Fertilizer Canada's Technology Roadmap Brief

2023

FERTILIZER CANADA

Technology Roadmap Study Report: GHG Emission Reductions in the Fertilizer Production Sector Brief

Summary

WSP developed a technology roadmap for decarbonizing the Canadian fertilizer production and manufacturing sector at the request of Fertilizer Canada in partnership with Natural Resources Canada. The report looks at five promising technologies that would make meaningful reductions in greenhouse gas (GHG) emissions from ammonia and potash production, the timelines, costs, and feasibility of these technologies, and how the fertilizer industry can work in collaboration with government to inform policies and incentives that support the sector and Canada's emission reduction goals.

Fertilizer's Impact

Fertilizer is vital to food security as it increases crop yields, prevents soil depletion, and improves the nutritional values of crops. Canada is the third largest fertilizer producing country, supplying North American and international markets with these vital inputs while contributing $23 billion to the Canadian economy annually.

Key Findings

- Canada produces some of the world's most sustainable fertilizer, Canadian potash is produced with approximately 50 per cent lower GHG emissions intensity and Canadian ammonia is produced with at least 30 per cent lower net GHG emissions intensity compared to global competitors. Industry and government must work together to develop and strengthen policies and regulations that incentivize investment and safeguard against carbon leakage that could increase global GHG emissions by protecting sustainably produced Canadian fertilizer.
- There is no easy solution to decarbonizing the fertilizer production and manufacturing sector. Canada's fertilizer manufacturers and producers have been investing in decarbonization technologies for decades and continue to, but adoption of technologies with 50 per cent reduction of GHG emissions or greater will require at least five to ten years to implement and costs range from millions to upwards of $1 billion per facility.
- The ammonia fertilizer production facilities produce various types and quantities of fertilizer products from ammonia and operate in four provinces. Therefore, there is no typical facility. Accordingly, there is no common decarbonization solution for all facilities.
- Small Modular Reactors have the greatest potential for GHG emission reductions for the potash sector, but it is not yet commercially available and requires a significant investment to be developed at the scale needed. There are also significant social concerns surrounding this technology being applied outside of a provincially mandated power producer.
- A combination of electrolysis to produce hydrogen and CCUS used with steam methane reformers have the greatest potential for GHG emission reductions for ammonia production.
- The ability for the fertilizer production and manufacturing sector to decarbonize relies heavily on investments in infrastructure outside our fence-line including access to a clean (low intensity) reliable, and affordable electricity grid and CO2 pipelines.
- Canada's fertilizer production is an energy intensive and trade exposed industry that must balance reducing emissions with remaining competitive in a global marketplace with countries that don't face the same environmental regulations.

Fertilizer Production

POTASH

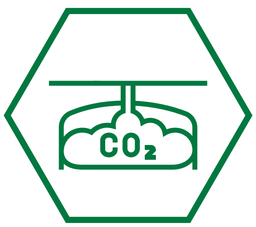
Potash is a mined mineral used for potassium (K) fertilizer. In Canada there are two ways to mine it, through a conventional mine or a solution mine. In a conventional mine potash is extracted from underground deposits through conventional mining equipment and brought to the surface for additional processing. In a solution mine a brine solution is heated and injected into the deposit. The brine dissolves the potash, and the solution is returned to the surface for further processing.

Solution mining is energy-intensive, and the extraction process represents 24 per cent of potash production emissions. Extraction of potash through traditional mining represents 15 per cent of potash production emissions.

AMMONIA

Ammonia production is an energy intensive process that takes nitrogen from the air and combines it with hydrogen to create ammonia. Hydrogen used in the process is usually created through steam methane reforming, which uses natural gas as a feedstock. Of the nine facilities in Canada only one does not use steam methane reforming and instead receives hydrogen and nitrogen from nearby petrochemical facilities.

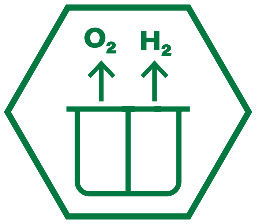
On average, 64 per cent of direct and indirect GHG emissions from ammonia production comes from process emissions, as a byproduct of the steam methane reform process. 61 per cent of these emissions were captured for other beneficial processes, such as urea production.

Carbon Capture Utilization and Storage		
	Emission Reduction Potential	**High (>50 per cent reduction in production emissions)**
	Timeline	**5–10 years**
	**Cost**	**High Capital Costs (>$50 million)/Medium Operating Costs (increase above status quo)**
	Technology Applicable To	**Nitrogen and Potash**
	Technology Readiness	**Commercially available**

Carbon Capture Utilization and Storage (CCUS) involves the process of capturing CO_2 emissions and either storing it, usually underground, or using it to make new products. In fertilizer production there are two sources of CO_2: process emissions from reactions in the nitrogen fertilizer manufacturing process and combustion emissions from the combustion of fuel for energy. This technology can be used for both ammonia and potash production.

