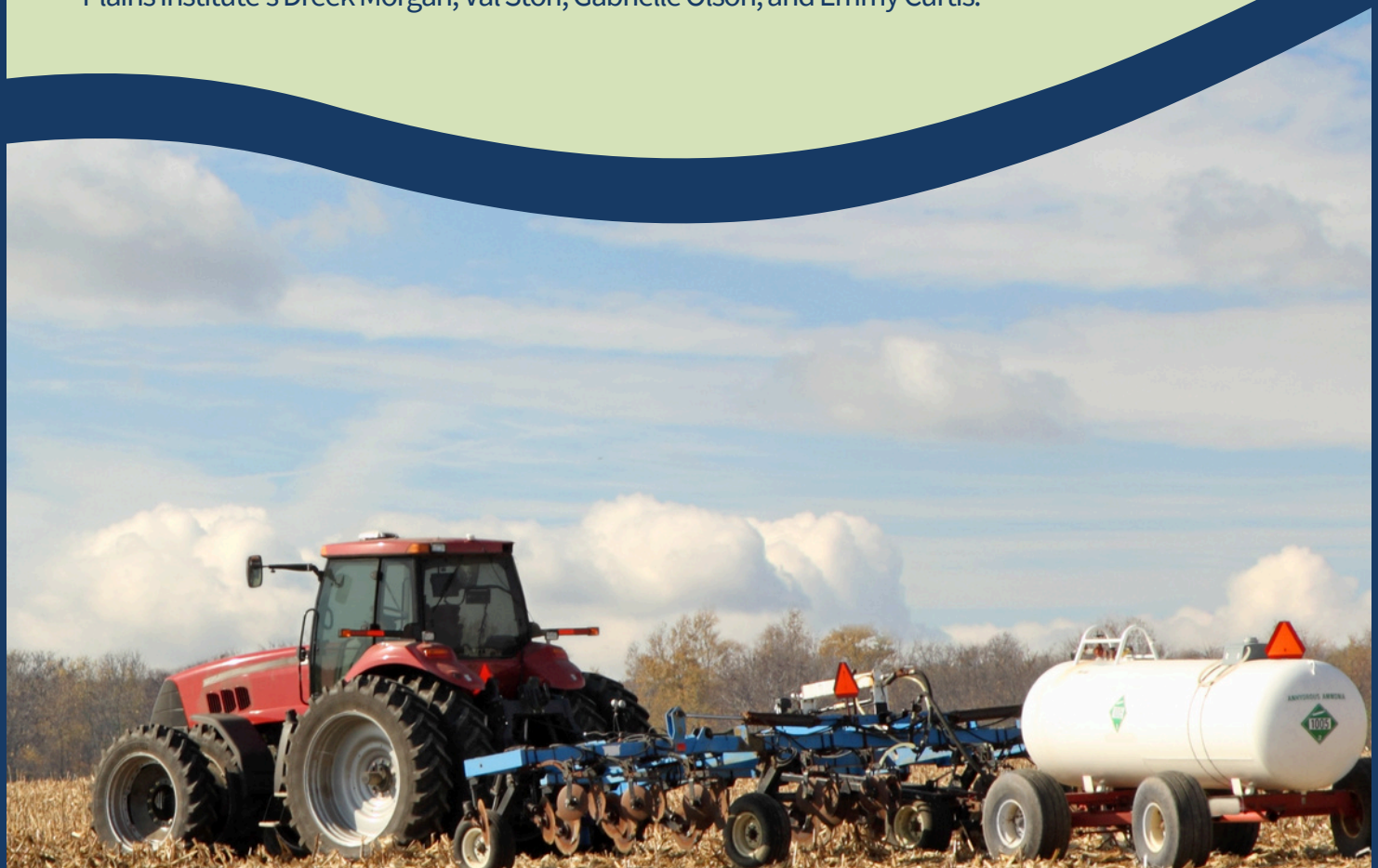
January 2026

Distributed Green Ammonia: Demonstrating Modular Systems for Sustainable Agriculture

An inside look at demonstration projects in Iowa and Manitoba

This report was prepared for the Hydrogen Economy Collaborative by the Great Plains Institute's Dreek Morgan, Val Stori, Gabrielle Olson, and Emmy Curtis.



About the Hydrogen Economy Collaborative

The Hydrogen Economy Collaborative (HEC) aims to coordinate national efforts, especially those in the Midwest, with emerging hydrogen industries to synchronize new supply chains. Focus areas include research and development, production, infrastructure, distribution, education, outreach, and market development to help meet consumer preferences for low-carbon energy solutions. The HEC is administered by the Great Plains Institute.

Learn more at https://betterenergy.org/hydrogen-economycollaborative/.

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Introduction

Global agricultural systems rely on ammonia for nitrogen-based fertilizers,[1] but the supply chains that deliver it are fragile, and production remains highly concentrated in natural gas-rich regions such as the US Gulf Coast, China, and Russia. This centralization means that ammonia travels hundreds or thousands of miles to reach farms, compounding the risk of supply disruptions caused by weather or transportation issues and increasing costs related to fuel and logistics. Additionally, global market dynamics, geopolitical relations, and international events further impact ammonia production, trade, and cost.[2]

Conventional ammonia is one of the most expensive and carbon-intensive inputs that farmers purchase. Its fossil fuel-based production accounts for ammonia's large global greenhouse gas emissions footprint, which is about 2 percent of global emissions and 10.6 percent of the agricultural sector's emissions.[3] Associated emissions arise from two main categories:

- energy-related emissions from the fossil fuels used to power the high-temperature and high-pressure ammonia production processes
- process emissions resulting from the use of fossil fuels as feedstock[4]

Unlike conventional ammonia, green ammonia is produced using renewable energy resources to create hydrogen, which is then combined with nitrogen captured from the air, thereby eliminating nearly all process-related emissions.

Distributed green ammonia (DGA), produced on-farm or within agricultural regions, offers several benefits:

- Provides a cost-effective, zero-carbon, reliable alternative that localizes supply, lowers emissions, and protects food security.
- Reduces greenhouse gas emissions further through shorter supply chains and transportation routes.
- Supports achieving the climate goals of food producers and fuel companies amid growing global demands for low-carbon fuels and sustainability-focused foods.

[1] Ammonia is an essential building block of synthetic nitrogen-based fertilizers.

[2] International Energy Agency, *Ammonia Technology Roadmap, Executive Summary* (International Energy Agency, October 11, 2021), https://www.iea.org/reports/ammonia-technology-roadmap/executive-summary.

[3] Stefano Menegat, Alicia Ledo, and Reyes Tirado, "Greenhouse gas emissions from global production and use of nitrogen synthetic fertilisers in agriculture," *Scientific Reports* 12, 14490 (2022), https://doi.org/10.1038/s41598-022-18773-w.

[4] "Ammonia industry net-zero tracker," World Economic Forum, November 28, 2023, https://www.weforum.org/publications/net-zero-industry-tracker-2023/in-full/ammonia-industry-net-zero-tracker.

Decarbonizing the agricultural industry is particularly urgent, as the world's crop production is expected to increase by 40 to 60 percent by 2050 to meet the demands of population growth.[5] Global demand for ammonia is also anticipated to increase threefold by midcentury; nearly all this demand will come from low-carbon ammonia.[6]

DGA projects can deliver local economic benefits to communities by keeping fertilizer spending within the region. For example, with nearly $500 million to $1 billion leaving Minnesota annually[7] to import 900,000 tons of nitrogen-based fertilizer from the Gulf Coast,[8] investing in local DGA production and renewable energy would retain this money within the state. Local investments in DGA facilities would have wide-ranging local benefits that would help strengthen rural communities:

- Benefit farmers and farmer-owned cooperatives
- Increase local energy independence by reducing reliance on fossil fuels
- Support the development of associated infrastructure
- Attract additional businesses and industries

About this report

This report is intended to help policy makers, farm cooperatives, rural electric cooperatives, and the clean energy industry at large recognize the economic and supply value of DGA systems and design or remedy existing policies and programs that promote the growth of a resilient agricultural sector through the scaling of DGA production.

The report was developed for the Hydrogen Economy Collaborative (HEC), a project of the Great Plains Institute. The HEC convenes stakeholders around the broader clean hydrogen economy and seeks to support the scaling of green hydrogen and hydrogen derivatives, such as ammonia, through peer learning, information sharing, and policy development.

The information in this report was gathered through a combination of primary and secondary research, including a literature review of policy documents and market analyses. Insights were gleaned from attending the Green Ammonia Summit hosted by the Minnesota Farmers Union in

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[5] Ron Sands, "Population and income drive world food production projections," *Charts of Note,* US Department of Agriculture Economic Research Service, December 11, 2023, https://www.ers.usda.gov/data-products/charts-of-note/chart-detail?chartId=108060#:~:text=As%20the%20world's%20population%20increases,such%20as%20meat%20and%20dairy.

