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FUTURE OF FUELS

RFA Outlook for Crude Oil, Refined Products, Biofuels and EVs

SAMPLE

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Introduction

This is the 7th edition of our Future of Fuels – Crude Oil, Refined Products, Biofuels and EVs report. As with the previous six editions (released in January/July 2023, February/July 2024 and January/February 2025), the report's purpose is to provide decision makers an important analytical tool to navigate the turbulent markets ahead for liquid fuels – both petroleum-based and biofuels.

- The domestic and global economic, geopolitical and regulatory environments have continued to inject new uncertainties into the crude and refined product markets, providing both challenges and opportunities for industry participants. .
- These new developments add to the many factors and trends which will continue to impact markets over both the short and long terms. Even among carryover issues, shifts are taking place – perhaps most notably in regard to climate change policies, where reality is causing energy transition goals to be pushed back. While our previous forecasts have generally showed stronger petroleum demand than most publicly available outlooks, we have also pushed our projections a bit higher in this edition.
- On the geopolitical front, the removal of Maduro in Venezuela and the instability in Iran, carry perhaps the most significant potential impacts on oil markets, although what happens next in those countries is highly uncertain. The similar unknowns regarding the Russian/Ukraine war, developments in China, other parts of the Middle East and Latin America, and in other key global regions, provide other difficulties in assessing petroleum markets. Of course, on the domestic front, the Trump administration, and its potential direction on policies and actions that will impact the economy and the energy sector, is as hard to predict as ever.

The Future of Fuels report considers all of the ongoing and potential developments and trends and incorporates these into a realistic analysis to provide detailed, quantitative forecasts for the direction of all key components of liquid fuel energy markets over the next 25 years.

- Included are detailed price forecasts for all relevant commodities: crude oil, refined products, biofuels, intermediates/other feedstocks and regulatory credits.
- Also included are detailed forecasts for refined product demand, petroleum refining and biofuels production capacity changes, EV penetration, biofuels demand, U.S. crude demand/refined product supply balances, and U.S./Canadian crude production.
- **In this edition, we have expanded our forecasts out to 2050 (from 2045 previously). As before, the exception is with our assessments of refinery and renewable fuels capacity additions, which are based on actual project announcements and go out for five years (through 2030 in this edition).**

This report will continue to be issued on a biannual basis in late January/early February and July.

- Both reports will provide a full refresh and update of all our regional and global analyses of supply, demand, prices and all other data sets included in Future of Fuels.
- In future editions we will cover additional developments related to potential new fuel sources such as hydrogen, ammonia and other "green" alternatives as they become more relevant in the global supply chain.

Global Gasoline Demand Stronger Than Diesel in the Short Term – After 2030 Diesel Demand Overtakes Gasoline – Jet, Petchem and Specialty Products Stay Strong Throughout

Petroleum gasoline (excluding biofuels) demand growth is expected to remain relatively robust through 2030, while petroleum diesel demand is expected to be particularly weak during this same time period. This will compress the diesel-gasoline price differential over the next several years. After 2030, the gasoline vs. diesel demand trajectories reverse and middle distillate price premiums increase.

- Total motor gasoline demand grows at an annual average rate of about 200 Mb/d over the next five years. Annual global petroleum diesel demand actually declines by almost 60 Mb/d through 2030 as renewable diesel (RD) demand grows and European de-dieselization continues (the latter of which also boosts gasoline demand).
- Motor gasoline then peaks in about 2034 (at about 1.25 MMb/d above 2025) and begins an accelerating downtrend trend, dropping below 2025 levels in about 2034. Excluding ethanol, gasoline demand peaks in 2032.
- By contrast, diesel demand does not peak until 2046-47 and jet fuel demand grows through 2050. Total middle distillate demand increases by 5.4 MMb/d between 2025 and 2050, with 4.5 MMb/d (83%) coming from jet fuel. Diesel demand growth will continue to be correlated to economic growth, although RD (and, to a lesser extent, CNG/LNG and electricity) will eat into its usage for cargo transport, and other forms of energy will eat into its share for industrial and other uses. Continued increases in air traffic will drive growth in jet fuel, which is also more expensive and difficult to replace, though SAF demand will grow considerably, reaching about 750 Mb/d in 2050 (a bit lower than our previous forecast for 2045), up from less than 50 Mb/d, globally, in 2025. Petroleum-derived middle distillate demand increases by 3.75 MMb/d through 2050, essentially all from jet fuel, as petroleum diesel is actually slightly down.
- Light petchem feedstocks (ethane and LPG) will also grow due to strong supply growth, consumer-driven demand for plastics, and the lack of ready alternatives. It will increase by 4.4 MMb/d from 2025 to 2050 (similar rate of growth as in our July forecast), exceeding 20 MMb/d, or 19% of total liquids demand, by 2050.

