Harvesting opportunity: the intersection of clean energy & agriculture

Prepared by:
Nuclear Innovation Institute

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Prepared By:
Nuclear Innovation Institute
620 Tomlinson Drive
Port Elgin, ON
N0H 2C0

1.0 EXECUTIVE SUMMARY

The intersection of clean energy and agriculture presents a significant opportunity to reduce greenhouse gas (GHG) emissions while enhancing the economic resilience of the agricultural sector. As the demand for energy security and clean economic growth increases, integrating innovative energy solutions into farming operations can contribute to broader decarbonization efforts. This report explores the potential of clean energy adoption in agriculture, focusing on on-farm electrification, alternative fuel use and production, hydrogen use and production, and clean energy generation in the Bruce County region.

The role of agriculture in decarbonization

The agriculture sector in Canada has long been an active participant in creating "carbon sinks" (i.e. places where organic carbon is stored naturally). Indeed, the role of agricultural operations in sequestering carbon in soil – through croplands and grazing lands – has been a benefit to efforts to reach decarbonization goals. That said, other elements of on-farm activity come with carbon output. Agriculture accounts for approximately 10% of Canada's GHG emissions from crop and livestock production, excluding emissions from fossil fuel use and fertilizer production. Historically, fossil fuels have been central to agricultural operations, powering machinery, heating facilities, and fueling transportation. Transitioning to cleaner energy sources such as electrified equipment, lower-carbon fuels and clean energy systems offers a viable path to reducing these emissions. The adoption of such technologies is complex and depends on factors such as cost, technological availability, infrastructure requirements and regulatory frameworks. However, significant opportunities also exist for the agriculture sector to play a critical role as a generator of new sources of clean energy production—providing key inputs to clean energy systems designed to meet the demands of a growing clean economy.

Key findings

On-farm decarbonization opportunities

The shift toward electrified agricultural equipment is emerging but remains limited due to the availability of high-horsepower machinery and the need for supportive infrastructure. While compact electric tractors and utility vehicles are entering the market, large-scale operations still rely heavily on diesel-powered equipment with higher horsepower that electric options simply do not meet at present. The development of charging infrastructure and further technological advancements will be crucial for widespread electrification.

Where direct electrification is not feasible, the use of lower-carbon fuels—such as biodiesel, renewable diesel and hydrogen—presents a viable alternative. The adoption of these fuels in agriculture is growing, with many farmers already integrating lower-carbon fuels into their operations. However, cost competitiveness and production scale remain barriers, particularly for on-farm biodiesel production. The concept of cooperative biodiesel production among farm communities offers potential advantages but requires further exploration.

Clean energy generation on farms

Ontario farms are increasingly investing in clean energy, with solar panels being the most widely adopted technology. Statistics show that 17.5% of farms in Ontario are generating renewable energy, with a sample of Bruce County farmers demonstrating an even higher adoption rate. The integration of Distributed Energy Resources (DERs), where farms generate and store their own electricity while contributing to local energy networks, presents a transformative opportunity. However, ensuring that prime agricultural land is preserved while expanding renewable energy infrastructure is a key challenge.

Hydrogen and biomass as emerging opportunities

Hydrogen is gaining traction as a clean fuel, with the Bruce-Grey-Huron region identified by the Government of Canada as an emerging hydrogen hub. The agriculture sector could play a role in hydrogen production through processes like methane pyrolysis, which utilizes agricultural biomass as a feedstock. This process produces clean hydrogen and solid carbon without emitting CO_2, offering a low-emission energy source. However, awareness among farmers about methane pyrolysis and hydrogen applications remains low, highlighting the need for further education and industry engagement.

Beyond hydrogen, agricultural biomass presents opportunities for the production of Renewable Natural Gas (RNG) and syngas. Anaerobic digestion (AD) systems allow farms to convert organic waste into RNG, which can be used as a direct natural gas replacement. While AD technology is already in use in some farm-based and centralized facilities, economic and logistical barriers remain, including the need for large-scale investment and efficient waste management systems that can easily integrate into current operations.

Stakeholder perspectives and challenges

Engagement with farmers in Bruce County indicates a growing interest in clean energy adoption, but cost remains the primary consideration when evaluating new technologies and processes. While many farmers have integrated solar panels and lower-carbon fuels into their operations, none have explored hydrogen applications, highlighting the early-stage nature of this transition. Additionally, concerns about the ease of integrating new energy solutions into existing farm operations must be addressed to encourage widespread adoption.

Conclusion

The agricultural sector has the potential to become a leader in Canada's clean energy transition, contributing to both economic sustainability and environmental responsibility. The adoption of clean energy technologies—including electrification, biofuels, hydrogen and renewable energy generation—can significantly reduce on-farm emissions while providing new revenue opportunities for farmers. However, realizing this potential will require overcoming cost barriers, improving technology availability, and fostering greater awareness among stakeholders. With strategic investment, policy support, and industry collaboration, the agriculture sector can drive meaningful change in Canada's energy landscape.

Potential Areas of Focus

This report sets out the rationale to support the following potential areas of focus. These areas of focus target both the public and private sector and seek to put in place the enabling conditions for the agriculture sector in Bruce County to fully capitalize on the transition to a decarbonized economy.

Potential Area of Focus	Audience/Target
Expand Incentive Programs for On-Farm Electrification Develop and expand granting and rebate programs that offset capital costs of electricity generation assets and electrified equipment (e.g. electric tractors).	Government of Canada Government of Ontario Bruce County
Enable Localized Biofuel Co-Ops and On-Farm Production Models Facilitate regulatory clarity, technical support, and funding for farmers to establish cooperative biodiesel production and distribution networks. Leverage existing agricultural co-op models to support shared access.	Industry – agriculture sector in Bruce County Bruce County
Further Support for DER Integration for Farm Operations Streamline the connection of on-farm electricity production to the grid and promote the development of Distributed Energy Resource (DER) networks in agricultural regions. Include agriculture sector representation in policy development on DERs.	Government of Ontario Independent Electricity System Operator (IESO)
Launch a Regional Biomass Feedstock Assessment and Mapping Initiative Conduct a comprehensive assessment of available agricultural biomass across Bruce County to quantify the volume, quality and	Bruce County

seasonality of feedstocks that could support methane pyrolysis, and AD & RD facilities. Mapping this supply chain is critical to de-risking investment and would position the region competitively in clean hydrogen and clean fuel infrastructure planning.	Bruce County Federation of Agriculture
Increase Farmer Education and Engagement on Clean Energy Technologies Create targeted outreach and education programs – led in partnership with local agricultural associations like the Bruce County Federation of Agriculture – to raise awareness of clean technologies (e.g. methane pyrolysis, hydrogen-powered equipment, ammonia production, RD, AD, electrification on-farm, etc.).	Government of Canada Government of Ontario Bruce County Bruce County Federation of Agriculture
Develop and Fund Regional Pilot Projects and Centralized Hubs for AD & RD facilities Launch regional pilot projects for centralized AD and RD facilities that aggregate agricultural waste from multiple farms.	Government of Canada Government of Ontario Bruce County

2.0 INTRODUCTION

A focus on energy security and clean economic growth has made decarbonizing global and localized energy systems ever more pressing. Among the sectors poised to make a significant contribution to these efforts is the agriculture sector—which stands out as a potential leader in decarbonization. This study aims to explore the intersecting realms of clean energy technologies and agricultural practices, exploring and assessing how innovative energy solutions can be leveraged to decarbonize agriculture while amplifying the sector's existing role in clean economic growth.

Agriculture, as a multifaceted industry encompassing practices like cultivation, livestock management, agri-food processing and more, is intricately intertwined with energy usage. Historically, fossil fuels have underpinned much of agricultural production, from powering machinery to providing heat for facilities. Addressing the sector's climate impact will rely on lowering this reliance on carbon-intensive energy in favour of cleaner, lower emissions energy sources. Furthermore, the agriculture sector can be leaned upon to provide new pathways for clean energy production.

The adoption of clean energy technologies in agriculture is not without its challenges. Technical, economic, regulatory and social barriers may hinder widespread implementation, necessitating supportive policies, financial incentives and knowledge-sharing initiatives. Moreover, the unique characteristics of agricultural systems, including their geographic diversity, resource constraints and socio-economic considerations must be carefully considered when pursing the implementation of clean energy solutions.