[6] S&P Global Commodity Insights, "Ammonia Market to Triple by 2050 with Nearly All Growth Coming from Low-Carbon Supply," *S&P Global Press Releases,* July 11, 2023, https://press.spglobal.com/2023-07-11-Ammonia-Market-to-Triple-by-2050-with-Nearly-All-Growth-Coming-from-Low-Carbon-Supply.

[7] Anne Schwagerl, vice president, Minnesota Farmers Union, presentation at the Green Ammonia Summit, December 10, 2024, https://www.greenammoniasummit.org/.

[8] TJ Kirk, Anton Krimer, Sheran Munasinghe, Elina Rodriguez, Joaquin Rosas, and Quailan Homann, *Roadmap for Distributed Green Ammonia in Minnesota* (RMI, 2024), 28, https://rmi.org/wp-content/uploads/dlm_uploads/2024/06/roadmap_for_distributed_green_ammonia_in_minnesota.pdf.

December 2024, where stakeholders convened to discuss the challenges and opportunities surrounding DGA implementation. At the summit, additional insights were gained through direct engagement with DGA developers and first movers such as FuelPositive and Landus. In addition, the authors directly engaged with TalusAg staff.

The report focuses on the Upper Midwest and Manitoba due to the unique characteristics that make them prime locations for DGA adoption. These regions are highly reliant on imported ammonia-based nitrogen fertilizers for agriculture, and face high transportation costs associated with importing fertilizers from distant production centers. Furthermore, both regions are susceptible to global price volatility and supply shocks.

Since both regions boast abundant renewable energy resources that can be harnessed to produce green ammonia, they are ideal markets for the growth of DGA production. They also offer an opportunity for local economies to benefit from local production.

This report does the following:

- Highlights the economic advantages of DGA, including cost-competitiveness with conventional ammonia, offering farmers price stability and reduced reliance on volatile global markets.
- Showcases how DGA facilities can leverage curtailed wind energy, turning an otherwise wasted resource into a valuable commodity and revenue stream for rural communities.
- Illustrates the need for improved incentives to support the initial capital expenses of DGA facilities. Supportive policies and incentives are crucial for bridging the cost gap between green ammonia and conventional ammonia in the near term.
- Demonstrates that farmer cooperatives can play a supporting role in scaling DGA.
- Provides real-world examples of DGA projects in Iowa and Manitoba, highlighting different ownership models, system scales, and policy environments.

The business case for distributed green ammonia in rural agricultural regions

DGA offers compelling economic, environmental, and supply chain resilience benefits for rural agricultural regions, such as the Upper Midwest and Manitoba, Canada. These regions depend on ammonia imports and face challenges due to price volatility and high transportation costs. The Upper Midwest largely imports ammonia from the Gulf Coast region using a complex transportation network that includes pipelines, rail, barges, and trucks. Similarly, Manitoba receives ammonia from distant provinces such as Alberta and Saskatchewan; this transport is conducted primarily by rail and, to a lesser extent, by truck.[9]

[9] Fertilizer Canada, *Transport 101,* Fertilizer Canada, August 12, 2021, https://fertilizercanada.ca/wp-content/uploads/2021/08/Fertilizer-Canada-Transport-101.pdf.

In 2023, global ammonia production reached approximately 186 million tons,[10] but only an estimated 185,000 tons were green, primarily originating from pilot projects worldwide.[11] Despite the limited production of green ammonia, interest in this technology is gaining traction, driven by emerging end-use applications in sectors such as shipping and industrial chemicals. This broader interest can drive investment and scale, diversifying supply-based opportunities for cross-industry collaboration and ultimately help to manage commodity market vulnerabilities.

Ammonia-based fertilizers, including anhydrous ammonia, urea, ammonium nitrate, and ammonium sulfate, are essential for delivering nitrogen to crops, particularly corn and other row crops. Green ammonia-based fertilizers provide the exact nitrogen needs for intensive row crop production without the carbon emissions. DGA production also introduces additional significant benefits: Localized production creates local jobs, drives local infrastructure development, and supports economic growth in agricultural communities.

Cost-competitiveness of distributed green ammonia systems

DGA systems have two primary cost inputs: equipment capital costs (e.g., electrolyzers, air separation units, storage) and electricity costs.[12] Here are some key data points on the cost-competitiveness of DGA systems:

- At the 50 metric kilotons per year scale, DGA production is already cost-competitive with industrial-scale green ammonia production.[13]
- By 2030, a 50 metric kilotons per year DGA facility is projected to be cost-competitive with conventional and blue ammonia (ammonia produced in combination with carbon capture and storage).[14]
- Under high natural gas pricing scenarios ($2-$8.5/MMBtu), DGA can also compete with ammonia production pathways that include carbon capture and storage.[15]
- Behind-the-meter systems are more cost-competitive than front-of-the-meter systems.

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[10] Yara, *Fertilizer Industry Handbook. 2025* (Yara, 2025), 42, https://www.yara.com/siteassets/investors/057-reports-and-presentations/other/2025/yara-fertilizer-industry-handbook-2025-with-notes.pdf.

[11] Kevin Rouwenhorst, "Technology Status: Ammonia Production from Electrolysis-Based Hydrogen," Ammonia Energy Association, January 31, 2023, https://ammoniaenergy.org/articles/technology-status-ammonia-production-from-electrolysis-based-hydrogen/#:~:text=Looking%20ahead:%20the%20next%20few,Possible%20Partnership%2C%20Sept%202022.

[12] Electricity represents 40-70 percent of the levelized cost of green hydrogen; the cost of electrolyzers is the next largest cost driver. Lazard, *Lazard's Levelized Cost of Hydrogen Analysis, Version 2.0* (Lazard, June 2021), https://www.lazard.com/media/erzb5rkv/lazards-levelized-cost-of-hydrogen-analysis-version-20-vf.pdf.

[13] Sheran Munasinghe and Anton Krimer, *Seeding a New Pathway: The Opportunity for Distributed Green Ammonia* (RMI, August 20, 2024), https://rmi.org/seeding-a-new-pathway-the-opportunity-for-distributed-green-ammonia/.

[14] Kirk et al., *Roadmap for Distributed Green Ammonia in Minnesota*, Exhibit 15, 27.

[15] Kirk et al., *Roadmap for Distributed Green Ammonia in Minnesota*, 27.

Other factors contribute to the price of green ammonia. For example, in 2024, as capital costs for electrolyzers increased, costs for green ammonia also rose, while blue ammonia prices fell by $50-60 per metric ton to their lowest levels since May 2023.[16] This dynamic demonstrates that green ammonia economics are highly sensitive to the capital cost of electrolyzers and to the price fluctuations in competing blue ammonia production pathways.

The role of farmer cooperatives

Farmer cooperatives (co-ops) are important early-technology partners for scaling DGA. Co-ops can pool resources to invest in shared ammonia production infrastructure, enabling farmers to benefit from economies of scale collectively. The cooperative model can help mitigate financial risks by distributing costs among multiple stakeholders while ensuring a reliable and affordable green ammonia supply.

Project financing structure improvements

A key financing structure to support the financial viability of DGA projects is offtake agreements. Currently, farmers purchase ammonia fertilizers on a short-term basis and at prices linked to global natural gas prices. This short-term purchasing practice creates price uncertainty and volatility for farmers. In RMI's *Roadmap for Distributed Green Ammonia in Minnesota*, the authors argue that long-term contracts—similar to power purchase agreements—would help stabilize prices, providing a hedge against natural gas market fluctuations and offering predictability for farmers and agricultural cooperatives.[17] Long-term contracts with creditworthy offtakers make DGA projects more attractive to lenders, making them bankable and helping them reach a final investment decision.

Business case examples: The Upper Midwest and the Province of Manitoba

The Upper Midwest and the Province of Manitoba are attractive markets for DGA projects, not only due to the high cost of transporting ammonia to their regions, but also because of their abundant renewable energy resources. For example, RMI modeling indicates wind resources in Minnesota are particularly strong and that solar costs are expected to drop significantly by 2030, reducing the levelized cost of ammonia by 15 percent.[18]

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[16] James Burgess and Eric Yep, "Blue Green Ammonia Prices Diverge as Electrolysis Power Prices Rise, Natural Gas Falls," *S&P Global,* March 19, 2024, https://www.spglobal.com/commodity-insights/en/news-research/latest-news/energy-transition/031924-blue-green-ammonia-prices-diverge-as-electrolysis-power-prices-rise-natural-gas-falls.

