Gap Assessment of Hydrogen Applications in High Emissions Components of Ontario Agriculture

Prepared For:
Innovation Farmers Association of Ontario

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1. INTRODUCTION

The two farm operations that are being considered in this study are grain drying and poultry barns in southwestern Ontario. The current state of high-emissions energy use in both operations are as follows. In poultry barns, natural gas or propane is used for space heating, while in grain drying operations, natural gas and propane are used as fuel to produce heat in the grain dryers. The future state of these two farm operations is focused on reducing GHG emissions and increasing overall efficiency to reduce fuel costs. As described in the Hydrogen Feasibility Study, hydrogen can help decarbonize both operations, however at this stage it is likely that converting to hydrogen powered equipment would increase both capital and operating (including fuel) costs for farmers.

A PESTLE (Political, Economic, Social, Technological, Legal, Environmental) gap analysis tool was used to determine the major gaps in decarbonizing the farming operations in this study.

Political	• Compared to other industries there are a lack of policies relating to decarbonization in agriculture and specifically a lack of decarbonization policies about fuel use in agriculture.
Economic	• Due to the nature of annual income and expenses in agriculture, decarbonization projects that require high levels of capital investment are challenging to implement. • Projects with higher operational costs than the current state are not likely to be implemented on small scale farms.
Social	• Acquainting and training experienced farmers with new pieces of equipment and new types of fuel is a challenge.
Technological	• There are no commercially available grain dryers or space heating systems that are designed to run on hydrogen or hydrogen derivatives.
Legal	• Due to varying industry specific and general hydrogen equipment regulations, the development and wide scale commercialization of hydrogen powered farming equipment will be slow-moving.
Environmental	• There are few decarbonization alternatives for these farming operations, and there is limited data available to farmers and organizations to make informed decisions on decarbonization technologies.

2. POLICIES AND PROGRAMS

Compared to other industries there are a lack of policies relating to decarbonization in agriculture and specifically a lack of decarbonization policies about fuel use in agriculture.

As agriculture is one of the industries the most negatively impacted by climate change, there are a limited number of policies driving change in the industry. Most decarbonization strategies in agriculture are being driven as direct mitigation to the effects of climate change itself such as soil and livestock management. Discussions around on-farm energy use have thus far mostly been around energy efficiency and conservation, as well as conversion to electricity and renewable energy where applicable. There are no policies today in Canada that will drive on-farm energy use in poultry barn heating and grain drying towards lower emission technologies. Although agriculture adds a much more complex lens to any policy development the following list of policies and programs have been successful in driving hydrogen adoption in other sectors:

- Low Carbon Fuel Credits – There are currently low carbon fuel credit programs successfully operating in BC, California, and Oregon. The Canadian federal Clean Fuel Regulation was finalized in July 2022, and will be implemented in 2023. The federal CFR program will allow primary fuel suppliers to purchase credits from low-carbon liquid and gaseous fuel providers. This program has the potential to lower the cost of low-carbon hydrogen supplied to consumers in Canada such as the farmers discussed in this report, depending on the market price of the credits.
- Zero-emission vehicle mandates- In the on-road transportation sector, ZEV mandates have been quite effective in BC and Quebec at incentivizing the development and commercialization of new ZEV technologies. Due to the size and impact of off-road vehicles it is not likely that there will be any ZEV mandates in agriculture, forestry, or mining any time soon however as vehicle manufacturers are converting manufacturing facilities to develop ZEV, the development of zero-emission off-road vehicles may accelerate.
- Equipment purchase and retrofit incentive programs – In California, and recently announced in the 2022 federal budget, purchase incentive programs for heavy-duty fleet vehicles have been successful in driving adoption in sectors where high capital costs are significant hurdles. It is recommended that farming associations should begin discussions with policy developers as purchase or retrofit incentive programs would be good tools to offset the high capital cost of low-carbon powered equipment.
- Renewable gas mandates – In BC, a target of 30% renewable natural gas by volume in 2030 for the grid, is driving adoption of hydrogen and other forms of renewable natural gas. Although it wouldn’t directly affect farmers operations, a higher content of renewable natural gas in the grid in Ontario would reduce GHG emissions from the farms that are connected to the natural gas grid.

3. FUNDING AND ECONOMIES OF SCALE

Due to the nature of annual income and expenses in agriculture, decarbonization projects that require high levels of capital investment are challenging to implement. Projects with higher operational costs than the current state are not likely to be implemented on small scale farms.