This study seeks to provide an initial review of how the sector can navigate these complexities, examining the potential synergies between clean energy technologies and the decarbonization efforts of the agriculture sector.

2.1 – Context – Agriculture in the Bruce County region

This study focuses specifically on the Bruce County region and the agricultural sector that operates with that region. Home to more than 1,600 farming operations[i] and a thriving clean energy sector—clean electricity generation from nuclear, wind, solar and associated supply chain companies—the region presents an excellent case study into how a marriage of the clean energy and agriculture sectors can support energy security and clean economic growth regionally, provincially and nationally.

The presence of the agriculture sector in Bruce County is significant comparatively. Employment data from the Government of Canada showed that in the Stratford-Bruce Peninsula Economic region of Ontario there were 13,300 individuals employed in agriculture regionally in 2023[ii], representing 16.9% of the total sector share province wide—the highest percentage of any economic region presented.

This concentration of employment highlights the clear significance of the sector in the region. Furthermore, as a foundational part of the Clean Energy Frontier region, Bruce County is also home to a significant local energy sector. Home to Bruce Power, one of the world's largest operating nuclear generating stations, and a network of associated supply chain companies supporting those operations, the Bruce region has substantial localized expertise in the development of clean energy systems and technologies.

Taken together, the presence of these two sectors presents a prime opportunity as the agriculture sector is called upon to do more to address on-farm emissions as well as contribute to broader economy-wide decarbonization efforts through new way to produce clean energy.

2.2 – Methodology – Literature review & stakeholder engagement

This study employed a simple approach—a comprehensive review of existing literature on key focus areas/technologies (as identified by project partners, Bruce County and the Bruce County Federation of Agriculture) as well as direct engagement with local farmers to ensure that assumptions on core priorities for the sector are based on feedback from those that would be called upon to implement them.

The literature review and identification of topics took place over the course of 2024, while direct engagement with farmers in Bruce County took place in early 2025 at Grey Bruce Farmers Week—an event hosted annually that provides learning sessions for those in various commodity groups across the Bruce County and Grey County ag sector. Direct engagement at this event took the form of conversations with local producers on clean energy topics for qualitative insights on the challenges and opportunities they see in the coming years.

Quantitative analysis used in this study is sourced from a survey that farmers at Grey Bruce Farmers Week were asked to complete and return to Bruce County and/or NII staff. The survey asked five (5) questions, was completely anonymous, and provided opportunity for additional comments. Survey results were tabulated and aggregated into the high-level results demonstrated throughout this study.

The study is separated into four (4) distinct sections from here, each exploring, at a high level, opportunities for decarbonization in the agriculture sector and opportunities for cleaner energy production from agricultural operations—in other words, the intersection between clean energy and agriculture.

3.0 ON-FARM DECARBONIZATION OPPORTUNITIES

In 2023, the Government of Canada stated that approximately 10% of Canada's greenhouse gas emissions (GHGs) are from crop and livestock production.[iii] Notably, this figure excludes emissions from the use of fossil fuels and from fertilizer production. While the GHG emissions associated with the use of fossil-based processes and equipment on farm as well as the associated emissions from operations varies significantly by subsector, one thing is clear: on-farm decarbonization efforts aimed at reducing reliance on fossil fuels in favour of lower-carbon or GHG-free options will be a significant driver of the reduction on-farm emissions.

This study examines potential GHG reduction opportunities such as: electrified processes/machinery,[1] the use of lower-carbon fuels (ex. syndiesel or renewable diesel), the use of hydrogen on farm, and the installation of electrical generating equipment (ex. solar panels) for electricity use on farm and for distribution to the grid or to localized distributed energy resource systems (DERs).

This section varies slightly from the following sections of the paper in that it focuses on the use of these energy sources on farm for farm-specific decarbonization rather than solely on the production opportunities associated with these technologies as will be explored in later sections.

3.1 – Overview of the landscape

3.1.1 – Electrified processes/machinery

The concept of "electrification" (the substitution of fossil fuel-based processes with an option powered by electricity) is an economy-wide conversation. Many are familiar with the steady transition of the passenger vehicle market from one based on vehicles powered by an internal combustion engine to one with an increasing share of electric-powered options. The same trend could start to emerge in Ontario's agriculture sector, but this transition remains nascent with a limited number of proven, reliable and cost-effective technology options available to farmers.

In 2022, BIS Research released a report titled *Global Powered Agriculture Equipment Market*, which indicates trends in electrified farming equipment. The study stated that: "the market is projected to grow from US$63.17 billion and 2,217.8 thousand units in the year 2019 to US$70.03 billion and 2,359.7 thousand units by 2025."[iv] The report outlines growing adoption of electrified technologies in agriculture around the world such as tractors, combines, planters, sprayers and other equipment such as tilling equipment, haymaking equipment and

[1] Electrified process/machinery defined as: "any direct substitution of fossil fuel-based machinery or process for an electric-powered option".

balers. The report is also clear that the motivation for adoption of these technologies is "improved yield, soil fertility, operational efficiency, and profitability."[v]

However, when it comes to which regions of the world are leading in electrified adoption, the Asia-Pacific region and Japan were among the global leaders, with China following and North America behind further. The lower level of adoption varies by region due to several factors—notably the availability of equipment to meet the current needs of the farming operation. In June of 2021, Darrin Qualman, Director of Climate Crisis Policy and Action at the National Farmers Union (Canada) stated: "It's different region to region because the scale of the machinery is a lot different. In a place where the machinery is smaller—tractors that are 200 horsepower or less—I think people are quite interested and open to electric tractors. [Elsewhere] farmers are buying tractors with hundreds and hundreds of horsepower and there is nothing available. There is just no path for that."[vi]

A limited review of electric options from a select source farm machinery providers emphasizes this point. When an electric option is available, it is typically for smaller-scale compact vehicles—not high-horsepower machinery that are essential pieces of equipment in most farming operations across Ontario.

Company	Outline of electric offerings
John Deere	"By 2026, John Deere will offer electric Compact Utility Tractors, commercial and residential mowers, Gator utility vehicles, and more than 20 models of construction equipment."[vii]
New Holland	T4 Electric Tractor [74 HP; 55KW][viii]
Kubota	Kubota LXe-261 [compact, all-wheel drive electric tractor used for mowing, hauling and other green space management][ix]

3.1.2 – The use of lower-carbon fuels

Given the limited technology options when it comes to direct substitution of fossil fuel-powered technologies for an electric option outlined in the section above, the use of lower-carbon fuels on-farm becomes a logical potential source for lowering on-farm emissions. Often referred to as "drop-in replacements/complements", the use of biodiesels and renewable diesels has seen a steady increase.

The *Biofuels in Canada 2024 Annual Report* prepared by Navius Research outlines the following when it comes to renewable fuel consumption:

- 2021 – 2022: renewable fuel consumption increased by 20%
- 2022 – 2023: renewable fuel consumption increased by 25%
- Changes in fuel consumption (2022 – 2023):

- Ethanol: +13%
- Biomass-based diesel: +68%[x]

As the figures above demonstrate, the biofuels sector economy-wide is seeing significant growth. This presents opportunities for the agriculture sector both as a consumer of these products (as will be explored in this section) and as a producer of the feedstocks necessary to create these products (as will be explored later in this paper).

Consumption of these fuels on farm mostly takes the form of fuel for farm machinery. That said, many producers in Ontario are expanding to include the production of fuel for their own use. For on-farm production and use of biodiesel, in 2023, the Government of Ontario produced the *On-Farm Biodiesel Production Factsheet*. The fact sheet provides producers with information necessary to determine "if small-scale biodiesel production is a feasible and economical farm-grown replacement for these farm inputs [petro-diesel]."[xi] The fact sheet is clear that it is an illusion that biodiesel produced using locally grown oilseed crops (soybeans or canola) could meet the current demand for petro-diesel. The authors state:

> "Oil derived from locally grown oilseed crops could never meet the demand for diesel fuel. For example, in Ontario, the 5-year (2015-2020) average soybean production was 3.8 million tonnes. Canola production is much less for the same period at 44,135 tonnes. Even if all the oilseed extracted from these oilseed crops were converted to biodiesel, it would only offset about 14% of Ontario's annual on-road diesel fuel consumption."[xii]

Further still, the factsheet outlines the cost-competitiveness challenge of biodiesel products at present. As demonstrated in Figure 1, when compared to the cost of conventional petro-diesel, the so-called "Green Premium" (i.e., the difference in cost between the conventional option and the lower-carbon fuel) remains significantly high.

