Alberta Innovation Ecosystem

BARRIERS TO COMMERCIALIZATION STUDY

FINAL REPORT (REV 1)

22 DECEMBER 2023

exergy

1 REPORT SUMMARY

1.1 INTRODUCTION

Despite Alberta's significant progress over the last decade in fostering innovative technology ideas and pioneering start-ups, the innovation ecosystem must continue to evolve at pace to meet changing landscapes and international competition. Recognizing that the path to commercialization can be fraught with challenges, the innovation ecosystem enablers in Alberta want to create the conditions to ensure that Alberta companies do not need to migrate to other jurisdictions to commercialize their technology.

The Alberta Innovation Ecosystem Partners ("Ecosystem Partners") represent a collective of organizations that are funded to support Alberta's entrepreneurs and technology development across a variety of sectors. For this study, the Ecosystem Partners include Emissions Reduction Alberta ("ERA"), Alberta Innovates, Prairies Economic Development Canada, and Sustainable Development Technology Canada. ERA, on behalf of the other named partners, engaged Exergy Solutions Inc. ("Exergy") in a study to better understand the non-technical barriers to technology commercialization in Alberta, with a specific focus on clean technologies, or "cleantech"[1].

The primary objective of this study, named the "Barriers to Commercialization Study" and referred to herein as "the Study", was to identify and assess the barriers hindering technology commercialization in Alberta and to provide recommended solutions to mitigate them. Conducted over approximately 5 months, the Study involved four main undertakings: **(1)** framing the strategic context; **(2)** conducting interviews with ecosystem players; **(3)** researching global best practices for innovation support (via a jurisdictional scan); and **(4)** formulating recommendations to address the identified barriers. These are outlined further in the following subsections of this report summary.

1.2 FRAMING THE STRATEGIC CONTEXT

In setting the strategic context, ERA's project data and business planning documents were analyzed to assess the current state of both Alberta's and Canada's innovation ecosystem. Key attributes of the innovation ecosystem, including how it currently operates, its key players, and its driving forces and constraints were identified and defined.

To understand the multiple dimensions of the technology innovator's journey, the funding sources and business activities were mapped out throughout the varying stages of the technology development lifecycle (from ideation through to commercialization and maturity). Throughout this process, it was highlighted that not all technologies follow the same technology-to-market channel to commercialize and that the type of channel informs the nature and impact of the barriers as well as what is needed to enable

[1] *Often referred to as "cleantech", clean technologies encompass processes, products, or services designed to diminish adverse environmental effects by achieving substantial enhancements in energy efficiency, promoting sustainable resource utilization, or engaging in activities focused on environmental protection.*

success. In fact, identifying the appropriate channel for a given technology is a critical aspect of understanding its barriers and success factors and for this reason is mentioned in the forefront of this report.

The traditional channels outlined to support the Study's analysis include Business-to-Customer (B2C), Business-to-Business (B2B), and Business-to-Government (B2G). In addition, as one of the defining outcomes of the Study, the need for a non-traditional channel, called Business-to-Project (B2P), was recognized. While traditional channels have been proven pathways to successfully commercialize many technologies, they are not suitable for all types of technologies. For technologies that require integration into large projects for commercial deployment, the B2P channel is necessary.

The B2P channel represents the pathway through which a new technology is deployed as a component of a discrete complex and capital-intensive project, where the new technology is likely to be integrated with several other new or conventional technologies. The full combination of resources required to conceive and execute these types of projects is not likely to be found in a single firm. Given that it is the most challenging channel and the avenue through which technologies with the greatest decarbonization potential need to commercialize, it was established as a key focus area for the Study.

1.3 Conducting Interviews with Ecosystem Players

The Study consisted of ~30 interviews with various ecosystem players to gain a nuanced understanding of non-technical barriers to commercialization. Specifically, 11 interviews were held with small and medium enterprises (SMEs) which are developing cleantech ("Technology Innovators"). Another eight (8) interviews were held with facility owners/operators deemed to be potential technology adopters, and 10 interviews were conducted with ecosystem "Enablers", categorized within the Study as organizations including accelerators, funders, and engineering firms.

These interviews revealed several non-technical barriers bucketed into three themes:

1) **Technology Innovator Needs (T):** those associated with a lack of resources and skills within SME technology innovator enterprises.

2) **Context (C):** those resulting from ecosystem conditions.

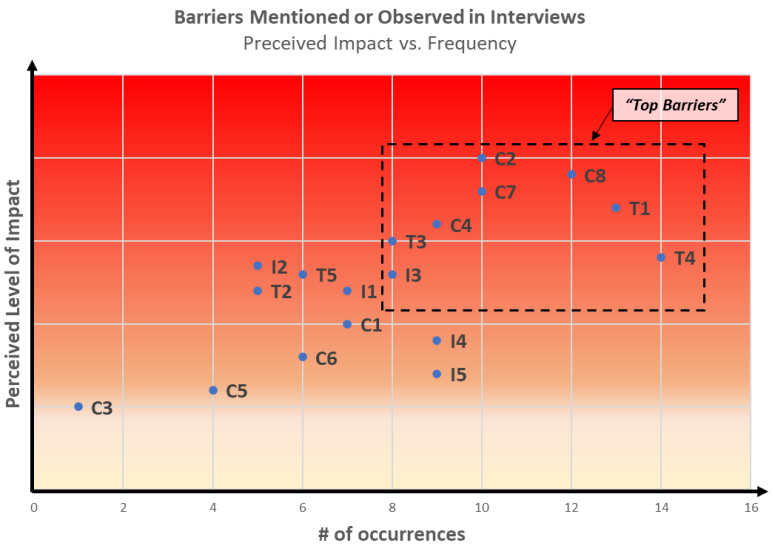
3) **Integration (I):** those linked to a lack of coordinated and effective collaboration among various parties within the ecosystem.

Leveraging the mapping of pain points along the technology innovator journey framework coupled with interview observations and analyses, these barriers were further synthesized into eight (8) "Top Barriers" and key patterns, providing guidance for the focus of the Study's recommendations.

In general, the interviews revealed that shortages or delays in technology commercialization faced by Alberta predominantly stem from external factors, depicting it as an ecosystem-wide challenge rather than simply due to shortcomings in individual partners or organizations.

While some barriers prevent deployment of cleantech in the province (such as first-of-a-kind deployment risk, inadequate and/or uncertain incentives / policies / regulations for cleantech adoption, and limited financing options for large projects), there are other barriers that slow the process of transforming ideas

into commercially viable solutions (such as lengthy grant processes, high cost of technology validation projects, investors' knowledge gaps, and innovators' skillset deficiencies).



Code #	Barrier Name
T1	Tech Innovator Skillset Gaps
T2	Network-Based Opportunity Access
T3	Resource-Intensive Tech Validation
T4	Lengthy & Constraining Grant Application Processes
T5	Use Case Knowledge Gap
C1	Boom-Bust Cycles of Potential Adopters
C2	Undervalued Sustainability Benefits
C3	Vendor Approval Process Onerous
C4	Culture of Risk Aversion and Fear of Failure
C5	Surplus of New Tech
C6	Expectations for Big Impacts Fast
C7	First of a Kind (FOAK) Project High Cost & Risk
C8	Government Policy/Regulatory Flux & Complexity
I1	Ecosystem Complex & Uncoordinated
I2	Project Financing Ecosystem Gaps
I3	Investors & Funders Knowledge Gaps
I4	Unclear Funding Agencies' Success Criteria
I5	Intellectual Property Protection

Note: This colour indicates a top barrier

More detailed descriptions for these barriers are provided in **Section 7.1**. Meanwhile, a summary of the Top Barriers is included here:

T1: Tech Innovator Skillset Gaps

Start-up technology companies can often lack certain skills, including a lack of business, financial, presentation, developer, and engineering skills. In addition, there is a supply shortage issue for certain skillsets in Alberta and Canada, further exacerbating the issue.

T3: Resource-Intensive Tech Validation

There is a lack of sites, supporting services, and partners for hard technology validation in industrial environments, hindering progress between TRL 4 and 7. Additionally, there is a shortage of funding options for technology validation projects requiring $1 million or more.

T4: Lengthy & Constraining Grant Application Process

Funding processes are too long causing uncertainty and cash flow issues, and funding calls are not aligned with plans of companies (scope & timing). In addition, prescribed costs eligible for innovator funding may not cover all their needs.

C2: Undervalued Sustainability Benefits

The non-economic and broader sustainability benefits associated with new technologies are not adequately recognized or quantified in the current incentive and regulatory frameworks. Facility owners/operators and potential adopters of cleantech, driven by their responsibility to shareholders, lack incentives to fund or adopt new technology, especially when it might disrupt existing operations and/or increase operating expenses.

C4: Culture of Risk Aversion

There is a reluctance or avoidance of taking risks on new technology due to a preference for certainty and a fear of potential negative outcomes. Resistance can include lack of comfort in/understanding that technology development requires risk and a portfolio approach. Developers, large industry players, and funders/lenders are hesitant to invest in technologies without a more certain chance of success.

C7: First of a Kind (FOAK) Project High Cost & Risk

FOAK projects generally have high cost and high risk that divert lenders, investors, and potential industry partners/operators as everyone is interested in being second or third, but no one wants to be first in the space. A "chicken and egg" scenario exists where funders/industry want the technology to be fully de-risked prior to investment, however, someone needs to go first before it can be fully de-risked.

C8: Government Policy / Regulatory Flux & Complexity

Many fear permitting delays, government interference, and changes in carbon reduction incentives and regulations. For innovators and large industries alike, comprehending complex regulatory and policy frameworks can be very difficult. In some cases, regulations and policies may favour large industry, presenting obstacles for smaller potential adopters of cleantech.

I3: Investors & Funders Knowledge Gaps

There is a potential lack of knowledge or understanding in the investor community, as well as among government policymakers and funding agencies, regarding factors such as the technical & practical merits and impacts of emerging technology and the needs/wants of potential adopters. Energy system, technical challenges, and technical solutions are very complex, and decision makers are not always equipped to understand what is presented to them.

1.4 Performing a Jurisdictional Scan

The Study also included a jurisdictional scan to identify successful ecosystem-enabling practices worldwide that could serve as strategies to alleviate barriers found in Alberta. This scan consisted of a review of literature pertaining to jurisdictions outside of Alberta, exploring cleantech programs, policy instruments, emergent hubs, and other success stories to gather valuable lessons. Examples of success factors from the jurisdictional scan include:

1) Affordable access to innovation infrastructure (labs, equipment).
2) Creative funding mechanisms that prevent depletion of the working capital needed in the early stages of innovation.
3) Deliberate networking support for start-up companies and the promotion of collaboration between start-ups as well as innovator-to-potential customer partnerships.
4) Support throughout the lifecycle of technology development for capacity & competency building (e.g., finance, project management and milestone tracking, validation reviews, etc.).

5) Creation of private-public partnerships used to establish cleantech hubs and value chain consortiums.

6) Introduction of legislation that promotes investments in clean energy production and tax credits aimed at reducing carbon emissions (as seen in the USA with the Inflation Reduction Act).

Positive examples were identified in Norway, Germany, USA and in other Canadian provinces, and components of these success stories were used to both validate and enhance the recommendations within the Study.

1.5 FORMULATING RECOMMENDATIONS

Based on the interview data, barrier analysis, and jurisdictional scan, the Study identified and evaluated potential barrier mitigations to enhance the strengths of the existing ecosystem enablers while stimulating transformative change. These solutions are categorized into four main themes:

- **Process Improvements:** These solutions are designed to address the barriers inherent in obtaining grants and to expedite the progress of technologies through their respective development lifecycles and de-risking projects.
- **Skills & Capacity Building:** These solutions target both the enhancement in innovator skills, resources, and network connections for existing entities as well as solutions aimed at establishing new entities or capacity within the ecosystem to aid in the execution of de-risking tech development projects and commercial project development.
- **Aggregation:** Through consolidating elements of the ecosystem and increasing collaboration and alignment among stakeholders, these solutions target improving the ecosystem navigation, enhancing integration between funding agencies, minimizing noise in the system, and fostering a culture of innovation.
- **Enabling Demand:** In response to barriers that hinder market demand for cleantech, these solutions include frameworks and programs designed to motivate potential adopters to collaborate with innovators and incentivize them to both adopt and invest in technologies upon commercial readiness.

A sequencing of the recommendations is offered across the near-, mid- and long-term horizon. Most of the near-term solutions are process improvements that can be implemented by any Alberta innovation ecosystem funder.

Meanwhile, mid-term solutions urge funders and other enablers within the system to expand the boundaries of their current scope and practices, and they demand more partnership and implementation efforts between industry and ecosystem funders. They focus on enhancing technology development stage-to-stage continuity, stimulating innovator-to-adopter collaboration and investment, and addressing innovators' techno-commercial skillset gaps.

The long-term recommendations have the potential to radically improve the process of cleantech deployment and commercialization in Alberta, but they require larger funding envelopes from government and culture shifts in how government, industry, and the Alberta innovation ecosystem work

together. This set of recommendations includes ways to address the distinct and substantial financial requirements, risks, and skillsets associated with constructing complex projects that include disruptive technologies using the B2P channel.

Each recommendation is summarized below, and more thorough descriptions for each recommendation are provided in **Section 9.2**:

Near Term: *Implement now*

S11 Grant Application Process Improvements
Consider changes to grant processes to align with the needs and pace of innovators. Proposed improvements cover grant award success criteria, improving applications through feedback, establishing a project proposal voucher program, bridging timing gaps in funding, and considering increased project cost contributions.

S14 Grant Agreement Terms Flexibility
Promote flexibility and avoid hindrances to exit opportunities, while reducing the financial burden of negotiations on the tech company. In addition, expand the scope of "benefits to Alberta" and contemplate supporting tech development projects conducted outside the province if they continue to contribute to job creation and knowledge generation in Alberta.

S09 Time-Bound IP Arrangements
Require proponents to provide proof of time-limited commercial terms between tech innovators and industry partners as a condition for grant funding qualification, thereby restricting the duration of the industry partners' IP rights.

S10 Voucher Programs Enhancement
Applicable government funding agencies to explore methods to optimize utilization of the ecosystem's voucher programs and aid innovators in understanding and utilizing the available voucher programs.

S13 Continuous Intake Program Expansion
Expand the budget for continuous intake as well as provide an opportunity for innovators without referrals from Trusted Partners (i.e., for those not eligible for the Partnership Intake Program (PIP)) to apply for funds when specific calls do not meet innovators' needs.

S17 Embedded Advisors
Consider providing expert "Technology-to-Market Advisors" or "Embedded Advisors" to proactively provide guidance and mentorship to start-up technology innovators throughout the execution of specific agency-supported projects. The Embedded Advisors' responsibilities would include holding proponents accountable for milestones, providing advice on techno-economic aspects, and offering support in areas where innovators lack expertise.

S21 Technology Portfolio & Success Marketing
Increase marketing of success stories of ongoing projects / technologies within a given program (e.g., ERA) and educate stakeholders about rates of success within technology development to address risk aversion and encourage persistence towards breakthroughs.

Medium Term: *Develop implementation plans now to execute in the medium term*

S08 Funding Continuity Initiative
Shorten the gap between the completion of one technology development project and the start of the next, ensuring consistent momentum and efficiency gains particularly for SME startup technology innovators aiming to progress new technologies through various TRL stages up to commercialization.

S18 Innovator Support Program
Establish an Innovator Support Program (e.g., under ERA) as an ongoing initiative to connect promising innovators with the expertise they need to enhance their technical and business readiness and improve their likelihood of future grant applications.

S03 Industry Problem Driven Challenges
Establish an ongoing program whereby industrial companies/emerging operators & applicable funders define a specific problem, utilize industry partner funds, sites and/or auxiliary services, and issue funding calls for innovator solutions.

S05 Adopter Calls
Imagined as the reverse of industry problem-driven calls, consider having funders leverage the "RFP" approach to garner commitment from potential adopters that are interested in collaborating with funder-selected technology companies.

S01 Regulations & Policymakers Engagement
Enhance the interaction between policymakers and regulation designers & administrators on both provincial and federal fronts, offering continuous and comprehensive education on clean technologies opportunities and barriers.

Long Term & Strategic: *Further definition & evaluation required in advance of implementation*

S06 Technology Validation Hubs
Establish more partnership programs like BC's *Integrated Marketplace Initiative* and the Edmonton Airport's hydrogen initiatives. These programs would set up sites as testbeds for innovators to test, advance, and de-risk their technologies in real world industrial environments, plus facilitate arrangements between innovators and industry/potential adopters.

S02 Government Contracts & Procurement
Revisit government procurement policies across municipal, provincial, and federal levels to prioritize emerging clean technology commercialization while leveraging government buying power to drive cleantech enhancements and cost reduction.

S07 Alternative Project Financing & Investment Approaches (B2P Focus)
Enhance support beyond non-dilutive grants by exploring innovative funding mechanisms for later-stage projects identified by proponents (e.g., forgivable/low-interest loans backed by the government) and develop ways to broaden the pool of strategic investors.

S19 Project Studios (B2P Focus)
Promote the establishment of "Project Studios" by provincial and federal governments. These studios would be designed to identify and evaluate emerging technologies in specific target areas, mitigate risks for the most promising ones, and then develop investable projects using one or more of these technologies to meet specific targets.

S04 Value-Chain Major Projects (B2P Focus)
Amplify enablers' focus on value chain initiatives and provide grants for vertically integrated deep decarbonization commercial projects. These efforts would underpin the execution of comprehensive commercial projects spanning the full spectrum of an emerging value chain (i.e., hydrogen economy), ensuring cohesive infrastructure and demand support for new technologies along the chain.

1.6 Next Steps

As highlighted in the Study, there are numerous obstacles that can hinder the commercialization and deployment of cleantech in the province and although Alberta continues to demonstrate their ability to develop the technologies, mastering the commercialization aspect remains a challenge for the region.

The proposed path forward can be summarized as a three-pronged approach:

1. **Continued exploration & future studies**

The focus of this Study was to conduct interviews and carry out research to identify the barriers to commercialization that exist within the ecosystem and high-level recommendations. Conducting additional research would play a pivotal role in comprehensively understanding the underlying factors contributing to each barrier, enabling the development of acute mitigation strategies.

By delving deeper into the **root causes** of each barrier, researchers can uncover intricate details and interconnections that may not be immediately apparent. This in-depth analysis facilitates a more nuanced comprehension of the challenges at hand, allowing for the identification of key influencers and systemic issues. Armed with such insights, the ecosystem policymakers, professionals, and decision-makers can tailor mitigation strategies that address the root causes directly, leading to more effective and sustainable solutions.

Proposed future studies are further explored in Section 10.1 to further enhance the accuracy of problem diagnosis and alignment of mitigation efforts.

2. **Implementation of recommendations – "quick wins"**

The results of the Study should be shared with the Government of Alberta, the Government of Canada, and other key ecosystem enablers for broad alignment on barriers, recommendations, and ownership of action across the stakeholders.

The Study recommendations should be assessed for those that can be readily implemented ("quick wins"). By targeting straightforward, achievable objectives, Ecosystem Partners can experience early successes that boost confidence and create a positive ripple effect, generating a sense of accomplishment and motivation that encourages further engagement in the improvement process. They also not only

empower individual parties to take proactive ownership of their responsibilities, but also set the momentum towards more wholesale collaborative improvement.

3. Collaborative thought partnership across ecosystem players

When addressing the more complex barriers that involve multiple stakeholders, it is crucial to adopt a collaborative and inclusive approach. Successful resolution of complex issues often requires patience, flexibility, and a commitment to finding common ground among stakeholders with varying priorities and perspectives.

To do so, it is recommended that a cross-functional team is established that represents the diverse perspectives and interests involved in these issues. Within the team, it is recommended to assign lead parties, roles, and responsibilities for the modification and evaluation of options, as well as the development of implementation plans for these more complex barriers.

Conducting a stakeholder analysis is critical, as is establishing common goals and objectives, and implementing inclusive decision-making processes and conflict resolution mechanisms to promote progress and change.

Key deliverables that could emerge from this process could include a confirmed list of initiatives to move forward with and a multi-party supported roadmap.

1.7 CONCLUSION

In summary, there exists a significant untapped potential to further enhance the prosperity of innovative companies, accelerate technology development lifecycles, and increase the deployment and commercialization of cleantech within the province. Upon the completion of the Study, a crucial immediate next step is for the Ecosystem Partners to review the recommendations and proposed future work outlined in this report. This review should determine which solutions will be implemented, which require further evaluation, and whether additional options should be considered. Lead parties, roles, and responsibilities for options refinement and the development of implementation plans need to be identified.

Regardless of the options selected, the way forward must involve improving coordination among ecosystem players. Given that working in silos would be ineffective in addressing the complex challenges highlighted herein (and in fact, doing so may exacerbate the problems), all players must collaborate frequently, creatively, and productively to achieve the goal of making Alberta a world-class environment for innovators so that they may readily bring their game-changing clean technologies to market.

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LIST OF ACRONYMS

AB	Alberta
ACCTC	Alberta Carbon Conversion Technology Centre
AI	Alberta Innovates
ARL	Adoption Readiness Level
ARPA-E	Advanced Research Projects Agency – Energy
B2B	Business-to-Business
B2C	Business-to-Consumer
B2P	Business-to-Project
BC	British Colombia
CAPEX	Capital Expense
CCUS	Carbon Capture, Utilization and Storage
CO2	Carbon Dioxide
CRL	Commercial Readiness Level
DARPA	Defense Advanced Research Projects Agency
DOE	Department of Energy
EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
ERA	Emissions Reduction Alberta
EU	European Union
FEED	Front-End Engineering Design
FID	Final Investment Decision

FOAK	First-of-a-Kind
FPP	Full Project Proposal
GHG	Greenhouse Gas
GHP	Global Hypergrowth Project
IEA	International Energy Agency
IP	Intellectual Property
IRA	Inflation Reduction Act
ITB	Industrial and Technological Benefits
LNG	Liquified Natural Gas
NREL	National Renewable Energy Laboratory
OEM	Original Equipment Manufacturer
PCI	European Projects of Common Interest
PIP	Partner Intake Program
R&D	Research & Development
RFP	Request for Proposal
RNG	Renewable Natural Gas
SDTC	Sustainable Development Technology Canada
SME	Small and Mid/Medium Sized Enterprise
SMR	Small Module Reactor
TIER	Technology Innovation Emissions Reduction
TRL	Technology Readiness Level
TRM	Technology Roadmap
US/USA	United States of America
VC	Venture Capital
YVR	Vancouver International Airport's Code

2 REPORT PURPOSE

This report is a comprehensive review of the "Barriers to Commercialization Study" (the "Study") conducted by Exergy to identify and assess the barriers that hinder technology commercialization in Alberta and to provide recommendations to stakeholders in the innovation ecosystem on ways to better support the commercialization of clean technologies.

Conducted in 2023 over 5 months, as per the timeline depicted in **Figure 1**, the Study was designed to gather insights from stakeholders within the innovation ecosystem. This report outlines the Study's strategic context, activities, and findings, and it concludes with a set of recommendations.

FIGURE 1: THE STUDY'S MILESTONE SCHEDULE

3 Background & Context for Study

The Alberta innovation ecosystem is dynamic and involves various stakeholders, including government agencies, research institutions, startup innovators, accelerators, and industry partners. Alberta has been actively working to foster innovation and economic growth by supporting research, development, and entrepreneurship.

It is recognized that innovation can encounter many challenges along its journey and that enablers in the system can potentially do more to overcome some of these challenges. As such, ERA (on behalf of a select group of ecosystem partners) commissioned Exergy to undertake this Study to better assess and understand the non-technical barriers to technology commercialization in Alberta. For this study, the Alberta Innovation Ecosystem Partners ("Ecosystem Partners") include ERA, Alberta Innovates, Prairies Economic Development Canada, and Sustainable Development Technology Canada.

ERA, an arm's length government agency, has a mandate to reduce greenhouse gas (GHG) emissions and grow Alberta's economy by accelerating the development and adoption of innovative technology solutions. The organization helps innovators develop and demonstrate GHG-reducing technologies which have high-potential to build more competitive industries, enable new business opportunities, and create solutions for Alberta and the world.

Alberta Innovates is a provincial agency in Alberta, Canada, dedicated to fostering innovation, research, and technology development across various sectors. As a government-funded organization, its mandate is to build on Alberta's strengths in traditional industries and create new opportunities in emerging technology areas by supporting research and innovation to address challenges and opportunities in the province.

Prairies Economic Development Canada ("PrairiesCan") is a federal department that supports economic growth in Alberta, Saskatchewan, and Manitoba by helping businesses, not-for-profits and communities grow stronger. Its mandate is to grow and diversify the economic of the Prairies and to advance the interests of western Canada in national economic policy, program and project development and implementation.

Sustainable Development Technology Canada helps Canadian companies develop and deploy sustainable technologies by delivering critical funding support at every stage of their journey. This includes funding the development and demonstration of new environmental technologies; fostering and encouraging collaboration among organizations in the private sector, academia, the not-for-profit sector, and others to develop and demonstrate new technologies; and promoting the timely diffusion of new technologies across key economic sectors in Canada.

The results of this Study serve to help guide the partners named above, along with other enablers within the innovation ecosystem, to determine ways to better support the commercialization and scale-up of technologies and the companies behind them. Furthermore, as agencies and organizations continue to evaluate and refine their current roles in Alberta's innovation ecosystem, the output of the Study can inform future strategic reviews and help define new ways the ecosystem can be supported moving forward.

4 The Technology Innovator's Journey: Key Concepts

This section clarifies the concept of "the Technology Innovator's Journey" and defines key terms used in designing the Study and in analyzing and interpreting the gathered data.

4.1 Dimensions of Tech Development Stages

Clean technology innovator firms, particularly startups, brave a challenging journey that demands simultaneous progress in both their business and technology development.

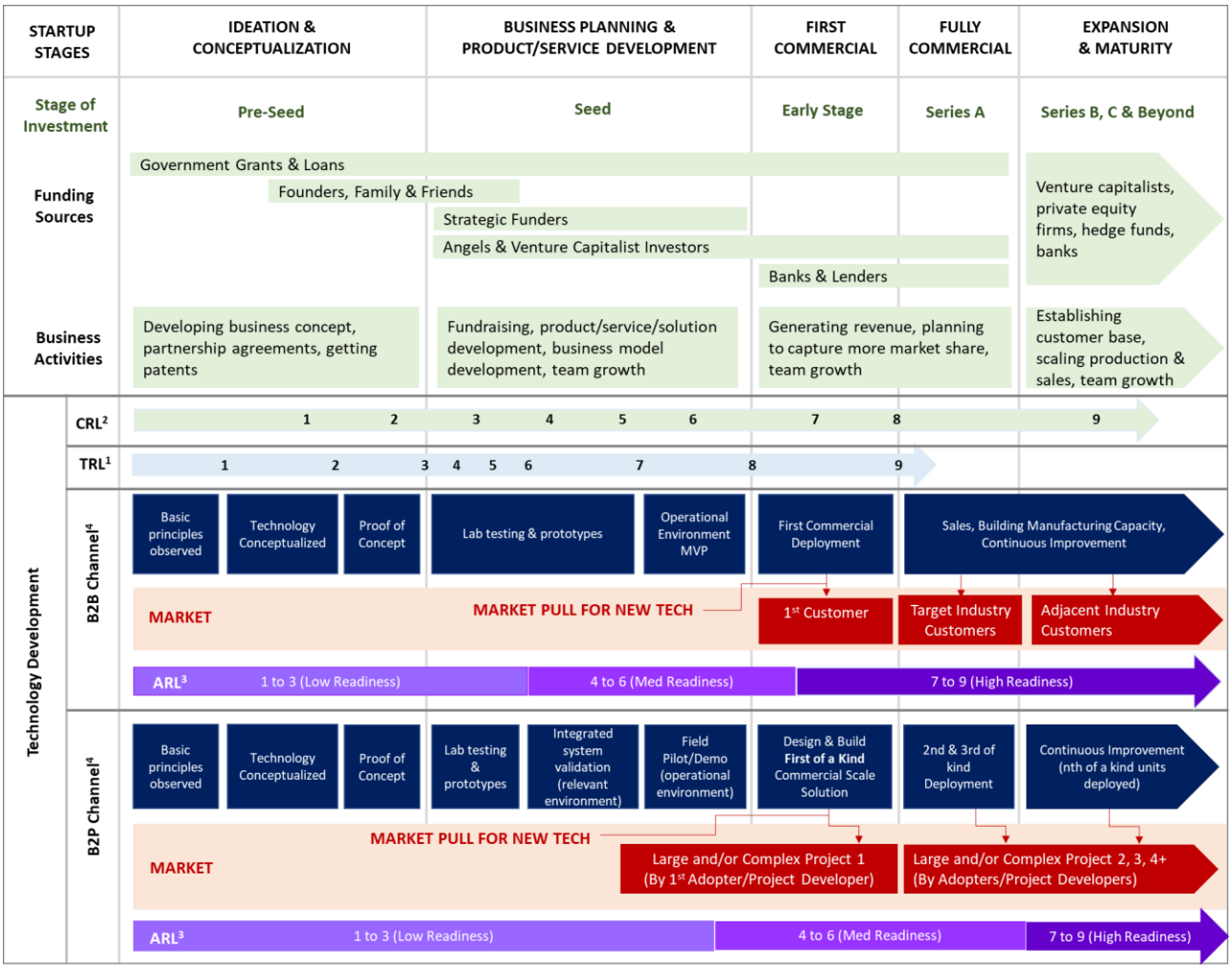


Figure 2: Dimensions of Tech Firm Development Stages

1. *Technology Readiness Level is a common way to quickly communicate the technical maturity of a given technology.*
2. *Commercial Readiness Level (CRL), created by the United States' ARPA-E, provides a means to communicate an innovator's commercial maturity with respect to their emerging technology* (ARPA-E, 2014).
3. *Adoption Readiness Level (ARL), developed by the DOE's Office of Technology Transitions (OTT) to complement the TRL, offers a representation of the adoption risk and considers multiple factors including techno-economic, market, licensing, and resource maturity risks* (OTT, 2023).
4. *Refer to Section 4.3 for channel definitions.*

As illustrated by **Figure 2**, the problem is multi-dimensional, where the scale-up journeys of technology firms are distinct yet interrelated with their business evolution, technology development lifecycles, and the associated downstream market growth.