Gasoline demand growth won't peak in several of the EMs until after 2045, while it has mostly peaked in the developed economies. Middle distillate demand growth will generally be strong in the EMs and a mixed bag in the developed economies, with significant variations within each group and individual countries.

- India and Africa dominate gasoline demand growth as upward mobility leads to strong growth in car ownership (from low base levels). We have Indian and African gasoline demand in 2050 at 2.1 MMb/d and 1.5 MMb/d above 2025 levels, respectively, with growth to continue past 2050. Middle East gasoline demand peaks around 2045, with Other Asia Pacific peaking between 2040/45 and Latin America peaking between 2035-40.
- Gasoline demand trajectories in developed economies vary widely. While the U.S. hit peak demand for gasoline in 2018-19 at 9.3 MMb/d, we expect only slow declines from the current 8.95 MMb/d to 8.75 MMb/d by 2030. Thereafter, gasoline demand declines accelerate, with demand falling to 6.9 MMb/d by 2045 and 6.1 MMb/d in 2050. Europe, due to the continuing de-dieselization trend, shows small increases through 2028 (though way below the peak hit back in the 1980s). Thereafter, gasoline demand declines accelerate (as in the U.S.), with 2050 demand almost 1.1 MMb/d (44%) below 2025 levels. Chinese gasoline demand is expected to decline only gradually through 2030 and begin an ever-steeper decline thereafter, with 2050 demand down by 1.5 MMb/d (43%) vs. 2025.
- Total middle distillate (diesel and jet) demand in 2050 is above 2025 in every region except Europe (by far the biggest decline at more than 2.2 MMb/d), Japan, the U.S., Canada and China (the smallest decrease). The largest increases come in Other Asia Pacific (2.2 MMb/d), India (1.9 MMb/d), Africa (1.6 MMb/d) and the Middle East (1.5 MMb/d). Jet/kero demand doesn't peak anywhere before 2050 except in Japan, where it peaked, last year due to declining usage as a heating fuel.

Absolute and Regional Crude Price Outlook – Change in OPEC Strategy Lowers Short-Term Forecast

OPEC's recent decision to defend market share by increasing production significantly this year will result in an oversupplied environment through around the end of 2027, resulting in substantively lower crude prices. We now expect Dated Brent to average $61.25 in 2026 (about $60.80 for the remainder of the year) and $60.41 in 2027, down from $61.90/bbl in 2026 and $71.05/bbl in 2027 in our July forecast. We had previously expected a more balanced supply/demand environment to emerge around the end or 2026 or early 2027, and now believe that this scenario won't emerge until late 2027 or early 2028.

- We expect prices to bounce back in 2028+ but still anticipate Brent to average below $80/bbl (in nominal/current dollars) through 2032 and below $80/bbl in 2025 real dollars through the end of the forecast period in 2050. Of course, excursions above this price level are likely, but they are not expected to persist for extended periods.
- The low prices over the next 24+ months will lead to substantive drops in production across all major U.S. shale basins. Also, we believe that production from Russia will be challenged by both the likelihood of stricter sanctions enforcement, internal issues, and continued low absolute crude prices. Finally, we expect OPEC to slightly moderate production in response to the lower prices by early 2027. Nonetheless, we expect Saudi Arabia to only lower production by 0.2 MMb/d in 2027 to around 9.8 MMb/d (from our forecasted 2026 production of about 10 MMb/d). This is still well above their low of 9.2 MMb/d in 2024.
- Longer term, as U.S. production peaks around 2035 (a year later than in our July report), OPEC is likely to gain better control of the market, resulting in slightly higher inflation-adjusted prices. Although many other major sources of global crude oil production growth (Argentina, Brazil, Canada, Guyana, Kazakhstan) also reach peaks in the 2030s, production increases in Iran, Iraq and Venezuela, combined with weaker demand growth, will lead to a flattening of the inflation-adjusted crude price by about 2040. We forecast the the real Brent price in 2025 USD (adjusted using PPI) to increase from $66.22/bbl in 2030 to $75.99/bbl by 2040 and trend just slightly higher to $78.43/bbl by 2045.

