Short-Term Energy Outlook

Forecast highlights

Winter Fuels Outlook

- In our Winter Fuels Outlook, we forecast that average household expenditures for home heating fuels will increase this winter because of both higher expected fuel costs and higher energy consumption due to colder temperatures. Compared with last winter, in nominal terms, we forecast expenditures for homes that heat with natural gas will rise by 28%, heating oil by 27%, electricity by 10%, and propane 5% from October–March.

Global liquid fuels

- The Brent crude oil spot price in our forecast averages $93 per barrel (b) in the fourth quarter of 2022 (4Q22) and $95/b in 2023. Potential petroleum supply disruptions and slower-than-expected crude oil production growth could lead to higher oil prices, while the possibility of slower-than-forecast economic growth may contribute to lower prices.
- OPEC+ announced a production cut of 2 million barrels per day (b/d) on October 5. OPEC crude oil production in our forecast falls from an average of 29.6 million barrels per day (b/d) in September to an average of 28.6 million b/d over 4Q22 and 1Q23.
- U.S. crude oil production in our forecast averages 11.7 million b/d in 2022 and 12.4 million b/d in 2023, which would surpass the record high set in 2019.
- We forecast that global consumption of liquid fuels will rise by an average of 2.1 million b/d for all of 2022 and by an average of 1.5 million b/d in 2023.
- U.S. retail gasoline prices in our forecast average $3.80 per gallon (gal) in 4Q22 and $3.57/gal in 2023. Retail diesel prices average $4.86/gal in 4Q22 and $4.29/gal in 2023.
- We expect U.S. gasoline consumption in 2022 to average 8.8 million b/d, down 40,000 b/d from 2021, and we expect it to stay near that level in 2023, with rising fuel efficiency offsetting price- and economy-driven increases in transportation demand.

Natural gas

- We expect the Henry Hub natural gas spot price to average about $7.40 per million British thermal units (MMBtu) in 4Q22 and then fall below $6.00/MMBtu in 2023 as U.S. natural gas production rises.
We forecast that U.S. natural gas inventories will end the injection season (April–October) at nearly 3.5 Tcf, which would be 6% below the five-year (2017–2021) average.

U.S. consumption of natural gas will average 87.9 billion cubic feet per day (Bcf/d) in 2022, up 3.9 Bcf/d from 2021, reflecting more consumption across almost all sectors. Consumption falls by 2.6 Bcf/d in the 2023 forecast because of lower consumption in the electric power and industrial sectors.

In 3Q22, U.S. dry natural gas production averaged 98.5 Bcf/d, up from 95.1 in 1Q22. We forecast natural gas production to average 99.1 Bcf/d in 4Q22 and 99.6 Bcf/d in 2023.

Electricity, coal, renewables, and emissions

We expect U.S. sales of electricity to ultimate customers to rise by 2.7% in 2022, mostly because of more economic activity but also because of slightly hotter summer weather than last year. We forecast U.S. sales of electricity to fall by 0.9% in 2023.

Increases in U.S. electricity generation in our forecast come almost entirely from solar and wind. We expect renewable sources will provide 22% of U.S. generation in 2022 and 24% in 2023, up from 20% in 2021.

Natural gas fuels 38% of U.S. electricity generation in 2022, up from 37% in 2021, but we forecast it to fall back to 36% in 2023. Coal-fired electricity generation falls from 23% of the U.S. total last year to 20% in 2022 and 19% in 2023. Growing generation from renewable sources limits growth in natural gas-fired generation, and coal’s generation share declines because of the expected retirement of some coal-fired capacity.

We forecast that wholesale electricity prices at major power trading hubs will be about 20-60% higher on average this winter. The highest wholesale electricity prices are likely to be in New England because of possible natural gas pipeline constraints, reduced fuel inventories for power generation, and uncertainty regarding liquefied natural gas (LNG) shipments given the tight global supply conditions.

We forecast the U.S. residential price of electricity will average 14.9 cents per kilowatthour in 2022, up 8% from 2021. Higher retail electricity prices largely reflect an increase in wholesale power prices, which are driven by higher natural gas prices.

U.S. coal production in the forecast increases by 20 million short tons (MMst) in 2022 to total 598 MMst for the year. We expect coal production will fall to 581 MMst in 2023.