The technology development lifecycle aspect encompasses both technical and commercial facets, making it a "techno-commercial" undertaking. Furthermore, external factors beyond the control of technology firms, such as market demand and maturity, existing infrastructure, regulations, supply chain conditions, and the availability of skilled talent, significantly impact the investment in and adoption of innovators' solutions. These external factors and their relationships with the given emerging technology play pivotal roles in the commercialization process.

Given this, understanding what hinders tech firms from success cannot be achieved by focusing on isolated aspects of their journey. Identifying and assessing barriers to commercialization requires examining both internal and external forces at play across each dimension and all stages of development. This reality set the stage for the Study, informing the team's approach, interview questions, and data analysis.

4.2 Technology Development Lifecycle Actors

To ground the understanding of the technology development lifecycle, a comprehensive review of critical interactions with major ecosystem actors was conducted. This section defines the various actors.

The technology development ecosystem framed for this Study defined 10 critical roles:

1. **Scientists & Research Providers** – Government funded or private institutions with specific mandates to support early technology research or industry supported development. Their primary role is to progress ideas through TRL 1-4 with academic and lab resources.
2. **Technology Innovators, Inventors & Start-Ups** – Privately funded entrepreneurs with disruptive technology in a specific field holding IP and a specific knowledge base. They convert scientific "phenomenon" into engineered and economic solutions TRL 2-9.
3. **Accelerators & Incubators** – A mix of private and conglomerate firms that provide targeted support to accelerate technology development.
4. **Angel Investors** – Very early-stage private investors. They are typically high wealth individuals or family funds versus a conglomerate of institutional investors, so from that perspective are slightly different than classic venture capitalists. They perform a similar function to VC's but usually for earlier stage companies.
5. **Venture Capitalists (VC's)** – Institutional investors looking for high risk-high potential technology to achieve financial gains through high growth. Looking for an outsized return by taking a risk early – return of the portfolio is a key metric. Provide dilutive and return-driven funding. Typically invest in companies, not generally project financing.
6. **Strategic Investors** – Institutional investors interested in high potential technology for specific products and processes. They are often potential Adopters of the new technology (as defined below) or manufacturers and potential sales channels for B2B products. They work with developers with a patient approach to the investment.

7. **Developers** – In the B2P context, these are the integrators of the machines, products and processes of the inventors and start-ups into deployable projects into which owners/operators can invest. They operate at the nexus of many worlds with the ability to collaborate with many other roles in the ecosystem. Developers define the implementation of the technology, typically supporting TRL 7-9.
8. **Government** – Agencies that provide financial and infrastructure support for entrepreneurs and technology developers. They also provide regulation and policy for the ecosystem.
9. **Banks & Lenders** – Provider of business loans and other funding mechanisms to support technology implementation with a lower risk/return portfolio.
10. **Adopters** – The customers of the clean technology product, service, and/or solution. For many industrial decarbonization technologies particularly in the B2B model, adopters/customers of the clean technologies will be the builders, owners, and operators of the facilities, such as incumbent energy companies. Adopters of technology in the B2P model could be either incumbents intending to build new infrastructure to support their operations or new businesses seeking to develop new value chains.

As technologies develop through the TRLs to validate and de-risk its technical merit, the invention progresses through a chain of events that could ultimately lead to commercial adoption and implementation. The ecosystem members use their expertise to support this process.

4.3 Technology-to-Market Channels

The journey to commercialization for any given technology is influenced by the sales channel or "technology-to-market" channel necessary for its deployment. It is crucial for innovators to identify the appropriate channel as they strive to progress their ideas into commercial solutions. The identified sales channel establishes the paradigm for bringing the technology to market. Opting for an unsuitable channel may lead to a misallocation of efforts, which in turn creates barriers to the acquisition of financing, skills, and stakeholder support required for success.

4.3.1 Traditional Channels

Three traditional channels are relatively well understood: Business-to-Government (B2G), Business-to-Consumer (B2C), and Business-to-Business (B2B). These are three distinct types of business relationships, each with their own characteristics and dynamics.

Business-to-Government: The B2G refers to transactions or interactions between private-sector businesses and government entities. In this business model, private enterprises provide goods, services, or information to government agencies. The interactions can involve various types of activities, such as selling products or services to government entities, bidding on government contracts, or participating in public-private partnerships. B2G relationships are essential for the functioning of governments, as they allow for the procurement of necessary goods and services from the private sector to support public initiatives and services.

Business-to-Consumer: The B2C channel the technology or service firm sells directly to individual consumers. Companies operating in the B2C space typically employ marketing strategies to appeal to a wide consumer base, prioritize customer satisfaction and convenience, and optimize their offerings for

mass consumption. B2C transactions often occur through retail channels, e-commerce platforms, or direct sales to consumers. In a new technology context, this model is most successful for digital solutions and new consumer products.

Business-to-Business: The B2B channel refers to transactions between businesses or organizations. Companies sell products, services, or solutions to other businesses. B2B relationships often involve longer sales cycles, negotiation of contracts, and a more complex decision-making process than B2C. Firms focus on delivering value, building long-term partnerships, and providing tailored solutions to meet the unique demands of business customers. The B2B channel is appropriate for new technologies that can be added on to existing facilities with minimal disruption to base design and operations. Instruments, devices, and digital solutions often fall into this category. Most technology solutions supported by the Alberta innovation ecosystem have traditionally targeted the B2B channel.

While these traditional channels have been proven pathways to successfully commercialize many technologies, they are not suitable for all types of technologies. For technologies that require integration into large complex projects for commercial deployment, an alternative channel called "Business-to-Project" is necessary.

4.3.2 The Introduction of a New Channel: Business-to-Project

One of the defining outcomes of this Study is the recognition of the need for a non-traditional channel to be acknowledged. The Alberta innovation ecosystem supports all the traditional market channels well, but this report posits that relying solely on traditional market channel thinking creates a significant gap in our understanding of technology commercialization.

Traditional channels (and their associated paradigms) have been used to deploy apps, instruments, devices, and, occasionally, add-on processes to existing operations; however, they are not suitable for deploying technologies that need integration into large-scale, capital-intensive, stand-alone, and disruptive infrastructure projects. For technologies that need integration into such complex projects for deployment, the Business-to-Project (B2P) channel is required.

Definition of the B2P Channel

Business-to-Project: The B2P channel represents the pathway through which a new technology is deployed as a component of a discrete project, where the new technology is likely to be integrated with several other new or conventional technologies.

B2P is the most difficult and complex channel to navigate. B2P deployment involves a wide range of skills, numerous stakeholders, and the coordination of multiple players. Project financing is required, which is different from Venture Capital (VC), strategic, or other kinds of start-up funding (See **Section 4.2** for definitions of funding types). These projects generally have high capital costs and require the collaboration of various stakeholders, such as financiers, operators, technology providers, EPCs, contractors, suppliers, and project managers. The full combination of skills required to conceive and execute these projects is not likely to be found in a single firm.

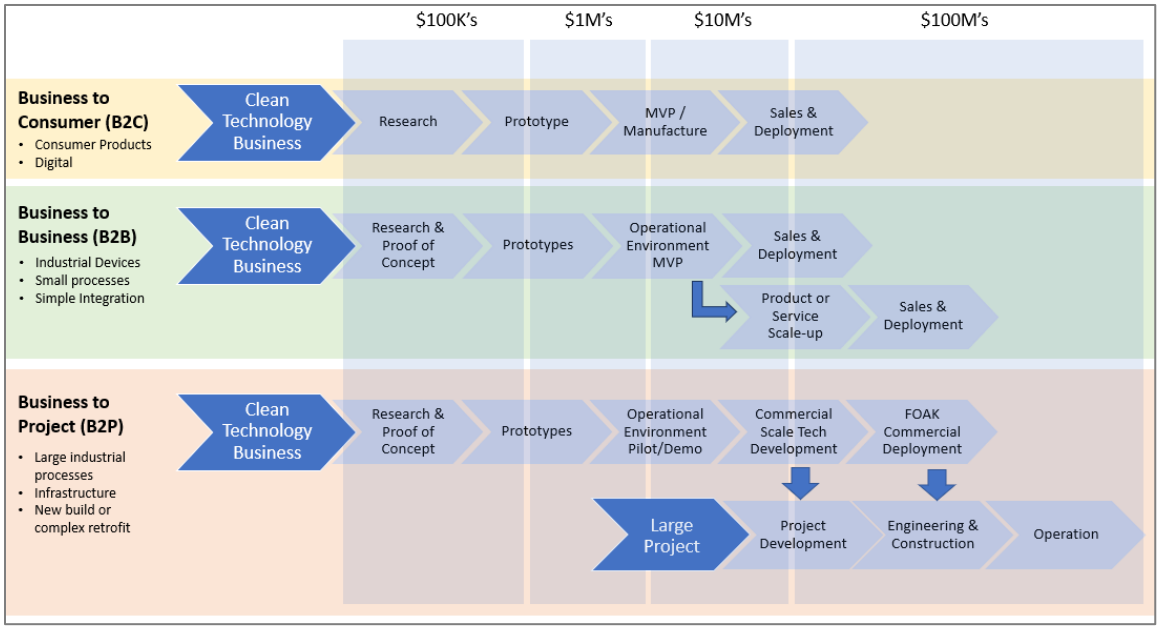


FIGURE 3: TECHNOLOGY TO MARKET CHANNELS

B2P Market Penetration

In the context of cleantech, commercializing through this channel involves adopting new methods for selling products and services and new ways of measuring success since these technologies do not necessarily translate to revenue generation. Companies seeking to adopt cleantech products in the B2P channel will likely need to have highly contextualized Environmental, Social, Governance (ESG) strategies linked to investor and senior executive outcomes.

In comparison to technologies that do not fall under the "clean" umbrella, many clean technologies provided through this channel often lack economic benefits for the adopting organizations. Rather, the clean technologies offer to support the adopters' decarbonization objectives in alignment with their respective ESG goals. Calculating economic benefits for these products and services may pose challenges for the adopting organization. As a result, making the final investment decision to adopt them becomes an even tougher hurdle compared to clean technologies that can be commercialized through traditional channels.

B2P Success Factors

Inherent in the channel definition, B2P clean technology commercialization requires potential adopters to be committed to ambitious ESG goals, collaboration across several organizations (public & private), a broad set of skills, robust & certain climate change policies and carbon markets, and different financing compared to traditional channels. Sophisticated project financing (beyond grants), which significantly reduces the project's risks for the adopters, is critical. From a collaboration perspective, as no SME innovator has the capabilities and capital in-house to execute the required deployment projects, B2P technology commercialization occurs when multiple organizations with complementary skills work together to deliver the associated project. As such, multi-party partnerships among government, adopters, and innovators have proven to be a successful recipe for the commercialization of B2P technologies.

5 Study Overview

5.1 Objectives

The Study's focus was in response to the question: **What are the barriers faced by firms working to commercialize GHG-reducing technologies in Alberta?**

The purpose of the Study was twofold: 1) to identify and assess the barriers that hinder technology commercialization in Alberta; and 2) to provide recommendations to the Ecosystem Partners on ways to better support the commercialization of clean technologies.

To accomplish these objectives, the Study was designed to:

- Assess and understand the barriers that firms have faced in the technology commercialization and company scale-up processes,
- Identify conditions, enablers, and key success factors for technology commercialization and technology firm scale-up, and
- Develop recommendations that the Alberta innovation ecosystem could consider to better enable:
    - GHG reduction technology commercialization, scale-up, and adoption
    - Clean technology firm scale-up
    - Appreciable GHG emissions reductions in Alberta

5.2 Tasks & Data Sources

The Study was designed with mixed methods, relying mainly on qualitative investigation. Data was sourced from a diverse cross section of Alberta innovation ecosystem stakeholders as well as publicly available literature regarding innovation ecosystem programs in Europe, the United States, and Canada.

As illustrated by **Figure 4** the project was broken out into the following four tasks and are described in the following sub-sections.

1. Strategic Context Development
2. Interviews
3. Jurisdictional Scan
4. Recommendations Development

FIGURE 4: PROJECT TASKS

5.2.1 STRATEGIC CONTEXT DEVELOPMENT

The Strategic Context Development activity was an ongoing task that spanned the duration of the Study. Key elements of this activity included reviewing ERA's key documents and other resources. ERA's project data and business planning document were analyzed to assess the current state of both Alberta's and Canada's innovation ecosystem. This task outlined key attributes of the ecosystem, including how it currently operates, its key players, and its driving forces and constraints.

5.2.2 INTERVIEWS

The Interviews Task was set up as the foundational activity of the Study, serving as its cornerstone around which the entire project plan was constructed. The Study was designed such that the information from the interviews would make up most of the data which would feed into the findings, recommendations, and conclusions. Because of its importance, this activity was started at project kick-off. This task included the development of questions, development of the interviewee list, session preparations, interview sessions, and interview notes/transcriptions review. **Section 6** provides further details on the methodology and process for the interviews.

The interviewees (i.e., data sources) included individuals from the following primary stakeholder groups:

- The Study's Steering Committee which included representatives from the following organizations:
  - Alberta Innovates
  - Avatar Innovation
  - Plug and Play
  - ATB Financial
  - PrairiesCan
  - SDTC

  - ERA
  - Sumex Capital
  - Foresight Canada
- Previously ERA-funded technology project proponents
- Incumbent industrial facility owners & operators
- Government owned ecosystem services
- Engineering & consulting firms
- Venture capital firms

5.2.3 Jurisdictional Scan: Programs/Policy & Project Review

In the interest of learning from the global community, the Study established two supplementary research tasks: the Programs/Policy Review and the Project Review. These tasks were executed concurrently within a unified workstream known as the "Jurisdictional Scan." Under this workstream, a few jurisdictions, which are known to support clean technology development, were identified, and examined. The team reviewed these few regions and identified key success stories/projects and their associated programs, policies, and other factors from which Alberta can learn. These examples and key success factors were then used to inform the Study's recommendations. This targeted review enabled the discovery of details which were used to help bring tangibility and credibility to the Study's recommendations.

For this task, data were sourced from publicly available literature concerning various jurisdictions, with a specific focus on Norway, Germany, and the United States. Furthermore, key publications detailing noteworthy programs in Canada were examined to extract relevant insights.

5.2.4 Recommendations Development

In the concluding phase of the project, this task focused on identifying barrier mitigation options through an analysis of interview data, supplementary research, and leveraging the expertise of the Study team. These options were defined and assessed, culminating in the formulation of the Study's recommendations. Throughout this process, the feedback provided by ERA and the Study's Steering Committee, particularly in response to the interim report known as the "Early Findings Report," was taken into careful consideration.

5.3 Focus Areas

To address the barriers hindering the scale-up of small technology firms, while concurrently evaluating the challenges associated with deploying high-impact technology in Alberta, the Study needed to strike the right balance between breadth and depth on the topic. To achieve this, the team identified the following focus areas:

- **B2P Technology-to-Market Channel.** The team focused on evaluating the most complex of the pathways (B2P) to ensure all key barriers across all pathways were covered.
- **Cleantech Deployment within Industrial Sectors.** The Study focused on industrial sectors, primarily the energy, chemical, and construction materials industries. This emphasis was motivated by the following factors:

- Interviewees' backgrounds – those who agreed to be interviewed worked within or are looking to sell to these industrial sectors.
- Potential GHG impact – these sectors have high potential to contribute towards greenhouse gas reduction goals.
- Quantity and complexity of barriers – heavy industrial sectors were expected to present more complex barriers to clean technology commercialization than other sectors.

5.4 CONSIDERATIONS

The following are underlying considerations to be taken when reading this report, to provide additional context and to frame additional opportunities in any future related activities.

1. **Interviewee selection process** – The interviewee sample was not statistically representative of the greater ecosystem population, but instead was based on individuals chosen for their potential insights as per the recommendations of ERA and Exergy, based on the nature and purpose of this Study. The interviewee sample represents a small subset of the broader ecosystem players and there is an opportunity for future studies to include companies that have adopted new clean technology for varying perspectives and experiences than those already captured within the interview process herein.
2. **Composition of the team** – Exergy specializes in assisting startups and large enterprises with tasks such as assessing, designing, engineering, testing, validating, and piloting their technologies. Consequently, the Study's approach, analysis, recommendations, and conclusions were informed by the perspective of a service provider operating within the innovation ecosystem.

   In addition, the team members' predominant work experiences are in Alberta's energy sector, particularly within large publicly traded energy firms and engineering, procurement, and construction firms (EPCs). As the Study recommendations are put in place, the addition of viewpoints from the public / government sector could be advantageous to capture its unique perspective.
3. **Research limited to publicly available data** – In assessing programs and jurisdictions that exist domestically or internationally, the available information was limited to what could be found publicly online. In future activities, a broader review of source documents that are not limited to public availability would be beneficial for more in-depth information and analysis.

6 PROCESS FOR THE INTERVIEWS

The primary objective of the Interviews Task was to gain valuable insights into the ecosystem and acquire a richer understanding of the challenges inhibiting clean technology commercialization. Rather than serving as a precursor to a statistical analysis exercise, these **interviews aimed to capture the pulse of the ecosystem and explore the barriers in depth**, examining their impact and the firsthand experiences of those affected by them. By delving into individual stories, the interviews sought to provide a nuanced understanding of the ecosystem dynamics.

The Interviews Task was comprised of three discrete sub-tasks: 1) planning & preparation; 2) interview sessions; 3) transcriptions review & coding.

Interviews planning and preparation included the following:

- Development of interviewee list
- Categorization of interviewees into groups/categories
- Issuance of invitations to participate in the interview sessions.
- Development of interview questions
- Scheduling of interview sessions
- Reviewing background information on interviewees (individual, company, and relevant projects, etc.)

One of the first steps in the planning and preparation activities, was to compile a list of individuals to invite to the interview sessions. Building off a list of ERA-supported proponents which ERA recommended be contacted for the Study, the Study team leveraged Exergy's, Hawk & Squirrel's, and the Project's Steering Committee members' existing relationships to expand and diversify the list. One indigenous-owned organization was included.

TABLE 1: INTERVIEW METRICS

Metric	No.
Invitations Sent	40
Interviews Completed	**29**
Technology Innovators	*11*
Facility Owners/Operators (Potential tech adopters)	*8*
Enablers (Accelerators, funders, EPC firms, etc.; Includes one (1) Indigenous Organization)	*10*
Total number of people interviewed	36
Total number of women interviewed	9

The interviews were then classified into three categories for which a different set of guiding interview questions were developed: 1) "Technology Innovators"; 2) "Facility Owners & Operators" (potential new tech adopters); and 3) "Enablers". The "Enablers" category captured several types of organizations such as engineering & consulting firms, accelerators, incubators, and funding organizations. By the end of the

interview period, 40 invitations to participate were sent, 10 invitations did not receive a response, and 29 interviews were conducted. **Table 1** shows the breakdown of interviews conducted by category. The “"Technology Innovator”" interviews could be further broken down into two groups based on the TRL of the technologies discussed. Five interviews focused on technologies with a TRL ranging from 4 to 6, while six interviews centered around technologies within the TRL 7 to 9 range.

The interview sessions were guided by three distinct sets of questions, one for each interview category. These question sets can be found in **Appendix A** for reference. The questions were crafted to encourage the interviewees to explore specific aspects of their experiences while ensuring minimal influence on or “leading” of their responses. To foster an environment of openness and honesty, the Study team ensured anonymity for each participant, committing to refrain from associating any shared information with specific individuals or organizations in any of the Study's deliverables. While a standard set of questions was initially prepared, the interviewers remained flexible by actively adapting and prioritizing questions based on the responses received and the time constraints of each session. While most interview sessions were allotted one hour, some participants were only able to spare 30 minutes of their time.

Upon completion of all interviews, the team reviewed the interview transcriptions and conducted a coding process. The term "coding" in this context refers to preliminary analysis and classification of the interview data. This involved carefully examining the notes and systematically identifying and cataloguing the barriers and suggestions that were mentioned or observed during each conversation. As a result of this coding process, the team compiled a list of 18 barriers which are described in **Section 7**. Approximately 30 suggestions for improvement offered by interviewees were also compiled and were used to develop a list of options for solutions.

7 FINDINGS FROM THE INTERVIEWS

Once the interviews were concluded, the notes collected from the sessions were meticulously reviewed, categorized, and analyzed. This section showcases the amalgamated interview data, highlighting the barriers articulated by the interviewees. It also includes an analysis of these barriers, delving into common themes and patterns which were used to inform the recommendations of the Study.

7.1 BARRIERS

To assist with the analysis, the Study team categorized the barriers uncovered during the interviews into three broad groups based on their relationships to a technology innovator's journey. The categories were established as follows:

- **Tech Innovator Needs:** This category encompasses the fundamental resources, skills, and support that technology innovators require to advance along the technology development journey. The barriers in this category directly pertain to the innovator, primarily stemming from deficiencies in the innovator's capabilities and resources.
- **Context:** This category pertains to the environment in which the Tech Innovator operates and endeavors to advance their technology. The barriers within this category arise because of the ecosystem's conditions, directly or indirectly impacting the innovator's progress or likelihood of success.
- **Integration:** This category focuses on the interplay and collaboration among various ecosystem players within the clean technology innovation sphere. The barriers outlined here represent the obstacles to connectivity that restrict efficiency or potential success among ecosystem players.

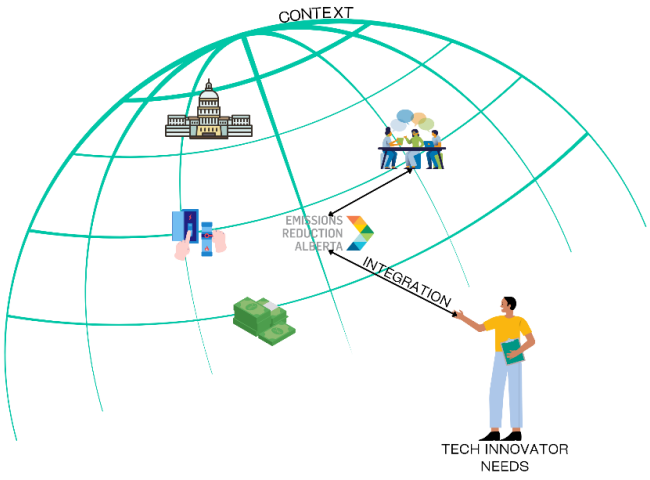


FIGURE 5: BARRIER CATEGORIES

Table 2 lists the barriers identified by the interviews, and the following subsections provide brief definitions of each. For a more comprehensive account of the insights shared in the interviews, refer to **Appendix C** which presents expanded barrier descriptions and offers additional anonymized and synthesized commentary derived from the various conversations.

Each barrier illuminates a gap or weakness within its given category. As the reader will see with the headings within the subsections, each individual barrier was assigned a title and a code number to assist with the analysis. The code number is a blend of a letter, representing the respective category, and a sequential number (refer to **Appendix B** for the list of barrier codes and abbreviated descriptions). It is important to note that the assigned numbers do not suggest any priority or level of importance. Refer to **Section 7.3.1** for a comparison of the barriers against each other.

TABLE 2: BARRIERS IDENTIFIED BY THE INTERVIEWS

Category	No.	Barrier Name
Tech Innovator Needs	T1	Tech Innovator Skillset Gaps
	T2	Network-Based Opportunity Access
	T3	Resource-Intensive Tech Validation
	T4	Lengthy & Constraining Grant Application Process
	T5	Tech Innovator Use Case Knowledge Gap
Context	C1	Boom-Bust Cycles of Potential Adopters
	C2	Undervalued Sustainability Benefits
	C3	Vendor Approval Process Onerous
	C4	Culture of Risk Aversion
	C5	Surplus of Emerging Tech
	C6	Expectations for Big Impacts Fast
	C7	First of a Kind (FOAK) Project High Cost & Risk
	C8	Government Policy/Regulatory Flux & Complexity
Integration	I1	Ecosystem Complex & Uncoordinated
	I2	Project Financing Ecosystem Gaps
	I3	Investors & Funders Knowledge Gaps
	I4	Unclear Funding Agencies' Success Criteria
	I5	Intellectual Property Protection

7.1.1 TECHNOLOGY INNOVATOR NEEDS

T1 – Technology Innovator Skillset Gaps

A significant challenge faced by tech innovators is the presence of skillset gaps within their teams. Interviews revealed these gaps encompass areas such as business administration, commercial, finance, presentation/communication, project development & execution, regulatory, land, supply chain management, and engineering skills. Additionally, there is a supply shortage issue for specific skill sets in Alberta and Canada. The scarcity of skilled labor, technical experts, and business leaders further exacerbates this problem.

T2 – Network-Based Opportunity Access

Some tech innovators have limited personal or business connections to rely on for support, advice, technical/industry resources, partnerships, and other valuable resources. This issue is

particularly prevalent among innovators from academic backgrounds or those who are new to the province or industry, as they may lack established connections to leverage. The impact of this barrier can be significant in regions and industries where personal relationships play a critical role in navigating the landscape, forging partnerships, and initiating business deals.

T3 – Resource Intensive Tech Validation

Technologies that require relatively high capital (>$1 million) and testing in industrial environments to be validated, have an especially tough time getting the funding, partners, and sites that they need to advance between TRL 4 and 7. In this stage of the readiness scale, investors hesitate to put-up funds due to the relatively high costs in comparison to the perceived level of risk. Consequently, many innovators are compelled to depend on grants that, unfortunately, only provide small-dollar funding insufficient for the substantial financial requirements of these tech validation projects. Furthermore, grants in Canada cover a lower percentage (i.e., < 50%) of the tech de-risking project costs than those of other regions like US and Europe. In addition, there is a lack of suitable facilities, services, partners, and field demonstration sites for technology validation in Alberta (and in Canada). These factors can lead innovators to either halt progress and/or take their business outside of Canada.

T4 – Lengthy & Constraining Grant Application Process

Tech innovators, owner/operators, and enablers provided common feedback that the lengthy, onerous, and the restrictive/prescriptive nature of many grant processes poses a barrier. They identified a mismatch in the speeds at which government grant organizations and startups operate. Startups move quickly and often change direction (pivot), which contrasts with the typical, slower pace of grant organizations. These protracted processes can lead to cash flow issues that SME innovators may not be able to tolerate.

Furthermore, funding calls, both in terms of scope and timing, do not always align with companies' plans. Companies often face challenges in aligning their plans with the prescriptive scope and timing of these calls, sometimes changing their strategies in hopes that it will make them more likely to receive grants. The uncertainty surrounding grant approval and disbursement timing not only hampers (and potentially halts) progress, but it also complicates planning. Many companies experience a loss of momentum and may burn through available funds while waiting for necessary grants, which they may not be awarded. For many potential proponents of high-capital and high-impact projects, this level of risk is often perceived as too burdensome and holds them back from developing the transformative opportunities.

