Springboard 360° | CLEANTECH

Innovation Advisory Committee

Cleantech Consultations

May – October 2021

UNDERSTANDING ATLANTIC CANADA MARKET NEEDS IN CLEANTECH AND TECHNOLOGY DEVELOPMENT OR COMMERCIALIZATION OPPORTUNITIES

Table of Contents

Preface

While the Springboard Atlantic network enjoys year-over-year increases in collaborative R&D projects across many sectors, we recognize that a more targeted approach is needed if we are to significantly move the innovation needle in those sectors critical to Atlantic Canada's future.

In 2021 we established Cleantech 360 — the first stream within the Springboard 360 Series as an initiative to bridge industry needs with the research strengths of our post-secondary institutions to address the transition to a clean economy.

This was a natural starting point given the Government of Canada's commitment to net-zero emissions, the effort required to meet our 2030 climate goals and our members' expertise in this field.

This report is a summary of the valuable work of our Cleantech 360 Innovation Advisory Committee comprising 12 experts convened by Springboard and the Atlantic Canada Opportunities Agency to identify and articulate our regional priorities. The Committee held 5 plenary sessions from May to October. There were also more than 40 individual meetings with committee members to gather their thoughts and ideas.

It provides a synopsis of the Atlantic Canadian landscape and our strengths and areas of opportunity across two main thematic streams — Clean Energy and Circular Economy. This work will lead to focused consultations with industry and help us articulate specific opportunities to examine and address going forward.

The next step within Cleantech 360 is to convene public, private and academic stakeholders and provide forums such as workshops and events where collaborations are formed, resulting in joint industry-institution research and commercialization initiatives, demonstration projects or even regional clusters.

Considerable transformation across industry, communities and government must take place to achieve the ambitious climate goals set out by government. This will require aggressive policies, regulations, and investment which favour risk-taking and the adoption of innovative solutions across traditional industries, communities and government; encourage and incentivize more applied research and development; support the commercialization of innovative ideas and help firms to scale; and help remote and Indigenous communities to transition and assume more leadership.

While Springboard may not directly influence many of these factors, we will ensure that our members and our partners are aligned and positioned to apply our knowledge and resources to tackle the climate challenge and deliver meaningful projects.

Daryl Genge

President & CEO – Springboard Atlantic Inc.

Introduction

SPRINGBOARD ATLANTIC OVERVIEW

Springboard Atlantic (Springboard) is a member-based organization supported by ACOA and a network of 19 post-secondary institutions. The network is designed to grow Atlantic Canada's innovation economy through collaboration among the member institutions and industry.

In 2020, Springboard and ACOA proposed an expanded role for the organization to:

- Help address innovation gaps among key sectors within Atlantic Canada
- Accelerate opportunities for sector growth through increased commercialization and targeted collaboration among industry, academia, and government
- Introduce new technologies or solutions to address specific regional challenges

This vision led to the creation of the Springboard 360 Series — a specialized approach for convening experts across industry, government, and academia to focus on new opportunities for applied research, and the domestic adoption of innovative technologies within those sectors key to the Atlantic economy.

The initial three main areas of focus are: Cleantech, Agri-Food and Life Sciences/MedTech.

WHY CLEANTECH 360?

In 2021, the Government of Canada put in place the *Canadian Net-Zero Emissions Accountability Act*, which commits Canada to achieve net-zero emissions by 2050. This means that our economy either emits no greenhouse gas emissions or offsets its emissions. The federal government has also tabled a plan to reach a more ambitious climate target of 40-45% emissions reductions below 2005 levels by 2030. Many provinces, including Atlantic provinces, have introduced similar or even more ambitious commitments.

Cleantech 360 was a natural starting point for the Springboard 360 Series given government's commitment to net-zero emissions, the important research and development already underway among our members, and the opportunities to transition Atlantic Canada to a cleaner economy.

MEMBERS OF THE CLEANTECH 360 INNOVATION ADVISORY COMMITTEE (IAC)

The IAC members were selected among:

- Industry associations (3)
- Academia (5)
- Private sector (2)
- Government (2)

Bios of experts included in Appendix 5.

The following pages will provide an extensive summary of the discussions that focused on topics such as understanding the market opportunity in Atlantic Canada as well as the development and commercialization of technologies supporting Clean Energy and circular economy initiatives.

Cleantech market scope in Atlantic Canada

Before narrowing down the Cleantech market opportunities within Atlantic Canada, the IAC members focused on the market scope and areas where research and government funding can support technological solutions for industry challenges.

The IAC also identified limitations to developing innovative Cleantech technologies within the region. Some examples were: lack of infrastructure (no high-speed train development in Atlantic Canada, for example), regulatory environment, and technologies already available in global markets. Investing funds in value-added solutions should consider the market demand, the maturity of some technologies currently available, and the relative strengths of our region.

Five were taken into consideration when assessing the Cleantech initiatives in Atlantic Canada:

- The existing natural resources within our regions
- Our academic research capability, commitment to industry/academic partnerships and existing solutions ready for commercialization
- Identification of demonstration sites needed for existing early-stage technologies
- The government policies and available funding
- The pace of adoption in Atlantic Canada for innovations.

NATURAL RESOURCES ADVANTAGE — MARINE AND OCEAN

The Atlantic Ocean is the foremost natural advantage in the region and has been a source of multiple research opportunities, including marine transportation, green energy, hybrid vessels and aquaculture, among many others.

This natural advantage has facilitated the emergence of a vast array of innovations driving the development of Atlantic Canada's Cleantech sector, spanning multiple industries from Marine Renewable Energy to nutraceuticals.

ATLANTIC CANADA WORLD-CLASS EXPERTISE AND RESEARCH CAPABILITIES

Atlantic Canadian post-secondary institutions have been working with industry, monitoring the emerging needs for a carbon neutral society, and producing innovative and enabling technologies for domestic, national, and international use.

Unique expertise in Research and Development was highlighted in a variety of areas including, but not limited to:

- Waste to added-value products
- Environmental characterization, sensing, and monitoring
- Carbon capture and storage
- Green energies, including energy production (wind and solar), battery storage, electrification.
- Energy system modelling

DEMONSTRATION SITES

The IAC emphasized the need for more demonstration sites to accelerate the transfer of innovation from the lab to the market.

It is important to acknowledge that the market size in Atlantic Canada is comparatively small; hence generating ideas and demonstrating technologies suitable for domestic and export markets is essential. Global opportunities validate the need for initial government investment to offset the high cost of early production and adoption. Thus, improving the overall commercial potential.

The positive environment of collaboration between stakeholders and major players in innovation and technology makes it easy to qualify Atlantic Canada as a "good living lab environment" where we can demonstrate locally and export globally.

GOVERNMENT POLICIES AND AVAILABLE FUNDING

Canada's federal government is committed to advancing an ambitious clean growth agenda as the most significant funder of Cleantech initiatives. The table below shows funds committed by the federal government through the Climate Change plan and the major areas of focus in terms of product development and services delivery *(See Appendix 2)*.