[17] Kirk et al., *Roadmap for Distributed Green Ammonia in Minnesota, 29*.

[18] Kirk et al., *Roadmap for Distributed Green Ammonia in Minnesota, 22*.

RMI's roadmap emphasizes that Minnesota and the broader Upper Midwest can significantly reduce emissions associated with ammonia-based fertilizers and lower costs for farmers by mitigating exposure to volatile global natural gas markets and reducing transportation expenses through on-farm or near-farm production. The roadmap outlines a vision for decentralized green ammonia production as a strategy to reduce reliance on fossil fuels and enhance economic resilience in Minnesota's agricultural sector.

The Upper Midwest's high-capacity factor wind and competitive renewable electricity prices, combined with natural gas prices exceeding $6/MMBtu,[19] may create favorable market conditions for DGA in the absence of federal tax, such as 45V, the clean hydrogen production tax credit, and 45Y, the clean energy production tax credit. Other factors would need to be considered, such as the following:

- a reduction in electrolyzer capital costs and improved efficiencies
- the cost of off-peak electricity or curtailed wind
- the execution of long-term power purchase agreements
- demand-side policies or premiums from new end-use sectors

Similarly, Manitoba presents an attractive market opportunity for DGA producers. The province not only has one of the cleanest grids in North America, but also one of the lowest-cost grids. Additionally, hydrogen is a key component of *Manitoba's Green Economy: Opportunities Report*, a strategic, comprehensive framework that provides the province with guidance on how to transition to a greener, more sustainable economy. [20] The province's interest in clean hydrogen is supported by the federal government's policies and incentives that provide roadmaps and financing options for low-carbon hydrogen projects. Canada's 2020 *Hydrogen Strategy for Canada* established the federal government's vision for hydrogen, providing a clear framework for government and industry.[21] This framework recommended financial incentives to support the nascent industry; in 2022, the federal government announced the Clean Hydrogen Investment Tax Credit, designed to incentivize investments in clean hydrogen production and infrastructure.[22]

[19] Natural gas prices exceeded $6/MMBTu in February 2025. You can see natural gas spot prices from 2020 on the Henry Hub Natural Gas Spot Price index: https://fred.stlouisfed.org/series/DHHNGSP.

[20] Manitoba Chambers of Commerce, *Manitoba's Green Economy: Opportunities Report* (Manitoba Chambers of Commerce, October 2024), https://mbchamber.mb.ca/wp-content/uploads/2024/10/Manitoba-Green-Economy-Opportunities-Report-FINAL.pdf.

[21] "Hydrogen Strategy for Canada," Natural Resources Canada, December 2020, https://natural-resources.canada.ca/energy-sources/clean-fuels/hydrogen-strategy.

[22] "Clean Hydrogen Investment Tax Credit (ITC)," Canada Revenue Agency, https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/corporations/business-tax-credits/clean-economy-itc/clean-hydrogen-itc.html.

Wind curtailment in Minnesota: An economic and energy opportunity

Wind curtailment occurs frequently in the Upper Midwest when the transmission system is experiencing congestion, when there is an oversupply of generation within a particular control area that exceeds load demand, or when negative pricing market signals emerge. Under these scenarios, wind turbines are "curtailed" or idled even though they are capable of generating electricity. The curtailment ensures that supply and demand are balanced, thereby avoiding reliability, stability, and safety problems.

In 2023, wind power curtailment averaged 4.6 percent across the country's seven regional transmission/independent system operators (RTOs/ISOs).[23] In the Midcontinent Independent System Operator (MISO) region, wind curtailment continued to be significant at 3.2 percent.[24] The average hourly wind curtailment in MISO was 508 megawatts (MW) in 2023, down from 726 MW per hour in 2022.[25] In 2025, transmission congestion resulted in a daily average of 607 MW of wind curtailments per hour.[26]

While the curtailment data provides an aggregate picture of the impacts of curtailment, impacts can be more pronounced at the local level. However, some localized regions experience much higher rates of wind curtailment. For example, in 2021, some Minnesota communities located in the Buffalo Ridge region experienced curtailment rates that, at times, exceeded 50 percent. The impact on rural communities was significant[27]—a group of three counties lost more than $1 million in revenue due to wind curtailments.[28] For rural county administrators, the problem is not

[23] Ryan Wiser et al., *Land-Based Wind Market Report: 2024 Edition, Executive Summary,* (Lawrence Berkeley National Laboratory, August 2024), https://emp.lbl.gov/sites/default/files/2024-08/Land-Based%20Wind%20Market%20Report_2024%20Edition_Executive_Summary.pdf.

[24] Ryan Wiser et al., *Land-Based Wind Market Report: 2024 Edition, Executive Summary*.

[25] US Energy Information Administration (EIA), "Why are Midwest Grid Operators Turning Away Wind Power?," *Today in Energy,* June 26, 2024, https://www.eia.gov/todayinenergy/detail.php?id=62406.

[26] Potomac Economics, *State of the Market Report for the MISO Electricity Markets,* Markets Committee of the Board of Directors, June 2025, https://cdn.misoenergy.org/20250626%20Markets%20Committee%20of%20the%20BOD%20Item%2004%20State%20of%20the%20Market%20Report703831.pdf.

[27] Dennis Welgraven, vice chair Murray County Board of Commissioners, letter to Commissioner Grace Arnold, Minnesota Department of Commerce, Docket No.05-1707 (March 25, 2022), https://efiling.web.commerce.state.mn.us/documents/%7B8014C27F-0000-C314-BDFF-4A58B4B6B9C2%7D/download?contentSequence=0&rowIndex=64.

[28] Molly Malone, "Transmission Congestion is Costing Rural Communities," Center for Rural Affairs, January 17, 2023, https://www.cfra.org/blog/transmission-congestion-costing-rural-communities.

just the loss of revenue—it is also the year-to-year uncertainty of curtailment that injects risk into annual county and township budgets.[29]

In Minnesota, wind curtailment has several significant negative consequences for communities and developers. First, curtailing wind directly reduces production, leading to a loss of wind production tax revenue for local communities. Second, wind developers lose potential revenue when the turbines stop spinning, and electricity generation ceases. Lastly, curtailment can impact a wind farm's ability to earn revenue from a power purchase agreement, depending on the specific terms of the contract; this further erodes the financial viability of wind projects.

DGA offers a promising solution for the issue of wind curtailment. By siting DGA facilities near wind farms, curtailed wind energy can be used to produce local green ammonia, turning a wasted resource into a valuable and economic commodity for the region and returning revenue to communities and developers alike.

Conventional ammonia production challenges

Conventional ammonia presents four significant challenges that undermine both environmental sustainability and reliable availability:

- The production process is highly carbon-intensive due to its reliance on natural gas.
- Significant indirect methane leakage occurs during natural gas extraction, processing, and transportation.
- Geopolitical factors, supply disruptions, and natural gas market fluctuations impact ammonia's availability and price.
- Centralized production methods lead to increased transportation costs and associated emissions while limiting local economic benefits.

Carbon emissions

The conventional method for ammonia production, primarily the Haber-Bosch process, uses fossil fuels as both a feedstock for hydrogen and a source of process energy that results in 2.6 tons of carbon dioxide (CO_2) emitted per ton of ammonia.[30] This process is energy-intensive as it combines hydrogen and nitrogen under high pressures and temperatures. To produce green ammonia, renewable energy powers both the electrolysis process for hydrogen production and the Haber-Bosch process, which combines nitrogen with hydrogen. This production methodology results in carbon-free ammonia.

[29] Dennis Welgraven, vice chair Murray County Board of Commissioners, letter to Commissioner Grace Arnold, Minnesota Department of Commerce, Docket No.05-1707 (March 25, 2022).

[30] World Economic Forum, *Ammonia Industry Net-Zero Tracker, Net-Zero Industry Tracker 2023 Edition* (World Economic Forum, November 28, 2023), 86, https://www.weforum.org/publications/net-zero-industry-tracker-2023/in-full/ammonia-industry-net-zero-tracker/.

Innovative alternatives to the Haber-Bosch process are being developed to decarbonize this energy-intensive production method, lower greenhouse gas emissions, and enable decentralized production that can more easily integrate with renewable energy sources.[31]

Indirect emissions from methane leakage present another climate concern. While the ammonia production process itself does not directly cause methane leakage, it is highly reliant on natural gas, which is composed mainly of methane. Methane leakage occurs during the extraction, processing, and transportation of natural gas. These indirect emissions significantly contribute to ammonia's overall carbon footprint.

