



FOCUSING ON OUTCOMES: AN ACTION PLAN FOR CLIMATE LEADERSHIP INNOVATION

FEBRUARY, 2018

albertainnovates.ca

LETTER FROM THE CEO



Alberta Innovates (AI) is evolving to meet the future challenges in the province, ensuring that every dollar invested in innovation and research supports the social health and well-being of Albertans and delivers economic diversification and job growth. This Action Plan clearly outlines AI's roles and actions to support the Alberta Climate Leadership Plan (CLP), Climate Change Innovation and Technology Framework (CCITF) and the Alberta Research and Innovation Framework (ARIF).

Related to climate leadership, AI's objective is to ensure Alberta's success in a low carbon economy. This requires strong partnerships between academia, industry, entrepreneurs and government. The partnership between AI and Emissions Reduction Alberta (ERA) is one clear example of the power of working together to achieve shared strategic and operational goals. ERA's portfolio, like AI, includes programs that will address Alberta's climate leadership priorities. The partnership provides the innovators and technologies we fund with a simple means of accessing both organizations resources and support.

As Canada's largest provincial research and innovation corporation, AI facilitates access to cross-sector knowledge and expertise, funding, networks and research facilities. AI's key market sectors include bio-industry, clean energy, health, and emerging technologies. This Action Plan is specific to AI's activities related to climate leadership innovation.

Our approach in support of Alberta's CLP is on three key priorities:

1. Building capacity by developing and attracting highly qualified personnel
2. Developing technology programs that lead to commercialization of clean technologies
3. Providing entrepreneurial and business support that connect innovators to customers.

Moving forward, we'll report on meaningful and relevant performance indicators, clear project milestones, and performance metrics that articulate outcomes.

Sincerely,

Laura Kilcrease,
CEO, Alberta Innovates

EXECUTIVE SUMMARY

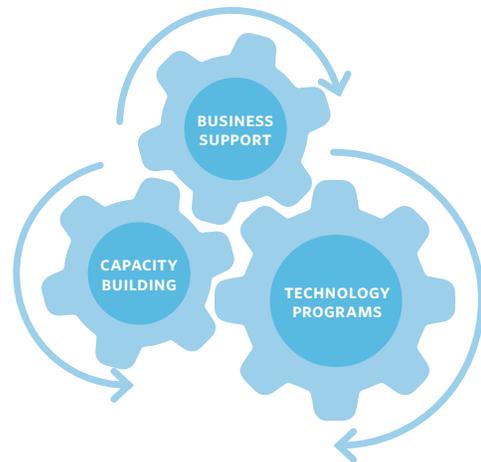
Alberta Innovates (AI) has developed an action plan for innovation to support the Government of Alberta's (GoA) Climate Leadership Plan and Climate Change Innovation and Technology Framework (CCITF). The Climate Leadership Plan is a made-in-Alberta strategy to reduce carbon emissions while diversifying our economy and creating jobs. The key aspects of the Climate Leadership Plan (CLP) include:

- implementing a new carbon price on greenhouse gas (GHG) emissions
- ending pollution from coal-generated electricity by 2030
- developing more renewable energy
- capping oil sands emissions to 100 megatonnes per year
- reducing methane emissions by 45 per cent by 2025.

Specific to innovations for the CLP, the GoA has established CCITF, with a vision, strategic goals, purpose, and implementation principles. The GoA has also developed the Alberta Research and Innovation Framework (ARIF) to guide research and innovation initiatives in Alberta.

AI is a catalyst for innovation. AI works with GoA departments, post-secondary institutions, entrepreneurs, industry, and other research and innovation agencies, to accelerate innovation to achieve prosperity for Alberta in a low carbon economy. AI's Action Plan will focus on three priorities to achieve Alberta's CLP goals:

1. **Capacity Building:** Build innovation capacity including and highly qualified people (HQP) and infrastructure for clean innovation
2. **Technology Programs:** Identify, organize, and support the development and commercialization of clean technologies
3. **Entrepreneurial and Business Support:** Help entrepreneurs and small and medium enterprises (SMEs) become successful in low carbon economy.



