spread averaged $1.55/gal (Figure 7). On average, inventories in all three trading hubs have been more than 30% below the five-year average since the beginning of the year. However, crack spreads increased more at the Singapore and NYH trading hubs as new dynamics interacted with the already tight global distillate market. In Singapore, lower refinery runs in China as a result of mobility restrictions in response to increased COVID-19 cases as well as lower export quotas constrained regional petroleum trade, leading the crack spread to nearly double from 43 cents/gal in March. In NYH, increasing distillate exports in the U.S. Gulf Coast, fewer imports from Europe, and lower refining capacity in PADD 1 pushed the crack spread to reach its highest level on record. Meanwhile, concerns about replacing Russia’s distillate exports to Europe continued to drive ARA crack spreads higher, rising by 25 cents/gal over March.

![Figure 7. International ULSD crack spreads](image)

*Source: Based on data from CME Group, as compiled by Bloomberg L.P.*  
*Note: ARA=Amsterdam, Rotterdam, and Antwerp; ULSD=ultra-low sulfur diesel; NYH=New York Harbor*

**Natural gas**

**Prices:** On May 5, 2022, the front-month natural gas futures contract for delivery at the Henry Hub settled at $8.78 per million British thermal units (MMBtu), which was up $3.06/MMBtu
from April 1, 2022 (Figure 8). The average closing price for front-month natural gas futures contracts in April was $6.70/MMBtu, the highest April monthly average in real terms since 2008.

Figure 8. U.S. natural gas front-month futures prices and current storage deviation from five-year average

[Graph showing natural gas futures prices and storage deviation]

The average front-month natural gas futures price for the month of April increased $1.73/MMBtu from its monthly average in March. Several factors have contributed to the rapid increase in natural gas futures prices:

- Storage inventories below the five-year average
- Steady demand, driven by the high levels of U.S. liquefied natural gas (LNG) exports, a cooler-than-normal spring that contributed to higher levels of residential and commercial demand, and high demand in the electric power sector
- Lower-than-expected increases in dry natural gas production

April’s natural gas stock builds were lower than the five-year (2017–2021) average by 33 billion cubic feet (Bcf). At the end of the month, natural gas inventories were at 1,597 Bcf, which is 320 Bcf (17%) below the five-year average. U.S. LNG exports reached a record-high level in March at just under 12.0 Bcf/d, and averaged 11.6 Bcf/d in the first quarter of 2022 (1Q22). We estimate LNG exports averaged 11.6 Bcf/d in April. High export levels are supported by high international LNG prices, as well by additional export capacity created by a new U.S. LNG export facility, Calcasieu Pass LNG, which exported its first LNG cargo on March 1 and continues to ramp up production. U.S. dry natural gas production reached 97.0 Bcf/d in December 2021 before declining to 94.1 Bcf/d in February, partially as a result of freeze-offs in key producing regions. Dry natural gas production has yet to return to its December level and averaged 95.5 Bcf/d in April, partly because of cost increases for key input materials as well as labor shortages that are limiting the ability of producers to use more rigs for increased production.
Supply and demand balance: Comparing overall U.S. production and consumption balances is a helpful indicator in determining the trajectory of natural gas prices. When natural gas supply (production plus imports) is lower than natural gas demand (consumption plus exports), natural gas prices increase because more natural gas is pulled from storage to meet demand. Natural gas demand has exceeded supply since February 2021. We expect this trend to continue through 2022, and we expect the Henry Hub spot price will remain elevated, averaging $8.34/MMBtu from 2Q22 through 4Q22. Limited opportunities for natural gas-to-coal switching for power generation keep the use of natural gas for power generation high in our forecast despite high natural gas prices. This dynamic creates conditions for natural gas prices to rise significantly above forecast levels, particularly if summer temperatures are hotter than assumed in this forecast and lead to higher-than-expected levels of electricity demand. However, we forecast supply to begin outpacing demand by early 2023 as producers steadily increase production in response to higher natural gas prices as well as higher oil prices, and demand stays relatively constant given close to normal weather conditions forecast in 2023 (Figure 9).

Futures price spreads: The natural gas 1st–13th price spread averaged $2.36/MMBtu in April, the highest backwardation (where near-term contract prices are higher than longer-dated contract prices) since October 2005, when it averaged $2.50/MMBtu (Figure 10). Often, the 1st–13th price spread increases when natural gas inventories are below the five-year range, and the price spread often decreases when inventories are above the five-year range. With inventories starting the injection season below the five-year average, high demand for natural gas is pushing prices up in the short term. The combination of low storage inventories to start the injection season, high demand for U.S. LNG exports, and lower-than-expected production levels are all contributing to near-term natural gas prices being much higher now compared with natural gas for delivery next year. We expect natural gas prices to remain high throughout the summer because opportunities for natural gas-to-coal switching for power generation are limited,
production increases will take several months to emerge, and continued high levels of LNG exports will contribute to high demand.

**Notable forecast changes**

- Russia’s liquid fuels production in the May STEO averages 10.0 million barrels per day (b/d) in 2022, which is 0.4 million b/d less than we forecast in the April STEO. Our forecast for Russia’s production averages 9.1 million b/d in 2023, which is 0.6 million b/d less than we forecast in the April STEO. The updated forecast reflects a larger drop in production during April than we had expected, lowering the starting point for our forecast.

- We have reevaluated our modeling of electricity generation to better account for the current constraints on the deliveries of coal and inventories at coal-fired power plants. Coal-fired power plants have been running more selectively in recent months as a result of low coal inventory levels and reduced abilities to replenish those inventories because of mine closures, rail capacity constraints, and labor market tightness. Coal plants have been running at high levels during peak demand periods in the winter and summer, but scaling-back operations during the shoulder months to conserve coal supply. These changes contributed to a shift toward natural gas generation and away from coal compared with our forecast in the April STEO, despite higher natural gas prices in this forecast. We now forecast coal generation in 2022 will decline by 30 billion kilowatthours (kWh) (3%) compared with a forecast increase of 27 billion (3%) kWh in the last STEO. Conversely, forecast natural gas generation rises by 13 billion kWh (1%) in this STEO compared with a forecast decline of 66 billion kWh (5%) in last month’s outlook.
• The Henry Hub spot price in our forecast averages $7.42 million British thermal units (MMBtu) in 2022, which is $2.19/MMBtu higher than our forecast in the April STEO. The higher forecast is mostly the result of updates to our power generation model to better account for coal market constraints.

• We expect natural gas inventories will end October at almost 3.4 trillion cubic feet, which is 9% below the five-year average, compared with our forecast of 4% below the five-year average in last month’s STEO. The lower storage levels largely reflect higher expected power generation this summer compared with last month’s forecast.

• U.S. coal production in our forecast totals 598 million short tons in 2022, up 3% from 2021. In last month’s forecast, we expected coal production to rise 7% from 2021. The updated forecast reflects adjustments to our power generation model that resulted in lower coal demand than previously forecast.

• You can find more information in the detailed table of forecast changes.