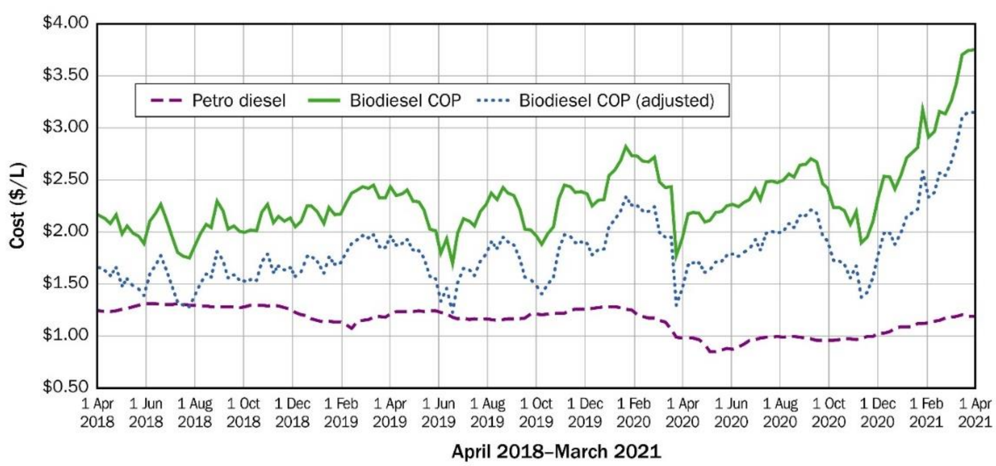

Figure 1 – From *Ontario On-farm Biodiesel Production Factsheet* – Comparison of farm petro-diesel cost with cost of production of biodiesel[xiii]

That said, this assessment misses the potential opportunity offered by smaller-scale, localized production and use of biodiesel. Localized on-farm production allows farmers the opportunity to offset emissions and cost using proven methods of biodiesel production. Furthermore, the opportunity to scale production from a single-farm model to one that services several operations by establishing local cooperative sharing models exists for farms on a community/regional basis.

3.1.3 – Clean electricity on farm – Generation

When it comes to the integration of clean electricity on farm, the Ontario agriculture sector is showing significant promise. According to Statistics Canada, the number of farms in the province of Ontario reporting they are engaged in renewable energy production increased by 68% to 8,483 in the year 2021.[xiv] As noted by Statistics Canada: "these farms accounted for 17.5% of total farms in Ontario, the highest proportion in any province and above the national rate (11.9%)."[xv]

The uptick in a greater number of Ontario farms generating electricity is a positive sign. In an age of increased demand on the electricity grid, Ontario's system operator predicts an overall increase in demand of 75% by the year 2050,[xvi] new sources of generation that maximize land use and efficiency are vital. In fact, when it comes to the agriculture sector in Ontario, the Independent Electricity System Operator (IESO) projects a range of scenarios for increasing demand from the sector. The scenario outlined in the IESO's *Pathways to Decarbonization Report*, as noted in Figure 2, demonstrates the most significant increase with projection from Annual Planning Outlooks in 2024 and 2025 showing a more modest but still significant increase in demand from the sector.

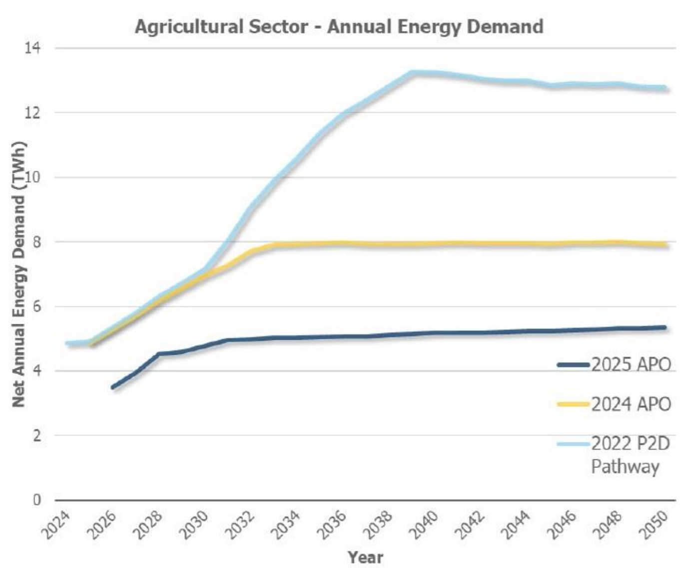

Figure 2 – IESO demand scenarios for Ontario agriculture sector

Distributed Energy Resources represent a potential opportunity for the increasing number of farms generating their own electricity. As was previously noted, Ontario is seeing an increasing number of farms adopt renewable electricity generation on farm. The motivation for this increased level of adoption is undoubtedly multi-faceted: some operations will be motivated by the potential to offset the cost of electricity on farm over the long-term, others will be motivated by the potential to increase revenue by selling electricity back to the grid, and others still will view the opportunity to source electricity from a GHG-free source of generation as a primary motivator. The emerging opportunity from DERs presents another significant motivating factor as energy dynamics on farm progress.

DERs are described by the IESO as follows:

> "One of the most significant changes to electricity systems around the world has been the emergence of new technologies that can support locally-owned facilities for electricity generation, control and storage. These technologies, often referred to as Distributed Energy Resources (DERs), are transforming the way communities meet their energy needs."[xvii]

Essentially, a network of DERs can operate as localized electricity "co-ops"—a model that the agriculture sector is quite familiar with. A network of generation and/or storage assets (solar photovoltaic systems, battery storage systems, wind turbines, co-generation (combined heat and power), are established within a contained system and used to meet the demand of a network of end users, therefore reducing the reliance of that network on the provincial grid system. With an increasing number of farms installing generation assets, the potential to establish localized DER networks is significant.

That said, there are challenges associated with the establishment of these systems. They require careful planning, engagement with local distribution companies (LDCs), and, in the context of the agriculture sector, ensure that prime agricultural land continues to be used for that purpose. In response to an IESO consultation in 2023, the Ontario Federation of Agriculture stated the following: "Decision-makers must enable DERs that serve rural (farm) community interests beyond simply helping the IESO balance grid system shortages. Policy design needs to include engagement with the farm sector before contemplating the assimilation of Ontario's finite farmland resources into industrial scales batter energy storage systems."[xviii]

While DERs present significant potential—especially given the growing number of farming operations demonstrating an interest in installing generation assets on farm—balancing the potential for DER growth with the imperative of preserving farmland will be critical.

3.2 – Benefits, challenges and opportunities

The following table outlines the benefits, challenges and opportunities associated with the technologies and decarbonization pathways outlined in the section above.

Pathway	Benefits	Challenges	Opportunities
Electrified machinery/processes	Emissions reduction Potentially lower costs (technology dependent)	Limited technology options to meet current needs Requirement to install additional infrastructure (i.e., charging stations)	Potential to transition smaller, compact equipment to available electrified options
Use of lower carbon fuel	Technology exists and is seeing growing use Direct emissions reduction through displacement of higher-carbon fuel	Cost Awareness and availability of fuel	Adoption of small-scale, on-farm production for on-farm use Establishment of localized co-op model for biodiesels and renewable diesels
Clean electricity generation on farm	Reduced reliance on the grid Sourcing electricity from clean generation Lower costs	High upfront capital investment Protection of prime agricultural land	Establishment of localized DER networks

3.3 – Stakeholder feedback – Barriers and enablers

Changing any business practice comes with risk and must be carefully measured. Decisions to alter a practice, process or technology must be weighed against a series of considerations that will ultimately demonstrate if the change is worth pursuing. As part of direct engagement with local farmers in the Bruce County region, it was clear that farmers are interested in and already implementing some of the measures and actions discussed in this section.