T5 – Technology Innovator Use Case Knowledge Gap

Based on feedback from enablers and facility owners/operators, it is evident that many technology innovators encounter challenges when it comes to developing compelling use cases and value propositions that resonate with potential adopters. One common observation is that tech innovators often lack a clear understanding of where and how their technology can be best implemented, as well as a general lack of awareness of their customer base. Many tech innovators lack an understanding of how their idea can be integrated into their customers' operations and the various disciplines and considerations that need to be addressed. This lack of understanding

can be attributed to several factors, including a limited experience in their customers' industries and a lack of opportunities to co-develop their technology with potential adopters.

7.1.2 CONTEXT

C1 – Boom-Bust Cycles of Potential Adopters

The volatile nature of the oil and gas industry has presented obstacles for tech innovators who need to partner with energy companies to progress their technology. One significant challenge arises when the energy companies retract or fail to fulfill their initial plans or commitments. These challenges stem from factors such as commodity price volatility, industry consolidation (i.e., where a small number of major firms own most of the industry's assets), potential adopter leadership and ownership changes, and government policy fluctuations that impact the economic and business planning cycles.

C2 – Undervalued Sustainability Benefits

Many interviewees highlighted the shortcomings of the current incentive and regulatory frameworks in Alberta and Canada when it comes to recognizing and quantifying the non-economic and broader sustainability benefits associated with decarbonization technologies. While some sustainability benefits are acknowledged, the incentives offered and regulations in place are deemed insufficient to drive a strong market demand for the rapid adoption of innovative clean technologies.

According to the interviewees, potential clean technologies adopters/customers are not adequately motivated to prioritize environmental benefits over short-term profits due to the lack of effective & stringent regulations ("sticks") and the absence of compelling incentives perceived to have "staying power" ("carrots"). Several interviewees drew comparisons between the Canadian landscape and that of the United States and European countries. They specifically highlighted the IRA in the United States and strict regulations in Europe as examples of effective frameworks that seem to be driving the advancement of cleantech in those regions.

C3 – Vendor Approval Process Onerous

Small firms trying to sell to large companies and government bodies, such as municipalities, struggle to fund the process of qualification itself. Governments especially have long cycles and due diligence can take a long time. Innovators also often move quickly or have timelines associated with grant money stipulating this, so these lengthy approval processes can be detrimental to progress.

C4 – Culture of Risk Aversion

Risk aversion and fear of failure are prevalent traits in the Canadian context, contributing to a general discomfort and limited understanding of the inherent risks in technology development. In the interviews, technology innovators and enablers noted the widespread risk aversion among investors and potential adopters in Canada, contrasting it with their counterparts in the United States. This cautious attitude prolongs decision-making processes, causing SME firms to deplete their cash resources while waiting for outcomes.

C5 – Surplus of Emerging Tech

In general, there is a large volume of ideas existing in the ecosystem, all at varying readiness levels, and many without clear use cases defined. Tech innovators and enablers describe difficulty in garnering attention or getting potential funders/investors to listen to new tech's value proposition. The space is flooded with many technologies and ideas, making it difficult for potential adopters and investors to find the promising ones. The lack of sufficient and consistent vetting and validation activities for the surplus of technologies hampers adopters and investors in making informed assessments, while the abundance of similar technologies reflects a general lack of collaboration among the innovators themselves.

C6 – Expectations for Big Impacts Fast

Feedback from interviewees suggests there exists a misalignment between the expectations of governments, the public, enablers, and investors regarding the timelines and impacts of GHG emissions reductions, highlighting a disconnect between what is perceived as achievable and what is possible. Climate targets are driving governments and adopters to inherently focus solely on commercial technologies, while neglecting lower TRL solutions that potentially offer higher impacts.

In addition, the perception of “big impacts fast” that innovators can face from potential adopters, governments, and investors often contradicts the nature of clean technologies innovation. This creates several challenges, including unrealistic expectations for faster results (termed "impatient capital"). Impatient capital may lead tech firms to attempt to bypass crucial development steps, consequently failing to sufficiently de-risk their technologies, resulting in the encounter of tougher obstacles in subsequent stages.

C7 – First of a Kind (FOAK) High Cost & Risk

FOAK projects and technologies face significant barriers due to their high cost and high risk, which can discourage lenders, investors, and potential industry partners/operators from getting involved. From the perspective of an operator that may only deploy a technology a limited number of times, adopting a "fast follower" strategy becomes a rational choice to avoid the high cost associated with FOAK projects. However, if everyone adopts a "fast follower" approach, there will be no one to pioneer and set the path for others to follow.

FOAK projects also face competition for capital from well-established or turnkey technologies that offer a presumed higher return on investment and lower risk compared to innovative and riskier ventures. Additionally, comprehensive risk matrices used by large owner/operators often prioritize more established technologies, which further limits the development and investment opportunities for FOAK projects.

C8 – Government Policy/Regulatory Flux & Complexity

In Canada, concerns about government interference and changes in climate policies are widespread, dissuading both innovators and large industry players and impeding investment in new clean technologies. The regulatory and policy frameworks in Canada are intricate and challenging to understand, creating uncertainty for all ecosystem players. Some interviewees

pointed out a "stroke of the pen" risk in Canada, emphasizing that sudden regulatory changes can significantly impact the financial projections of clean technologies projects as well as the willingness of large industry players to collaborate with tech innovators.

Perceived biases within government policies contribute to this sense of uncertainty, with concerns about biases towards "anti-fossil fuels" sentiments and preferences for large incumbent companies potentially hindering the progress of more effective clean technology solutions and system improvements. Nearly all the interviewees described regulatory and funding processes in Canada as overly complicated and influenced by politics.

7.1.3 INTEGRATION

I1 – Ecosystem Complex and Uncoordinated

The innovation ecosystem is packed with numerous players and suffers from a lack of collaboration among them. This includes the absence of connectivity or direct pathways between these players and available services, as well as insufficient support from funding organizations to transition from one technology development stage to the next. Innovators often struggle to determine their next steps after completing a specific development stage or funded project.

While the essential elements exist within the ecosystem, there are gaps in terms of the flow or connections between the players; a crucial "passing of the baton" is missing. Many organizations within the system, including engineering, procurement, and construction firms, accelerators, government agencies, technology companies, and industry stakeholders, are attempting to achieve similar goals or solve identical problems but are not collaborating effectively. Moreover, several technology innovators are working on similar projects and could potentially address each other's challenges if they collaborated.

I2 – Project Financing Ecosystem Gaps

While government and venture capital funding appear accessible to support technology innovators in their early startup stages, securing funds for capital-intensive projects that enable the early commercial-scale deployment of clean technologies is especially challenging. Project financing solutions seem to be limited. Technology innovators often rely on potential adopters to finance commercial projects deploying their new technology, as venture capitalists typically do not invest in projects, and institutional investors are absent. These commercial clean technologies projects compete with potential adopters' conventional projects, which offer higher and more predictable returns. In many cases, the conventional projects prevail, hindering the higher-risk project from advancing and impeding the commercialization of its associated clean technology.

I3 – Investors & Funders Knowledge Gaps

Innovators, enablers, and owner/operators have all indicated a knowledge gap in the investor community as well as among government stakeholders (including policy makers and funding agencies) regarding factors such as the technical & practical merits and impacts of emerging technology and the needs/wants of potential adopters. Energy systems, technical challenges, and their corresponding solutions are often highly complex and interrelated, posing a challenge for decision-makers who may not have the necessary expertise. These challenges place innovators at

a disadvantage, particularly if their technologies' technical merits are not easily comprehensible and if the innovators lack strong presentation skills that can resonate with and convince investors.

It is worth emphasizing the positive feedback about ERA obtained during the interviews on this issue. Many interviewees highlighted ERA's notable proficiency in understanding technical issues, setting it apart from its peers. Some interviewees suggested that ERA should leverage this strength to help governments, other ecosystem funders, and investors understand complex technical problems and solutions, facilitating decisions that consider practical, transitional, and long-term impacts across the system.

I4 – Unclear Funding Agencies' Success Criteria

During the interviews, innovators, enablers, and owner/operators expressed that funders need to provide clearer definitions of the objectives in their funding calls. Stakeholders within the system find it challenging to discern which grants are best suited for their projects and how the various funding programs across the province and the country interconnect to fulfill an overarching strategy. Consequently, innovators often resort to applying for multiple grants, leading to a potential waste of resources as they strive to find the right match. Moreover, the lack of clarity regarding the definition of success for each agency and at each government level generates uncertainty among stakeholders regarding whether government funding is being distributed in a way that will maximize the overall impact.

Feedback from innovators indicates a lack of transparency and feedback, particularly in the case of unsuccessful grant applications. Considerable time, effort, and resources are invested in putting together applications, and innovators generally seek constructive criticism to improve and progress further. Many innovators have been encouraged to apply and led to believe that they are suitable candidates for calls, only to be rejected during the review process without receiving feedback that could help them improve their chance of success in future applications.

I5 – Intellectual Property Protection

The desire for competitive advantage and IP protection can impede technological advancement; innovators resist co-developing with others, avoid joining forces, and may limit themselves from potential benefits associated with collaboration and sharing. Additionally, there is a lack of transparency from technology vendors concerning their "black box" technology, which they may be reluctant to share with funders, investors, adopters, and operators. A general fixation on IP can lead to contentious deals or conversations between innovators and industry partners or funders.

Furthermore, the pursuit of competitive advantage and access to IP can lead to large companies developing technologies that compete with small firms or iterating on small firms' ideas using the greater capital available to them. In some cases, IP can become entangled in commercial agreements between innovators and potential adopters who ultimately do not implement the technology or idea. This situation can result in the technology being trapped in a state of limbo, where it remains unused and unapplied.

7.2 System Map

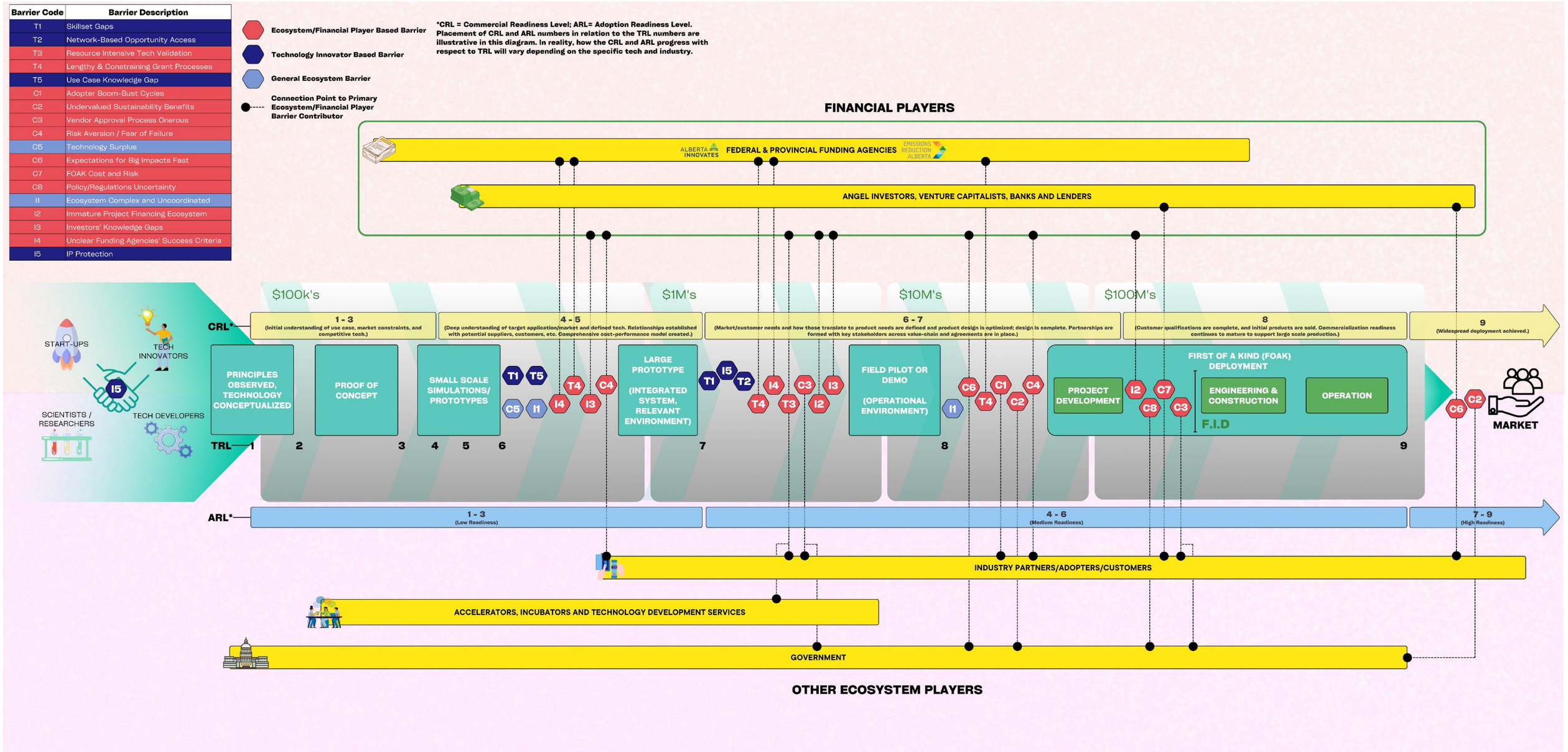
To provide a clear visualization of the key stakeholders associated with the barriers and the significant points in the technology innovators' journey where these barriers have a material impact, a "System Map of a Cleantech Innovator's Journey" was created. This diagram is presented in **Figure 6**. The Tech Innovator (used generally to represent Tech Innovators, Start-Ups, Tech Developers, and Scientists/Researchers on the far left) and their journey (depicted as navigating the B2P channel) are represented in the system map's center, flowing from left to right along the TRL/CRL/ARL scales. Ecosystem players are shown along the periphery of the Tech Innovator's journey and tend to coincide with certain readiness levels along that journey.

As the Tech Innovator progresses, they encounter barriers. These are the barriers described in **Section 7.1** and listed in the map's legend. Barriers often impact the Tech Innovator directly and are therefore shown along their journey. To illustrate when specific players have a significant influence on the manifestation and/or mitigation of a given barrier, black dotted lines connecting the barrier to the influencing players are included. Dark purple barrier icons indicate the barriers where the source of the issue lies within the technology innovator's firm, and the light purple icons represent the barriers that cannot be attributed to any specific players.

The placement of the barriers along the technology development journey was determined based on the stories shared during the interviews. Each barrier was positioned according to where it was perceived to have significant impacts. While many barriers exist throughout multiple stages of the journey, the diagram highlights the points where they pose the highest risk of halting progress or causing significant challenges for technology innovators. A notable observation from the map is that these critical points often occur between key technology development activities (i.e., between the staged process gaps). It is between the stages when firms are focused on raising funds, expanding their teams, and finding the necessary resources and partners to execute their projects. In the interest of revealing novel patterns that could guide solutions, this phenomenon is further explored in **Section 7.3.3.**

FIGURE 6: SYSTEM MAP OF CLEANTECH INNOVATOR'S JOURNEY

Barrier Code	Barrier Description
T1	Skillset Gaps
T2	Network-Based Opportunity Access
T3	Resource Intensive Tech Validation
T4	Lengthy & Constraining Grant Processes
T5	Use Case Knowledge Gap
C1	Adopter Boom-Bust Cycles
C2	Undervalued Sustainability Benefits
C3	Vendor Approval Process Onerous
C4	Risk Aversion / Fear of Failure
C5	Technology Surplus
C6	Expectations for Big Impacts Fast
C7	FOAK Cost and Risk
C8	Policy/Regulations Uncertainty
I1	Ecosystem Complex and Uncoordinated
I2	Immature Project Financing Ecosystem
I3	Investors' Knowledge Gaps
I4	Unclear Funding Agencies' Success Criteria
I5	IP Protection

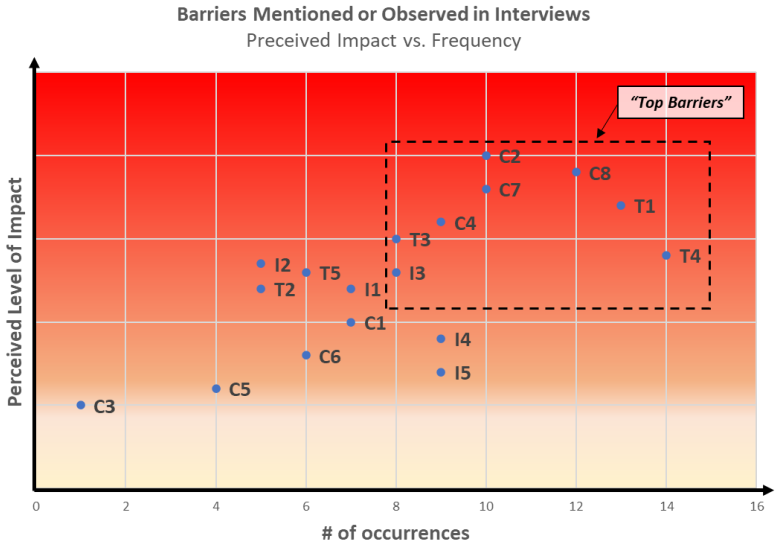


7.3 Analysis

7.3.1 Prioritization

To help identify the key barriers on which the team would focus for the Study recommendations, an assessment was conducted to determine their relative importance. This assessment considered both the frequency of mention and the perceived impact expressed in the interviews. **Figure 7** presents a comparison of the barriers, graphing how many times they were mentioned or observed against the perceived level of impact on the probability that a given technology will be commercialized. While this assessment is subjective, it offers a directional indication of each barrier's significance based on the team's interpretation and extrapolation of the stories gathered during the interviews.

The team assigned the barriers positioned in the top-right quadrant of the heat map as the Study's "Top Barriers." This prioritization did not result in the other barriers being disregarded in the process of devising potential solutions. Instead, it functioned as a guiding principle throughout the remainder of the Study, ensuring that each final recommendation would aim to address, at a minimum, one of these barriers to offer meaningful positive impact.



Code #	Barrier Name
T1	Tech Innovator Skillset Gaps
T2	Network-Based Opportunity Access
T3	Resource-Intensive Tech Validation
T4	Lengthy & Constraining Grant Application Processes
T5	Use Case Knowledge Gap
C1	Boom-Bust Cycles of Potential Adopters
C2	Undervalued Sustainability Benefits
C3	Vendor Approval Process Onerous
C4	Culture of Risk Aversion and Fear of Failure
C5	Surplus of New Tech
C6	Expectations for Big Impacts Fast
C7	First of a Kind (FOAK) Project High Cost & Risk
C8	Government Policy/Regulatory Flux & Complexity
I1	Ecosystem Complex & Uncoordinated
I2	Project Financing Ecosystem Gaps
I3	Investors & Funders Knowledge Gaps
I4	Unclear Funding Agencies' Success Criteria
I5	Intellectual Property Protection

Note: This colour indicates a top barrier

Figure 7: Barriers Perceived Impact vs. Frequency of Mention

7.3.2 Barriers to Demand & Speed

In the process of determining the relative ranking of the barriers, some notable observations were made. While certain barriers seem to persist throughout the entire technology lifecycle journey and primarily act as impediments that slow down progress, others have a greater potential to become outright showstoppers. At higher techno-commercial readiness levels (when substantial resources and capital are required), barriers which become dominant can often pose debilitating challenges and result in a halt of progress. In contrast, many of the non-technical barriers prevalent at lower readiness levels may hinder

progress and cause disruptions, but they generally appear to be more surmountable. (Of course, if it takes an excess amount of time and effort to surmount these barriers, they too can lead to companies abandoning their pursuits.)

The dichotomy between the different ends of the readiness scale could be attributed, in part, to how the skills, capital, stakeholder engagement, and resource requirements evolve and grow along the journey. For example, from a skills perspective, in the early stages of their journey, technology innovators need a wide range of skills, along with deep expertise in crucial aspects such as achieving product-to-market fit and honing their intellectual property. However, as they move closer to commercialization and look to execute more complex projects and commercial arrangements, both the depth and breadth of required skills expand to enable successful project execution and more sophisticated business administration. Furthermore, the distinction in the manageability of barriers between higher and lower readiness levels might also be attributed to the abundance of grant funding for ventures in the earlier stages compared to what is available for the more capital-intensive later stages.

Expanding upon this concept, the team's analysis revealed that several barriers function as significant roadblocks when technologies reach a higher level of maturity (i.e., when they are nearing readiness for commercialization). These barriers can be considered "barriers to demand" as they effectively hinder potential adopters and commercial project investors from choosing to embrace or invest in these emerging technologies. As such, the barriers can be further aggregated into two distinct groups: 1) Barriers to Demand and 2) Barriers to Speed. These groupings are presented in **Figure 8**.

Barriers to Demand

Code #	Barrier Name
C1	Boom-Bust Cycles of Potential Adopters
C2	Undervalued Sustainability Benefits
C4	Culture of Risk Aversion and Fear of Failure
C6	Expectations for Big Impacts Fast
C7	First of a Kind (FOAK) Project High Cost & Risk
C8	Government Policy/Regulatory Flux & Complexity
I2	Project Financing Ecosystem Gaps

Note: This colour indicates a top barrier

Barriers to Speed

Code #	Barrier Name
T1	Tech Innovator Skillset Gaps
T2	Network-Based Opportunity Access
T3	Resource-Intensive Tech Validation
T4	Lengthy & Constraining Grant Application Processes
T5	Technology Innovator Use Case Knowledge Gap
C3	Vendor Approval Process Onerous
C5	Surplus of New Tech
I1	Ecosystem Complex & Uncoordinated
I3	Investors & Funders Knowledge Gaps
I4	Unclear Funding Agencies' Success Criteria
I5	Intellectual Property Protection

FIGURE 8: BARRIERS TO DEMAND & SPEED

The impact of the barriers is not strictly binary. Each barrier possesses the potential to impede or halt progress at various stages along the journey. However, pinpointing key barriers that exert a more pronounced influence on market pull can assist in prioritizing the implementation of solutions. For instance, if the ecosystem is encountering multiple emerging high-potential technologies being halted just before the commercialization stage, directing efforts towards resolving the barriers to demand could yield a significant impact on the province's overall greenhouse gas emissions and clean technologies deployment objectives.

7.3.3 Barrier Clustering

As introduced in **Section 7.2**, the barriers appear to gather in three key areas along the technology development journey: before the large prototype project, before the field pilot project, and around the project development stage of the FOAK commercial project. As expected, barriers become most impactful at the interfaces between stages of development, indicating that challenges generally arise in transitioning from one stage to the next. Each of these transitions represents an order of magnitude increase in costs, ranging from tens of thousands of dollars in a laboratory setting to millions of dollars for a small-scale pilot, and potentially even tens of millions of dollars for a full-scale demonstration in certain instances. At each transition, different skill sets, processes and most importantly, sources of funds come into play.

After closer examination, these groups can be further consolidated into two clusters. The first cluster pertains to the development and scaling-up of technologies to prepare them for commercialization – the ones in this cluster are the key barriers along the technology development journey. The second cluster is related to the conversion of technologies into commercial products or projects – the ones in this cluster are the key barriers that hinder the commercialization of the technologies and are felt more acutely by technologies that need to follow the B2P pathway.

The first cluster of barriers, listed in **Table 3**, includes those that occur between the small- and large-scale prototypes and between large scale prototypes and demonstration facilities. Of these 13 barriers, seven are related to finance, four are related to the technology innovator and two are related to the general ecosystem, suggesting that a broad range of solutions will be required to address this cluster of barriers.

Table 3: Key Barriers that Impede Tech Development (Cluster 1)

	Barrier Name	Key Influencing Players	Barrier to
T1	Skillset Gaps	Technology Innovators	Speed
T2	Network-based Opportunity Access	Technology Innovators	Speed
T3	Resource Intensive Tech Validation	Services/Adopter/ Financial Players	Speed
T4	Lengthy & Constraining Grant Processes	Financial Players	Speed
T5	Use Case Knowledge Gaps	Technology Innovator	Speed
C3	Vendor Approval Process Onerous	Adopter/Financial Players	Speed
C4	Risk Aversion / Fear of Failure	Adopter / Financial Players	Demand
C5	Technology Surplus	General Ecosystem	Speed
I1	Ecosystem Complex and Uncoordinated	General Ecosystem	Speed
I2	Project Financing Ecosystem Gaps	Financial Players	Demand
I3	Investor Knowledge Gaps	Financial Players	Speed
I4	Unclear Grant Success Criteria	Government / Financial Players	Speed
I5	IP Protection	Technology Innovators	Speed

The second apparent cluster of barriers occurs after the field pilot/demo stage and affects a given innovator's ability to transform its technology into a commercialized product or service (i.e., its ability to overcome the "final valley of death"). The barriers in this cluster are listed in **Table 4,** and, as illustrated

in **Figure 6**, they primarily manifest themselves prior to and during the FOAK project development phase, frequently serving as the primary hindrances to reaching the final investment decision.

TABLE 4: KEY BARRIERS THAT IMPEDE TECH COMMERCIALIZATION (CLUSTER 2)

	Barrier Name	Key Influencing Players	Barrier to
T4	Lengthy & Constraining Grant Processes	Financial Players	Speed
C1	Adopter Boom-Bust Cycles	Adopter/Financial Players	Demand
C2	Undervalued Sustainability Benefits	Government/ Financial Players	Demand
C3	Vendor Approval Process Onerous	Adopter/Financial Players	Speed
C4	Risk Aversion/Fear of Failure	Adopter / Financial Players	Demand
C6	Expectations for Big Impacts Fast	Government / Financial Players	Demand
C7	FOAK Cost & Risk	Adopter/Financial Players	Demand
C8	Policy/Regulations Flux & Complexity	Government/Financial Players	Demand
I1	Ecosystem Complex & Uncoordinated	General Ecosystem	Demand
I2	Project Financing Ecosystem Gaps	Financial Players	Demand

When examining the list of barriers in the second cluster, it becomes evident that nine out of the ten barriers pertain to deficiencies in financial support for large commercial projects, implying that the ecosystem lacks the essential financing solutions, as well as willing adopters, investors, and lenders. The magnitude of the impact of these barriers on a given technology's commercialization journey will be highly dependent on the scale, capital intensity, complexity, and interdependence with parallel projects that the FOAK deployment requires. Therefore, it is at the post-field demo/pilot juncture that the distinction between Business to Project (B2P) and Business to Business (B2B) technologies becomes pronounced, with the barriers in the second cluster posing significantly greater challenges for B2P technologies.

For B2B technologies, often the field/demo stage has achieved a minimum viable product that can be used to initiate revenue generation which supports business growth and further product scale-up development. B2B technologies are commercialized as aggregations of multiple units (such as devices or apps) or services that are sold to existing operations. On the other hand, B2P technologies can only be commercialized as components of larger projects. When the technology requires the construction of a large new facility or retrofitting an existing one for commercialization, costs typically run into the hundreds of millions of dollars, and the challenges associated with overcoming that final valley of death are more formidable than in B2B technology commercialization projects which are generally less complex and capital-intensive.

To illustrate this reality, consider existing energy producers, along with their financial backers and supporters, who have predominantly focused their efforts on enhancing efficiency and reducing emissions within their existing facilities and value chains. While these endeavors are commendable, there appears to be a notable absence of active involvement in financing or developing new value chains, including hydrogen, second-generation renewable fuels, renewable energy, geothermal energy, small modular reactors, and others. Unfortunately, the deficiency of well-funded emerging adopters, willing to establish growth-oriented enterprises around pioneering value chains, poses a significant challenge. In their absence, the deployment of new technologies will probably be limited to lower-GHG-impact business-to-business (B2B) sales within established operations and industries.

7.3.4 Discussion: Synthesizing the Insights

By reviewing the improvement suggestions provided by interviewees in conjunction with analyzing the barriers, key themes emerged. This section discusses these key themes, serving to highlight the relationships between different barriers and identify critical areas that require solutions. It captures the team's supplementary qualitative analysis and interpretation that formed the foundation for the Study's recommendations.

Skillset and resource gaps need to be addressed in a way that enables innovators to hone their strengths and progress more efficiently without imposing excessive burdens.

Related Top Barriers:
Tech Innovator Skillset Gap; Resource-Intensive Tech Validation; Government Policy/Regulatory Flux & Complexity

As several of the barriers described in this report highlight, many innovators lack the knowledge, skills, and capacity required to advance their inventions from conception all the way to commercial products. Many start out as experts in their idea and/or invention but not often in the greater system, environment, and/or market in which their tech could be deployed. These gaps are especially limiting for small/medium start-up firms developing technologies that need to be integrated into industrial settings. Particularly when seeking to validate and demonstrate their technology in real-world field environments, they often face challenges in securing partners and with project execution.

