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**RE: CF Industries' Comments in Response to the Ministry of Environment, Conservation and Parks' Ontario Low-Carbon Hydrogen Strategy Discussion Paper**

CF Industries Holdings, Inc. ("CF Industries" or "CF"), as the parent company of Terra International (Canada) Inc., welcomes the opportunity to provide input on the Ontario Low-Carbon Hydrogen Strategy Discussion Paper (Discussion Paper). As Ontario's Discussion Paper outlines, hydrogen has emerged as a leading clean energy source that can enable Ontario (as well as Canada and other countries) to reduce dependence on carbon-based fuels and, thereby, reduce greenhouse gas emissions and help achieve climate goals.

As the world's largest ammonia manufacturer, CF is a major producer of hydrogen as part of the ammonia manufacturing process, producing approximately 1.6 billion kilograms of hydrogen annually. CF has committed to decarbonize our manufacturing network by 2050 through investments in clean energy technologies that support the hydrogen economy and we support Ontario's efforts to accelerate clean hydrogen development. In this context, we offer the following feedback on Ontario's proposed hydrogen strategy.

**About CF Industries**

CF Industries is a leading global manufacturer of hydrogen and nitrogen products for clean energy, emissions abatement, fertilizer, and other industrial applications and is the world's largest producer of ammonia. Headquartered in Deerfield, Illinois, CF's world-class nitrogen manufacturing complexes are located in in Ontario, Alberta, the United States and United Kingdom. CF also operates an extensive network of fertilizer distribution facilities in Alberta, Saskatchewan, Manitoba and the major grain-producing regions of the American Midwest. CF's existing nitrogen fertilizer products are essential inputs into Canadian and global food production. These products increase crop yields while reducing the amount of land needed to feed the world and preventing the destruction of carbon-sequestering forests.

<u>Ontario Presence</u>

For more than 50 years, CF's Courtright Nitrogen Complex ("Courtright") near Sarnia has been an essential part of Ontario's agricultural supply chain and an important contributor to the provincial economy. Courtright is Ontario's only nitrogen fertilizer manufacturing facility,

producing nitrogen-based products such as ammonia, urea ammonium nitrate (UAN), and diesel exhaust fluid (DEF) for agricultural, industrial, and environmental applications.

CF's Clean Energy Commitment

CF recognizes and accepts the challenge of acting to address climate change. In October 2020, CF committed to reducing $CO_2$-equivalent emissions by 25% per ton by 2030 and achieving net zero carbon emissions by 2050.[1] CF also announced the first green ammonia project for the company at its Donaldsonville Nitrogen Complex in Louisiana, and has set in place a structure to develop other zero- and low-carbon projects, including carbon capture and sequestration and other carbon abatement projects throughout its global network.[2] These are critical parts of CF's broader environmental, social and governance (ESG) goals[3] and areas where we see enormous growth opportunities, partnerships and expansion across our network.

**The Role of Ammonia in a Clean Hydrogen Economy**

The benefits of green and blue hydrogen as a clean energy source are becoming widely recognized. Less well understood is the significant role that low-carbon ammonia can play in the global hydrogen economy. As explained below, CF believes zero and low-carbon ammonia can help accelerate the move to green and blue hydrogen as an energy source in a scalable way.

Background on Ammonia Production and Distribution

Ammonia and ammonia-based products have been used as fertilizers for more than a century and remain vital to achieve global food security. Indeed, the invention of the Haber-Bosch process to mass produce ammonia has played a critical role in improving crop yields and feeding the world's growing population.

Most North American ammonia manufacturing begins with the production of hydrogen from natural gas using a steam-methane reforming process. The hydrogen is then combined with atmospheric nitrogen and converted to ammonia through the century-old Haber-Bosch process. Conventional ammonia produced in this manner generates greenhouse gases.[4] However, with the right cost and regulatory conditions, ammonia production, like hydrogen, can be decarbonized. The two forms of low-carbon ammonia are:

- *Green or carbon-free ammonia* – produced through the electrolysis of water to produce carbon-free hydrogen and synthesis to ammonia.

[1] CF Industries Announces Commitment to Clean Energy Economy (Oct. 29, 2020), accessed at https://cfindustries.q4ir.com/news-market-information/press-releases/news-details/2020/CF-Industries-Announces-Commitment-to-Clean-Energy-Economy/default.aspx.
[2] CF Industries' Commitment to a Clean Energy Economy (Oct. 2020), accessed at https://www.cfindustries.com/globalassets/cf-industries/media/documents/cf-commitment-to-a-clean-energy-economy.pdf.
[3] CF's ESG Goals, accessed at https://www.cfindustries.com/globalassets/cf-industries/media/documents/cf-esg-goals2.pdf.
[4] Note that in other parts of the world, notably China, ammonia is produced through coal gasification, which results in much higher greenhouse gas emissions.

- *Low-carbon (or "blue") ammonia* – produced through conventional processes but with $CO_2$ removed through carbon capture and sequestration (CCS) or other abatement measures.