The IAC emphasized the need to partner with the federal government to see where Atlantic Canada could naturally fit in a broader category for Cleantech and contribute to national goals. Areas can then be identified where the region can actively add value through human capital, institutional and industrial capacity, and natural resources.

ADOPTION PACE

Determining market opportunities and/or market size requires a better understanding of the commercial and consumer demands in the marketplace.

The pace of adoption of new technologies is an important factor in determining the market opportunities in the near future within Atlantic Canada. As a region, we seem to be late adopters to clean energy and clean technology. Many discussions highlighted the fact that demonstration projects could emerge as a solution to help raise awareness among contributors to the supply chain while demonstrating to the public that the innovative technology is safe, environmentally responsible and sensitive to local societal and cultural expectations.

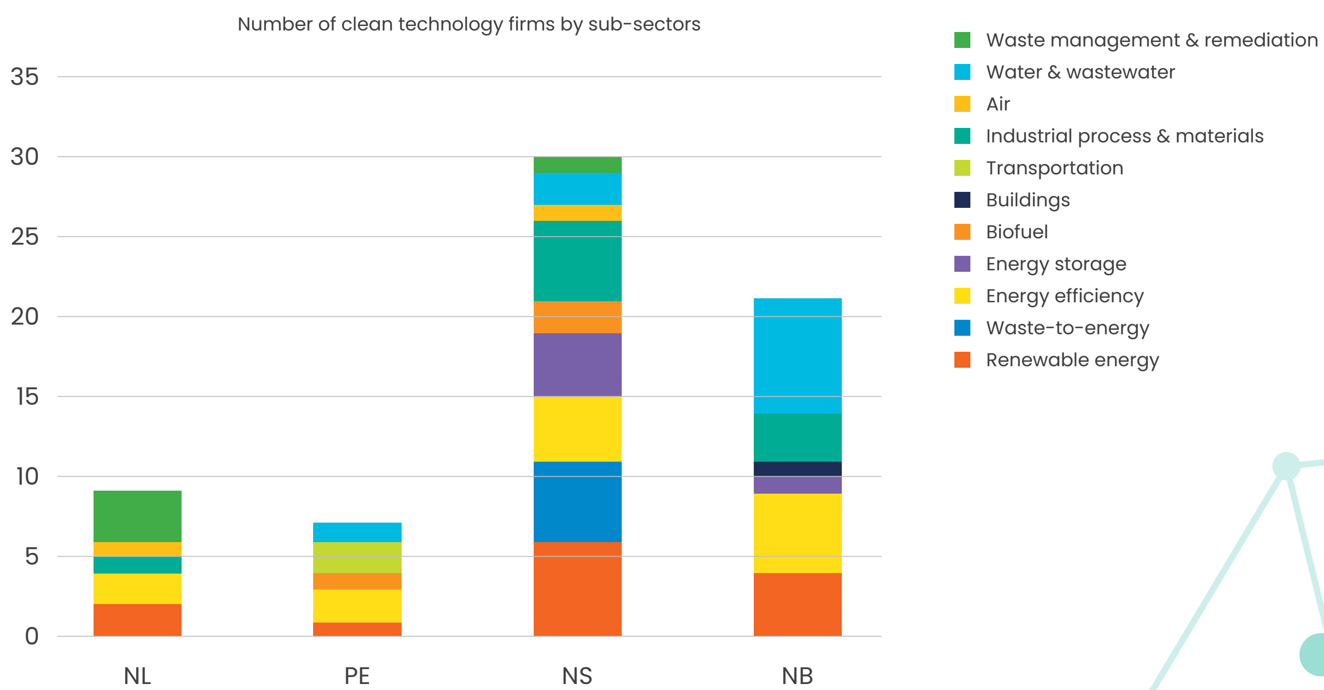
The adoption can also be "pushed" to the consumer through the products and services offered by cleantech companies operating in Atlantic Canada.

A detailed study around Clean technology firms in Atlantic Canada can be found in a report issued by APEC in 2018, and the graph below highlights the sub-sectors covered by these Atlantic Canadian firms.

Another research study issued by APEC in 2021 focuses on accelerating Clean Technologies adoption in Atlantic Canada. The APEC study shows that only 7% of Atlantic businesses adopted clean technology in 2019, below the national rate of 9%.

The growth potential is remarkably present within the Cleantech market in Atlantic Canada, which has led IAC members to discuss specific areas of focus.

Clean Technology Firms Spread Across Many Sub-Sectors



Source: APEC

Cleantech areas of focus for Atlantic Canada

The first meetings of the IAC focused on the different segments that comprise the Cleantech field and how to best structure the discussion so that the committee could start addressing opportunities and challenges for Atlantic Canada.

The IAC determined that the discussions should be divided into to two major categories (or frameworks) which represent distinct, yet interrelated opportunities for development.

1. **Clean energy** — The clean energy framework includes five elements: production, storage, delivery and use of clean energy. It also includes carbon capture, utilization and storage.
2. **Circular Economy** — The circular economy framework includes six elements: waste to value products, food waste, product reuse, water remediation, biofuels and environmental sensing and characterization.

The IAC was divided into two groups who each tackled a framework. A visual representation of each framework can be found in Appendices 3 and 4.

CLEAN ENERGY

The IAC discussed different elements within clean energy and highlighted significant areas of focus *(See below)*.

The first column indicates the market opportunity for domestic use or export, and the second column highlights the maturity level of the technology and the need for future research.

Energy production

	Market opportunity (domestic and global)	Existing technologies and potential for future research
ONSHORE WIND	• Some domestic opportunity for onshore wind, but ultimately dependent on decisions made by provinces and utilities. • Local demand for additional onshore wind capacity will be stimulated by the Green Choice program in NS. • Additional demand can be stimulated through resource assessments (where absent) and increased social license (especially in densely populated areas). • Export opportunity to the US exists.	• Mature technology. • Improve turbine design and materials to enhance efficiency. • Variable Renewable Energy (VRE) integration modelling studies. • Identify and develop cost reduction strategies/technologies. • Quantification of export market (electricity and hydrogen).
ONSHORE SOLAR	• Variable resource across Atlantic Canada — overall lower capacity factors than in solar-prone regions. • Local demand for additional solar capacity will be stimulated by the NS Shared Solar Program, for example. • Increase demand for solar buildout in regions with strong solar potential that are close to load centres.	• Mature technology and the industry are highly competitive. • Technologies developed would have to be extremely niche and targeted to have potential. • Thermal energy storage options in temperate climates. • Variable Renewable Energy (VRE) integration modelling studies. • Cost reduction.

