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Barbra Korol, Executive Director
Natural Gas Strategy and Engagement
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Via e-mail: ENERGY.Hydrogen@gov.ab.ca

February 10, 2021

RE: Alberta's Hydrogen Roadmap

Dear Ms. Korol,

Fertilizer Canada appreciates your ongoing engagement and the opportunity to inform the Alberta Hydrogen Roadmap through our written response regarding the advancement of the Alberta hydrogen economy.

Fertilizer Canada represents manufacturers, wholesale and retail distributors of nitrogen, phosphate, potash and sulphur fertilizers – the backbone of Canada's agri-food economy. Fertilizer keeps soils productive by replenishing nutrients; accountable for roughly 50 per cent of food production and is essential in meeting the food, fuel and fibre needs of the growing world population.

Alberta is home to one of the largest concentrations of nitrogen production facilities in North America, consisting of seven facilities that produce ammonia and its primary upgrade products (urea and ammonium sulphate), and nitric acid and its primary upgrade product (ammonium nitrate). Nitrogen manufacturing is a significant contributor to Alberta's manufacturing and value-added economy. In Alberta, fertilizer manufacturing generates a direct economic benefit of $2.3 billion, adding $800 million to GDP as well as almost 3,000 jobs. Our nitrogen production facilities upgrade Canadian natural gas, the most efficient and lowest carbon dioxide (CO_2) emission feedstock and fuel source, into nitrogen fertilizers which help keep agricultural soils productive and contribute to the global food supply.

Canadian fertilizer manufacturers produce about 12 million tonnes of nitrogen, phosphate and sulphur fertilizers annually in some of the most technologically advanced, energy efficient and safest facilities in the world. The Canadian fertilizer industry is well positioned to significantly contribute to the Alberta hydrogen economy with nitrogen fertilizer production being identified as an established hydrogen production supply chain[1].

[1] Hydrogen Strategy for Canada.

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An Overview of Nitrogen Production

Nitrogen Fertilizer Manufacturing Process

Nitrogen is an essential nutrient required for plant growth however, until the discovery of the Haber-Bosch process in the early 1900s, nitrogen could not be chemically produced, jeopardizing global food security for a growing population. Large scale production of ammonia and ammonia-based products via the Haber-Bosch process continues to significantly contribute to crop production and is necessary to feed our population today. To date, there is no comparable process to produce nitrogen-based fertilizers at this scale.

The Haber-Bosch process combines hydrogen with nitrogen in the air to produce ammonia. Hydrogen production is therefore the first step in this manufacturing process. Alberta's nitrogen production facilities rely on natural gas as a feedstock which, through steam-methane reforming, produces hydrogen, carbon monoxide and small amount of CO_2. The hydrogen produced is then reacted with atmospheric nitrogen in the presence of a catalyst to produce ammonia.

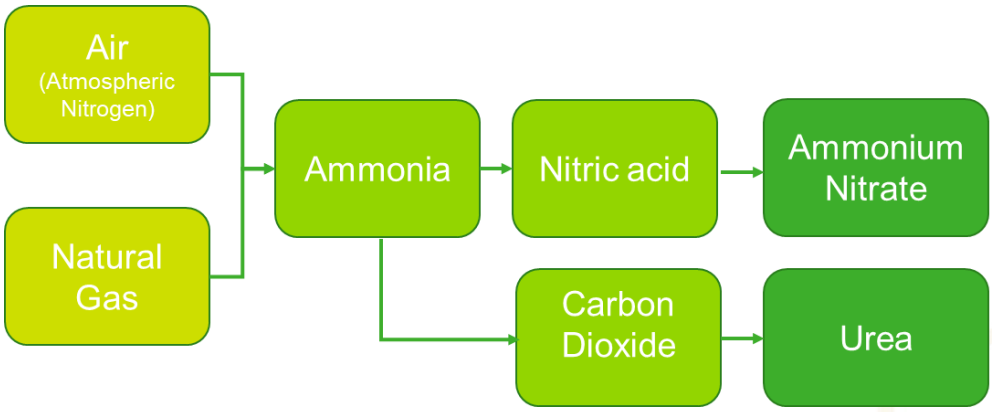

Figure 1: General outline of the nitrogen manufacturing process.

