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Ammonia Build-Out: Recipe for Risks

Todd Leahy, Director
Trey Cowan, Oil and Gas Analyst
Anika Juhn, Energy Data Analyst
Michelle (Chaewon) Kim, Energy Finance Specialist

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Ammonia build-out would likely have only a limited impact on local jobs, as the ratio of jobs per unit of ammonia production has plummeted—from 2001-2024, production rose by 53.5% while the number of direct jobs dropped by 6.1%.

Rising construction costs and operational expenses, together with market uncertainty, pose financial risks—and have even led to cancellation of some large ammonia projects.

Domestic agriculture is not driving ammonia expansion in the United States—demand is relatively flat, and the United States already produces most of the ammonia used for current domestic purposes.

The U.S. ammonia industry faces multiple challenges and risks in building out ammonia production intended for export to a global energy market that will likely be limited.

Executive Summary

Federal, state, and local agencies have been awarding financial incentives for construction of ammonia production plants that may fail to achieve robust economic benefits for host communities.

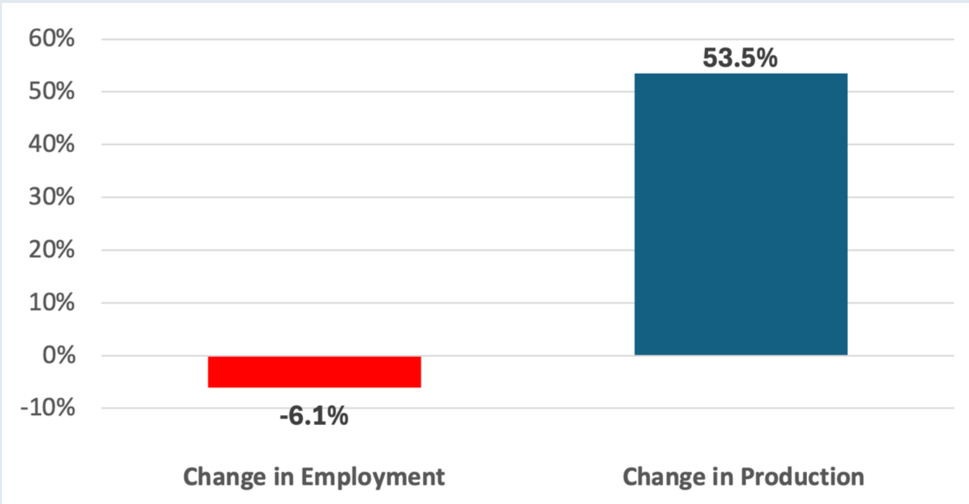
Government agencies typically justify awarding tax incentives, grants, or other support based on company predictions that a project will produce a large number of jobs and bolster the local economy. Some support is based on hopes that ammonia will play a big role in energy markets.

This report explains why ammonia production is constricted as a job engine; why energy markets for ammonia will not likely be robust; and why public monies and tax benefits should not be invested in ammonia given the risks of such enterprises. IEEFA's analysis finds:

- Ammonia build-out would likely have only a limited impact on local jobs: The ratio of jobs per unit of ammonia production has plummeted. From 2001-2024, ammonia production rose by 53.5% but the number of direct jobs dropped by 6.1%.
- Rising construction costs and operational expenses, together with market uncertainty, pose financial risks—and have even led to cancellation of some large ammonia projects.
- Domestic agriculture is not driving the ammonia expansion in the United States. Demand is relatively flat, and the United States already produces most of the ammonia used for current domestic purposes.
- The U.S. ammonia industry faces multiple challenges and risks in building out ammonia production intended for export to a global energy market that will likely be limited.

Meanwhile, ammonia production and transport pose community safety issues that present financial risks to the industry and policy pitfalls for government economic development strategies. Roughly 57% of U.S. ammonia production is concentrated in just three states: Louisiana, Oklahoma, and Texas. The communities targeted to bear the burden of the ammonia production build-out are likely to experience fewer economic benefits than expected and lower tax revenues due to government incentives to private industry—in exchange for increased public health and safety risks.

Percentage decrease in employment vs. productivity in U.S. ammonia industry, 2001-2024



Source: U.S. Bureau of Labor Statistics (NAICS code 325311 – Nitrogenous fertilizer manufacturing), U.S. Geological Survey—Minerals Yearbook (MYB)

Introduction

Ammonia, a chemical compound comprised of 82.2% nitrogen and 17.8% hydrogen, is a colorless gas in its anhydrous form well known for its pungent odor.[1] Ammonia is predominantly marketed in fertilizer products for agricultural use, although it is also employed in the manufacture of fibers such as nylon, explosives, and various chemical products.[2] In recent years, ammonia has been touted widely as a potential energy source, and the specter of an expanded market has fueled interest in boosting production of the chemical.[3]

This report shows the scale of the proposed ammonia production buildout in the United States far exceeds the existing domestic demand currently served by imports. The plans are predicated instead on hopes for a greatly expanded domestic and global ammonia market, which may not fully appear. Although many governmental leaders involved in efforts to encourage ammonia plant development may hope to boost employment, IEEFA research indicates actual job benefits are likely to be limited.

[1] USGS. Mineral Commodity Profiles: Nitrogen. 2004 (hereafter, USGS 2004 Commodity Profile for Nitrogen), p. 5.
[2] See*, e.g.,* LSB Industries, Inc. Form 10-Q report for Q3 2025. October 30, 2025 (hereafter, LSB Industries Form 10-Q report for Q3 2025, p. 7.
[3] See, e.g., *ibid.*, p. 18.

Also, the promise of economic development depends on the profitability of the proposed ammonia plants, but several risks to such profitability exist. This report discusses a range of risks, including risks identified in financial reports by some leading public corporations engaged in ammonia production. The U.S. Securities and Exchange Commission (SEC) mandates disclosure of “material factors that make an investment in the registrant or offering speculative or risky.”[4] To be clear, a corporation’s identification of a material risk in a report to the SEC is not a statement of certainty or an assertion of likelihood that the risk will become reality. Rather, a public corporation is required to disclose a risk as material if a reasonable investor would consider the information important in making an investment decision.[5] The transparency rules promote fairness by seeking to ensure all investors have access to the same material information.

Taken together, the risks identified in this report raise cause for concern about directing public subsidies to new ammonia production projects. Any plan to gamble public monies or grant tax incentives for a project that has a significant risk of not delivering on its promises—or poses environmental safety or health risks to the host community—should be subject to rigorous scrutiny and robust public discussion.

Part 1: The Ammonia Build-Out Will Likely Have Only a Limited Impact on Local Jobs

Corporations seeking to expand ammonia production often seek government financial incentives to offset many of their expenses, whether in the form of outright grants, low-interest loans, or tax exemptions. Business tax incentives and development grants are sold to communities as public investments in jobs. Governments that offer such benefits generally do so under the rationale that the project will boost jobs and the local economy.[6] But development deals that deprive the host municipality or school district of the benefit of tax revenues while failing to deliver substantial benefits risk becoming a net loss for the community.

Business development tax incentives are not “free.” Such incentives typically block tax revenues the property might otherwise generate from reaching—and benefiting—local communities and schools. A review of the impact of business tax incentives on St. Louis County, Missouri, found economic development tax abatements cost public school students more than $380 million in the past eight

[4] See SEC regulation 17 CFR § 229.105 (a). Federal laws related to corporate risk disclosure include the Securities Act of 1933 (15 USC Chap. 2A)—enacted after the 1929 stock market crash and commencement of the Great Depression—which established the U.S. registration system for securities offered for public sale, the Securities Exchange Act of 1934 (15 USC Chap. 2B), and the Sarbanes-Oxley Act of 2002 (P.L. 107-204).
[5] The term “material” is defined in other sections of the regulation. See 17 CFR §240.12b-2 (“The term ‘material,’ when used to qualify a requirement for the furnishing of information as to any subject, limits the information required to those matters to which there is a substantial likelihood that a reasonable investor would attach importance in determining whether to buy or sell the securities registered.”) Also see: *TSC v. Northway*, 426 U.S. 438, 449 (1976).
[6] Louisiana Economic Development, a state agency, has stated its mission is “to cultivate jobs and economic opportunity for the people of Louisiana.” LED. About LED. Accessed January 12, 2026.

years, also having a disproportionate impact with regard to income, race, and special needs.[7] Even tax incentives with a more generalized impact affect the revenue base for state and local government operations.

Also, studies have questioned the extent to which business tax incentives for a company project really have a "spillover effect" by generating new business activity and "indirect" employment. One analysis concluded:

> *"While we find some evidence of direct employment gains from attracting a firm, we do not find strong evidence that firm-specific tax incentives increase broader economic growth at the state and local level."*[8]

Even projections of direct jobs should be scrutinized, as technology changes can reduce an industrial facility's employment requirements.

The ammonia industry in the United States has been losing jobs over the last 25 years. Annual U.S. Bureau of Labor Statistics data show employment at ammonia plants (under NAICS code 325311 – Nitrogenous Fertilizer Manufacturing) has declined for more than two decades. The number of ammonia plants in operation has fluctuated during this period as spiking volatile feedstock (i.e., natural gas) prices have pushed operational economics into unprofitable stretches, leading to lowered plant capacity use and, in some cases, even plant closures. Between 2001 and 2024, industry-wide employment dropped by 6%, from 9,458 to 8,881 employees over the 2.5-decade span. During the same period, the number of plants operating peaked at 39 facilities, fell to a low of 22 facilities, and ended with 37 facilities.

Yet the industry saw growing productivity during this period. Although the trend for employment followed a declining path, the trajectory for ammonia production was upward (see Figure 1).

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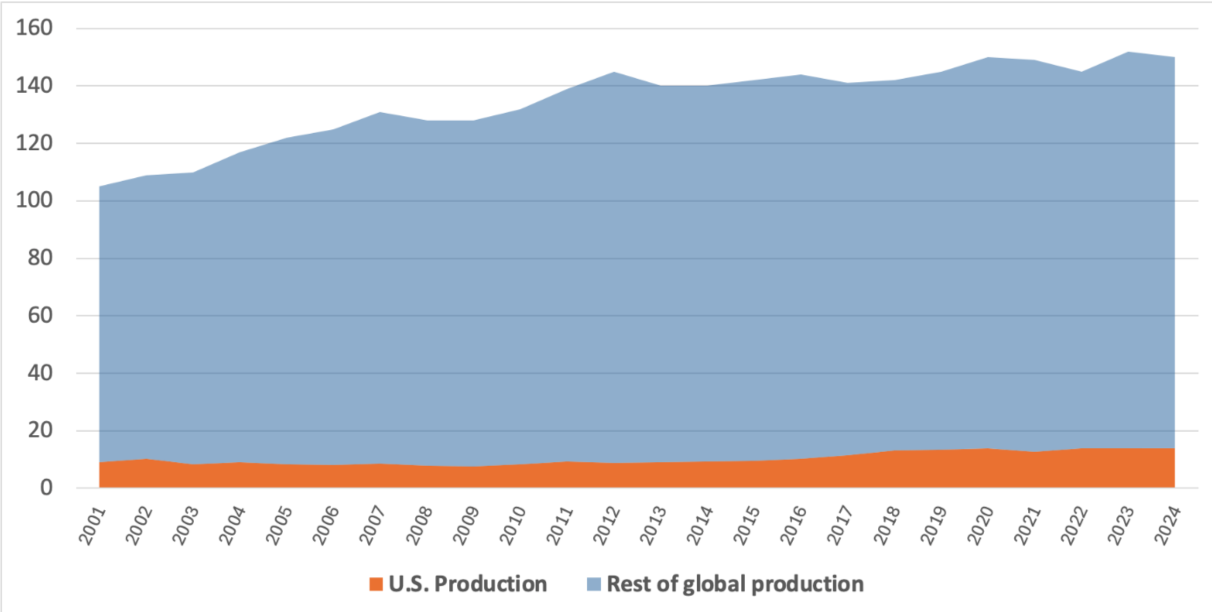
[7] Good Jobs First. Increasing Student Losses: Cloudy horizons as data centers and developers gain at schools' expense. December 2025.

[8] C. Slattery and O. Zidar. Evaluating state and local business incentives. *Journal of Economic Perspectives* 34(2):90-118, 91. Spring 2020.

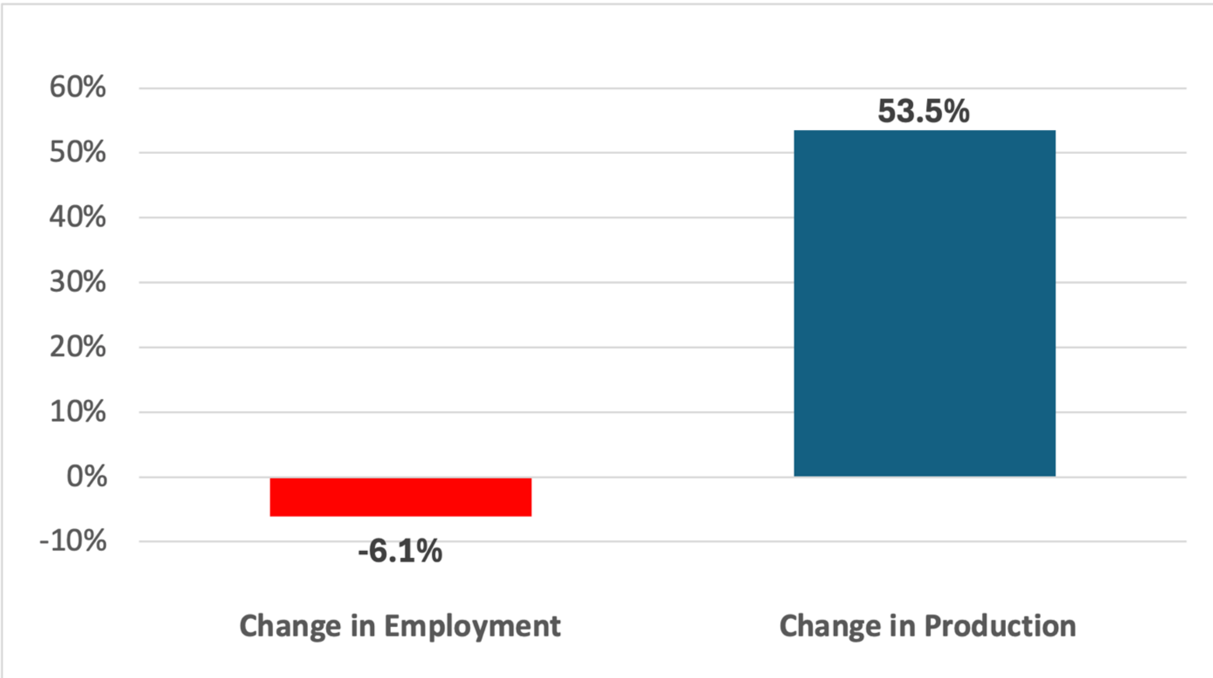
Figure 1: Annual U.S. and Global Ammonia Production, 2001–2024 (Million Tonnes)



Source: U.S. Geological Survey—Minerals Yearbook (MYB)

As industry-wide employment shrank 6% and the number of plants fell by 5%, U.S. ammonia output increased by 53%—with production rising from 9 million tonnes (Mt) in 2001 to 14 Mt in 2024 (see Figure 2).

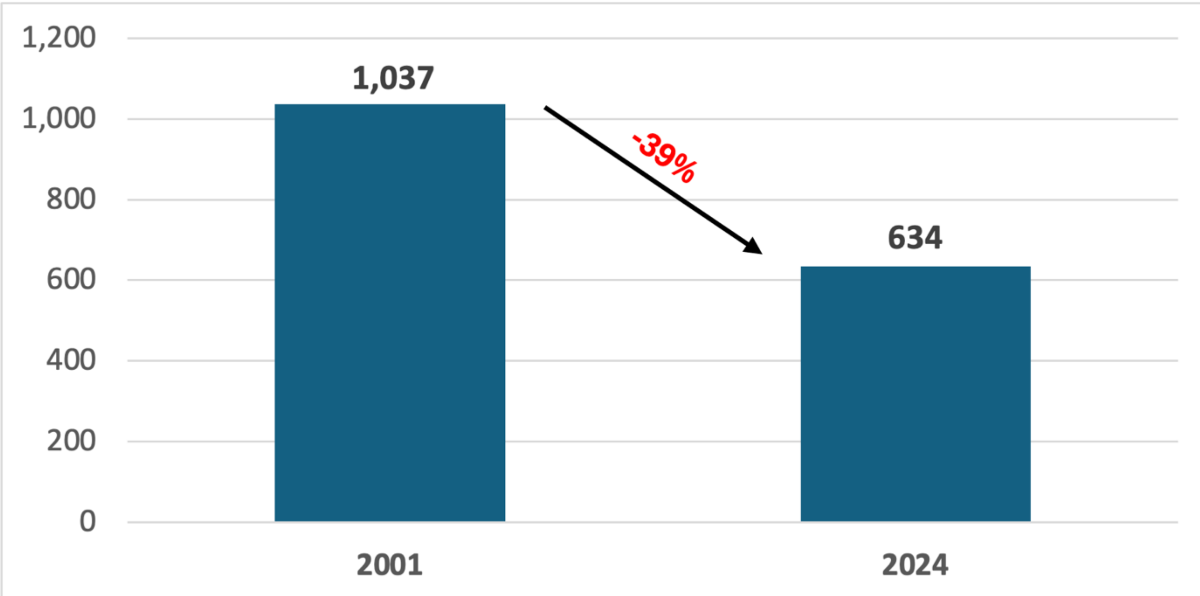
Figure 2: Percentage Decrease in Employment vs. Productivity in U.S. Ammonia Industry, 2001–2024



Source: U.S. Bureau of Labor Statistics (NAICS code 325311 – Nitrogenous fertilizer manufacturing), U.S. Geological Survey—Minerals Yearbook (MYB)

Juxtaposed against the declining figures for total plants and total employees, ammonia production grew at a compounded rate of about 2% per annum over the last 25 years—but with fewer jobs provided per unit of ammonia productivity (see Figure 3).