Many technology start-ups lack the necessary tools to navigate the uncoordinated ecosystem, tight-knit business/industry networks, government regulations, supply chain management, and land aspects of their technology de-risking projects. Furthermore, they struggle to build realistic strategies and roadmaps and face challenges with effectively persuading investors and lenders of the viability of their ventures. These issues become even larger and harder to overcome for innovators who have high TRL technologies that require complex and expensive projects to achieve full commercialization (i.e., the B2P technologies).

Solutions that empower innovators to focus on their strengths, sparing them from the need to rapidly expand and diversify into many disciplines, are needed. Innovative strategies aimed at augmenting support capacity within the ecosystem and ensuring its effective utilization have the potential to expedite numerous technology development journeys. By alleviating innovators from some of the burden of capacity building, these approaches could lead to a reduction in the time required for the planning and execution of each de-risking project.

Additionally, the system requires more effective approaches that enable tech innovators to proactively tackle their weaknesses and blind spots, while also facilitating their navigation of the ecosystem, education of government regulations/policies, and collaboration with the appropriate stakeholders. These approaches should be tailored to their specific needs (and incorporated into existing processes where possible) without imposing excessive burdens.

Grant funding processes need to be more agile and streamlined to expedite innovation.

Related Top Barriers:
Lengthy & Constraining Grant Application Processes; Investors & Funders Knowledge Gaps; Resource-Intensive Tech Validation

Most interviewees conveyed that the pursuit of funding posed significant challenges for them. Over 75% of them expressed their struggles with government funding procedures, citing their lengthiness, restrictive nature, and ambiguity regarding success criteria for awards. They recounted instances of losing technology advancement momentum and depleting resources while navigating the grant application process and seeking potential funding partners. These experiences led to a start-and-stop dynamic in their journey, ultimately prolonging their respective technology development lifecycles.

The seemingly uncoordinated and fragmented approach to government funding in Canada exacerbates the inefficiencies experienced by technology innovators and technology project proponents. The existence of multiple government-sponsored organizations, each with slightly similar mandates that sometimes overlap, leads to confusion as well as unnecessary effort expended. Proponents seeking funding can become uncertain about which grants or funds they should pursue, often resulting in significant time and effort being expended on applications that ultimately prove to be ill-suited or to not fully cover their needs. Compounding the problem, according to stories shared in Tech Innovator interviews, proponents are sometimes encouraged by funding organizations to apply for grants, only to find out after going through the process that their odds of success were not favorable from the outset. From a public interest perspective, as Enabler interviewees suggested, the absence of a single entity accountable for the coordination of the ecosystem government funding is creating a risk of ineffective distribution and/or underutilization of funds.

Innovators and Facility Owners/Operators interviewed also expressed a general lack of support to transition from one technology development stage to the next. One interviewee, that was previously supported by ERA, remarked, “You get funding and buy-in for a pilot project, but then it doesn’t get funding for the next project to scale it up…” Multiple factors likely contribute to this phenomenon; however, it does suggest there is an opportunity for funding agencies to do more to improve the connectivity between the stages.

All of this points to a need for a more streamline and coordinated approach to supporting technology innovators as they progress through the technology development lifecycle. Grant processes have room for improvement: these processes could better cater to the agility, pace, and challenges that start-up tech innovators face and funding agencies could better coordinate with each other to minimize gaps, redundancies, and inefficiencies in the ecosystem.

Continuous education of investors and governments is necessary, and ERA has the potential to play an impactful role in this endeavor.

Related Top Barriers:

Government Policy/Regulatory Flux & Complexity; Investors & Funders Knowledge Gaps; Undervalued Sustainability Benefits; Resource-Intensive Tech Validation; Culture of Risk Aversion

Several interviewees emphasized that some investors and government funders lack the technical knowledge and understanding of the needs of prospective adopters required to make optimal investment decisions. This knowledge gap poses a significant barrier for technologies in securing the necessary funds and support for successful commercialization.

Investor knowledge gaps become a significant challenge for innovators aiming to advance their technologies into field/industrial environment validation stages. At this juncture, they need an injection

of capital that often is too high for most investors, primarily due to the relatively lower readiness level (i.e., high risk level) of these specific technologies at that stage. The barrier intensifies further with each subsequent increase in required capital raising. If investors lack a comprehensive understanding of the technology, its application, and its potential market demand, assessing its value becomes challenging and often leads to a misunderstanding of the risks associated with the technology development journey. Furthermore, there is a lack of collaboration between investors and industry, resulting in investors not understanding what industry needs, missed opportunities, and undervalued prospects. In many cases, it is the presentation skills of the tech innovator firm's leaders that sway investors, rather than the true viability and value of the technology itself.

This phenomenon extends beyond the investor community to impact government policymakers and regulatory designers as well. Knowledge gaps are likely fundamental sources of various barriers discussed during the interviews, such as inadequate incentives for adopting clean technology, uncertainties and biases within policies and regulations, fragmented and overlapping funding programs with unclear objectives, insufficient grant coverage for technology development expenses (in comparison to other regions of the world), and regulations that exhibit favoritism toward specific clean technologies (while penalizing others), thereby impeding both innovation and investment.

In short, industrial & energy systems, technical challenges, and technical solutions are very complex, and decision makers are not always equipped to understand what is presented to them, leading to a misrepresentation of risk. Investors and governments require support to grasp these issues. ERA is poised to assume an elevated role in this arena. Necessary are solutions that capitalize on ERA's credibility, expertise, and relationships to consistently and effectively educate both investors and governments. Ideas that should be considered include the following:

- Integration of measures within existing processes (such as handover/recommendation processes between funding agencies) and engagement practices to enrich investor understanding of emerging technology. This transformation would position ERA as a staunch advocate for the technologies it supports.
- Formation of ERA-led committees comprising industry leaders who play a pivotal role in informing funder and investor decisions. Additionally, employing trusted service providers to offer impartial technology assessments, akin to the established practice of transactional due diligence.
- Exploring avenues for ERA to enhance its role in educating government policymakers and regulatory designers. This endeavor would strive to facilitate the development of a more unified national strategy for promoting clean technology advancement, ultimately ensuring that regulations and incentives align investments with the goal of expediting decarbonization.

More problem-centric approaches to technology development are needed.

Related Top Barriers:
Undervalued Sustainability Benefits; Resource-Intensive Tech Validation; Culture of Risk Aversion

While many technologies are making significant progress in their development journeys, notable challenges persist in terms of attraction of strategic investors (during expensive de-risking stages) and uptake and adoption, commonly referred to as a lack of market pull. This challenge arises due to various

factors, including the absence of sufficient motivators for individuals to adopt new decarbonization technologies, which can be attributed in part to deficiencies in government policy and regulation. However, in addition, there is a mindset that prevails in the ecosystem, playing a fundamental role in this phenomenon: there appears to be an emphasis on nurturing numerous new technologies and small tech firms, rather than a focus on solving real-world problems that exist today.

A few adopter/enabler interviewees stated that funding organizations seem to allocate funds to promote potentially promising ideas that have not yet been evaluated in terms of their market demand or financial viability. Based on their experience working with innovators in such scenarios, they noted that many innovators lack an understanding of the practical applications for their ideas, and there is a lack of collaboration from potential adopters in the development of new technology.

Increasing the focus towards problem-solving and aligning technology development with tangible requirements would be instrumental in driving meaningful adoption of innovative solutions in the near term. A key message here is: if potential customers in the market see that they have a real need for the solution a technology offers, they are more likely to see that the benefits of investment and adoption outweigh the associated risks – this dynamic is what attracts investment in the technology de-risking projects and it is what spurs market demand for the technology when it is ready to be commercialize.

In summary, the ecosystem requires additional programs and frameworks that cultivate problem-centric approaches. These approaches should motivate potential adopters to define their issues, invest in, co-develop solutions alongside technology innovators, and commit to adopting the resultant technology. Mere facilitation of connections between innovators and industry players falls short; it is imperative to establish programs which ensure a collaborative, mutually beneficial relationship between the parties to truly make a substantial impact on the market uptake issue.

The system lacks the financial solutions and willing owner/operators required to deploy the disruptive and high impact clean technologies.

Related Top Barriers:
FOAK Project High Risk & Cost; Undervalued Sustainability Benefits

B2P technologies encounter the greatest challenges in the "final mile" of their commercialization journey. This is because, to fully commercialize, they need to be incorporated into larger and more complex projects. These projects require motivated and well-funded entities to take ownership, along with the implementation of sophisticated project financing solutions.

Analysis of the interview data has highlighted that such large and complex commercial projects (which would enable FOAK deployment of these technologies) struggle to be convened and secure funding and financing. This points to an immature ecosystem for project financing as well as an absence of entities. Venture capitalists typically invest in companies rather than individual projects, while institutional investors and banks perceive new tech projects as too risky. The current practice of relying on incumbents, particularly large firms, to self-finance the deployment of new technologies often results in stalled commercialization projects, particularly for projects that fall outside the boundaries of existing operations. These projects struggle to compete with base-business projects that are better understood and deemed less risky.

As discussed in the analysis of barrier clustering, incumbent firms primarily concentrate on enhancing their current operations and lack the motivation to establish the novel value chains required for substantial greenhouse gas emissions reduction. In addition, there is a notable absence of well-funded emerging adopters capable of establishing growth companies centered around new transformative value chains. For emerging clean technologies that fall within the B2P channel, this is a critical barrier to commercialization.

Creative approaches to attract strategic investors and emerging clean technology owner & operators as well as finance FOAK commercial projects are needed. The government, ERA, or analogous entities within the ecosystem must explore methods to further mitigate the risk to project owners and investors. This could potentially be achieved by employing financial instruments that go beyond non-dilutive funding and by assuming a leading role in project development and investment. These ideas are discussed further in **Section 9.2.3**.

8 JURISDICTIONAL SCAN

As the team sought to identify strategies to alleviate the barriers unveiled during the interview process, it was important to investigate successful ecosystem-enabling practices worldwide. For the Jurisdiction Scan, the team reviewed literature pertaining to jurisdictions outside of Alberta, exploring clean technologies programs, policy instruments, emergent hubs, and other success stories to gather valuable lessons. This section offers a summary of the key methods that have been proven to successfully foster innovation.

8.1 A GLOBAL LOOK

To find meaningful examples of successful clean technology development programs in other jurisdictions, the team reviewed relevant studies which focused on worldwide programs and their successes. The International Energy Agency (IEA) published a report titled "How Governments Support Clean Energy Start-ups" in March 2022 (IEA, 2022). Of the studies and publicly available information reviewed, this IEA report proved the most insightful, offering valuable concepts that were used to identify potential barrier mitigations.

IEA's report highlights the main policy and program instruments or strategies by which jurisdictions can enable innovators to develop clean technology. The following presents a summary of these methods.

Access to Laboratory Infrastructure

The IEA report highlighted that the value some government services provide to startups far outweighs the financial cost to the taxpayer. Granting access to laboratory infrastructure was called out as a particularly impactful service. It was found that clean energy startups generally require more time in laboratories with expensive equipment than other new ventures. Various jurisdictions around the world have discovered ways to make their publicly owned energy/research laboratories and research and development (R&D) staff available to startups. These R&D staff members offer valuable expertise that innovators can utilize to assist in lab activities and proposal evaluation.

Networking Facilitation

Governments can organize stakeholder interactions relatively inexpensively, through events or online networks that leverage the government's reputation and profile. Additionally, governments can use public funds to launch more targeted networks for overlooked elements of the innovation system. Intergovernmental networking can also be beneficial in stimulating tech development: governments have opportunities to exchange best practices and solutions in clean energy policymaking. Generally, networking and collaboration are constructive for startups and jurisdictions alike.

Post-Program Monitoring/Data Validation

The IEA contends that once a startup has exited a public support program, evaluating whether it fulfilled its estimates and promises to abate emissions becomes another challenge. Moreover, it is difficult to determine the actual emissions impact of any technology development public support program. Allocating resources to conduct follow-on data validation of participants can provide valuable data to the program and aid in continual improvements. Some programs do require surveys to be completed at varying

intervals after project completion or require continued reporting of emissions for a fixed period. Other programs connect the ex-ante and ex-post evaluations: at the end of the project, recipients must update their estimates of emission avoidance potential made during the application phase.

Various/Flexible Funding Schemes

Early startups looking to secure capital often face the challenge of avoiding the depletion of their working capital in the immediate future rather than securing large or prestigious grants in, say, 12 months' time. This challenge can change as startups progress through the successive stages of scaling up (if they are successful); their financial needs will evolve, and governments can play a major role in strategizing their policies carefully to accommodate gaps in areas like growth equity financing or the public sector's risk appetite. Channeling the right money at the right time is key.

Various funding methods and delivery pathways exist, with the main recommendations from the IEA's study highlighted below:

- Use of permanently open calls that complete evaluations quickly.
- Award grants as stipends with few constraints on eligible costs.
- Tailored grant programs and services for successive stages of scale-up (various TRL's)
- Avoid dilutive funding for early startups (can also differentiate public from private resources).
- Strategize for long-term budget consistency, allowing participants to transfer to successive, tailored grant programs.
- Use of concessional grants or loan guarantees to avoid startups selling ownership before they can take root and remain in their originating jurisdiction.

Inter-Start Up Collaboration Facilitation

Facilitating collaboration between startup companies has emerged as a particularly impactful service that governments can provide. Elevating the overall success of all entrepreneurs who have the potential to help solve clean energy technology problems is a major public sector interest.

Additionally, the startups operating in these domains often do not compete with one another and are usually eager to (or at least should be encouraged to) share their experiences; this increased interaction also has the benefit of motivating startups through each other's successes. Establishing a collaborative networking system also encourages innovators to work on common challenges and reveals synergies between innovators who may not realize they can become important value-chain proponents of emerging technologies in the future.

Active Promotion of Participants

According to the IEA, "Participation in a government program confers a 'badge of quality' that is not available from most private sector incubators or investors. As this recognition can be particularly helpful for startups seeking follow-on funding or customers, active promotion of participating startups is a core part of the services several initiatives offer." Raising awareness of tech developers and their innovations/ideas can benefit clean energy innovation overall.

Technology Prioritization

Governments, which have identified their jurisdiction's priorities based on their region's natural resources and strengths, have achieved an important step. By narrowing their focus on specific technology areas and aligning their policy priorities accordingly, governments can differentiate themselves from the private sector and emphasize their impact. Policy experience suggests that focusing startup support from the government on priority technologies/technology areas can both advance their technology maturity and help governments learn about the scope and status of the possible solutions.

Milestone/Progress Tracking

Many incubators help startups set milestones and track progress, so this is frequently included in the services provided when governments channel support indirectly through incubators. Feedback from startups studied by the IEA indicates that these types of services can be valuable, although they do vary in quality and effectiveness. For example, advice is found to be most valuable when provided by experts familiar with the peculiarities and challenges of the relevant clean energy sector, rather than by generalists or experts in unrelated fields, such as software development. Moreover, clean technology innovators require support not only in navigating the technical and commercial aspects of their technology but also in achieving significant business milestones. In short, to ensure that incubators and similar enablers offer optimal assistance to such startups, they should consider multidisciplinary advisory teams with relevant experience in the innovator's specific industry.

Combination of Financial and Service-Based Support

Nearly all the case studies IEA evaluated offered combinations of financial and service-based support together for start-ups. Services and support systems that exist to help startups advance both their commercial and technical readiness, such as laboratory access or expertise, networking, and collaboration facilitation, etc., are just as valuable to those startups as strategic funding support. **Table 5** displays a cross-section of example programs from around the world that offer at least one, or a combination, of the main support systems described in the previous sections.

TABLE 5: EXAMPLE PROGRAM SUPPORT SYSTEMS

	Main Program Support Systems								
Jurisdiction / Program	Access to **Laboratory Infrastructure**	**Networking** Facilitation	Post-Program **Monitoring**/Data Validation	Various/**Flexible Funding** Schemes	Inter-Start Up **Collaboration** Facilitation	Actie **Promotion** of Participants	Technology **Prioritization**	Milestone/ **Progress Tracking**	**Combination** of Financial and Service-Based Support
American Made Challenges (USA)	✓	✓			✓		✓		✓
Inovation Incubator (IN^2) (USA)	✓	✓	✓						✓
Ecolabs-COI (Singapore)	✓	✓				✓		✓	
Green Innoboost (Morocco)	✓	✓		✓	✓				
Incubatenergy Network (USA)		✓							
Clean Energy International Incubation Centre (India)	✓	✓		✓			✓	✓	✓
Swedish Energy Agency (Sweden)		✓	✓	✓					✓
Innovation Norway (Norway)		✓	✓	✓					✓
Women in Cleantech Challenge (Canada)	✓	✓	✓	✓	✓			✓	✓
Start Up Energy Transition (Germany)		✓				✓	✓		
Start Up Chile (Chile)		✓					✓		
EIT InnoEnergy Highway (European Union)	✓	✓					✓	✓	✓

8.2 NOTEWORTHY JURISDICTIONS AND CASE STUDIES

Over the course of the Study's literature review, a few notable approaches emerged as successful and effective in accelerating clean technologies innovation. This section provides a summary of these examples.

8.2.1 NORWAY – INNOVATION NORWAY

Norway is known as a jurisdiction with unique qualities that enable success of its clean technologies' innovators. Upon closer examination, its *Innovation Norway* program is a clear contributor to this success, making it an intriguing case study from which Exergy and ERA can draw inspiration.

Norwegian based startups or SME's looking to validate, demonstrate and hone their technology for market entry are the target innovator type *Innovation Norway* seeks. Applications can be made at any time and applicants do not have to wait for specific calls. Account managers are also assigned to each start-up that applies to help navigate the different programs offered by the agency to find the best match. They offer both non-dilutive grants and loans. **Table 6** presents some of the noteworthy attributes to the *Innovation Norway* program.

TABLE 6: INNOVATION NORWAY PROGRAM ATTRIBUTES

ELEMENTS OF SUCCESS	DESCRIPTION

PERMANENTLY OPEN CALLS	*Innovation Norway's* three main financial instruments include:
	• Start-up grants and loans
	  ○ These vary based on start-up maturity, risk profile and needs. In some cases, grants may precede a loan once the start-up makes progress through the program.
	• Environmental technology grants
	  ○ These are specifically for projects building/piloting new environmental technologies.
	• Innovation contracts
	  ○ These are grants provided for projects structured as contracts between a Norwegian tech innovator and a potential customer or industry partner (from any country). This potential customer must cover at least 20% of project costs to indicate their dedication, in which case *Innovation Norway* would then fund up to 50% of the start-up's remaining project costs.

ADVISORY OVERSIGHT FOR APPLICANTS	Applying through a common system/portal, applicants are then guided by an advisor toward the best/most appropriate financial support pathway and call. The advisor considers things such as: • The product market fit. • Strength of the applicant's team. • Long-term commitment to building out the business. The advisor can also help them identify potential partners for environmental technology grants or innovation contract projects.
OTHER SERVICE CONNECTIONS	*Innovation Norway* has a broad network of business services they can lean on to connect start-ups with helpful resources; this includes assistance with intellectual property (IP), market research/novelty/potential evaluation, and general business guidance. They also work with industrial partners to assess potential project opportunities. Infrastructure assistance can be available through Norway's Marine Energy Test Centre, which can provide expertise and testing facilities for certain industries.
NETWORKING OPPORTUNITIES	Advisors, regardless of whether an applicant successfully receives funding, can connect applicants with additional external assistance in the form of other government agencies, incubators, etc. These connections extend internationally as well through *Innovation Norway's* extensive network.

Following program completion, *Innovation Norway* requires participants to update their emission reduction values to include all potential downstream emissions, allowing for a comparison to initial estimates. Additionally, they conduct post-funding surveys four years later to monitor the progress and performance of all funded participants.

In general, participants provide positive feedback on the program, highlighting the value of the connections facilitated by *Innovation Norway* with potential customers and pilot partners. This is

particularly beneficial for startups that may face challenges due to limited experience, track records, or financial resources, which can hinder their access to other grant funding programs. *Innovation Norway* presents a uniquely holistic approach to technology development, and Canadian/Albertan ecosystem supporters could gather ideas from this approach to build upon their current suite of offerings.

8.2.2 UNITED STATES

8.2.2.1 Government Sponsored Programs

Many opportunities exist in the US that encourage and facilitate clean technologies development alongside a myriad of funding and service-based programs. A few noteworthy examples, the *American Made Challenges* program and the *Innovation Incubator (IN^2)* program are both facilitated by the National Renewable Energy Laboratory (NREL). The *American Made Challenges* program seems to focus on technologies from TRL 1 to 6, whereas the IN^2 program is geared towards technologies that have reached the stage of requiring precision technology testing or refinement (TRL 3-8 typically).

In addition, the Advanced Research Projects Agency – Energy (ARPA-E) is tasked by the United States government (and modeled after the Defense Advanced Research Projects Agency, DARPA) to promote and fund research and development of advanced energy technologies (ARPA-E, Advanced Research Projects Agency - Energy, 2023). Run through the Department of Energy (DOE), specific funding opportunities that prioritize certain industries or problems to solve are announced for application. **ARPA-E can provide experts and advisors to assist participants and is well connected to the agencies and infrastructure DOE partners work with.** They also often seek defense contract opportunities, as high-cost projects are not often show-stoppers for the military, and first-of-a-kind (FOAK) tech deployment can occur more readily there under these contracts, subsequently bringing down future costs for customers. ARPA-E touts that they tend to fund high-risk, high-reward technologies, with their main mandate to work towards achieving 2050 emission mandates in the US.

***American Made Challenges*, IN^2, and ARPA-E** are all in partnership, work closely with, or are administered by the NREL, **inherently benefiting the participants in terms of the connections, facilities, partnerships, and expertise that come from the NREL.** This is a mutual and reciprocal relationship, in that the value and credibility that comes from working with the NREL attracts potential investors, while collaborating with innovative start-ups gives government researchers direct access to new technology solutions. Both programs provide invaluable access to national energy laboratories and equipment/infrastructure.

While the *American Made Challenges* program and ARPA-E rely on traditional calls for proposal and application based on identified technology needs, IN^2 uses expert referrals and extends invitations to potential recipients. They all provide non-dilutive grants, though IN^2 sources its funding from private sources.

Some of the key takeaways from each program, which guided some of this Study's recommendations, are shown in **Table 7**. Post program completion, each program collects feedback on teams' experiences during the program to make continual improvements that are shared with the DOE. The NREL can also help participants estimate potential emissions reductions as it works with them to evaluate their technologies and provide these details to potential customers.

Additionally, *American Made Challenges* and ARPA-E have well-laid-out portals for accessing information, timelines, and prize values for their extensive list of open challenges, through which start-ups can learn about the challenges they may be eligible to compete in. A comprehensive portal for accessing information and viewing open calls/challenges is a valuable, consolidated resource for all applicants.

Various attributes of these American programs were considered and used in conjunction with interviewee feedback to develop the recommendations offered in **Section 9.2**. Notably, their services voucher programs and the integration of clean technologies development into government/defense contracts were key sources of inspiration.

TABLE 7: AMERICAN MADE CHALLENGES, IN^2 AND ARPA-E PROGRAM ATTRIBUTES

ELEMENTS OF SUCCESS	DESCRIPTION
EXPERT ANALYSIS IN RECIPIENT SELECTION PROCESS	*American Made Challenges* and ARPA-E designs challenges in cooperation with the DOE, and an expert panel from the NREL and DOE judge the applicants. *IN^2* utilizes support from its network of 60 "channel partners" who refer start-ups to the program. These partners include incubators, accelerators, and universities.
VOUCHERS AND ACCESS TO NATIONAL ENERGY LABORATORIES	In addition to granting non-dilutive cash prizes to recipients, the *American Made Challenges* program also issues vouchers for startups to utilize National Energy Laboratory or other qualified facilities to assess valuable equipment used to test, validate and prototype/pilot their new tech. Access to these facilities is also a key service offered by ARPA-E and *IN^2*, where an assigned laboratory researcher guides recipients through the processes of testing, validating, and improving their technology. The ARPA-E projects that the NREL undertakes are perhaps NREL's most innovative ones.
VALUABLE NETWORK AND INDUSTRY PARTNERS	All programs have extensive networks to draw from for technical assistance, investor introduction, industry partnerships, and more. The NREL asks its network members to provide this technical insight, marketing expertise, etc. to support start-ups. *American Made Challenges* also has the unique trait of providing small monetary rewards to network members that voluntarily support start-up teams. Though relatively small, this aims to encourage collaboration within the clean technology's ecosystem.

8.2.2.2 Migration to the USA – IRA & Other Drivers

A frequently observed phenomenon is the migration of clean technologies innovators into the US market for development, investment, or acquiring customers. This section provides some discussion and perspectives on this trend to provide additional context for the Study.

American incentivization programs, the most oft referenced one being the Inflation Reduction Act (IRA), seem to be the main driver of the recent jumps south of Canada's border. The bill creates the most supportive regulatory environment in clean technologies history, according to Goldman Sachs Research (Bakx (1), 2023). Massive subsidies can be realized from the IRA for innovators, along with the influx of clean technologies activity due to these subsidies as the ecosystem in the US is exponentially expanding;

the economics and customer base of many SME's projects just make more sense now in the US. This can be particularly impactful for later-stage projects like the ones ERA funds.

Kevin Krausert, CEO of Avatar Innovations, speaking to CBC (Bakx (1), 2023) says Canada needs to offer incentives comparable to the IRA to slow down the amount of investment dollars leaving Canada. He contends a **dollar in the US can net investors superior returns vs. a dollar in Canada right now.** Robert Delamar of Kanata Clean Power, in the same article, highlights that their company can get roughly 2/3 of a proposed ammonia plant subsidized by the IRA, whereas a similar plant in Canada is much more complicated as certain pieces of equipment would receive varying levels of subsidies than others. "It's just cheaper to build these facilities in the United States (US) because of the IRA", Delmar states.

Also described in a Globe and Mail article (Radwanski, 2023), think tanks Clean Prosperity and The Transition Accelerator released a report studying this Canada-US incentive disparity. Though the report offers many potential ideas to stem the flow of technology over the border, it highlights the **fundamental need for Canada to get funds from government programs into the hands of innovators/industry in a more strategic, predictable, and expedient manner, targeting industries/sectors where matching or surpassing the US is a realistic possibility.** In other words, while Canada may struggle to be competitive in some sectors like battery manufacturing, there is potential for Canada to make significant progress in domestic projects, such as sustainable aviation fuels. This determination is based on comparing the credits available in the US through the IRA (and other mechanisms) with those available from Canada's industrial carbon credits, assuming they reach their full intended value, and Canada's robust biofuels industry, where a matching production tax credit could be implemented (in this example).

Lastly, an unfortunate reality, highlighted by Richard Brown of Kathairos Solutions in another CBC article, is that many innovative technologies originate in Canada but are adopted at scale in the US (Bakx (2), 2023). There is support in Canada for new tech development in the early stages, but the eventual deployment at scale is much greater in the US, leading to the realization of economic benefits flowing south. One reason discussed for this includes the introduction of strict regulations; in 2018, the Canadian federal government introduced regulations to reduce oil and gas methane emissions while increasing funding for monitoring, avoidance, and reduction technologies. These regulations gave rise to dozens of startups with favorable economics for development. **Currently, in the US, the Environmental Protection Agency (EPA) is proposing rules that would surpass Canada's stringency**, prompting oil and gas companies in the US to pre-empt the looming regulations by investing in new clean technologies. "Having the certainty that [the new regulations] are coming is creating a whole bunch of action with some of the more proactive oil and gas producers," says Connor O'Shea of Westgen Technologies.

According to some experts, the **US also precedes Canada by approximately a year in terms of this stricter regulatory landscape**. Richard Brown suggests that greater expediency on the part of the Canadian government could foster more opportunities domestically. It is also crucial to acknowledge the size of the US market and overall economy (compared to that of Canada), which tends to attract innovators due to its "gravitational pull".

In summary, these cases underscore how the regulatory landscape in the US is attractive for high TRL technology development projects, often proving more advantageous for innovators compared to the current landscape in Canada. Measures should be taken at both provincial and federal levels to bolster these incentives for Canadian innovators. While more comprehensive analysis is required than what is offered in this Study regarding these mechanisms, the Study's solutions acknowledge this reality and

provide various recommendations aimed at facilitating more expedient, later-stage, pre-commercial technology development.

