In focus...

Decentralised ammonia production

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Grey ammonia is produced on large chemicals plants close to sources of coal and natural gas. With a transition to blue and green ammonia, production will migrate to locations with access to low-cost renewable electricity and CO_2 geological storage sites to mitigate emissions from hydrocarbon-based ammonia production.

In parallel, the applications of ammonia are broadening from its use as a nitrogen fertiliser and precursor for mining explosives production. Increasingly, ammonia is being considered as a fuel and hydrogen carrier. Demand centres for ammonia will expand beyond farming communities to industrial centres and urban populations.

As the supply and demand side transitions take place, the supply chain will undoubtedly transform. However, within this transformation fundamental questions remain. Will ammonia production remain 'centralised' in new locations, with distribution by ship, pipeline and rail, as today? Or, will a more decentralised production model emerge?

Cost-effective supply chains

Supply chain network optimisation considers the best places to make things and the distribution network to markets.

Food products must be customised for local circumstances: local production with local ingredients, making products suitable for local tastes and climates is essential. On the other hand, for commodities with universal specifications, such as ammonia, centralised production with global distribution is possible.

Ammonia is a low-value commodity and distribution costs rise as distances increase, favouring multiple production hubs. On the other hand, production must be located close to feedstocks to balance the distribution cost to and from the factory. Minimising the overall cost at the customer is the goal of network optimisation.

Conversions cost

When energy can be used directly, the overall system is likely to be more efficient. So converting renewable electricity to electrolytic hydrogen, followed by ammonia synthesis and the use of that ammonia in the same location to generate electricity will result in multiple losses. Direct use of the renewable electricity will generally be more efficient.

Where storage or distribution is required, conversions can be justified. However, as a general rule, they should be minimised.

With the above logic in mind, localised green ammonia production should focus on use cases where the ammonia is required for its chemical properties, not as an energy vector. Fertilisers and civilian use of explosives are clear examples.

Focus on fertilisers

Ammonia and ammonia derivatives are nitrogen-rich fertilisers. Without them, it would not be possible to grow sufficient food on our planet to sustain the global population.

Achieving high yields of staple food crops such as wheat, rice and corn all relies on regular fertiliser application.

In developing nations, fertilisers are often applied by hand. Granules are essential in these cases and urea is commonly used as a nitrogen-rich fertiliser. Urea is produced when ammonia is reacted with CO_2.

The application of liquid fertilisers such as urea ammonium nitrate (UAN), or di-ammonium phosphate (DAP) solutions, is increasingly popular in more industrial agricultural locations. Ammonia can also be dissolved in water and applied as aqueous ammonia.

In the US, and Western Canadian prairie provinces, direct application of anhydrous ammonia is also common. In these regions, agriculture is heavily industrialised and the farmers and supply chain are geared up to handle ammonia to work safely with this toxic gas.

For higher value products, such as UAN and DAP, the profitable distribution radius is higher than low-value products such as ammonia. Therefore, localised production of anhydrous or aqueous ammonia for direct application in North America is potentially a primary use case for decentralised ammonia production.

Drivers of decentralisation

In the US, there is an ammonia pipeline that runs from production locations in the Gulf Coast region, where natural gas prices are low, to mid-west farming states where corn is king. In addition to pipeline transmission, there are 'last mile' distribution requirements to local ammonia storage hubs, from which farmers collect anhydrous ammonia for application on their land.

At the production node, ammonia prices may be \$500 per tonne. However, when pipeline transmission and other land-based distribution costs and supply chain profit margins are added, the farmer is likely to pay \$800 per tonne. Whilst centralised production on the Gulf Coast benefits from both economies of scale and low-cost natural gas, localised production cuts out the distribution costs.

Farmers rely on ammonia to achieve the crop yields that result in profitable use of their agricultural land. Rural communities are at the mercy of a corporate supply chain which is perceived to dominate the producer/consumer power balance. Decentralisation means democratisation: restoration of the farmer's status, local supply security, and price stability.

The case for continued centralisation

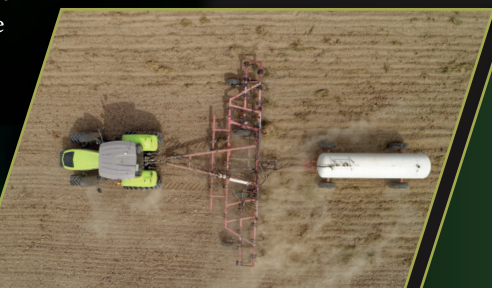
Regional hubs currently distribute nurse tanks containing 1,000 to 2,000 gallons (approx. 3,700 to 7,500 litres) of pressurised liquid anhydrous ammonia to farmers within a circa 30-mile radius. The empty nurse tanks are collected by the hub-owner a few days later.