Figure 3: Jobs Provided per Unit of U.S. Ammonia Productivity, 2001 vs. 2024



Source: U.S. Bureau of Labor Statistics (NAICS code 325311 – Nitrogenous fertilizer manufacturing), U.S. Geological Survey—Minerals Yearbook (MYB)

In 2001, 39 ammonia plants operated with collective employment at 9,458, averaging 243 jobs per facility. In 2024, 37 ammonia plants operated with collective employment at 8,881, averaging 240 jobs per facility. In addition to the evident pattern of increased productivity achieved while the number of jobs per plant has somewhat declined, company-published employment projections for staffing operations (after the construction of proposed plants) point to a steeper drop in employment per plant.

Announced plans and proposals for building new ammonia plants generally confirm the declining employment trend in the industry. The average employment across seven ammonia plants currently planned for completion by 2030 is 184 jobs—well below the historical average (see Table 1).

Table 1: Announced Plans for Ammonia Plants and Projected Post-Construction Employment (U.S.)[9]

Project Name	Project Cost ($ billion)	Capacity (MTPA)	Employment	City/Parish	State	Proposed Start	Company
Cronus Chemicals Tuscola Project	2	0.9	130	Tuscola	IL	TBD	Cronus Chemicals
Beaumont New Ammonia Project	2.4	1.1	70	Beaumont	TX	2026	Woodside
Project YaREN	2.9	2.8	200	Ingleside	TX	2029	Enbridge and Yara
CF Industries – Gulf Coast Blue Point	4	1.4	104	Ascension Parish	LA	2029	CF Industries, JERA, and Mitsui
St. Charles Clean Fuels – St. Rose Blue Ammonia	4.6	2.9	216	St. Charles Parish	LA	2027	Copenhagen Infrastructure Partners and Sustainable Fuels Group
Ascension Clean Energy Project	7.5	2.4	350	Donaldsonville	LA	2029	Clean Hydrogen Works
Louisiana Clean Energy Complex	4.5	2.8	200	Ascension Parish	LA	2029	Air Products, resold to Yara

Source: Company or project websites and press releases for projects.

[9] Table 1 is not a comprehensive list, but rather a reasonably representative sampling of the larger projects announced in recent years. See: Project announcement press releases and project websites for Cronus Chemicals Tuscola, Beaumont New Ammonia, YaREN, CF Industries Gulf Coast Blue Point, St. Charles Clean Fuels/St. Rose Blue Ammonia, Lake Charles Clean Ammonia, Ascension Clean Energy, Channel Low-Carbon Ammonia, Louisiana Clean Energy Complex. Also of note, the Clean Hydrogen Works' Ascension Clean Energy Project is embroiled in a lawsuit with ExxonMobil, who took over a partnership position with the acquisition of Denbury.

The ammonia industry appears to have become more technology-driven than jobs-driven. In light of the trend, the argument that communities should be asked to give up public funds or tax revenues for the industry is not compelling.

Part 2: Rising Construction Costs and Operational Expenses, Together With Market Uncertainty, Pose Financial Risks

In addition to boosting employment at an industrial site, investment of public monies should ideally result in robust new economic benefits from the profitability of the industry created. Governments faced with requests for financial incentives to support the current ammonia buildout, however, should consider carefully the suitability of new ammonia production as an economic development investment.

Several factors collectively pose financial risks for ammonia production projects. These include:

- The capital cost to construct ammonia production facilities (and the related risk of relatively high interest rates lenders may charge on debt, to offset inflationary construction conditions).
- The price of natural gas, which is the feedstock for most U.S. ammonia production.
- Controversies related to carbon capture and carbon sequestration and storage.
- The existence or loss of federal subsidies.
- Uncertainties in the market.

Other risks can include high interest rates, the need for bankable long-term offtakes, supply chain issues (especially for electrical equipment), labor shortages, scarcity of purpose-built ammonia infrastructure such as pipelines and storage facilities, and regulatory uncertainty.[10]

LSB Industries, in its 2024 Form 10-K (a form submitted annually by public corporations to the SEC), framed the risk: "We may not be successful in the development and implementation of our low carbon ammonia projects in a timely or economic manner, or at all."[11]

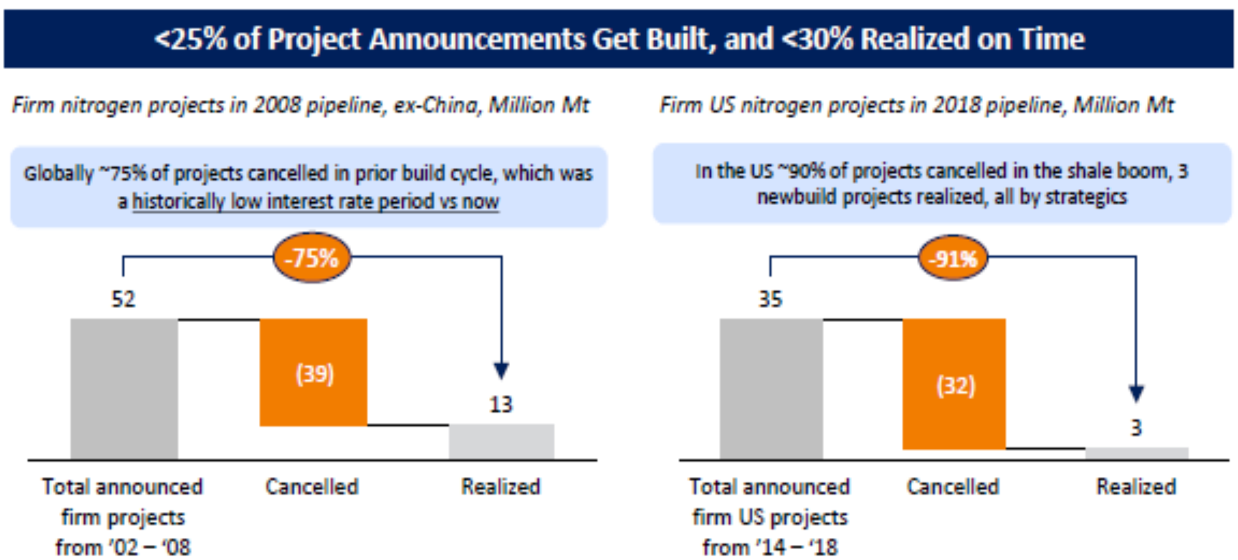
Such concern was raised during the recent shareholder activism led by Mantle Ridge Capital Management that resulted in the ousting of Air Products' then-CEO in early 2025. Mantle Ridge and its allies advocated Air Products needed to scale back its investment in risky products, including the Louisiana Clean Energy Complex described in Table 1.[12] Although the Air Products Board at the time

[10] OCI Global. Q2 2024 Results Presentation. August 2024, p. 38.
[11] LSB Industries Form 10-K for 2024, p.14.
[12] CNBC. D.E. Shaw, Mantle Ridge zero in on key fixes to build shareholder value at Air Products. October 19, 2024.

opposed the Mantle Ridge effort, heavy lobbying by shareholders resulted in a shift in board membership and a plan for CEO transition.[13] Under new CEO Eduardo Menezes, Air Products divested from the ammonia and storage aspects of the Louisiana project.[14] In a June 2025 credit opinion update in which Moody's Ratings had changed the company's outlook from stable to negative, the credit agency nevertheless praised CEO Menezes, stating he "has returned the company to its old business model, terminated projects that don't have committed off-takers and plans to de-risk its Louisiana Clean Energy project."[15]

The industry has also been plagued by project cancellations. In 2024, OCI boasted in a presentation to investors about their likelihood of completing construction in 2025 of the OCI Clean Ammonia project (now under new ownership and titled Beaumont New Ammonia). The company provided industry statistics on how few announced ammonia projects had actually been built, comparing conditions in 2008 and 2018 (Figure 4).

Figure 4: Companies' Announced Ammonia Projects That Failed To Materialize



Source: OCI Global Q2 2024 Results Presentation[16]

[13] Reuters. Air Products loses proxy fight to Mantle Ridge, CEO stays for now. January 23, 2025. Also see: Air Products. Press release. Air Products' Board of Directors Issues Response to Mantle Ridge. January 8, 2025.
[14] The new CEO was installed effective February 7, 2025. Air Products. Press Release. Air Products Board of Directors appoints Eduardo F. Menezes CEO. February 4, 2025.
[15] Moody's Ratings. Credit Opinion Update: Air Products and Chemicals, Inc. June 24, 2025, p. 4. Proprietary. Also see statement of CEO Eduardo F. Menezes regarding "discussions to divest the carbon sequestration and the ammonia production elements of this project." Air Products and Chemicals. Q2 2025 Earnings Call Transcripts. May 1, 2025.
[16] OCI Global. *op. cit*.

The above chart is based on conditions that existed before the 45Q tax credit was increased in 2022, which has become a strong incentive for the industry. Nevertheless, the tax credit is not always enough to overcome the challenges for project development.

In 2022, Nutrien had announced a plan to build what it termed “the world’s largest clean ammonia production facility” in Geismar, Louisiana, at a projected cost of $2 billion.[17] But the company suspended work on the project in 2023, explaining that estimated capital costs had risen by 15% to 20%, and although tax incentive programs under the federal Inflation Reduction Act (IRA) provided a significant boost, a Nutrien official explained it “didn't get [the firm] over the hurdle in terms of the economics of the project at this point.”[18]

Nutrien also cited a market concern about “continued uncertainty on the timing of emerging uses for clean ammonia.”[19] In June 2024, as part of its target of “Simplifying portfolio and focusing on core assets and markets to enhance earnings quality and free cash flow,” the company announced, “[W]e are no longer pursuing our Geismar clean ammonia project.”[20] In its 2024 Annual Report, the company disclosed it took a $195 million non-cash impairment on the project’s property, plant and equipment in the second quarter of 2024.[21]

Some high-profile ammonia projects were delayed or cancelled in 2025, reportedly due to profitability concerns related to capital and operational expenses or market uncertainties. For example:

- German chemical corporation BASF terminated a multi-billion-dollar plan to build a 1.2 to 1.4 million tonnes per annum (MTPA) blue ammonia project in the U.S. Gulf Coast in August 2025. The ambitious venture would have been undertaken in partnership with Yara Clean Ammonia (YCA), a subsidiary of Norwegian fertilizer producer Yara International.[22] The companies’ joint news release announcing the cancellation stated, “This decision reflects the companies’ commitment to focus on initiatives with the highest potential to achieve their respective value creation goals.”[23] One commentator reported the project was “shelved due to unfavorable market conditions and economic uncertainties.”[24] In addition to the fertilizer market, the project plan was to market ammonia as a maritime fuel and a hydrogen carrier,[25] markets that also have uncertain futures, as explained in this report.
- ExxonMobil announced in November 2025 that it put its large Baytown blue hydrogen production facility on hold, citing weak demand.[26] As reported by Reuters, ExxonMobil’s CEO

[17] Nutrien, Ltd. Press Release: Nutrien announces intention to build world’s largest clean ammonia production facility. May 18, 2022.
[18] Argus Media. Nutrien halts work on low-carbon ammonia plant: Update. March 8, 2023.
[19] *Ibid*.
[20] Nutrien, Ltd. Press Release: Nutrien to highlight strategic priorities and 2026 targets at Investor Day. June 12, 2024.
[21] Nutrien. Annual Report 2024. February 20, 2025 (hereafter, Nutrien Annual Report 2024), p. 66.
[22] See: Offshore Energy. Yara and BASF to work on low-carbon blue ammonia project in U.S. June 30, 2023.
[23] BASF Trade News BASF and Yara end joint project for low-carbon ammonia at U.S. Gulf Coast. August 26, 2025.
[24] Stocks Today. BASF halts multi-billion-dollar US ammonia project in strategic shift. August 29, 2025.
[25] Ship & Bunker. BASF and Yara scrap US Gulf Coast ammonia project targeted for shipping. August 27, 2025. Also see: Offshore Energy. BASF, Yaro axe blue ammonia site project in US Gulf Coast. August 27, 2025.
[26] Pipeline & Gas Journal. Exxon halts Baytown hydrogen project amid weak market demand. November 21, 2025.

said they could not find enough customers willing to pay the premium that carbon capture storage would have imposed on its prices.[27]

- LSB Industries, which was jointly collaborating with INPEX, Air Liquide and Vopak Moda, placed The Channel Low-Carbon Ammonia Plant in La Porte, Texas on pause in 2025. LSB's CEO and Chairman Mark Behrman stated:

> *"Regarding our Houston Ship Channel project, given the impact of U.S. tariff-related price increases and other global economic uncertainties on costs, coupled with a slower-than-anticipated ramp-up of low carbon ammonia demand, we have decided to put a pause on the project."*[28]

- A green ammonia project at the Port of South Louisiana in Reserve, Louisiana, appears off the table considering AmmPower, who signed a letter of intent with the port to study and plan the project, recently had its stock delisted in 2025.[29]

Local and state governments facing requests for development incentives should be cautious. If historical norms for the industry continue through the current phase of announced construction, then many of the announced projects may fail to become operational.

The Capital Construction Costs of Ammonia Projects Can Rise Substantially

Industrial construction input costs have risen 41.9% since 2020. In the past year alone, costs for industrial construction project materials showed an overall 4.4% increase compared to 2024 (September to September). Increases were 5% or more for construction sand, gravel, and crushed stone (6.1%); copper wire and cable (9.1%); fabricated structural metal products (6.7%); iron and steel (9.0%); plumbing fixtures and fittings (6.9%); steel mill products (12.4%); and industrial controls equipment (10.3%). The increases provided here for 2025 do not yet reflect tariffs placed in the past year on key inputs such as iron, steel, aluminum, and copper.[30] The cost of purchasing natural gas in construction rose 25% over the same period.[31] In addition, labor costs for construction have risen 46% over the past 10 years, although mostly due to inflation.[32]

The Blue Point Facility in Ascension Parish is an example of how capital construction costs can balloon. In 2022, CF Industries Holdings, Inc. (CF Industries)—which owns the world's largest

[27] Reuters. Exxon freezes plans for major hydrogen plant amid weak customer demand. November 21, 2025.
[28] LSB Industries. LSB Industries, Inc. reports operating results for the 2025 First Quarter. April 29, 2025.
[29] Canadian Securities Exchange. 2025-1009 - Suspension - AmmPower Corp. (AMMP). October 6, 2025.
[30] Associated Builders and Contractors. Construction Materials Prices Continue to Rise, Up 3.5% Since Last September. November 2025 (Table: Producer Price Index September 2025) (an analysis of federal data).
[31] *Ibid*.
[32] Adjusted for inflation, the increase amounts to 7%. This is based on a comparison of hourly wage in September 2015 of $37.35 (as adjusted for inflation from $27.35) vs. $40.08 August 2025. See Construction Coverage. U.S. construction industry facts, stats & trends. Last updated November 17, 2025.

ammonia production network[33]—announced it was considering building the large blue ammonia facility in collaboration with Mitsui & Co., Ltd., an investment and trading company, at an estimated cost of "over $2 billion."[34] The estimate rose to $3 billion in 2023. Company CEO Tony Will said of the price increase at the time: "I think that's reflective of the relatively tight labor market and inflation in general, particularly around some of the exotic metals that are required."[35] In 2025, CF Industries announced the project had become a three-way joint venture, adding JERA Co., Inc. (Japan's largest energy company)—and the estimated construction cost of the 1.4 MTPA ammonia project was increased to $4 billion.[36]

The proposed Louisiana Clean Energy Complex, which would produce hydrogen and ammonia, provides another example of how costs can escalate over time. Air Products and Chemicals, Inc. (Air Products) announced the project in October 2021 with a planned construction price tag of $4.5 billion.[37] The projected costs subsequently ballooned due to project expansion and design changes, along with inflation.[38] The changes were made to align the project with the federal Internal Revenue Service Code Section 45Q tax credit incentive for carbon capture,[39] as modified pursuant to the IRA of 2022.[40] The reported increase was to $7 billion—an additional $2.5 billion in capital costs.[41] The company decided to divest the ammonia production and storage assets as part of a strategy to reduce risk.[42] Today, Air Products anticipates the project will cost $8 to $9 billion to complete, and YARA—in an agreement that has generated some controversy—has consented to purchase the ammonia production and storage facilities of the project.[43,44]

[33] CF Industries Holdings, Inc. Form 10-K for period ending December 31, 2024. February 25, 2025 (hereafter, CF Industries Form 10-K for 2024, p. 1.
[34] Louisiana Economic Development. CF Industries announces planned $2 billion carbon-capture ammonia complex in Ascension Parish. August 17, 2022.
[35] Statement of CEO Tony Will, in CF Industries. Transcript, Earnings Call: Full Year and 4th Quarter 2023. February 15, 2024.
[36] CF Industries. CF Industries announces joint venture with JERA Co., Inc., and Mitsui & Co., Ltd., for production and offtake of low-carbon ammonia. April 8, 2025. The company plans to install autothermal reforming (ATR) production technology. Whether any design changes also affected the construction cost increase is not clear from public statements.
[37] Louisiana Economic Development. Air Products announces $4.5 billion blue hydrogen clean energy complex. October 14, 2021.
[38] See: Carbon Herald. Air Products to go ahead with $7 billion hydrogen project in Louisiana with carbon capture included. November 16, 2023.
[39] Internal Revenue Code, 26 U.S.C. § 45Q (credit for carbon oxide sequestration).
[40] Inflation Reduction Act of 2022, P.L. 117-169, § 13104, 136 Stat. 1818, 1924-1929 (2022). The statute increased pre-existing subsidies to $85 per tonne of CO_2 permanently stored underground and $60 per tonne for injection of the gas underground to help extract oil. The One Big Beautiful Bill Act, P.L. 119-21, § 70522 (2025), subsequently increased the extraction injection subsidy to $85 per metric ton.
[41] See: Carbon Herald, op. cit.
[42] Air Products. Air Products and Chemicals, Inc. (APD) Q4 FY 2025 earnings call transcript (comments of CEO Eduardo Menzes). November 6, 2025.
[43] Air Products. Air Products and Yara in advanced negotiations to partner on low-emission ammonia projects. December 8, 2025.
[44] Air Products' stock price dropped on the announcement of the agreement, with some analysts citing concern that part of the agreement would potentially expose Air Products to risk related to future market prices for green ammonia to be produced at the company's NOEM facility. See S&P Global. Air Products & Chemicals shares fall on partnership talks with Yara. December 8, 2025. Others cited the lack of detail in the announcement. Barron's. This chemicals stock is worst performer in the S&P 500 today. Here's why. December 8, 2025.