Energy production *(Continued)*

	Market opportunity (domestic and global)	Existing technologies and potential for future research
OFFSHORE WIND (OSW)	• Excellent resource in Atlantic Canada, however demand for OSW capacity is currently constrained by the lack of additional electricity generation capacity for domestic demand. • Potential opportunity depending on the outcome of Atlantic Loop discussions (probably an opportunity for large-scale clean electricity development) but limited size of domestic opportunity. • International OSW market is developing quickly. • OSW/hydrogen hybrid projects receive a lot of attention, especially in Europe. • Some export possibilities might exist (further research needed).	• Mature technology. • Future research will reduce costs. • There is a small group of companies in Atlantic Canada that provide technologies supporting the offshore wind industry. • Existing technologies in other oceans industries to be applied in the offshore wind context. • Turbine's design and materials. • Resource assessment. • Environmental assessment. • Viability of electricity export to the US. • Viability of hydrogen/OSW projects. • Quantification of export market (electricity and hydrogen).
OFFSHORE SOLAR	• Local resource needs to be assessed, but cloud coverage limits applicability in Atlantic Canada. • Can be used in combination with OSW. • Offshore platforms for energy (wind, solar) could link in with environmental sensing - sensors and could be mounted on a platform and yield valuable data on environmental conditions. • Jaza Energy, an NS based company, commercializes clean solar energy to international markets (such as Tanzania) and is a good example of an IP developed locally offering export opportunities.	• Mature panel technology, developing new applications. • Resource assessment (with respect to integration with OSW). • Applicability in temperate climates. • VRE integration modelling studies.
TIDAL	• Local resource has attracted developers. • LCOE is a significant adoption barrier. • International limited applicability, but some interesting markets (e.g., UK). • Modular tidal could satisfy demand in off-grid communities.	• Developing technology, NS/NB are home to some exciting R&D activities around tidal (FORCE). • Species-specific automated identification methods.
HYDRO	• Resource limited in large parts of Atlantic Canada. • Possibly very substantial market with unexploited resources in Labrador. • Resource potential and demand for resource development (location-specific). • NEIA is doing research to understand international opportunity. • Increasing lack of social license for large hydro projects.	• Mature technology. • Location-specific investigation of how hydropower can be used to enable the integration of VREs.
WAVE	• Resource limited in large parts of Atlantic Canada. • LCOE is a significant adoption barrier. Commercializing requires significant cost reductions. • Resource potential and demand for resource development (location specific). • Good resource potential in BC, Australia, etc.	• Developing technology. • CNA in NL has engaged in wave energy research. • How to scale up wave energy converters. • Environmental assessments.
FRACKED GAS	• Limited applicability in parts of Atlantic Canada (moratorium in NS, controversial in NL). • With natural gas becoming an often-used transition fuel, fracking will likely continue to be in demand. • Coal bed methane could be a more acceptable option in some regions of Atlantic Canada.	• Mature technology. • Local resource assessments. • Minimizing methane leaks.
NUCLEAR	• Large market demand if social license challenges are overcome.	• Early-stage work - Moltex in NB. • Integration. • Cost reduction.

Since the majority of the technologies currently in use within energy production are mature, the opportunities exist more into adapting/enabling these technologies for local use, reducing production costs and barriers to adoption.

Regional academic strengths in monitoring and data analytics, as well as artificial intelligence will be key.

Carbon Capture, Utilization, and Storage (CCUS) is another category that emerged through the discussion. Note that CCUS also fits under energy storage. The visual framework (*Appendix 3*) is considered a separate category as the technology used may involve storage, production, and use.

Energy production

	Market opportunity (domestic and global)	Existing technologies and potential for future research
CARBON CAPTURE & STORAGE (CCS)	• Future demand for CCS is not known in Atlantic Canada but is a very important area of focus in the federal Climate change plan. • Storage options exist in Atlantic Canada, but suitability and capacity must be determined. • International demand for CCS will likely rise in jurisdictions with Greenhouse Gas (GHG) emission reduction targets due to the continued use of fossil fuels in electricity generation and industrial activities.	• Mature technology. • Chemists are working in the region to convert carbon dioxide into various products (plastics, fuels, materials). • Local storage capacity assessments. • Jurisdiction-specific quantification of CCS demand. • Nature-based sequestration potential and methods for calculating offsets.

Energy storage

	Market opportunity (domestic and global)	Existing technologies and potential for future research
BATTERIES	• With increasing VRE adoption, batteries will become increasingly important. • Lots of opportunities for rural and remote communities and industries, balancing electricity supply and demand, including over seasons. • Nova Scotia has great strength in R&D in batteries, including academic teams (Dalhousie) and companies (e.g. Kraken, AKA, etc.)	• Mature technology. • The market for batteries of various kinds is large and growing. • Flow battery system. • Materials research. • Usage strategies, which KPIs are minimized for which level of coordination (neighbourhood vs. region). • Control systems (software).
COMPRESSED AIR	• CAES could become increasingly important with increased long-term storage needs, fuelled by increased VRE adoption. • Salt cavern storage possibilities exist in Atlantic Canada • With increasing VRE adoption CAES could become increasingly important.	• A small number of projects are in operation. • Local resource assessments. • Offshore CAES potential assessments.
PUMPED STORAGE	• Limited applicability in large parts of Atlantic Canada due to our geographic features and elevations. • Important energy storage option in many jurisdictions (e.g., Norway).	• Mature technology.
HYDROGEN & AMMONIA	• Studies have found market development and production potential in Atlantic Canada. • The international market for hydrogen is developing fast.	• Mixture of mature technologies (e.g., electrolysers) and developing technologies (e.g., fuel cell use in transportation). • Market quantification. • Local feasibility studies (e.g., integration with OSW). • Regulations, codes, standards, etc. • Feasibility of simultaneous electrification and alternative fuels adoption (modelling). • Seasonal use of electrolysers (e.g., only used in summer when domestic electricity demand is low).
THERMAL	• Research has been done in multiple jurisdictions proving a value to leveraging thermal mass as a storage strategy that can then be used for grid resilience. This approach in technologies such as hot water building envelope is used successfully in other jurisdictions for grid resilience.	• Smart Hot water tanks. • Smart Home/thermostats. • Code Development. • Ancillary services usage. • Rate design.

Energy transportation

	Market opportunity (domestic and global)	Existing technologies and potential for future research
ELECTRICITY TRANSMISSION	• Interprovincial transmission will become increasingly important in Atlantic Canada (e.g., Atlantic Loop). • Interjurisdictional transmission will become increasingly important due to increased VRE shares.	• Mature technology. • Regional modelling studies will determine the necessary transmission upgrades.
ELECTRICITY DISTRIBUTION	• Interprovincial electricity distribution could become increasingly important in Atlantic Canada due to increased peak loads in the coming decades.	• Regional modelling studies will determine the necessary grid upgrades. • Grid simulation hardware.
HYDROGEN TRANSMISSION & DISTRIBUTION	• Developing market: transmission and distribution will be necessary when local market is being developed.	• See below for more information regarding the integrated hydrogen model presented by AKA.