The hub will generally have a 30,000 to 50,000 gallon pressurised anhydrous liquid ammonia storage tank: sufficient to fill 20 to 30 nurse tanks. These hubs are served by road tankers carrying about 8,000 gallons of liquid anhydrous ammonia from an ammonia wholesaler.

The wholesalers operate large terminals, generally located directly on the ammonia pipeline. Tanks at this level in the supply chain are about 200 times larger than those operated by the regional hubs and will be low pressure refrigerated tanks to minimise the tank construction costs.

If ammonia were to be made in a decentralised model, it would be most suitable to either make it at the farm, the regional hub, or the wholesaler. In each case, technical operation of the ammonia synthesis plant would take place further down the supply chain, adding risk and complexity at these distributed nodes. For this reason, it is highly unlikely that farmers would produce for themselves.

Decentralised production at the regional hubs would render the wholesaler's storage assets and their role in the value chain obsolete. This may create a competitive reaction that negates the benefits of localised production. On the other hand, decentralised production at the wholesaler would mean they no longer leverage the installed pipeline infrastructure and unit costs of ammonia distribution by pipeline may increase to other locations that the wholesaler operates. ▸



Seasonality requires storage

Ammonia is applied to clay soils in autumn between November and December when the ground is below 50° Fahrenheit (10°C) but not freezing. This reduces volatilisation of the ammonia and enables microbes to fix nitrogen into the soil. Anhydrous ammonia must be applied after the corn or soya harvest, in preparation for spring wheat or corn.

A spring application between March and May is more appropriate for loamy soil. Sandy soils are not suited to anhydrous ammonia application because the gas leaks through the soil before microbes have a chance to fix the nitrogen. In any given location, application of anhydrous ammonia only takes place for a few weeks each year.

If decentralised anhydrous ammonia production were to be implemented, the ammonia synthesis plant would either be very large and idle for 11 months of the year, or would be of a smaller size and operated throughout the year. In this case, anhydrous ammonia must be stored locally for application to the soil during the appropriate weeks of the year.

The centralised infrastructure is more flexible to respond to the seasonal demand peaks since production and storage exists for multiple offtakers and international customers where the growing seasons are at different times of the year.

Centralised production has an averaging effect on the capital asset utilisation and enables high volume storage and technically complex operations to be in heavily industrialised areas, remote from rural communities.

A green future in the balance

Distributed green ammonia production has not been an easy area for start-ups to gain traction. ReMo Energy was founded in 2020 in the US. It proposed several projects that would convert renewable electricity to anhydrous ammonia. However, ReMo has not completed any projects. In Canada, Ammpower pursued a similar concept. On October 6, 2025, it ceased trading on the Canadian Securities Exchange.

On a positive note, the start-ups Ammobia and Nium are still active in the US and UK. Another highlight is the TalusAg green ammonia plant which commenced production in 2025 at Boone, Iowa. The facility is a partnership with Landus Cooperative. It uses solar power to produce green ammonia. An additional notable success was announced in April 2025 by the Japanese player Tsubame BHB. It will deploy a distributed green ammonia plant in partnership with Atvos in Brazil to fertilise corn for bioethanol production.

Established technology licensors and EPC players have also developed green ammonia technologies. Leaders include Casale (FlexAMMONIA), Topsøe (DynAMMO™), thyssenkrupp Uhde (Dynamic Uhde® Ammonia Synthesis Technology), StamiCarbon (NX Stami Green Ammonia™) and KBR (K-GreeN®) offering processes that are able to flex between circa 10% and 100% of nominal ammonia production capacity. This is designed to align with the fluctuating availability of renewable power generation and electrolytic green hydrogen production.

Hopes for blue ammonia

A 1,500 tonne per day blue ammonia production facility to be located at Belle Plaine in Canada's Saskatchewan province has been proposed by Genesis Fertilizers. This plant size is somewhere between a fully decentralised model and a world-scale ammonia plant, which would be two or three times larger. Fertilisers from the plant are intended to be used in Saskatchewan, Manitoba and Alberta: Canada's grain belt prairie provinces.

The Genesis Fertilizers model will be vertically integrated and farmer-owned. Natural gas will be converted to ammonia in a conventional synthesis process. CO_2, which is removed from the synthesis gas to protect the ammonia catalyst, will be sequestered at the Belle Plaine Carbon Hub, managed by Whitecap Resources Inc. The CO_2 will be transmitted by a circa 15km pipeline to the geological storage site. Whilst the idea of decentralised green ammonia production is making some progress, the Genesis Fertilizers concept offers a potentially more competitive pathway through blue hydrogen produced at an intermediate scale, covering farms in three states in Western Canada.

Grey, blue or green? Centralised, decentralised or regional? The status quo is being challenged, but the future remains open. gw

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