The Operational Expense of Procuring Natural Gas for Ammonia Production Has Been Low but Is Subject to Volatility—Which Can Lead to Production Instability

Ammonia production has been at an all-time high in the United States due to low natural gas prices. Blue and gray ammonia manufacturers here use natural gas as a feedstock, and typically also use it onsite as a fuel. Nutrien comments in its 2024 Annual Report, "North American nitrogen producers currently have an advantaged cost position due to the relatively low price of natural gas compared to competitors in Europe and Asia."[45]

Continued U.S. competitiveness based on comparatively cheaper gas prices, however, is not a given. Volatility levels for domestic natural gas prices have surged compared to the five-year period that preceded the United States initiating liquefied natural gas (LNG) exports (2011 to 2015) and the subsequent five-year-period in which LNG exports were ramping up (2016 to 2020) but much of the terminal buildout was still under construction (see Table 2).

Close inspection of the standard deviation divided by the average price of natural gas for these five-year periods reveals greater volatility, even though average gas prices remained similar.[46] Price swings over the last five years doubled the range of variation when compared to the preceding decade. In summary, a greater influence by extreme outliers on natural gas prices of late has resulted in lower predictability and higher exposure to larger price swings.[47]

Table 2: Volatility Comparison of Pre-LNG Export (2011 to 2015), LNG Exports Ramping Up (2016 to 2020), and Last 5 Years (2021 to 2025)

Henry Hub Spot Prices (Monthly Averages)					
	Average ($/mmBtu)	Standard Deviation	Coefficient of Variation	Skew	Kurtosis
2011-2015	$3.50	$0.83	23.70%	0.234	0.019
2016-2020	$2.65	$0.56	21.10%	0.232	0.254
2021-2025	$3.71	$1.76	47.40%	1.257	1.004

Source: Federal Reserve Economic Data (FRED), Federal Reserve Bank of St. Louis

[45] Nutrien Annual Report 2024, p. 21.
[46] The standard deviation divided by the average price, also known as the coefficient of variation, is a measurement of the dispersion away from the mean of a data set.
[47] The exacerbated volatility is evidenced by the increased skew and kurtosis (a measure of how much of the data in a probability curve is concentrated in the "tails" compared to the center). A growing positive skew indicates a lengthening of the right tail and greater asymmetry in the distribution of prices from the mean. Growing kurtosis indicates the thickness of the tail—larger figures indicate greater likelihood of extreme deviations from the mean. The growth of both skew and kurtosis suggests the mean is having less relevant value in predicting future outcomes.

Increasing natural gas price volatility—especially during pronounced gas price spikes—is detrimental to the ammonia industry because:

- Greater volatility makes production costs uncertain, causing difficulties in financial forecasting and pressuring operating margins.
- Such risks to planning and profitability spur lenders to charge greater interest rates, which increases the costs of borrowing for the industry.
- Volatile natural gas markets also force ammonia producers to hold larger than optimal cash reserves to cushion sudden changes in price.

Historically, sustained natural gas price spikes have resulted in lowered ammonia production and, in some cases, plant closures. For example:

- Over a one-year period between January 2000 and January 2001, spot prices for U.S. natural gas rose from $2.52 to $10.16 per million British thermal units (Btu), a 303% increase. The price of U.S. anhydrous ammonia over that time span, however, did not keep pace, rising only 144%, from $119 per ton to $290 per ton. This was a clear case of rising production costs that could not be passed on. The lowered margins spurred U.S. ammonia producers to reduce ammonia production by 25% in 2001.[48]
- In outlining risks related to its business, LSB Industries—a leading ammonia producer in the United States—acknowledged in its 2024 Form 10-K (issued March 2025): “We have suspended in the past, and could suspend in the future, production at our chemical facilities due to, among other things, the high cost or lack of availability of natural gas and other key components, which could adversely affect our competitiveness in the markets we serve.”[49]
- Leading up to and after Russia’s invasion of Ukraine in 2022, spiking natural gas prices across Europe took their toll on the region’s ammonia production. Fertilizers Europe reports the EU ammonia industry cut production 70% temporarily in Q4 2021. The EU also suspended 40%-50% of ammonia production during the first half of 2023.[50] Some of the suspended ammonia production became permanent closures. Yara’s Tertre Ammonia plant in Belgium, CF Industries’ Billingham UK plant, and BASF’s Ludwigshafen Germany plant ceased producing ammonia after 2022. Job losses occurred in each instance.[51,52,53]

LSB Industries, in discussing business risk factors in its 2024 Form 10-K, explains that it cannot always pass higher natural gas costs on to its customers, stating:

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[48] U.S. General Accounting Office. Natural Gas: Domestic Nitrogen Fertilizer Production Depends on Natural Gas Availability and Prices. GAO-03-1148. September 2003.
[49] LSB Industries, Inc. Form 10-K for Fiscal Year ending December 31, 2024. March 2025 (hereafter, LSB Industries Form 10-K for 2024), p. 12.
[50] New AG International. Yara Set to Close Ammonia Capacity at Belgium Plant. October 17, 2024.
[51] *Ibid*.
[52] CF Industries Press Release. CF Fertilisers UK Announces Proposal to Permanently Close Ammonia Plant at Billingham Complex. July 25, 2023.
[53] Chemical & Engineering News. BASF is cutting back at its main site in Germany. February 27, 2023.

> *"Natural gas represents the primary raw material in the production of most of our chemical products. Although we enter into contracts with certain customers that provide for the pass-through of raw material costs, we have a substantial amount of sales that do not provide for the pass-through of raw material costs. Also, the spot sales prices of our agricultural products may not correlate to the cost of natural gas but rather reflect market conditions for similar and competing nitrogen sources. This lack of correlation can compromise our ability to recover our full cost to produce the products in this market. As a result, in the future, we may not be able to pass along to all of our customers the full amount of any increases in raw material costs. Future price fluctuations in our raw materials may have an adverse effect on our business, financial condition, liquidity and results of operations."*[54]

Feedstock price volatility that creates operating challenges for ammonia producers is a well understood phenomenon and can in some circumstances help lead to plant closures, with attendant job losses.

To assume domestic natural gas prices will remain subdued compared to international natural gas prices (providing a strong competitive advantage) would be risky. We have already witnessed the rise in volatility that occurred as the United States shifted over a period of eight years from exporting nearly no LNG to becoming the largest global LNG exporter.[55] Given developers' plans to double U.S. LNG export capacity in the coming years, increasingly volatile trading conditions on the horizon could worsen the already tenuous value proposition for ammonia buildout in the United States.

CF Industries, in its Form 10-K for 2024 (issued in February 2025), acknowledged increasing LNG exports as a risk, stating:

> *"Any increases in the volume of [LNG] exported from the United States to other regions or increases in natural gas development outside the United States, particularly in regions where nitrogen products are produced, could increase our natural gas costs and/or lower natural gas costs for our competitors…. If natural gas prices outside of North America were to decrease or North American natural gas prices were to increase, our favorable energy cost differentials relative to the industry's marginal nitrogen producers could significantly erode, which could have a material adverse effect on our business, financial condition, results of operations and cash flows."*[56]

LSB Industries similarly reports that "increased demand for natural gas, particularly in the Gulf Coast Region, due to increased industrial demand and increased natural gas exports could result in increased natural gas prices."[57]

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[54] LSB Industries Form 10-K for 2024, p. 12.
[55] See S&P Global. LNG-led demand growth poised to lead to materially higher gas prices in 2026. December 24, 2025.
[56] CF Industries Form 10-K for 2024, p. 14.
[57] LSB Industries Form 10-K for 2024, p. 12.

Some competitors in the global market are state-owned or government-subsidized, and may have reasons to increase subsidies or accept lower prices to achieve other goals such as employment or a trade advantage.[58] Some also may benefit from non-market or government-set rates for natural gas pricing. Such uncertainties present competitive risk in the export market for U.S. producers.

Another operating cost that has risen is transportation of ammonia and nitrogen-based products for distribution or end use. LSB Industries notes that "higher transportation costs have and could continue to impact our margins, where we are unable to fully pass through these costs to our customers."[59] More broadly, the transportation sector itself ranks tariffs and energy prices as the most important factors they expect to monitor as they seek to navigate costs and disruptions in 2026.[60]

The Uncertainty of Federal Subsidies Presents Risks to U.S. Competitiveness in the Global Market

Many observers expected the tax credits provided by the U.S. Inflation Reduction Act of 2022 (IRA) to reduce prices for "low-carbon" hydrogen and co-products such as ammonia, making them more competitive compared to cheaper gray products.[61] Slow roll-out of rules from the Department of Treasury, however, in addition to problems in permitting CO_2 injection wells, and difficulties in obtaining binding long-term off-take contracts, have hampered industry efforts to move announced projects to Final Investment Decision (FID).[62]

Changes in government policy have further frustrated industry efforts. CF industries reported in its Form 10-K for 2024 that "changes to the IRA may impact our ability to receive anticipated tax credits for our low-carbon ammonia projects, which, in turn, could negatively affect the profitability of these projects."[63] Subsequently, the 2025 budget reconciliation legislation reduced or eliminated some subsidies that had been expected to spur investment and reduce production costs for green and blue ammonia. For example, although the legislation retained and augmented the lucrative 45Q carbon capture and storage/use credit, it shortened the eligibility window for 45V credits (which can provide up to $3 per kilogram of hydrogen produced) by five years, to apply only to projects that begin construction by December 31, 2027.[64] While blue hydrogen projects tend to avail themselves of the 45Q credit rather than the 45V credit, green hydrogen projects generally seek to use the 45V credit. Exxon CEO Darren Woods, in an article on the potential for postponing the Baytown blue

[58] See CF Industries Form 10-K for 2024, p. 12. Also see LSB Industries Form 10-K for 2024, p. 14.
[59] LSB Industries. Form 10-Q report for Q3 2025, p. 21.
[60] Breakthrough. 2026 State of Transportation Report. February 2026.
[61] See, *e.g.*, Wall Street Journal. Soot to dollars: IRA tax credits for clean hydrogen and carbon capture. May 9, 2023. Also see: Resources for the Future. Incentives for Clean Hydrogen Production in the Inflation Reduction Act. November 2022.
[62] GasWorld. ExxonMobil 'pauses major blue hydrogen project' amid offtake struggles. November 24, 2025. Also see: Decarbonfuse. Exxon Baytown FID prospects increasingly slim for 2025. October 16, 2025.
[63] CF Industries Form 10-K for 2024, p. 23.
[64] 26 U.S.C. §45V(c)(3).

hydrogen and ammonia project, opined the amended 45V credit would "undermine the development of the broader market."[65]

The ammonia industry's heavy reliance on government subsidies to make its projects profitable leaves it vulnerable to shifts in political winds.

Oversupply of the Market Could Place Downward Pressure on Prices

The extent of the currently planned ammonia production build-out in the United States—in light of the limited domestic ammonia market and competition risks in the international market—raises concern that the market may not adequately support the investments in the industry.

Whether for domestic use or export, overbuilding of ammonia capacity can place downward pressure on prices. CF Industries reported in its Form 10-K:

> *"The construction of new nitrogen manufacturing capacity in the industry, and improvements to increase output from existing production assets, increase nitrogen supply availability and place downward pressure on nitrogen selling prices, particularly when supply growth outpaces demand growth. For example, in the two-year period ended December 31, 2017, additional production capacity came online, and the average selling price for our products declined 34%, from $314 per ton in 2015 to $207 per ton in 2017."*[66]

If increased production causes supply to exceed demand, the market glut may result in lower prices for ammonia as a commodity or underuse of facilities—or both.[67] Such a result will dampen earnings and profitability, putting jobs and tax revenues at risk.

CF Industries disclosed market uncertainty for ammonia or hydrogen as a "strategic risk" in its Form 10-K, stating:

> *"If a sustainable market for low-carbon ammonia or hydrogen fails to develop, develops more slowly than we anticipate, or develops in a way that is not viable to serve with our assets and capabilities, we may decide not to implement, or may not be successful in implementing, one or more elements of our multi-year strategic plan or may have committed to investments involving substantial capital expenditures which might not yield returns required to justify such investments."*[68]

[65] Decarbonfuse, *op. cit*.
[66] CF Industries Form 10-K for 2024, p. 12.
[67] See LSB Industries Form 10-K for 2024, p. 13.
[68] CF Industries Form 10-K for 2024, p. 24.

As explained below, the domestic market is not likely to save the day for ammonia, and the export market is subject to competitive forces that may affect U.S. opportunities.

Part 3: The United States Already Produces Most of the Ammonia Used To Meet Current Domestic Demand, and Imports Are on the Decline

Ammonia build-out intended to access new domestic markets is likely to encounter challenges. In 2024, the U.S. produced 16.6 Mt of ammonia, covering roughly 94% of domestic consumption (~17.7 Mt). The remainder of U.S. domestic consumption was covered by imported ammonia.[69] Table 3 provides a current list of ammonia production plants operating in the United States, with their rated capacities (as opposed to actual production outputs that generally vary somewhat from year to year).

Table 3: Operating Ammonia Production Plants in the U.S. and Capacity

State	Company	Location	Capacity (MTPA)
AK	Cypress Chemical	Helena	0.43
AL	LSB Industries	Cherokee	0.17
AR	LSB Industries	Eldorado	0.45
CA	Chevron	El Segundo	0.02
GA	Nutrien	Augusta	0.76
GA	Shoreline Chemical	Gordon	0.03
IA	CF Industries	Port Neal	1.12
IA	Koch	Lee County	0.80
IA	Koch	Fort Dodge	0.36
IA	Greeen Valley Chemical	Creston	0.03
IL	Coffeyville Resources	East Dubuque	0.36
KS	Coffeyville Resources	Coffeyville	0.43
KS	Koch	Dodge City	0.28
LA	CF Industries	Donaldsonville	3.93
LA	CF Industries	Waggaman	0.80
LA	Nutrien	Geismar	0.60
LA	Mosaic	Faustina	0.45
MS	CF Industries	Yazoo City	0.52
NE	Koch	Beatrice	0.40
OH	Nutrien	Lima	0.70
OK	Koch	Enid	1.63
OK	CF Industries	Verdigris	1.10

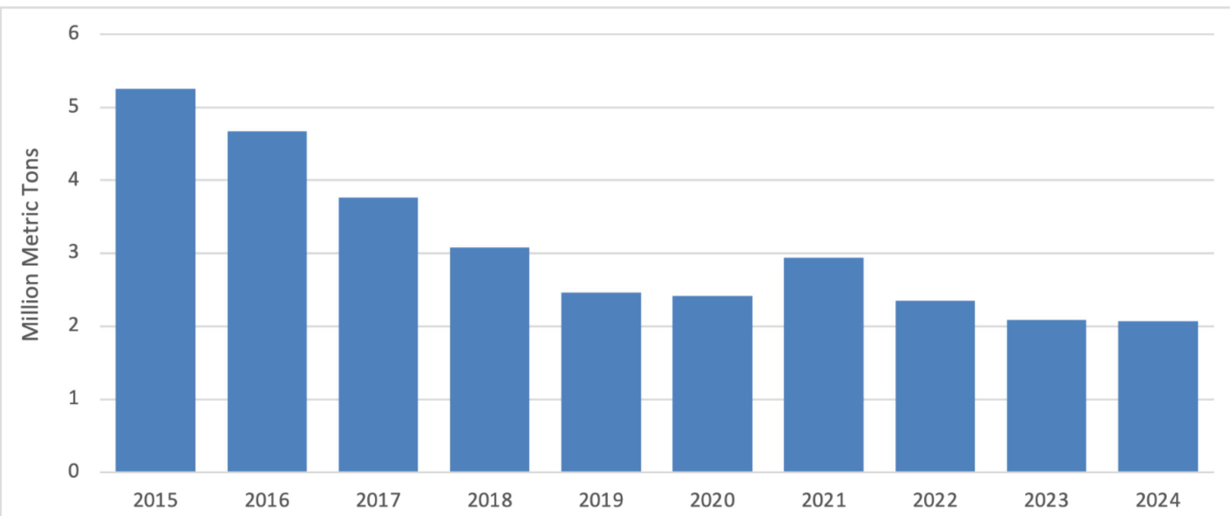
[69] ICIS. Proprietary.

OK	CF Industries	Woodward	0.44
OK	LSB Industries	Pryor	0.21
PA	Carbonair	Palmerton	0.03
TX	BASF and Yara	Freeport	0.75
TX	Gulf Coast Ammonia	Texas City	1.31
TX	OCI	Beaumont	0.30
TX	Nitromite	Dumas	0.13
TX	Nutrien	Borger	0.50
VA	Honeywell	Hopewell	0.49
WY	JR Simplot	Rock Springs	0.24
WY	Incitec Pivot (IPL)	Cheyenne	0.17
Total Capacity			**19.96**

Source: Argus Media; capacity figures in bolded rows are updated by data in company Annual Reports.[70]

U.S. imports of ammonia have been declining, on average, over the past decade.[71]

Figure 5: Decline in U.S. Ammonia Imports



Source: ICIS, IEEFA

[70] Argus Media. Major North America fertilizer and production rail network (posted on DASCO, Inc. website). Accessed November 14, 2025. IEEFA updated the source data with company reported figures from recent 10K documents where available – these rows are bolded.
[71] See Figure 5. Also see: U.S. Geological Survey. Mineral Commodity Summaries: Nitrogen (Fixed)—Ammonia. February 2026 (hereafter, USGS Nitrogen Summary 2026) (showing net import reliance as a percentage of apparent consumption has declined by 61.5% over the past five years).

Canada and the Republic of Trinidad and Tobago, combined, supply about 98% of the ammonia currently imported to the United States.[72] U.S. ammonia imports from Canada exceeded those from Trinidad and Tobago in 2023 and 2024.[73]

The domestic supply gap for existing domestic demand has been shrinking fast. An increase in ammonia production of just 2.07 MTPA, based on the 2024 import number, could allow the United States to become self-sufficient in its domestic supply, while also maintaining ammonia exports at the current level.