The goals of AI's innovation programs are to reduce GHG emissions, increase GDP, create jobs, and diversify the economy in Alberta. AI's technology programs include:

- Clean Oil and Gas Production
- Renewable Energy and Energy Storage
- Industry Energy Efficiency
- Biological GHG Management
- Green Products and Services.

As AI's technology programs advance, existing industry sectors such as energy, forestry, and agriculture will become more competitive. It is anticipated new cleantech industries will also emerge.

AI will strengthen and leverage partnerships as a strategic approach to achieve our goals. AI and Emissions Reduction Alberta (ERA) have a very strong partnership for delivering innovative solutions in support of the CLP. This partnership provides innovators with a simplified means for accessing resources and support in Alberta. AI's other key partners include:

- Canada's Oil Sands Innovation Alliance (COSIA)
- Petroleum Technology Alliance of Canada (PTAC)
- Natural Resources Canada (NRCan) and CanmetEnergy
- Sustainable Development Technology Canada (SDTC)
- Post-secondary institutions such as the Universities of Alberta and Calgary.

To advance national partnerships, AI has been contributing to the Clean Resource Innovation Network (CRIN) supercluster development. CRIN's vision is that Canada is the global leader in producing clean hydrocarbon energy from source to end use. This vision is highly aligned with Alberta's CLP.

To assess the progress and performance of AI's Action Plan for Climate Leadership Innovation, a Performance Management and Evaluation (PME) plan is in development. The methodology will include mixed methods and multiple data sources to assess the outcomes of investments across the research and innovation continuum. Outcome measures will be collected annually to track progress and additional indicators and measures will be collected through periodic scheduled evaluations and case studies to assess and communicate outcomes achieved. Section 5 of this report outlines the approach and a placeholder for success indicators. This PME plan aligns to the overarching AI PME plan that covers all sector strategies.

AI is an integral player in Alberta's research and innovation system and consequently will be working together with our partners (Economic Development and Trade, ERA and the Alberta Climate Change Office) to make certain the PME plan and its measures also support the CCITF. This collaborative approach will allow AI to establish baseline performance and benchmark the organization's performance with other organizations.

TABLE OF CONTENTS

1. ALBERTA INNOVATES	5
1.1 Corporate Vision and Mandate	
1.2 Alberta's Innovation System	
1.3 Purpose of this Action Plan	
2. STRATEGIC CONTEXT FOR CLIMATE LEADERSHIP	7
2.1 Alberta's Greenhouse Gas Emission Profile	
2.2 Alberta Research and Innovation Framework (ARIF)	
2.3 Alberta's Climate Leadership Plan	
2.4 Climate Change Innovation and Technology Framework	
2.5 Emissions Reduction Alberta	
2.6 Alberta Innovates' Priorities for Innovations an Climate Leadership	
3. STRATEGIC PRIORITIES	13
3.1 Capacity	
3.2 Technology Programs	
P1: Advanced Hydrocarbons	
P2: Renewable Energy and Energy Storage	
P3: Energy Efficiency	
P4: Bioenergy and Biological Processes	
P5: Green Products and Services	
3.3 Entrepreneur and Business Support	
4. ACCELERATING INNOVATION IN CLIMATE LEADERSHIP	19
4.1 Market-Centric and User Driven	
4.2 Portfolio Approach	
4.3 Collaborative Partnerships	
4.4 Agile and Nimble Business Processes	
4.5 Resource Allocation	
5. MEASURING SUCCESS	22
5.1 Implementation Approach	
5.2 Measurement - Outcomes Framework	
5.3 Reporting	
APPENDIX I - TECHNOLOGY READINESS LEVEL	24
APPENDIX II - ALBERTA INNOVATES' SIMPLIFIED OUTCOMES PATHWAYS FOR CLIMATE LEADERSHIP INNOVATION	25

1. ALBERTA INNOVATES

1.1 CORPORATE VISION AND MANDATE

The November 1, 2016, consolidation of the four predecessor Alberta Innovates (AI) corporations—Bio Solutions, Energy and the Environment Solutions, Health Solutions, and Technology Futures—was driven by the need to bring focus and improve demonstrable outcomes from the provinces’ investment in innovation. The consolidation offers the opportunity to leverage cross-sectoral expertise, formerly embedded in each corporation, and to achieve shared outcomes more efficiently. This benefits the Corporation and our partners by better leveraging research and innovation capacity and over time will streamline access to funding and other support services by providing a single point of entry to innovators.