The largest barrier to adoption of hydrogen in agriculture is the economics. Commercializing hydrogen as a decarbonization fuel requires high levels of capital and operational expenditures across the entire value chain. Production of low-carbon hydrogen is expensive due to high electricity rates and large capital equipment that is not yet manufactured on a large scale. At a small scale the distribution of gaseous hydrogen is economical, however when large amounts need to be distributed to decarbonize transportation, producing and distributing liquid hydrogen or liquid ammonia minimizes transportation costs, but increases overall production costs. Hydrogen powered technologies, both fuel cell vehicles and combustion equipment are more expensive than existing fossil fuel powered technologies, and most alternative electricity powered equipment. This is largely due to the fact that most hydrogen powered equipment (with the exception of forklifts and buses) is not manufactured on a commercial scale today.

As governments across the globe are trying to meet their GHG emission reduction goals, they are investing heavily in scaling up hydrogen infrastructure. Reports by BloombergNEF, DNV, and IEA show the cost of hydrogen produced by different methods decreasing from now until 2050 (see figures 1 and 2 below).[1 2 3] Bloomberg projects the highest cost reductions, with renewable hydrogen in Canada decreasing from USD $2.25-4.25/kg-H2 in 2022 to ~USD $1.00/kg-H2 in 2050.

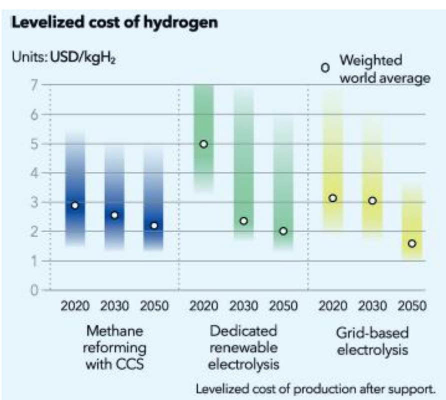

Figure 2: DNV projections for levelized cost of hydrogen globally (USD)

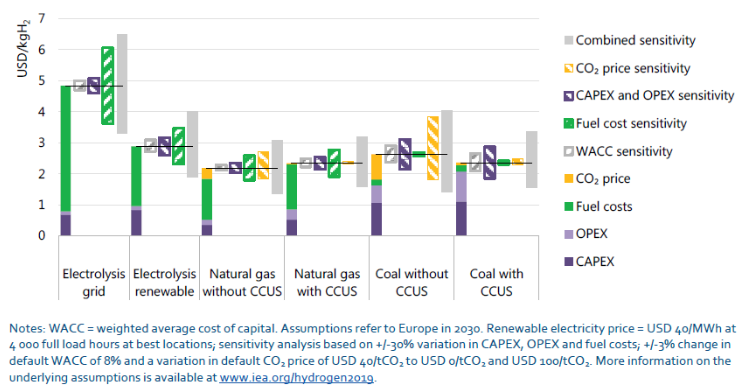

Figure 1: IEA projections for levelized cost of hydrogen in 2030 (USD)

To develop these economies of scale and accelerate cost reductions, significant amounts of government funding will be required across the hydrogen value chain. As described in the section above, various policies and programs could help drive adoption by producers and end-users alike. Additionally, large amounts of funding will need to be mobilized to minimize the economic barriers of this necessary decarbonization tool.

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[1] DNV, Hydrogen Forecast to 2050, https://www.dnv.com/focus-areas/hydrogen/forecast-to-2050.html
[2] BloombergNEF, 2022
[3] IEA The Future of Hydrogen Seizing Today's Opportunities, 2019

4. INDUSTRY EDUCATION/TRAINING

Acquainting and training experienced farmers with new pieces of equipment and new types of fuel is a challenge. Due to varying industry specific and general hydrogen equipment regulations, the development and wide scale commercialization of hydrogen powered farming equipment will be slow-moving.

The same farm equipment and fuels have been used across Ontario farms for decades. Introducing a new type of fuel with new safety considerations, handling, and operating skills is a challenge for a sector that is distributed across a large region. Although there are similarities between using hydrogen and other gases such as natural gas or propane, significant testing and training will be required before hydrogen can be utilized on farms in Canada. Converting low-carbon hydrogen to ammonia could help minimize some of these barriers to adoption. Ammonia has been used as a fertilizer in agriculture and as a fuel in the marine sector for many decades. There are existing safety restrictions and training that can be applied more quickly if ammonia is used as a combustion fuel in the agricultural industry.

