

Fertilizer Focus



Developing marketing strategies for the fertilizer sector

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Exploring new paths for low carbon ammonia

Written by

Blake Adair, Senior Manager, Innovation and Environmental Performance, Nutrien, Canada

The development of low carbon ammonia for use in agriculture, industry and as an energy source is a key strategic pillar of Nutrien’s aspirations to be a leader in sustainability across the ag value chain and in emerging energy markets.

Economics of farms across the planet are beholden to local and international commodity pricing. It is not common for a farmer to be financially rewarded to lower the carbon intensity of their products. This needs to change in order to drive adoption of the widespread use of low carbon ammonia and its derivative fertilizer products. Late last year, we launched a new carbon programme for our farmers. It provides them with end-to-end support to drive sustainable agriculture while boosting their profitability using a combination of science, technology and a carbon credit system that builds a new market around positive carbon outcomes. We believe that over time, this will provide growers with the profits they need to make the most sustainable fertilizer choices, allowing us to rapidly decarbonize the fertilizer industry.

Ammonia’s potential role in the decarbonization of our current energy system is an exciting opportunity, but one that needs to be developed in step with the United Nation’s sustainable development goals. It is critical that our food systems are not put at risk, which would subject the

We have the ambition, assets and experience to be a provider of commercially viable low carbon ammonia – driving meaningful greenhouse gas emission reductions in agriculture, industry and energy markets.

Raef Sully, EVP & CEO, Nitrogen and Phosphate, Nutrien

world’s most vulnerable populations to undue hardship. Responsible development must also be mindful to neither increase the utilization nor construction of coal based ammonia capacity. Low carbon ammonia’s development should be viewed as an opportunity to address climate change, but also serve as a catalyst to eliminate hunger and poverty.

Significant investment and development of low carbon green ammonia technology, which requires only sun, wind and water, will provide economic opportunities in regions of the developing world with an abundance of these resources. As technology costs decline and efficiency improves, small and medium scale green ammonia facilities could also be a supplier of

commercially viable ammonia for agricultural use across the globe.

There are viable low carbon blue ammonia pathways that can drive meaningful emissions reductions today. These include steam methane reforming of natural gas with carbon capture and permanent sequestration, as well as emerging methane pyrolysis technology.

Adapting facilities

There is also significant potential to hybridize existing steam methane reforming facilities. A portion of the necessary hydrogen can be supplied via electrolysis of water and carbon free electricity. The oxygen produced from the electrolysis unit can be directed to the reforming process to

reduce the amount of required fuel gas (and their associated GHG emissions).

There are significant barriers to the adoption of low carbon ammonia at scale. Ammonia infrastructure will need to be safely developed across the globe, in many cases in close proximity to populated areas. Ammonia-fuelled engines and turbines need to prove that they can be operated efficiently, reliably, and safely while also mitigating nitrous oxide (N₂O), NO_x or ammonia emissions. New technology pathways need to be de-risked and rapidly developed at scale. These are only a subset of the many challenges to facilitate this energy transition.

The goal of all low carbon ammonia stakeholders should be the development of a functioning and economically viable global supply chain that meets emissions reduction targets. This will necessitate the development of low carbon ammonia technology that plays to the strengths of regional geography, resources, and regulatory environments. Debating the merits of blue versus green, or blue then green, is counterproductive. We need all pathways to be responsibly developed across to globe now.

Nutrien has actively been pursuing the development of low carbon ammonia for more than a decade. This has positioned us to be one of the world’s largest low carbon ammonia producers today, with up to 1 million tonnes of production capability. We have three world class assets currently in operation. Our Redwater, Alberta and Geismar, Louisiana operations utilize carbon capture and storage to lower our carbon intensity, while our Joffre, Alberta facility takes advantage of low carbon by-product hydrogen. We are positioned to immediately supply emerging low carbon markets in agriculture, industry or for use as a fuel or as a hydrogen carrier.

Our existing footprint is well suited to the development of low carbon blue ammonia, which can be deployed at scale today with proven, low risk, low-cost scalable technology.

Geismar - A Low Carbon Ammonia Hub

Our Geismar facility currently has the capability to produce more than 200,000 t of low carbon blue ammonia annually. We are uniquely positioned to expand production, benefiting from a stable and cost competitive supply of natural gas, suitable geology for CO₂ sequestration, world-class CO₂ infrastructure and regulatory environment to support Carbon Capture and Sequestration (CCS) at scale.