Energy use

	Market opportunity (domestic and global)	Existing technologies and potential for future research
PASSENGER ELECTRIC VEHICLE (EV)	• Atlantic Canada faces an increasing adoption of EVs but is still trailing behind other regions. • Important decarbonization option for all jurisdictions.	• Mature technology. • Battery research. • Infrastructure buildout plans. • Modelling system impacts of increased peak demands. • Adoption possibilities of controlled charging. • Simulation hardware.
TRUCK EV	• Market might develop in combination with the demand for hydrogen fuel cell trucks. • Important decarbonization option for all jurisdictions (in combination with hydrogen fuel cell trucks).	• Early-stage development. • Battery research. • Infrastructure buildout plans.
AIRPLANE & MARINE EV OR LOW CARBON FUELS-MARINE VESSELS	• Decarbonizing air travel and marine transportation will become important in low-carbon societies — alternative fuels seem more likely than batteries. • How to improve environmental performance across the board for marine vessels is important, as so much of Atlantic Canada's economy depends on marine transportation in some shape or form.	• Propulsion systems. • Particular need of understanding how to improve environmental performance of small craft (e.g. fishing vessels), of which there are many in Atlantic Canada.
RESIDENTIAL SINGLE DETACHED/ MULTI- UNIT & COMMERCIAL BUILDINGS	• Reducing the energy demand in buildings is an important aspect of deep decarbonization strategies in all jurisdictions.	• Research will focus on the end-uses of energy (e.g., reducing heating demand). Many concepts exist and are applied in other jurisdictions — applicability for local building stock is important. • Building to grid optimization research.
INDUSTRIAL	• Industrial decarbonization will become important in Atlantic Canada and jurisdictions with large industrial loads.	• Finding alternatives for GHG. • Emitting industrial processes (sector-dependent).
AGRICULTURE	• Agricultural decarbonization will become important in Atlantic Canada, but its importance will differ from province to province.	• Finding alternatives for GHG. • Emitting agricultural processes.

CIRCULAR ECONOMY

Canada's government defines a Circular Economy as a different way of doing business.

n a circular economy, nothing is wasted. The circular economy retains and recovers as much value as possible from resources by reusing, repairing, refurbishing, remanufacturing, repurposing, or recycling products and materials.

It's about using valuable resources wisely, thinking about waste as a resource instead of a cost, and finding innovative ways to better the environment and the economy.

(Source: https://www.canada.ca/en/services/environment/conservation/sustainability/circular-economy.html)

The framework designed by the IAC Committee helps to understand better the opportunities for technology development in the various areas covered by Circular Economy.

Circular Economy

	Domestic and international market opportunities	Existing applied research and technologies	Required future research
WASTE UTILIZATION	• Some increasing opportunities but currently somewhat limited due to capacity and issues such as distance between communities and waste facilities. • Greater market — opportunity for international partnerships for waste utilization. • Right now, transportation can be an issue. This can allow for transfer of technologies to utilize waste to other regions of Canada / internationally.	• Technologies for biomass utilization in areas of food, nutrition, agriculture, extraction value from industrial wastewater. Other areas like mattress recycling and reuse are being explored. • Sustain Technologies is developing new technology that can take municipal solid waste and convert it back to raw materials. Propel BioEnergy is developing technologies that convert low-value waste (wood and municipal solid waste) into high-value energy products. • Several companies are looking to take food waste from their production line and create secondary products for other verticals (food, animal feed, nutraceuticals, agriculture). • Other companies exist in Canada (e.g. Enerkem in Edmonton AB and Quebec) that are doing great work with waste utilization.	• Creating technologies that can be used in smaller communities across the region so that each area can benefit from waste diversion without high costs of shipping to centralized facilities. Also, utilizing waste at the source of waste creation may be useful. • For example, technologies that can help food producers convert waste into value added products at their production facility rather than partnering with another company to make use of these waste products. • New technologies that can work on a smaller scale with lower population densities rather than relying on shipping waste (due to economies of scale).
CONSTRUCTION	• Smaller market — localized opportunities useful in remote areas where waste transportation is costly and/or local storage is becoming problematic. • Lots of opportunities in North America for construction waste such as siding / shingles. (Perhaps not as relevant internationally). Construction waste amounts to a great deal more waste than household waste (at least in NA). Other materials in other markets likely have huge potential as well.	• Research being done that looks at secondary markets for roofing shingles that both repurpose them and are an environmentally friendly alternative to fill and other items being used. • New materials are being tested for use in construction (insulation / concrete). For example, additives to concrete that retain strength but capitalize on secondary products — reducing primary resource use (and are also more environmentally friendly). • As construction materials and methods can be region-specific, focusing on key broadly used materials such as concrete would be significant.	• Effective waste separation technologies to help large construction projects sort waste at the site — moving end-use waste to the landfill and separating waste with potential value into usable categories for transfer to places that can remediate the waste / recycle parts.

Circular Economy *(Continued)*

	Domestic and international market opportunities	Existing applied research and technologies	Required future research
WATER / OCEAN PRODUCTS	• Some significant opportunities: Areas like Boat Harbour are working to remediate their water supply. Indigenous communities in AC lack clean water; companies creating wastewater are looking to free it of contaminants (costly to dispose of) and find ways to extract value from the wastewater itself for salvage and further use. • Plenty of water needing remediation throughout Canada and internationally. Oceans are certainly a huge opportunity nationally and internationally with numerous applications / opportunities.	• Variety of filtration technologies are in development — many endeavouring to develop technologies that use less energy and are more effective at removing trace key contaminants. Also, isolating important items from the extraction process and salvaging them for future use. • New technologies that can work on a smaller scale with lower population densities rather than relying on shipping waste (due to economies of scale). • There is a mixture of existing technologies (e.g., developed in Japan etc.) that could be imported, but also lots of traditional knowledge and regional expertise that could be built on too.	• Nationally, we need to develop technologies that can bring clean drinking water to Indigenous communities (and others?) lacking this basic right. Once developed, this can be a fantastic technology to transfer internationally. There are tremendous opportunities in terms of ocean technologies, to name a few: sensors, biofouling, ocean renewables, etc.
MINING/ FORESTRY ETC. (NATURAL RESOURCES)	• Abandoned mines require remediation and have water that can be “mined” for valuable minerals. Waste from forestry can be used in many applications - biochar is made from many types of woody biomass. • Same opportunities exist nationally and internationally. Mining for current and abandoned mines.	• There are regional centres on ‘adding value’ to forestry and large companies (e.g., Vale) working in the mining sector in the region. There is significant research in these areas across universities in the region (scientists and engineers) and some existing collaborations related to traditional knowledge (e.g. https:birchbarkoil.com). • Sea tree char is another example of a company that uses biochar (from forestry and seafood waste) to produce products that can be used in cosmetics, agriculture, and construction. • Extracting valuable minerals from abandoned mines - helps with environmental issues and extracts valuable resources. • Much work is ongoing with CNA in NL on process optimization.	• A lot of research has been done in Quebec and BC (e.g., paprika/ crystalline nanocellulose products) to develop new technologies for forestry. • A lot of the work in the region is on a smaller scale. Scaling up to demonstrate these technologies in other locations would aid in their transmission to new regions and promote commercialization of the research.
AGRICULTURE	• Only limited by population considerations. • Greater market due to more operations nationally and internationally.	• Many of the areas above have application in agriculture. • Lots of opportunities for soil amendments from waste products (sea and forestry), water diversion, planning to help crop rotation, energy-efficient technologies to assist with farming, green fertilizers / pest repellants.	• N/A

Members’ perspectives

Some additional areas were presented by some members of the Innovation Advisory Committee. We will detail the following two: The Hydrogen production and reuse presented and the Environmental Characterization and Monitoring.