For example, when asked about which technologies of processes farmers have implemented in their own operations, only 18% indicated that they had not adopted any of the following technologies: electrified processes, solar panels, and lower-carbon fuels.

When it comes to clean electricity generation on farm—namely through the installation of solar panels on farm buildings—32% of the farmers engaged in this survey indicated that they had adopted this as a decarbonization technique—nearly double the 17.5% of farms province-wide that have adopted clean electricity generation on farm. This signals a leadership role that farms across Bruce County can play when it comes to the integration of clean electricity generation and agricultural operations.

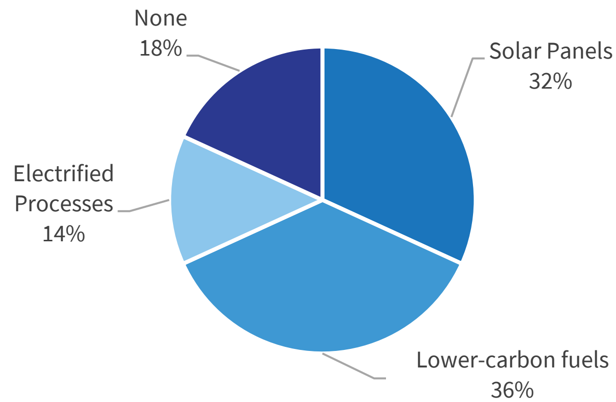

Figure 3 – Share of responses from Bruce County Farmers on technologies/ processes adopted within their operations

Notably, the highest adopted practice is the use of lower-carbon fuels on farm, with 36% of farmers surveyed indicating that they had adopted this practice in their own operations.

Farmers surveyed as part of this engagement were also asked what factors played the most significant role when it came to considering new processes or technologies within their operations. The question asked was as follows: "Rank the following factors in terms of significance for you when considering new processes or technologies in your operations." An aggregation of the responses resulted in the following ranking.

1. Cost
2. Reliability and durability of equipment
3. Environmental impact
4. Availability of technology
5. Ease of integration in current operations

Figure 4 – Ranking of priorities from Bruce County farmers when considering new processes or technologies

As can be seen from the results of this engagement, farmers are rightfully concerned about cost when considering any change of technology or process to their operations. Interestingly, the availability of technology options ranked lower down the list and could reflect the reality within which farmers are currently operating (i.e., this is not currently a core consideration because the technology landscape is already so limited).

These results demonstrate that when it comes to decarbonization efforts on farm, farmers in Bruce County will, and already do, pursue options that make financial sense and where reliable and durable technology options exist. On-farm decarbonization in Bruce County is already showing encouraging signs of progress. Farmers in the region are taking practical steps to reduce emissions by adopting clean electricity generation and lower-carbon fuels where feasible. This study' survey results suggest that cost and reliability remain the most important factors in decision-making, and technologies that align with these priorities are more likely to be adopted. With notable rates of solar adoption and ongoing interest in renewable fuels, Bruce County farms are quietly but steadily contributing to broader climate objectives.

As technology options improve and support becomes more accessible, the region has a solid foundation to continue making measured, meaningful advancements in agricultural decarbonization.

4.0 FUEL PRODUCTION FROM AGRICULTURAL BIOMASS

As Canadian consumers—both industrial and everyday consumers—seek cleaner options to power their lives and operations, there is a growing demand for clean fuels. As demonstrated in Figure 5[xix] (and earlier in this paper), the demand for lower carbon fuels like biodiesel, ethanol and renewable diesel have been steadily rising in Canada since 2020. This significant growth in demand presents a significant opportunity agriculture sector to capitalize on.

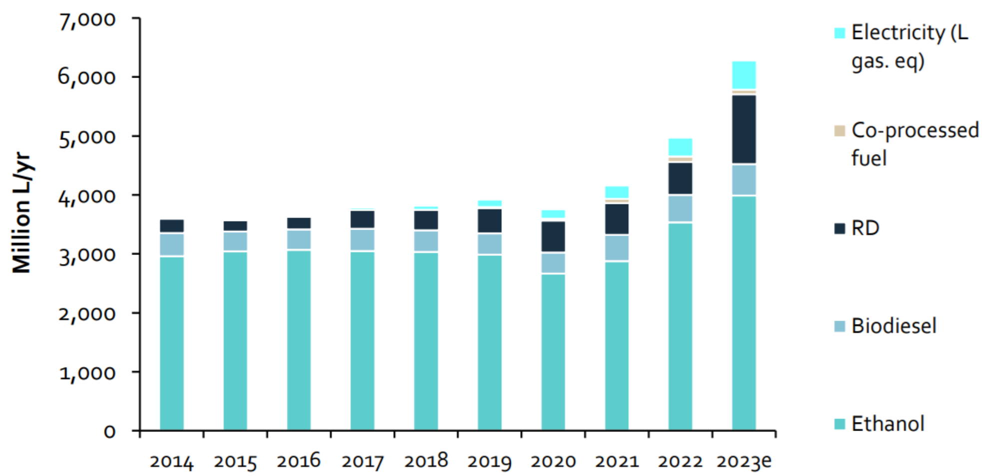

Figure 5 – NAVIUS – Total clean fuel consumption in Canada (26% growth in 2023)

4.1 – Alternative fuel production from agricultural biomass

Fuel production from agricultural biomass can take several forms—each with its own pathway to production and considerations along the way. This section will focus on the opportunity that Renewable Natural Gas (RNG) and lower-carbon fuels like syngas and renewable diesel (RD) present to the agriculture sector and the considerations that must be made to capitalize on this opportunity.

4.1.1 – Overview of Landscape

Renewable Natural Gas

Renewable natural gas (RNG)—or biomethane—has seen a steady increase in production since 2003.[xx] The fuel itself is comprised of methane—the same primary component of conventional natural gas. However, rather than being produced by drilling for gas underneath rock formations, RNG is produced by using waste products (ex. landfill biogas capture, agriculture/food waste, wastewater processing and wood waste)[xxi].

For the agriculture sector, RNG use and production present significant opportunities. On-farm solutions already exist that enable farmers to participate in the RNG market through a process known as anaerobic digestion (AD). AD is the process through which organic waste materials are broken down by micro-organisms without oxygen.[xxii]

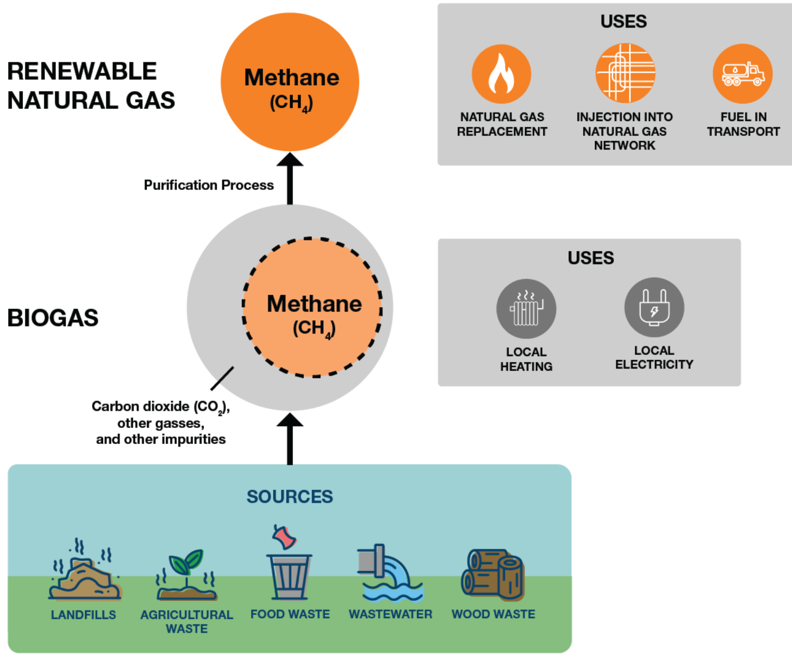

Figure 6 – Renewable Natural Gas Production (Credit: Canada Energy Regulator)

A Government of Ontario fact sheet outlines the following pathways after the AD process takes place:

> "Depending on the system design, biogas is combusted to run a generator producing electricity and heat (called a co-generation system), burned as a fuel in a boiler or furnace, or cleaned (called 'upgrading') and used as a natural gas replacement. Pipeline-quality upgraded biogas is referred to as renewable natural gas."[xxiii]

The scale and type of AD facilities that can be adopted vary and depend on geography as well as socio-economic factors. The following table highlights three options for scaling AD systems seen in Ontario.