Availability and price factors

Ammonia supply chain disruptions impact the availability and cost of nitrogen-based fertilizers, chemical feedstocks, and fuels. As the world explores additional ammonia end uses such as shipping fuel or energy storage, its global availability and vulnerability to supply chain disruptions become critical. Factors such as natural gas availability, geopolitical tensions, and weather events contribute to these disruptions. For example, in September 2024, ammonia prices in North America surged due to the limited availability of natural gas, linked to geopolitical factors and adverse weather-related events in key manufacturing regions.[32] These disruptions, along with associated price volatility (or price spikes), significantly impact global food security.

Russia's invasion of Ukraine in 2022, compounded by the COVID-19 pandemic, resulted in additional disruptions to ammonia transportation and trade restrictions.[33] Fertilizer prices increased more than 50 percent between February and April 2022.[34] Price spikes have a significant effect on US farmers:

- wheat and corn farmers spend nearly 45 percent of their operating expenses on fertilizers[35]
- soybean farmers spend almost a quarter of their budget on fertilizers[36]

In response to high fertilizer prices, farmers adjusted their planting decisions. In March 2022, farmers indicated that they intended to increase soybean cultivation by 4.4 percent and

[31] Kevin H.R. Rouwenhorst, Aloijsius G.J. van der Ham, and Leon Lefferts, "Beyond Haber-Bosch: The Renaissance of the Claude Process," *International Journal of Hydrogen Energy* 46, no. 41 (2021): 21, 566-78, https://www.sciencedirect.com/science/article/pii/S0360319921012660.

[32] Jai Sen, "Global Ammonia Market Sees Price Surge amid Natural Gas Shortages and Supply Constraints," *ChemAnalyst,* September 30, 2024, https://www.chemanalyst.com/NewsAndDeals/NewsDetails/ammonia-market-sees-price-surge-amid-natural-gas-shortages-and-supply-constraints-30527.

[33] Jennifer Kee, Lila Cardell, and Yacob Abrehe Zereyesus, "Global Fertilizer Market Challenged by Russia's Invasion of Ukraine," *Amber Waves,* US Department of Agriculture, Economic Research Service, September 18, 2023, https://www.ers.usda.gov/amber-waves/2023/september/global-fertilizer-market-challenged-by-russia-s-invasion-of-ukraine.

[34] Kee et. al, "Global Fertilizer Market Challenged by Russia's Invasion of Ukraine."

[35] Kee et. al, "Global Fertilizer Market Challenged by Russia's Invasion of Ukraine."

[36] Kee et. al, "Global Fertilizer Market Challenged by Russia's Invasion of Ukraine."

decrease corn cultivation by 4.1 percent compared to 2021.[37] Soybeans require significantly less nitrogen fertilizer than corn.

Centralized production impacts

Conventional ammonia supply chains rely on centralized production facilities. In the US, these are primarily located along the Gulf Coast, necessitating the transportation of ammonia over long distances via pipelines, rail, ships, or trucks to reach agricultural markets in the Upper Midwest. This extended supply chain increases costs, introduces logistical hurdles, increases carbon emissions, and raises the risk of disruptions from weather events, infrastructure malfunctions, or geopolitical uncertainties. Furthermore, reliance on centralized production in the Gulf Coast region and overseas leads to local dollars leaving the region as funds are spent on transportation and external suppliers. Conversely, decentralized production retains local dollars within the region, contributing to economic resilience and supporting local agricultural communities.

Distributed green ammonia's role in agricultural resilience and sustainability

Decentralized green ammonia production facilities located closer to consumption areas can mitigate issues found in conventional ammonia significantly by reducing transportation emissions and supply-side vulnerabilities such as geopolitical disruptions. DGA can also play a vital role in decarbonizing agriculture.

Since nitrogen-based fertilizers are key inputs for modern agriculture, integrating DGA production throughout agricultural regions can help ensure the resilience of the fertilizer supply chain, even during disruptions caused by geopolitical events or other global disturbances.

Growing demand for green ammonia in the Upper Midwest

In Minnesota, interest in DGA production began in 2013 at the University of Minnesota's West Central Research and Outreach Center (WCROC) in Morris.[38] Its pilot facility uses a 1.65 megawatt (MW) wind turbine collocated with an electrolyzer to produce up to 25 tons of anhydrous ammonia fertilizer annually.[39] In January 2026, WCROC will commission a next-generation green ammonia pilot plant, collocated with wind and solar power, to produce up to 1

[37] New York Farm Bureau, comments on "USDA's Request for Information (RFI) on Access to Fertilizer: Competition and Supply Chain Concerns" (comment ID: AMS-AMS-22-0027-1338), submitted to the US Department of Agriculture Agricultural Marketing Service, June 2022, https://www.regulations.gov/comment/AMS-AMS-22-0027-1338.

[38] Michael Reese, "Green Hydrogen and Ammonia: Opportunities and Challenges for Minnesota," University of Minnesota West Central Research and Outreach Center (Morris, MN), April 27, 2023, https://wcroc.cfans.umn.edu/about-us/wcroc-news/green-hydrogen-ammonia.

[39] Clean Energy Resource Teams (CERTs), "Green Hydrogen and Ammonia: Implications for Minnesota and Beyond," CERTs, October 2023, https://www.cleanenergyresourceteams.org/story/green-hydrogen-and-ammonia-implications-minnesota-and-beyond.

metric ton of anhydrous ammonia per day.[40] Since the initial pilot, interest in green ammonia has extended beyond its use as a carbon-free fertilizer. Additional potential uses have surfaced in recent years, including the following:

- Collocating green ammonia production with ethanol production facilities. Capturing the CO_2 from ethanol production and combining it with the green ammonia would create urea, which is rapidly becoming a preferred fertilizer in the Midwest.
- Ammonia as a drop-in fuel replacement for ships, heavy industry, and farm tractors. Its high energy density makes it an attractive fuel for decarbonizing sectors that are fuel-intensive.
- Ammonia as a fuel for grain drying. Green ammonia would replace the propane used in grain dryers. When burned under optimal conditions, ammonia emits neither CO_2 nor NOx. According to research at WCROC, using green ammonia to dry grain could reduce a farm's corn fossil footprint by an additional 42 percent.[41]

The Heartland Hub, one of seven regional Clean Hydrogen Hubs originally funded by the US Department of Energy, focuses on the Upper Midwest's opportunity to decarbonize the agriculture and industrial manufacturing sectors through the production of low-carbon fertilizers, such as ammonia, ammonium nitrate, and calcium ammonium nitrate.[42]

Policy innovations

Despite their smaller scale, DGA projects are still capital-intensive and more expensive than conventional ammonia projects in the short term.[43] At this early stage of technology development, DGA projects will need the support of federal and state grants and loans. These offer more favorable interest rates and terms than conventional lending institutions.

Some states in the Midwest, such as Minnesota and North Dakota, launched incentive programs to support a growing DGA market. In November 2023, the North Dakota legislature authorized $125 million for a forgivable loan targeting the state's agricultural sector through improved fertilizer supply; eligible projects were required to produce hydrogen through water electrolysis. Upon project completion, the loans are converted to grant funding.[44]

Similarly, on December 10, 2024, the Minnesota Department of Agriculture announced the launch of its Green Fertilizer Grant Program. Eligible entities are agricultural and rural electric

[40] University of Minnesota West Central Research and Outreach Center, "WCROC Tour," page for the 4th Symposium on Ammonia Energy, updated September 27, 2025, https://soae.umn.edu/agenda-tours/wcroc-tour.

[41] Jeff Beach, "Grain Dryer Experiment Will Put Green Ammonia to the Test," *West Central Research & Outreach Center News* (University of Minnesota), June 28, 2022, https://wcroc.cfans.umn.edu/news/green-dryer.

[42] "Heartland Hydrogen Hub," Heartland Hydrogen Hub, accessed May 6, 2025, https://undeerc.org/research/projects/heartland-h2-hub.html.

[43] Kirk et al., *Roadmap for Distributed Green Ammonia in Minnesota*.

[44] Scout Nelson, "$125M Boost for North Dakota Fertilizer Projects," *North Dakota Ag Connection,* January 24, 2024, https://northdakotaagconnection.com/news/125m-boost-for-north-dakota-fertilizer-projects.

cooperatives within the state that have long-term offtake agreements between the green ammonia production facility and the cooperative. Additionally, applicants must match their electrolysis consumption with wind and solar production (temporal matching to be determined by the commissioner) or be directly connected to a wind or solar project. Awards may range between $250,000 and $6,665,000 for business-ready and shovel-ready projects.[45] State incentive programs like these are essential for building a scalable and growing DGA market.

Canada has a supportive policy landscape for decarbonizing green ammonia. Several federal policies, such as the Canadian Agricultural Partnership and the Agricultural Clean Technology program, along with provincial efforts, provide policy levers and incentives for greening the production of ammonia fertilizer.

