

North America Green Ammonia Market, By Production Method (Alkaline Water Electrolysis, Proton Exchange Membrane, Solid Oxide Electrolysis), By End Use (Power Generation, Transportation, Fertilizers, Others), By Country and Competition, Forecast & Opportunities, 2023-2032F

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Abstracts

The North America Green Ammonia Market is anticipated to project robust growth in the forecast period. Green ammonia production entails the creation of ammonia through entirely renewable and carbon-free processes. This remarkable substance finds a multitude of applications due to its unique properties, including the ability to be stored at ultra-low temperatures, as low as -33°C , or in substantial quantities as a liquid under minimal pressures, typically around 10–15 bar. Notably, green ammonia is heralded as a zero-carbon fuel, suitable for combustion in engines or utilization in fuel cells to generate electricity. Moreover, it serves as a green hydrogen carrier, facilitating the storage and transportation of clean hydrogen, a critical component in the renewable energy landscape. The significance of green ammonia extends to addressing pressing global challenges, including food security for an ever-growing world population and the generation of carbon-free electricity. Additionally, it holds immense promise as a potential climate-neutral transportation fuel in the future, offering a sustainable alternative to traditional fossil fuels. Furthermore, plans are underway to harness green ammonia in the development of carbon-neutral fertilizer products, which could revolutionize agricultural practices by reducing the carbon footprint associated with fertilizer production and application. The convergence of these factors collectively contributes to the growth of the North America Green Ammonia Market within the forecast period.

Key Market Drivers

Rising Demand of Green Ammonia in the Power Generation Sector

In the pursuit of cleaner and more sustainable energy sources, green ammonia has emerged as a promising candidate, particularly in the power generation sector. Green ammonia, produced using renewable energy sources and emitting minimal or no carbon dioxide during production, presents a compelling solution to reduce greenhouse gas emissions and transition toward a low-carbon energy future. Ammonia, with its high hydrogen content, has long been recognized as a potential energy carrier. However, traditional ammonia production methods, heavily reliant on fossil fuels and emitting substantial carbon dioxide (CO₂), were at odds with sustainability goals. Green ammonia, on the other hand, is produced using renewable energy sources, primarily wind and solar power, to generate hydrogen through a process called electrolysis. This hydrogen is then combined with nitrogen to produce ammonia. The result is a clean, carbon-free fuel with diverse applications across industries. One of the most significant drivers of green ammonia demand is its application in power generation. Green ammonia can be used as a clean fuel in thermal power plants, helping to replace coal and natural gas. When burned in combustion turbines, green ammonia produces heat and electricity with zero CO₂ emissions, making it an attractive option for reducing the carbon footprint of power generation. Ammonia combustion technology is already well-established, making it relatively straightforward to integrate green ammonia into existing power plants. The ability to retrofit ammonia into conventional power facilities further accelerates its adoption, offering a practical solution for reducing emissions from the energy sector.

Moreover, energy storage is a critical component of a sustainable energy system, enabling the efficient use of intermittent renewable energy sources such as wind and solar power. Green ammonia has garnered attention as a reliable energy storage medium. Excess renewable energy, during periods of low demand, can be used to produce green ammonia through electrolysis. This green ammonia can then be stored and transported to where it is needed, acting as a flexible energy reservoir. When electricity demand surges, green ammonia can be converted back into electricity through ammonia-based fuel cells or gas turbines, releasing stored energy and stabilizing the grid. This versatility in energy storage positions green ammonia as a vital tool for ensuring a consistent and reliable energy supply, even in the face of fluctuating renewable energy generation.

Furthermore, the power generation sector is under increasing pressure to reduce its

carbon emissions as nations commit to ambitious climate goals. Green ammonia presents a compelling solution for power plants to decarbonize their operations without the need for costly infrastructure changes. By incorporating green ammonia as a clean fuel, power plants can align with sustainability objectives and significantly reduce their carbon footprint. The rapid expansion of renewable energy sources, such as wind and solar power, has created a need for efficient energy storage solutions. Green ammonia, as an energy carrier, complements renewable energy integration efforts by providing a means to store excess energy during peak generation periods and release it when needed. This role in energy storage positions green ammonia as an essential component of a reliable and resilient energy grid. The rapid expansion of renewable energy sources, such as wind and solar power, has created a need for efficient energy storage solutions. Green ammonia, as an energy carrier, complements renewable energy integration efforts by providing a means to store excess energy during peak generation periods and release it when needed. This role in energy storage positions green ammonia as an essential component of a reliable and resilient energy grid. Therefore, increasing demand of green ammonia in power generation sector leading to the growth of North America Green Ammonia Market.