System	Description
Farm-based systems	Designed for farm manure, the manure of other nearby farms, and/or for the use of energy crops from local fields.
Food-processing systems	Located at food-processing sites and designed to remove organic

	matter from wastewater.
Centralized systems (Non-farm AD systems)	Centralized facility receives material from many farms and food-processing plants.

The pathway from AD to the production of RNG and integration into local distribution systems remains expensive. RNG produced from AD tends to carry a premium as compared to traditional natural gas. As the costs of RNG and traditional natural gas products converge, and as users look to embrace the use of RNG in their operations, the opportunity for farmers to participate in the AD process and ultimately the RNG market will increase.

Lower-carbon fuel

Low-carbon fuel sources have been viewed as a significant opportunity for decarbonization. In 2020, the Government of Canada's Clean Fuel Regulations were implemented and set in motion an uptick in the number of projects across Canada to produce cleaner sources of fuel.[xxiv] Both RD and syngas have been considered as important drivers in the clean fuel space but should be kept distinct from one another as they hold different composition, considerations and end uses.

The following table provides an overview of the key features of each of these fuel sources at a high level.

Feature	Syngas	Renewable diesel
Composition	Mixture of hydrogen, carbon monoxide, and carbon dioxide	Hydrocarbon fuel (similar to petroleum diesel but produced from renewable sources)
Production process	Gasification of organic materials	Hydroprocessing of oils and fats
Primary use	Intermediate for chemicals, electricity, fuels	Direct use in diesel engines
Fuel quality	Low energy density, not a direct fuel replacement	High-quality diesel, compatible with engines
Carbon footprint	Can be carbon-neutral depending on feedstock	Low carbon intensity—lower emissions than petroleum diesel

End use	Requires further conversion (ex. Fischer-Tropsch process)	Used directly in transportation and industry
Example feedstocks	Corn stover; wheat straw; livestock manure; food waste (ex. fruit/vegetable scraps); forestry residues	Soybean oil; canola oil; animal fats (ex. beef tallow, pork lard); used cooking oils

Both fuel sources present an opportunity for the agriculture sector to serve as a provider of important feedstocks for their production. And, in the case of RD, a potential end use and decarbonization opportunity exists.

Unfortunately, while there is significant promise in the Bruce region to leverage potentially available feedstocks and end users for RD, investment in RD production facilities in Ontario remains sparse.[xxv]

Figure 7 – Existing and planned Canadian Renewable Diesel facilities (Canada's Energy Regulator)

4.1.2 – Stakeholder feedback

If the agriculture sector is to meaningfully capitalize on the demand of biomass feedstocks, the sector must be prepared to integrate new processes, technologies and considerations into current operations. Understanding the barriers and top considerations for the adoption.

Engagement with the local agriculture sector suggests that the top consideration for farmers when it comes to "changing waste management practices in order to divert agricultural waste products to the production of clean energy" is cost. This is consistent with the response to a previous question about the adoption of new technologies/processes on farm.

An interesting change with respect to this question is how much higher the "ease of integration into current operations response" climbed. When asked about priorities for integrating new technologies on farm, ease of integration ranked in last (fifth). In this question, that response jumps all the way to second, behind only cost as the top consideration. This suggests an entrenchment of waste management practices as they exist today and a hesitancy to amend processes unless they can seamlessly integrate into current operations.

1. Cost
2. Ease of integration into current operations
3. Environmental impact
4. Long-term viability
5. Social impacts

Figure 8 – Ranking of considerations with respect to changing waste management practices in order to divert agricultural waste products to the production of clean energy

Bruce County is well-positioned to become a provincial leader in the production of alternative fuels from agricultural biomass. With a strong agricultural base, access to diverse feedstocks, and a growing awareness of the environmental and economic benefits of clean energy, the region has the foundational elements needed to support the expansion of renewable natural gas and lower-carbon fuels like syngas and renewable diesel. While cost and integration remain key challenges, targeted support from all levels of government—through incentives, infrastructure investment, and technology deployment—can help bridge the gap between potential and action. By aligning these supports with the practical realities faced by local farmers, Bruce County can unlock new revenue streams for producers, reduce its carbon footprint, and play a leading role in driving Ontario's transition to a low-carbon energy economy.

5.0 HYDROGEN PRODUCTION OPPORTUNITIES

Hydrogen has long been discussed in Canada as an innovative clean fuel that can serve to decarbonize sectors of the economy wherein electrification is simply not feasible. While progress on enabling a nascent hydrogen economy has been slower than some may have expected, the *Hydrogen Strategy for Canada: Progress Report* outlines significant progress that has been made across Canada to spur investment in hydrogen production. This includes deployed hydrogen production capacity of 3,450 tonnes of H_2 per year, 80 projects announced, under construction or under development, and total announced project investment of >$100B.[xxvi] Furthermore, the report outlines a clear path forward for hydrogen to play a critical role in Canada's economy-wide decarbonization pathway and highlights the Bruce-Grey-Huron region (the Clean Energy Frontier region) as an "Emerging Hub" (see Figure 9).

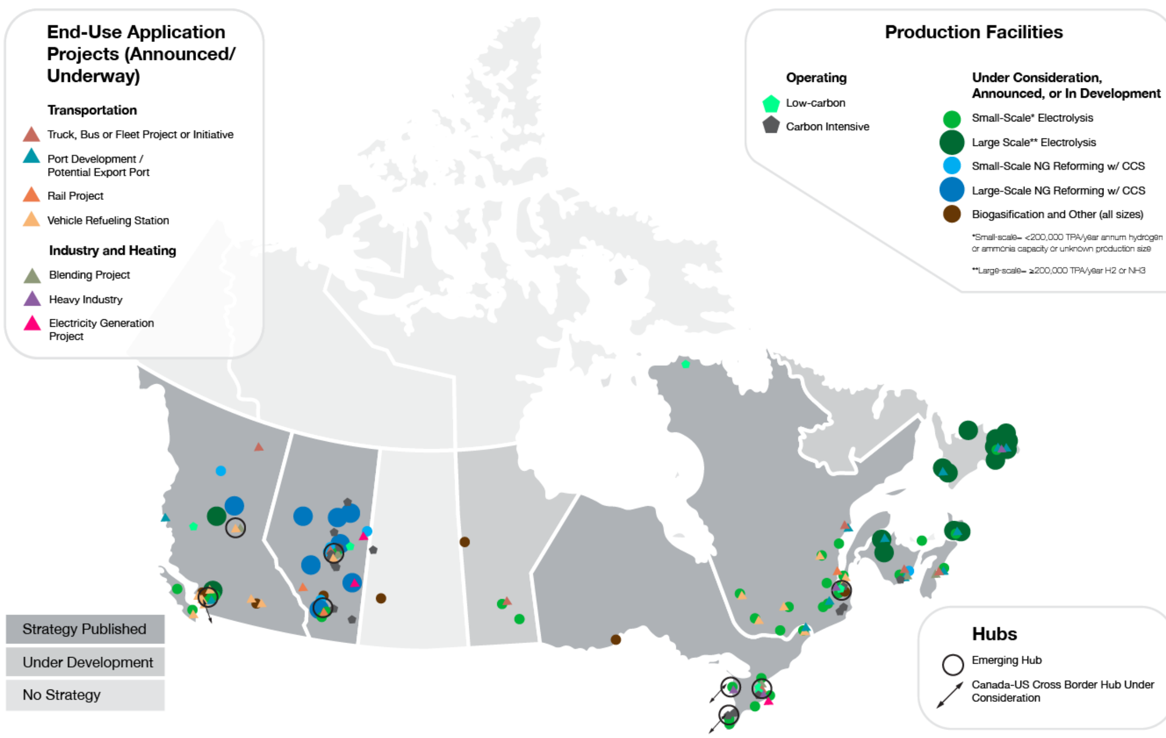

Figure 9 – *Hydrogen Strategy for Canada Progress Report* highlights the Bruce-Grey-Huron region as an emerging hydrogen hub

This enthusiasm—both nationally and regionally—for hydrogen presents significant opportunities for the agriculture sector in Bruce County. This research focuses on the potential of methane pyrolysis using agricultural biomass feedstocks for hydrogen production as well as hydrogen use cases and applications in agriculture as two primary opportunities.