AKA group presented a case for a clean fuel project through an Integrated Hydrogen model. An Atlantic Hydrogen Alliance has been launched end of 2021.

ATLANTIC CANADA’S INTEGRATED HYDROGEN OPPORTUNITY

Waste energy from renewables can power the electrolyser process in creating hydrogen, making this process more efficient.

This hydrogen is then used for:

- Trucks.
- Buses.
- Cars.
- Ferries.
- Inshore and nearshore marine fleet.

Atlantic Canada can set up the ideal infrastructure for these applications, given the context of increased renewables on the grid.

- Regional Hydrogen production.
- Mobile H2 refuelling truck.
- Hydrogen Refuelling Stations.

Benefits

- Major reduction in greenhouse emissions.
- Reduced reliance of Atlantic Canada on external energy sources — become an energy export economy.
- Position region for first-mover advantage.
- Capture of waste energy based on excess renewables.
- Choose focus elements based on the opportunities.
- Create a regional technical niche for global energy transition (exportable service and products).

Research opportunity

Producing hydrogen from “excess” renewable electricity poses a technical challenge if that renewable electricity is primarily wind power. “Excess” wind power varies greatly on short timelines, but a hydrolysis plant that makes hydrogen runs better at a constant rate. Solving that issue could be one of the focal points of applied research work.

ENVIRONMENTAL CHARACTERIZATION AND MONITORING

Atlantic Canada has developed world-class expertise in the field of environmental sensing, characterization, and monitoring. This area of activity includes the use of various technologies (e.g., laser, sonar, radar, satellite, eDNA, etc.) to understand our impact on the environment and the impact of the environment (e.g., climate change) on us. Significant expertise and capacity exist in both the private sector and research institutions throughout the region with particular richness in ocean and offshore operations, but this expertise extends into terrestrial applications as well. There are opportunities for continued innovation within this micro-cluster, including how technologies might be developed and deployed relative to new clean energy applications.

Recent research undertaken titled "Understanding current activity and capacity in clean technology research, development, and innovation in Canada's Offshore Oil and Gas Industry" explicitly identifies and references this area as being a strength in Atlantic Canada that should be supported. The report can be viewed and downloaded.
The space between digitalization, oceans, and the environment is increasingly becoming a top priority within Atlantic Canada — and its strengths related to environmental characterization and monitoring will be one of the primary drivers.
The acquisition of ocean data is consistently rising to the top of the list in discussions re: Cleantech and blue economy in the region — it is a great need, challenge, and opportunity that could benefit significantly from greater attention, focus, and support.

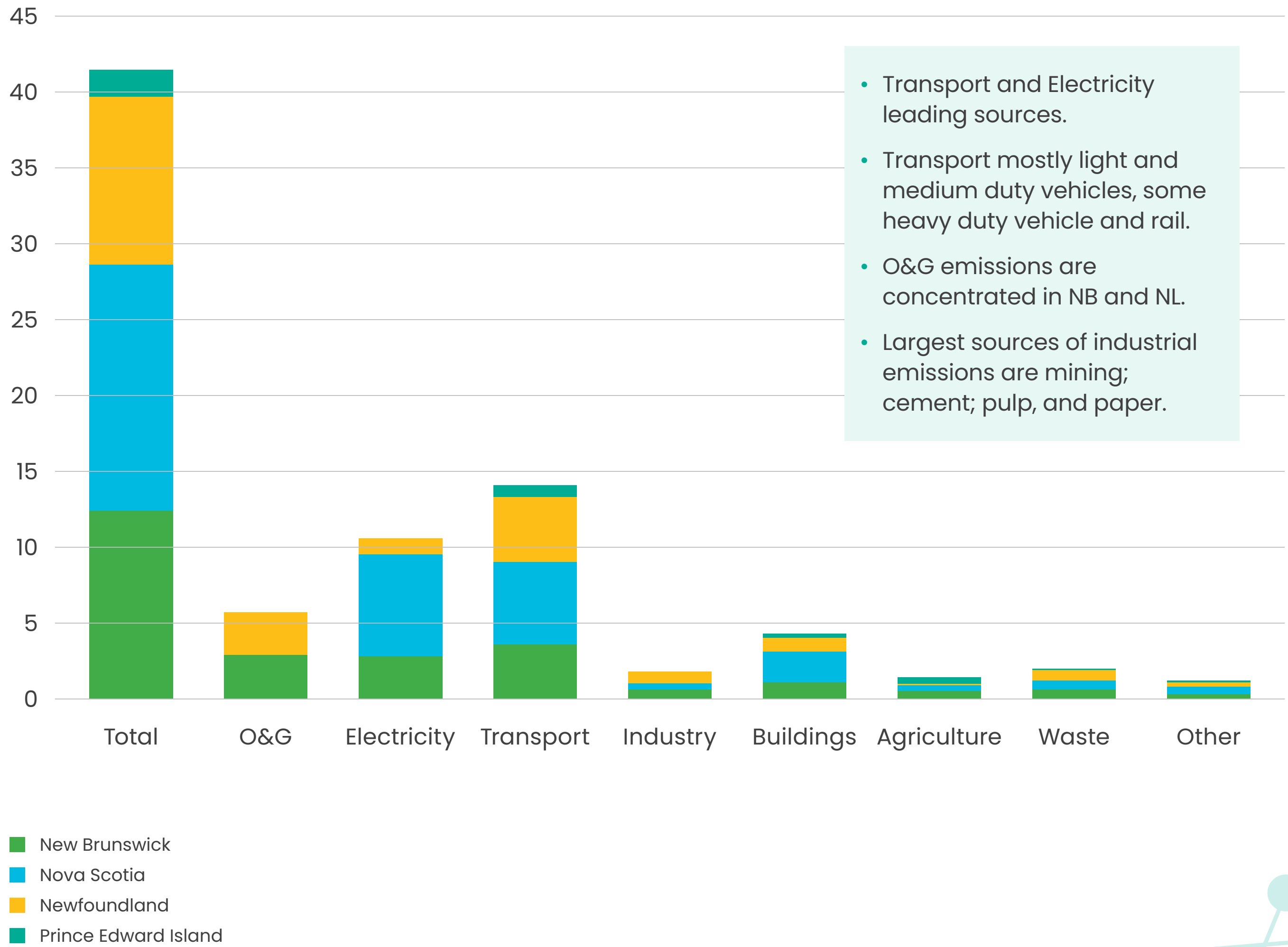
Conclusion

The recommendations of the IAC Committee after the discussions wrapped up in November 2021, were to seek more engagement between industry and academia based on the identified needs. Connector events will be held to underline challenge statements and further assess opportunities for technology development. Work has already started to understand communities needs in terms of energy transition, and other research is being conducted around waste to value. This market study will aid in advancing specific projects by using the expertise of our valuable researchers and will contribute to the increased adoption and usage of Clean Technologies in Atlantic Canada.

A special thank you to all the members of the Innovation Advisory Committee who contributed with their time and expertise to this work.