Urea and UAN are two of the most globally traded fertilizers. In ammonia production, process emissions are captured and utilized downstream as a feedstock to produce urea. In fact, 61 per cent of nitrogen fertilizer process emissions are already repurposed for use in urea fertilizer production, and therefore are not available for CCUS. The GHG reduction potential for this technology is high, but so are costs for implementation, particularly for capturing combustion emissions which are more challenging to capture than process emissions, investment infrastructure, such as pipelines, and operating costs. CCUS is not in use in Canadian fertilizer facilities for capturing combustion emissions.

Hydrogen Production through Electrolysis

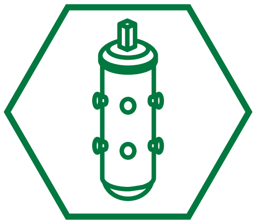


Emission Reduction Potential	**Medium to High (10-50+ per cent reduction in production emissions)**
Timeline	**5–10+ years**
Cost	**High Capital Costs (>$50 million)/High Operating Costs (significant increase over status quo)**
Technology Applicable To	**Nitrogen**
Technology Readiness	**Feasibility**

Electrolysis is the process of splitting water into oxygen and hydrogen, using electricity and water to generate hydrogen, rather than natural gas. This can replace steam methane reforming of a natural gas feedstock for the production of ammonia.

It has high potential for GHG reductions in ammonia production but is dependent on the carbon intensity of the electricity grid, requiring a reliable electricity supply at a low intensity and low price, as well as access to water. The technology is only available on a small scale and is not commercially operational at a scale to support fertilizer production. Costs are also high as an electrolyzer has a high capital cost and operating costs are also significant due to electricity consumption.

Small Modular Reactors



Emission Reduction Potential	**Medium (10–50 per cent reduction in production emissions)**
Timeline	**5–10 years**
Cost	**High Capital Costs (>$50 million)/Low to Medium Operating Costs (similar to status quo to increase above status quo)**
Technology Applicable To:	**Nitrogen and Potash**
Technology Readiness:	**Demonstration projects**

Small Modular Reactors are nuclear fission reactors that are smaller than traditional nuclear power plants and offer potential benefits for sites that are located off-grid or in regions that are supplied by high carbon intensity electricity.

As a replacement electricity source, this is applicable to all fertilizer manufacturing. GHG reduction potential will depend on the emissions intensity of the power grid in the province and could also use the waste heat from the process such as solution mining. While SMRs have no direct emissions, fuels for operation do need to be mined. Capital costs are high, but operating costs are considered low, depending on the cost of electricity it is replacing. There are also concerns among the public about safety aspects and the regulatory licensing process federally and provincially. The technology is at the demonstration project phase and not commercially available.

Cogeneration		
	Emission Reduction Potential	**Low to Medium (up to 50 per cent reduction in production emissions)**
	Timeline	**1-–5 years**
	Cost	**Medium to High Capital Costs (>$50 million)/Low to Medium Operating Costs (similar to status quo to increase above status quo)**
	Technology Applicable To	**Nitrogen and Potash**
	Technology Readiness	**Commercially available**

Cogeneration is the process of generating electricity and useful heat simultaneously using one process. Applicable to all facilities and widely available, this is considered a transitional technology that needs to be paired with CCUS of combustion emissions in the long term to maximize carbon reductions. Capital costs range from medium to high while operating costs are on the lower end. This is the only technology that has a short-term implementation timeline. Regulatory barriers exist in some provinces concerning who can buy or sell power, such as in Saskatchewan.

Electrification of Mine Fleets Converts Diesel		
	Emission Reduction Potential	**Low (>10 per cent reduction in production emissions)**
	Timeline	**5–10 years**
	Cost	**Low Capital Costs/Low to Medium Operating Costs**
	Technology Applicable To	**Potash (conventional mines)**
	Technology Readiness	**Early stage of commercially available**

Converting diesel vehicles and machinery used in potash mining to an electric battery-powered fleet. This technology is primarily applicable to conventional potash mines and timelines depend on availability of electric options for equipment. GHG reduction potential is low because mine fleet emissions are a relatively small portion of overall sector emissions. The reduction potential is dependent on the carbon intensity of the electricity grid replacing diesel.

Government Recommendations

- Provide federal and provincial regulatory certainty and long-term commitments that promote investments in decarbonization technology, along with targeted programs and investment tax credits that reflect the cost for these technologies. As well as look to other jurisdictions when developing policies and funding mechanisms to emulate their success, ensure Canada is competitive, and protect domestic fertilizer production.
- All levels of government work in collaboration with industry to ensure policies reflect realistic timelines for the wide commercial adoption of decarbonization technologies and adjust funding programs to support technology at early stages of development such as feasibility and engineering level studies. As well as clarify and simplify regulatory approvals to expedite technology readiness.
- Work with industry and stakeholders to build out infrastructure our industry depends on beyond our fence-line to make reductions in GHG emissions, such as CO2 pipelines and a reliable, affordable, clean electricity grid.

Methodology

Information and data were collected from Canadian fertilizer manufacturers and from publicly available data. WSP completed the analysis, along with information from the Sustainable Hydrogen and Ammonia Forum that was a discussion among industry and government.

This report was commissioned on behalf of Fertilizer Canada with funding support from Natural Resources Canada.

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