Growing Demand for Green Ammonia in the Transportation Sector

The transportation sector is at the forefront of global efforts to reduce greenhouse gas emissions and combat climate change. As the world seeks cleaner and more sustainable alternatives to traditional fossil fuels, green ammonia has emerged as a promising solution for decarbonizing various modes of transportation. The transportation sector is a significant contributor to global carbon emissions, with road vehicles, ships, and airplanes relying heavily on fossil fuels like gasoline, diesel, and kerosene. To address the environmental challenges associated with traditional transportation fuels, there is a growing imperative to transition toward cleaner and more sustainable alternatives. Green ammonia, produced using renewable energy sources and emitting minimal or no carbon dioxide (CO₂) during production, holds tremendous potential as a clean and sustainable transportation fuel. Its use can significantly reduce greenhouse gas emissions, mitigate air pollution, and contribute to a more sustainable future.

Moreover, green ammonia can replace conventional marine fuels, reducing emissions from cargo ships, cruise liners, and other vessels. Ammonia-powered engines offer high energy density, enabling longer voyages without refueling. Green ammonia can be used as an alternative to kerosene in aviation. The development of ammonia-based fuel cells and gas turbines for aircraft propulsion holds promise for reducing aviation emissions. Ammonia can be used as a fuel in internal combustion engines or converted to

hydrogen on-board fuel cell vehicles. Its application in heavy-duty trucks, buses, and off-road vehicles can contribute to cleaner urban transportation. Ammonia-powered locomotives can offer an eco-friendly solution for freight and passenger rail services, reducing emissions along rail networks.

Furthermore, governments are investing in the development of ammonia production and distribution infrastructure to support the use of green ammonia in transportation. This includes the construction of ammonia production facilities, transportation networks, and refueling stations for ammonia-powered vehicles and vessels. Public and private sector investments in research and development are driving innovation in green ammonia technologies for transportation. These investments fund projects focused on improving ammonia-powered engines, fuel cells, and conversion systems, making green ammonia more accessible and efficient. Thus, the large number of benefits of green ammonia is anticipated to drive the demand of North America Green Ammonia Market in the forecast period.

Rising Demand for Green Ammonia in the Fertilizer Industry

The fertilizer industry plays a crucial role in ensuring food security and supporting agricultural productivity. Fertilizers are essential for providing crops with the necessary nutrients to thrive and meet the growing demands of a burgeoning world population. However, the conventional production of ammonia-based fertilizers has been associated with significant environmental challenges, including carbon emissions and energy-intensive processes. In response to these concerns, the demand for green ammonia in the fertilizer industry has been steadily rising. Fertilizers are a cornerstone of modern agriculture, enhancing crop yields and ensuring the availability of sufficient food supplies for a growing global population. These essential inputs provide plants with vital nutrients, primarily nitrogen, phosphorus, and potassium, which are often deficient in soils. Nitrogen-based fertilizers, particularly ammonia-based ones, are among the most widely used in agriculture due to their ability to promote plant growth and boost crop production.

Moreover, the urgent need to address climate change has prompted governments, industries, and consumers to seek sustainable alternatives to high-emission processes. Green ammonia production aligns with global efforts to reduce greenhouse gas emissions and limit global warming. The transition to renewable energy sources, such as wind, solar, and hydropower, has created opportunities for sustainable ammonia production. These renewable energy sources can power electrolysis processes to produce green hydrogen, a key component in green ammonia synthesis. Growing

awareness and concern about the environmental impact of food production has led consumers to support sustainable and eco-friendly farming practices. Green ammonia allows the fertilizer industry to respond to these consumer preferences. Green ammonia can be used as a feedstock to produce ammonium nitrate, a common nitrogen-based fertilizer. This sustainable alternative reduces the carbon footprint of ammonium nitrate production while maintaining its effectiveness in promoting crop growth. Thus, these factors dominate the growth of North America Green Ammonia Market in the forecast period.

Key Market Challenges

Cost Competitiveness

One of the primary challenges facing the green ammonia market is cost competitiveness. The production of green ammonia, using renewable energy sources like wind or solar power, can be more expensive compared to traditional ammonia production methods, which rely on fossil fuels. The higher initial investment required for green ammonia production infrastructure, such as electrolyzers and renewable energy facilities, can deter potential investors. To address this challenge, governments, research institutions, and private companies must collaborate to drive innovation and reduce production costs. Advancements in electrolyze technology, economies of scale, and the development of integrated energy systems can help make green ammonia more cost-competitive with conventional ammonia production.