The year 2026 is expected to add 1.46 MTPA of new ammonia production capacity, and more facilities will be under construction in 2027 and subsequent years, leading to 4.7 MTPA of total incremental capacity by 2029 (see Table 4, which identifies the amount of capacity projected to be added each year by ammonia projects under construction).

Table 4: U.S.-Based Ammonia Projects Completed in 2025 or Currently Under Construction (MTPA)

State	Company	Site	Start Year	2026	2027	2028	2029	Total New
IL	Cronus Chemicals	Tuscola	2028			0.84		0.84
LA	Air Products	Ascension	2026	0.36				0.36
LA	Blue Point	Ascension	2029				1.40	1.40
TX	Exxon/Mobil	Baytown	2029				1.00	1.00
TX	Woodside Energy Group	Beaumont	2025	1.10				1.10
Total new capacity added				1.46	0	0.84	2.40	4.7

Sources: ICIS, IEEFA

[72] S&P Global commodity Insights. US ammonia exports decline 8.4% on year in 2024, capacity to rise in 2025. February 7, 2025.
[73] *Ibid*. The role of Trinidad and Tobago in export is decreasing, as the country's access to natural gas production has been declining for more than a decade. The Energy Chamber of Trinidad and Tobago reports domestic use of natural gas in ammonia-based industries dropped by 20% from 2015 to 2024. Energy Chamber of Trinida and Tobago. Natural Gas Utilization in Trinidad and Tobago. May 8, 2025. Methanex Corporation CEO Rich Sumner has stated the offshore gas fields in Trinidad and Tobago are "all mature and at end of life," and the country's hopes for continued ammonia activity hinge on access to gas resources in Venezuela. Daily Express (Port of Spain, Trinidad & Tobago). Methanex says future of T&T operations hinges on gas supply, Venezuela link. December 3, 2025.

Several more ammonia production projects are on the drawing boards. A 2025 report issued by the Ohio River Valley Institute (ORVI), raising concerns about the massive planned buildout of U.S. ammonia production, noted the build-out could increase U.S. production capacity to 80 MTPA within ten years (more than a four-fold expansion).[74]

If the new U.S.-based ammonia is price-competitive against potential imports and the export market is more limited than anticipated, or if the domestic market is price-competitive with the export market, U.S. importation of ammonia could shrink further or be eliminated.[75]

Roughly 88% of U.S. consumption of ammonia is in agricultural fertilizer use, including direct application of anhydrous ammonia and ammonia fertilizer products such as urea, ammonium nitrates and ammonium phosphates.[76] The remaining 12% is used to make explosives, and in production of synthetic fibers and resins, plastics, and other chemical products,[77] as well as exhaust fluid for diesel vehicle emissions reduction.[78]

As explained below, although some growth will occur, none of the existing markets are expected to balloon.

Domestic Agricultural Fertilizer Use Is Not a Rationale for Major Expansion of Ammonia Production, and Other Conventional Ammonia Uses Are Much Smaller in Scale

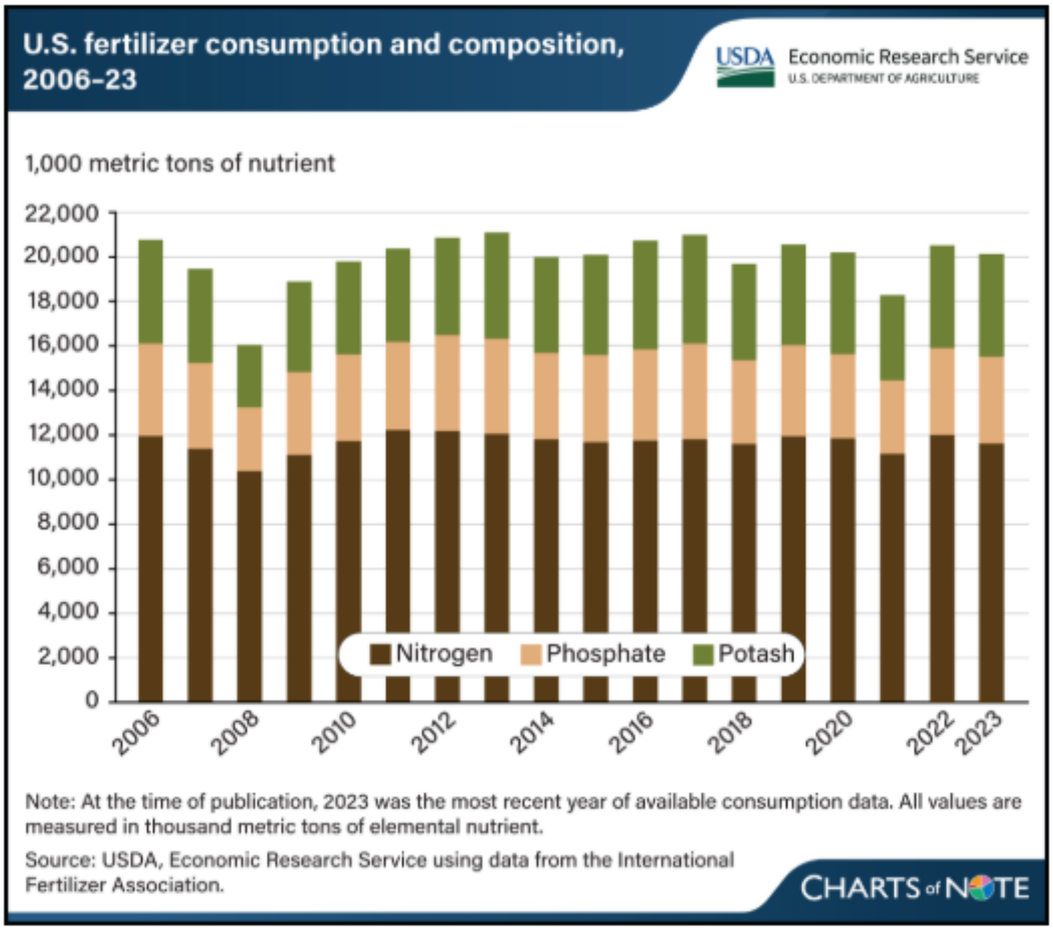
U.S. domestic agriculture's demand for fertilizer is not the driving force behind the planned ammonia production build-out. Agricultural use of nitrogen has been relatively conservative, with only slight variations (other than marked dips in 2008 and 2021 reflecting economic downturn impacts) over roughly the past couple decades.

The U.S. Department of Agriculture (USDA) comments that U.S. fertilizer consumption remains below pre-2008 recession levels, positing the declined use is related to increases in fertilizer costs per acre and as a share of total operating costs.[79] The University of Illinois's Department of Agricultural and Consumer Economics reports the efficiency of fertilizer use for corn increased 20%

[74] Ohio River Valley Institute. The Uncertain Ammonia Industry, Present & Future. February 2025 (hereafter, ORVI Report), p.3. The data was extracted from a database developed and maintained by the Environmental Integrity Project.
[75] But note: CF Industries observes, "in recent years, high volumes of urea ammonium nitrate solution (UAN) imports from Russia and Trinidad and Tobago (Trinidad) have negatively affected U.S. producers' UAN profitability." CF Industries Form 10-K for 2024, p. 13.
[76] USGS Nitrogen Summary 2026. Urea, typically comprised of 45.9% nitrogen, is the most commonly used source of nitrogen in agriculture because of its high nitrogen content (typically 45.9%) and its generally lower cost per unit of nitrogen. USGS 2004 Commodity Profile for Nitrogen, p. 5.
[77] USGS Nitrogen Summary 2026. Also see USGS 2004 Commodity Profile for Nitrogen, p. 7.
[78] CF Industries Form 10-K for 2024, p. 10.
[79] USDA. Drivers of Fertilizer Markets: Supply, demand, and prices. ERR Report No. 354. September 2025 (hereafter, USDA Report on Fertilizer Markets), p. 34.

from 2002 to 2024. It attributes the increased efficiency for corn and other crops to genetic advancements, improved management practices and timing of fertilizer applications, and better products.[80]

Figure 6: U.S. Fertilizer Consumption and Composition, 2006–2023[81]



Source: USDA

Corn is the top driver of nitrogen fertilizer demand.[82,83] The market for corn, in turn, is significantly driven by a non-food use—ethanol production, which comprises about 40% of total U.S. corn

[80] H. Monaco, *et al*. Trends in fertilizer use and efficiency in the U.S. University of Illinois Department of Agricultural and Consumer Economics Farmdoc Daily (15):98. May 29, 2025.
[81] USDA. Charts of Note: U.S. fertilizer consumption rebounds from 2021 drop. September 24, 2025. Also see USDA Report on Fertilizer Markets.
[82] USGS Nitrogen Summary 2026. Also see: Nutrien Annual Report 2024, p. 21.
[83] Other main crops that rely heavily on nitrogen fertilizer are soybeans, wheat, canola and cotton. Nutrien Annual Report 2024, p. 19.

demand. Ethanol is primarily blended with gasoline for motor vehicle use, and the U.S. ethanol market is driven in large part by federal mandates on renewable fuel use.[84]

LSB Industries, citing ethanol production as "a major factor underlying the solid level of demand for our nitrogen-based fertilizer products," identified several risks related to the ethanol end-use market. Its 2024 Form 10-K stated:

> *"To date, the RFS [federal renewable fuel standards] has been satisfied primarily with fuel ethanol blended into gasoline. However, a number of factors, including the continuing 'food versus fuel' debate and studies showing that expanded ethanol usage may increase the level of greenhouse gases in the environment as well as be unsuitable for small engines, have resulted in calls to reduce subsidies for ethanol, allow increased ethanol imports and to repeal or waive (in whole or in part) the current RFS, any of which could have an adverse effect on corn-based ethanol production, planted corn acreage and fertilizer demand. Therefore, ethanol incentive programs may not be renewed, or if renewed, they may be renewed on terms significantly less favorable to ethanol producers when compared with current incentive programs. Consequently, a decrease in ethanol production or an increase in ethanol imports could have a material adverse effect on our overall business, results of operations, financial condition and liquidity."*[85]

Two trends in the auto industry could reduce demand for ethanol, which would curb demand for corn and likely reduce demand for ammonia-based fertilizer:

- Improvements in vehicle fuel efficiency; or
- Expanded use of electric vehicles and hybrid vehicles in the United States despite elimination of the tax credit for purchase.

Substantial gains in vehicle fuel efficiency have been made in the United States. The average internal combustion vehicle efficiency in 2024 reached 24.9 miles per gallon, compared with 19.9 in 2005.[86] Further research is underway to improve combustion engine efficiency,[87] increase lightweighting of vehicle materials,[88] and enhance aerodynamics and reduce other parasitic loss of energy.[89]

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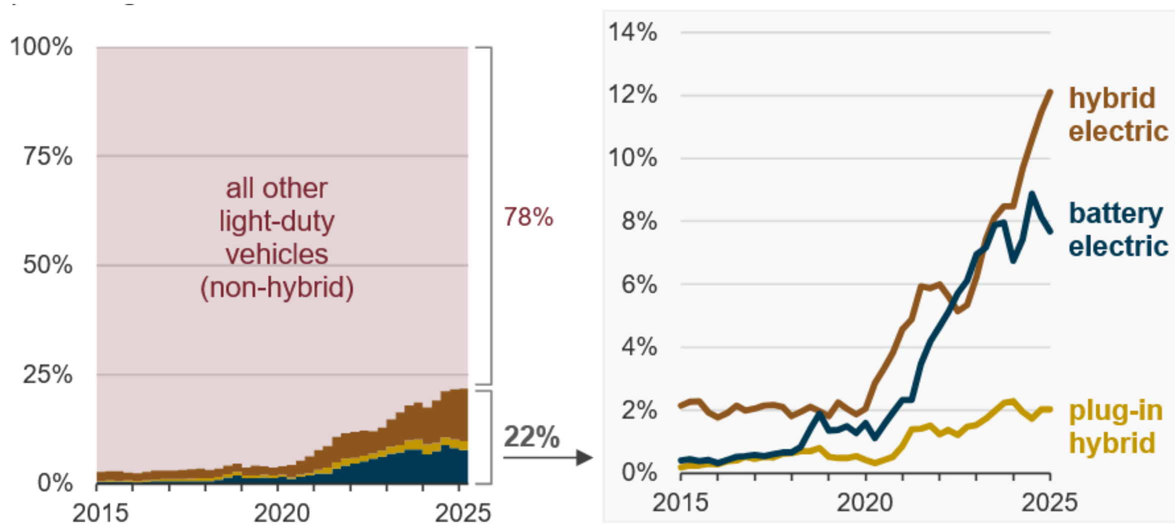
[84] Fuel ethanol use was boosted, beginning in 2002, as a substitute for methyl tertiary butyl ether (MTBE), a gasoline additive to improve combustion that was banned by several states because of groundwater contamination issues. Ethanol's use was further expanded by the Renewable Fuel Standard (RFS) established under the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007. See U.S. Energy Information Administration (EIA). Biofuels explained: Ethanol. Last updated February 23, 2004.
[85] LSB Industries Form 10-K for 2024, p. 14.
[86] U.S. Environmental Protection Agency. The 2024 Automotive Trends Report. November 25, 2024, pp. 6 and 14.
[87] See U.S. DOT. Advanced combustion strategies. Accessed December 30, 2025.
[88] See U.S. DOT. Short-term lightweight materials research (advanced high-strength steel and aluminum). Accessed December 30, 2025.
[89] See U.S. DOT. Parasitic loss reduction research and development. Accessed December 30, 2025.

Although the 2025 budget bill slowed battery EV sales by eliminating the federal tax credit for purchasing EVs and cutting funding for EV charging stations, new vehicles continue to enter the U.S. market with improved efficiency and lower cost.[90] Also, hybrid electric cars are continuing to gain market share.[91]

Figure 7: Quarterly U.S. Light-Duty Vehicle Sales by Powertrain (1Q15-1Q25)[92]



Source: EIA

Unlike plug-in hybrids, hybrid electric vehicles generate their own electric power from operation and don't depend on EV charging stations.

Possibly more important in the coming years, the used-EV supply is growing—and becoming more cost-competitive. Cox Automotive reports lease returns and trade-ins are boosting the supply of used EVs, and in August 2025, the price difference between a used EV and a used internal combustion engine (ICE) vehicle fell to just $897—the lowest on record—and 14 used EV models had a lower average price than their gasoline-powered internal combustion competitors.[93] Cox Automotive observes:

> *"For mainstream buyers, EV affordability in the used-vehicle space is finally within reach. At the same time, hybrids and plug-in hybrids continue to appeal to shoppers who value fuel economy and the convenience of familiar refueling. But the long-term trajectory favors full electrification…. Consumer intent to purchase an EV reinforces this outlook."*[94]

[90] Bloomberg Newsletter. Automakers try to entice U.S. drivers with sub-$35,000 EVs. January 17, 2026.
[91] EIA. Hybrid vehicle sales continue to rise as electric and plug-in vehicle shares remain flat. May 30, 2025. Also see: Bloomberg. How hybrid models are helping keep automakers' electrification plans afloat. December 29, 2025.
[92] EIA. Hybrid vehicle sales continue to rise as electric and plug-in vehicle shares remain flat, *op. cit.*
[93] Cox Automotive. EV Market Monitor – August 2025. September 16, 2025.
[94] Cox Automotive. After the credits: How EV adoption advances when incentives fade. September 23, 2025.

Cox Automotive believes EVs can achieve a 25% share of new car sales by 2030, which it deems "well short of the 50% once envisioned, but certainly moving out of the 'niche' category."[95]

CF Industries acknowledges increased EV and hybrid sales may reduce ethanol demand:

> *"Lower gasoline prices and fewer aggregate miles, driven by increased automobile fuel efficiency and the expansion of electric vehicle use, may put pressure on ethanol prices that could result in reduced profitability and lower production for the ethanol industry. This could have an adverse effect on corn-based ethanol production, planted corn acreage and fertilizer demand."*[96]

The U.S. Geological Survey (USGS) reported the number of hectares of agricultural land planted with corn rose by 5% in crop-year 2025, after having dropped by 3% from 2023 to 2024, but projected corn acreage in crop-year 2026 will decrease slightly because of anticipated lower returns for corn compared with other crops, along with crop rotation.[97]

With regard to the remaining 12% of the ammonia market in the United States, the chemical's non-agricultural uses as a refrigerant and industrial chemical are likely to continue to grow.

Domestic use of ammonia in explosives will continue as well, although growth may be limited. Roughly 56% of ammonium nitrate-based explosives were used in coal mining in 2019, based on USGS's most recent report.[98] The Congressional Research Service (CRS) reported in June 2025 that the first Trump administration's efforts to boost the coal industry did not increase coal production or jobs, nor did it stop coal plants from retiring, and the impact of the second Trump administration's efforts remains to be seen.[99] Overall, the CRS observed, "Coal consumption, production, employment, and exports are largely driven by industry decisions based on market conditions, rather than executive or legislative direction."[100] Despite recent U.S. government actions taken to extend the life of existing coal-fired power plant industry, some plants face reliability issues,[101] and some orders to extend plant life are being challenged based on cost as well as environmental impact.[102] Major new U.S. coal-mining activities that would require extensive use of ammonium nitrate-based explosives appear to be unlikely.

[95] Cox Automotive. After the Credits, *op. cit.*
[96] CF Industries Form 10-K for 2024, p. 14.
[97] USGS Nitrogen Summary 2026.
[98] USGS. Minerals Yearbook 2019: Explosives [advance release]. March 2024, p. 23.1. The coal mining market share that year was followed by construction (18%), nonmetal mining (15%), metal mining (9%) and other uses (3%).
[99] CRS. U.S. Coal Industry Trends. R48587. June 30, 2025, p. 14.
[100] *Ibid.*
[101] See IEEFA. Newest big U.S. coal-plant offline until 2027. October 7, 2025.
[102] The States of Illinois and Minnesota have filed a challenge in federal court to a U.S. Department of Energy order to extend the life of a coal plant in Michigan. Petition, *State of Minnesota et al. v. Wright et al*., No.25-1254 (D.C. Circ.), filed October 31, 2025. Also see: Motion to intervene, request for rehearing, and motion to stay by State of Washington, Federal Power Act § 202(c) Emergency Order TransAlta Centralia Generation, Order No. 202-25-11, January 13, 2026. Also see: Law 360. Washington urges DOE to reconsider coal plant restart. January 14, 2026.