APPENDIX 1:
Atlantic Canada emissions profile

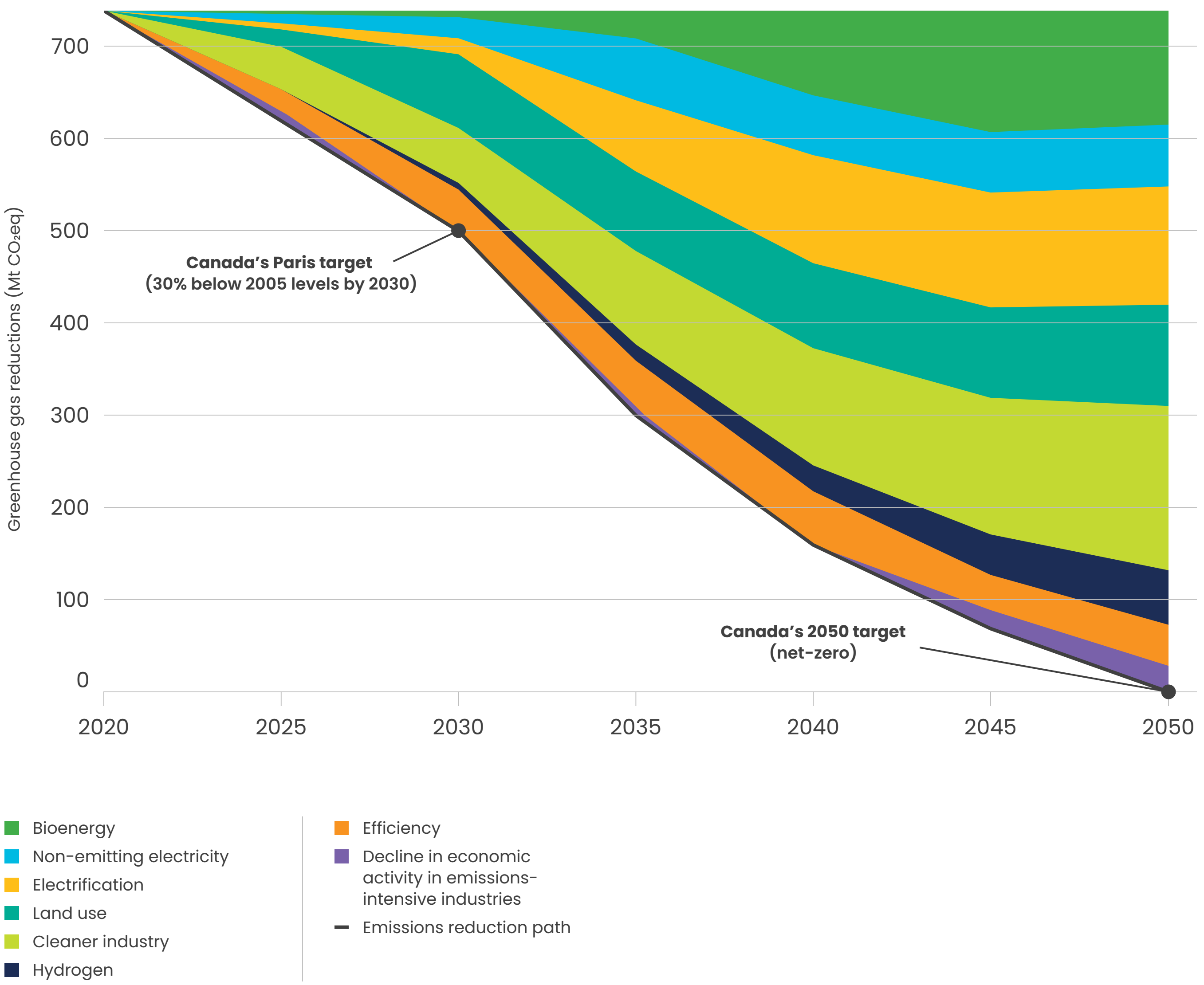
2019 GHG Emissions by Province/Sector (Mt CO_2eq)



- Transport and Electricity leading sources.
- Transport mostly light and medium duty vehicles, some heavy duty vehicle and rail.
- O&G emissions are concentrated in NB and NL.
- Largest sources of industrial emissions are mining; cement; pulp, and paper.