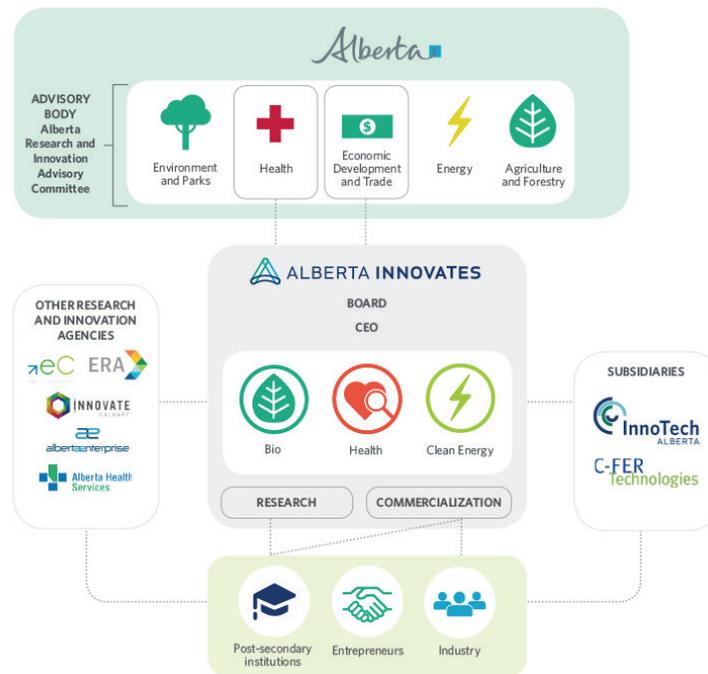
AI and the Ministry of Economic Development and Trade (EDT) have developed a new corporate vision, mandate and values for the single consolidated AI. These were established collaboratively to reflect a common understanding of the respective roles, responsibilities and accountabilities between EDT and AI. They also respond to the need for a new approach to support and enhance innovation capacity and opportunities in the province, and reflect the partnership mindset AI will pursue going forward.

The vision of Alberta Innovates is to be indisputably recognized as a leader—provincially, nationally and internationally—in catalyzing research and innovation. The objective of the Corporation is to support research and innovation activities aligned with Government of Alberta priorities in areas such as agriculture, forestry, energy, health, environment and others. Fostering the development and growth of new and existing industries through research and innovation is another major objective of the Corporation.

1.2 ALBERTA’S INNOVATION SYSTEM

As a part of Alberta’s innovation system, AI works with Government of Alberta (GoA) departments, post-secondary institutions, entrepreneurs, industry, and other research and innovation agencies (Figure 1). Related to Alberta’s climate leadership, the GoA departments set policy objectives, strategies, and frameworks. AI and Emissions Reduction Alberta (ERA) are two key agencies and strategic partners for delivering innovation solutions. AI and ERA closely coordinate their funding programs, including stewardship between these programs. In greenhouse gas (GHG) reduction technologies, for example, AI tends to focus on earlier stages, at technology readiness levels (TRL) 1-6. ERA tends to focus on technologies at TRL 4-8. Appendix I shows the TRL definition used by AI and Emissions Reduction Alberta (ERA). There is a seamless project handover between AI and ERA where early-stage projects supported by AI move into later-stage development supported by ERA. AI also provides ERA the additional services they require for planning, program adjudication, and project management.