Hopes for Large New Domestic Energy Markets for Ammonia Are Likely To Be Disappointed

Hopes that the accelerated expansion of ammonia capacity will be met in a substantial way by new domestic markets in energy, such as hydrogen transport, maritime fuel and co-firing in coal plants are likely to be disappointed. As explained in Part 4, energy markets for ammonia are highly speculative. CF Industries expressed some caution in its Form 10-K regarding the energy market. Although CF Industries stated, “We have made and expect to continue to make significant investments in our clean energy strategy,”[103] the company also acknowledged:

> *“We believe the demand for green and low-carbon ammonia could take several years to materialize and then ten or more years to fully develop and mature, and we cannot be certain that this market or the market for green and low-carbon hydrogen will grow to the size or at the rate we expect or at all.”*[104]

Part 4 outlines many reasons exist for such uncertainty, both in domestic and export marketing.

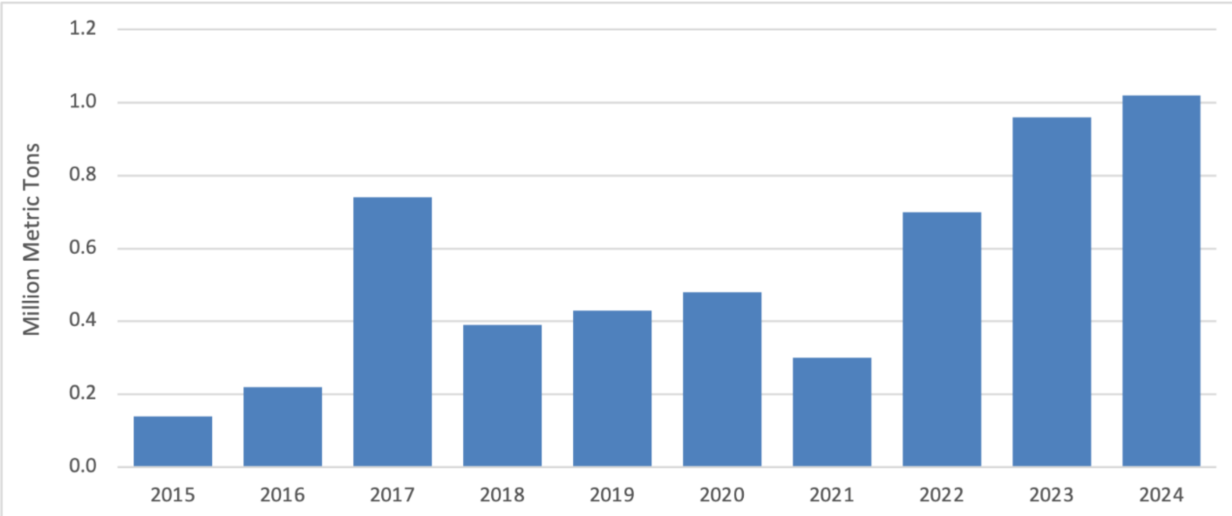
Part 4: The Global Market for Ammonia Is Full of Uncertainty

The United States Will Likely Face Robust Competition in the Global Market

The United States exported slightly more than 1.0 MTPA, or roughly 7% of its ammonia production in 2024 (see Figure 8). The overall trend has been upward for the past decade.[105]

[103] CF Industries Form 10-K for 2024, p. 24.
[104] *Ibid*.
[105] With regard to ammonia exports, the United States currently has the majority of its eggs in just two baskets: Morocco and Norway. Morocco served as the top U.S. export market in 2024, taking 35% of U.S. ammonia shipments. Norway was in second place, at 26%, with the UK trailing in third place at just 8% of U.S. exports. *Ibid*.

Figure 8: Total U.S. Ammonia Exports[106]



Source: ICIS, IEEFA

Ammonia is produced from chemicals that are plentiful worldwide and the technology is readily accessible—resulting in little or no product differentiation. CF industries, which accounts for five of the 12 largest ammonia production facilities in the United States (see Table 3), describes global competition as "intense," stating:

> *"We are subject to intense price competition from other producers. The nitrogen products that we produce are global commodities or are derived from global commodities, with little or no product differentiation. Customers tend to make their purchasing decisions of these products principally on the basis of delivered price and, to a lesser extent, customer service and product quality. As a consequence, conditions in the global market, including pricing competition, for nitrogen products significantly influence our operating results."*[107]

Many countries are in the ammonia export business.

[106] Data derived from ICIS database. The ICIS data includes an assumption of some non-reported trades from the United States to Mexico, and thus may be more complete than findings from some other sources.
[107] CF Industries Form 10-K for 2024, p. 12.

Table 5: Top 25 Ammonia Exporting Countries (Data in MTPA)

COUNTRY/TERRITORY	2023	2024	2025
TRINIDAD	3.07	3.24	2.92
SAUDI ARABIA	2.56	2.2	2.31
INDONESIA	1.79	1.69	1.62
CANADA	1.06	1.08	1.12
UNITED STATES	0.96	1.02	1.34
ALGERIA	0.82	0.95	0.97
IRAN	0.67	0.54	0.77
OMAN	0.61	0.45	0.63
QATAR	0.55	0.45	0.44
EGYPT	0.50	0.48	0.27
RLJSSLAN FEDERATLON	0.45	0.75	0.94
BAHRAIN	0.42	0.07	0.07
MALAYSA	0.40	0.47	0.41
GERMANY	0.32	0.47	0.39
NETHERLANDS-THE	0.31	0.48	0.36
ALJSTRALIA	0.24	0.32	0.34
LIBYA	0.24	0.26	0.34
CHINA	0.22	0.39	0.30
FRANCE	0.10	0.11	0.05
UNITED ARAB EMLRATES	0.10	0.11	0.10
BELGIUM	0.08	0.08	0.15
BULGARIA	0.06	0.06	0.02
BRAZIL	0.05	-	-
CZECH REPUBLIC	0.05	0.03	0.02
SPAIN	0.05	0.11	0.16

Source: ICIS, IEEFA (2025 data consists of ICIS estimates for 2025)

LSB Industries reports:

> *"Expansions or upgrades of competitors' facilities and international and domestic political and economic developments continue to play an important role in the global nitrogen fertilizer industry economics. These factors can affect, in addition to selling prices, the level of inventories in the market which can cause price volatility and affect product margins."*[108]

Perhaps the most significant uncertainty factor in the international picture is China. In an analysis of the potential market in Asia for co-firing ammonia with coal in power plants, Rystad observes:

> *"Due to abundant renewable resources in Inner Mongolia, China is well-positioned to produce low-carbon hydrogen and ammonia at scale, giving it an advantage compared to regional peers. This year, Envision Energy commissioned the world's largest green ammonia plant in Chifeng, Inner Mongolia, with an initial capacity of 0.32 Mtpa and plans to expand to 1.5 Mtpa by 2028. As deal-making accelerates China could bolster its role as a dependable ammonia supplier for the region and pave the way for exports, though the required volumes still remain unclear."*[109]

China's role in the fertilizer export market has been a fluctuating factor. Currently, China produces more than three times as much ammonia as the United States,[110] but as Table 5 shows, exports substantially less by comparison. CF Industries observes China has surplus capacity and many high-cost plants operating at less than full capacity. The company reported in February 2025 that China's government is limiting exports, but cautions, "A number of factors could encourage China to increase production capacity utilization or expand exports of nitrogen fertilizers."[111] Nutrien, similarly, warns the key factor in balancing global supply with demand is "continued Chinese urea export restrictions."[112] IBISWorld reported in April 2025 that China was becoming more active in the global fertilizer market, due to rapid expansion of coal-based urea production capacity.[113] But LSB Industries reported in October 2025, "Resumption of Chinese urea exports on 2H 2025 caused prices to moderate in late Q3 despite strong demand, but China is once again limiting its urea export, which should provide a tailwind to prices."[114]

The USGS in February 2026 projected global ammonia capacity would rise, with ammonia production expansions expected in regions with comparatively low-priced natural gas, including Asia and Eastern Europe as well as North America.[115]

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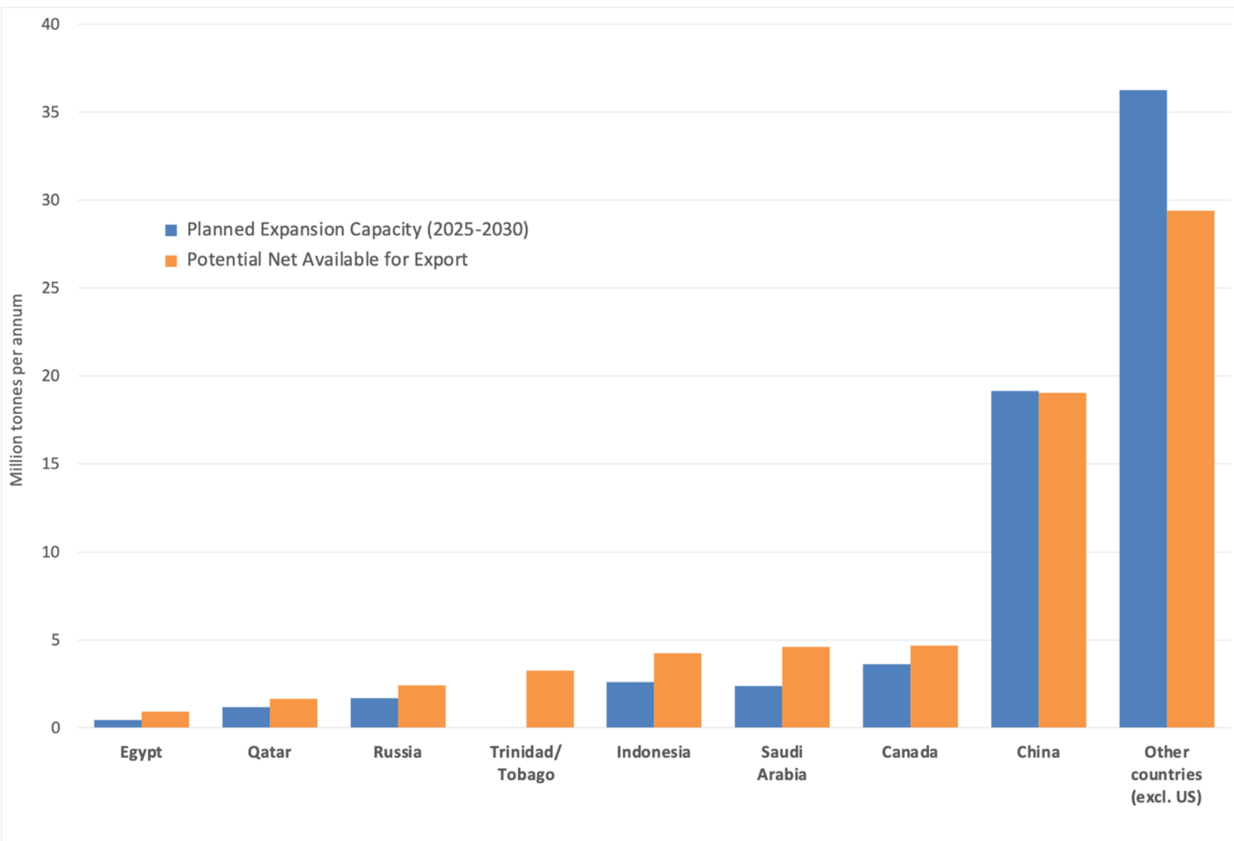
108 LSB Industries Form 10-Q report for Q3 2025, p. 20.
109 Rystad Energy. Asia turns to ammonia co-firing despite supply and cost pressures. August 18, 2025.
110 USGS Nitrogen Summary 2026.
111 CF Industries Form 10-K for 2024, p. 13.
112 Nutrien Annual Report 2024, p. 21.
113 IBISWorld. Global fertilizers & agricultural chemicals manufacturing. April 2025, p. 8. Proprietary.
114 LSB Industries, Inc. Form 8-K for Q3 2025. October 30, 2025 (hereafter, LSB Industries Form 8-K for Q3 2025), p. 5.
115 USGS Nitrogen Summary 2026.

Similarly, CF Industries notes that global competition may increase, observing that many proposed low-carbon ammonia projects have been announced or considered recently, and:

> *"[F]uture hydrogen, energy or environmental/carbon policies may support development of additional nitrogen production in locations outside North America, including Europe, Australia, India and the Middle East."*[116]

Sizeable potential competitors for the global ammonia market have expansion plans for the next five years that appear to exceed domestic supply needs (see Figure 9).[117]

Figure 9: Selected Countries That May Pose Growing Competition for the United States in Global Ammonia Market (Data in MTPA)



Source: ICIS, IEEFA

If any of the competition cost-competitively produces green ammonia or ammonia from methane fields with less leakage, the United States could find itself at a disadvantage. U.S. government policy

[116] CF Industries Form 10-K for 2024, p. 13.
[117] Ukraine is not included on the list at this time. Although it had a thriving fertilizer industry a few years ago, the current war has caused a significant collapse in production. Substantial efforts would be needed to rebuild Ukraine's fertilizer industry, see: Center for Strategic and International Studies. From the Ground Up: Demining Farmland and Improving Access to Fertilizer to Restore Ukraine's Agricultural Production. December 2023.

defining "clean" blue hydrogen, used to make blue ammonia, is weak, which may prove to be a competitive limitation in export markets seeking very low-carbon ammonia. Europe, Japan and South Korea are hoped-for markets for U.S. ammonia exports. The EU may focus entirely, or nearly entirely, on importing green ammonia. Japan and South Korea will likely import a combination of blue and green ammonia,[118] but if they expect the U.S. blue ammonia to be "clean," they may be disappointed.

Previous research by IEEFA, focused on one of the largest planned blue hydrogen projects in the United States—Air Products' planned Louisiana Clean Energy Complex—revealed the project would likely only capture between 33% and 52% of carbon emissions (well-to-gate). The range depends on the level of upstream methane emissions, and the percentage of emission reductions depends on the sponsor's assumption of a 95% CO_2 carbon capture rate applied to the plant's direct process emissions. But IEEFA's analysis of real-world commercial-scale projects finds no evidence that 95% carbon capture rates are realistic. Based on real-world data and current scientific research, the actual capture rate could be much lower. Existing hydrogen production facilities using steam methane reformers (SMRs) have achieved average capture rates between 40% and 68%. The project IEEFA examined proposes to use a newer technology, an autothermal reformer (ATR) system, which has no existing commercial-scale track record that can be examined.[119]

Attaining the label of "low-carbon" or "blue" ammonia requires not only carbon emissions capture equipment but also infrastructure to manage the carbon collected. Many affected property owners are pushing back against proposed carbon pipeline projects that involve application of eminent domain laws. The South Dakota governor signed legislation in March 2025 banning the use of eminent domain to build carbon dioxide pipelines, in response to such concerns.[120] Facing similar pushback, Louisiana has placed a moratorium, by gubernatorial executive order, suspending review of any new applications to construct Class VI (injection) wells "unless directed otherwise."[121]

CF Industries disclosed in its Form 10-K some risks to successful captured-carbon management, stating:

> *"If our assumptions about the engineering and project execution requirements necessary to successfully build or convert the facility capacity that we are contemplating and to scale up to larger production quantities prove to be incorrect, we may be unable to produce substantial quantities of low-carbon ammonia, and the cost to construct such low-carbon ammonia facilities, or the production costs associated with the operation of such facilities, may be higher than we project. The production of low-carbon ammonia depends to a large extent*

[118] S&P Global Commodity Insights. The ammonia market today and a bridge to the future. Presentation at Ammonia Energy Association Annual Conference 2024. November 11-13, 2024 (hereafter S&P Global Presentation 2024).
[119] IEEFA. Blue Hydrogen's Carbon Capture Boondoggle. March 2025.
[120] See South Dakota. House Bill 1052 - Eminent Domain Bill, "An Act to prohibit the exercise of eminent domain for a pipeline that carries carbon oxide."
[121] Office of the Governor, Louisiana. Executive Order No. JML 25-119: CO_2 Capture and Storage Limits and Moratorium. October 15, 2025, p. 6.

> *upon the ability of third parties to develop class VI carbon sequestration wells and CO_2 transportation pipelines, which currently do not exist at large scale and are subject to a permitting process and operational risks, which may result in delays, impact viability in some or all situations, or create long-term liabilities."*[122]

Also, if federal subsidies for carbon capture and blue hydrogen are removed, it is possible some U.S. facilities currently proposed as "blue" ammonia plants may eliminate the carbon capture and storage component. This could affect the competitiveness of such U.S. ammonia in some markets.

The U.S. Ammonia Industry Faces Multiple Challenges and Risks in Building Out Ammonia Production Intended for Export to a Global Energy Market That Will Likely Be Limited

When Nutrien canceled its Geismar low-carbon ammonia project (intended, as noted above, to be the world's largest low-carbon ammonia facility), it stated in that year's sustainability report:

> *"Although we still believe in the technological potential of clean ammonia, in 2024, we decided to not pursue our previously announced Geismar, LA clean ammonia project. This decision was based on the strategic priority of taking a focused and disciplined approach to capital allocation and the continued uncertainty on the timing of emerging uses, market premiums, and incentives for clean ammonia."*[123]

The company made the decision even though it reportedly had signed a preliminary agreement with Japanese conglomerate Mitsubishi for offtake of up to 480,000 tonnes per year of ammonia, from the plant for delivery to the Asian fuel market, including Japan.[124] Nutrien's concern about the timing of emerging uses is reasonable.

The potential rates of development of new global ammonia markets in power production, shipping, and serving as a hydrogen carrier are far from clear. The ORVI report pointed to three major yet widely divergent projections on the future of ammonia's energy market: The projected increases ranged from 125 to 354 to 900 MTPA of global demand.[125] The projections involve a lot of predictions about demand, costs, and competition from other technologies.