We expect energy-related carbon dioxide emissions in the United States to increase by 1.5% in 2022 and then to decrease 2.3% in 2023 to just under 2021 levels.
Petroleum and Natural Gas Markets Review

Crude oil

**Prices:** The front-month futures price for Brent crude oil settled at $94.42 per barrel (b) on October 6, an increase of $2.06/b from the September 1 price of $92.36/b. The front-month futures price for West Texas Intermediate (WTI) crude oil for delivery at Cushing, Oklahoma, increased by $1.84/b during the same period, settling at $88.45/b on October 6 (Figure 1). These price increases are mostly attributable to expectations around crude oil production cuts by OPEC+ producers, which were announced at 2 million b/d on October 5. From September 30 to October 6, the front-month futures price for Brent crude oil increased by $6.46/b and the front-month futures price for WTI crude oil increased by $8.96/b.

Prior to the OPEC+ announcement and the speculation of cuts in the days immediately preceding the announcement, crude oil prices were generally decreasing due to increasing concerns around weakening global economic conditions. In addition, the 180 million barrel Strategic Petroleum Reserve release conducted in recent months may also have relieved supply concerns. The front-month futures price for Brent crude oil averaged $7/b lower in September than in August. September marked the third consecutive month in which the Brent crude oil futures price decreased, bringing the total decrease to $27/b in those three months. These decreases in crude oil prices have not affected all countries evenly, however, because Brent crude oil is priced in U.S. dollars. Investors have increasingly purchased U.S. financial assets as a result of the Federal Reserve raising interest rates to curb inflation and because investors seek out U.S. currency as a safe-haven asset during uncertain economic conditions. This trend has led to the U.S. dollar increasing to its highest value since 2002. For countries using other currencies, including many of the globe’s emerging markets, the strengthening U.S. dollar makes it more expensive to convert local currency into the U.S. dollars necessary to import crude oil. A
strengthening dollar also creates additional macroeconomic uncertainty by raising debt servicing costs for countries holding U.S. dollar-denominated debt.

With macroeconomic uncertainty rising, Oxford Economics lowered its forecast for global GDP growth to 2.2% for 2023, down from 2.7% last month. We use Oxford Economics’ forecast as an input into our global oil demand model. This reduction in forecast GDP led us to lower our forecast for global petroleum demand in 2023 by 0.5 million b/d compared with the September Short-Term Energy Outlook.

**Brent price and S&P 500:** In the past few years, the price of Brent crude oil has often, but not always, moved in the same direction as the value of the S&P 500, an equity index of widely traded U.S. public companies. For example, from the second half of 2020 (2H20) through 2021, the Brent crude oil price and the value of the S&P 500 both increased as economic growth was reflected in the rising profitability of companies as well as in rising demand for oil (Figure 2).

Oil prices and equities began moving in opposite directions in early 2022, when the price of crude oil continued increasing as Russia’s full-scale invasion of Ukraine intensified global petroleum supply concerns. These price increases contributed to higher inflation and input costs for companies, leading to a decline in the S&P 500. As the Federal Reserve has increased interest rates to curb inflation, borrowing costs for companies have grown and expectations for economic growth have declined, putting further downward pressure on the S&P 500. However, from July to September 2022, the price of Brent crude oil resumed a positive relationship with equity prices, with both declining as concerns about global economic conditions also reduced expectations of petroleum demand growth, accompanied by pressure from the strong US dollar (discussed above).

**Brent price and inflation expectations:** Inflation expectations also often move together with crude oil prices. One measure of inflation expectations is the percentage difference between

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Figure 2. S&P 500 and Brent crude oil prices

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Source: CME Group, Intercontinental Exchange, and Bloomberg L.P.
yields for five-year Treasury Inflation-Protected Securities (TIPS) and U.S. treasury bonds. This spread indicates expectations for what the inflation rate will be in five years. Inflation expectations peaked in March at 3.6% (Figure 3), decreasing in recent months in part due to:

- Inflation, as measured by the U.S. Consumer Price Index, has flattened and slightly decreased recently, in part because energy-sector inflation has slowed down as oil prices have dropped; and
- Expectations for future economic activity, which have also fallen.

![Figure 3. Crude oil and inflation expectations](image)

Although the price of Brent crude oil continued to increase from April to June when inflation expectations were decreasing, persistent concerns about economic conditions and petroleum demand have contributed to crude oil prices decreasing with inflation expectations from July through September.