Figure 1. Alberta's innovation system



1.3 PURPOSE OF THIS ACTION PLAN

AI's innovation covers Alberta's key sectors in bio-industry, clean energy, health and emerging technologies. This Action Plan provides a clear statement of AI's role in innovation in support of Alberta's Climate Leadership Plan (CLP). It describes AI's critical position in the innovation ecosystem related to climate leadership; its focus in innovation programs, capacity building, and entrepreneurial and business support; its strategic approach to accelerating innovation; and its performance measurement system for success. The plan clearly outlines how AI is to work with key partners under the Climate Change Innovation and Technology Framework (CCITF), and contribute to the goals and objectives of Alberta's CLP.

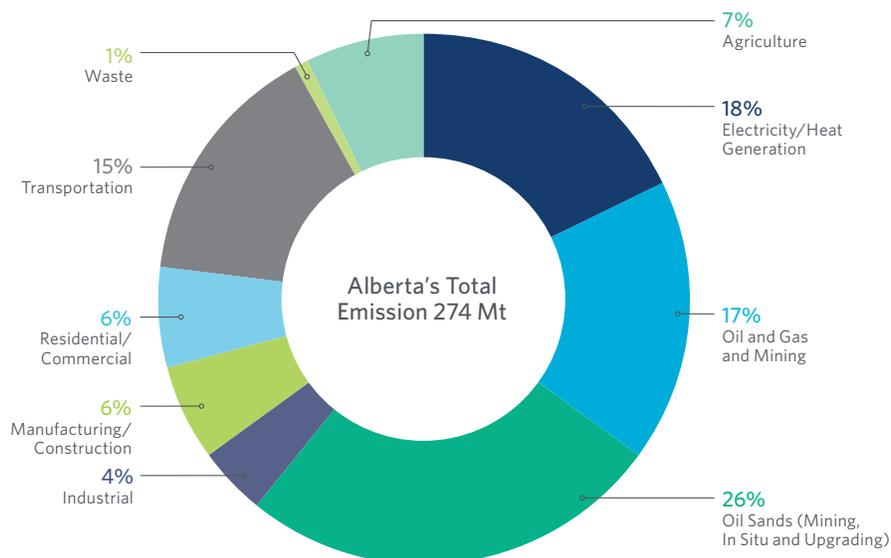
2. STRATEGIC CONTEXT FOR CLIMATE LEADERSHIP

2.1 ALBERTA'S GREENHOUSE GAS EMISSION PROFILE

In 2015, Alberta greenhouse gas (GHG) emissions were 274 mega tonnes (MT), approaching 38 per cent of Canada's total emissions. The oil sands, electricity and oil and gas sectors together account for over 60 per cent of the total GHG emissions in Alberta (Figure 2). Transportation, agriculture, forestry and waste, buildings and houses, and manufacturing and construction are also significant GHG emissions contributors.

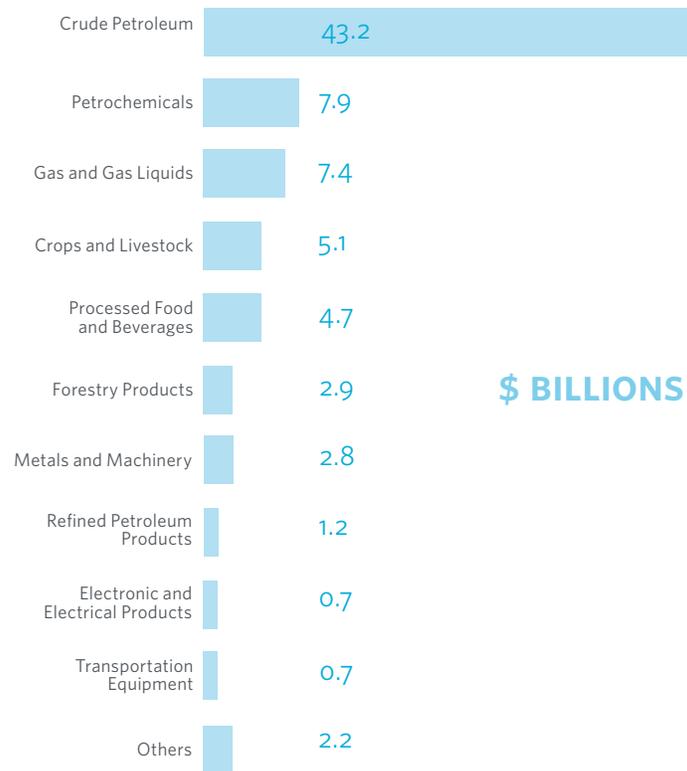
The oil and gas sector is the greatest contributor to Alberta's economy, accounting for 25.5 per cent of Alberta's GDP in 2014, and 16.4 per cent in 2016. This is the direct GDP from the energy sector and does not include the indirect impact on construction, manufacturing, finance and real estate, and business and commercial services. The oil and gas sector's impact on Alberta's economy is best illustrated by the value of its exports. Total exports from crude petroleum, gas and gas liquids, petrochemicals, and refined petroleum products were \$59.7 billion, accounting for 75.8 per cent Alberta's total export (Figure 3).