Ammonia's Role as a Hydrogen Transport and Storage Medium

Ammonia is among the most efficient transport and storage mechanisms for hydrogen energy and, with its existing built-in infrastructure, can help meet the current challenges and accelerate Ontario's transition to the use of hydrogen energy.

Hydrogen is difficult to store and transport given its combustible nature and extremely low boiling temperature (-253ºC). In contrast, ammonia has a much higher boiling point (-33ºC) and can be stored and transported as a warm liquid at moderate pressures. Moreover, ammonia's energy density is 1.5x that of liquid hydrogen, 3x that of gaseous hydrogen and 14x that of lithium ion batteries. All of these characteristics provide for more economic transport and storage of energy.

Ammonia is comprised of three parts hydrogen and one-part nitrogen. By converting hydrogen and nitrogen into ammonia, hydrogen can be safely transported and stored through existing ammonia transportation infrastructure. The hydrogen can then then be disassociated from the ammonia for its end use through a mature technology.

The infrastructure for ammonia storage, distribution and export is already highly developed with more than 180 million tons of ammonia being produced globally each year. That infrastructure includes pipelines, railways, ports and distribution facilities across Canada, North America and the globe. Given that substantial infrastructure, using ammonia as a hydrogen transport and storage mechanism provides a ready means to accelerate Ontario's move to the use of hydrogen in a scalable way.

Ammonia's Role as a Fuel

In addition to its promising role as a hydrogen transportation and storage medium, ammonia is also a fuel in its own right. It can be used directly for power generation in ammonia-fired turbines, engines, marine vessels and mixed with coal in power plants. Japan is currently looking at ammonia as a fuel in power generation, industrial furnaces and maritime applications.[5] As well, the International Marine Organization has identified ammonia and hydrogen as fuels for a decarbonized shipping industry.[6]

Ammonia and Hydrogen Demand Growth

The global market for green and low-carbon hydrogen and ammonia is in its infancy. CF sees significant growth and opportunity as more countries and industries seek low-carbon technologies to help achieve climate goals. Industry experts project hydrogen will meet

[5] Japan Ministry of Economy, Trade and Industry, International Resource Strategy (March 2020), accessed at ttps://www.meti.go.jp/english/press/2020/0330_005.html#:~:text=The%20Ministry%20of%20Economy%2C%20Trade%20and%20Industry%20%28METI%29,environments%20surrounding%20Japan%E2%80%99s%20policies%20for%20resources%20and%20fuels.

[6] Argus Media. Ammonia to lead shipping in decarbonization.

approximately 20% of the world's energy need by 2050, up from less than one percent today.[7] Moreover, Natural Resources Canada's recent Hydrogen Strategy for Canada identified nitrogen fertilizer production as an established hydrogen production supply chain that can be leveraged in the near term.[8]

CF anticipates that ammonia will help fulfill the need for safe and efficient transportation and storage of green and blue hydrogen, as the hydrogen economy develops around the world. In this context, Ontario's hydrogen strategy should leverage the province's existing ammonia manufacturing base, storage and distribution networks and global expertise in green and low-carbon ammonia production to take advantage of the opportunities ahead.

**Policy Challenges and Opportunities**

To fully realize the benefits of a clean hydrogen economy, Ontario's hydrogen strategy should address the following challenges and opportunities.

Challenges

***Electricity costs are a fundamental barrier to green ammonia and hydrogen production in Ontario.*** Green ammonia production depends on reliable access to large volumes of clean, low-cost electricity. While Ontario's electricity grid is very low in carbon, its cost is exceptionally high. CF's electricity costs at Courtright are approximately 40% higher than the CF facility with the next highest costs.

While recent changes to the Global Adjustment charge are welcome, Ontario's electricity rates currently remain too high to enable investment in green ammonia production. As the cost of renewable energy falls globally, Ontario must be able to realize these cost improvements to compete with other jurisdictions, both in Canada and internationally, that produce abundant, low-cost, low-carbon electricity.

***Early technology deployment requires enabling government policy and incentives to promote longer-term investments.*** The opportunities for green and low-carbon hydrogen and ammonia production are potentially transformational. Yet, the industry is in its infancy, investment and production costs remain high when compared to conventional hydrogen and ammonia production, and markets for decarbonized products have yet to fully develop. Enabling government programs are essential to accelerate the initial deployment of clean technologies such as green ammonia and hydrogen and the growth of demand for decarbonized products.

There are numerous areas where government policy can help accelerate this transition. To be most effective, any incentives in Ontario and Canada should be market based, globally competitive and recognize the long timeframes and high capital costs involved when investing in and deploying new technology at a commercial scale. For example, other jurisdictions, such as the United States, have well-established and useful programs, such as the 45-Q tax credit, to

[7] The Hydrogen Council. Hydrogen: Scaling Up, accessed at https://hydrogencouncil.com/en/study-hydrogen-scaling-up/

[8] Natural Resources Canada: Hydrogen Strategy for Canada: Seizing the Opportunity for Canada (December 2020).

encourage investment in low-carbon technologies such as CCS. The precise design of these programs will require significant public consultation, including with the private sector.