8.2.3 Germany – North Shore Renewables Hub

Besides investigating specific government programs in various jurisdictions, analyzing the development of clean energy hubs worldwide can reveal additional factors that create thriving innovation or clean technologies ecosystems. Germany's northern shore stands out as a recognized hub for renewable commodities and technology.

Germany's ambitious goal to achieve net-zero emissions and reduce dependence on Russian gas has led to significant investment in constructing clean energy infrastructure at Wilhelmshaven, its largest naval deepwater port. **Energy firms are planning to invest over $5.5 billion in this endeavor**, shifting their focus from liquefied natural gas (LNG) to hydrogen and ammonia imports, hydrogen production, and offshore carbon emissions storage (Eckert, 2023). The investment is expected to take place between 2026 and 2030, with major players like Wintershall Dea, Uniper, and Tree Energy Solutions leading the way. This development is not only crucial for Germany's energy needs but also holds promise for boosting the region's economy, generating jobs, and potentially attracting companies from other industrial regions in the country.

A high-level diagram of the envisioned infrastructure and processes at Wilhelmshaven is shown in **Figure 9**, and some of the key reasons for selecting Wilhelmshaven as the location to build Germany's renewable and clean technologies industry are listed below (Uniper, 2022):

- Geographical location:
  - Offshore salt caverns for hydrogen storage exist in the sea around Wilhelmshaven.
  - Germany's only deepwater port provides access to large vessels.
- Existing infrastructure:
  - Existing rail lines to and from the port from legacy activities/industry.
  - Existing piping and other oil & gas infrastructure from legacy activities/industry that can be repurposed to transport hydrogen.
  - Early connection to the hydrogen pipeline for the European Hydrogen Backbone project.
  - Growing offshore wind energy presence to provide clean energy to the port (for electrolysis).
- Existing import/export businesses:
  - Importation of ammonia (hydrogen source) is already an established industry.
  - Ammonia is also safe/easy to transport and has existing ships capable of transporting it.
- Existing customer base locally and further downstream:
  - Germany's need for energy import from ammonia at Wilhelmshaven due to insufficient domestic renewable electricity production.
  - Expansion of offshore wind and hydrogen electrolysis at the port to meet energy demands.
  - Third-party companies in the area are already engaging with the port projects to utilize waste heat from planned electrolysis plants (e.g., paper plant) or to receive green hydrogen for their processes (e.g., steelmaking).

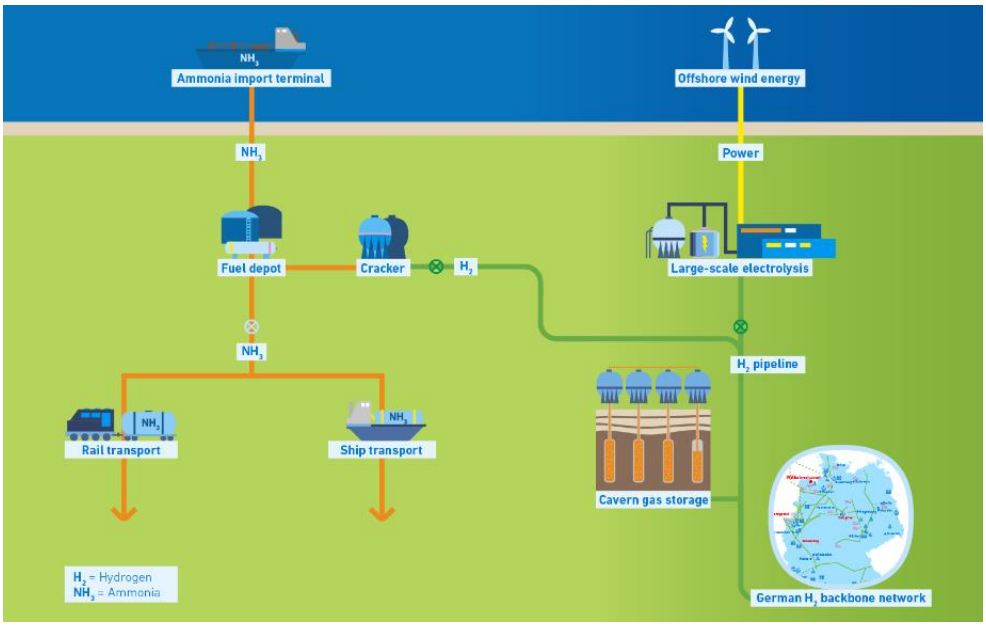


FIGURE 9: WILHELMSHAVEN HUB **(UNIPER, 2022)**

Wilhelmshaven benefits from leveraging the **European Projects of Common Interest (PCI) funding schemes**, which could see the port projects receive funding for up to 30-50% of project costs. This organization's goal is to unify energy systems in the European Union (EU), using cross-border infrastructure to help the EU achieve their energy and climate goals in line with the Paris Agreement.

Furthermore, the establishment of a hydrogen hub in this region is firmly supported by the **very public commitment of the German government to be a leader in clean hydrogen technology**, evident through its National Hydrogen Strategy, collaborative import and export agreements with other nations, and a substantial **USD 9.6 billion investment**.

Insights from examining the hub at Wilhelmshaven and others worldwide — such as the Texas Hydrogen Hub or the Fukushima Renewables Hub — typically suggest that their success relies on several key attributes:

- Geographical proximity or accessibility to clean electricity (wind/solar) and geological formations that can store hydrogen and carbon emissions.
- Existing infrastructure and transportation networks for commodities or electricity (transmission network).
- Existing upstream supply networks and downstream distribution networks.

Notably, Alberta boasts several similar attributes to these successful hubs. This observation highlights the province's significant potential to emerge as a prominent clean energy hub. By recognizing and embracing the similarities, Alberta can learn from the established frameworks in these regions, adapting and implementing best practices to accelerate its own transition to a thriving clean energy hub.

Clean energy and industrial hubs have a proven track record of igniting new industries and propelling innovation, effectively addressing the persistent "market pull issue." The proximity of supply and demand within these hubs substantially reduces technology implementation costs, rendering clean energy solutions more appealing to potential adopters and fostering a surge in demand. Consequently, this spurs the need for amplified supply, thereby facilitating a powerful domino effect that catalyzes rapid growth and advancement. Moreover, these hubs serve as nurturing grounds for emerging technologies, providing an ideal environment with abundant support services, testing sites, and a readily available pool of potential adopters.

However, creating a hub is not an easy feat. **Establishing anchor tenants is one of the most crucial aspects to hub creation**. Anchor tenants play a pivotal role, providing the necessary scale of demand that justifies the development of infrastructure build-out and upstream value chain components. Without commitments from anchor tenants, the desired domino effect cannot materialize. As a result, governments seeking to enable such hubs must adopt effective strategies to incentivize, mitigate risks for, and eliminate barriers for potential anchor tenants. These strategies may encompass substantial subsidies, the consideration of public-private partnerships, financial de-risking solutions, adjustments to regulations, and clarification of permitting processes.

Furthermore, the **successful establishment of hubs necessitates complex collaboration among diverse stakeholders**. Clear comprehension of the ultimate objectives and efficient teamwork is essential for governments, innovators, potential adopters, and support infrastructure providers. Breaking down barriers and improving coordination within the innovation ecosystem are imperative to ensure seamless cooperation and progress. Equally important is the need to shed existing paradigms that impede progress. These concepts were considered by the Study team during the formulation of recommendations.

8.3 Specific Canadian Examples for Consideration

8.3.1 "Integrated Marketplace" Projects

With the key goal of driving uptake of clean technology along the whole value chain of a particular industry or site, the provincial government in British Columbia, specifically as part of the StrongerBC Economic Plan, partnered with the Vancouver International Airport to undertake their *Integrated Marketplace Initiative* (Ministry of Jobs, Economic Recovery and Innovation , 2022). Its aim is to electrify airport infrastructure to help them meet their goal of net zero emissions by 2030 to become the world's greenest airport. The British Colombia (BC) government will be providing **$2.5M over three years for pilot projects at the Vancouver Airport (YVR) testbed.** This unique partnership has a few noteworthy benefits for both the airport and clean technology innovators:

- Innovators have a real-world test bed for implementing and testing their technology.
- The airport becomes an adopter/buyer of these clean technologies, inherently creating the market pull for innovators. The airport is also committed to investing $135M over the next 10 years to achieve net zero emissions.

- Increase the resilience and productivity of B.C industries, supply chains, innovation sector, etc. to allow them to expand beyond this airport project.

In addition to the Vancouver airport initiative, StrongerBC plans to introduce the *Integrated Marketplace Initiative* at the **Port of Prince Rupert to establish it as the greenest port in Canada**. While specific funding amounts were not immediately available, StrongerBC has collaborated with the port to bring about similar advantages as those seen at the airport, primarily focused on reducing emissions through the electrification of equipment, exploration of alternative fuel sources, and optimization of operations.

Similarly, in Edmonton, at their international airport, the Airport City Sustainability Campus has been established, housing the **Edmonton airport hydrogen initiative program**. This program aims to foster partnerships, test new technologies, and showcase the advantages of hydrogen fuels (Edmonton's Hydrogen Hub, n.d.). The initiative is actively developing plans for over 25 projects that cover various aspects of the hydrogen value chain, including production, transportation, end-use, and carbon capture and storage. Leveraging the airport as a testbed for hydrogen fueling infrastructure allows for numerous end-use case scenarios across ground vehicles and air fleets.

Of significance, the airport's focus lies in generating demand for low-carbon hydrogen, with the assumption that the supply will subsequently follow. Like the Vancouver airport, this serves as an exemplary case where **emphasis is placed on the demand side of the equation**, expected to yield benefits for hydrogen and clean technologies developers upstream as they strive to commercialize new technologies. Initiatives such as these epitomize innovative approaches to stimulating demand for clean technology, providing crucial infrastructure access for innovators to validate their products, and ultimately contributing to the reduction of greenhouse gas emissions.

8.3.2 Canadian Federal Innovator Support Services

Often thought of as a “concierge” service, the **Government of Canada’s *Clean Growth Hub*, launched in 2018, aims to be a central source of information and resources on federal supports for clean technology development** (with links to some provincial/regional supports) (Government of Canada, 2018). From a team of experts, innovators anywhere along their journey (or TRL) can request assistance from the *Clean Growth Hub*. Even the website and portal itself is detailed and allows innovators to filter through the available programs for their needs. For more comprehensive support, and for projects/technologies at a TRL 3+, a form can be submitted to be put in touch with experts. The fundamental services offered include:

- An online inventory of clean technologies-focused funding programs, services, and opportunities.
- Resources and tools to help plan and access support for cleantech projects.
- Free advisory services to help connect cleantech initiatives with appropriate federal supports.

The program is specific in that it is not a funding program, does not influence final funding decisions, and is fundamentally a support and funding advice service for innovators, developers or adopters trying to navigate the ecosystem. Other jurisdictions studied, like *Innovation Norway*, offer a similar service for their applicants to reported success and favourability.

Taking the *Clean Growth Hub*’s mission a step further, **Canada’s new *Global Hypergrowth Project (GHP)* aims to provide in-depth support across all aspects of an innovator’s commercialization journey**

(Government of Canada, 2023). Having already selected a preliminary group of firms, through the GHP they will receive a dedicated account executive from a team of public and private sector experts. The executive will facilitate connections for the firm, and provide focused attention where needed most; some key areas of support provided include:

- Funding.
- International expansion.
- Talent acquisition.
- Navigating federal regulations.
- Navigating procurement projects/processes.
- Streamlined access to expertise and mentorship.
- Custom service plan tailored to the firm's needs.
- Facilitated, fast-tracked connections to government support.

Innovator support services such as the *Clean Growth Hub* and *Global Hypergrowth Project* represent innovative approaches to meeting the needs of SMEs as they navigate their commercialization journey. These services play a crucial role in fostering ongoing commercialization success by providing essential business, financial, and technical expertise that innovators may lack. As barrier mitigation solutions are designed and implemented, it is important to consider how these existing services can be leveraged, learned from, and built upon to enhance the support for the innovation ecosystem in Alberta and Canada. This is discussed further in the Solutions section of this report.

9 SOLUTIONS

9.1 IDENTIFICATION & ASSESSMENT OF OPTIONS

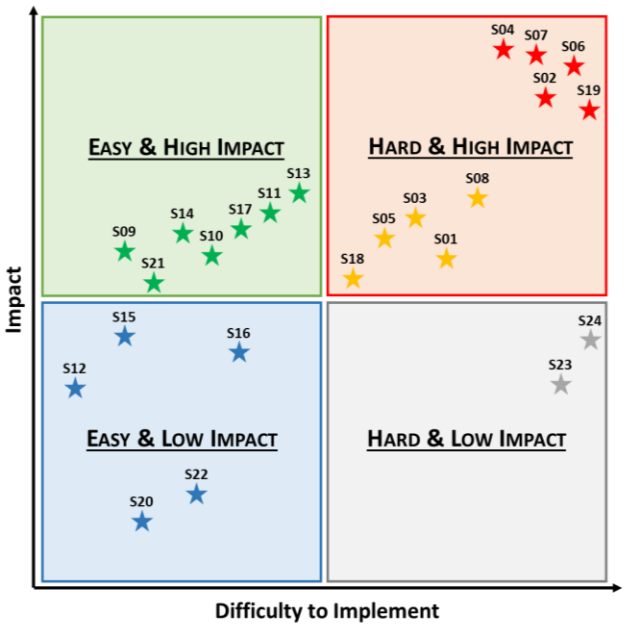
Throughout the interviews and jurisdictional scan activities, numerous suggestions for potential solutions to mitigate the non-technical barriers were identified. Over the duration of the Study, whenever an idea for a solution was introduced, the Study team added it to the designated gathering list. While most ideas on this raw list were contributed by the interviewees themselves, some ideas were formulated based on Exergy's experience in the ecosystem as well as the Study team members' interpretations of interview insights, barriers analysis, jurisdictional scan literature reviews, and relevant work experiences.

The team conducted an initial review of the list of ideas to determine which ones warranted further refinement and evaluation. During this initial review, suggestions that were considered to have limited potential in addressing priority barriers or focus areas, deemed excessively abstract or impractical for translation into tangible recommendations, or found to be in misalignment with the Study's objectives or target audience, were systematically screened out and excluded from further definition and assessment.

The ideas that successfully passed the screening process underwent further refinement and evaluation, culminating in the compilation of potential options listed in **Appendix D**. These potential mitigation options were numbered and grouped into the following four categories:

- **Process Improvements:** This grouping comprises potential solutions primarily aimed at introducing incremental enhancements to ERA's current grant funding processes. These solutions are designed to address the barriers inherent in obtaining grants and to expedite the progress of technologies through their respective development lifecycles and de-risking projects.
- **Skills & Capacity Building:** The solutions within this category predominantly target the challenges arising from deficiencies in innovator skills, resources, and network connections. This category also encompasses solutions aimed at establishing new entities or capacity within the system to aid in the execution of de-risking/tech development projects and commercial project development. All options in this grouping include facets which aim to assist with ecosystem navigation and enable technology innovators to focus on their strengths.
- **Aggregation:** The options within this category aim to consolidate elements of the ecosystem, with the goal of mitigating challenges arising from the lack of collaboration or alignment among numerous parties. This grouping includes approaches primarily dedicated to improving ecosystem navigation, enhancing integration between funding agencies, minimizing noise in the system, and fostering a culture of innovation.
- **Enabling Demand:** The solutions within this category encompass those aimed at addressing significant barriers that hinder market demand for clean technologies. This category presents potential frameworks and programs that would be designed to motivate potential adopters to engage in collaboration with innovators and to incentivize them to commit to adopting and investing in technologies when they reach the point of commercial readiness.

Once the potential options were defined and sorted into categories, the team conducted a qualitative assessment of each option using two criteria: 1) the projected level of implementation difficulty; and 2) the expected level of positive impact upon implementation. For both criteria, a scale ranging from low to high (low, medium-low, medium-high, high) was employed. The determination of difficulty and impact was informed by the Study team's experience-based judgments. **Figure 10** presents the results of this exercise.



No.	Solution Title	Category
S01	Regulations & Policy Makers Engagement	Enabling Demand
S02	Government Contracts	Enabling Demand
S03	Industry Problem Driven Challenges	Enabling Demand
S04	Value Chain Major Projects	Enabling Demand
S05	Adopter Calls	Enabling Demand
S06	Technology Validation Hubs	Enabling Demand
S07	Alternative Project Financing Approaches	Enabling Demand
S08	Funding Continuity Initiative	Process Improvements
S09	Time-Bound IP Arrangements	Process Improvements
S10	Voucher Program Enhancement	Process Improvements
S11	Grant Application Process Improvements	Process Improvements
S12	Partnership Intake Program Portal Improvements	Process Improvements
S13	Continuous Intake Program Expansion	Process Improvements
S14	Grant Agreement Terms Flexibility	Process Improvements
S15	Project Close Out	Process Improvements
S16	Innovator Collaboration Incentives	Skills & Capacity
S17	Embedded Advisors	Skills & Capacity
S18	Innovator Support Program	Skills & Capacity
S19	Project Studios	Skills & Capacity
S20	Pan-Canadian Funders Collaboration	Aggregation
S21	Technology Portfolio & Success Marketing	Aggregation
S22	Clean Growth Hub Integration	Aggregation
S23	Clean Tech Noise Filtering	Aggregation
S24	Clean Tech Funding One-Stop-Shop	Aggregation

FIGURE 10: IMPACT VS. DIFFICULTY OF POTENTIAL SOLUTIONS

Based on this assessment, along with feedback received from the Study's Steering Committee, the team concludes that at least two of the ideas, "Clean Tech Noise Filtering" and "Clean Tech Funding One-Stop-Shop" (the ones in the grey quadrant), should not be pursued further. Both would require significant efforts to implement, but they are not anticipated to substantially enhance the likelihood of technology commercialization. The team also concludes that the medium to high impact potential solutions (green & red quadrant) should be prioritized over the potential solutions ranked as easy & low impact (blue quadrant).

The evaluation highlights that all options under the “Enabling Demand” category, projected to deliver medium-high to high impact, are anticipated to be challenging to implement. This is a critical finding of the Study: **the demand/uptake of clean technologies is stifled by formidable barriers which require systemic, complex, costly, and multi-stakeholder solutions**. The Ecosystem Partners cannot implement the high-impact solutions on their own. Achieving accelerated clean technology deployment and greenhouse gas reductions in Alberta requires a systemic approach.

Technology commercialization cannot occur without market demand, so solutions that enable demand must be implemented in Alberta if a step change in clean technologies commercialization in the region is to occur. There is need for enhanced government participation and for the ecosystem to operate in a more collaborative way. Incumbent industry parties and potential adopters need to be enabled to value

sustainability differently and to find new ways of calculating the benefits of large decarbonization projects.

In contrast to the Enabling Demand category, the other solution categories present options that might be easier to implement while still holding the potential to effectively alleviate certain obstacles that often slow technology advancement.

9.2 RECOMMENDATIONS

The Study team proposes that ERA and other entities within the ecosystem implement the solutions listed in **Table 8**. Corresponding with the options in the green & red quadrants in **Figure 10**, these are being recommended because they are expected to have a medium to high impact on mitigating the top barriers. Each of these recommendations is described in the subsequent subsections, and the table provides hyperlinks for convenient access to each specific description.

TABLE 8: LIST OF RECOMMENDATIONS

TIME HORIZON	NO.	RECOMMENDATION TITLE	SOLUTION CATEGORY
Near Term *Implement now (Section 9.2.1)*	S11	Grant Application Process Improvements	Process Improvements
	S14	Grant Agreement Terms Flexibility	Process Improvements
	S09	Time-Bound IP Arrangements	Process Improvements
	S10	Voucher Programs Enhancement	Process Improvements
	S13	Continuous Intake Program Expansion	Process Improvements
	S17	Embedded Advisors	Skills & Capacity Building
	S21	Technology Portfolio & Success Marketing	Aggregation
Medium Term *Develop implementation plans now to execute in the medium term (Section 9.2.2)*	S08	Funding Continuity Initiative	Process Improvements
	S18	Innovator Support Program	Skills & Capacity Building
	S03	Industry Problem Driven Challenges	Enabling Demand
	S05	Adopter Calls	Enabling Demand
	S01	Regulations & Policymakers Engagement	Enabling Demand
Long Term & Strategic *Further definition & evaluation required before deciding to implement (Section 9.2.3)*	S06	Technology Validation Hubs	Enabling Demand
	S02	Government Contracts & Procurement	Enabling Demand
	S07	Alternative Project Financing & Investment Approaches **(B2P Focus)**	Enabling Demand
	S19	Project Studios **(B2P Focus)**	Skills & Capacity Building
	S04	Value-Chain Major Projects **(B2P Focus)**	Enabling Demand

Near-Term Recommendations

Among the recommendations, those in the first subset (labeled as "near term") aim to make incremental improvements or enhancements to the existing practices and programs of government funding agencies. The recommendations in this subset are perceived to require relatively less effort compared to others, making them suitable for near-term implementation.

Medium-Term Recommendations

The recommendations in the second subset (labeled as "medium term") are expected to demand more implementation efforts than the “near term” ones. These aim to challenge ecosystem enablers to consider expanding their scope. These proposed solutions seek to accelerate the progression of promising technologies through their techno-commercial development journey and increase the probability of market uptake.

Long-Term Recommendations

The third set of recommendations in the table (labeled as “Long Term & Strategic”) propose even more challenging-to-implement and higher-impact solutions than the first two subsets. These have the potential to radically improve the process of clean technology deployment and commercialization in Alberta. However, it is acknowledged that these ideas would be very difficult and complex to implement. They will require larger funding envelopes from government and culture shifts in how government, industry, and the Ecosystem Partners work together to achieve shared goals. The team suggests that the Ecosystem Partners undertake a thorough process involving clarification, stakeholder engagement, and careful evaluation of these recommendations before decisions to implement are made.

9.2.1 Near Term: Elevating Existing Approaches (Med-Low Difficulty)

Grant Application Process Improvements		**S11**
Solution Category	***Key Barriers Addressed***	
Process Improvements	*Lengthy & Constraining Grant Processes*	*Tech Innovator Skillset Gaps*
	Unclear Funding Agencies’ Success Criteria	
Proposed Responsible Party: ***Applicable Funders***		

Funders should implement the following improvements where applicable into their process to better support SME technology innovators:

- Refine the **definition of success criteria for grant awards** and tailor them to differentiate between small/medium-sized enterprises and large enterprises.
- Establish **constructive feedback frameworks** for applicants. If an applicant is unsuccessful, clear reports detailing the technical and commercial gaps in proposals will allowing innovators to prioritize areas for improvement.

- Implement a small monetary program that provides **full project proposal vouchers**, aiding startups in the development of applications for various calls.
- Provide an immediate **line of credit** to successful proponents, bridging the gap between the award and the receipt of funding.
- **Award guarantees** to applicants that have yet to find a funder/partner to match the remainder of the funds. Conditional public funding in particular gives them credibility when approaching other organizations or banks/lenders.
- **Increase funder's project cost contribution**, particularly for innovators that are in the pre-revenue stage. This could give them a better chance of finding the smaller remaining funds.

Grant Agreement Terms Flexibility		**S14**
Solution Category	***Key Barriers Addressed***	
Process Improvements	*Lengthy & Constraining Grant Processes*	*Resource-Intensive Tech Validation*
	Intellectual Property Protection	*Boom-Bust Cycles of Potential Adopters*
Proposed Responsible Parties: ***Applicable funders***		

In grant agreements, funding agencies should consider implementing a "claw back" solution (with interest) instead of resorting to the use of blocking rights and IP rights in the event of a future sale of a tech company. Change of control provisions, which give the granting agency blocking rights, are particularly challenging for early-stage companies. The intent of this solution would be to **promote flexibility and avoid hindrances to exit opportunities,** while reducing the financial burden of negotiations on the tech company.

Furthermore, granting agencies should consider expanding the definition of "benefits to Alberta" within the context of evaluating and making decisions on grant applications. For example, they should contemplate supporting tech development projects conducted outside the province if they continue to contribute to job creation and knowledge generation in Alberta. This flexible approach would provide a solution in cases where there are no partners or sites in Alberta willing to support tech validation, pilot, or demonstration projects, compelling tech companies to carry out their tech validation and de-risking projects elsewhere.

Time-Bound IP Arrangements		**S9**
Solution Category	***Key Barriers Addressed***	
Process Improvements	*Intellectual Property Protection*	*Boom-Bust Cycles of Potential Adopters*
Proposed Responsible Parties: ***Applicable funders***		

As a condition for funding qualification, require proponents to provide proof of time-limited commercial terms between tech innovators and industry partners, **restricting the duration of the**

industry partner's IP rights. This condition would seek to prevent technology development from stalling/stopping due to exclusive deals with unresponsive industry players, while also motivating industry partners to engage in technology development and deployment projects to maintain their competitive advantage. The acceptable time limit will be determined based on the projected timeline for commercialization at the time of grant application.

Voucher Programs Enhancement		S10
Solution Category	***Key Barriers Addressed***	
Process Improvements	*Lengthy & Constraining Grant Processes*	*Tech Innovator Skillset Gaps*
Proposed Responsible Parties: ***Applicable funders***		

All ecosystem funders should consider instituting and/or enhancing existing voucher programs.

Example: Small-dollar ($15-20k for example) vouchers can enable the mitigation of start-up technical due diligence & business/market analysis gaps in an effective and cost-efficient way. Innovators can utilize vouchers to contract the technical and commercial expertise of vetted service providers to continue progressing while they are in between (and sometimes to help them receive) large sums of funding/investment.

Funders that already have voucher programs in place should **explore methods to enhance, expand, and ensure the maximum utilization of the ecosystem's voucher programs.** A few interviewees suggested the government agencies establish voucher programs in the Alberta ecosystem, implying that the existing programs might not be well marketed, may be oversubscribed, and/or could exclude many innovators from eligibility.

In addition, all **government agencies should aid innovators in understanding and utilizing the voucher programs available within the ecosystem.** For instance, even though ERA does not administer a voucher program itself, it should establish clear referral channels to the programs operated by other entities. This initiative could involve adding transparent information to ERA's website and adopting standardized procedures to assess whether ERA applicants would benefit from (or be better suited for) accessing voucher funding. This could lead to more robust ERA grant applications submitted by technology innovators who have utilized the voucher program to better prepare themselves for the larger funding calls.

Continuous Intake Program Expansion		S13
Solution Category	***Key Barriers Addressed***	
Process Improvements	*Lengthy & Constraining Grant Processes*	*Network-Based Opportunity Access*
Proposed Responsible Party: ***ERA***		

To enable more frequent and flexible submission of applications for clean technologies projects, **ERA should consider expanding the budget for its continuous intake program** as well as provide

an opportunity for innovators without referrals from Trusted Partners (i.e., for those not eligible for the Partnership Intake Program (PIP)) to apply for funds.

Given that the continuous intake method empowers innovators to advance their plans when they are ready without restrictions on specific periods or scopes, if ERA were to cast a wider net and increase the funds distributed through this method, it could expedite technology development lifecycles for many innovators at the TRL 6+ stages. In addition, widening the continuous intake program's reach would expand ERA's exposure to a broader array of innovators and their technologies compared to their current reach through the PIP.

Embedded Advisors		**S17**
Solution Category	***Key Barriers Addressed***	
Skills & Capacity Building	*Government Policy/Regulatory Flux & Complexity*	*Tech Innovator Skillset Gaps*
	Network-Based Opportunity Access	*Ecosystem Complex & Uncoordinated*
Proposed Responsible Party: ***ERA***		

ERA should consider employing expert "Technology-to-Market Advisors" or **"Embedded Advisors" to proactively provide guidance and mentorship** to start-up technology innovators throughout the execution of ERA-supported projects. These advisors, sourced from ERA personnel or external specialists (directly compensated by ERA), would maintain regular interaction with proponents as a condition of the funding.

The Embedded Advisors' responsibilities would include holding proponents accountable for milestones, providing advice on techno-economic aspects, and offering support in areas where innovators lack expertise. Advisors could offer support in areas such as project execution, stakeholder involvement, customer attraction, ecosystem navigation, and permitting. In addition, they could offer guidance on how to effectively communicate and collaborate with potential adopters or industry partners relevant to the innovator's technology. Rather than offering generic advice, the aim would be for these embedded advisors to provide support tailored to the innovators' specific requirements and skillset gaps and to push them to be proactive with their technology and business development planning.