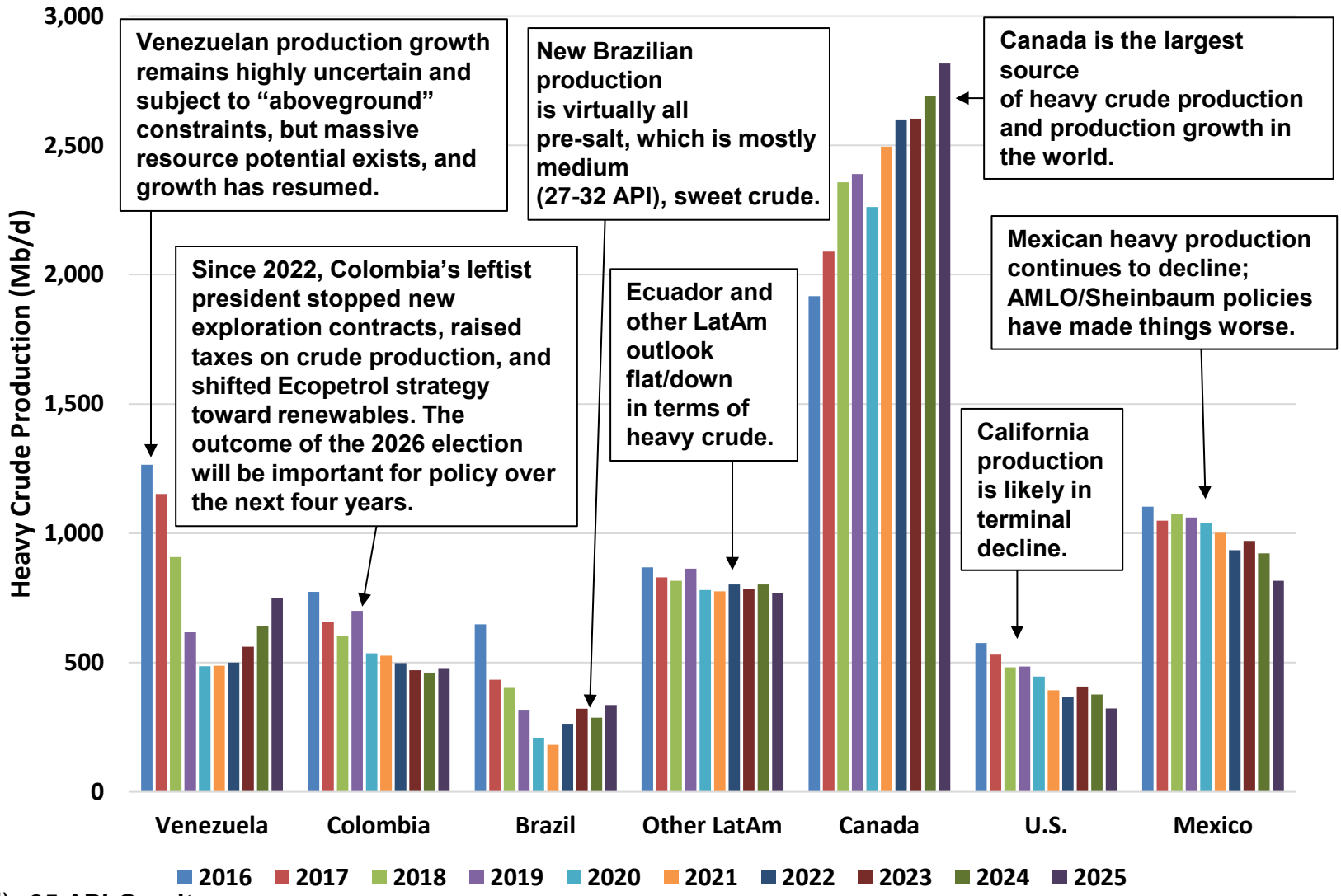
Regional crude differentials are primarily determined by logistics (marine freight rates and pipeline developments), but government policies such as sanctions and tariffs can also play a part.

- As mentioned earlier in this report (and consistent with our July report), we have not included the impacts of any potential new tariffs for crude on Canada, Mexico, or any other countries with which we have significant petroleum products trade, as we don't expect them to last for any length of time, even if ever implemented.
- The completion of the Enterprise SPOT VLCC export terminal remains off our forecast and we currently believes odds of eventual completion of the facility are less than 10%. If it or another VLCC export terminal in the Houston area did get built, it would increase the value of WTI at Houston to price approximately equal to, or slightly above, that in Corpus Christi.