5.1 – Methane pyrolysis for hydrogen production

Methane pyrolysis is a process that involves breaking down methane (CH_4) at a high temperature (~1000 °C) in the absence of oxygen, producing hydrogen gas (H_2) and solid carbon (C) rather than CO_2 emissions. The process provides a low-emissions way to generate clean hydrogen while capturing excess carbon in a solid form that can then be sequestered rather than emitted into the atmosphere. The process has the added benefit of requiring biomass as a feedstock and therefore eliminates emissions associated with the natural decay or alternative use of that biomass. A simple schematic of the methane pyrolysis process (using agricultural biomass as a feedstock) is outlined below.

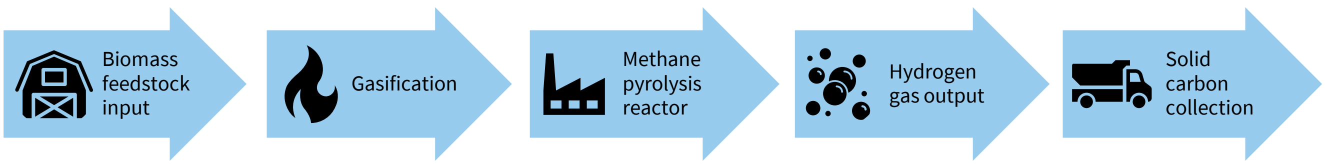

Figure 10 – Simple schematic of methane pyrolysis process using biomass feedstock

As can be seen from the graphic above, the primary opportunity for agriculture in the methane pyrolysis process comes at the beginning of the process as a source biomass feedstock. Translating this opportunity into tangible outcomes will be explored later in this section.

5.1.1 – Overview of landscape

An analysis from the B.C. Centre for Innovation and Clean Energy in 2024 stated that as of December 2023, there were "32 tech companies specific to methane pyrolysis" technologies development[xxvii]. Some examples of methane pyrolysis projects and their associated technology readiness levels (TRLs) are included in the table below.

Project	Location	Overview	TRL
BASF Methane Pyrolysis Plant[xxviii]	Ludwigshafen, Germany	The plant will produce hydrogen by splitting natural gas or biomethane directly into hydrogen and solid carbon. The process requires approximately 80% less electricity than alternative hydrogen production methods.	6 – pilot stage
Monolith Methane	Olive Creek,	Full commercial scale facility	9 – commercial

Pyrolysis Plant[xxix]	Nebraska, USA	using methane pyrolysis to produce hydrogen from natural gas.	operation
Ekona Power Inc.[xxx]	Burnaby, British Columbia, Canada	Development of the xCaliber™ Reactor – a novel methane pyrolysis platform that coverts natural gas into hydrogen and solid carbon. Burnaby pilot project to be complete in 2025.	6 – pilot stage
HAZER® Group[xxxi]	Perth, Australia	Development of a process/technology that enables the conversion of natural gas, and similar feedstocks into hydrogen and high-quality graphite.	6 – pilot stage

As can be seen from the table above, the methane pyrolysis landscape is an emerging space for new and novel technologies that are entering pilot and production phases. That said, nearly all case studies analyzed as part of this study are being conducted at a large scale. These facilities require careful planning with several factors playing a key role in investment decisions. The table below outlines some of these considerations.

Consideration	Outline
Feedstock availability	Access to significant sources of methane (biomass feedstocks for gasification, natural gas, biogas or syngas from biomass)
Energy costs	Proximity to low-cost, reliable electricity or heat sources to power the pyrolysis process
Infrastructure & logistics	Availability of transportation networks for: i) feedstock delivery; ii) hydrogen transport; iii) management of solid carbon.
Market demand	Nearby industry requiring hydrogen (ex. refining, ammonia, steelmaking, fuel cells) and/or solid carbon (battery making, rubber, construction materials).
Regulatory & incentive landscape	Government policies, tax credits or subsidies supporting clean hydrogen and carbon utilization/storage.
Environmental & permitting requirements	Compliance with emissions standards, zoning laws and carbon management regulations.
Workforce & technology access	Access to skilled labour, research institutions or partnerships with clean energy and materials science organizations

For the agriculture sector in Bruce County, some of these criteria could be met to encourage investment in a localized methane pyrolysis facility—notably, the availability of local feedstock, the infrastructure and logistical systems to support the delivery of this feedstock, and potentially market demand for ammonia fertilizer production or for fuel cell vehicles.

5.1.2 – Benefits, challenges and opportunities

Benefits

The benefits of methane pyrolysis processes becoming integrated with agricultural biomass as a feedstock are clear. This integration would establish a process wherein clean hydrogen could be produced while making use of waste products from farming operations. That same clean hydrogen could then be used for ammonia production and used as fertilizer locally.

Challenges

When it comes to methane pyrolysis and the agriculture sector, there are a significant number of barriers that must be overcome as well as factors on the scale of production facilities that must be considered. The table below outlines these barriers when it comes to the practical feasibility of methane pyrolysis being conducted at a localized, on-farm level.

Barrier	Explanation
Scale and equipment	The technology required for methane pyrolysis is still in varying stages of development with large-scale operations being the focus of most current research and pilot programs. On-farm methane pyrolysis would require a modular or compact technology which is not yet widely available.
Cost-effectiveness	The economic viability of a localized, on-farm setup could prove to be unfeasible. The cost of equipment combined with energy inputs and the management of by-products could outweigh the benefits without significant technological advancements or financial incentives.
Energy requirements	Methane pyrolysis requires a significant amount of heat. Achieving these temperatures on farm would require a significant amount of energy which could pose a challenge to localized operation.
Carbon and hydrogen management	Both by-products of the pyrolysis process (carbon and hydrogen) would require management systems, storage and/or transportation—all of which would require additional infrastructure.

Furthermore, in order to attract significant investment in a localized methane pyrolysis facility, the local agriculture sector in Bruce County would be required to demonstrate both an availability of biomass feedstock for gasification to support methane pyrolysis operations as well as the infrastructure and logistical systems required to support pyrolysis operations. Bruce County has significant advantages in this regard but a local stocktaking exercise and early engagement with the agriculture community would need to take place should methane pyrolysis be a source of energy production that is of interest.

Opportunities

The opportunity to site a localized methane pyrolysis facility would carry significant opportunities for both the agriculture sector as well as the region more broadly. These facilities carry significant investment and would provide an avenue for additional revenue for local farming operations via the sale of biomass. Furthermore, such a facility would provide a new source of potentially low-cost, low-emissions hydrogen for use in a local ammonia value chain or as a clean fuel source – therefore, spurring additional investment in a local hydrogen economy.

5.1.3 – Stakeholder feedback – Barriers and enablers

When engaging with local farmers on the topic of methane pyrolysis, a significant barrier was identified: awareness of the technology and its potential benefits/implications for the agriculture sector.

Levels of familiarity, as outlined in Figure 11, were identified on the survey as follows:

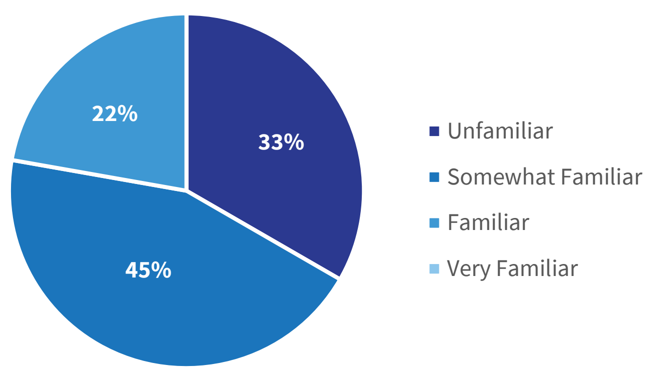

Figure 11 – Responses from engagement with local farmers on their level of familiarity with methane pyrolysis

- **Unfamiliar** – I have never heard of it
- **Somewhat familiar** – I have a vague idea of what it is
- **Familiar** – I understand what it is and the potential it presents for agriculture
- **Very familiar** – I have a detailed understanding of it

Therefore, only 22% of respondents felt that they understood the potential benefits of methane pyrolysis activities as it relates to agriculture. This underscores the importance of engagement with farmers to better educate them on how such facilities could drive new revenue opportunities and spur investment in local hydrogen production. An increased level of familiarity with the methane pyrolysis process will be an essential precursor to attracting investment in a large-scale facility to the region.