The development of such a program could draw insights from various sources, including ERA's *Innovator Support Services Program*, the Government of Canada's *Global Hypergrowth Project*, the Alberta Innovates *Fund and Fellowship* approach, and the USA's ARPA-E *Cooperative Agreements*, among others. Similarly, *Innovation Norway*'s program has seen success in providing advisors who assist innovators in areas such as assessing the product's market fit, evaluating the strength of the applicant's team, and assessing their commitment to building a commercial business.

Technology Portfolio & Success Marketing		**S21**
Solution Category	***Key Barriers Addressed***	
Aggregation	*Culture of Risk Aversion*	*Surplus of New Tech*
	Ecosystem Complex & Uncoordinated	
Proposed Responsible Party: ***ERA***		

Enhance public and adopter awareness of the technologies within ERA's portfolio and reinforce the promotion of ongoing ERA project and technology success stories. One significant advantage of these efforts would be to help ERA educate stakeholders about the probabilistic nature of technology development: a substantial investment in multiple projects is crucial to yield a certain percentage of high-impact, game-changing technologies for the market. Innovators facing early challenges can offer valuable insights into technical or business barriers for both innovators and adopters.

Potential adopters, technology innovators, and ecosystem service providers would benefit from easy access to an aggregated list of technologies vetted by ERA. This approach would be advantageous in several ways. Firstly, it would foster a portfolio mindset in technology development, reframing what is considered failure. Secondly, it would enable potential adopters to quickly identify which technologies are under ERA's development for their consideration. By showcasing successful commercialization stories backed by government funding, maintaining a public list of endorsed technologies, and openly communicating the realities of success rates, ERA could mitigate risk aversion and foster perseverance in achieving breakthroughs.

A potential approach to accomplish this goal would be to **establish a registry that would be managed and regularly updated by ERA on their website, utilizing data already gathered from their previous and ongoing projects.** This registry could be filtered by industry, technology category, and other relevant parameters, and could be designated as the "Clean Technology Portfolio". Such information would also directly support or be necessary for other recommendations proposed, such as ***Government Contracts & Procurement*** and ***Industry Problem Driven Challenges***.

As identified in the IEA's "How Governments Support Clean Energy Start-ups" report, participation in a government program confers a "badge of quality". The marketing of ERA's participants could grant innovators exposure and credibility.

9.2.2 Medium Term: Broadening Horizons to Cultivate Momentum (Medium-High Difficulty)

The solutions in this category propose the implementation of solutions that are more difficult than the near-term grouping, but they are expected to offer more impactful mitigation of some of the key barriers. These solutions **urge funders and enablers within the system to expand the boundaries of their current scope and practices**, all with the goal of further mitigating the obstacles faced by technology innovators and ensuring a market demand for their technologies.

Funding Continuity Initiative looks to create a more seamless flow of funds to reduce the time between development stages, and the ***Innovator Support Program*** proposes ERA help those promising

applicants that are devising high-potential technologies but need help maturing before they can be awarded large grants. ***Industry Problem Driven Challenges*** and ***Adopter Calls*** seek to improve adopter engagement certainty by providing stronger connection to adopters and their specific problems. ***Regulations & Policymakers Engagement*** aims to leverage the Ecosystem Partners' positions in the ecosystem to educate decision makers, to ensure regulations are not impeding clean technology commercialization, and to offer informed suggestions for policy, regulations, and incentives improvements.

The solutions in this category aim to accelerate the journey to commercialization by:

1) enhancing stage-to-stage continuity
2) stimulating innovator-to-adopter collaboration and investment
3) addressing innovators' techno-commercial skillset gaps

It is important to note, however, that the solutions in this grouping do not address a few of the high-impact barriers that the B2P technologies face in achieving their first commercial scale deployment. Refer to **Section 9.2.3** for recommendations for those unique challenges.

Funding Continuity Initiative		**S08**
Solution Category	***Key Barriers Addressed***	
Process Improvements	*Lengthy & Constraining Grant Processes* *Investors & Funders Knowledge Gap*	*Ecosystem Complex & Uncoordinated* *Project Financing Ecosystem Gaps*
Proposed Responsible Parties: ***All funders***		

This recommendation proposes that ecosystem funders work together to establish a framework/program to shorten the gaps experienced by innovators between the completion of one technology development project and the start of the next, ensuring consistent momentum and efficiency gains. This program would cater to SME startup technology innovators aiming to progress new technologies through various development stages up to commercialization. It could potentially satisfy those seeking a technology development roadmap funding approach.

The core components of this proposed initiative would encompass leveraging ERA's existing Partnership Intake Program (PIP) approach; establishing more **proactive handoff procedures** between ERA and other funders, financiers, and investors; defining clear **stage graduation criteria**; and implementing a "**stage bridging funding**" policy whereby innovators could apply for funding for upcoming successive stages early, while still engaged in their current one. The handoff procedures would alleviate some of the fundraising and grant application writing burdens for small tech innovator companies, and the stage bridging funding would allow companies to secure funding for a portion of their upcoming stages while they are still engaged in the current stage (thus minimizing downtime between projects).

Another facet of this continuity initiative would involve funding agencies taking proactive steps to engage and educate investors about the technology. ERA should proactively look for ways to

inform investors of the value the technology offers and/or offer ways to de-risk the financing aspect of early commercial projects for the technology.

Get Started

1. **Explore ways to be more proactive with the handoff of projects to/from funding agencies**, particularly within "Trusted Partner Program" agencies. This could include building in inter-agency milestones that, once reached, initiated handoff procedures and/or the commencement of successive funding applications early to minimize lag time between.
2. Funder should **review how its strategies align with the expectations of investors and industries** regarding pre-commercial technologies that necessitate investment or partnerships. Organize interviews or working sessions to identify any existing gaps and explore ways to achieve greater alignment with these pivotal stakeholders. This is essential for ensuring a successful project handoff from funder upon completion.
3. **Consider how stage bridging funding award criteria and stage graduation criteria could be established**. For the stage bridging, identify what criteria would make each funding agency feel more "comfortable" evaluating and awarding funding prior to current project

Innovator Support Program		**S18**
Solution Category	***Key Barriers Addressed***	
Skills & Capacity Building	*Tech Innovator Skillset Gaps* *Network Based-Opportunity Access*	*Ecosystem Complex & Uncoordinated*
Proposed Responsible Parties: ***ERA***		

Establish the *Innovator Support Program* as an ongoing ERA initiative. Like the premise of ERA's *Innovatory Support Pilot*, the *Innovator Support Program* would be **designed to serve technology innovators who were unable to secure an ERA grant (due to insufficient readiness) but were assessed as high-potential companies.**

Through the program, the innovators would collaborate with specialized service providers to address their skill set gaps and enhance their likelihood of success. The service providers would be compensated directly by ERA based on agreed-upon terms. The **program would look to enhance the innovators' technical and commercial readiness**, offering essential support in crucial areas so that they can be successful in future grant applications, organizational strategy, financial planning, marketing, and customer attraction.

The potential value that this type of programming could offer is implied by some of the insights shared in the Study's interviews. A few of the technology innovators interviewed shared how the targeted guidance and advisement they received from accelerator/mentorship programs enabled their journey so far. They described how these programs helped them broaden their networks, refine their use cases, map out their business growth plans, identity other ecosystem supports/resources, and meet potential adopters.

As a component of the implementation plan of this recommendation, ERA should consider creating and advertising a "Trusted Development Partner Registry" (see proposed definition and further elaboration below). By establishing and maintaining this registry, ERA could refer innovators to vetted organizations which can help them expedite their progress.

"Trusted Development Partner" Registry definition: The Trusted Development Partner registry would be a compiled list of reputable developers or service providers recommended by ERA. Innovators could be encouraged to utilize these resources for prototyping, validation, testing, and technology commercialization activities. The list would need to include vetted organizations that offer services and facilities that startups often do not have inhouse including engineering & design, financial and techno-economic modeling, prototype or pilot testing/validation infrastructure, and business incubation.

Get Started

1. **Establish network of service providers** whose services align with typical innovator needs and skill gaps (see "Trusted Developer Partner" registry above; these would be the providers who ERA can rely on to support and advance innovators who need more support).
2. ERA to **request appropriate budget to sustain program annually** and regular surveys, innovator interviews/check-ins, and other measures to elicit feedback on effectiveness should be employed to allow for continual program improvements as needed.

Industry Problem Driven Challenges		**S03**
Solution Category	***Key Barriers Addressed***	
Enabling Demand	*Unclear Funding Agencies' Success Criteria*	*Undervalued Sustainability Benefits*
	Use Case Knowledge Gap	*Surplus of New Tech*
Proposed Responsible Parties: ***Applicable funders***		

Start with the problems rather than solutions to ensure technology will have a market pull. Establish an ongoing program (multiple calls a year) whereby industrial companies, emerging operators, and applicable ecosystem funders **define a specific problem and issue funding calls to solve it.** A short list of innovators (one for each industrial site offered by industry partners for the given challenge) would be awarded funding to execute projects that demonstrate their proposed solution. Innovators selected would collaborate with the industry partners to develop and execute the technology development project associated with the proposed solution.

This program would require industry partners to contribute funds (along with the government agency/funder) and would encourage the industry partners to offer their sites and auxiliary services (land, regulatory, supply chain, etc.) where applicable.

The Alberta innovation ecosystem should seek inspiration from entities like Catapult in the UK and Fraunhofer in Germany to explore ways of partnering with industry for the delivery of these

problem-focused calls. To provide a clearer definition of how these challenges and the corresponding partnerships could be structured, funders could consider adopting something like an XPRIZE approach, engaging innovators in new yet familiar formats. Connecting industry to technology solutions in innovative ways will contribute to better alignment with the B2P market segment defined in this report.

Get Started

1. **Survey high-emitting industry players** (along with marketing campaign to generate interest in initiative) to gauge interest/commitment and generate ideas for pertinent and urgent problem statements within predefined bounds / parameters set by the government agency/funder.
2. Advertise ongoing innovations and tech development via the **"Clean Technology Portfolio"** to aid in drumming up interest/engagement from industry.
3. Screen and **select industry partners** and their proposed ideas mapping out a challenge rollout plan/schedule for the next 3 years (to be later published and advertised in the ecosystem).
4. Develop and issue “calls for solutions”.

Adopter Calls		**S05**
Solution Category	***Key Barriers Addressed***	
Enabling Demand	*Network-Based Opportunity Access*	*Undervalued Sustainability Benefits*
	FOAK Project High Cost & Risk	*Use Case Knowledge Gap*
Proposed Responsible Parties: ***Applicable funders***		

The proposed approach here can be imagined as the reverse of industry problem-driven calls: funders could put out calls or **requests for proposals (RFPs) to organizations interested in collaborating with the given funder’s selected technology companies** which have technology that is ready (or near ready) to commercialize. The specific technologies and companies forming the basis of the call would be selected from the given funder’s portfolio of proponents that it has previously assisted in advancing, aiming to ensure the impact of the government’s prior investment. The successful applicants of this call would receive funds from the funder to cover a portion of the costs of the adoption of the technology.

Through this approach **specified solutions are advertised to potential adopters, stimulating a market pull.** It could lead to increased visibility, innovator & adopter co-development, and increased uptake of new technologies. To encourage and facilitate this uptake from adopters, additional incentivization should be considered above and beyond the implementation/adoption costs covered by the funder.

Get Started

1. **Identify technology companies ready for early commercial deployment** through screening process. Utilize "technology registry" or portfolio to understand attractive/relevant industry partners.
2. Help innovators further advance techno-commercial readiness of these technology companies to the level expected by industry:
    a. **Readiness sprint program** (identify and mitigate major risks)
    b. Adoption pitch package (validated TEA, LCA, project plan, etc.)
3. **Organize a 'Showcase Day'** to gauge and introduce industry to technologies of interest. Innovators will be prepared for showcase through the action above.
4. **Design funding calls aimed at pairing at least one adopter with each of the advancing technology companies** (may be structured such that there is a catalogue of technologies, potential adopters would declare their interest, the funder would do the match making).
5. **Assign third-party collaborator** that would act as relationship manager / facilitator between the technology provider and adopter to ensure project success. This could help address power/experience imbalance and any potential misalignment of expectations.

Regulations & Policymakers Engagement		**S01**
Solution Category	***Key Barriers Addressed***	
Enabling Demand	*Government Policy/Regulatory Flux & Complexity* *Expectations for Big Impacts Fast*	*Undervalued Sustainability Benefits*
Proposed Responsible Parties: ***Alberta Innovation Ecosystem Partners***		

This recommendation proposes that **Ecosystem Partners enhance their interaction with policymakers and regulation designers & administers on both provincial and federal fronts**, offering comprehensive education on clean technologies as well as feedback on relevant regulations & policies. Funders should consider organizing more frequent sessions with the key groups responsible for formulating and administering policies and regulations that may impact the advancement of clean technologies.

As part of the ongoing tasks to support this endeavor, it is recommended that funding agencies regularly communicate with each other across the country to ensure alignment wherever possible and to ensure that funders' feedback to governments is informed by a comprehensive set of learnings.

This education would aim to ensure policy decisions are informed by each funding agency's understanding of energy systems, each region's unique geographical attributes, available & emerging clean technologies, and realistic implementation timelines.

During this engagement, Ecosystem Partners could encourage governments to address a couple fundamental barriers hindering the commercialization of clean technology. This includes addressing barriers such as "Government Policy/Regulatory Flux & Complexity" and "Undervalued Sustainability Benefits".

Get Started

1. **Share the Barriers to Commercialization Study Report** with provincial and federal government contacts/stakeholders.
2. Request follow up meeting or **organize workshop in which government can collaborate with the ecosystem partners** and play an active role in identifying and breaking down barriers within their control or influence.
3. **Appoint an engagement committee or taskforce** with participants from Ecosystem Partners, other applicable ecosystem funders, and relevant regulators and policy makers to define taskforce objectives, convene regularly to exchange information, and develop & report on a common roadmap to address barriers.
4. **Kick off addition studies** to develop detailed recommendations to government regarding policy and regulatory changes that might be needed to accelerate clean technology adoption in Alberta and Canada.

9.2.3 Long Term: Revolutionary Concepts for Transformative Impact (High Difficulty)

This section presents recommendations that are expected to be very difficult to implement but are anticipated to hold **potential to significantly alleviate key barriers to demand**. ***Technology Validation Hubs*** and ***Government Contracts & Procurement*** take the aspirations of the medium-term recommendations to a higher level, proposing to create environments that facilitate further de-risking of mature emerging technologies by aligning the technologies with a multitude of customers and having the government offset the high initial commercial costs.

The remaining recommendations in this section (***Alternative Project Financing & Investment Approaches***, ***Project Studios***, and ***Value-Chain Major Projects***) aim to mitigate a particularly persistent cluster of challenges. These challenges pertain to the commercialization of promising emerging B2P technologies. These recommendations are labelled in **Table 8** and in the sub-section headings below as having a "B2P Focus".

The "B2P Focus" solutions aim to attract developers, builders, clean technologies adopters/investors, and owner/operators to develop and execute transformative projects. Importantly, these solutions are designed to address the distinct and substantial financial requirements, risks, and skillsets associated with constructing new infrastructure using disruptive technologies.

The "B2P Focus" recommendations can be considered revolutionary due to their relative implementation challenges as well as their potential for making a significant impact in reducing greenhouse gas emissions.

These recommendations represent a shift in mindset, moving beyond the exclusive focus on generating successful technology companies producing B2C and B2B products and services. They emphasize deploying disruptive technologies into new value chains with the necessary infrastructure and partnerships. The underlying premise of this proposed shift in focus is as follows: **effectively dismantling the barriers confronting B2P technologies will serve as a catalyst for broader system-wide impacts** and the generation of additional opportunities for other emerging clean technologies across all technology-to-market channels.

Technology Validation Hubs		**S06**
Solution Category	***Key Barriers Addressed***	
Enabling Demand	*Culture of Risk Aversion*	*Network-Based Opportunity Access*
	Ecosystem Complex & Uncoordinated	*Resource-Intensive Tech Validation*
Proposed Responsible Parties: ***Various TBD***		

This recommendation proposes the **establishment of public-private partnership technology validation hubs**, like BC's *Integrated Marketplace Initiative* and the hydrogen initiatives at the Edmonton Airport. These programs would create designated sites/areas functioning as testbeds for clean technology innovators, enabling them to test, advance, and de-risk their technologies in real-world industrial environments. They would also facilitate partnerships between innovators and industry/potential adopters.

The development, administration, and execution of these programs would **necessitate the involvement of multiple ecosystem players**, with a single party, potentially an existing government ecosystem support agency, assigned as the lead coordinator. Ideal sites/areas would be those where various aspects of the value chain are co-located and multiple potential adopters operate. Existing operators would play a crucial role in enabling technology testing, providing access to infrastructure, and offering opportunities for co-development, use case identification, and refinement. Essentially, operators or infrastructure owners would need to provide 'in-kind' support using their facilities.

Funders would be required to identify target industries and clean technologies impacts and subsequently designate industrial sites per target industry (e.g., oil production, water treatment, hydrogen, etc.). These initiatives would **primarily target technologies at higher TRL and CRL stages poised to enter pilot, demonstration, or FOAK stages**. Projects at earlier TRL and CRL stages should be encouraged to utilize existing facilities such as InnoTech's Alberta Carbon Conversion Technology Centre (ACCTC), a platform where innovators can conduct prototype testing and validations. Notably, facilities like ACCTC are essential components and form the core offerings of programs like ARPA-E and *American Made Challenges* in the US.

Get Started

1. **Conduct a review of this recommendation with key stakeholders** to discuss if it is something that should be further evaluated and defined. Determine roles and responsibilities for the evaluation and definition exercise.
2. Assigned party to lead study and engagement effort to **understand mechanisms/processes utilized by StrongerBC and the Edmonton International Airport** to develop their airport-based integrated validation hubs.
3. Assigned party can **leverage Edmonton Region Hydrogen Hub connection** for engagement, specifically to determine additional potential sites for hydrogen or other sector development.
4. Commission a study to **engage potential industry partners to understand what this would look like from their perspective,** how they would define success, and what industrial assets/sites they would be able to provide.
5. **Conceptualize a commercial model** for developing, scoping, and initiating Technology Validation Hubs in conjunction with industry partners. Understand if it is developed as a program of continuously expanding portfolio of sites vs. discrete, large industrial hubs.

Government Contracts & Procurement		**S02**
Solution Category	***Key Barriers Addressed***	
Enabling Demand	*FOAK Project High Cost & Risk*	*Undervalued Sustainability Benefits*
	Boom-Bust Cycles of Potential Adopters	*Resource-Intensive Tech Validation*
Proposed Responsible Parties: ***Governments***		

Governments can boost the demand for innovative technologies by selecting emerging technologies and services for government-operated organizations and infrastructure, effectively shouldering the high costs and risks of near-commercial and early commercial projects. ERA and other **ecosystem supporters could advocate for a revision of procurement policies at municipal, provincial, and federal levels to prioritize emerging clean technologies that are ready for commercialization.**

Drawing inspiration from strategies employed in military and space contracts, historically proven to facilitate technology enhancement and cost reduction through field demonstrations, pilots, and initial commercial-scale deployments, this concept aims to leverage government buying power to drive the enhancement and cost reduction of clean technology. This approach would make the technology more appealing to a broader market of potential investors and adopters.

As a subset of this idea, Canada's Industrial and Technological Benefits (ITB) policy should undergo review, identifying opportunities for improvement and considering ways to incorporate a clean

technology emphasis. To support this recommendation, one can look to the success of ARPA-E in the US, which operates under the DOE. ARPA-E frequently seeks clean technologies that can be integrated into defense contract opportunities, leveraging the substantial funding available within America's military budgets.

Get Started

1. **Identify departments with purchasing authority at the various government levels** where clean technologies may be applicable. Learn from these agencies what their criteria/procedures are for approving vendors or purchasing technologies is as a starting place.
2. **Develop a searchable online registry/database of emerging clean technologies ready for commercialization.** Technologies will be deemed ready for commercialization based on a formal vetting process (including techno-economic assessment).

Alternative Project Financing & Investment Approaches (B2P Focus)		**S07**
Solution Category	***Key Barriers Addressed***	
Enabling Demand	*FOAK Project High Cost & Risk*	*Project Financing Ecosystem Gaps*
	Boom-Bust Cycles of Potential Adopters	
Proposed Responsible Parties: ***Applicable funders****, governments, investors*		

Create new methodologies and programs with investors to address project financing ecosystem gaps and reduce the FOAK financial risk to potential adopters. Alternative financing and investment mechanisms include methods of disbursing funding beyond non-dilutive grants. In general, these mechanisms could provide a way for government funders to participate in later stage projects that have been identified by either technology innovators or incumbent large heavy emitting industry players. Options to consider include:

- Government-backed forgivable or low-interest loan programs.
- Governments or funders taking a lead investor role in targeted project consortiums.
- Governments allocating a portion of facility owners/operator taxes to establish a fund for technology advancement specific to that facility.

Get Started

1. **Conduct a study, engaging directly with finance groups (VCs, private equity)** to understand what their barriers are and how those could potentially be mitigated.
2. **Engage with banking community** to understand their perspective vs. independent financing, and what they need to be more involved in this ecosystem.
3. **Consider a fund managed by (or working closely with) ERA that could be used specifically for investing in FOAK to commercialization.** This could also be debt-financing. This could be a place where investors could allocate money to this fund to expose themselves to the clean technologies' world. Could be combined with the "partnership" opportunity between funders who may be looking for equity

Project Studios (B2P Focus)		**S19**
Solution Category	***Key Barriers Addressed***	
Skills & Capacity Building	*FOAK Project High Cost & Risk*	*Undervalued Sustainability Benefits*
	Tech Innovator Skillset Gaps	*Resource-Intensive Tech Validation*
Proposed Responsible Parties: ***Various TBD***		

Provincial and federal governments should promote and invest in the **establishment of "Project Studios."**

These proposed studios would serve two primary roles:

1) De-risking emerging technologies by leading in technology development and scale-up.
2) Developing commercial projects that enable the first-of-a-kind deployment of clean technologies up until the completion of front-end engineering design (FEED).

The Project Studios would assume leadership roles in the two functions listed above, while the technology innovators would remain actively engaged as subject matter experts and IP owners for their respective technologies. The studios would provide services and expertise that are typically absent in small tech companies, along with potential partner networks, access to supply chain management capabilities, and in-house prototyping and testing resources.

Innovators at later stages of readiness could be directed by ERA and other ecosystem supporters to these studios, or the innovators could reach out to studios independently. The studios would then undertake the development and execution of de-risking projects, such as field pilots and demonstrations. Additionally, these studios would develop commercial projects consisting of near-commercial technologies across feasibility, pre-FEED, and FEED stages (up to the FID gate). Their mandate would be to develop investable projects, facilitating the groundbreaking deployment of clean technology. The government, perhaps through ERA, would provide funding or investment for these viable projects, acting as an incentive for other investors and entities to acquire, own, and operate the projects.

This approach offers the advantage of providing funding for the development of new projects embodying new technologies without requiring incumbent operating companies to establish internal groups and carry out this work on their balance sheets. While significant free cash flow is generated by incumbent companies, their shareholders are typically focused on dividends and do not reward incremental costs that are not associated with a project or directly contribute to immediate returns. From the operators' perspective, postponing the costs associated with de-risking technologies and treating the initial development of new technology projects as project costs enables them to be internally written off against future project revenues, thereby meeting shareholders' expectations for returns.

Get Started

1. **Develop an RFP** detailing the intent, scope, goals, and governance of the Project Studios. This would include conceptualizing the commercial and investment arrangements.
2. Administer an RFP process to **encourage entities to participate in the establishment of Project Studios.**
3. **Conceptualize commercial arrangements** associated with investment/funding that would be awarded to the selected proponents to help initiate Project Studios.

Value-Chain Major Projects (B2P Focus)		**S04**
Solution Category	***Key Barriers Addressed***	
Enabling Demand	*Undervalued Sustainability Benefits*	*Project Financing Ecosystem Gaps*
	Culture of Risk Aversion	*Ecosystem Complex & Uncoordinated*
Proposed Responsible Parties: ***Applicable funders***		

To bolster the uptake of transformative clean technologies, applicable ecosystem funders should amplify their focus on value chain initiatives and **provide grants for vertically integrated deep decarbonization commercial projects.** These efforts would center on consortia proposing comprehensive commercial projects spanning the full spectrum of an emerging value chain, such as the hydrogen economy, ensuring cohesive infrastructure and demand support for technologies along the chain.

Encouraging vertically integrated consortia would motivate innovators, project developers, and potential adopters to collaborate, potentially attracting strategic investors interested in funding transformative endeavors. This idea arises from the reduced uncertainty concerning demand and other potential gaps in the value chain that are essential for deploying a solution but are beyond the control of technology innovators or adopters. These gaps could include supporting infrastructure, process feedstocks, by-product off-takers, and more.

This recommendation effectively proposes that the government support the entire lifecycle of these major projects to ensure sustained demand for clean technologies. However, for longer-term, high-cost projects, a staged approach could be adopted. In this approach, the initial call or challenge could focus on government funding for the FEED stage, with a commitment to assess funding options for subsequent execution stages at the end of FEED.

While initiatives like the *Accelerating Hydrogen Challenge* focus on advancing the readiness of emerging hydrogen technologies without the requirement for projects to be value-chain consortia, this recommendation proposes that the government **establish calls that make value-chain partnerships a prerequisite for the award**, while also not discriminating against the deployment of already commercial clean technologies. This approach would foster additional infrastructure and opportunities to nurture less mature technologies for future deployment.

To determine the target scope of each value chain call, all emerging energy transition levers for which capacity needs to be built out in the province could be considered. Some examples include hydrogen, renewable diesel, renewable natural gas (RNG), CO2-based fuels, pre-combustion capture, district heating/cooling, waste-to-energy, and small module reactor (SMR), etc. Note that these examples are largely sector agnostic and are complementary not competitive options, given that multi-sectoral deep decarbonization requires the deployment of multiple application-specific technologies and establishment of the associated value chains.

Get Started

1. Like the recent Hydrogen challenge**, identify other emerging energy transition levers for which capacity needs to be built out in the province.**
2. With the expected complexity and capital expense (CAPEX) magnitude in mind, **secure co-investors that will help match the government funds.** Potential alternative strategic investors could include project developers, equipment and materials vendors, new tech OEMs, emerging operators, and high-wealth individuals.
3. **Design funding calls in support of these value chains.** Funding criteria should reflect the intent to enable vertically integrated projects that ultimately demonstrate or facilitate the adoption of novel technology at scale: Project-based funding; named/committed project contributors along the vertical; strong interdependencies; replicable solution/model.

10 Next Steps & Future Studies

Upon concluding the Study, the team identified future studies for consideration, along with immediate next steps. Both are presented in this section.

10.1 Future Studies

To gain a deeper understanding of the root causes behind certain barriers and gather additional information to help refine continuous improvement/mitigation strategies and their associated implementation plans, ERA and/or other ecosystem enablers should consider executing future studies which look to answer the following research questions:

- What factors facilitate the adoption of clean technologies and investment in their associated deployment projects? How do these elements contribute to the decision-making process of potential adopters?
    - This study could incorporate a series of **interviews with companies that have adopted clean technology in Alberta**, as well as investors/lenders that have invested in capital-intensive projects which incorporated FOAK deployment of clean technologies.
    - Interviewees could be asked to share the challenges they faced in the process, what their final investment decision-making criteria was, and what ultimately enabled them to take the risk on clean technologies.
- **What policy and regulatory changes are required to improve the rate of clean technology adoption and its widespread use in Alberta?** This research would require:
    - A review of the types of mechanisms/frameworks (including “carrots” and “sticks”) that have proven effective in accelerating clean technology adoption/deployment in other parts of the world; and
    - A more in-depth examination of what currently encourages and hinders adoption in Alberta and Canada (i.e., what is working and what is not).
- Based on the successful mega clean energy hubs that are either under construction or in operation today, **what can all levels of government** (along with their regulators and innovation ecosystem support agencies) in Alberta **do to encourage and facilitate the development of new clean energy hubs?** This includes identifying:
    - Policies, regulations, programs, partnerships, and frameworks that have yielded the desired result in other jurisdictions.
    - The conditions (political, geographical, environmental, economic, social, regulatory, etc.) required to facilitate the development of clean hubs. **Can the right conditions be established in Alberta, and if so, how?**

10.2 NEXT STEPS

To confirm how the Study results will be utilized, the following immediate next steps are recommended:

- **Share the results of this Study with the Government of Alberta and the Government of Canada.** Initiating conversations with these entities, based on a common understanding of key terms, and identified barriers to commercialization, will facilitate mutual progress.