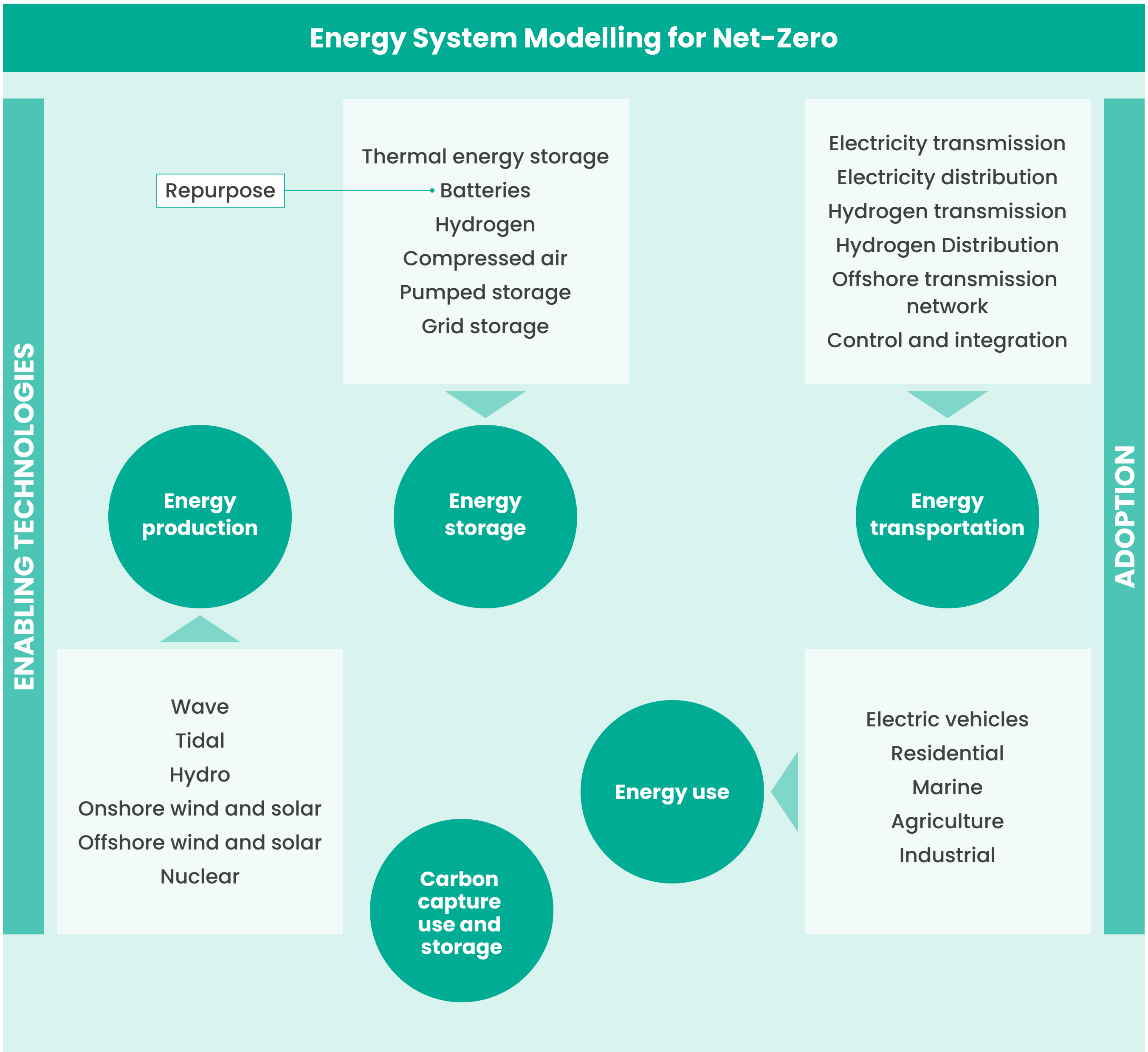
Source: Natural Resources Canada

APPENDIX 2:
Canada's path to net-zero



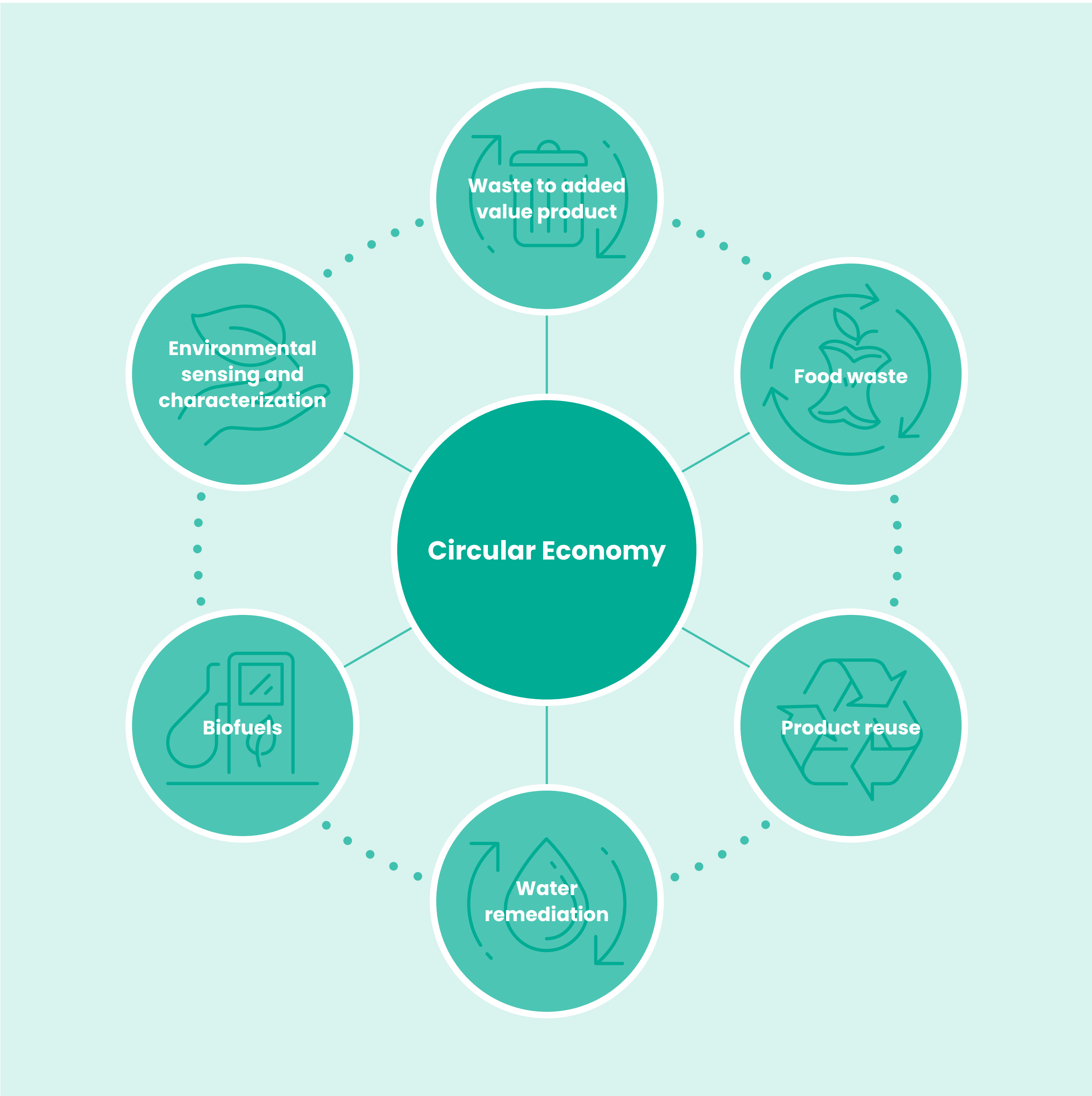
Source: Natural Resources Canada

APPENDIX 3:
Energy table framework



APPENDIX 4:

Circular economy table framework



APPENDIX 5:
IAC experts' bios

Lynn Adams

Director, Energy Policy and Coordination
ATLANTIC CANADA OPPORTUNITIES AGENCY (ACOA)

Lynn Adams is responsible for providing strategic advice and solutions to senior management on complex and sensitive energy policy issues, as well as developing cooperative relationships, consulting, negotiating and engagement with senior officials in industry, provincial and federal departments, municipal governments, communities, and institutions.

Lynn has more than 25 years of public administration experience at both the federal and provincial levels. She obtained a Bachelor of Arts degree from St. Francis Xavier University, followed by a Master of Public Administration from Dalhousie University, where she was the recipient of the Institute of Public Administration of Canada's Award for Academic Excellence.

Lynn manages a team focused on analytical, research, coordination, and advocacy activities whose work informs federal efforts in support of the development of energy projects in the region.

Graham Allen

Manager, Investments and Partnerships (Office of Energy Research and Development)
NATURAL RESOURCES CANADA

Graham is the Manager of Investments and Partnerships for the Office of Energy Research and Development at Natural Resources Canada. He manages the Energy Innovation Program, which provides support for clean energy technology research, development, and demonstration (RD&D) across Canada. Prior to this, Graham has worked on climate technology innovation and international trade policy and promotion for the Government of Canada in positions with Sustainable Development Technology Canada; Innovation, Science and Economic Development Canada; The Canadian Consulate in New York City; and Global Affairs Canada.

Jason Aspin

CEO and CTO
ASPIN KEMP AND ASSOCIATES (AKA)

Jason Aspin co-founded Aspin Kemp and Associates in 1996 where he fulfills the positions of CEO and CTO. Since graduating in marine engineering from the Canadian Coast Guard College in 1987 with specializations in power engineering and systems integration, he has built over 35 years of progressive experience in systems engineering in the Industrial, Marine, and Offshore environments.
As an innovator, he dedicates his time to designing solutions which are both socially and environmentally responsible often introducing energy storage technologies to new applications. He has collaborated with other global innovators to develop new technologies of which several have been patented and have made a significant contribution in reducing the environmental footprint, increasing reliability, and reducing operating costs for land-based and marine power generation systems around the world.