Western Hemisphere Heavy Crude(1) Production Declining

Americas heavy (<25 API) crude production declined from 7.2 MMb/d in 2016 to a low of 5.8 MMb/d in 2020, and has since recovered to around 6.3 MMb/d in 2025 due to continued Canadian production growth and some recovery in Venezuelan heavy crude supply. Meanwhile, Americas light/medium crude production has increased from 14.9 MMb/d in 2016 to 22.5 MMb/d in 2025, driven mostly by growth in U.S. shale crude production, with additional significant light crude production growth from Argentina's Vaca Muerta shale formation, light/medium crude from Guyana, and medium sweet crude from Brazilian pre-salt formations.

Western Hemisphere Heavy Crude(1) Production



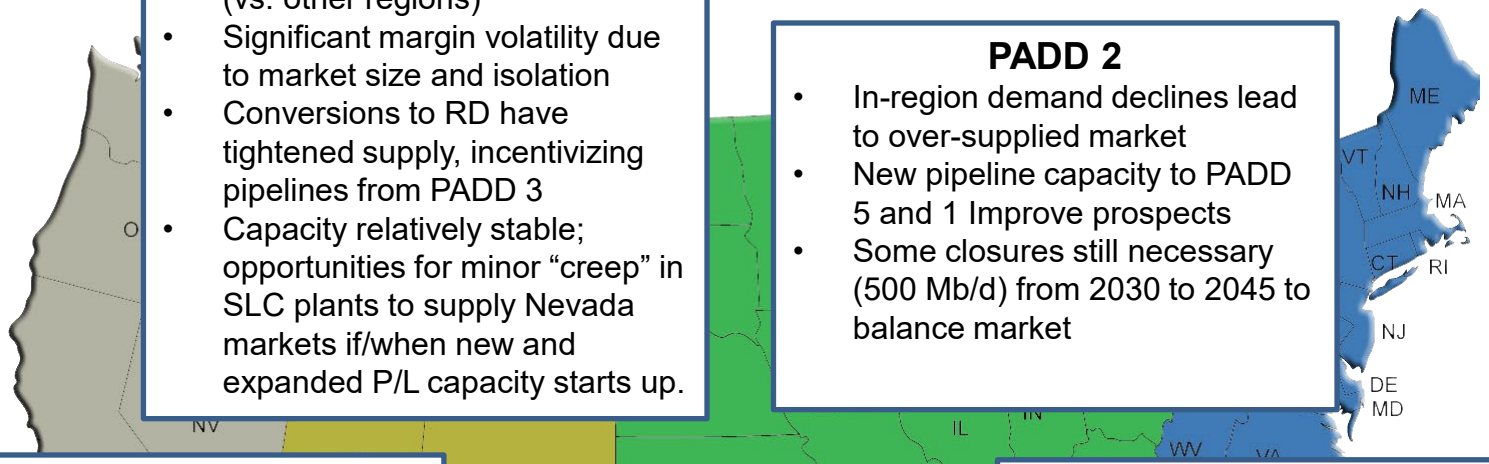
(1) <25 API Gravity

Supply and Demand Factors Cause Refining Margins to Deteriorate Gradually Over the Next Few Years Before Recovering By 2029/2030 – Widening Heavy/Light and Distillate to Gasoline Differentials Will Favor Coking Refineries Long Term

Refining margins generally strengthened through 2025 due to global refinery capacity additions being more than offset by several major refinery closures, including LyondellBassell Houston (289 Mb/d), P66 Wilmington (139 Mb/d), Shell Wesseling (150 Mb/d), Petroineos Grangemouth (145 Mb/d), Prax/Lindsey Refinery (113 Mb/d), CNPC/Petrochina Dalian (410 Mb/d), and an estimated 200 Mb/d of Chinese teapot closures.