- **Conduct stakeholder engagements and workshops** to review the recommendations and proposed future studies presented in this report.
    - The review process should identify the measures to be taken and solutions to be actioned, those requiring modifications, and those needing further definition and evaluation before any decision is made.
    - The process should encourage the presentation of additional mitigation options for consideration.
    - Assign lead parties, roles, and responsibilities for the modification and evaluation of options, as well as for the development of implementation plans for selected initiatives.
    - Key deliverables that could emerge from this process could include a confirmed list of initiatives to move forward with and a multi-party supported roadmap.

11 Conclusion

As highlighted by the Study's interviews, there are numerous obstacles that can hinder the commercialization and deployment of clean technology in Alberta. The non-technical barriers that prevail include those associated with a lack of resources and skills within SME technology innovator enterprises (the "Technology Innovator Needs" category of barriers), those resulting from ecosystem conditions (the "Context" category of barriers), and those linked to a lack of coordinated and effective collaboration among various parties within the ecosystem (the "Integration" category of barriers).

The Study results have emphasized that the prolonged duration or the halting of commercialization for many technologies in Alberta can be attributed to a confluence of factors outside the control of technology innovators. This illustrates the complex nature of the issue as an ecosystem challenge rather than simply deficiencies within individual firms. "Barriers to Speed" impede the progress of converting ideas into commercially viable solutions. Simultaneously, "Barriers to Demand" deter entities from adopting clean technologies and from building, owning, and operating transformative infrastructure and facilities. As a result, many technology innovators find themselves struggling to secure funds, partners, and sites for their costly technology de-risking projects, and, once ready for commercial deployment, they are left with limited (if any) demand for their offerings.

To mitigate these barriers, the Study team recommends a multi-pronged approach that includes the implementation of various types of solutions. This approach seeks to enhance the current strengths of the ecosystem and its participants, doubling down on what is already effective, while also challenging ecosystem enablers to broaden their scope and revise their strategies to drive transformative change. The team recommends an approach that incorporates near-, medium-, and long-term initiatives, each focused on one or more of the following: 1) improving existing grant funding processes to align with the pace of innovators and ensure continuity between stages, 2) fostering the development of skills and capacity within technology innovator firms and the broader ecosystem, and 3) alleviating the risks that hinder innovator-potential customer collaboration as well as clean technology adoption (i.e., alleviating risks that impede market demand).

Of particular importance, the team suggests that ecosystem enablers direct special attention toward implementing solutions, such as alternative project financing methods, project studios, and value-chain consortium calls, which target the persistent barriers hindering deployment of the technologies that need to be integrated into large complex projects to be commercialized (i.e., the B2P technologies). Given the significant potential of many B2P technologies to reduce greenhouse gas emissions, the alleviation of their barriers must be prioritised if the province is to achieve its decarbonization goals.

At the completion of this Study, a crucial immediate next step is for the Ecosystem Partners to review the recommendations and proposed future work outlined in this report. This review should determine which solutions will be implemented, which require further evaluation, and whether additional options should be considered. Lead parties, roles, and responsibilities for options refinement and the development of implementation plans need to be identified. Regardless of the options selected, the way forward must involve improving coordination among ecosystem players. Given that working in silos would be ineffective in addressing the complex challenges highlighted herein (and in fact, doing so may exacerbate the problems), all players must collaborate frequently, creatively, and productively to achieve the goal of making Alberta a world-class environment for innovators so that they may readily bring their game-changing clean technologies to market.

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APPENDIX A: INTERVIEW QUESTIONS

GENERAL NOTES FOR THE INTERVIEWERS

- As interviewers, we want to make sure that we allow the interviewees to feel safe enough to share their learnings and their "failures".
- Start off each interview by first stating the intent of the Study & interview, who Exergy is, and assure them that **any information/commentary shared in the interview will not be attributed to any specific person or company (unless otherwise permitted by the interviewee) in the Study deliverables.**
- Before jumping into the interview, **take a moment to get acquainted** (if you are not already). Introduce yourself and then ask the interviewees to introduce themselves.
- The prepared questions below are a guideline. To the best of our ability, we will "follow the conversation" and adjust the questions we ask based on the responses and information the interviewee shares.
- Interviewers will need to listen deeply. Try to hear what the interviewees are trying to say but have not found the words yet. Sometimes, you may have to ask the same question in different ways and/or ask new questions to probe for additional valuable information.
- Timekeeping will be important. Go into the interview with an idea of how much time you would like to spend on each question. If tangents do arise, do your best to get the conversation back on topic. If you are running out of time, use your best judgement on which remaining questions you will prioritize.

11.1 FOR TECHNOLOGY INNOVATORS

Q1: Could you provide us with the following information to help us understand where your company fits within the clean technology innovation ecosystem?

a) Briefly (in less than 30 secs), tell us what your company vision and mission is?
b) What is your target market, location, and/or assets?
c) What is your technology's current technical readiness level?
d) How would you categorize your organization? Choose from the options below:
    - Inventor/Technology Intellectual Property Owner/Technology Developer
    - Facility Builder/Owner/Operator
    - Enabler/funder/accelerator/government agency/engineering firm/consultant
    - Other?

Q2: Tell us about your innovation/project journey. Could you take us through the timeline of that journey?

- *What were the chain of events and how did the development process evolve?*
- *Were there any pivotal moments or events that changed the trajectory?*
- *Were there unexpected advancements?*
- *What challenges and successes stand out in your mind?*

- *Have you partnered with any other organizations along the way?*

Q3: What were your expectations when you set out on this journey? Have your expectations been met? Why or why not?

- *How did the timing play out?*
- *Did you come to a 'wheels spinning' moment?*

Q4: In the past, how have you engaged/interfaced with stakeholders?

- *What stakeholders did you have to interface with – internally and externally?*
- *In what way were they influential to your journey?*
- *What were their interests (financial, technical, IP, etc.)?*

Q5: Tell us about your team.

- *What skills/expertise did your team bring? Break it down and share their backgrounds.*
- *What skills/expertise did you seek out for support?*
- *Did you have trouble finding certain skills/expertise?*

Q6: Tell us about your approach to financing.

- *Do you look to finance on a per project basis or is it more time-based?*
- *What is your outlook for your company? For example, do you have a 1 yr., 2 yr., 5 yr., or 10+ yr. plan?*

Q7: Looking back, could anything have removed the blockages or further facilitated success, if so, what would those solutions have been?

- *What types of partners or complementary assets would have enabled/helped?*
- *Do you think you could have done anything differently to prepare for and or mitigate the impact of the barriers ahead?*

Q8: What advice would you have for organizations like ERA who are looking to better enable decarbonization technology commercialization and deployment in Alberta?

- *If you could talk to someone at ERA, what advice would you give them?*

11.2 For Enablers

Q1: How does your company enable clean technology development and commercialization? What role do you see your company playing in the new technology innovation ecosystem in Alberta?

Q2: Based on your observations and interactions, what would you say are the barriers (and the solutions to those barriers) **for technology developers?** Could provide examples from which you have gained these observations?

- *Do you think there is a lack of action and/or effective funding? If so, why do you think that is the case?*

- *Do you think many technologies see extended commercialization timelines? If so, why?*
- *Are many tech developers still struggling to prove their financial viability? If so, why?*
- *Who could address each of the above and what could they do?*

Q3: Based on your observations and interactions, what would you say are the barriers (and the solutions to those barriers) **for industry players looking to incorporate clean technology into their operations?** Could provide examples from which you have gained these observations?

- *Do you think there is a lack of action and/or effective spending? If so, why do you think that is the case?*
- *Do you think many new technology deployments experience extended timelines? If so, why?*
- *Do you think there is a lack of commitment? If so, why?*
- *Do you think there is a lack of financial viability? If so, why?*
- *Who could address each of the above and what could they do?*

Q4: Could you provide any examples of clean technology projects or companies that you were supporting that you thought should have succeeded, but didn't? Why do you think they have not succeeded?

Q5: What are some of the common pitfalls into which you see clean technology projects or companies fall? Why do you think that this happens? Is there something that organizations like ERA could do to help them avoid these pitfalls?

Q6: Have you observed certain market segments/industries experience more headwinds/barriers in implementing decarbonization technologies? If so, which one(s) and why do you think that is?

Q7: What advice would you give organizations like ERA to help further enable clean technology commercialization?

11.3 For Facility Owners/Operators

Q1: How do clean technologies and innovations fit into your company's strategy? What is your team's role in the implementation of this strategy?

- *What are the company's current priorities, near-term goals, and long-term targets in the context of decarbonization technology?*
- *What specific business units and/or operations are you looking to decarbonize through the incorporation of new clean technology? What geographical locations are you focusing on?*
- *How are your people and finance resources aligned to support that strategy?*
- *What actions are you taking to execute that strategy?*
- *Is this a new strategy, if so, how has it changed from what it was before?*

Q2: Tell us about your company's process to identify, evaluate, and select the clean technologies that you will deploy.

- *If you are charged with finding ideas, what do you do? How do you decide which technology developers you will work with?*
- *Are you inundated with requests? How do you manage those requests?*
- *What is your process for searching for and screening new technologies? What has proven most effective?*
- *Do you employ external parties to help search for and screen technologies?*
- *Has your team developed new processes?*
- ***What is the decision criterion that clean technology projects need to meet to be approved for implementation?*** *Is this criterion different than for traditional projects? What does that approval process look like?*
- *How do clean technology initiatives get financed? Is it different than traditional initiatives, projects, or programs?*

Q3: Tell us about your team and tools that support the process of identifying, evaluating, selecting, and implementing clean technologies in your organization?

- *What skills/expertise did your team bring?*
- *What skills/expertise did you seek out for support?*
- *Do you have trouble finding any skills/expertise? Which ones? What has helped you fill those gaps?*
- *How does the greater enterprise impact/support/hinder the day-to-day of your clean technology team?*

Q4: Tell us about an example where a clean technology deployment was <u>unsuccessful</u> at your company. Walk us through the timeline.

- *What was the technology and application? What was the TRL?*
- *Who were the players and what roles did they play?*
- *What were the chain of events and how did the development process evolve? How did the projected timeline compare to the actual one?*
- *What were your expectations? Were they met? Why or why not?*
- *What were the barriers that could not be overcome? Who do you think could have addressed these barriers and how?*
- *How did you engage/interface with stakeholders (e.g., government, funding organizations, public, partners, etc.)?*
- ***How did you come to the decision to pause/cancel?***
    - *Did you come to a "wheels spinning" moment?*
    - *Could anything been done to advance it past that point? If so, who/what parties could have made the difference and what could they have done?*
- *Have you been a part of or observed any "zombie projects", where it took a long time to decide to not spend resources on it anymore? Why do you think it dragged on?*

Q5: What were the main barriers you faced as you worked to commercialize your technology? What would have helped to address these barriers?

Q6: What advice would you have for organizations like ERA who are looking to better enable decarbonization technology commercialization and deployment in Alberta?

APPENDIX B: BARRIER CODES LIST

BARRIERS			
Categories	**Code #**	**Code/Title**	**Description**
Tech Innovator Need	T1	Tech Innovator Skillset Gaps	Technology companies lack certain skills; can include lack of business, financial, presentation, developer, and junior engineering talent/skills. In addition, supply shortage issue for certain skillsets in Alberta and Canada. Lack of supply of skilled labour, technical experts, and business leaders exacerbates this issue.
Tech Innovator Need	T2	Network-Based Opportunity Access	Technology companies lack useful industry (or other) connections to lean on for support, networking, etc. The influence of this barrier can be significant in regions and industries where personal relationships are pivotal in navigating the landscape, establishing partnerships, initiating business deals, and especially in cases where a small number of organizations control the majority of the industry's assets.
Tech Innovator Need	T3	Resource-Intensive Tech Validation	Lack of sites, supporting services, and partners to conduct technology validation in industrial environments. Lack of funding options for technologies that require $1M or more to validate it to get investors (often an issue that hard tech faces).
Tech Innovator Need	T4	Lengthy & Constraining Grant Application Process	Funding processes are too long causing uncertainty and cash flow issues. In addition, funding calls (scope & timing) are not aligned with plans of companies. Also, eligible costs that innovators can spend that funding on may not cover all the kinds of resources they need (BD resource hiring, for example). Small tech firms can become distracted by grants and end up framing their plans around grants rather than developing strategic plans that will enable long term success. Timing issues with "shovel ready" calls are a significant concern, as reaching a "shovel ready" stage requires substantial time, money, and resources. Companies often struggle to tailor their plans to fit the scope and timing of these calls, and the uncertainty surrounding grant approval and funding disbursement adds further risk.
Tech Innovator Need	T5	Use Case Knowledge Gap	Tech innovators may not have a clear idea where/how their technology can be best implemented. This barrier includes a general lack of understanding of who their customers are and/or their customers' needs.
Context	C1	Boom-Bust Cycles of Potential Adopters	Includes commodity price volatility, leadership/ownership changes, and business planning cycles.
Context	C2	Undervalued Sustainability Benefits	This barrier highlights the idea that the non-economic and broader sustainability benefits associated with new technologies are not adequately recognized or quantified in the current incentive and regulatory frameworks. Facility owners/operators, driven by their responsibility to shareholders, lack incentives to fund or adopt new technology, especially when it might disrupt existing operations (and/or increase operating expenses). Operators prioritize safety and reliability. The potential benefits (economic, reputational, etc.) of new clean technologies implementation are not great enough for large companies to take the risk and/or to choose funding it over base-business, familiar, and fully de-risked opportunities.

Context	C3	Onerous Process to Become Approved Vendor	Small firms trying to sell to large companies and government bodies, such as municipalities, struggle to fund the process of qualification. Governments especially have long cycles and due diligence can take a long time.
Context	C4	Culture of Risk Aversion	Can include lack of comfort in/understanding that technology development requires risk. A portfolio approach ("game of probabilities" mindset) is necessary. Also, developers, large industry and funders/lenders are fearful of technology failure. Technology encountering challenges/barriers provides insights on technical or business barriers to success and is a good thing in the context of technology development though many do not see it that way and would rather miss out on opportunities than risk losing money.
Context	C5	Surplus of Emerging Tech	There is a high volume of emerging technologies in the ecosystem, many without clear use cases defined.
Context	C6	Expectations for Big Impacts Fast	There is a misalignment between expectations around timelines/impacts and what is possible. This leads to several issues including: - Requirements for large companies to make big impacts to GHG by 2030 and then to reach net zero by 2050 is driving big companies to prioritize commercialized technologies. - People expecting results faster than what is possible can lead to impatient capital. - Small tech firms trying to skip steps in the development journey (i.e., they do not de-risk the tech enough) resulting in them "hitting a wall" at a certain level of capital raise.
Context	C7	First of a Kind (FOAK) Project High Cost & Risk	FOAK projects/tech generally have high cost and high risk that put-off lenders, investors, and potential industry partners/operators. Seems that everyone is in the race to be second or third, but no-one wants to be first. The "chicken and egg": funders/industry want the technology to be fully de-risked prior to investment, however, someone needs to go first before it can be fully de-risked.
Context	C8	Government Policy/Regulatory Flux & Complexity	Fear of delays, government interference, and carbon reduction incentives changing. For innovators and large industry, understanding the complex regulatory/policy frameworks can be challenging. Regulation/policy may in some cases also favor large industry, making adoption more difficult for smaller players.
Integration	I1	Ecosystem Complex & Uncoordinated	The innovation ecosystem suffers from a lack of collaboration and connectivity between its various players. For a tech innovator, the system can be very tricky to navigate and understand. Where to go for the right or specific support/guidance is often unclear. There is a lack of connectivity between players and available services. In addition, there is a lack of support to go from one stage of the development journey to the next.
Integration	I2	New Clean Technology Project Financing Ecosystem Gaps	Government and VC funding available for early stage and pilot projects. Rely on incumbent operators to self-finance commercial projects deploying new technology. These projects compete with conventional projects with higher and more predictable returns. Project financing is out of scope for VC's. Institutional investors are currently absent.

Integration	I3	Investors & Funders Knowledge Gaps	Potential lack of knowledge or understanding in the investor community as well as on the government side (policy makers and funding agencies). Energy system, technical challenges, and technical solutions are very complex, and decision makers are not always equipped to understand what is presented to them.
Integration	I4	Unclear Funding Agencies' Success Criteria	ERA and other funders to better define what they are aiming to achieve. Propose problem that aligns with overall ERA strategy and goals and then put a call out for solutions. Clear definition of their mandate/success criteria can help innovators focus on achieving those. ERA and other funders to improve their metric and strategy on who should receive funding to achieve the emission reduction targets.
Integration	I5	Intellectual Property Protection	Desire for competitive advantage (and IP protection) getting in the way of technology advancement. Innovators resist co-developing with others, small firms do not join forces. In addition, there is a lack of transparency from technology vendors regarding their "black box" (technology). The desire for competitive advantage and access to IP can result in big companies developing tech that competes with small firms. It can also result in IP being tied-up in commercial agreements with single potential adopters that never implement the idea.

APPENDIX C: EXPANDED BARRIER DESCRIPTIONS & INTERVIEW INSIGHTS

This appendix provides expanded descriptions of the barriers identified in the interviews conducted for the Study. Supplementing the descriptions presented in the main body of the report, it includes additional anonymized and synthesized commentary, insights, and examples extracted from the conversations.

TECHNOLOGY INNOVATOR NEEDS

T1 – Technology Innovator Skillset Gaps

A significant challenge faced by tech innovators is the presence of skillset gaps within their teams. Interviews revealed these gaps encompass areas such as business, finance, presentation, project development, regulatory, land, supply chain management, and junior engineering skills. Particularly in later stages of the readiness scale, the absence of strong presentation and communication skills can hinder an innovator's ability to secure funding, particularly from venture capitalists and other investors. Innovators who can effectively communicate their ideas and garner support from industry or corporations tend to be more attractive to VCs, as compared to those who solely rely on government funding.

In the B2P model, where technology development transitions into project development, execution, and operation, tech innovators face the challenge of either outsourcing specialized functions required for the safe and efficient construction and operation of large projects or developing these capabilities in-house.

These skillset challenges are further compounded by a broader talent shortage issue. Alberta and Canada experience a scarcity of skilled labor, technical experts, and business leaders with expertise in new tech development. Graduates and experienced engineers often lack hands-on skills, while most seasoned professionals have limited experience with running technology startups. The talent shortage makes it even more challenging for tech innovators to fill their skillset gaps, hindering their ability to find professionals who can address their business, financial, technical, or engineering needs.

In Indigenous communities, a distinct challenge arises from the lack of "clean technologies champions" possessing the necessary skillsets to lead projects. This shortage of expertise is compounded by the overall scarcity of resources available for clean technologies initiatives in these communities. The progress towards improving this situation has been hindered by the discontinuation of previous government programs and grants that were specifically intended to foster and cultivate these essential skills in Indigenous communities. As a result, the absence of champions and limited resources inhibits Indigenous communities to drive and implement clean technologies projects.

It is important to highlight that the accelerator and incubator services that have emerged in Alberta have been working to mitigate some of the skill set gaps, and a couple of people raised this in their interviews as examples of what has helped the early stages of their respective journeys. These interviewees shared how these services helped them to identify and address some of their business skills gaps as well as make important connections. However, in aggregate, the interviews found that the extent of the benefits derived from these types of services varies widely depending on the specific case, suggesting that additional measures and approaches to address the skillset gaps are required.

T2 – Network-Based Opportunity Access

Tech innovators often face the challenge of limited personal or business connections to rely on for support, advice, technical/industry resources, partnerships, and other valuable resources. This issue is particularly prevalent among innovators from academic backgrounds or those who are new to the province or industry, as they may lack established connections to leverage. The impact of this barrier can be significant in regions and industries where personal relationships play a critical role in navigating the landscape, forging partnerships, and initiating business deals. A couple of the technology innovator interviewees shared how this barrier impacted the rate of their progress early on in their journey, particularly because they established their companies when they were newcomers to Alberta, lacking pre-existing connections to leverage.

T3 – Resource Intensive Tech Validation

Technologies that require relatively high capital (>$1 million) and testing in industrial environments to be validated, have an especially tough time getting the funding, partners, and sites that they need to advance between TRL 4 and 7. In this stage of the readiness scale, investors hesitate to put-up funds due to the relatively high costs in comparison to the perceived level of risk. Consequently, many innovators are compelled to depend on grants that, unfortunately, only provide small-dollar funding insufficient for the substantial financial requirements of these tech validation projects. Notably, tech validation projects costing more than $1 million particularly face difficulties in securing the necessary funds for advancement. The lack of suitable facilities, services, and partners for technology validation in Alberta (and in Canada), as well as challenges in acquiring field demonstration sites, further impede progress. Moreover, the insufficient coverage provided by Canadian grants (on a per project basis) compared to other regions like the US and Europe has prompted some innovators to explore opportunities elsewhere.

Insights from the interviews underscore the challenges associated with securing field demonstration or piloting sites. This difficulty arises not only from the challenge of identifying a willing industrial partner but also from the complexities involved in navigating operator approval, safety, environmental, and regulatory considerations. In addition, innovators may face challenges in finding companies that not only offer the right services and expertise to address their internal resourcing gaps but also possess the specific know-how needed for technology development and testing.

A recurring concern raised by interviewees is the disparity in grant coverage between Canada and other regions. Canadian grants typically cover less than 50% of project costs and require proponents to demonstrate the ability to finance the remainder. However, for small start-ups with technologies at the mid-TRL level, attracting the additional funding can seem like an insurmountable challenge. The inherent risks associated with hard technologies at this stage often deter investors from providing the necessary financial support. In contrast, grants in Europe and the US often provide close to 100% coverage. This discrepancy has led some tech developers to explore opportunities outside of Canada.

T4 – Lengthy & Constraining Grant Application Process

Tech innovators, owner/operators, and enablers all provided common feedback that the lengthy and onerous nature of applying for and receiving grant funds was a barrier. They also identified a misalignment in the inherent speeds of government grant organizations and startups; the latter moves much faster and often pivots, which runs counter to the standard operation of grant organizations. This protracted process can lead to cash flow issues that innovators may not be able to tolerate or survive while completing applications or awaiting funds upon successful applications.

Common timing and planning issues shared include the fact that innovators may not be ready to apply for grants with limited scopes or timelines, as their progress may outpace the TRL requirements specified by the grants. For instance, if a grant funding process takes a year to complete and the organization only funds projects at TRL 6-9, an innovator who advances from TRL 4 to TRL 6 within that year faces uncertainty regarding the appropriate timing for application submission. In some instances, they found themselves unprepared when ERA announced its timing window, and when the next funding call was issued, it may have been too late for them to apply.

Along with this timing discrepancy, there was frequent feedback that there is often discontinuity in innovator's scope or plans as they align with grant calls. Innovators often encounter issues where the eligible costs covered by grants may not encompass all the necessary resources they require, such as hiring business development personnel. In addition, small tech innovator firms can become overly focused on grants, leading them to shape their plans solely around grant requirements rather than developing strategic plans for long-term success.

For high capital FOAK commercial projects, timing challenges arise with "shovel ready" calls. Significant investments of time, money, and resources are required to reach a "shovel ready" stage. Due to the limited grant coverage available for the associated high-cost Front-End Engineering Design (FEED) activities, a small number of companies are willing to take the risk of initiating such projects and having them ready when a funding call is issued. Companies may face the pressure of hastily tailoring their plans to align with the specific requirements of "shovel ready" grant calls, potentially diverting from their original strategic objectives. Moreover, the lengthy grant processes introduce risks, as companies incur expenses while awaiting confirmation of grant approval. This level of risk is often perceived as too burdensome for many companies to undertake and holds them back from developing the transformative large projects.

T5 – Technology Innovator Use Case Knowledge Gap

Based on feedback from enablers and facility owners/operators, it is evident that many technology innovators encounter challenges when it comes to developing compelling use cases and value propositions that resonate with potential adopters. One common observation is that tech innovators often lack a clear understanding of where and how their technology can be best implemented, as well as a general lack of awareness of their customer base. Many tech innovators lack an understanding of how their idea can be integrated into their customers' operations and the various disciplines and considerations that need to be addressed. This lack of understanding can be attributed to several factors, including a limited experience in their customers' industries and a lack of opportunities to co-develop their technology with potential adopters.

Additionally, innovators may become emotionally attached to their ideas, which can hinder their ability to adapt or modify their technology to suit different use cases, industries, or market conditions. To overcome these challenges, it is crucial for innovators to engage with end users early in the development process, gaining insights into their specific needs and requirements. This collaborative approach enables innovators to align their technology with the industry's demands and tailor their value propositions accordingly. Furthermore, the ability to pivot and adapt technology to diverse applications is highly valuable. Innovators who embrace this flexibility can avoid the limitation of restricting their technologies to a single industry or application. By exploring and identifying potential cross-industry applications, innovators can broaden their customer base and increase the appeal of their technology to a wider range of adopters.

Overall, a deeper understanding of customers' operations, effective collaboration with potential adopters, and a willingness to adapt and pivot technology are crucial factors in developing compelling use cases and value propositions that resonate with potential adopters.

CONTEXT

C1 – Boom-Bust Cycles of Potential Adopters

The volatile nature of the oil and gas industry has presented obstacles for tech innovators, particularly when it comes to partnering or working with larger energy companies. One significant challenge arises when these companies retract or fail to fulfill their initial plans or commitments.

These challenges stem from factors such as commodity price volatility, leadership and ownership changes, and government policy fluctuations that impact the economic and business planning cycles. Both innovators and adopters are affected by these issues. Large operators, for instance, work with three-year business plans, however these plans are updated and changed annually. While strategies may be approved, the availability of capital to execute those strategies can be uncertain or reallocated when the time comes.

According to some interviewees, this barrier becomes more significant when the target adopters of clean technology operate in an industry that has experienced consolidation. This is evident in the current state of the Canadian energy industry, where a small number of major firms dominate and control most industry assets. These firms are characterized as lacking agility and having limited prioritization for new technology development. As a result, the challenges faced by tech innovators in partnering with these larger companies are amplified.

It is worth noting that the support for new technology within large owner/operators often relies on one or two champions within the company. If these champions leave or change positions, the potential adoption of that technology within the large company may be hindered or even abandoned altogether.

C2 – Undervalued Sustainability Benefits

Many interviewees highlighted the shortcomings of the current incentive and regulatory frameworks in Alberta and Canada when it comes to recognizing and quantifying the non-economic and broader sustainability benefits associated with new decarbonization technologies. While some sustainability benefits are acknowledged, the incentives offered and regulations in place are deemed insufficient to drive a strong market demand for the rapid adoption of innovative clean technologies.

According to the interviewees, potential clean technologies adopters/customers are not adequately motivated to prioritize environmental benefits over short-term profits due to the lack of effective & stringent regulations (“sticks”) and the absence of compelling incentives perceived to have "staying power" (“carrots”). Additionally, there is a perceived undervaluation of non-greenhouse gas reduction environmental benefits such as freshwater consumption. For example, sectors such as road construction, well abandonment, chemicals, and concrete manufacturing, which often go unnoticed in political and social discussions, have less regulations and incentives to motivate them to improve their sustainability performance than the energy industry.

Feedback from all interviewees indicates that large incumbent companies and adopters often lack the necessary and certain incentives to integrate or adopt new technologies into their portfolios, particularly when it poses potential disruption to their existing operations. Driven by their accountability to shareholders, existing facility owners/operators prioritize safety, reliability, and the continuous improvement of their existing assets over venturing into riskier investments in new or renewable technologies. The potential benefits, whether environmental, social, reputational, or economic, of implementing new clean technologies are not substantial enough for these companies to justify the associated risks and divert funding from familiar and lower-risk opportunities. Incumbent large industry companies are primarily focused on delivering returns to their investors and operating in a "dividend mode" rather than pursuing growth and taking risks to expand, as may have been the mindset in the past. These companies are typically structured for operational excellence rather than fostering innovation. Specifically, incumbent companies are disinclined to allocate funding for technology development on their balance sheets due to potential impacts on free cash flow or return on capital employed. Many operating firms will only choose to adopt clean technologies if it becomes the most economical way to meet regulatory compliance requirements.

In addition, as incumbent companies prioritize dividend payouts, there appears to be a lack of new entrants venturing into the development of new value chains in Alberta. The scarcity of organizations executing projects that deploy high-impact clean technology in the province may indicate an insufficient "prize" to justify the cost and risk of such ventures. In contrast, explicit incentives, such as the IRA in the United States, are propelling the adoption of disruptive technologies within the US borders.