Although industry education and training is not applicable today, due to the lack of available commercial technologies and fuel supply, it is considered in this gap assessment as education programs take time to develop and should be considered as part of an overall industry adoption strategy.

To minimize the challenge of educating and training a distributed industry with a new technology and fuel source, pilot projects are recommended. For example, the province of Ontario could sponsor a grain drying condo where farmers could bring their grain to test alternative technologies and be trained by experts. Ultimately some government funding will be needed to provide education to the agriculture sector. Beyond education and training for farmers, general community outreach and awareness initiatives are a recommended tool to introduce the idea of a new technology to the community, prior to testing or a demonstration project.

5. TECHNOLOGY DEVELOPMENT

There are no commercially available grain dryers or space heating systems that are designed to run on hydrogen or hydrogen derivatives today.

Hydrogen technology development in the agriculture sector is lagging behind other sectors such as transportation. Hydrogen technologies are being developed in sectors where there is a great potential to reduce GHG emissions, and where there is an encouraging business case, such as transportation. To accelerate the development of hydrogen technologies for high emission applications in Ontario agriculture, the sector must deploy pilot projects and invest in R&D.

Pilot projects and case studies from other areas will be necessary in providing data to understand the use case for hydrogen and its derivatives in certain applications such as grain drying and poultry barn heating. Technically hydrogen can be combusted for high heating applications, however the actual operating conditions and potential GHG emissions reductions need to be demonstrated before the technology is developed on a wider scale. It is recommended that industry organizations, government organizations and equipment manufacturers work together to develop and demonstrate hydrogen powered technologies across a range of high-emitting farming applications including but not limited to grain drying and poultry barn heating.

Although government funding and pilot projects are necessary to help kickstart the use of hydrogen in the agriculture sector, sustained investments in R&D are needed to reduce barriers to entry and discover efficient and cost-effective solutions. The past few years have seen significant investment in the hydrogen value chain in Canada and across the globe. With the release of the low-carbon hydrogen strategy in Ontario, the government has shown that it is committed to increasing investments, jobs, and expertise in the Ontario hydrogen sector. The agriculture sector in Ontario could build off this momentum by creating or leveraging existing industry innovation organizations to centralize programs for hydrogen R&D and increase collaboration.

6. ALTERNATIVE TECHNOLOGIES

There are few decarbonization alternatives for these farming operations, and there is limited data available to farmers and organizations to make informed decisions on decarbonization technologies.

Hydrogen ad its derivatives could become a useful decarbonization tool for high emissions applications in Ontario agriculture. However, there are alternative technologies that could also provide emissions reductions such as biomass, and electricity. To date there is not enough data or commercial experience with any of these three technologies to be able to determine which technology will provide the most emissions reductions at the lowest cost to farmers. Expensive pieces of equipment are not replaced very regularly in the agricultural sector, and with limited information on which equipment will have the lowest operating costs over the next 10-20 years, it is difficult for farmers to convert to lower-carbon alternatives. In discussions with an agriculture industry expert, they articulated that the sector is waiting to see which decarbonization pathway emerges as the lowest cost before investing heavily in equipment conversions for any one technology.

Due to the high capital costs of converting existing equipment to run on hydrogen or ammonia, high fuel costs and expensive storage equipment, converting grain dryers and poultry barn heaters to run on hydrogen or its derivatives is not expected to provide any cost savings in the near-term even with the increasing carbon tax. Nonetheless with the expected reductions in hydrogen production costs, economies of scale at grain drying co-ops, potential government funding opportunities, synergies with other high-emissions applications such as tractors, and expected technology developments, hydrogen could become a competitive fuel in the long-term. To determine how competitive hydrogen is today and in the long-term compared to alternative technologies such as biomass and electricity the following next steps are recommended as a result of this study:

- Compare the hydrogen feasibility study to a similar study on biomass and electricity for grain drying and poultry barn operations
- Assess the use of hydrogen and its derivatives throughout an entire farming operation and compare to biomass and electricity (infrastructure, operating costs, technology readiness of end-use technologies, etc..)
- Begin discussions with government officials to identify need for policies and funding programs and to determine level of support that may be available
- Deploy a pilot project that can compare the most competitive technologies in real world operating conditions
- Begin community outreach to raise awareness and identify stakeholder concerns