***Other jurisdictions have made an early start to attract investment.*** Jurisdictions such as Germany, Australia, the United Kingdom and other Canadian provinces are moving quickly to establish fiscal and regulatory frameworks to attract investment in the clean hydrogen economy. In Alberta, for instance, new government programs such as the Alberta Petrochemical Incentive Program (APIP) and the Technology Innovation and Emissions Reduction (TIER) fund were launched in 2020 to attract early investors in clean technology projects in the province's petrochemical sector and beyond.

Opportunities

***Low-carbon ammonia is a key enabler for clean hydrogen energy.*** As explained above, more than 180 million tons of ammonia are safely produced, transported and consumed globally each year through existing transportation and distribution infrastructure. Ammonia, therefore, stands as one of the most advantageous pathways to unlock the full potential of a global hydrogen economy.

**Blue hydrogen and ammonia could provide a more cost efficient means to begin development of a low carbon hydrogen economy.** Existing natural gas based hydrogen production facilities can be paired with CCS technology to create low-carbon hydrogen and ammonia at capital and operating costs much lower than for new green hydrogen capacity. These facilities supply existing product demand, some of which could be supplanted with alternative products as incremental demand for low-carbon hydrogen or ammonia develops, providing a scalable approach.

***The global market for green and low-carbon ammonia is expected to grow significantly in ways that Canada can access***, creating an opportunity for Ontario to participate as an exporter of clean energy. Natural Resources Canada has identified five key potential export markets for Canada: the United States (particularly California and the Eastern U.S.), Japan, South Korea, China, and the European Union.[9] While Ontario may choose to pursue domestic hydrogen use in power generation, heavy industry and transportation, the province should also examine the potentially significant opportunities to export green and low-carbon hydrogen and ammonia to these and other international markets as they start to develop. Moving forward, polices to support both domestic and export opportunities will help accelerate the commercialization of these clean energy products.

***The hydrogen and ammonia manufacturing asset base, infrastructure and skill set already exist in Ontario.*** CF produces approximately 450,000 gross tonnes of ammonia per year at Courtright and moves its products via an established North American transportation and distribution network. CF's planned green ammonia project in Louisiana will provide valuable expertise to facilitate the broader deployment of this technology as the company evaluates additional decarbonization projects across its entire network.

More broadly, Ontario's Sarnia-Lambton region is home to petrochemical companies with deep expertise in hydrogen production as well as access to the low-carbon electricity, water supply

[9] Natural Resources Canada: Hydrogen Strategy for Canada: Seizing the Opportunity for Canada. December, 2020.

and water treatment facilities required for green hydrogen and ammonia production. The Sarnia region also offers a skilled workforce, extensive transportation infrastructure and proximity to the U.S. market. With the right policy and regulatory conditions, the Sarnia region could emerge as a leading production hub in North America's clean hydrogen economy.

**Recommendations**

- Identify green and low-carbon ammonia production in Ontario's hydrogen strategy as an important enabler of Ontario's clean hydrogen economy given ammonia's transportation and storage potential and as a low-carbon fuel in its own right.
- Provide meaningful electricity cost rebates for producers of green hydrogen and green ammonia until such time that Ontario's electricity costs are competitive with other jurisdictions.
- Provide support for both blue and green hydrogen production as a means to establish a hydrogen economy.
- To avoid a patchwork of regulations, incentives and programs across Canada, work closely with the federal and other provincial governments to establish consistent, durable and globally competitive approaches to facilitate private sector investment in Ontario's hydrogen economy.
- Work with industry to develop sector-specific roadmaps to clearly identify the role key industries (*e.g.*, fertilizer manufacturing, refining, transportation) can play across the full hydrogen value chain, including the enabling factors required for each industry.
- Establish the Sarnia-Lambton region as a potential clean hydrogen/ammonia hub through targeted programs and infrastructure investment that support early deployment of these technologies.
- Support the recommended in-depth federal study of hydrogen export opportunities to further define Ontario's potential role as an exporter of hydrogen to emerging international markets.[10]

As a global company with a longstanding Ontario manufacturing and distribution footprint, CF supports market-oriented and durable policy development by governments to facilitate the transition to a clean energy economy. Once Ontario finalizes its hydrogen strategy, we encourage further engagement with industry and other stakeholders to begin to develop tangible actions and timelines. We look forward to continuing to work with the Ontario government on this opportunity.

Thank you for your consideration.

Sincerely,

Greg Kennette
General Manager

[10] Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen.

Courtright, Ontario

cc:
Hon. Jeff Yurek, Minister of Environment, Conservation and Parks (MECP)
Hon. Greg Rickford, Minister of Energy, Mines and Northern Development
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