Canada's Greenhouse Gas Pollution Pricing Act established a national carbon price; provinces may implement their own systems, but the federal government sets the national minimum price per ton of CO_2e (CO_2 equivalent) and emissions caps as a backstop. The act creates economic incentives to reduce carbon emissions across all sectors, including agriculture.[46]

In addition, the *Hydrogen Strategy for Canada* supports the use of hydrogen and its derivatives for decarbonizing high-value end-use applications, such as ammonia and nitrogen fertilizers, steel production, energy storage, and industrial applications.[47]

Demonstration project highlights

In this report, we highlight two entities that are deploying DGA projects at the demonstration and commercial scale: the TalusAg/Landus DGA production facility in Boone, Iowa, and the FuelPositive DGA production facility in Manitoba, Canada.

Both projects are leveraging local production to support domestic supply security and strategic deployment of DGA to farmers and local communities in high-need regions. Through small, distributed-scale production with on-site or grid-based renewable energy, these projects demonstrate the economic and environmental benefits of cooperative and farm ownership.

The two companies offer different ownership models and systems, operating at varying scales within distinct policy environments. TalusAg offers larger mid-size systems appropriate for development at the regional level. In contrast, FuelPositive offers smaller systems (up to 500 tons) with turnkey financing that are easy for farmers to operate. Both companies are focused on improving farm economics, lowering agricultural emissions, and ensuring food security.

[45] Minnesota Department of Agriculture, "MDA Announces New Grant to Support Green Fertilizer Production," December 10, 2024, https://www.mda.state.mn.us/mda-announces-new-grant-support-green-fertilizer-production.

[46] Greenhouse Gas Pollution Pricing Act, S.C. 2019, c. 12, s. 186, https://laws-lois.justice.gc.ca/eng/acts/g-11.55/.

[47] Natural Resources Canada, *Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen: A Call to Action* (Natural Resources Canada, December 2020), https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf.

Demonstration project 1: Boone, Iowa

A partnership between Talus Renewables and Landus has launched the first DGA system in North America, which uses renewable energy from on-site solar and the use of renewable energy certificates from the regional grid to locally produce anhydrous ammonia for regional agricultural use. This demonstration project is in Boone, Iowa, and is strategically positioned in the Upper Midwest, a region that offers a strong foundation for producing ammonia fertilizers. The region is conducive to DGA production due to agricultural demand, high transportation costs due to importing fertilizer from the Gulf Coast, and access to affordable, renewable electricity.

About Landus

Landus is an agricultural cooperative with headquarters in Des Moines, Iowa, and several regional facilities and service locations throughout Iowa and Minnesota. The cooperative operates across 34 states and 16 countries.[48] As described on the company website, Landus specializes in providing practical solutions in grain marketing, agronomy, soybean processing, and other modern sustainable agriculture practices. Its mission is focused on stewarding a secure food and fuel future by empowering and connecting farmers to the global market.[49]

Landus's cooperative model operates on the principle of member ownership, where each farmer-member holds an ownership stake in the company while participating in the decision-making processes.[50]

Landus is exploring sustainable alternatives such as green ammonia to reduce the carbon footprint associated with fertilizer production. Its investments in green ammonia demonstrate how co-ops can reduce reliance on volatile global fertilizer markets while advancing decarbonization efforts within the agricultural sector.[51]

About TalusAg and its Talus Renewables subsidiary

As described on the company website, TalusAg is an agricultural technology subsidiary of Talus Renewables, specializing in providing low-cost, carbon-free nitrogen fertilizers through a distributed network of on-site ammonia systems.[52] TalusAg partners with agricultural cooperatives to deploy its modular ammonia production systems. It focuses on the local production of ammonia fertilizers to improve food security and provide value for its farmer owners, particularly in places where imported fertilizers are costly and have vulnerable supply chains.

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[48] "Landus Cooperative," Landus Cooperative, accessed April 4, 2025, https://www.landus.org.

[49] "Our Story," Landus Cooperative, accessed April 4, 2025, https://www.landus.ag/company/our-story.

[50] "Membership," Landus Cooperative, accessed April 4, 2025, https://www.landus.ag/company/membership.

[51] Landus and TalusAg, "Iowa Innovation Puts Green Ammonia to the Test," *PR Newswire,* April 23, 2025, https://www.prnewswire.com/news-releases/iowa-innovation-puts-green-ammonia-to-the-test-302436322.html.

[52] TalusAg, "Farm Management Solutions," accessed April 5, 2025, https://www.talusag.com/for-farms.

TalusAg currently offers two modular models:

- the smaller TalusOne, which is capable of producing 1 to 2 tons of ammonia per day[53]
- the larger TalusTen, which is capable of producing up to 20 tons per day[54]

TalusAg has been manufacturing and providing DGA production technologies since 2012, with a primary focus on the agricultural sector in Sub-Saharan Africa. In this region, fertilizer prices are among the highest in the world, often double or triple the costs faced by farmers in Iowa. This price disparity has contributed to a steady increase in food prices, leaving many small farms without access to fertilizers. Additionally, global supply chain disruptions have historically impacted commodity prices and export demand. By implementing TalusAg's modular, containerized ammonia production systems, Sub-Saharan farmers have benefited not only from lower fertilizer costs but also from stabilized pricing, a secured supply, and enhanced protection against market volatility.[55]

Building on its experience in Sub-Saharan Africa, TalusAg is now piloting its approach to DGA production in Iowa, where farmers currently face similar challenges related to fertilizer price volatility and supply chain disruptions. The company's expertise in designing and deploying modular, containerized ammonia production units for small farms now informs its pilot in Iowa.

Boone, Iowa, ammonia project overview

The ammonia project in Boone, Iowa, represents a pioneering effort in DGA production, combining modular design with distributed deployment to meet the environmental and economic needs of farmers. Launched in the summer of 2024, this project is a collaborative initiative between TalusAg and Landus.[56]

Traditionally, Iowa farmers have relied on ammonia imports from the Gulf Coast, a supply chain that is vulnerable to disruptions from geopolitical factors and disruptive weather events, which can lead to supply shortages and price volatility. Through local ammonia production, Landus mitigates these risks, stabilizing the fertilizer supply for its member farmers and reducing the logistical challenges associated with ammonia distribution.[57]

The Boone project serves as a demonstration facility. It spans 75,000 square feet and is situated on a 35.8-acre site adjacent to an existing 33-acre Landus grain facility.[58] Landus

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[53] Talus Renewables, "Talus Renewables Announces $22 Million Raised in Series A Financing," *PR Newswire,* November 2, 2023, news provided by Talus Renewables, https://www.prnewswire.com/news-releases/talus-renewables-announces-22-million-raised-in-series-a-financing-301974223.html.

[54] Talus Renewables, "Talus Renewables Announces $22 Million Raised in Series A Financing."

[55] Andrew Allee, Anton Krimer, and Rushad Nanavatty, *"The Opportunity for Distributed Green Fertilizer in Africa,"* August 27, 2025, https://rmi.org/the-opportunity-for-distributed-green-fertilizer-in-africa/.

[56] Landus and TalusAg, "Iowa Innovation Puts Green Ammonia to the Test."

[57] Landus and TalusAg, "Iowa Innovation Puts Green Ammonia to the Test."

[58] Landus Cooperative, "Rural Matters: Grand Opening of Boone Fertilizer Facility," Landus Cooperative, June 17, 2024, https://www.landus.ag/posts/rural-matters-grand-opening-of-boone-fertilizer-facility.

facilities have had ammonia storage tanks on site for several years, which makes adding local ammonia production easier from a permitting perspective. The facility utilizes a 1.4 MW electrolyzer and the TalusOne modular ammonia production system developed by TalusAg. It produces up to one ton of ammonia per day.[59]

The ammonia produced by the Boone plant directly supports local farmers through low-cost, fixed-price ammonia. Domestic production of ammonia reduces the costs of ammonia distribution. Bloomberg's Green Markets commodities service estimates the cost of commodity ammonia delivered to Iowa farmer cooperatives to range from $619.80 per ton of ammonia to $877.30 per ton of ammonia between 2025 and 2040.[60] TalusAg offers a fixed-price wholesale range of $400-$450 per ton of ammonia,[61] eliminating price volatility for Landus members and enabling local production of a cheaper and more reliable nitrogen fertilizer.[62]

The Talus Renewables-Landus partnership is effective because it combines private investment with cooperative-driven implementation. TalusAg provides the funding and renewable energy expertise to deploy a modular ammonia facility. At the same time, Landus leverages its member network, its strong balance sheet, and long-term investment capacity to ensure adoption and alignment with farmer needs. This cooperation strengthens supply chain stability, supports local economic development, and directly benefits the cooperative's farmer-members. Other farmer cooperatives with similar capacities are well-positioned to replicate this model, harnessing DGA to advance environmental and economic sustainability and resilience in their communities.[63]

Benefits beyond low-cost ammonia

While cost is an essential measure of success, DGA projects, like the Boone plant, have several additional benefits. These benefits emphasize the advantages of DGA projects, stretching from providing value to the local community to relieving local electricity grid congestion:

- **Providing value to the local community.** The local community demonstrated strong customer demand for Talus' green ammonia through letters of intent for 12- to 15-year take-or-pay agreements.[64]
- **Enhancing system reliability and stability.** The Boone system offers fully interruptible operational flexibility, enabling control over system load to manage demand peaks and maintain stability in the local electric grid. With load factors ranging from 40 percent to 95 percent, the Boone system provides substantial operational flexibility, enabling

[59] "Landus Green Ammonia Plant," Ideal Energy, accessed April 18, 2025, https://ideal.energy/landus-plant.