Combustion versus Process Emissions

Natural gas is essential to the fertilizer sector – both as a fuel for heat production and as a feedstock. It is the primary input in nitrogen production with 70 to 90 per cent of a facility's input costs typically attributed to natural gas due to its role as a feedstock in ammonia production. It is also used as a fuel to provide the heat required in nitrogen and potash production.

Natural gas is delivered to nitrogen production facilities through a pipeline where it is used to heat the steam methane reformer and to provide the required methane for this reaction. The steam-methane reforming process is endothermic meaning it requires heat to produce

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the necessary pressure that can react methane with steam to produce the hydrogen required for the Haber-Bosch process. Natural gas is primarily composed of methane which provides the necessary reactant for this process – making natural gas both a feedstock and a fuel for ammonia production.

Ammonia is a nitrogen fertilizer product in its own right; however, it can also be converted to urea by reacting it with the CO_2 emissions produced during the steam methane reforming process. Displayed in the following reactions, you can see that for every molecule of hydrogen produced there is an equal amount of CO2 produced which is referred to as process emissions. Therefore, a significant portion of process CO_2 emissions are fixed by chemistry and cannot be reduced by the nature of steam methane reforming process. A substantial amount of these process CO_2 emissions are captured and used by Alberta producers in the associated production of a solid urea fertilizer product.

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

$$CO + H_2O \rightarrow CO_2 + H_2$$

Figure 2: Steam-methane reforming and water-gas shift reaction.

The Hydrogen Strategy for Canada states that Canada is one of the top ten global producers of hydrogen via steam-methane reformation of natural gas and is well positioned to transfer to clean pathways going forward. It is important to understand the different opportunities for emission reductions at a nitrogen production facility.

Nitrogen manufacturers have eliminated the “low hanging fruit” for further emissions reductions; a position not universally held by other manufacturing industries. The sector implements the best technology and practices available, and current production systems based on Haber-Bosch and Ostwald have been used for decades as the most efficient method to produce ammonia and nitric acid, respectively.

It is true that the fertilizer industry already captures a significant amount of process emissions through the production of urea, however, science limits the ability of the industry to make further reductions in greenhouse gas emission levels. A study sponsored by Natural Resources Canada concludes that the theoretical maximum reduction potential on combustion gas is minimal[2].

[2] Canadian Ammonia Producers Benchmarking Energy Efficiency and Carbon Dioxide Emissions

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Ammonia: An Opportunity for Alberta's Hydrogen Economy

Hydrogen Storage and Transport

Hydrogen has a large potential in Canada and around the world – as a fuel, for heat and as a feedstock for industrial processes. However, due to its chemical composition, hydrogen is very difficult to store and transport safely. Not only is hydrogen a combustible gas that requires high pressure tanks, but it also has a very low boiling point as a liquid which requires it be stored and transported at cryogenic temperatures.

Ammonia is made of a single nitrogen atom and three hydrogen atoms and with a higher boiling point can be stored and transported as a warm liquid. As a readily used fertilizer, ammonia is already safely stored and transported in large volumes via pipelines, railways, trucks, and ports in Canada, and globally. Canada's industry sets exceptionally high standards for product handling and stewardship, through world-class codes of practice, advanced tank car design and robust regulation. The Canadian fertilizer industry offers a unique opportunity to safely produce, store and transport hydrogen as ammonia through existing production and transportation infrastructure.

A required increase in transportation infrastructure presents social and economic challenges for the efficient transportation of hydrogen. For example, railway transport introduces costly tariff agreements or constructing a pipeline to Pacific ports through British Columbia could be challenged by social or political concerns. These challenges will need to be addressed proactively if Alberta hopes to export hydrogen as a global commodity. With its track record of safe and efficient transport of ammonia across Canada and globally, the Canadian fertilizer industry should be consulted to leverage existing infrastructure and knowledge.

Ammonia as a Fuel Source

After storage and transportation of ammonia, hydrogen can be separated from the nitrogen atom and used as fuel or feedstock. Additionally, ammonia can also be used as a carbon-free fuel without the need to extract hydrogen from the molecule. Since ammonia carries three hydrogen atoms for every nitrogen atom, it has a very high hydrogen density which allows it to be used as a fuel through combustion or with solid oxide fuel cells[3]. An international export market for ammonia as a fuel is being supported by global investments. Japan is currently investigating ammonia as a fuel for power generation[4] and by the International Marine Organization is looking to hydrogen and ammonia as low-carbon, alternative fuel sources[5].