**Market-derived probabilities:** Crude oil prices have been subject to high levels of uncertainty due to geopolitical factors, uncertain OPEC+ production, and concerns that a global recession could reduce crude oil demand. **Market-derived price probabilities** that are based on futures and options prices reflect this price uncertainty. They also reflect the downward price movements in September and the upward price movements in October. As of September 30, the probability of the December 2022 WTI contract expiring at more than $80/b was 43%, a decrease from 66% on September 1 (Figure 4). The probability of the December 2022 WTI contract expiring above $90/b was 23% on September 30, and the probability of it expiring above $100/b was 11%. Conversely, there was also a 32% chance of the December WTI crude oil contract expiring at or below $70/b as of September 30. But in October, when crude oil prices began to rise in anticipation of OPEC production cuts, higher future crude oil prices became more likely. As of October 6, the probability of WTI expiring above $80/b was 57% and the probability of it expiring above $90/b was 33%, both increases from September 30 but decreases from September 1.
We forecast the WTI crude oil price to be $85/b in December and $87/b in January. We expect the WTI crude oil price to increase to an average of $89/b in 2023, and we expect the Brent crude oil price to be $6/b higher than the WTI price throughout 2023.

We forecast oil prices to generally remain near current levels in 2023 with Brent averaging $95/b. We lowered our price forecast for 2023 by $2/b compared with last month’s forecast, which largely reflected a 0.5 million b/d reduction in our forecast for global oil consumption in response to a lower forecast for global GDP from Oxford Economics. Lower oil consumption resulted in us lowering our price forecast in early 2023. We also reduced our forecast for global oil production by 0.6 million b/d in 2023, with the largest downward revision for next year in 4Q23. As a result of lower production at the end of next year, we forecast Brent prices will end 2023 higher than previously expected, despite a lower crude oil price forecast on average for next year. Our forecast had already included a reduction in OPEC+ crude oil production that was largely consistent with the cuts the group announced on October 5. Accounting for these changes, global oil markets are relatively balanced in our 2023 forecast. The possibility of petroleum supply disruptions and slower-than-expected crude oil production growth continues to create the potential for higher oil prices, while the possibility of slower-than-forecast economic growth creates the potential for lower prices.

Petroleum products

Gasoline prices: The front-month futures price of RBOB (reformulated blendstock for oxygenate blending, the petroleum component of gasoline used in many parts of the country) settled at $2.68 per gallon (gal) on October 6, up 30 cents/gal from September 1 (Figure 5). The RBOB-Brent crack spread (the difference between the price of RBOB and the price of Brent crude oil) settled at 43 cents/gal on October 6, up 25 cents/gal since September 1.
RBOB prices started September at their lowest level since January after the RBOB front-month contract rolled over to October delivery, which reflects winter grade gasoline that is cheaper for refiners to produce. Through the end of September, RBOB prices increased by more than crude oil prices as higher gasoline export levels offset lower-than-average domestic gasoline consumption amid low inventory levels. We estimate U.S. gasoline consumption averaged 8.8 million barrels a day (b/d) in September, which is 2% (0.2 million b/d) lower than the five-year (2017–2021) average for that month. U.S. gasoline exports for the four weeks ending September 30 averaged 1.0 million b/d according to EIA’s *Weekly Petroleum Status Report (WPSR).* If confirmed in monthly data, this level would be 32% (240,000 b/d) higher than the five-year average export volume for September. We estimate gasoline inventories declined by 3% (7.2 million barrels) to 208 million barrels in September, which is 10% below the five-year average and the lowest end-of-September level since 2012.

Declining crude oil prices contributed to the RBOB-Brent crack spread increasing in September after reaching its lowest level since February 2021 on September 1. The average RBOB-Brent crack spread in September was 30 cents/gal, 29 cents/gal lower than in August but still 7 cents/gal higher than the five-year average for September. From September 30 to October 6, RBOB prices rose by 8%, and Brent crude oil prices increased by 7% over the same period.

**Spot market gasoline prices:** Although West Coast spot market prices for gasoline are typically priced higher than in other parts of the country, West Coast premiums in late September increased to more than $2/gal on average over New York RBOB prices. In September, spot gasoline prices in Los Angeles, San Francisco, and Portland increased by at least 50% while prices in New York decreased by 4% over the same time period *(Figure 6).*
Multiple refinery outages for planned and unplanned maintenance on the West Coast, amid West Coast gasoline inventories at their lowest level since May 2012, contributed to the price increase along with lower imports. Gasoline imports to the West Coast, which have historically increased supplies during past instances of market tightness, did not materialize in a substantial way through the end of September. *WPSR* data show West Coast gasoline imports averaged 30,000 b/d for the four weeks ending September 30, after unusually low import levels in the second half of July and all of August. This lack of imports contributed to an increase in West Coast retail gasoline prices, which rose 17% (84 cents/gal) from September 19 to October 3. The California Air Resources Board issued a notice on September 30 to allow the early sale of winter-blend gasoline to help reduce high prices. From October 4 to October 6, West Coast premiums over New York RBOB declined by 92 cents/gal on average as some refinery capacity came back online in California and expectations rose for an increase in short-term imports.