[60] John Baffes and Kaltrina Temaj, "Fertilizer Prices Soften but Remain Constrained by Trade Policies," *World Bank Blogs,* December 4, 2025, https://blogs.worldbank.org/en/opendata/fertilizer-markets-soften-but-remain-constrained-by-trade-polici.

[61] Tristan Peitz (TalusAg), email to author, May 7, 2025.

[62] Tristan Peitz (TalusAg), email to author, May 7, 2025.

[63] Tristan Peitz (TalusAg), video call with author, May 7, 2025.

[64] Tristan Peitz (TalusAg), email to author, May 7, 2025.

adjustments on a monthly, daily, or even hourly basis.[65] The project already optimizes its power consumption by operating the electrolyzer intermittently, capitalizing on key periods of low demand between grain-drying demand spikes.[66]

- **Alleviating local electricity grid congestion.** The TalusTen system can rapidly reduce its load from 11.5 MW to 500 kW in less than ten minutes,[67] enabling demand response during peak events and optimizing economic incentives. Through an intelligent metering system, the electrolyzer adjusts its production based on real-time data that tracks solar production, total facility/farm usage, and electrolyzer consumption.[68]
- **Facilitating renewable integration into the electric grid.** Renewable resources, such as wind and solar, can experience congestion and curtailment, leading to intermittent power generation. The Boone system's operational control allows Talus to utilize renewable resources while optimizing both cost and environmental impact.
- **Lowering electricity costs for other local rate payers.** The Boone system reduces overall electricity costs for local ratepayers by cutting net grid demand through on-site solar, operating the electrolyzer as a flexible load that avoids peak demand (and peak demand charges), and by storing excess renewable electricity as ammonia, which avoids having to purchase high-priced energy at other times.

Strategic fit: Ideal markets for distributed green ammonia

The Boone DGA project was developed in a high-demand agricultural zone with a dense concentration of corn and soybean farms, which account for over 75 percent of the total land area in Boone County.[69] In comparison, corn and soybean farms represent only 6.35 percent of the total land area in the US.[70] This significant demand for ammonia fertilizers makes it an invaluable resource for farmers in the region, creating a favorable market for DGA.

Affordable renewable electricity is a key driver for the DGA market, as it enables carbon-neutral production. The Boone plant was built in an area with competitive renewable energy prices of 15.18 cents per kilowatt-hour (kWh), which is approximately 10 percent lower than the nationwide average of 16.73 cents per kWh.[71] In 2024, Boone County generated over 1.3

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[65] Tristan Peitz (TalusAg), email to author, May 7, 2025.

[66] "Landus Green Ammonia Plant," Ideal Energy.

[67] Tristan Peitz (TalusAg), email to author, May 7, 2025.

[68] "Landus Green Ammonia Plant," Ideal Energy.

[69] USDA, National Agricultural Statistics Service, *County Profile: Boone County, Iowa* (2017 Census of Agriculture) (USDA-NASS, 2019), https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Iowa/cp19015.pdf.

[70] USDA, National Agricultural Statistics Service, *2022 Census of Agriculture – Full Report, Volume 1, Chapter 1: United States,* Table 35 (USDA-NASS, 2024), https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1%2C_Chapter_1_US/st99_1_035_035.pdf.

[71] "Boone County, Iowa Electricity Rates & Statistics," FindEnergy, accessed September 23, 2025, https://findenergy.com/ia/boone-county-electricity/.

million megawatt-hours of renewable energy while consuming only 460,000 megawatt-hours. As a result, the energy consumed by residents of Boone County produces zero CO_2 emissions per person annually.[72]

To further enhance sustainability, the TalusAg-Landus system uses a 1 megawatt on-site solar array that is integrated with the local utility.[73] The on-site solar array is registered with CleanCounts—North America's largest clean energy registry—and generates renewable energy credits (RECs). These RECs, in combination with RECs from the regional grid, are retired to provide the auditable proof of matching renewable energy use with ammonia production.[74]

Public policy and industry alignment

Federal incentives and grants were vital to make local production viable in the initial phases of the Boone green ammonia project. For example, the US Department of Agriculture Fertilizer Production Expansion Program grant, valued at approximately $4.9 million, played a critical role in supporting the construction of the Boone plant.[75]

Simultaneously, the 45V Clean Hydrogen Production Tax Credit, set to expire in December 2027 for new projects, plays a crucial role in reducing ammonia costs by lowering the cost of hydrogen, a primary input and cost driver. The tax credit offers an incentive of up to $3 per kilogram of clean hydrogen produced, helping DGA to remain cost-competitive with conventional ammonia. By leveraging the 45V tax credit, the Boone plant cut ammonia costs by more than half.[76]

The 30 percent investment tax credit (ITC) for clean energy investments, including electrolyzers and solar projects, helped further lower costs for the Boone DGA project.[77] The ITC enhanced the project's financial reliability, reducing the risk for investors and helping secure additional project financing in the form of RECs for future projects.[78]

Additionally, the Iowa Economic Development Authority and the US Department of Energy funded an analysis titled *Renewable Hydrogen in Iowa*, developed by Ideal Energy, a solar energy company based in Fairfield, Iowa. The report assesses the potential of Iowa's hydrogen economy and the impact of hydrogen on employment and the national hydrogen market.[79] It also builds on the broader decarbonization goals outlined in the Iowa Energy Plan, prioritizing the transition to low-carbon technologies in the energy and agricultural sectors.

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[72] "Boone County, Iowa Electricity Rates & Statistics," FindEnergy.

[73] "Landus Green Ammonia Plant," Ideal Energy.

[74] Rob Davis, CleanCounts, email to author, January 11, 2026.

[75] Landus Cooperative, "Rural Matters: Grand opening of Boone Fertilizer Facility."

[76] "Talus Local Ammonia," TalusAg, accessed, May 1, 2025, https://www.talusag.com/#section_about.

[77] Tristan Peitz (TalusAg), email to author, May 7, 2025.

[78] Tristan Peitz (TalusAg), email to author, May 7, 2025.

[79] Eric Johnson and Greg Wilson, *Renewable hydrogen in Iowa* (Ideal Energy, LLC, August 24, 2022), https://ideal.energy/white-papers.

Looking ahead

DGA is a key building block for the future of low-carbon agriculture. It can position the Upper Midwest to stabilize nitrogen fertilizer supply and costs by producing fertilizer close to demand. By replacing a portion of imported fertilizer with locally produced ammonia, DGA is keeping more dollars in rural communities while strengthening co-ops and local electric utilities. Moreover, low-carbon crops are attractive to food companies seeking to lower their Scope 3 emissions (indirect greenhouse gas emissions from a company's value chain) and/or meet European disclosure and procurement specs. Food and beverage companies, as well as biofuel producers, often offer premiums or longer-term contracts for low-emissions agricultural products like corn and soy.[80] Together, premium pricing for low-carbon crops, shorter supply chains, and transparent, predictable pricing make DGA an integral component of a resilient, sustainable, and economically valuable Midwest agricultural system.

Opportunities for future DGA projects are abundant in the Midwest. For example, Talus Renewables continues to explore the Midwest for DGA-primed markets where fertilizer is valued and profitable, and where agricultural cooperatives have a robust presence, including other counties in Iowa and the broader Corn Belt.[81] Agricultural cooperatives with healthy balance sheets, proven safety records, and the necessary fertilizer infrastructure are well-positioned to develop DGA systems. In fact, Talus Renewables is currently deploying the first TalusTen system capable of producing 20 metric tons of green ammonia per day to Eagle Grove, Iowa. This system will begin operating under a ten-year fixed-price offtake contract and is anticipated to be commissioned by the end of 2026. Later this year, a second TalusTen system is planned to begin construction in Manning, Iowa.[82]

Demonstration project 2: Manitoba, Canada

In Manitoba, FuelPositive is pioneering DGA with a modular, on-site system, the FP300, which delivers regional economic benefits to farmers and small industries. The company also manages and maintains these systems for a per-ton fee, simplifying adoption for farmers.