[3] Science and technology of ammonia combustion
[4] Japan Ministry of Economy, Trade and Industry, International Resource Strategy
[5] Argus Media. Ammonia to lead shipping in decarbonization.

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Market Demand for Low-Carbon Fuel

As the world seeks to mitigate climate change and meet its net zero targets, the global demand for low-carbon fuels will continue to grow significantly. The Canadian fertilizer industry is uniquely positioned to meet this demand through experienced production of hydrogen and ammonia but requires significant investment opportunities to modify equipment and chemical processes.

Through the Haber-Bosch process outlined above, grey hydrogen is produced when manufacturing ammonia and other ammonia-based products. Most nitrogen production facilities in North America produce grey hydrogen, with a few producing blue hydrogen through implementation of CCS technologies. Green hydrogen, or carbon-free hydrogen, can be produced through electrolysis of water, but implementation of this technology has not yet been seen in Canada due to its technical and economic challenges.

The transition from grey to blue or green hydrogen will require investments, infrastructure adjustments, and access to alternative energy sources. Alberta's nitrogen manufacturers already safely produce, store and transport hydrogen as ammonia. It is recommended that the Alberta Hydrogen Roadmap create opportunities for existing hydrogen producers to achieve reductions in carbon intensity and work with Alberta's existing ammonia production facilities to realize the potential of a low-carbon fuel economy.

Recommendations

Maintain Industry Competitiveness

Increasing hydrogen production rates or implementing innovative, clean technologies to produce green hydrogen on a commercial scale will require significant investments in time and capital which can be supported by incentives that protect our industry in a competitive global market.

Nitrogen manufacturing is also one of Alberta's most energy-intensive, trade-exposed (EITE) industries. The nitrogen industry operates in an extremely competitive environment, exporting approximately 40% of its product but accounting for only 1% of global supply. As a mature EITE industry, any increase in the cost of production will be absorbed by our members – not passed on to our customers – and will impact the industry's viability and investment in Alberta.

Fertilizer Canada and our member companies appreciate and support the treatment of industrial process emissions under the Technology, Innovation and Emissions Reduction

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(TIER) Regulations which recognizes the challenges associated with emissions tied to our chemical reaction processes and protects our EITE status.

It is essential that the vulnerability of the nitrogen sector's global and domestic competitiveness continue to be recognized through the TIER system and measures be put in place to ensure that Alberta's industry remains competitive and able to support farmers in Alberta, Canada and around the globe.

The protection of our EITE status and global competitiveness has never been more important. Global demand for low-carbon fuels will present opportunities for the Canadian fertilizer sector but investments and protective measures are required to ensure our industry can recognize these opportunities while remaining globally competitive.

Recognize Technical Challenges & Safety Concerns

Hydrogen Blending in Natural Gas

Fertilizer production is a highly sensitive manufacturing process requiring high quality fuel of continuous and predictable composition and heating value. Altered fuels do not always have the same energy content as traditional fuels and have the potential to introduce contaminants into the manufacturing process or negatively impact current and legacy equipment.

Blending hydrogen in natural gas has been proposed as a mechanism to lower the carbon intensity of the fuel source. Changes to the composition of fuels may have direct impacts on the manufacturing process itself by impacting chemical process performance, combustion characteristics potentially impacting equipment capacity (e.g. dryers, furnaces, boilers, etc.) or other unintended consequences (e.g. underground mine air quality). Real logistical challenges still exist as sites typically receive all natural gas from Canadian producers through the same pipeline, regardless of whether it is destined to be feedstock or combustion fuel. Altered process fuels have the potential to introduce contaminants into the manufacturing process whose impacts could include poisoned catalysts, reduced efficiency, increased greenhouse gases (GHGs) or process failure. Fuel composition changes have the potential to shorten the expected lifetime of industrial equipment – which for example can be ten years or more for a catalyst or 50 years or more for a boiler with good operating and maintenance practices. This would result in additional costs borne by Canadian industry and not by global competitors. Additionally, given seasonal condition at our manufacturing facilities, there is concern that a varied fuel composition could be problematic in low temperatures.