In the Midwest, a similar situation is developing as unplanned outages at two refineries led to an increase in the Chicago spot gasoline price by 30% in September. Subsequently, Midwest retail gasoline prices increased 6% (20 cents/gal) from September 19 to October 3.

**Ultra-low sulfur diesel prices:** The front-month futures price for ultra-low sulfur diesel (ULSD) for delivery in New York Harbor settled at $3.86/gal on October 6, a 30 cents/gal increase from September 1 (*Figure 7*). The ULSD-Brent crack spread (the difference between the price of ULSD and the price of Brent crude oil) increased 25 cents/gal during the same period and settled at $1.62/gal on October 6.
ULSD prices and crack spreads both decreased in September on a monthly average basis in response to lower estimated demand in the United States and broader expectations of wavering economic activity. In addition to lower crude oil prices in September, we estimate monthly average distillate consumption in September was 3.7 million b/d, the lowest consumption so far in 2022, likely because of lower trucking and industrial demand related to decreasing economic expectations. We expect distillate consumption to increase in the fourth quarter of 2022, primarily in response to seasonal factors, including agricultural demand brought on by the fall harvest season and winter demand for distillate heating oil. These seasonal factors along with rising crude oil prices are likely contributing to the sharp increase in distillate prices in early October. Agricultural demand is primarily concentrated in the Midwest, and heating demand for distillate is primarily in the Northeast. Distillate inventories in the Midwest and Northeast have both been below their five-year lows through the summer of 2022, so transport constraints between Gulf Coast producers and these regions present the potential for relatively higher distillate prices in these markets.

We expect downward pressure on distillate prices and crack spreads, related to economic conditions, to continue through the end of 2022 and the first half of 2023, but we still forecast distillate crack spreads to remain well above historical levels through the end of the year. The potential for further low demand related to uncertain economic conditions, as well as potential variability in harvest or heating oil demand, are all significant factors in our forecast. Changes in distillate net exports present an additional source of uncertainty, which could mean fewer distillate imports into the United States (primarily to the East Coast) as well as further calls on U.S. distillate exports (mostly from the Gulf Coast) from international markets.

**U.S. heating oil expenditures:** In the 2022–2023 winter season (October 2022 through March 2023), we currently estimate U.S. average household heating oil consumption—most of which occurs in the Northeast—will be 519 gallons, which would be the most since the 2014–2015
winter season (Figure 8). High heating oil prices going into this winter, combined with higher forecast consumption result in our expectation that heating oil expenditures will be about $2,350 this winter, for homes in which heating oil is the primary space heating fuel. Expenditures at that level would be the highest since 2013–2014 winter season when adjusted for inflation.

The high estimated consumption this winter is a result of our estimates for higher heating degree days, based on the current winter outlook from the National Oceanic and Atmospheric Administration (NOAA). For more information, please see our Winter Fuels Outlook.

Natural Gas

Prices: The front-month natural gas futures contract for delivery at the Henry Hub settled at $6.97 per million British thermal units (MMBtu) on October 6, 2022, down $2.29/MMBtu from September 1, 2022 (Figure 9). The price for front-month natural gas futures contracts averaged $7.76/MMBtu in September, compared with $8.78/MMBtu in August.
We estimate U.S. dry natural gas production in September reached a record-high 98.8 billion cubic feet per day (Bcf/d). The record production contributed to September’s natural gas stock builds of 428 Bcf, which were 20% higher than the five-year (2017–2021) average. Despite the above-average builds, natural gas inventories at the end of the month were 3,135 Bcf, which is 8%, or 280 Bcf, below the five-year average. U.S. liquefied natural gas (LNG) exports averaged 10.1 Bcf/d in September, as liquefaction terminals other than the off-line Freeport terminal operated near full capacity.