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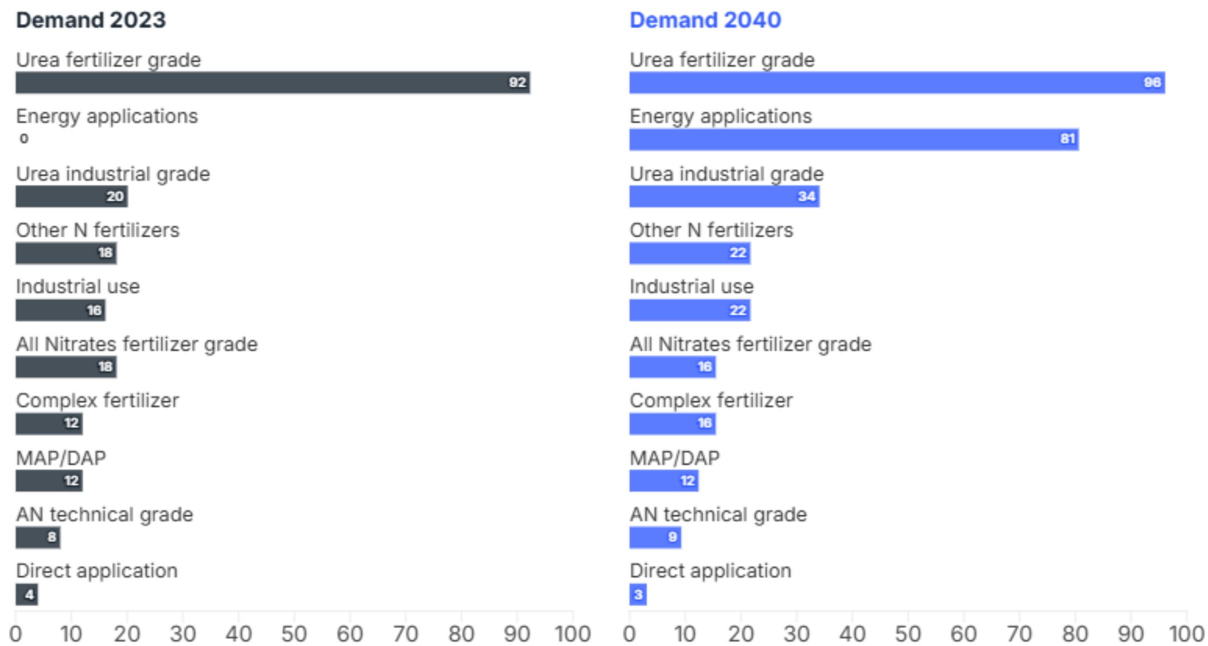
[122] CF Industries Form 10-K for 2024, p. 24.
[123] Nutrien, Ltd. 2024 Sustainability Report, p. 20.
[124] Argus. Nutrien suspends work on US low-carbon ammonia plant. March 8, 2023.
[125] ORVI Report, p. 14-15. Sources included the International Energy Agency (IEA), the Institute for Sustainable Process Technology (ISPT), and the International Renewable Energy Agency (IRENA). See IEA. Ammonia Technology Roadmap. October 2021, p. 71. Also see: ISPT. Clean Ammonia Roadmap. January 3, 2024, pp. 5-6. Also see: IRENA and Ammonia Energy Association. Innovation Outlook Renewable Ammonia. 2022, p. 92.

In 2024, an S&P Global presentation had suggested about 74% of the future global growth of ammonia demand by 2040 would be in energy applications (see Figure 10).[126]

Figure 10: One Projection of Global Ammonia Market Growth (MTPA)[127]



Source: S&P Global, IEEFA

Such energy applications, however, do not currently have a realized market, and information has since arisen that casts doubt on the extent to which such a market is likely to grow.

The International Energy Agency (IEA) identified some weaknesses in the existing global market for ammonia and its most common precursor, hydrogen. IEA's Global Hydrogen Review for 2025 noted a decline in hydrogen offtake agreements, from 2.4 MTPA in 2023 to 1.7 MTPA in 2024.[128] The agency further noted the percentage of firm agreements—as opposed to preliminary agreements such as letters of intent or memoranda of understanding—dropped from about 30% in 2023 to about 20% in 2024.[129]

The IEA also reported the total volume of hydrogen in offtake agreements for new energy applications such as power generation, shipping and other uses, grew only slightly in 2024.[130] This is

[126] S&P Global Presentation 2024, p. 2 and IEEFA calculation.
[127] See S&P Global Presentation 2024, p. 2.
[128] IEA. Global Hydrogen Review 2025. September 12, 2025 (hereafter, IEA Global Hydrogen Review 2025), p. 34.
[129] *Ibid*., p. 34.
[130] *Ibid*.

not surprising, as the financial, technical, and practical challenges for ammonia in the global energy market are significant.

Efforts to Co-Fire Imported Ammonia With Coal in Power Plants Will Face Cost Issues, Practical Hurdles, and Likely Disappointing Emission Results

U.S. ammonia producers are aware that the government of Japan is particularly interested in importing ammonia to co-fire with coal in power plants, and have been hopeful that South Korea would be a major market as well.[131] Such co-firing would require large volumes of ammonia.[132] While Japan and South Korea had been interested in importing green hydrogen or ammonia from Australia in 2023 and earlier,[133] certain major projects did not materialize,[134] and the U.S. Gulf Coast became a favored potential source for blue ammonia.[135]

Japan is developing turbines for ammonia co-firing, and is testing the technology in small power plants.[136] JERA Co., a partner with CF Industries and Mitsui & Co., Ltd., in the Blue Point low-carbon ammonia production facility targeted to open in 2029 in Louisiana, has stated it plans to supply ammonia produced from the Blue Point plant to the large Hekinan coal power plant in Japan.[137] Japan also hopes to sell the technology to other countries that continue to depend on coal-fired power, particularly in Southeast Asia.[138]

South Korea's 11th Basic Electricity Supply and Demand Plan (BPLE), released in February 2025, included a plan to triple its electricity generation from low-emission hydrogen and ammonia between 2030 and 2038.[139] Indonesia's National Hydrogen and Ammonia Roadmap, released in April 2025, announced plans to achieve 10% ammonia co-firing in coal power plants by 2030 and 30% by 2045, plus 2 gigawatts (GW) of 100% ammonia-fired capacity by 2045.[140] IEA's Global Hydrogen Review

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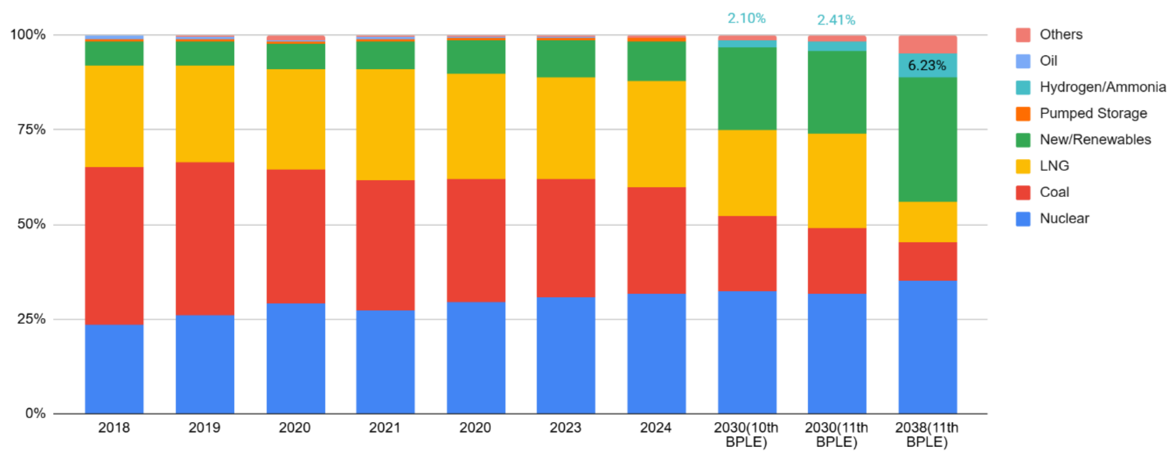
131 See, *e.g.*, comments of Air Products CEO Eduardo Menezes in Air Products and Chemicals, Inc. (APD) Q3 2025 Earnings Call Transcript. July 31, 2025.
132 OPIS Chemical Market Analytics. Clean Ammonia for Power Generation—Is the Hype Fizzling Out? April 11, 2025.
133 See: Minerals Council of Australia. Australia's Emerging Hydrogen and Ammonia Industry. February 2023.
134 PV Magazine. Stanwell exists Gladstone green hydrogen project. July 1, 2025. Also see: Renew Economy. Major project cancellation exposes fatal flaws in Australia's hydrogen export strategy. July 16, 2025.
135 Natural Gas Intelligence. What do Asian investments in U.S. ammonia, hydrogen exports mean for the natural gas market? October 5, 2023.
136 Reuters. Asia's ammonia co-firing power plant trials. March 19, 2024. Also see: GE Vernova. IHI and GE Vernova complete large-scale combustion test facility for ammonia gas turbine development. June 23, 2025.
137 Jera Co., Inc. Press Release: JERA certified as a low-carbon hydrogen and derivatives supplier under Japan's price-gap support scheme: Realizing Japan's first large-scale low-carbon ammonia value chain. December 19, 2025. Also see: Ammonia Energy Association. From Louisiana to Japan: new government support to establish full supply chains by 2030. December 21, 2025.
138 BloombergNEF. Japan's Costly Ammonia Coal Co-Firing Strategy, *op. cit.*. Also see: R. Manuel, Opinion Editorial, Nikkei Asia. Japan's 'green' aid for ASEAN is more about money than climate. December 12, 2023.
139 See IEEFA. South Korea's 11th power plan makes partial progress towards decarbonization. March 25, 2025. Also see IEA Global Hydrogen Review 2025, p. 76.
140 See Global Green Institute (GGGI). Indonesia strives for an ecosystem of clean hydrogen for a greener future. June 1, 2025. Also see: IEA Global Hydrogen Review 2025, p. 76.

2025 had projected the total power generation capacity using hydrogen or ammonia could reach 7,500 megawatts (MW) by 2030, compared to 360 MW in 2024, with Japan and South Korea representing more than a third of this planned capacity.[141]

But recently the ammonia hype has been showing signs of faltering, particularly in South Korea.

South Korea's BPLE rolled out a plan to use hydrogen and ammonia co-firing in gas and coal-fired power generation. Under the BPLE, South Korea planned to achieve hydrogen/ammonia co-firing at up to 2.41% in the power mix by 2030, rising to 6.23% in 2038. The goal was slightly up from the 10th BPLE, which planned to achieve hydrogen/ammonia co-firing by only up to 2.1% by 2030.[142]

Figure 11: South Korea's Power Mix by Energy Sources (%) in 2018–2038



Source: Ministry of Trade, Industry and Energy (MOTIE)(South Korea), Korea Electric Power Corporation

Table 6: Power Generation by Energy Sources in the 11th BPLE (GWh)

Year	Nuclear	Coal	Gas	New/ Renewable	Hydrogen/ Ammonia	Others
2030 (11th BPLE Final)	204200	110500	161000	139600	15500	11800
Share (%)	31.8%	17.2%	25.1%	21.7%	2.4%	1.8%
2038 (11th BPLE Final)	248300	70900	74300	232100	43900	34900
Share (%)	35.2%	10.1%	10.5%	32.9%	6.2%	5%

Source: MOTIE

[141] IEA Global Hydrogen Review 2025, p. 74. IEA noted Japan is developing both hydrogen and ammonia power generation projects, while most South Korea hydrogen-based power project announcements to date have focused on direct use of hydrogen.
[142] See IEEFA. South Korea's 11th power plan makes partial progress towards decarbonization. March 25, 2025. Also see IEA Global Hydrogen Review 2025, p. 77.

South Korea's recent pledge to phase out coal-fired power plants by 2040 made during the COP30, by joining the Powering Past Coal Alliance (PPCA),[143] however, signals that the plan for ammonia co-firing in coal-fired power plants will likely be abandoned or adjusted from the previous plans, as mentioned in the 10th and 11th BPLE.

In 2021, South Korea had aimed to use ammonia co-firing in a fuel mix with at least 20% ammonia in more than half of the country's coal-fired thermal power plants by 2030.[144] Policy uncertainty is increasing, however, not only with regard to ammonia-coal co-firing but also regarding hydrogen-LNG co-firing plans, which were outlined in the previous two BPLEs. In October 2025, the Ministry of Climate, Energy and Environment in South Korea cancelled the Clean Hydrogen Power Generation Bidding (CHPS), which could have subsidized hydrogen and ammonia co-firing power.[145]

Speculation is growing that only clean hydrogen co-firing with LNG plants would be included in the government subsidies, but no clear government policy exists on how to handle ammonia-coal co-firing. The preliminary 12th BPLE, which is expected to include detailed energy transition plans as well as how to handle the transitional technologies, such as hydrogen and ammonia co-firing, will likely be released in the first half of 2026.[146]

Ammonia co-firing raises issues similar to those regarding co-firing hydrogen with natural gas—which has numerous financial and technical barriers to successful deployment, as IEEFA has outlined in a report.[147] The problems are practical:

- Ammonia, like hydrogen, has a much lower energy density than methane (about 40% by volume), meaning more must be burned to produce the same amount of energy.[148]
- Ammonia, like hydrogen, produces higher levels of nitrogen oxides (NOx) emissions per unit of energy than methane, requiring additional abatement measures.[149]
- Producing low-carbon hydrogen, converting the hydrogen to ammonia, liquefying the ammonia and shipping it from one port to another is costly. Rystad estimates the levelized cost of electricity for a 10% ammonia blend would be about 50% higher than the cost of coal-only generation.[150]

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143 S&P Global. COP30: South Korea commits to phase out majority of coal plants by 2040. November 18, 2025. Also see: The Korea Times. Korea pledges to phase out coal plants. November 18, 2025.
144 IEA. Ammonia and hydrogen co-firing ambitions. September 2025. Also see: IEA. Strategies for Coal Transition in Korea. March 23, 2023.
145 Energy News. Korea's abrupt cancellation of clean hydrogen power bidding highlights deep policy uncertainty. October 28, 2025.
146 See Seoul Economic Daily. Government launches 12th round of 'energy charge'…nuclear power plants seem to be shrinking and renewable energy increasing. December 22, 2025 (updated).
147 IEEFA. Hydrogen: Not a solution for gas-fired turbines. August 1, 2024.
148 National Energy Technology Laboratory (NETL). Ammonia as a Hydrogen Carrier—Combustion Considerations. October 26, 2023, pp. 13-15.
149 Journal of the Energy Institute. NOx formation in pulverized coal co-firing with ammonia and hydrogen: effects of fuel properties and air-staging. February 2026.
150 Rystad, op. cit.

- Although Rystad projects ammonia power demand in Asia could grow ninefold by 2030, the infrastructure to receive, transport and use the ammonia is inadequate. Rystad warns that "without firm offtake commitments and accelerated development of critical import infrastructure, this growth could stall."[151]

IEA commented regarding some project cancellations occurring internationally:

> *"The relatively large hydrogen or ammonia volumes needed for commercial power plants…, the slow development of the hydrogen sector in terms of cost reductions and infrastructure, as well as regulatory or political uncertainties, are mentioned as reasons for projects being postponed or cancelled."*[152]

The high costs of developing necessary infrastructure and technology for bunkering and burning ammonia are becoming increasingly apparent.[153] The sector faces uncertainty on the supply side as well. Saudi Aramco, for example, announced in its 4th Quarter 2024 earnings call that its target for blue ammonia production "has been revised to 2.5 million tonnes by 2030, down from 11 million tonnes, due to challenging offtake agreements."[154] The company added, "We are ready to proceed once market conditions improve."[155]

Also, co-firing ammonia with coal in a power plant is not likely to achieve robust carbon emission reductions. An IEEFA analysis produced in 2024 concluded that Jera Co. Inc., which controls over one-third of electrical generation in Japan, is pursuing a costly and ineffective strategy of co-firing ammonia and hydrogen in fossil fuel power plants rather than pursuing more aggressive acceleration of proven renewable energy strategies. IEEFA's calculations found JERA's roadmap would fall far short of the IEA's net-zero path (see Figure 13).[156]

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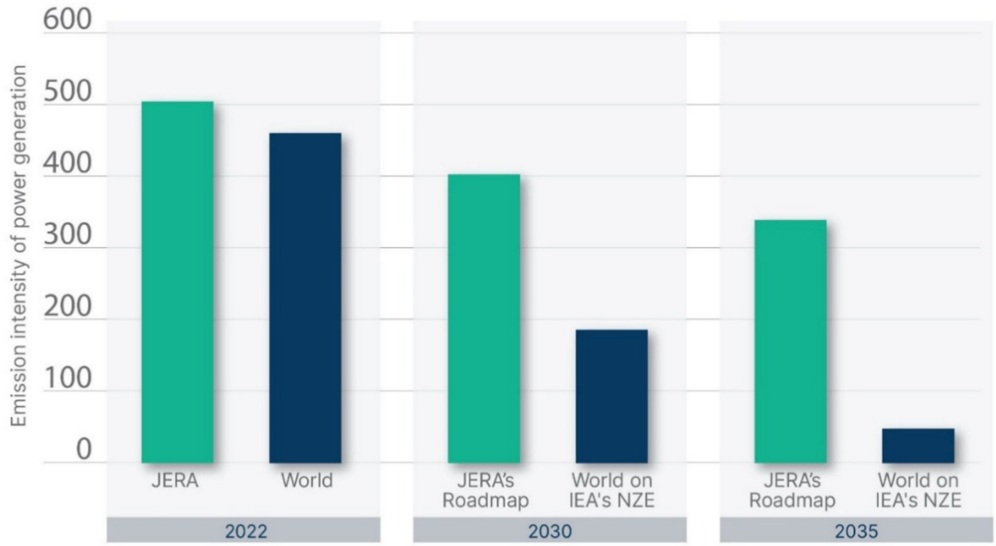
[151] Rystad, op. cit.
[152] IEA Global Hydrogen Review 2025, p. 75.
[153] S&P Global Platts. Ammonia bunkering focus to shift to price once regulatory barriers overcome. January 23, 2025. Also see: OPIS Chemical Market Analytics, *op. cit*.
[154] Saudi Aramco Oil Company. Earnings Call 2024 Q4 (highlights). March 4, 2025.
[155] *Ibid*. Also see: Gas Strategies. Aramco trims blue ammonia targets as buyers discouraged by high costs. March 4, 2025.
[156] IEEFA. JERA is putting Japan's decarbonization goals at risk. January 26, 2024.