Figure 2. Alberta's GHG emission in 2015



Note: Total emission in 2015: 274 million tonnes (MT) CO₂e. Compiled by Alberta Climate Change Office, based on data from 2017 Canadian National Inventory Report.

Figure 3. Alberta's major exports 2016



There is potential for GHG emission reductions across the economy with GHG emission reductions in energy sectors being the most critical. The challenge for Alberta is to reduce GHG emissions in such a way that its economic pillar will remain strong while continuing to grow a more diverse and broader economy. The Government of Alberta has developed several strategic documents to help position Alberta to reduce GHG emissions and grow its economy. These are described briefly in the next sections. While energy is a key sector, Alberta Innovates (AI) will also pursue emissions reductions in other sectors.

2.2 ALBERTA RESEARCH AND INNOVATION FRAMEWORK (ARIF)

The Government of Alberta has developed the ARIF to guide the research and innovation initiatives in Alberta. ARIF seeks to focus research and innovation to outcomes in:

- Economic Diversification and Job Creation
- Environmental Stewardship and Climate Leadership
- Effective Resource Management
- Engaged Individuals and Communities for a Healthy Alberta.

ARIF establishes aspirational innovation targets through five government wide collaboratories in energy, environment, food, fibre, and health. The 2030 innovation targets in Energy, Environment, and Emerging Technologies are most relevant to the Climate Leadership Plan (CLP).

2030 Targets for Energy and GHG Mitigation:

- **Reduce GHG Emissions:** Support Alberta's climate change goals by accelerating solutions to reduce methane emissions by 45 per cent by 2025 and ensure a dynamic portfolio of GHG emission reduction technologies (2014 base)
- **Increase Value and Market Access:** Support the successful commercialization of new value-added products to increase the market value of Alberta's oil and gas exports by 25 per cent and expanding access to market
- **Improve Oil Sands Efficiency:** Oil sands production efficiency and economics improve by decreasing fresh water use by 50 per cent, GHG emissions by 50 per cent on a per bbl basis, and supply cost of bitumen to be globally competitive
- **Renewable Energy:** Renewable sources, like wind and solar, will contribute 30 per cent of Alberta's electricity generation.

2030 Targets for Environment and Climate Adaptation:

- **Conserving Biodiversity:** Biodiversity is maintained or enhanced at levels relative to reference conditions
- **Restoring Alberta's Landscapes:** Reduce landscape disturbance intensity by 20 per cent and accelerate reclamation of disturbed lands to promote native habitat and species recovery
- **Sustainable Water Management** Safe, secure, and reliable water resources, while enhancing the health of the aquatic ecosystems and improving overall water use efficiency by 30 per cent (2010 base).