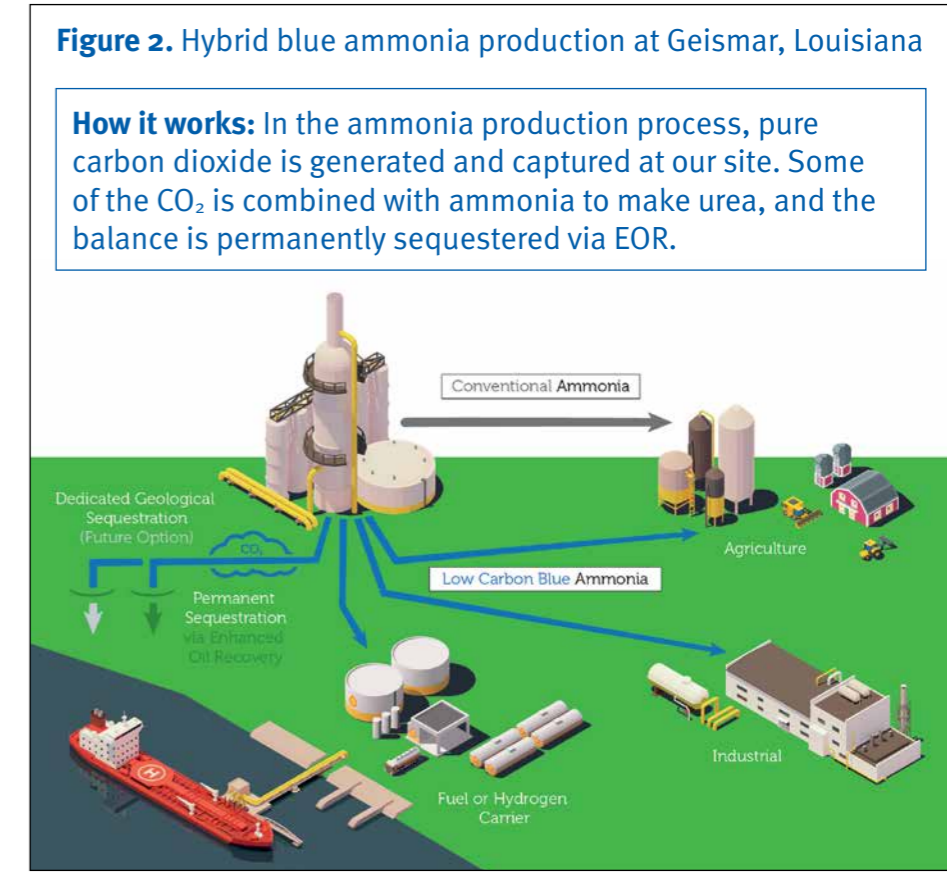
Our operations are tied into a CO₂ pipeline network that transports CO₂ mined from underground reservoirs for use in Enhanced Oil Recovery (EOR). In 2013, Geismar began directing previously vented process CO₂ into this pipeline network for permanent sequestration. As the Gulf Coast’s CO₂ infrastructure matures, dedicated sequestration will be a viable alternative to EOR, especially when supported by regulations such as the 45Q tax credit.

Our ammonia plant is a hybrid CCS facility that makes two grades



Figure 1. With tidewater access that can accommodate a wide variety of ammonia vessels and a fleet of four ammonia vessels, Nutrien is positioned to export low carbon blue ammonia today.

of ammonia – conventional grey ammonia and low carbon blue ammonia. The grey ammonia is primarily upgraded into urea that is directed towards the agricultural market. The low carbon blue ammonia can be directed for use in agriculture, industry or as a fuel or hydrogen carrier.



Reforming with carbon capture and sequestration - cost effective low carbon ammonia

To meet the surge in global demand for low carbon ammonia, Auto-Thermal Reforming (ATR) or Steam Methane Reforming (SMR) combined with CCS can be deployed at scale. ATR is similar to a conventional SMR plant, with a few key distinctions. The steam methane reforming and partial oxidation are combined into a single reactor by utilizing pure oxygen. This minimizes the requirement for fired heating, which represents approximately one-third of the GHG emissions in a conventional SMR plant. This technology is proven, scalable and low risk – it has been used for years to produce methanol and can be adapted for ammonia production.