Figure 12: Emission Intensity of Power Generation—JERA vs. World on a Net-Zero Pathway[157]



Source: IEA's net zero emissions by 2050 scenario (NZE), JERA, IEEFA calculations.

A BloombergNEF analysis found a 50% mix of ammonia (blue or green) and coal produced more CO_2 emissions than a natural gas-fired plant, and would emit more nitrous oxide (N_2O),[158] a powerful greenhouse gas and a significant ozone-depleting chemical.[159]

Finally, as explained above, to the extent a market for ammonia in power production develops, the United States may experience tighter competition for its ammonia export opportunities than in the past.

The Maritime Market for Ammonia Generally Appears Stymied

The idea of using ammonia as a fuel to decarbonize the shipping industry has gained some attention in recent years.[160] A Global Maritime Forum report found blue ammonia, based on total-cost-of-ownership modeling, to be cost-competitive with conventional shipping fuels and LNG through 2030 and the lowest-cost option from 2037 through 2045.[161] But practical issues and impediments make adoption of ammonia in the shipping industry difficult and risky.

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157 *Ibid*.
158 BloombergNEF. Japan's Costly Ammonia Coal Co-Firing Strategy, *op. cit.*, pp. 11-12.
159 Nitrous oxide is the largest anthropogenic source of ozone-destroying compounds. R. Portmann, *et al.* Stratospheric ozone depletion due to nitrous oxide: influences of other gases. Philos. Trans. R. Soc. B: Biol. Sci. 376(1593):1256-1264. May 5, 2012. Also see: UN Environment Programme. Environment Programme and Food and Agriculture Organization of the United Nations. Global Nitrous Oxide Assessment. Nairobi. 2024 (hereafter, UN Environnent Programme 2024 Global Nitrous Oxide Assessment), p. 30.
160 See, *e.g.*, International Renewable Energy Agency (IRENA). A Pathway to Decarbonise the Shipping Sector by 2050. 2021. Also see H. Wang, *et al*. Life cycle analysis of ammonia fueled ship – case ship studies for marine vessels. Journal of Cleaner Production 520(15):14605. August 2025.
161 Global Maritime Forum. IMO policy measures: What's next for shipping's fuel transition? Implications of IMO's Net Zero Framework. May 2025. Under the model used, green ammonia would become the lowest cost compliance option after 2045.

The impetus for maritime decarbonization recently hit a stumbling block. The International Maritime Organization (IMO) adopted non-binding goals in 2023 to cut GHG emissions 20% by 2030 and achieve net zero by 2050.[162] IMO members were expected to vote to adopt a Net Zero Framework decarbonization strategy in October 2025, but the Trump administration expressed opposition and the decision was delayed, adding uncertainty to investment decisions.[163] Reportedly, the pace of new orders for alternative fuel vessels has since declined.[164]

Even if the policy moves forward, however, ammonia does not appear to be a favored maritime decarbonization strategy among decision-makers in the shipping industry.

The market for ammonia in shipping is almost nonexistent today. Det Norske Veritas (DNV), an independent assurance and risk management provider, reports only three ammonia-powered ships operating in the world as of August 2025, with 38 ships "on order."[165] IEA notes ammonia is seeing some commercial use in smaller vessels,[166] but the technological development of ammonia-powered ships lags methanol technology.[167] IEA observes:

> *"Large methanol-powered ships have been on the water since the 2010s, whereas only a couple of small demonstration ammonia-powered vessels are operational at present."*[168]

In contrast, DNV reported 70 methanol ships were already on the water in mid-2025 and 336 were on order.[169] Although IEA believes ammonia will eventually become cost competitive,[170] methanol already has a strong headstart in claiming market share.

Part of the interest in ammonia as a shipping fuel is that it has ubiquitous infrastructure for manufacturing and distribution, given its long-time use in agriculture,[171] which is true for methanol as well.[172] Practical issues arise, however. The Advanced Motor Fuels Technology Collaboration Programme notes:

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[162] IMO, Marine Environment Protection Committee. Annex 15, Resolution MEPC.377980) 2023 IMO strategy on reduction of GHG emissions from ships. Adopted July 7, 2023. The reduction targets are presented relative to 2008 levels. Also see: IMO. 2023 IMO Strategy on Reduction of GHG Emissions from Ships. July 2023.
[163] Canary Media. Can cargo shipping stay the course toward cleaner fuels? October 22, 2025.
[164] *Ibid*.
[165] DNV. Energy Transition Outlook 2025: Maritime Forecast to 2050. 2025, p. 6.
[166] IEA Global Hydrogen Review 2025, p. 67.
[167] *Ibid*., p. 65.
[168] *Ibid*., p. 65.
[169] DNV, *op. cit.* Roughly 80% of methane ship orders are container ships. Advanced Motor Fuels Technology Collaboration Programme (AMF TCP). Task 60: The progress of advanced marine fuels. October 2023, p. 86.
[170] IEA Global Hydrogen Review 2025, p. 65.
[171] See F. Al-Aboosi, *et al.* Renewable ammonia as an alternative fuel for the shipping industry. Current Opinion in Chemical Engineering. 31:1006770 March 2021.
[172] AMF TCP, *op. cit.*, p. 89.

> *"The energy density of ammonia is lower than that of diesel oil, so the ship needs to design a larger space for storing ammonia fuel, which is used to arrange the space for ammonia fuel storage, safety protection and liquid gas conversion devices."*[173]

Infrastructure is an issue as well. To support large-scale new shipping operations, ammonia would need to be bunkered in huge volumes at ports. S&P Global projects an enormous increase in bunkering demand for low-carbon ammonia (blue or green).[174] Bunkering ammonia is expected to be more costly than bunkering methanol or biofuels given ammonia's toxic and corrosive properties, entailing special handling and storage infrastructure.[175] S&P Global reports:

> *"The cost of ammonia bunkering will be the key criterion determining the uptake of the fuel, once the International Maritime Organization finalizes proposals to introduce rules on greenhouse gas emissions from the sector, market participants have told S&P Global Energy."*[176]

Although S&P Global states that "the cost of bunkering is expected to ease over time as supply expands and economies of scale come into play,"[177] the issue is a potentially significant barrier to entry for ammonia as producers seek to develop a market in the shipping industry.

Also, investment timelines can be problematic. Many fuel producers seek long-term offtake contracts to secure investment. But shipowners tend to make contracts of five years or less, producing a stark challenge for producers looking to finance multibillion dollar projects.[178]

Ammonia presents safety issues in a maritime setting that are sobering. A comparative study found that ammonia increased onboard hazard levels by 24 times or more than carbon-based fuel systems, particularly due to the severe consequences of toxic dispersion in an ammonia release. While water-based mitigation systems can be used to reduce the impact of spills, the researchers noted, "Still, such measures may be largely ineffective at protecting the crew and passengers aboard a ship due to limited safety distances and the complexity of the onboard layout."[179] The researchers conclude ammonia (and hydrogen) would not play a significant role in the maritime transition until "advances in technology, infrastructure, and risk management mitigate their current drawbacks."[180]

A technical journal article based on an in-depth literature review on safety of ammonia as a marine fuel warned that "ammonia is particularly dangerous in confined spaces," and stated, "Ensuring

173 *Ibid*., p. 101.
174 S&P Global Presentation 2024, p. 15.
175 S&P Global. Ammonia bunkering focus to shift to price once regulatory barriers overcome. January 23, 2025.
176 *Ibid*.
177 *Ibid*.
178 Global Maritime Forum, *op. cit.*, p. 8.
179 F. Zanobetti, *et al*. Quantitative sustainability assessment of e-fuels for maritime transport. Sustainable Energy & Fuels 9:6506, 6515. 2025.
180 *Ibid*.

safety onboard ships fueled with ammonia, as well as during bunkering operations, is critical,"[181] observing, for example, that "due to the high toxicity of ammonia, the required distances for safe dispersion in the ambient air are greater compared to [LNG] under similar operational conditions."[182] The article also cautioned that despite the existence of some guidelines, no international regulations specifically for the use of ammonia as a shipping fuel exist.[183] Such regulations would be needed, the researchers noted, to address "ammonia leakage during bunkering, in fuel preparation rooms, and in engine rooms."[184] The reviewers stated that using ammonia as a marine fuel will require "extensive safety investigations in both the design and operational phases of a ship's lifecycle."[185]

Finally, ammonia's effectiveness in reducing maritime emissions is subject to question. Key problems for ammonia in shipping are related to its leakage, or "slip," and the formation of nitrogen-based compounds that pose risks to human health and climate.[186] A study modeling nitrogen-based emissions from marine fuel on a well-to-wake life-cycle basis found blue ammonia could achieve a 17% to 30% emissions reduction compared to fuel oil in the lowest leakage scenarios—but had more than 26% higher emissions than fuel oil in high-leakage scenarios.[187] Another well-to-wake life-cycle analysis found carbon capture rate, leakage of ammonia and methane, NO_x emissions at combustion, and energy required to distribute ammonia must be well-controlled for blue ammonia to have a low-carbon intensity.[188]

Because nitrous oxide has a global warming potential (GWP) roughly 270 times higher than carbon dioxide on a molecule-for-molecule basis—and a lifetime of approximately 120 years in the atmosphere—even small leaks can have a large impact.[189]

181 N. Pocitarenco, *et al.* A systematic literature review on safety of ammonia as a marine fuel. Chemical Engineering Transactions. 116: 733-738. 2025, pp. 733-34.
182 *Ibid.*, p. 736.
183 *Ibid.*, p. 734.
184 *Ibid.*, p. 736.
185 *Ibid.*
186 See Bertagni, *et al.* Minimizing the impacts of the ammonia economy on the nitrogen cycle and climate. PNAS 120(46) November 6, 2023 (updated), pp. 8-9. Also see AMF TCP, *op. cit.*, p. 112.
187 S. Esquivel-Elzondo, *et al.* Climate Impact of Direct and Indirect N_2O Emissions from the Ammonia Marine Fuel Value Chain. Environmental Science & Technology 59(18): 9037-9048. May 2, 2025.
188 A.P. Moller-Maersk, *et al*. Life Cycle Assessment of Ammonia Fuel. March 20, 2025, p. 158. Also see: A. Wong, *et al.* Climate and air quality impact of using ammonia as an alternative shipping fuel. Environmental Research Letters 19:084002. 2024.
189 UN Environment Programme 2024 Global Nitrous Oxide Assessment, p. 30.

Some International Use of Ammonia as a "Carrier" for Hydrogen Is Likely To Occur, but Will Face Criticism Because the Process Is Energy Inefficient

Some new market growth may occur for U.S. export of ammonia as a "carrier" for hydrogen. Conversion to ammonia is a favored transportation method because ammonia is less costly and difficult to transport.[190] Transporting hydrogen requires expensive compression, or liquefaction at a very low temperature (-423.4°F, or -253°C), and costly energy storage technology. Also, its high flash point rate requires special safety practices. Ammonia, in contrast, can be liquified much more easily under pressure at a comparatively less extreme temperature (-27.7°F, or -33°C), and typically is shipped as a liquefied compressed gas.[191] Due to the complexity and danger of transporting hydrogen, ammonia is viewed as a more practical carrier molecule.

The carrier market will depend on the extent to which the market grows for hydrogen imports.

S&P Global projects the EU will be the largest importer of ammonia by 2040, at 24 MTPA, but it is expected that all the EU demand will be for green hydrogen, not fossil-based blue.[192] The EU is supporting large renewables-powered projects in Africa that would deliver green ammonia via pipeline and be "cracked" back to hydrogen for various uses.[193]

Even in a green hydrogen scenario, however, the process of producing hydrogen, converting it to ammonia, transporting the ammonia to the recipient, and then re-converting the ammonia back to hydrogen—is very energy inefficient. One analysis found the multi-stage process would leave only about 11% to 19% of the original electricity input as electricity at its endpoint.[194]

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190 J. Palandri, *et al.*, Blue vs. Green: A comparative analysis of ammonia production and export in Western Canada and Australia. Renewable Energy. 239. December 2, 2024. p. 1.

191 US. Department of Energy. Potential roles of ammonia in a hydrogen economy: A study of issues related to the use of ammonia for on-board vehicular hydrogen storage. February 2006 (hereafter, DOE 2006 report on ammonia), p. 6. Using the Kelvin temperature scale, hydrogen can be liquefied at 20°K and ammonia at 240°K.

192 S&P Global Presentation 2024, p. 14.

193 S&P Global. US Gulf becomes lowest-price blue ammonia delivery region. June 27, 2024.

194 Hydrogen Science Coalition. Hydrogen trade: Can shipping deliver a global hydrogen market? May 25, 2024. Also see: Spitfire Research, Inc. The myth of hydrogen for export (a briefing posted on LinkedIn). Updated June 5, 2023.

The Global Fertilizer Market Will Grow, but the U.S. Share of Export Volumes Is Declining

The international market for ammonia as fertilizer historically has grown slowly and steadily. Nutrien notes China and India are the largest-consuming countries of nitrogen products, accounting for about 40% of global consumption.[195] Nutrien also observes Brazil is the largest soybean producer in the world, and the third largest producer of corn globally, making it a substantial consumer of nitrogen fertilizers. For potential market expansion, Brazil is a large and fast-growing agricultural market,[196] and imports more than 80% of the fertilizer it consumes.[197]

One analysis found expanded access to fertilizers among farmers in Africa is a factor that could quicken the pace of global agricultural fertilizer market growth by roughly five percent.[198] The IEA reports the ammonia market for chemical applications, principally fertilizer uses, accounted for 33% of cumulative firm agreements for hydrogen globally from 2021 to 2025.[199]

Rising competition from the expanding production of ammonia internationally, as noted above, is a limiting factor for the United States. The impact of such competition is particularly evident in the fertilizer market. The USDA recently reported that global trade volumes in fertilizer rose by 18.8% between 2006 and 2022, but the U.S. share of global exports declined by 25% or more over the same period.[200]

Key factors may slow the pace of global fertilizer expansion even as populations rise and countries increase their agricultural activities. Although a McKinsey 2024 report posed a "business as usual" scenario under which global fertilizer demand would grow at about 2.1% per annum through 2027, the analysts also identified several emerging factors that could cause significant demand shifts.[201]

Two substantial factors, each of which McKinsey analysts anticipate may cause as much as a 5% to 10% decrease in 2040 demand volumes, include:

- Accelerated adoption of "next-gen inputs," including bio-stimulants such as nitrogen-fixing biologicals, beneficial bacteria and fungi, humic, fulvic and other organic acids, protein hydrolysates (proteins broken down by hydrolysis into smaller components, such as amino acids and peptides), and seaweed extracts and botanicals. McKinsey analysts report about

[195] Nutrien Annual Report 2024, p. 21. Australia is another noted player in the global market, particularly as it requires fertilizer to help it take advantage of export demands for grains and oilseed—such as sunflower seeds, soybeans, flaxseeds and rapeseed (for canola oil). *Ibid*., p. 19.
[196] *Ibid*., p. 19.
[197] Karel Tomsik, *et al*. Global trends in fertilizer commerce: a dual analysis of general and nitrogen fertilizer markets. Conference: Hiradec Economic Days. April 2024.
[198] McKinsey. The 2040 fertilizer industry: how could industry trends affect demand? December 17, 2024.
[199] IEA Global Hydrogen Review 2025, p. 35.
[200] USDA Report on Fertilizer Markets, p. iv.
[201] McKinsey, *op. cit.*

20% of farmers globally have already started using bio-stimulants, and an additional 6% plan to adopt them in the next few years.

- Declining application rates in China and India, historically excessive users who are seeking to become more efficient, if they both achieve parity with global averages.[202]

As part of its effort to reduce domestic fertilizer consumption, China is pursuing measures to withdraw subsidies and promote efficient uses through advanced techniques.[203]

Factors anticipated to result in up to a 5% decrease each in 2040 demand volumes include:

- Accelerated adoption of "precision agtech," which uses data analytics, geospatial data, and sensors to improve efficiency of fertilizer applications. McKinsey analysts report 20% to 30% of farmers globally are already engaged in this technology and an additional 5% plan to adopt it in the next two years.
- Shifting land use related to climate patterns as well as possible shifts in diet trends that reduce animal feed production.
- Increased regulation of agriculture for climate and environmental purposes.[204]

The researchers questioned whether soil degradation could increase or decrease the use of fertilizer, suggesting a potential 10% change could occur in either direction.[205]

CF Industries, in identifying technological advances and government regulation as risks, states:

> *"Any reduction in the demand for our nitrogen fertilizer products, including as a result of technological developments or limitations on the use and application of nitrogen fertilizers, could have a material adverse effect on our business, financial condition, results of operations and cash flows."*[206]

Government action may be based on a range of fertilizer pollution issues—including not only greenhouse gas atmospheric emissions but also fertilizer runoff and other effects on groundwater and surface water systems. Canada, for example, plans to reduce emissions from fertilizers by 30% below 2020 levels by 2030, partly through improved nitrogen management and optimizing fertilizer

[202] *Ibid*.
[203] IBISWorld, *op. cit.* Proprietary.
[204] McKinsey, *op. cit.*
[205] *Ibid*.
[206] CF Industries Form 10-K for 2024, p. 14.

use.[207] Similarly, the EU Green Deal's "Farm to Fork Strategy" calls for a 20% reduction in use of fertilizers by 2030, and an increase in organic farming from 8% to 25% of agricultural land.[208]

Finally, as noted by one group of researchers from the Czech Republic:

> *"It is compelling to note that the global dependency on nitrogen fertilizers has led to a significant increase in agricultural productivity, contributing to food security. However, recent shifts in trade patterns, coupled with environmental and geopolitical factors, have raised concerns about the stability and sustainability of the global fertilizer market."*[209]

Reducing dependence on imported fertilizer may grow in importance as a part of some countries' security strategies.