A couple interviewees commented on how technologies designed for emerging markets that lack established infrastructure require significant incentives to progress towards commercialization. Technology innovators working on such solutions, which require complex and high-cost infrastructure and value chains, face challenges in articulating their value proposition to target customers and investors who seek assured returns. Forecasting and predicting demand and costs for these technologies is particularly difficult.

One interviewee offered hydrogen technologies as an example of the types of technologies that face the emerging market problem. These technologies require substantial government support, either through incentives or regulations, to encourage investments. It's a classic chicken and egg problem: without established hydrogen value chains, all hydrogen technologies remain economically unviable. Companies are reluctant to invest in building hydrogen value chain infrastructure due to the lack of current demand for hydrogen and hydrogen end-use technologies. To establish a hydrogen economy, governments must take additional steps to stimulate the initial demand (e.g., incentivize anchor tenants) for hydrogen and to mitigate the highest-risk aspects of value chain infrastructure. This approach, in theory, would broaden hydrogen accessibility and subsequently bolster the economic viability of future hydrogen end-use products.

C3 – Vendor Approval Process Onerous

Small firms trying to sell to large companies and government bodies, such as municipalities, struggle to fund the process of qualification itself. Governments especially have long cycles and due diligence can take a long time. Innovators also often move quickly or have timelines associated with grant money stipulating this, so these lengthy approval processes can be detrimental to progress. This is particularly prevalent in the B2B model.

C4 – Culture of Risk Aversion

Risk aversion and fear of failure are common traits observed in the Canadian context, often leading to a lack of comfort, and understanding regarding the inherent risks associated with technology development. This aversion is further amplified by the absence of a portfolio approach and a "game of probabilities" mindset among developers, industry players, and funders/lenders who exhibit a strong fear of technology risk. Consequently, the risk-averse attitude of potential adopters, with whom innovators collaborate, prolongs the decision-making processes, leading to small firms depleting their cash resources while awaiting outcomes.

In interviews, several technology innovators and enablers highlighted the prevailing risk aversion among investors, enablers, and potential customers in Canada compared to their counterparts in the United States. One interviewee speculated that Canadians place a higher value

on the dollar compared to Americans, contributing to their risk-averse behavior. This cultural aspect may be attributed to the relatively limited availability of funding and opportunities in Canada compared to those associated with the larger economy of the United States.

Moreover, it was noted that many large industry players in Canada do not have the culture required for innovation since they primarily focus on manufacturing and operation of conventional businesses. Consequently, decision-makers at larger firms may demand accurate risk assessments and success metrics that are often unattainable for emerging technology development. Many of them struggle to accept that early technology failure can indeed indicate success in a broader context, resulting in a lack of strategic investment in the advancement of emerging technologies within the ecosystem.

Enablers also expressed concerns about risk-adverse technology innovator/start-up "development paralysis" characterized by excessive time spent on theoretical development details rather than promoting practical implementation and testing activities. This further hinders the progress and advancement of technologies in the Canadian context.

C5 – Surplus of New Tech

In general, there is a large volume of ideas that exist in the ecosystem, many without clear use cases defined. Tech innovators and enablers describe difficulty in garnering attention or getting potential funders/investors to listen to new tech's value proposition; the space is flooded with many technologies and ideas that makes it difficult for potential adopters and investors to find the promising ones. The lack of sufficient vetting and validation activities for the surplus of technologies hampers adopters and investors in making informed assessments, while the abundance of similar technologies reflects a general lack of collaboration among the innovators themselves.

One notable example is the experience shared by an interviewed innovator who is involved in advancing hydrogen technology. They highlighted the challenges they faced in gaining attention and recognition for their unique technology. They have often encountered dismissive attitudes from potential funders and investors who mistakenly believed that what they were offering was already disproven, even though this was not true. This innovator faces the reality of operating in a hydrogen space characterized as having "excessive noise", a proliferation of emerging technology ideas, and a flood of individuals claiming expertise without substantial knowledge or experience.

C6 – Expectations for Big Impacts Fast

Feedback from interviewees suggests there exists a misalignment between the expectations of governments, the public, enablers, and investors regarding the timelines and impacts of GHG emissions reductions, highlighting a disconnect between what is perceived as achievable and what is possible. Essentially, the perception of "big impacts fast" that innovators can face from potential adopters, governments, and investors often contradicts the nature of clean technologies innovation. As one adopter interviewee described, climate targets are driving government and adopters to inherently focus solely on commercial technologies, while neglecting potential, lower TRL

solutions. Another enabler interviewee said there is a “misalignment between government and societal expectation about what is possible”, and highlighted that solutions take a long time to prove out.

This creates several challenges, such as unrealistic expectations for faster results (resulting in "impatient capital"), tech firms attempting to bypass crucial development steps (thus failing to sufficiently de-risk their technologies) and encountering obstacles during capital raising, and large companies being compelled to prioritize commercialized technologies due to their significant emissions and the urgency to achieve GHG reduction goals by 2030 and net-zero targets by 2050.

There is a prevalent tendency to pursue "silver bullet" or perfect solutions for achieving net-zero targets, often neglecting the potential of transitional solutions and incremental improvements capable of yielding immediate but smaller emissions reductions. During the interviews, one participant emphasized this trend, providing an example of an innovative technology aimed at gradually improving the carbon intensity of diesel combustion in vehicles through hydrogen injection. According to the interviewee, this transitional solution has encountered limited government support and public interest, primarily because the focus remains primarily on advancing zero-emissions technologies (e.g., fuel cells and battery electric vehicles). The interviewee contended that bypassing the transitional phase is impractical and that the lack of support for more transitional solutions, which could possibly lower infrastructure costs for future zero-emissions technologies, will ultimately prolong the journey to achieving net-zero status.

C7 – First of a Kind (FOAK) High Cost & Risk

FOAK projects and technologies face significant barriers due to their high cost and high risk, which can discourage lenders, investors, and potential industry partners/operators from getting involved. From the perspective of an operator that may only deploy a technology a limited number of times, adopting a "fast follower" strategy becomes a rational choice to avoid the high cost associated with FOAK projects. However, if everyone adopts a "fast follower" approach, there will be no one to pioneer and set the path for others to follow.

The "chicken and egg" scenario is a common challenge for tech innovators. Funders and industry partners often require technologies to be fully de-risked before making high-dollar investments, but someone needs to adopt first to achieve full de-risking.

FOAK projects also face competition for capital from well-established or turnkey technologies that offer a presumed higher return on investment and lower risk compared to innovative and riskier ventures. Additionally, comprehensive risk matrices used by large owner/operators often prioritize more established technologies, which further limits the development and investment opportunities for FOAK projects.

A few interviewees brought up an interesting point: established large firms often exhibit a reluctance to be early or even second adopters, whereas companies in a growth phase, reliant on expansion for survival, demonstrate a greater readiness to take risks and embrace new

technologies. This observation highlights the influence of industries that are predominantly controlled by a small number of well-established firms. It suggests that such industries may exhibit less motivation to take risks on new technologies.

C8 – Government Policy/Regulatory Flux & Complexity

In Canada, concerns regarding government interference and climate policy changes are widespread, discouraging innovators and large industry players and hindering investment in new clean technologies. The regulatory and policy frameworks in Canada are intricate and challenging to navigate, creating uncertainty for all ecosystem players.

Perceived biases within government policies contribute to this sense of uncertainty, with apprehensions about biases towards "anti-fossil fuels" sentiments and favoring large companies, potentially impeding the progress of more effective clean technology solutions and system improvements. Examples of government policy biases highlighted in the interviews include challenges faced by smaller players in injecting carbon dioxide into depleted reservoirs due to the preference for the carbon capture, utilization, and storage (CCUS) hub model and the exclusion of hydrocarbon by-production in geothermal power generation. Nearly all the interviews described the regulatory and funding processes in Canada as overly complicated and influenced by politics, often favoring tailored solutions led by large companies.

The risk of sudden regulatory changes, known as "stroke of the pen" risk, significantly impacts the financial projections of clean technologies projects and the willingness of large industry players to collaborate with tech innovators. Simplifying regulations and treating every tonne of carbon dioxide equivalent equally was suggested by two interviewees to achieve more efficient greenhouse gas reductions. The United States' IRA was highlighted as a positive example, praised for its perceived efficiency and clear CO2 emission baselines and funding rates. One interviewee stated that some venture capitalist firms are prioritizing the US as their first market due to the perception of it being a more favorable funding environment.

INTEGRATION

I1 – Ecosystem Complex and Uncoordinated

The innovation ecosystem is packed with numerous players and suffers from a lack of collaboration among them. This includes the absence of connectivity or direct pathways between these players and available services, as well as insufficient support from funding organizations to transition from one technology development stage to the next. Innovators often struggle to determine their next steps after completing a specific development stage or funded project.

While the essential elements exist within the ecosystem, there are gaps in terms of the flow or connections between the players; a crucial "passing of the baton" is missing. Many organizations within the system, including engineering, procurement, and construction firms, accelerators, government agencies, technology companies, and industry stakeholders, are attempting to achieve similar goals or solve

identical problems but are not collaborating effectively. Moreover, several technology innovators are working on similar projects and could potentially address each other's challenges if they collaborated.

Overall, there is an excessive amount of competition and insufficient collaboration. Navigating and comprehending the ecosystem can also be challenging; it is unclear where to seek the right or specific support and guidance. Innovators and enablers have expressed encountering a lot of "noise," making it difficult to discern valuable opportunities and distinguish what is worth their time. Generally, there is a lack of awareness of, and connectivity to, the existing ecosystem services. Additionally, some find the funding processes overly complicated.

I2 – Project Financing Ecosystem Gaps

Although government and venture capital funding appear accessible to support technology innovators in their early stages as they establish themselves as a start-up and work on developing their technology readiness, securing funds for capital-intensive projects that facilitate the early commercial-scale deployment of clean technologies is challenging. Innovators often must rely on incumbent operators to finance the commercial projects that will deploy their new technology, as venture capitalists do not typically invest in projects and institutional investors remain absent. These commercial clean technologies projects then compete with conventional projects that yield higher and more predictable returns. In many cases, the conventional projects prevail, preventing the higher-risk project from moving forward and obstructing the commercialization of its associated clean technology.

Offering some colour to this barrier, Innovators and enablers interviewed shared the sentiment that “capital is tight and not readily available in Canada right now”, siting post-COVID debt repayment priorities, rising interest rates or preferences towards conventional projects and a lack of understanding of clean technologies financing schemes.

I3 – Investors & Funders Knowledge Gaps

Innovators, enablers, and owner/operators have all indicated a knowledge gap in the investor community as well as among government stakeholders (including policy makers and funding agencies) with regards to the technical complexities of clean technology products and projects. Energy systems, technical challenges, and their corresponding solutions are often highly complex and interrelated, posing a challenge for decision-makers who may not have the necessary expertise. This points to a lack of energy literacy and systemic thinking.

Some stakeholders have expressed the view that funding agencies and policymakers struggle to identify the most effective points for seeding the value chains of the ecosystem, limiting the potential for meaningful impact. Moreover, preconceived notions about certain energy or power generation schemes have resulted in biases that can hinder the acceptance of technological innovations. Initial skepticism regarding new technologies, often without a strong basis, has, in the perception of innovators, impeded their ability to persuade investors of the value proposition, even with institutional or academic backing.

These challenges place innovators at a disadvantage, particularly if their technologies' technical merits are not easily comprehensible and if the innovators lack strong presentation skills that can resonate with and convince investors. It is worth emphasizing the positive feedback about ERA obtained during the interviews on this issue. Many interviewees highlighted ERA's notable proficiency in understanding technical issues, setting it apart from its peers. Some interviewees suggested that ERA should leverage this strength to help governments, other ecosystem funders, and investors understand complex technical problems and solutions, facilitating decisions that consider practical, transitional, and long-term impacts across the system.

I4 – Unclear Funding Agencies' Success Criteria

During the interviews, innovators, enablers, and owner/operators expressed that funders need to provide clearer definitions of the objectives in their funding calls. Stakeholders within the system find it challenging to discern which grants are best suited for their projects and how the various funding programs across the province and the country interconnect to fulfill an overarching strategy. Consequently, innovators often resort to applying for multiple grants, leading to a potential waste of resources as they strive to find the right match. Moreover, the lack of clarity regarding the definition of success for each agency and at each government level generates uncertainty among stakeholders regarding whether government funding is being distributed in a way that will maximize the overall impact.

Feedback from innovators indicates a lack of transparency and feedback, particularly in the case of unsuccessful grant applications. Considerable time, effort, and resources are invested in putting together applications, and innovators generally seek constructive criticism to improve and progress further. Many innovators have been encouraged to apply and led to believe that they are suitable candidates for calls, only to be rejected during the review process, with feedback being insufficient for their needs.

During an interview, an analogy was drawn between Canada's approach to distributing funds for technology development and a piñata game. The interviewee highlighted proponents (deemed qualified based on unclear and sometimes biased criteria) are eagerly grabbing and consuming the available 'candies.' However, the concern arises after funding has been distributed. Simply receiving the funds does not ensure meaningful outcomes or long-term impact. The interviewee emphasized the significant allocation of funds but noted a lack of clear strategy, follow-up, stewardship, and accountability to guarantee that the funds align with the intended overall objectives. Merely measuring the amount of money issued cannot serve as the sole metric of success. Instead, funders should prioritize metrics such as the overall reduction in emissions achieved by the country and the extent to which the funds have contributed to these outcomes.

I5 – Intellectual Property Protection

The desire for competitive advantage and IP protection can impede technological advancement; innovators resist co-developing with others, avoid joining forces, and may limit themselves from potential benefits associated with collaboration and sharing. Additionally, there is a lack of transparency from technology vendors concerning their "black box" technology, which they may be reluctant to share

with funders, investors, adopters, and operators. A general fixation on IP can lead to contentious deals or conversations between innovators and industry partners or funders.

Furthermore, the pursuit of competitive advantage and access to IP can lead to large companies developing technologies that compete with small firms or iterating on small firms' ideas using the greater capital available to them. In some cases, IP can become entangled in commercial agreements between innovators and specific potential adopters who ultimately do not implement the technology or idea. This situation can result in the technology being trapped in a state of limbo, where it remains unused and unapplied.

APPENDIX D: SOLUTION CODES LIST

POTENTIAL SOLUTIONS

Cat.	No.	Code/Title	Description	Difficulty	Impact	Barriers Addressed
Enabling Demand	**S01**	Regulations & Policy Makers Engagement	Propose Ecosystem Partners enhance their interaction with policymakers and regulation designers & administers on both provincial and federal fronts, offering comprehensive education on clean technologies as well as feedback on relevant regulations & policies. Organize more frequent sessions with the key groups who are formulating and administering policies and regulations which may impact the advancement of clean technologies.	Med-High	Med-High	Government Policy/Regulatory Flux & Complexity Undervalued Sustainability Benefits Expectations for Big Impacts Fast
	S02	Government Contracts & Procurement	Applicable government departments should revise their procurement policies across municipal, provincial, and federal levels to prioritize emerging clean technologies ready for commercialization. Drawing inspiration from strategies in military and space contracts, this concept looks to use government buying power to drive clean technology enhancement and cost reduction, thereby setting up the technology to be more attractive to the broader market of potential adopters.	High	High	First of a Kind (FOAK) Project High Cost & Risk Resource-Intensive Tech Validation Boom-Bust Cycles of Potential Adopters Undervalued Sustainability Benefits Expectations for Big Impacts Fast
	S03	Industry Problem Driven Challenges	Start with the problem rather than solutions to ensure technology will have a market pull. Establish an ongoing program (multiple calls a year) whereby industrial companies/emerging operators & applicable funders define a specific problem, utilize industry partner funds and/or sites and auxiliary services, and issue funding calls to solve it. Innovators would then submit proposals with pitch solutions that directly address the problem.	Med-High	Med-High	Use Case Knowledge Gap Surplus of New Tech Undervalued Sustainability Benefits Unclear Funding Agencies' Success Criteria Vendor Approval Process Onerous
	S04	Value-Chain Major Projects	Applicable ecosystem enablers should amplify its focus on value chain initiatives and provide grants for vertically integrated deep decarbonization commercial projects. These efforts would center on consortia proposing comprehensive commercial projects spanning the full spectrum of an emerging value chain, such as the hydrogen economy, ensuring cohesive infrastructure and demand support for technologies along the chain.	High	High	Culture of Risk Aversion and Fear of Failure Project Financing Ecosystem Gaps Undervalued Sustainability Benefits Ecosystem Complex & Uncoordinated
	S05	Adopter Calls	Applicable funders could put out calls or "RFPs" to organizations interested in collaborating with funder-selected technology companies which have technology that is ready (or near ready) to commercialize. The specific technologies and companies forming the basis of the call would be selected from the given funder's portfolio of proponents that it has previously assisted in advancing, aiming to ensure the impact of the government's prior investment.	Med-High	Med-High	First of a Kind (FOAK) Project High Cost & Risk Network-Based Opportunity Access Undervalued Sustainability Benefits Use Case Knowledge Gap
	S06	Technology Validation Hubs	This concept proposes the establishment of more partnership programs which would be like BC's *Integrated Marketplace Initiative* and the Edmonton Airport's hydrogen initiatives. These programs would set-up sites/areas that would be used as testbeds for clean technologies innovators to test, advance, and de-risk their technologies in real-world industrial environments and would facilitate arrangements between innovators and industry/potential adopters. Ideal sites/areas would be ones where multiple aspects of the value chain are co-located and where multiple potential adopters operate.	High	High	Use Case Knowledge Gap Resource-Intensive Tech Validation First of a Kind (FOAK) Project High Cost & Risk Tech Innovator Skillset Gaps Network-Based Opportunity Access Vendor Approval Process Onerous

						Ecosystem Complex & Uncoordinated
						Culture of Risk Aversion and Fear of Failure
						Surplus of New Tech
	S07	Alternative Project Financing Approaches	Enhance support beyond non-dilutive grants by exploring innovative funding mechanisms for later-stage projects identified by proponents. Consider options like forgivable/low-interest loans backed by the government, tax/royalty funds allocated for technology advancement, and partnerships for issuing green bonds. Develop and implement ways to broaden the pool of strategic investors.	High	High	Project Financing Ecosystem Gaps
						First of a Kind (FOAK) Project High Cost & Risk
						Boom-Bust Cycles of Potential Adopters
Process Improvements	**S08**	Funding Continuity Initiative	All funders to establish a framework to shorten the gap between the completion of one technology development project and the start of the next, ensuring consistent momentum and efficiency gains. This program would cater to SME startup technology innovators aiming to progress new technologies through various TRL stages up to commercialization, leveraging the existing Partnership Intake Program, establishing proactive handoff procedures between ERA and other funders, financers, and investors, defining clear stage graduation criteria, and implementing a "stage bridging funding" policy.	Med-High	Med-High	Lengthy & Constraining Grant Application Processes
						Investors & Funders Knowledge Gaps
						Ecosystem Complex & Uncoordinated
						Project Financing Ecosystem Gaps
	S09	Time-Bound IP Arrangements	As a condition for grant funding qualification, require proponents to provide proof of time-limited commercial terms between tech innovators and industry partners, restricting the duration of the industry partner's IP rights.	Low	Med-High	Intellectual Property Protection
						Boom-Bust Cycles of Potential Adopters
	S10	Voucher Program Enhancement	The applicable government funding agencies should explore methods to enhance, expand, and ensure the maximum utilization of the ecosystem's voucher programs. In In addition, all government agencies should aid innovators in understanding and utilizing the voucher programs available within the ecosystem.	Med-Low	Med-High	Lengthy & Constraining Grant Application Processes
						Tech Innovator Skillset Gaps
	S11	Grant Application Process Improvements	Funders should implement several changes to its grant processes to better align with the needs and pace of innovators. Proposed improvements include revising and clarifying grant award success criteria, providing constructive feedback to applicants, establishing a project proposal voucher program, issuing lines of credit to winning applicants to bridge the gap between the award and funding receipt, increasing funder's percentage of project cost contribution, and considering ways to expedite the flow of funds after the award, including setting up agreements with fewer stage gates or milestones.	Med-Low	Med-High	Lengthy & Constraining Grant Application Processes
						Unclear Funding Agencies' Success Criteria
						Tech Innovator Skillset Gaps
	S12	Partnership Intake Program Portal Improvements	Clarity should be provided on ERA's website around the intake and eligibility criteria for the PIP. Though it is displayed as a "Current Opportunity" for technology funding, it is not clear what the process for being able to access the funds available through the PIP is. If innovators need to go through the Trusted Partner network first to be involved with ERA (if there is not an open call specific to their tech they can apply for), this should be articulated better. ERA could list specific requirements that make an innovator eligible for PIP funds or be more descriptive about innovators approaching Trusted Partners before being considered for the PIP.	Low	Med-Low	Ecosystem Complex & Uncoordinated
						Unclear Funding Agencies' Success Criteria
	S13	Continuous Intake Program Expansion	To enable more frequent and flexible submission of applications for clean technologies projects, ERA should consider expanding the budget for its continuous intake program as well as provide an opportunity for innovators without referrals from Trusted Partners (i.e., for those not eligible for the Partnership Intake Program (PIP)) to apply for funds. ERA could still apply the desired eligibility criteria to initially screen applicants that aligns with ERA's strategic objectives.	Med-Low	Med-High	Lengthy & Constraining Grant Application Processes
	S14	Grant Agreement Terms Flexibility	In granting agreements, exchange funder's blocking rights and IP rights in the case of tech company being sold in the future with a claw back (with interest) solution. The intent of this solution would be to promote flexibility and avoid hindrances to exit opportunities, while reducing the financial burden of negotiations on the tech company. Moreover, funders should contemplate expanding the scope of "benefits to Alberta," thereby potentially supporting tech development projects conducted within the province if they continue to contribute to job creation and knowledge generation in Alberta. This flexibility would offer a solution in cases when there are not any partners or sites in AB willing to support tech validation/pilot/demo projects, driving tech companies to construct their projects elsewhere.	Med-Low	Med-High	Intellectual Property Protection
						Lengthy & Constraining Grant Application Processes
						Resource-Intensive Tech Validation
						Boom-Bust Cycles of Potential Adopters

	S15	Project Close Out	Following projects or project's stages of progression, evaluating lessons learns to facilitate ongoing improvement and accountability of grant money use would give additional oversight to funder/lender and reflection to innovator.	Low	Med-Low	Investors & Funders Knowledge Gaps Tech Innovator Skillset Gaps
Skills & Capacity Building	**S16**	Innovator Collaboration Incentives	Establish a program to incentivize innovators to co-develop technology and create mutual beneficial partnerships. This could include funding organizations encouraging companies developing related (adjacent), or complementary technology to work together by offering funding incentives for such collaborations. Funding organization would identify companies ideal for collaboration based on recommendations from subject matter experts. These experts, leveraging grant application reviews and meticulous due diligence, would identify where two or more companies possess the potential to complement one another (for example, one technology may satisfy a value chain element required by another company), thereby enhancing the likelihood of commercialization success for all parties involved.	Med-Low	Med-Low	Network-Based Opportunity Access Tech Innovator Skillset Gaps Use Case Knowledge Gap Ecosystem Complex & Uncoordinated Intellectual Property Protection Surplus of New Tech
	S17	Embedded Advisors	ERA should consider employing expert "Technology-to-Market Advisors" or “Embedded Advisors” to proactively provide guidance and mentorship to start-up technology innovators throughout the execution of ERA-supported projects. These advisors, sourced from ERA personnel or external specialists (directly compensated by ERA), would maintain regular interaction with proponents as a condition of the funding. The Embedded Advisors’ responsibilities would include holding proponents accountable for milestones, providing advice on techno-economic aspects, and offering support in areas where innovators lack expertise.	Med-Low	Med-High	Tech Innovator Skillset Gaps Network-Based Opportunity Access Government Policy/Regulatory Flux & Complexity Ecosystem Complex & Uncoordinated
	S18	Innovator Support Program	Establish the Innovator Support Program as an ongoing ERA Initiative to bridge the gap between promising innovators and the expertise they need to enhance their technical and business readiness so that they can be successful in future grant applications. It would be extended to applicants with high potential but insufficient readiness for ERA grants, connecting them with service providers whose compensation is directly paid by ERA based on agreed-upon terms.	Med-High	Med-High	Tech Innovator Skillset Gaps Network-Based Opportunity Access Ecosystem Complex & Uncoordinated
	S19	Project Studios	Provincial and federal governments should consider promoting the establishment of private 'Project Studios' and taking a lead investor role in them. These studios would be designed to identify and evaluate emerging technologies in specific target areas, mitigate risks for the most promising ones, and then develop investable projects using one or more of these technologies to meet specific targets. These projects would be brought to the point of the final investment decision (FID) and then monetized through a buyout or royalty basis, providing returns for the investors.	High	High	Tech Innovator Skillset Gaps First of a Kind (FOAK) Project High Cost & Risk Network-Based Opportunity Access Government Policy/Regulatory Flux & Complexity Resource-Intensive Tech Validation Undervalued Sustainability Benefits Boom-Bust Cycles of Potential Adopters Project Financing Ecosystem Gaps
Aggregation	**S20**	Pan-Canadian Funders Collaboration	ERA could enhance and expand its existing frameworks, currently utilized to engage with organizations like SDTC, NRCan, and ISED, to extend its outreach, influence, and partnership with the various funding organizations across the country. Create a structured framework for ERA to regularly exchange insights and collaborate with similar entities at provincial and federal levels on goal setting and planning. This approach would aim to harmonize goals, enhance shared understanding, and magnify the impact of funding efforts on a wider, national scale.	Low	Low	Ecosystem Complex & Uncoordinated Investors & Funders Knowledge Gaps Unclear Funding Agencies' Success Criteria
	S21	Technology Portfolio & Success Marketing	Increase the public/adopter accessibility and marketing of success stories of ongoing ERA projects/technologies while educating stakeholders about the fact that technology development is a game of probabilities/a numbers game. Highlighting successful commercialization stories with government funding, maintaining a public list of supported technologies, and communicating openly about the realities of success rates could address risk aversion and encourage persistence in achieving breakthroughs. This could be achieved via a portal managed and updated by ERA on their website, using the data that they already collect from their past/ongoing projects.	Med-Low	Med-High	Culture of Risk Aversion and Fear of Failure Surplus of New Tech Ecosystem Complex & Uncoordinated

	S22	Clean Growth Hub Integration	Improve ERA's collaboration and connectivity with federal-level programming by better integrating with the Clean Growth Hub. Steps to achieve this could involve adding direct links to ERA's programs and services on the Clean Growth Hub website, ensuring Clean Growth Hub advisors are aware of ERA's mandate, services, and funding, and establishing a regular presence of ERA staff within Clean Growth Hub operations and/or vice versa.	Med-Low	Low	Ecosystem Complex & Uncoordinated
	S23	Clean Tech Noise Filtering	ERA (or some other organization) could consolidate comprehensive information on innovator's tech and connections within the ecosystem to be the authority on who/what exists and filter the noise for adopters looking for new tech, agnostic of industry but filterable by industry, etc. Potential adopters being able to easily realize what new technologies exist could increase uptake all around. This could be a portal managed exclusively by ERA for industry information or a partnership between ERA and organizations that already provide this service. Through ERA's Trusted Partners, it may be possible to create and maintain a consolidated index of ongoing projects, featuring details such as progress, funding, target industries, and more, which would be regularly updated. Partners could submit monthly (frequency to be determined) status updates to ERA for publication.	High	Med-Low	Investors & Funders Knowledge Gaps
						Surplus of New Tech
						Ecosystem Complex & Uncoordinated
	S24	Clean Tech Funding One-Stop-Shop	Establish a single entity that companies can go to for all funding asks and ecosystem support services, regardless of TRL, industry, or location. That entity would be responsible for identifying which funding programs (at all government levels) would be best suited for the given case and act as the "middleman" between the proponents and funding programs. Key objectives of this approach would be to 1) maximize the chance of effective and coordinated deployment of available funds, 2) limit the occurrence of companies burning cash on applications that are not suitable for them, and 3) ensure all technology proponents and potential adopters are aware of all government-sponsored services available across the country. It could also offer tutorial sessions on the ecosystem. It would expand on the Clean Growth Hub concept yet offer enhanced comprehensiveness and improved navigation by encompassing all TRLs across every province and territory, functioning as a unified advisory center and one-stop-shop.	High	Med-Low	Lengthy & Constraining Grant Application Processes
						Unclear Funding Agencies' Success Criteria
						Ecosystem Complex & Uncoordinated

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