- Inflation-adjusted refining margins are expected to be better in 2026 than they were in 2025 and be mostly in line with 2024 margins. A slightly wider light-heavy differential means coking margins improve more in 2026 than do cracking margins.
- Margins are then expected to weaken through 2029 as refinery capacity additions exceed demand growth globally. As of now, there are no further announced major refinery closures globally other than Valero Benecia (150 Mb/d), which is scheduled to close in April 2026. However, additional closures are likely in Europe, Japan, and potentially the USWC and USAC. A stronger-than-expected rate of closures, absent major global economic weakness, could cause margins to hold up better over the next four years.
- USGC inflation adjusted margins for WTI cracking refineries will decline from $14.94 per barrel in 2026 to $12.31 per barrel by 2029, compared to the average 2019 margin of $13.99 per barrel. A USGC WCS coking refining is forecast to have a refinery margin of $19.52 per barrel in 2026, declining to $17.59 per barrel by 2029, while the 2019 margin was $18.94 per barrel due to the wider heavy/light spread in 2019.
- USGC WTI cracking refineries will see margins improve to $13.40 by 2031, before gradually declining over the subsequent years to about $11.30 per barrel by 2050, as increasing distillate margins can't make up for the increasingly steeper declines in gasoline margins (at least at FCC-focused refineries).
- USGC WCS coking refineries will see margins improve to $18.64 per barrel by 2031, with average margins remaining in this relatively healthy range ($18 to $19 per barrel) through 2050. The model assumes hydrocracking capacity of around 15% of crude oil capacity. A coking refinery with no HCU capacity would see meaningful margin deterioration post 2035.
- While short-term volatility will persist and cause margins to move significantly above or below our forecast levels in reaction to economic/geopolitical or "wild card" disruptions and recessions, the downward volatility may not last as long as in past cycles as refiners will be quicker to close marginal plants. This situation contrasts with past periods where strong margins always led to cycles of new investment and overbuilding, which ultimately brought down those margins. We don't expect this same tendency to overbuild to develop as energy transition fears result in a persistent pessimism about long term demand and margins, discouraging investment despite attractive short-term margins. Still, limited new capacity additions will be needed globally as demand growth slows, so continued refinery closures will be needed (with most of these concentrated in Europe, developed Asia, older Chinese plants, the USWC and USAC, and potentially Eastern Canada and the U.S. Mid-Continent) to maintain balanced markets as new capacity comes on line other places.
- Periods of weakness will lead to shutdowns of less competitive refiners (generally gasoline-focused refineries), particularly in geographic regions which become oversupplied due to demand declines. This will maintain relatively balanced markets and support margins for the surviving, competitively configured refineries.

U.S. Regional Prospects and Challenges



PADD 4

- Advantaged crude supply/positive demand growth (vs. other regions)
- Significant margin volatility due to market size and isolation
- Conversions to RD have tightened supply, incentivizing pipelines from PADD 3
- Capacity relatively stable; opportunities for minor "creep" in SLC plants to supply Nevada markets if/when new and expanded P/L capacity starts up.

PADD 2

- In-region demand declines lead to over-supplied market
- New pipeline capacity to PADD 5 and 1 Improve prospects
- Some closures still necessary (500 Mb/d) from 2030 to 2045 to balance market

PADD 5

- Very difficult regulatory environment continues
- Crude supply situation has improved with TMX completion, but not enough to prevent additional closures - expect capacity decreases of 1.2 MMb/d from 2026 to 2045 to maintain a relatively balanced gasoline market, with jet imports increasing
- Recent and expected future closures, combined with high-cost alternate supplies, result in periods of attractive margins for surviving refineries

PADD 3

- Relatively favorable regulatory environment
- Ability to access export markets has been major advantage; growing dependency is a risk
- Projects to shift production from gasoline to petrochemicals, distillates and specialty products provide attractive opportunities
- "Capacity creep" (net of about 360 Mb/d in our forecast) from 2026 to 2045 – closures possible at less-competitive plants

PADD 1

- Disadvantaged crude supply and regulatory environment
- European and in-PADD shutdowns have improved outlook
- Pipeline capacity limits and Jones Act support tighter/ product market
- Waterborne gasoline imports decline significantly as do pipeline movements from USGC
- 330 Mb/d of capacity reductions needed from 2026 to 2045 (most likely after 2030)
- Expected Laurel P/L reversal all the way to Philly results in additional competition from PADD 2 refiners.