5.2 – Clean hydrogen – Use cases/applications for agriculture

Section 4.1 focused specifically on the methane pyrolysis process and the potential it presents to the agriculture sector in Bruce County. This section will focus more broadly on the connection between hydrogen and agriculture and the associated benefits of greater levels of localized hydrogen production in Bruce County and the surrounding region. The section will explore the production of ammonia fertilizer and the potential use cases for hydrogen on farm.

5.2.1 – Overview of landscape

Hydrogen as an input for local fertilizer production
As referenced in section 5.1.1, one of the critical considerations for siting a large-scale methane pyrolysis facility is the demand for the resulting hydrogen from such a facility. The local production of fertilizer could be one of the most promising pathways.

Hydrogen plays a crucial role in fertilizer production, primarily through the Haber-Bosch process, which is used to synthesize ammonia (NH_3). Ammonia is a key ingredient in many fertilizers, including urea, ammonia nitrate, and ammonium sulfate. The process involves combining hydrogen (H_2) with nitrogen (N_2) under high pressure and temperature in the presence of a catalyst.

As global demand for fertilizers continues to rise and as geopolitical events compromise long-standing supply chains, it is more important than ever to onshore fertilizer production where possible. In 2022, Canada imported $3.14B in fertilizer products.[xxxii] This included imports from countries such as the United States, Algeria, Russia, the Netherlands and Morocco. In an ever-changing geopolitical environment, onshoring greater levels of fertilizer production capacity is a welcome advancement.

Carlsun Energy's "Power-to-Ag" project is a local example of the potential in this regard. The Power-to-Ag project is described by Carlsun Energy (a company based in Bruce County) as follows:

> "An electrolysis plant that will use off-peak grid electricity to split water into hydrogen and oxygen… An ammonia plant will combine clean hydrogen, from the process above, with nitrogen from the air to make ammonia. The ammonia will be utilized as fertilizer, while excess hydrogen will be utilized to fuel hydrogen-powered vehicles and equipment. Clean power generation may also be incorporated in future phases."[xxxiii]

This project highlights the potential use case for hydrogen as a feedstock for products that will eventually support agricultural operations in the region.

Additional use cases for hydrogen on farm

Beyond the use of hydrogen as a feedstock for ammonia-based fertilizer production, there are additional potential use cases for hydrogen on farm. These opportunities are highlighted in the table below.

Use case	Description
Hydrogen-powered equipment	Hydrogen fuel cells can be used to power tractors and other farm equipment—and though technology options are starting to become available,[xxxiv] they remain limited at present.
Energy storage	Hydrogen can be used as an energy storage solution for farms that generate solar or wind energy. Surplus generation can be stored using hydrogen and deployed using fuel cells during period of low-production or high demand on the grid. This is a highly complex system of storage and would require specialized expertise and sophisticated infrastructure.
Heat and power	Hydrogen could be used to power systems that maintain optimal conditions for livestock (i.e., heating and ventilation for barns). This is also highly complex and would require specialized expertise and infrastructure.

While these additional uses cases remain interesting and significant in terms of their decarbonization potential, more integrated end uses of hydrogen on farm remain years away from viable implementation or widespread use. The most impactful use case for hydrogen in local agriculture in Bruce County would be as a feedstock for localized fertilizer production.

5.2.2 – Stakeholder feedback

Of note, when asked the question about which practices farmers in Bruce County have implemented on farm to decarbonize their own operations, none of those engaged indicated that they had employed the use of hydrogen on farm—this despite hydrogen being among the list of potential responses.

The limited use of hydrogen so far in current farming operations is representative of the nascent state of the sector more generally. Before hydrogen is more broadly used by farmers across Bruce County, stable sources of production must be established, and realistic and practical sources of end use must be made clear.

That said, Bruce County is uniquely positioned to harness the emerging opportunities of clean hydrogen to benefit both its agriculture sector and the broader regional economy. Identified by the federal government as an emerging hydrogen hub, the region already enjoys a confluence of strategic advantages—including a strong agricultural base, potential feedstock availability, proximity to clean energy infrastructure, and early momentum from innovative local projects like Carlsun Energy's "Power-to-Ag."

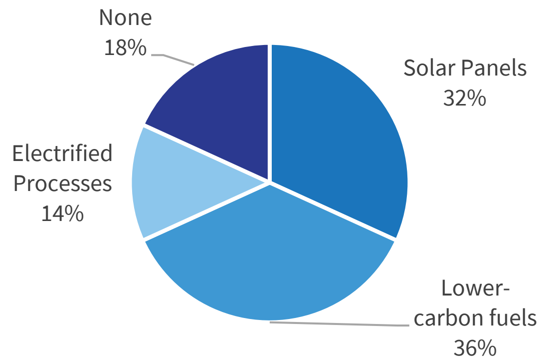

Figure 12 – Share of responses from Bruce County farmers on technologies/ processes adopted within their operations (hydrogen not identified)

Methane pyrolysis, using locally sourced agricultural biomass, could offer a pathway to clean hydrogen production while adding value to on-farm waste streams. However, realizing this potential will require targeted outreach, education, and investment to address knowledge gaps, scale challenges, and infrastructure needs. By fostering awareness, supporting pilot projects, and ensuring hydrogen applications—such as ammonia fertilizer production—are accessible and economically viable, Bruce County can lead Ontario in demonstrating the value of hydrogen in rural, agricultural communities.

6.0 CONCLUSIONS & AREAS OF FOCUS

The agricultural sector has the potential to become a leader in Canada's clean energy transition, contributing to both economic sustainability and environmental responsibility. The adoption of clean energy technologies—including electrification, biofuels, hydrogen, and renewable energy generation—can significantly reduce on-farm emissions while providing new revenue opportunities for farmers.

However, realizing this potential will require overcoming cost barriers, improving technology availability and fostering greater awareness among stakeholders. With strategic investment, policy support and industry collaboration, the agriculture sector can drive meaningful change in Canada's energy landscape.

When asked what kind of policy support would be most impactful when it comes to encouraging farmers to adopt new practices or processes, farmers engaged in this study noted that financial measures (either tax incentives or new funding programs) would have the most significant impact.

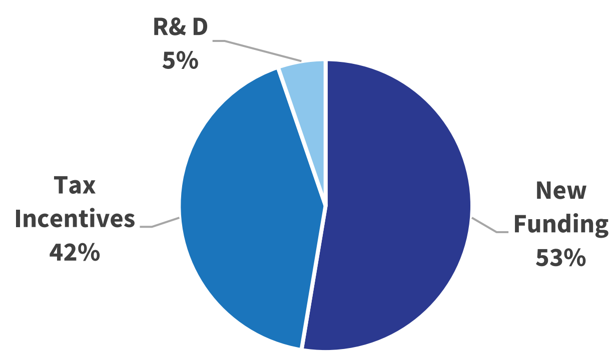

Figure 13 – Responses from farmers on what type of government support would be most helpful when it comes to adopting new technology or processes

Investment in research and development initiatives received limited favour with the farmers engaged as part of this study and, in conversation, farmers noted that while some regulatory barriers exist, the primary driver and barrier with respect to adopting new technologies or processes comes down to cost. If the opportunity presents an opportunity for new revenue or a reduction in cost, it immediately becomes more attractive. Conversely, as has been demonstrated throughout this study, if an opportunity requires a significant amount of upfront capital with an unclear pathway to revenue, it becomes significantly less attractive.

Throughout this study, it has been noted that the "green premium" (i.e., the price difference between the conventional fossil-based option and a lower carbon intensive option) remains significantly high for some opportunities for clean energy production in the agriculture sector. Where possible, government policy should be targeted at reducing that green premium and offering incentives to farmers to participate in these new and emerging opportunities.