Globally, existing non-fertilizer uses of ammonia—which occur on a smaller scale—are likely to see some expansion. Some international growth in explosives reportedly is likely to occur as a result of increased mining and large-scale construction activities—particularly in Asia Pacific, Latin America and Africa—that will increase demand for ammonium nitrate-based explosives.[210] LSB Industries notes "sustained strength in gold and copper prices has boosted mining activity worldwide."[211]

In other industrial uses the information is less clear. The IEA observes that although offtake agreements for hydrogen use in established applications such as ammonia production for chemical processes and refining decreased only slightly in 2024, the percentage of firm agreements plummeted from 65% in 2023 to just 20%,[212] possibly indicating market uncertainty.

[207] Government of Canada. Canada's 2021 Nationally Determined Contribution under the Paris Agreement. Environment and Climate Change Canada, p. 6. Canada has followed up on the goal by adopting an Agricultural Clean Technology program, an Agricultural Climate Solutions program, a Sustainable Canadian Agricultural Partnership and other initiatives. See Government of Canada. Charting the course towards the 2035 emissions reduction target: Canada's high level description. Accessed January 4, 2026.
[208] European Commission. Farm to Fork Strategy: For a fair, healthy and environmentally-friendly food system. 2020, pp. 9-11.
[209] Karel Tomsik, *et al*., *op. cit*. p. 144.
[210] See Grand View Research. Ammonium Nitrate Market (2026-2033). 2025. Summary posted online.
[211] LSB Industries Form 8-K for Q3 2025, p. 5.
[212] IEA Global Hydrogen Review 2025, p. 34.

Part 5: Ammonia Production and Transport Pose Community Safety Issues That Present Financial Risks to the Industry and Policy Pitfalls for Government

The communities that host ammonia production facilities are subject to a range of risks. Ammonia exposure from inhalation, ingestion, and skin or eye contact poses health risks. Symptoms of such exposure can include, but are not limited to, wheezing, dyspnea (breathing difficulty), chest pain, irritation to the eyes, nose, or throat and—where skin exposure to ammonia liquid occurs—skin burns and even frostbite.[213] CF Industries discloses:

> *"Our operations are subject to hazards inherent in the manufacture, transportation, storage and distribution of chemical products, including ammonia, which is highly toxic and can be corrosive, and ammonium nitrate, which is explosive."*[214]

Beyond direct exposure to ammonia, under certain conditions the chemical can pose risks related to fire or explosion. The National Institute for Occupational Safety and Health (NIOSH) warns that, "Although NH3 does not meet the DOT definition of a Flammable Gas (for labeling purposes), it should be treated as one."[215] The State of New Jersey's Department of Health, as part of its Right to Know program for chemical risks, bluntly warns that ammonia "may ignite and burn with explosive force," and "poisonous gases are produced in fire." It further warns that "containers may explode in fire."[216]

Ammonia production and products are typically subject to state and federal environmental laws and regulations regarding chemical materials and fire risk management. But the laws do not always succeed in preventing accidents.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) spent nearly three years investigating a fire and explosion that occurred at the West Fertilizer Company (WFC) site in West Texas on April 17, 2013. The facility did not produce but rather stored and distributed fertilizer-grade ammonium nitrate (FGAN), along with other fertilizers, chemicals, grains and farming supplies. The CSB at the time described the explosion, which detonated about 30 tons of FGAN, as "one of the most destructive incidents" it had ever investigated.[217] The CSB's report stated:

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[213] National Institute for Occupational Safety and Health (NIOSH). Ammonia. October 30, 2019 (hereafter, NIOSH Information Topic: Ammonia).
[214] CF Industries Form 10-K for 2024, p. 19.
[215] NIOSH Information Topic: Ammonia.
[216] New Jersey Department of Health. Right to Know Program. Hazardous Substance Fact Sheet: Ammonia. February 2016.
[217] CSB. Investigation Report (Final): West Fertilizer Company Fire and Explosion. January 16, 2023, pp. 13, 16 and 21.

"The violent explosion at the WFC facility fatally injured 12 emergency responders and 3 members of the public. All of the fatalities except one resulted from fractures, blunt force trauma, or blast force injuries sustained at the time of the explosion."[218]

Local hospitals reported treating more than 260 injured people. The blast, according to the CSB report, completely destroyed the West Fertilizer Company facility and damaged more than 50 buildings off-site.[219] The CSB explained that ammonium nitrate, a salt compound formed by neutralizing nitric acid with anhydrous ammonia, is a stable material under normal conditions, but in a fire incident can result in uncontrollable fire, decomposition with the formation of toxic gases, and explosion.[220] The CSB raised possible factors or conditions that likely contributed to the fire and detonation, but confessed that "the scenario that contributed to the detonation at the WFC might never be precisely determined."[221]

On a much smaller scale but still disturbing for the host community, an explosion at a hydrogen and nitrogen product manufacturing plant located north of Yazoo City in Mississippi last fall resulted in a leak of anhydrous ammonia. Times Now News stated that no injuries were reported from the explosion. Still, the incident, which occurred around 4:25 pm on Wednesday, November 5, 2025, prompted "widespread evacuations and shelter-in-place orders across the area."[222] The Yazoo County Emergency Management Director, Jack Willingham, explained:

"Once we were able to determine that the leak had been stopped, we brought in air monitoring with MDEQ [the state's environmental agency]. We monitored the areas that were in danger until we found safe readings, and we allowed our residents to return home."[223]

Such incidents are disruptive to communities and a burden on local emergency management teams.

Ammonia transport also carries risks.[224] Ammonia production plants typically rely on natural gas pipelines to transport gas for feedstock and for operational fuel use, and on rail, trucks, water-based transportation or pipelines to deliver their products to domestic or foreign manufacturers for further processing, or directly as final product to domestic or foreign customers.[225] CF Industries reports:

"These transportation operations, equipment and services are subject to various hazards and other sources of disruption, including adverse operating conditions on the inland waterway

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[218] Ibid., p.30.
[219] Ibid., p. 13.
[220] Ibid., p. 58.
[221] Ibid., p. 64.
[222] Times Now News. Mississippi chemical plant explosion: Ammonia leak triggers mass evacuations in Yazoo City. November 6, 2025. Also see: CBS News. Explosion at Mississippi plant causes ammonia leak, sends large plume of yellow smoke into the air. November 6, 2025.
[223] WLBT. Yazoo County EMA director's efforts after chemical plant explosion. November 10, 2025.
[224] The ORVI Report, p. 13, discusses the ways ammonia is transported, including as a pressurized liquid by rail, on highways or in ships, and by pipelines, as well as the form in which it is moved (as a pressurized liquid or gas, or—after manufacturing—as a solid product such as urea, ammonia nitrate, calcium nitrate or potassium nitrate.
[225] See CF Industries Form 10-K for 2024, p. 16.

> *systems or on the seas with respect to oceangoing vessels, adverse weather conditions, system failures, unscheduled downtime, labor difficulties or shortage, shutdowns, delays, accidents such as spills and derailments, vessel groundings and other accidents and operating hazards. Additionally, due to the aging infrastructure of certain rail lines, bridges, roadways, pipelines, river locks, and equipment that our third-party service providers utilize, we may experience delays."*[226]

The concern is not an idle one. Ammonia accidents can put first responders, community residents and workers at risk. On the night of November 12, 2025, for example, an 8,500-gallon tanker truck transporting ammonia began leaking.[227] The vehicle parked in a lot outside a hotel in Weatherford, Oklahoma. The local police department received 911 calls at about 9:58 p.m. The policy department estimated the number of people evacuated within about a square mile of the truck—from the hotel, two assisted living centers, local residences and businesses—ranged from 300 to 500. The shelter-in-place order was lifted at about 8:00 a.m. the next day,[228] but Weatherford public schools were closed November 13 on "the advice of local authorities."[229] No fatalities were reported, but five of about 50 first responders on the scene within the first hour sustained chemical burns to their airways, and nine others suffered exposure to the chemical. A hospital in Weatherford treated 34 patients.[230]

Related infrastructure such as pipelines transporting hydrogen to ammonia plants, ammonia to liquified gas terminals or industrial facilities, or CO_2 for use in oil extraction or underground injection for storage pose risks as well. The National Transportation Safety Board (NTSB) investigated a rupture of an anhydrous ammonia pipeline that occurred on October 17, 2016 a few miles north of Tekamah, Nebraska. The incident released 2,587 barrels (108,654 gallons) of liquid ammonia, which vaporized and produced a plume the NTSB described as "toxic." The NTSB reported, "A local resident who had left his home to investigate the accident scene died of respiratory failure due to exposure to the ammonia vapor," and 49 people were evacuated.[231] The investigation determined the probable cause of the pipeline rupture was corrosion fatigue cracks that grew and coalesced under disbonded polyethylene tape coating," exacerbated by "external loading that caused bending stress" and "the cyclic stresses in the pipe from the internal pressure of the ammonia."[232]

Even under typical operation conditions, ammonia releases can occur. LSB Industries acknowledged in its 2024 Form 10-K, "We periodically experience minor releases of ammonia related to leaks from

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[226] *Ibid*., pp. 16-17.
[227] CBS News. Ammonia leak in Oklahoma leaves dozens hospitalized, forces hundreds to evacuate. November 13, 2025.
[228] Weatherford Police Department. News release posted on Facebook, November 13, 2025.
[229] Weatherford Public Schools. Facebook page posting dated November 13, 2025.
[230] Weatherford Policy Department, *op. cit.* Also see: CBS News, *op. cit.*
[231] NTSB. Pipeline accident brief: Magellan pipeline anhydrous ammonia release near Tekamah, Nebraska, October 17, 2016. PAB-20/01. January 29, 2020.
[232] *Ibid.*

our equipment."[233] Leakage from ammonia production, distribution and management remains a significant problem. Princeton University researchers note:

> *"Even though the ammonia infrastructure has a high level of maturity, and many regulations to mitigate ammonia risks have been established worldwide, satellite observations reveal that industrial NH3 production plants are hotspots of ammonia emissions, which are greatly underestimated in inventories by a median factor of 50…. In the ammonia economy, emissions from pipelines, distribution and storage systems, fuel stations, and combustion and cracking sources may also occur."* [234]

Also, even at well below the toxicity threshold, ammonia can be detected by smell (the odor threshold is only 2-5 parts per million),[235] and can present nuisance conditions in a community.

Finally, the USGS has expressed concern about theft of ammonia for illicit drug-related purposes, explaining:

> *"Ammonia can be a component in the synthesis of methamphetamine, which is of particular concern to drug and law enforcement agencies. … [T]heft of anhydrous ammonia fertilizer from farms, retail outlets, and even ammonia pipelines for production of methamphetamines has escalated."*[236]

Ammonia production plants are subject to several security laws and regulations. In the United States, however, the Chemical Facility Anti-Terrorism Standards, previously promulgated in 2007, were subject to a sunset provision. Congress extended the program several times, but the last extension expired in July 2023. Proposals have been offered to revive the program but no legislation has yet been adopted, and the program relies on voluntary compliance.[237]

The burdens and risks of the ammonia industry are not distributed evenly throughout the country. About 57% of domestic ammonia production capacity is generated in just three states: Louisiana, Oklahoma, and Texas.[238]

About one-third of current ammonia production capacity is centered in Louisiana, which hosts the largest capacity ammonia plant, the CF Industries facility in Donaldsonville, along with three other plants. The Donaldsonville complex on the west bank of the Mississippi River in southeastern Louisiana, for example, has a capacity of more than 3.93 MTPA.[239] The Donaldson plant provided

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[233] LSB Industries Form 10-K for 2024, p.13.
[234] Bertagni, *et al.*, p. 4.
[235] N. Pocitarenco, *et al*., *op. cit.*, p. 733.
[236] USGS 2004 Commodity Profile for Nitrogen, pp. 7-8. Also see DOE 2006 report on ammonia, p. 20.
[237] See LegalClarity (Administrative and Government Law). CFATS reauthorization status: Compliance during the lapse. December 13, 2025.
[238] USGS Nitrogen Summary 2026.
[239] See Table 3.

about 40% of the company's total ammonia production capacity in 2024.[240] Much of the remaining ammonia production capacity is in Texas (three plants) and Oklahoma (four plants), but as highlighted in Table 7 below, some of the largest ammonia plants can also be found in other states, including Georgia, Iowa, Ohio and Oklahoma.

Table 7: Ten Largest Ammonia Plants Currently Operating in the United States

STATE	COMPANY	SITE	Capacity (Million Metric Tons)
LOUISIANA	CF INDUSTRIES	DONALDSVILLE/LA	3.93
TEXAS	GULF COAST AMMONIA	TEXAS CITY/TX	1.31
OKLAHOMA	CF INDUSTRIES	VERDIGRIS/OK	1.10
IOWA	CF INDUSTRIES	PORT NEAL/IA	1.12
OKLAHOMA	KOCH FERTILIZERS	ENID/OK	1.63
GEORIGA	NUTRIEN	AUGUSTA/GA	0.92
LOUISIANA	CF INDUSTRIES	WAGGAMAN/LA	0.80
IOWA	KOCH FERTILIZERS	LEE COUNTY/IA	0.76
TEXAS	YARA/BASF (FREEPORT)	FREEPORT/TX	0.75
OHIO	NUTRIEN	LIMA/OH	0.70

Source: Argus Media; updated with company Annual Reports, IEEFA

The health and safety risks to communities located near ammonia plants and transport infrastructure pose financial risks to the company. CF Industries acknowledges it is not fully insured against all the hazards and risks associated with its industry. The company disclosed in its Form 10-K:

> *"We maintain property, business interruption, casualty and liability insurance policies, but we are not fully insured against all potential hazards and risks incident to our business, and certain hazards and risks associated with our operations may not be uninsurable. If we were to incur significant liability for which we were not fully insured, it could have a material adverse effect on our business, financial condition, results of operations and cash flow…. The*

240 CF Industries Form 10-K for 2024, p. 17. This assertion appears to apply to the company's total ammonia production capacity, including not only its U.S.-based plants, but also two plants in Canada and another in Trinidad.

policies also contain exclusions and conditions that could have a material adverse impact on our ability to receive indemnification thereunder."[241]

LSB Industries similarly acknowledges in its 2024 Form 10-K:

"While we maintain liability, property and business interruption insurance, including certain coverage for environmental contamination, it is subject to coverage limits and policies that may exclude coverage for some types of damages… even a partially uninsured claim, if successful and of significant magnitude, could have a material adverse effect on our business, results of operations, financial condition and liquidity."[242]

CF Industries has expressed concern that the railroad industry is seeking to limit its potential liability for transport risks from Toxic Inhalation Hazard materials, which would increase CF Industries' liability risk. The company observes:

"[V]arious railroads shift liability to shippers by contract, purport to shift liability to shippers by tariff, or otherwise seek to require shippers to indemnify and defend the railroads from and against liabilities (including in negligence, strict liability, or statutory liability) that may arise from certain acts or omission of the railroads, third parties that may have insufficient resources, or the Company or from unknown causes or acts of God. These initiatives could… increase our liability for releases of our anhydrous ammonia while in the care, custody and control of the railroads, third parties, or us, for which our insurance may be insufficient or unavailable."[243]

Proposals for government to grant public financial incentives to an industry that presents risks to host communities should be held to an extremely high standard of scrutiny.

Conclusion

IEEFA's research casts doubt on the purported rationale for awarding public money or tax breaks to private developers of ammonia projects. Capital costs, volatile operational expenses, and market uncertainties create risks for project revenues and cash flows. Also, environmental safety issues from ammonia production and transport pose risks to host communities. When the industry's job generation potential is diminishing, and when the primary purpose of the project is export rather than to address a significant unmet domestic need, the risks are hard to justify. Local and state governments should identify and invest in businesses that provide more local jobs, target more reliable markets, and generate more reliable economic benefits for the public.

241 *Ibid*., p. 19.
242 LSB Industries Form 10-K for 2024, p. 20.
243 CF Industries Form 10-K for 2024, p. 17.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

About the Authors

Todd Leahy, Director, North America

Todd has worked in a variety of roles in academics, the nonprofit, and government sectors. Most recently, he was the Deputy Cabinet Secretary for the New Mexico Energy, Minerals and Natural Resources Department, but has also managed the New Mexico affiliate of the National Wildlife Federation, worked as an attorney for the Missouri Department of Natural Resources, and in a prior life was a college history professor. He has a JD from the University of Missouri-Kansas City and a PhD in Native American history from Oklahoma State University. He is the author of four books, a handful of articles, and numerous book reviews on Native American history.

tleahy@ieegfa.org

Trey Cowan, Energy Analyst, Oil & Gas, North America

Trey Cowan is an oil & gas Energy Analyst focused on U.S. upstream and global energy markets with a keen interest in Texas activities. At IEEFA, Trey contributes research, commentary, and independent analysis assessing the energy industry's transition to cleaner, more affordable and sustainable solutions. As a finance professional for over 20 years, he is skilled at presenting thought-provoking data in formats that are persuasive and easily graspable. His work and insights have been covered by Reuters, NPR, Forbes, and Investor's Business Daily as well as national, broadcast, and local news outlets. Trey holds a Bachelor of Science in Accounting from University of Houston-Clear Lake, a Master of Business Administration in Finance from Vanderbilt University, and is a Texas-licensed Certified Public Accountant.

tcowan@ieegfa.org

Anika Juhn, Energy Data Analyst, North America

Anika Juhn is an energy data analyst for IEEFA with expertise in data analysis, spatial data analysis, and cartography. Currently, her research at IEEFA is focused on fossil hydrogen production and issues surrounding carbon capture and storage.

ajuhn@ieegfa.org

Michelle (Chaewon) Kim, Energy Finance Specialist, South Korea

Michelle Kim is an Energy Finance Specialist, South Korea at IEEFA. Over the past 17 years, she has worked across various energy and commodity sectors in Power, Renewables, Natural Gas and Petrochemicals. Before her tenure at IEEFA, Michelle worked at S&P Global Commodity Insights and IHS Markit in Singapore, where she served as a senior energy market analyst, focusing on trading and fundamental analysis on Oil, LNG, and Petrochemicals. She also held positions at Ernst & Young's Energy M&A Advisory team in Korea as an assistant director. She holds a bachelor's degree in Sociology from Yonsei University in Seoul, South Korea, and a Master of Science in International Business from the University of Birmingham in the United Kingdom.

mkim@ieegfa.org

Research assistance provided by Beth Cook, IEEFA Business Research Librarian.

Institute for Energy Economics and Financial Analysis