**Supply and demand balance:** When natural gas supply (production plus imports) is lower than natural gas demand (consumption plus exports), natural gas prices tend to increase as more natural gas is pulled from storage to meet demand. The 12-month rolling average of natural gas demand has exceeded supply since February 2021 (Figure 10), which has contributed to an elevated Henry Hub spot price that doubled between June 2021 and July 2022. Monthly storage inventories have remained below the five-year average since June 2021, except for in December 2021 when unusually warm weather led to lower-than-normal storage withdrawals. We expect the Henry Hub spot price to remain elevated until the second quarter of 2023 when we forecast the 12-month rolling average of supply to rise closer to average demand and inventories to rise above the five-year average.
As a result of higher forecast natural gas prices and consumption, we expect households that use natural gas as their primary space heating fuel will spend 28% more this winter (October 2022 through March 2023) than they spent last winter. Nearly half of all U.S. households heat primarily with natural gas. We expect average household winter consumption to be 58 thousand cubic feet (Mcf), up 5% from last winter. For more information, please see our Winter Fuels Outlook.

We forecast the Henry Hub spot price will start to decline in the first half of 2023 as producers continue to increase supply. In the first three quarters of 2022, U.S. dry natural gas production grew steadily. We forecast dry natural gas production to continue to increase, averaging 99.1 Bcf/d in 4Q22.

**Futures price spreads:** Natural gas futures contracts allow natural gas to be bought and sold for delivery at specific dates in the future corresponding to the start of each month. The natural gas 1st–13th month spread represents the difference between the price of natural gas sold for delivery 1 month from now compared to natural gas sold for delivery 13 months from now. The natural gas 1st–13th month price spread averaged $2.32/MMBtu in September, down nearly $1.13 from the record-high monthly average of $3.45/MMBtu set in August (Figure 11). The 1st–13th price spread has averaged over $2.00/MMBtu every month since April. During that time, natural gas prices have remained elevated, averaging $7.74/MMBtu, and natural gas inventories remained 8% or more below the five-year average.
When the 1st–13th price spread is positive, known as backwardation, near-term contract prices for the current month are higher than longer-dated contract prices for natural gas delivery one year further in the future. This difference reflects a market that puts greater value on natural gas sold for delivery one month from now compared with natural gas sold for delivery at the same time next year, encouraging market participants to sell natural gas from inventories instead of storing for future sales. Often, this situation occurs when natural gas demand is greater than supply, drawing inventories below the five-year range. The high 1st–13th price spread since April 2022 reflects the highest annual natural gas demand on record, driven by the electric power sector and high LNG export levels. High demand is keeping inventories at a deficit to the five-year average. Dry natural gas production has increased since April but not by enough to significantly reduce the storage deficit to the five-year average. As a result, the 1st–13th price spread has remained at its highest monthly levels on record.

We expect natural gas spot prices to remain elevated in late 2022 before falling in 2023. We forecast the Henry Hub spot price to average about $7.40/MMBtu in 4Q22, then fall below $6.00/MMBtu in 2023 as U.S. natural gas production rises.

Notable forecast changes

- Global oil production for 2023 in our forecast averages 100.7 million barrels per day (b/d). Our production forecast is 0.6 million b/d lower than in the September STEO and reflects announced cuts from OPEC+ as well as lower forecast crude oil production in the United States.
- Our forecast for global oil consumption forecast for 2023 is 101.0 million b/d, which is 0.5 million b/d lower than in the September STEO and reflects Oxford Economics
lowering its forecast for global GDP growth in 2023 to 2.2% this month from 2.7% last month.

- We expect U.S. crude oil production will average 12.4 million b/d in 2023, which is down from a forecast of 12.6 million b/d last month. Lower crude oil production in the forecast reflects lower crude oil prices in 4Q22 than we previously expected.

- Our 2023 forecast for U.S. gasoline consumption was revised down by 0.1 million b/d. The downward revision reflects lower forecast vehicle miles traveled as a result of lower expected employment growth, based on forecasts from S&P Global, next year as well as higher expected growth in vehicle fuel efficiency.

- We forecast the Henry Hub natural gas spot price will average about $7.40 per million British thermal units (MMBtu) in 4Q22, which is about $1.60/MMBtu less than we forecast in the September STEO. The forecast largely reflects price declines in September that lowered the starting point for our forecast, amid slightly higher expectations for U.S. production in late 2022.

- We raised our forecast for electricity generation by natural gas-fired power plants as a result of lower natural gas prices in recent weeks. We forecast natural gas-fired generation will rise by 5% in 2022, compared with expected growth of 3% in the previous STEO. We have also lowered our forecast for coal-fired generation, which is now expected to fall by almost 7% in 2022 compared with a forecast decline of 4% in the previous STEO.

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