With the right alignment of policy, funding, and industry partnerships, the agricultural sector is positioned for success. As a region with deep agricultural roots and a growing commitment to sustainability, Bruce County is uniquely positioned to become a leader in clean energy innovation. Local farmers have the capacity to supply critical biomass feedstocks and benefit directly from the economic and environmental gains of clean energy adoption. By targeting policy tools—such as tax incentives and funding programs—toward reducing the green premium and supporting practical, cost-effective integration of new technologies, governments and industry partners can empower Bruce County's agricultural sector to take a leading role in Canada's clean energy future. With continued collaboration, Bruce County can become a model for rural resilience, low-carbon growth, and agricultural leadership in the energy transition.

Potential Areas of Focus

The following list of potential areas of focus has been developed using the contents of this analysis. They reflect the actions needed to ensure that the agricultural sector in Bruce County is positioned as a leader in the transition to a decarbonized economy.

Potential Area of Focus	Audience/Target
Expand Incentive Programs for On-Farm Electrification Develop and expand granting and rebate programs that offset capital costs of electricity generation assets and electrified equipment (e.g. electric tractors).	Government of Canada Government of Ontario Bruce County
Enable Localized Biofuel Co-Ops and On-Farm Production Models Facilitate regulatory clarity, technical support, and funding for farmers to establish cooperative biodiesel production and distribution networks. Leverage existing agricultural co-op models to support shared access.	Industry – agriculture sector in Bruce County Bruce County
Further Support for DER Integration for Farm Operations Streamline the connection of on-farm electricity production to the grid and promote the development of Distributed Energy Resource (DER) networks in agricultural regions. Include agriculture sector representation in policy development on DERs.	Government of Ontario Independent Electricity System Operator (IESO)
Launch a Regional Biomass Feedstock Assessment and Mapping	

Initiative Conduct a comprehensive assessment of available agricultural biomass across Bruce County to quantify the volume, quality and seasonality of feedstocks that could support methane pyrolysis, and AD & RD facilities. Mapping this supply chain is critical to de-risking investment and would position the region competitively in clean hydrogen and clean fuel infrastructure planning.	Bruce County Bruce County Federation of Agriculture
Increase Farmer Education and Engagement on Clean Energy Technologies Create targeted outreach and education programs – led in partnership with local agricultural associations like the Bruce County Federation of Agriculture – to raise awareness of clean technologies (e.g. methane pyrolysis, hydrogen-powered equipment, ammonia production, RD, AD, electrification on-farm, etc.).	Government of Canada Government of Ontario Bruce County Bruce County Federation of Agriculture
Develop and Fund Regional Pilot Projects and Centralized Hubs for AD & RD facilities Launch regional pilot projects for centralized AD and RD facilities that aggregate agricultural waste from multiple farms.	Government of Canada Government of Ontario Bruce County

7.0 REFERENCES

[i] Bruce County Federation of Agriculture, 2021. *Welcome to the Bruce County Federation of Agriculture.* Retrieved from: Bruce County Federation of Agriculture.

[ii] Government of Canada, 2025. *Agriculture (NAICS 11): Ontario, 2024-2026.* Retrieved from: Agriculture: Ontario 2024-2026 - Job Bank

[iii] Agriculture Canada, 2023. *Greenhouse gas emissions and agriculture.* Retrieved from: Greenhouse gas emissions and agriculture - agriculture.canada.ca.

[iv] BIS Research, 2022. *Global Powered Agriculture Equipment Market.* Retrieved from: Powered Agriculture Equipment Market Application, and Country Analysis 2026.

[v] Ibid.

[vi] Electric Autonomy, 2021. "Electrifying agriculture: how Canada's farm industry is starting to transition." Retrieved from: Electrifying agriculture: how Canada's farm industry is starting to transition

[vii] John Deere, 2025. *Electric Equipment: Helping Our Customers Overcome their Biggest Challenges.* Retrieved from: Electric Equipment: Helping Our Customers Overcome Their Biggest Challenges

[viii] New Holland, 2025. *T4 Electric Power.* Retrieved from: Electric Tractor 74Hp: T4 | New Holland UK

[ix] Kubota, 2025. *E-Powered Compact Tractor. The Mission: Zero Emissions.* Retrieved from: E-Powered Compact Tractor. The Mission: Zero Emissions

[x] Navius Research, 2025. *Biofuels in Canada – 2024 Annual Report.* Retrieved from: Biofuels in Canada 2023.

[xi] Government of Ontario, 2023. *On-Farm Biodiesel Production Factsheet.* Retrieved from: On-farm biodiesel production | ontario.ca.

[xii] Ibid.

[xiii] Ibid.

[xiv] Statistics Canada, 2022. *Ontario is an agricultural powerhouse that leads in many farming categories.* Retrieved from: Ontario is an agricultural powerhouse that leads in many farming categories.

[xv] Ibid.

[xvi] IESO, 2024. *Electricity Demand in Ontario to Grow by 75 per cent by 2050.* Retrieved from: Electricity Demand in Ontario to Grow by 75 per cent by 2050.

[xvii] IESO, 2025. *Distributed Energy Resources.* Retrieved from: Distributed Energy Resources.

[xviii] Ontario Federation of Agriculture, 2023. *Hybird Integration Project.* Retrieved from: Hybrid Integration Project

[xix] Navius Research, 2025. *Biofuels in Canada – 2024 Annual Report.* Retrieved from: Biofuels in Canada 2023.

[xx] Canada Energy Regulator, 2023. *Market Snapshot: Two Decades of Growth in Renewable Natural Gas in Canada.* Retrieved from: CER – Market Snapshot : Two Decades of Growth in Renewable Natural Gas in Canada

[xxi] Ibid.

[xxii] Government of Ontario, 2022. *Anaerobic digestion basics.* Retrieved from: Anaerobic digestion basics | ontario.ca

[xxiii] Ibid.

[xxiv] Government of Canada, 2023. *Market Snapshot: New Renewable Diesel Facilities Will Help Reduce Carbon Intensity of Fuels in Canada.* Retrieved from: CER – Market Snapshot: New Renewable Diesel Facilities Will Help Reduce Carbon Intensity of Fuels in Canada

[xxv] Canada's Energy Regulator, 2024. *Market Snapshot: New Renewable Diesel Facilities Will Help Reduce Carbon Intensity of Fuels in Canada.* Retrieved from: CER – Market Snapshot: New Renewable Diesel Facilities Will Help Reduce Carbon Intensity of Fuels in Canada

[xxvi] Government of Canada, 2024. *Hydrogen Strategy for Canada: Progress Report.* Retrieved from: Hydrogen Strategy for Canada: Progress Report - Natural Resources Canada.

[xxvii] Centre for Innovation and Clean Energy, 2024. *The potential for methane pyrolysis in B.C.* Retrieved from: PowerPoint Presentation.

[xxviii] BASF, 2022. *Methane pyrolysis test plant at the Ludwigshafen site.* Retrieved from: Methanpyrolyse-Testanlage am Standort Ludwigshafen - TV Service Portal.

[xxix] Monolith Materials, 2021. *Taking Methane Pyrolysis from Concept to Industrial Plant*. Retrieved from: 08 OK -Monolith_ARPAE_MethanePyrolysis2021_v3.pdf.

[xxx] EKONA Power Inc., 2025. *Rapid-to-deploy clean hydrogen production, driven by combustion.* Retrieved from: Technology | Ekona Power.

[xxxi] HAZER Group, 2025. *About Hazer Group.* Retrieved from: About | hazergroup.com.au.

[xxxii] The Observatory of Economic Complexity, 2022. "Fertilizers in Canada." Retrieved from: Fertilizers in Canada | The Observatory of Economic Complexity.

[xxxiii] Carlsun Energy, 2025. *Power-to-Ag.* Retrieved from: POWER TO AG | Carlsun 2.0

[xxxiv] Booker, Robin. 2022. "Hydrogen-powered tractor engines becoming reality". *The Western Producer.* Retrieved from: Hydrogen-powered tractor engines becoming reality | The Western Producer.

8.0 TERMS OF USE

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