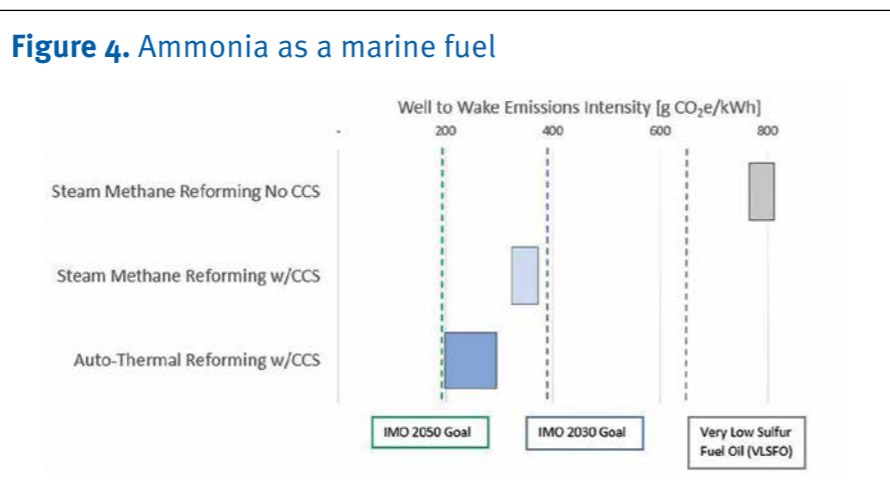
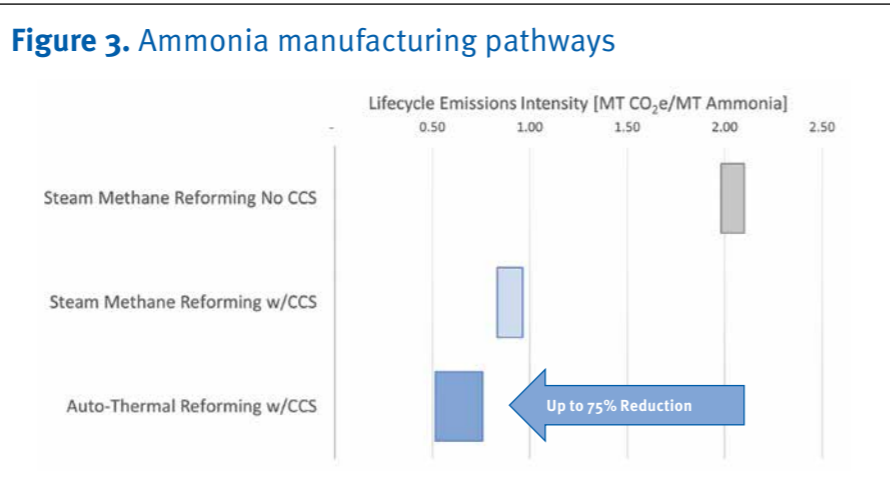
When compared to green ammonia pathways at their current state of technical maturity, the construction of a world-scale low carbon blue ammonia plant will have significantly less risk, require less capital and have lower operating costs.

Low carbon blue ammonia will enable rapid, significant and meaningful emissions reductions in any application, whether it be agriculture, industrial or in the emerging fuel market. When lifecycle emissions are accounted for, ATR can result in an emissions reduction of almost 75% below conventional ammonia production.

Low carbon blue ammonia as a marine fuel

Ammonia is emerging as a fuel of choice for the marine industry to transition away from Very Low Sulphur Fuel Oil (VLSFO). Blue ammonia produced on the Gulf Coast with ATR can approach the International Marine Organization's (IMO) 2050 goal of achieving a 70% emissions intensity reduction.

Blue ammonia production from the Gulf Coast will be amongst the lowest cost sources in the world. The region has access to abundant and low-cost natural gas, a skilled workforce



and world-class carbon capture and sequestration infrastructure. Development of production at scale utilizing dedicated geological sequestration is de-risked through the support from the 45Q tax credit. The blue ammonia produced will drive significant and meaningful emissions reductions at a competitive cost for use in agriculture, industry or emerging fuel markets. Development can begin now

– with low carbon blue ammonia playing a critical role in the advancement of a global ammonia supply chain.

Nutrien will continue to assess the scope and investments required for transformational low-carbon ammonia production pathways, including exploring technology partnerships, investing in internal research and pursuing scalable pilot projects to enable commercial-scale production in the future. ■

About Nutrien

Nutrien is the world's largest provider of crop inputs and services, playing a critical role in helping growers increase food production in a sustainable manner. We produce and distribute 25 mn t of potash, nitrogen and phosphate products world-wide. With this capability and our leading agriculture retail network, we are well positioned to supply the needs of our customers. We operate with a long-term view and are committed to working with our stakeholders as we address our economic, environmental, and social priorities. The scale and diversity of our integrated portfolio provides a stable earnings base, multiple avenues for growth and the opportunity to return capital to shareholders.