Renewable natural gas (RNG) has similar carbon content as traditional natural gas but is more expensive and a policy which may involve actions such as increasing RNG content will increase the cost of fuel – and by extension, the cost of production – for large natural

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gas consumers. As an EITE industry competing in a global market, the fertilizer sector is a price taker, and does not have the same ability to pass on costs to consumers as other industries may have. Consequently, these additional costs will be borne by the industry. Certain other costs for Alberta producers are high compared to competing jurisdictions; therefore, continued access to affordable natural gas feedstock is an essential component of Alberta's competitive advantage. Environment and Climate Change Canada has previously estimated that Canada has RNG potential of roughly 1,100 to 2,420 million metric tonnes per year from agricultural, landfill and municipal solid waste sources. However, it is not clear what RNG capacity exists in Canada today. Even with widespread uptake of the practices required to realize these estimated capacities, major new infrastructure would need to be approved and constructed for distribution.

Emissions impacting air quality are also regulated – such as occupational health and safety requirements for underground mines and federal/provincial regulatory standards for air pollution (e.g. NOx). It is currently unknown how modified fuels will impact other regulated emissions and there is concern that changes to natural gas fuel compositions will unintentionally cause violations under other regulatory obligations.

Reliable Clean Electricity for Green Hydrogen

Carbon-free hydrogen or ammonia can be produced via electrolysis of water, however there is still a need for an alternative clean energy supply. Electrolysis of water requires electricity to split water into hydrogen and oxygen – in addition to the technical constraints and infrastructure investments required to implement electrolysis at an established manufacturing plant, there would still be a need for a cost-effective, reliable zero-emissions electricity source. Despite recent investments in the province, the availability of clean electricity in Alberta is relatively low when compared to provinces such as British Columbia, Manitoba, Ontario and some U.S. states. Furthermore, the cost is not comparable to natural gas for use on an industrial scale. In addition to clean electricity, electrolysis requires large quantities of water which would result in significantly increased water use and would require an increase in water intake limits for facility water licenses. The Alberta Hydrogen Roadmap should include a comprehensive strategy for increased water usage and universal access to abundant, low-cost, clean, and reliable electricity that can support emerging technologies.

<u>Outline Opportunities for Ammonia</u>

Fertilizer Canada and our member companies recommend that the role of ammonia in Alberta's hydrogen economy be explicitly outlined in the Alberta Hydrogen Roadmap. Ammonia has significant opportunities as a hydrogen storage and transport mechanism, and opportunities as a fuel itself which should be captured and highlighted in the roadmap. We ask that the government consult with our industry to determine the best way to represent these opportunities.

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Alignment of Canadian Hydrogen Strategies

With the development of a Federal Hydrogen Strategy for Canada, we ask that the Alberta Government work closely with the Government of Canada to ensure a cohesive hydrogen framework for all Canadians that will encourage investment and implementation of new technologies in Alberta.

Develop Opportunities for Growth and Investment

Government policies, programs and incentives are required to secure the investments necessary for commercial scale adoption of green technologies such as CCS or electrolysis. Although there are significant opportunities for low-carbon hydrogen production; unparalleled production costs, a lack of cost-effective electricity and newly formed markets create investment uncertainties. Government can encourage early adoption of these technologies with incentives or construct programs that expand the global hydrogen market. Fertilizer Canada asks that the Government of Alberta review incentive programs in other jurisdictions, such as the 45Q tax credit in the United States and consider other programs beyond tax incentives to promote investments in new technologies and the global hydrogen market.

On behalf of our member companies, Fertilizer Canada would like to thank the Government of Alberta again for your proactive engagement of industry and the opportunity to comment on the Alberta Hydrogen Roadmap. We stand ready to work with you as the development of the roadmap continues and welcome any questions with respect to this submission.

Sincerely,

McKenzie Smith
Director, Stewardship & Regulatory Affairs

CC:

The Honourable Seamus O'Regan, Minister of Natural Resources
The Honourable Jason Nixon, Minister of Environment and Parks
The Honourable Devin Dreeshen, Minister of Agriculture and Forestry
The Honourable Sonya Savage, Minister of Energy
The Honourable Dale Nally, Associate Minister of Natural Gas and Electricity
Christyne Tremblay, Deputy Minister of Natural Resources Canada
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