2030 Targets for Emerging Technologies:

- **Grow Alberta's Green Economy:** Support the Cleantech sector to increase industry sales revenue by 25 per cent, thereby increasing Alberta's global market share by 20 per cent
- **Advanced Manufacturing and Materials:** The value of Alberta's manufacturing sector will increase from \$18.8 billion to \$40 billion through the development of advanced materials, instrumentation, and repurposing jobs (2014 base)
- **Digital Economy:** The ICT industry in Alberta generates more than \$20 billion in annual revenues and the province is the best in Canada for digital literacy and connectivity.

In addition, the waste reduction 2030 Target in Fibre and Bio-industry is also relevant. It aims for a 50 per cent reduction in organic waste to landfill through innovative technologies which produce value-added products.

2.3 ALBERTA'S CLIMATE LEADERSHIP PLAN

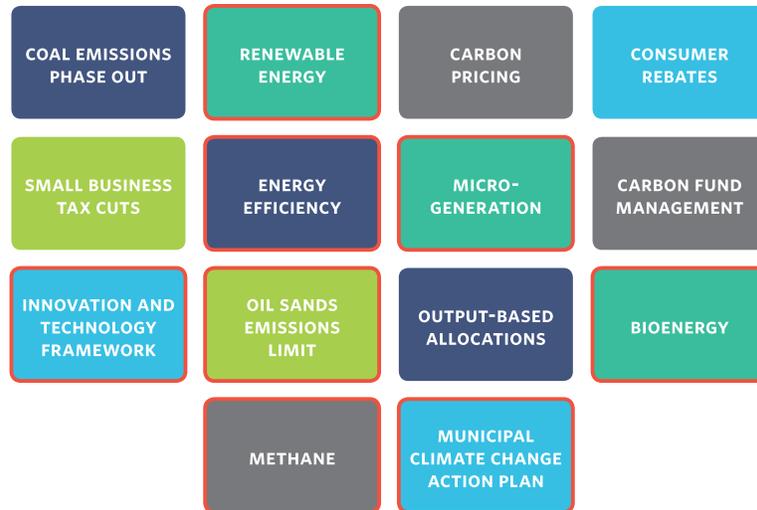
The CLP is a made-in-Alberta strategy to reduce carbon emissions while diversifying our economy and creating jobs. The plan is developed based on recommendations put forward by the Climate Leadership Advisory Panel. The CLP is designed specifically for Alberta's unique economy. The key aspects of the plan are:

- Implementing a new carbon price on greenhouse gas emissions
- Ending pollution from coal-generated electricity by 2030

- Developing more renewable energy
- Capping oil sands emissions to 100 megatonnes per year
- Reducing methane emissions by 45 per cent by 2025.

Government of Alberta is pursuing at least 14 initiatives within the CLP (Figure 4). AI will focus on innovations related to Innovation and Technology Framework, renewable energy, energy efficiency, oil sands emissions limit, methane reduction, micro-generation, and bioenergy.

Figure 4. Government of Alberta CLP Priority Initiatives.
Alberta Innovates will focus on the initiatives outlined in red



2.4 CLIMATE CHANGE INNOVATION AND TECHNOLOGY FRAMEWORK (CCITF)

The Climate Change Innovation and Technology Framework is a priority initiative in Alberta’s CLP. It is based on the recommendations put forward by the Climate Technology Task Force. The framework contains a vision, strategic goals, purpose, and implementation principles. It is intended to position Alberta to:

- Meet or exceed the objectives of the CLP
- Enable a diverse, high-value, lower carbon economy, supporting sustainable economic growth and jobs
- Become a leader in the development and deployment of globally competitive clean technology in areas relevant to Alberta such as energy transition
- Enhance the performance of the innovation system.

The framework identifies seven pathways to a low carbon economy in Alberta (Figure 5):

- Lower carbon electrical system
- Energy efficiency solutions
- Holistic water management
- Sustainable waste management
- Cleaner oil and gas development

- Sustainable mobility
- Green products and services.

Although organized differently, AI's technology programs described in Section 3 match well with these lower carbon economy pathways.