Sarah Conrod

Manager, Industry Partnerships & Research Commercialization
CAPE BRETON UNIVERSITY (CBU)

As the Manager of Industry Partnerships & Research Commercialization Sarah is responsible for leading commercialization and industry engagement and managing intellectual property protection activities, providing project management and drafting and managing contracts for collaborative projects. She has extensive experience mentoring researchers and entrepreneurs, working with faculty to explore the commercializing of their research, and developing academic-industry research partnerships which extend the expertise of CBU faculty and researchers to external partners. She also provides outreach through developing and delivering workshops, coaching entrepreneurs and liaising with partnering organizations in the community.

While in previous roles at CBU Sarah was nominated for a World Technology Award and is recognized as a co-inventor on two patents with IBM. Sarah has co-authored several scholarly articles and presented at conferences throughout North America and Europe. She sits as a board member at Navigate Start-up House, is a committee member for the Divert NS student funding committee and is an active member of the Springboard IM Committee. Sarah has a BSc and Certificate in Public Administration from CBU, a Masters of Education in IT from Memorial University and has attained Project Management Professional designation (PMP).

Hart Devitt

Director, Industry and Government Services
UNIVERSITY OF NEW BRUNSWICK (UNB)

As part of UNB's Office of Research Services, Hart and his team connect external partners with university expertise, bringing applied, innovative solutions to industry. With undergraduate and graduate degrees from UNB, Hart emigrated to Australia, working 10 years in research administration at the University of New South Wales. Returning to Canada in 2008 he has extended his scope of work, providing him with a broad perspective on academic/industry partnerships in the region and the funding landscape that provides project support. He and his team work closely with economic development agencies and other stakeholders to ensure that the intellectual property developed at UNB is relevant and accessible to industry, business, and the broader community.

Wayne Groszko

Applied Energy Research Scientist
NOVA SCOTIA COMMUNITY COLLEGE (NSCC)

Wayne Groszko works to facilitate the transition to clean energy as Applied Energy Research Scientist at the Nova Scotia Community College. Dr. Groszko is a researcher, consultant, teacher, and speaker in energy sustainability with 13 years of experience. He has completed work for the Province of Nova Scotia, Nova Scotia Power, the Community Energy Co-operative of New Brunswick, and the Ecology Action Centre. Wayne is also an Adjunct Professor at Dalhousie University and completed a study on the solar energy industry in Atlantic Canada for Solar Nova Scotia. He holds a Bachelor of Science (Hon.) from the University of Calgary, and a Ph.D. from Dalhousie University.

Kieran Hanley

Executive Director
ECONEXT

Kieran Hanley is the Executive Director of econext, an association of over 200 working towards accelerating clean growth in Newfoundland and Labrador. Kieran has worked within the clean technology, green economy, and environmental services sector for over nine years — making him one of the province's subject matter experts on clean growth and the economic development associated with it. Kieran has an MBA (Community Economic Development) from Cape Breton University, a Bachelor of Commerce (International Business) with Dalhousie University, and a Certificate in Economic Development from the University of Waterloo. He is the Vice-Chair of the Economic Development Association of Newfoundland and Labrador (EDANL).

Francesca Kerton

Professor, Chemistry
MEMORIAL UNIVERSITY OF NEWFOUNDLAND (MUN)

Francesca Kerton is a professor of Green Chemistry at Memorial University of Newfoundland and has a global reputation for her pioneering research on sustainable chemistry related to the oceans in particular using waste biomass from aquaculture and the fisheries. She also performs research in the area of carbon dioxide utilization and is part of an NSERC-funded training network "Centre for Innovation and Research on Carbon Utilization in Industrial Technologies". Her group studies both natural (e.g., chitin, collagen) and synthetic polymers (e.g. polyesters, polycarbonates), and they have been investigating their degradation under chemical and biological conditions. She is a member of the recently established Atlantic Canada Environmental and Sustainable Chemistry Centre.

Alisdair McLean

Executive Director
OFFSHORE ENERGY RESEARCH ASSOCIATION (OERA)

Alisdair McLean is the Executive Director of OERA. Alisdair brings to the OERA 30 years of experience in technology-driven companies, working to commercialize innovation. For the past 14 years Alisdair has worked for start-ups in the renewable energy and energy conservation industries. As an engineer, he co-authored several patents, and as a business development executive he led renewable-energy project development initiatives across North America, in Europe, Australia and China. He has a Mechanical Engineering degree from Dalhousie University, and is a Professional Engineer.

Gregory Robart

CEO
SMART GRID INNOVATION NETWORK (SGIN)

Greg has a career in solving industry challenges and has held several senior leadership positions in energy management, automation, building design and utility transformation over the past twenty years. Prior to leading the Smart Grid Innovation Network Canada Inc. His previous position at Siemens was Siemens' Global lead for its Managed Transition offering that supports utilities during their transition toward a cleaner, digitalized operational model. He has championed this type of transformation work in Canada, the US, and the Middle East. Prior to Siemens, Greg held Sr positions responsible for complex System integration project Delivery Management and Risk Management in the Health Care, Corrections, Government and Communications sectors. Greg was also a Partner in an Engineering consulting firm responsible for managing the Buildings practice in a multi-disciplinary firm. Greg started his career responsible for the regional engineers and union personnel for Honeywell Ltd., delivering energy audits and automation solutions and services in the Commercial and Institutional sectors. Greg has held positions in professional organizations, including the Association of Professional New Brunswick and is past president of the Consulting Engineers of New Brunswick.

Lukas Swan

Associate Professor, Department of Mechanical Engineering
DALHOUSIE UNIVERSITY (DAL)

Lukas Swan is a Professor of Mechanical Engineering and the Principal Investigator at the Dalhousie University Renewable Energy Storage Laboratory. He has 20 years' experience with battery energy storage for electric vehicles and renewable energy (he has been an EV driver for decades). He focuses his R&D on unique, elegant, and robust solutions to transition from fossil fuels to efficient electrification. Lukas has a broad range of experimental and modeling experience with major battery chemistries and energy storage technologies. He has developed, tested, and evaluated an enormous variety of battery packs ranging from hand tools to freight trains to grid storage to remote islands. He is also a member of CSA and UL committees that have created and published international standards for energy storage systems. Lukas received his PhD and Master's from Dalhousie University and his Bachelor's from California Polytechnic San Luis Obispo.

Evan Willemson

Business Development Manager
ASPIN KEMP AND ASSOCIATES (AKA)

Evan Willemsen is the Business Development Manager for Aspin Kemp and Associates and has over 25 years of international experience in the maritime sector. After graduation from the Technical University of Twente in the Netherlands and as a commercial/mechanical engineer, he has held several commercial and operational positions in ship owning companies. Within AKA his focus is the transition from fossil fuel based electrical systems to renewable energy fuelled systems.

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