Manitoba is a promising region for deploying modular green ammonia systems due to the province's abundant supply of clean, low-cost hydroelectricity and its rural and remote nature, which exposes its farmers to conventional ammonia price spikes and supply chain disruptions.[83]

Canada's traditional ammonia supply chain is highly centralized; most of the ammonia in Canada is produced at large industrial facilities in Alberta, Ontario, and Saskatchewan, then

[80] NuWay-K&H Cooperative, "The Benefits of Lower Carbon Intensity (CI) Corn Farming," NuWay-K&H Cooperative, April 15, 2024, https://nuway-kandh.com/the-benefits-of-lower-carbon-intensity-ci-corn-farming/.

[81] Tristan Peitz (TalusAg), email to author, April 10, 2025.

[82] Schmuecker Renewable Energy System, *Iowa Farm Bureau: Green Ammonia Plant Opens in Boone,"* May 20, 2025, https://solarhydrogensystem.com/2025/05/20/iowa-farm-bureau-green-ammonia-plant-opens-in-boone/.

[83] Approximately 97 percent of Manitoba's electricity comes from renewable sources such as hydroelectricity and wind, making Manitoba one of the cleanest electricity territories in North America. Manitoba Hydro, *Manitoba's Energy Supply: Good for Manitobans, good for our environment,* Manitoba Hydro (June 2023), https://www.hydro.mb.ca/docs/resources/teachers/manitoba_energy_supply.pdf.

transported by rail or truck to supply farmers across the country. In the fall of 2024, farmers paid approximately Can$1,300/ton of delivered ammonia. Fall 2025 prices are expected to remain stable or slightly increase.[84] Decentralized green ammonia production enables farmers to produce their fertilizer on-site, reducing dependency on often volatile global ammonia fertilizer markets and complex transportation logistics, and stabilizing costs.

About FuelPositive

FuelPositive is a clean technology company based in Waterloo, Ontario, that is commercializing on-site, on-farm green ammonia production systems that operate autonomously and require no direct operation or maintenance by farmers.[85] The company aims to improve the availability and affordability of ammonia by enabling distributed production at the point of use.
FuelPositive's FP300 green ammonia modular system in Manitoba is the company's first commercial-scale system and the province's first DGA production facility.[86] The modular system is containerized and designed for direct on-site deployment at points of use such as farms or small industrial sites.[87] This enables distributed production to be closer to the point of demand.

FuelPositive technology and project overview

FuelPositive's modular FP300 system is being piloted at the Hiebert Family Farm in Sperling, Manitoba, demonstrating how distributed ammonia production can serve as a practical alternative to centralized supply.[88] The containerized and scalable system produces roughly 100 metric tons of anhydrous green ammonia annually (300 kg of anhydrous green ammonia per day), laying the groundwork for the larger FP1500 systems, which will serve larger farms with an annual output of approximately 500 metric tons per year.[89]

The Hiebert demonstration project showcases the potential for enhanced economic resilience, reduced exposure to volatile ammonia markets, and lower emissions by utilizing Manitoba Hydro's low-carbon electricity to power ammonia synthesis. The project is designed to be scalable, inform broader adoption in rural and remote regions with challenging logistics for delivering ammonia, and align with broader federal goals for reducing agricultural emissions.

Some key economic and environmental details about the Hiebert project:

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[84] Top Crop Manager, "Reducing Uncertainty: Producing On-Farm Green Ammonia," *Inputs: The Podcast,* October 8, 2025, https://www.topcropmanager.com/podcasts/reducing-uncertainty-producing-on-farm-green-ammonia/.

[85] "FuelPositive: Fertilizer Independence and Farming Resilience," FuelPositive, accessed April 9, 2025, https://fuelpositive.com/.

[86] "Fuel Positive: First Scalable Green Ammonia Production System Successfully Installed on Manitoba Farm," FuelPositive, July 19, 2024, https://fuelpositive.com/fuelpositive-completes-on-farm-commissioning-of-the-first-scalable-green-ammonia-production-system-and-announces-new-manitoba-based-partnerships/.

[87] FuelPositive, "FuelPositive Announces Completion of Factory Acceptance Testing and Shipping of First Commercial System," *Global Newswire,* April 15, 2024, https://www.globenewswire.com/news-release/2024/04/15/2863213/0/en/FuelPositive-Announces-Completion-of-Factory-Acceptance-Testing-and-Shipping-of-First-Commercial-System.html.

[88] "FuelPositive Provides Update on Corporate Strategy and On-Farm Progress," FuelPositive*,* July 18, 2025, https://fuelpositive.com/fuelpositive-provides-update-on-corporate-strategy-and-on-farm-progress/.

[89] "FuelPositive Provides Update on Corporate Strategy and On-Farm Progress," FuelPositive.

- Upfront capital expenses for the FP300: Can$950,000.[90]
- Operating cost target for the FP300: Can$560 per ton.[91]
- Demonstration funding secured: Can$1.4 million from the federal Agricultural Clean Technology program[92] and Can$300,000 from Manitoba via the Canadian Agricultural Partnership.[93]
- Projected carbon emissions reductions: Up to 2 tons CO_2e reduced per ton of ammonia produced.[94]

The Hiebert farm FP300 project launched in June 2024, with on-site engineering completed in June 2025, and will become operational once operational funding is secured. The FP300 is designed to produce 100 metric tons of green ammonia annually, supporting the farm's needs while establishing a scalable model for DGA production.[95] It will be capable of delivering up to 300 kg of anhydrous green ammonia daily, which is sufficient for a 1,800-acre farm.[96]

[90] "Ask Us – FAQ," FuelPositive, accessed April 9, 2026, https://fuelpositive.com/ask-us/.

[91] "Ask Us – FAQ," FuelPositive.

[92] FuelPositive Corporation, "FuelPositive Provides Updates on Site Approvals and Project Timeline," press release, September 25, 2024, https://fuelpositive.com/fuelpositive-provides-updates-on-site-approvals-and-project-timeline; Grants and Contributions: Green NH3 Demonstration Phase," Agriculture and Agri-Food Canada, agreement no. 235-2023-2024-Q2-00026, Search Open Canada.

[93] FuelPositive, "FuelPositive Receives Government Support and Funding for Manitoba-Based Project," *Global Newswire,* December 14, 2022, https://www.globenewswire.com/news-release/2022/12/14/2573642/0/en/FuelPositive-Receives-Government-Support-and-Funding-for-Manitoba-based-Project.html.

[94] FuelPositive, "FuelPositive Provides Update on Corporate Strategy and On-Farm Progress."

[95] FuelPositive, "FuelPositive Provides Update on Corporate Strategy and On-Farm Progress."

[96] "FuelPositive Business Model," FuelPositive, accessed April 17, 2025, https://fuelpositive.com/business-model/.

Financials at a glance for the FP300 Green Ammonia Production System

Category	FP300 Green Ammonia Production System
Upfront capital expenses	Can$950,000*
Operating cost target	Can$560/ton of anhydrous green ammonia*
Annual production capacity	100 metric tons of DGA (300 kg/day)†
Electricity cost	Can$0.055–$0.060 per kWh‡
Projected electricity costs for the project	Can$800–$900 per ton (includes capital costs)‡
Federal funding secured	Can$1.4M from Agricultural Clean Technology Program§
Additional funding secured	Can$300,000 from the Canadian Agricultural Partnership‖
Total funding secured	Can$1.7M
Projected carbon emissions reductions	Up to 2 tons CO_2e/ton of ammonia produced#

*FuelPositive Corporation, “Sales.”
†FuelPositive, “FuelPositive Provides Update on Corporate Strategy and On-Farm Progress.”
‡ Tristan Peitz (TalusAg), video call with author, May 7, 2025.
§ FuelPositive Corporation, “FuelPositive Provides Updates on Site Approvals and Project Timeline,” press release, September 25, 2024, https://fuelpositive.com/fuelpositive-provides-updates-on-site-approvals-and-project-timeline; Grants and Contributions: Green NH3 Demonstration Phase,” Agriculture and Agri-Food Canada, agreement no. 235-2023-2024-Q2-00026, Search Open Canada.
‖ FuelPositive Corporation, “FuelPositive Receives Government Support and Funding for Manitoba-based Project,” *GlobalNewswire,* December 14, 2022
#FuelPositive Corporation, “FuelPositive Reports Progress on Manitoba System and Government Funding Discussions,” press release, July 2, 2025.