Figure 5. Seven pathways to a low carbon economy in Alberta, identified in CCITF



2.5 EMISSIONS REDUCTION ALBERTA (ERA)

ERA was created in 2009, as the Climate Change and Emissions Management Corporation (CCEMC) to support Alberta's climate change goals. ERA was rebranded in 2016, to make it clear that the organization is part of Alberta's climate change efforts and to better reflect ERA's mandate, which is to identify and accelerate innovative solutions that secure Alberta's success in a lower carbon future.

ERA's 2017 - 2020 Business Plan identifies four strategic priorities:

- **Accelerate GHG reducing technologies:** fund innovative solutions that result in meaningful GHG emissions reductions in Alberta and contribute to a lower carbon world
- **Advance innovation system priorities:** Leverage our strengths to contribute to critical climate change innovation priorities in Alberta
- **Measure and communicate success:** Define and report on metrics to demonstrate results
- **Advance operational excellence:** Strive for excellence in operations and efficiency while maintaining responsiveness to stakeholders and funders.

ERA has identified four areas of focus in its technology road map:

- Transformative technologies and innovation to reduce the GHG footprint of the fossil fuel supply chain and reduce methane emissions while reducing production costs
- Technology and innovation to reduce the GHG footprint of Alberta's electricity supply mix and add more non-emitting supply to meet overall demand
- Innovation and early stage technologies for biological resource optimization in supporting energy system transformation, such as biofuels/bioproducts and carbon retention opportunities

- Industrial process efficiency technologies to deliver GHG reductions through opportunities such as energy conservation and energy efficiency.

Like AI, ERA's portfolio includes projects that will address Alberta's climate leadership priorities and 2030 Innovation Targets. ERA invests in solutions that industry needs to address the problems Alberta must solve today, while also seeking out transformative technologies to address Alberta's largest sources of GHG emissions over the longer term.

The ongoing partnership between AI and ERA is critical to achieving shared strategic and operational goals. More importantly, the partnership provides the innovators and technologies we fund with a simplified means for accessing our resources and supports.

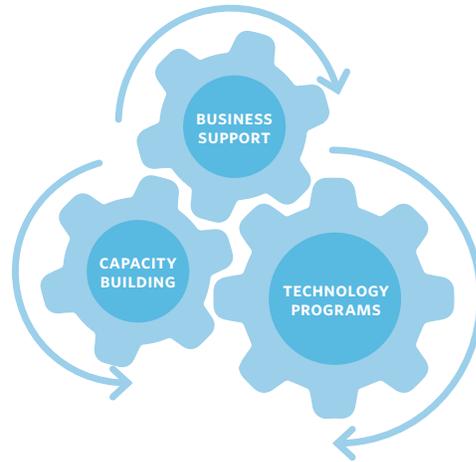
2.6 ALBERTA INNOVATES' PRIORITIES FOR INNOVATION IN CLIMATE LEADERSHIP

From the strategic context review above, it is evident that the Government of Alberta (GoA) has a comprehensive and clear strategy for climate leadership. The GoA's goal is to grow a strong low carbon economy. Technology and innovation is a key strategy to achieve that goal. As a catalyst for innovation, AI's objective is to support research and innovation activities aligned with GoA priorities. Specific to climate leadership, AI's objective will be to accelerate innovation to ensure Alberta's success in a low carbon economy. AI's will work with our key partners in the innovation system to accomplish the objective.

3. STRATEGIC PRIORITIES

Several government departments and agencies, private companies, and post-secondary institutions are working on the initiatives towards the goals of Alberta's Climate Leadership Plan (CLP). Alberta Innovates (AI) will focus on accelerating innovations to a lower carbon economy. We will focus on three priorities:

1. **Capacity Building:** Build innovation capacity including highly qualified people (HQP) and infrastructure for clean innovation
2. **Technology Programs:** Identify, organize, and support the development and commercialization of clean technologies
3. **Entrepreneurial and Business Support:** Help entrepreneurs and small and medium enterprises (SMEs) become successful in low carbon economy.