The production process has many technical obstacles that must be overcome as they affect production costs. Green ammonia production relies on energy-intensive technologies that require high temperatures and pressures, increasing capital and operating costs. The increasing cost of renewable energy and electrolysis is one of the significant reasons that is constraining the adoption of green ammonia. In addition, it is estimated that the production cost of green ammonia is 1.5 times higher than traditional natural gas-based ammonia product. Hence, high production costs are expected to limit the growth of the global green ammonia market during the forecast period.

Levelized Cost of Green Ammonia

There is great uncertainty in the production costs of green ammonia, mainly due to the large quantity of production forecast and lack of reliable experience, which affects the capital cost of electrolysis. These uncertainties should decrease significantly over the next few years as more large-scale electrolysis projects are implemented. A similar level

of uncertainty exists for the cost of capital, which can be driven by economic and political factors. As the demand for renewable energy is increasing, it is expected that cracking ammonia without reconverting to hydrogen suggests that manufacturers should prioritize to achieving a green ammonia compatibility to fuel turbine technology in the long term. All the mentioned factors led to increased production costs and hindered market growth.

Key Market Trends

Green Ammonia for Energy Storage

The demand for green ammonia as a solution for energy storage is rapidly gaining momentum as the world seeks sustainable alternatives to traditional energy sources. Green ammonia, produced through a process powered by renewable energy sources like wind or solar, has emerged as a promising candidate for storing and transporting clean energy. Green ammonia can be stored and transported efficiently, making it a versatile energy carrier. It can be stored in liquid form under moderate pressure and at relatively low temperatures, which simplifies the logistics of storage and transportation. This flexibility means that green ammonia can be transported from regions with surplus renewable energy to areas with high energy demand, effectively acting as a renewable energy transport and storage medium.

Furthermore, the most significant advantage of green ammonia as an energy storage solution is its high energy density. Ammonia has a considerably higher energy density by volume compared to other energy carriers like hydrogen or lithium-ion batteries. This makes it well-suited for long-term storage and transportation, enabling the use of green ammonia in various applications.

Moreover, green ammonia can serve as a source of clean hydrogen, as it can be easily converted back into hydrogen when needed. This hydrogen can then be utilized in fuel cells to generate electricity or as a clean fuel for various industrial processes, further increasing its versatility as an energy carrier. In addition to its energy storage capabilities, green ammonia is a versatile chemical compound with numerous industrial applications. It can be used as a fertilizer in agriculture, a feedstock in chemical manufacturing, and a coolant in industrial processes. This dual usability increases its demand and economic viability, making it an attractive option for sustainable energy storage.

Favorable Government Initiatives

Favorable government initiatives regarding green ammonia in North America are shaping the region's transition towards sustainable energy and decarbonization. In the United States, the Biden administration's commitment to combating climate change and advancing clean energy has spurred several initiatives aimed at promoting green ammonia. The American Jobs Plan includes provisions for the development of clean hydrogen and ammonia as energy carriers, with a focus on using them in the transportation and industrial sectors. This plan allocates substantial funding for research, development, and deployment of green ammonia technologies. Additionally, federal tax credits and incentives for clean energy production and storage are driving investments in green ammonia infrastructure. State-level initiatives, such as California's push for clean fuels and energy storage solutions, further bolster the demand for green ammonia in the country.

Moreover, the government's strong commitment to sustainable energy aligns with the development of green ammonia. Canada's Hydrogen Strategy, released in 2020, highlights the role of hydrogen and ammonia as critical components of the country's clean energy future. The government is providing financial support for research and development projects related to green ammonia production, with a focus on utilizing excess renewable energy generated in provinces like Alberta. In addition, Canada's Low Carbon and Zero-Emissions Fuels Regulations incentivize the use of low-carbon fuels like green ammonia in the transportation sector, further promoting its adoption.

Furthermore, the regulatory framework in North America is evolving to accommodate green ammonia. Government agencies are working on establishing clear guidelines and standards for the production, transportation, and use of green ammonia, ensuring safety and reliability in its deployment. These regulatory efforts provide confidence to investors and industry stakeholders, facilitating the growth of green ammonia markets.