Global Regional Refining Comparison – Positioning Impacted by Both Fundamentals and Politics

U.S.	Second-largest in world, most complex/dynamic refineries. Advantaged on crude and natural gas supply vs. other developed economies. Stagnating domestic demand, global leader in exports.
China	Surpassed U.S. in capacity in 2023 to become largest global refiner. Targeted on domestic, not export demand. Growth slowing, complexity increasing, focus on petrochemicals.
Middle East	Future capacity additions slowing - focused on export/petchem markets, driven by politics. Advantaged crude supply; high capital costs and significant geopolitical risks.
India	Fastest long-term demand growth region; private facilities are large, complex and efficient. Russian sanctions temporarily provided advantaged crude – Ven crude production growth provides some long-term benefit. Potential for more regulatory issues/higher costs in the future.
Rest of Asia/Pacific	Demand growth center, challenging region for financing and project development/construction, with the situation varying significantly by country.
Latin America	Economic woes, governance issues and trouble with project execution limit expansion. Demand growth will continue to be met primarily by U.S. exports.
Developed Asia/Pacific	Disadvantaged due to higher crude and operating costs, declining regional demand and difficult regulatory environment. South Korean refiners most complex and competitive in the region.
Africa	Strong demand growth but significant issues with project execution, corruption, regulatory environment, access to skilled labor, financing, infrastructure and operating ability. Success with Dangote, Angolan projects could increase investment and improve prospects.
Russia	Sanctions/lack of outside investment and technology will cause “slow bleed” in refinery conditions and capabilities. Extended war with Ukraine worsens prospects, increases damage to refineries, results in “brain drain.” Decreased access to European market will be long term.
Europe	Same disadvantages as developed APAC, but worse, especially regulatory. Loss of Russian crude and gas particularly challenging. Expect continued closures/conversions to biofuels and terminals.

U.S. Biofuels Overbuild Leads to Exports – Capacity and Production Growth Slows, but Proposed RVOs and Import Rules are Increasing Domestic Demand and Improving RD/SAF Economics

With a number of new projects coming online in the last few years, The U.S. switched from always being a substantial net importer of combined biodiesel, renewable diesel and SAF in 2023 and before, to being roughly balanced in 2024, to being a net exporter of all three fuels in 2025. While capacity additions are slowing due to recent weak economics for RD/SAF production in 2024 and 2025, margins are beginning to recover in response to the stronger RVOs proposed for 2026 and 2027.

- We forecast that domestic production of RD and SAF will average 272 Mb/d in 2026, around 160% above 2022 levels of 105 Mb/d, as capacity expanded from 84 Mb/d at the beginning of 2022 to around 300 Mb/d today. Capacity additions will be slower going forward with U.S. RD+SAF production capacity expected to reach around 330 Mb/d by 2030. This number could still be revised upward if new capacity additions are announced and/or moved to our Probable List, or if some projects that were returned to fossil service are converted back to RD service.
- Demand growth for biodiesel/RD and SAF will be based on the growth rate of RVOs set by the EPA. The most recent aggressive RVOs proposed in June 2025 for 2026-27 will likely lead to strong a strong demand rebound in 2026, with 2026 BD+RD+SAF demand expected to average 358 Mb/d, up from 259 Mb/d and 336 Mb/d in 2025 and 2024, respectively.
- While the U.S. is expected to barely remain a net exporter of RD, BD, and SAF in 2026 and 2027, the U.S. flips back to being a net importer in 2028 as domestic demand growth outpaces supply growth. Details around the U.S. RD, BD, and SAF supply/demand balance can be found in appendix 4.
- We forecast the U.S. to remain a next exporter of SAF through at least 2030 (the end our net export forecast period), with most or all of these exports flowing to Europe as the UK and EU SAF mandates ramp. Nonetheless, net imports of BD and RD are expected to more than offset these SAF exports.
- The biggest threat to U.S. biofuels exports would be the imposition of import tariffs and/or the buildout of significant foreign capacity. Of course, EPA-set RVOs for future years will impact the level of RD and SAF available for exports. Existing punitive BD and RD (but not SAF) import tariffs in the EU currently discourage U.S. BD and RD exports to Europe.
- While RD/SAF production margins were very weak in 2025 (such that significant capacity was idled or operated at reduced throughput rates) we've seen substantial recovery in margins to start 2026, with margins now in line with 2H 2024 levels, but still well below pre-2024 levels. We expect margins to continue to recover over the next 2-3 years, but still remain well below pre-2024 levels. Specifically, the RD "crack spread" (the value of RD with all credits attached plus production tax credits less feedstock costs) generally ocellated between $2 and $3 per gallon prior to 2024 before falling to $1.30/gallon in 2024 and just $0.86/gallon in 2025 using soybean oil as a feedstock. This crack spread currently sits at ~$1.20/gallon and is expected to increase further to ~$1.50/gallon by 2028.

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