This low-carbon fertilizer will not only help the farm achieve government-mandated agricultural emissions reductions but also enhance the farm’s economic resilience by reducing the risk of market volatility. The project is grid-tied, with an estimated electricity cost of Can$0.055 - 0.06 per kWh, resulting in approximately Can$800-900 per ton of DGA, including capital costs.[97]

FuelPositive also manufactures the FP1500 system, enabling scaled production of DGA for larger agricultural operations of approximately 10,000 acres.[98] Designed for higher output, the

[97] Tristan Peitz (TalusAg), video call with author, May 7, 2025.

[98] FuelPositive Corporation, “FuelPositive Issues Clarification Regarding a Statement Made in Its August 13 2025 Press Release,” press release, August 15, 2025, https://www.newswire.ca/news-releases/fuelpositive-issues-clarification-regarding-a-statement-made-in-its-august-13-2025-press-release-846586836.html.

FP1500 produces 500 metric tons per year (up to 1,500 kg daily).[99] The FP1500 system needs approximately 1 acre to accommodate six modular production containers and a 500-ton pressurized storage tank.[100] When paired directly with renewable generation, the FP1500 system requires approximately 4 MW of installed solar or wind capacity, which would necessitate an additional 15 acres.[101]

The Manitoba grid, dominated by hydroelectric power, supports the potential for low-carbon ammonia production. When grid-tied, both systems would use electricity from Manitoba Hydro to produce low-carbon green ammonia. Compared to centralized gray ammonia production, on-site production with hydro-powered electricity reduces lifecycle emissions. FuelPositive estimates that the FP300 can reduce emissions up to 2 tons of CO_2e per ton of ammonia produced. [102]

Economic, financing, and policy support

The FP300 upfront cost is Can$950,000, with the final price varying based on site-specific configurations and customer needs.[103] Operating costs are estimated at Can$560 per metric ton, depending on electricity costs.[104]

The larger FP1500 system, which includes a 500-ton pressurized storage tank, has an estimated capital cost of Can$5 million.[105]

Beyond the initial capital costs, the primary additional expenses are electricity and minimal operations and maintenance fees. In Manitoba, early adopter farms are paying electricity costs between $0.045 and $0.06 per kWh.[106] FuelPositive aims to reduce these costs over time by integrating on-site renewable energy generation, targeting a price of Can$0.03 to $0.04 per kWh.

There are several incentives and financial mechanisms to reduce system capital costs. Canada's federal and provincial governments provided support for the deployment of the FP300. FuelPositive received a Can$1.4 million funding commitment from the Canadian

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[99] FuelPositive, "FuelPositive Provides Update on Corporate Strategy and On-Farm Progress."

[100] Top Crop Manager, "Reducing Uncertainty: Producing On-Farm Green Ammonia," *Inputs: The Podcast,* October 8, 2025.

[101] Top Crop Manager, "Reducing Uncertainty: Producing On-Farm Green Ammonia," *Inputs: The Podcast,* October 8, 2025.

[102] FuelPositive Corporation, "FuelPositive Reports Progress on Manitoba System and Government Funding Discussions," press release, July 2, 2025, https://fuelpositive.com/fuelpositive-reports-progress-on-manitoba-system-and-government-funding-discussions/.

[103] FuelPositive Corporation, "Sales," accessed April 17, 2025, https://fuelpositive.com/sales/.

[104] FuelPositive Corporation, "Sales," https://fuelpositive.com/sales/.

[105] FuelPositive Corporation, "Sales," https://fuelpositive.com/sales/.

[106] Fuel Positive, "Corporate Update: FuelPositive Releases Operational Costing Model and Timeline for Green Ammonia Production System," *Global Newswire,* November 18, 2021, https://www.globenewswire.com/news-release/2021/11/18/2337496/0/en/Corporate-Update-FuelPositive-Releases-Operational-Costing-Model-and-Timeline-for-Green-Ammonia-Production-System.html.

government through the Agricultural Clean Technology program, administered under the Agriculture and Agri-Food Canada Research and Innovation Stream for direct support of testing and demonstration of the on-farm system.[107] Manitoba's provincial government provided an additional Can$300,000 through the Canadian Agricultural Partnership in 2022.[108]

FuelPositive aims to provide turnkey financing for its DGA systems, helping to familiarize lenders and the agricultural sector with this innovative technology.[109] The company is currently targeting the agricultural sector for financing, as it best understands the value of ammonia to farmers.

There is potential for additional revenue through carbon credit and environmental attribute markets, subject to regulatory and market development. FuelPositive has been exploring how its DGA systems might generate environmental attribute certificates (EACs) by documenting the use of renewable electricity in its ammonia production process.[110] The company has begun engaging with provincial authorities to help establish a regulatory framework for robust measurement, reporting, and verification. A platform for tracking environmental attributes—such as the hourly-based renewable energy tracking registry operated by CleanCounts—supports credible claims and provides a transparent chain of custody. Transacting EACs for ammonia could open new revenue opportunities for project owners and farmers, along with providing a verifiable emissions profile for FuelPositive's ammonia product.

Looking ahead

FuelPositive is exploring several alternative methods to make its DGA systems more accessible. The company is exploring financing and delivery models to assist farmers in overcoming the high upfront capital costs associated with system ownership. They are exploring a lease-to-own program and turnkey financing through formalized partnerships with agricultural investors, such as Farm Credit Canada and other lenders that understand the technology, the opportunity, and the value it offers to farmers.[111] Similarly, FuelPositive is actively collaborating with the Royal Bank of Canada to develop lease-to-own models through innovative finance

[107] FuelPositive Corporation, "FuelPositive Provides Updates on Site Approvals and Project Timeline," press release, September 25, 2024, https://fuelpositive.com/fuelpositive-provides-updates-on-site-approvals-and-project-timeline; Grants and Contributions: Green NH3 Demonstration Phase," Agriculture and Agri-Food Canada, agreement no. 235-2023-2024-Q2-00026, Search Open Canada, https://search.open.canada.ca/grants/record/aafc-aac%2C235-2023-2024-Q2-00026%2Ccurrent?sort=undefined&search_text=undefined&page=1.

[108] FuelPositive Corporation, "FuelPositive Receives Government Support and Funding for Manitoba-based Project," *GlobalNewswire,* December 14, 2022, https://www.globenewswire.com/news-release/2022/12/14/2573642/0/en/FuelPositive-Receives-Government-Support-and-Funding-for-Manitoba-based-Project.html.

[109] Top Crop Manager, "Reducing Uncertainty: Producing On-Farm Green Ammonia," *Inputs: The Podcast,* October 8, 2025.

[110] FuelPositive Corporation, "FuelPositive Provides Updates on Site Approvals and Project Timeline," press release, September 25, 2024.

[111] "Top Crop Manager, "Reducing Uncertainty: Producing On-Farm Green Ammonia," *Inputs: The Podcast,* October 8, 2025.

mechanisms.[112] Through these innovative mechanisms, farmers can preserve their working capital and build equity through ownership.

In addition to innovative finance mechanisms, FuelPositive is exploring aqueous ammonia modular systems; these farm-ready systems are under development as the FP300A and the FP1500A systems.[113] According to FuelPositive, an aqueous ammonia system will offer a safer, easier-to-apply solution for farmers and provide them with the flexibility to produce aqueous ammonia in concentrations and quantities that respond to variable agricultural settings and diverse crop types.[114]

Lastly, FuelPositive is broadening its marketing to highlight additional applications for green ammonia beyond fertilizer, including fuel for grain drying and internal combustion engines, as well as applications in fuel cells and energy storage. With modular systems designed to offer flexibility, including adjustable ammonia concentrations and the ability to ramp production in response to variable electricity inputs and pricing, farmers can run the system to produce ammonia for both fertilizer and/or grain drying.

[112] FuelPositive Corporation, "FuelPositive Approaches Activation as Strategic Alliances Strengthen," press release, August 26, 2024, https://fuelpositive.com/fuelpositive-approaches-activation-as-strategic-alliances-strengthen/.

[113] Top Crop Manager, "Reducing Uncertainty: Producing On-Farm Green Ammonia," *Inputs: The Podcast,* October 8, 2025.

[114] FuelPositive Corporation, "FuelPositive Files Patent for Green Aqueous Ammonia Production Module and Provides Update on First Farm-Ready System," press release, March 22, 2024, https://www.globenewswire.com/news-release/2024/03/22/2850718/0/en/FuelPositive-Files-Patent-for-Green-Aqueous-Ammonia-Production-Module-and-Provides-Update-on-First-Farm-Ready-System.html.