Segmental Insights

Type Insights

Based on the production method, the alkaline water electrolysis segment is expected to register the highest growth of 55.08% during the forecast period 2024-2032. Alkaline Water Electrolysis (AWE) is emerging as a highly promising production method for green ammonia, offering several key benefits that contribute to its growing popularity in the field of sustainable agriculture and industry. One of the primary advantages of AWE is its reliance on clean and renewable energy sources, such as wind or solar power, for

the electrolysis process. This results in minimal or even zero carbon emissions during ammonia production, aligning perfectly with the goal of reducing greenhouse gas emissions and combatting climate change. Additionally, AWE exhibits excellent scalability, making it suitable for both large-scale industrial applications and smaller, decentralized systems. Its adaptability and flexibility in adjusting production volumes to meet specific demands enhance its appeal.

Furthermore, AWE offers a high level of energy efficiency, allowing for the effective utilization of surplus renewable energy. This means that excess energy generated during periods of peak availability can be stored as green ammonia, serving as an energy carrier or a clean fuel source for various applications, including fertilizers. Green ammonia produced through AWE also boasts high purity, ensuring its compatibility with a wide range of industries beyond agriculture, such as power generation and transportation. In summary, Alkaline Water Electrolysis presents a sustainable and versatile method for green ammonia production, embodying the principles of environmental responsibility, energy efficiency, and scalability essential for a sustainable future.

End Use Insights

Based on the end use, the power generation segment is expected to register the highest growth of 55.38% during the forecast period, 2024-2032. The demand for green ammonia in power generation applications is steadily on the rise as the world seeks cleaner and more sustainable energy sources. Green ammonia, produced through renewable energy-powered electrolysis, holds immense potential as a clean energy carrier and storage solution. Its role in power generation is multifaceted. Firstly, green ammonia can be used directly as a fuel in gas turbines or engines, providing a reliable and emissions-free source of electricity generation. Moreover, it can serve as an energy carrier, converting surplus renewable energy into ammonia during periods of excess supply and then reconvert it into electricity when needed, effectively storing intermittent renewable energy.

Furthermore, green ammonia's ability to transport hydrogen in a denser and safer form makes it a crucial component in the emerging hydrogen economy. Ammonia can be easily transported and stored, making it an ideal medium for the international trade of hydrogen, which is seen as a key element in the transition to clean energy. The power generation sector recognizes the potential of green ammonia to reduce carbon emissions, enhance grid stability, and support the integration of renewables. As a result, it is increasingly viewed as a vital solution for achieving a sustainable and low-carbon

future in the power generation industry, driving the growing demand for green ammonia in this critical application.

Country Insights

United States will witness fastest growth during the forecast period, 2024-2032. In the United States, the demand for green ammonia is witnessing a significant uptick, driven by a pressing need to transition towards cleaner and more sustainable energy and agriculture practices. Green ammonia, produced using renewable energy sources and sustainable methods, is gaining recognition as a versatile and eco-friendly solution. In the energy sector, there is a growing interest in using green ammonia as a clean fuel and energy carrier. It holds promise for decarbonizing various industries, including power generation, transportation, and industrial processes. As the U.S. strives to reduce greenhouse gas emissions and combat climate change, green ammonia is emerging as a key player in achieving these environmental goals.

Furthermore, the agricultural industry in the United States, which heavily relies on ammonia-based fertilizers, is exploring the adoption of green ammonia to mitigate the environmental impact of traditional ammonia production. Green ammonia offers the potential to reduce emissions in agriculture while maintaining crop yields, aligning with the sector's growing emphasis on sustainable and environmentally responsible farming practices. The U.S. government's commitment to renewable energy and sustainability initiatives, coupled with increasing investments in green technology and infrastructure, is expected to further propel the demand for green ammonia in the country. As the nation seeks innovative solutions to address environmental challenges and meet ambitious climate targets, green ammonia is poised to play a crucial role in shaping a more sustainable future across multiple industries in the United States.

Key Market Players

Greenfield Nitrogen LLC

Avina Clean Hydrogen Inc.

AmmPower Corp

LSB Industries, Inc.

CF Industries Holdings, Inc.

Report Scope:

In this report, the North America Green Ammonia Market has been segmented into the following categories, in addition to the industry trends which have also been detailed below:

North America Green Ammonia Market, By Type:

Alkaline Water Electrolysis

Proton Exchange Membrane

Solid Oxide Electrolysis

North America Green Ammonia Market, By Application:

Power Generation

Transportation

Fertilizers

Others

North America Green Ammonia Market, By Country:

United States

Mexico

Canada

Competitive Landscape

Company Profiles: Detailed analysis of the major companies present in the North America Green Ammonia Market.

Available Customizations:

The North America Green Ammonia Market report with the given market data, Tech Sci Research offers customizations according to a company's specific needs. The following customization options are available for the report:

Company Information

Detailed analysis and profiling of additional market players (up to five).

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