In addition, AI provides critical technical support for several key Government of Alberta policies and strategies related to CLP including:

- **Energy Diversification Advisory Committee (EDAC).** EDAC explores opportunities to diversify Alberta's energy sector, create jobs and stimulate investment by adding value to our energy resources.
- **Oil Sand Advisory Group (OSAG).** OSAG advises government on the oil sands aspects of the Climate Leadership Plan.
- **Methane Reduction Oversight Committee (MROC).** MROC helps to develop recommendations and options to inform cost-effective regulations for new and existing facilities in the oil and gas sector.
- **Economic Development and Trade's (EDT) Clean Technology Roadmap (CTR).** CTR helps set a course towards development of the regional cleantech sector, offering coordinated and impactful initiatives across multiple sectors.

3.1 CAPACITY (PEOPLE AND INFRASTRUCTURE)

AI will build capacity to achieve Alberta's climate leadership goals. The capacity will include cleantech HQP, entrepreneurs, and infrastructure. AI will support cleantech HQPs and entrepreneurs through its programs in post-secondary institutions and industry associate program. Our senior technical and management staff will also offer guest lectures for a cleantech class and short courses.

A key strength in Alberta lies in some of the existing expertise and HQPs in areas that can potentially cut across multiple sectors or innovative programs. This expertise includes digital and ICT technologies (like artificial intelligence), nano-enabled sensors and communications systems, and genomics, which can play a key role in optimizing biological greenhouse gas (GHG) management. AI will leverage existing

mechanisms, such as networking and development grants and strategic research project funding, as well as develop new methods, to ensure that HQPs are knowledgeable of Alberta's challenges in climate leadership. This approach will formally engage HQPs to target their expertise and infrastructure to these priorities. Additionally, AI funded centres and facilities, such as the nanoFab at the UofA, TECTERRA, AMII, and the Alberta Centre for Advanced Micro/Nano Technology Products (ACAMP), support researchers and industry in developing and deploying novel and emerging technologies, many of which have applications within this strategy's identified innovation program areas.

In infrastructure related to climate leadership, AI will focus on two centres:

- **Center for Biowaste and Methane Conversion Technologies (CBMCT):** The Centre is designed to extend the activities of the existing Alberta Innovates' W2VA initiative, which helps Alberta's municipalities and waste sector to evaluate and select technologies that best meet their individual needs, and also expand its scope to include the activities that add value to methane feedstock. The initial two years of operation will focus on testing the pre-commercial technologies that convert biowaste and methane to biofuel. AI will coordinate the bioenergy related initiatives and the natural gas conversion activities in Alberta (e.g., Future Energy System Research Institute at the University of Alberta, InnoTech Alberta, CANMET Energy in Devon and Clean Tech Centre in Drayton Valley) as well as the activities under the Canadian Biofuels Network. It would make use of the expertise and infrastructure of the existing Advanced Energy Research Facility (AERF) and the Edmonton Waste Management Center Excellence (EWMCE) facility. The long-term goal of the CBMCT is to become a world-class centre for development, demonstration and deployment of biowaste and methane conversion technologies/solutions, as well as train personnel for constructing and operating the biowaste and methane conversion facilities in Alberta.
- **Alberta Carbon Conversion Technology Centre (ACCTC):** AI and InnoTech will partner with industry and industry associations to build, own and operate scaled facilities that will reduce the risk of investment at the next stage of commercialization. Jointly funded by federal and provincial governments, and situated at the Shepard Energy Centre in Calgary, the center will test the capture and conversion of a CO₂ stream from a gas fired power plant at a semi-commercial scale (five bays x five tonnes/day). The initial two years of operation will serve as the test location for Canada's Oil Sands Innovation Alliance (COSIA)/X-Prize carbon conversion competition winners, after which the centre will serve as a hub to test technologies sourced internationally. Demonstration of capture and conversion technology at this scale will accelerate the adoption of these by the oil and gas sector, and accelerate emissions reduction.

In addition, AI is also developing three other testing facilities:

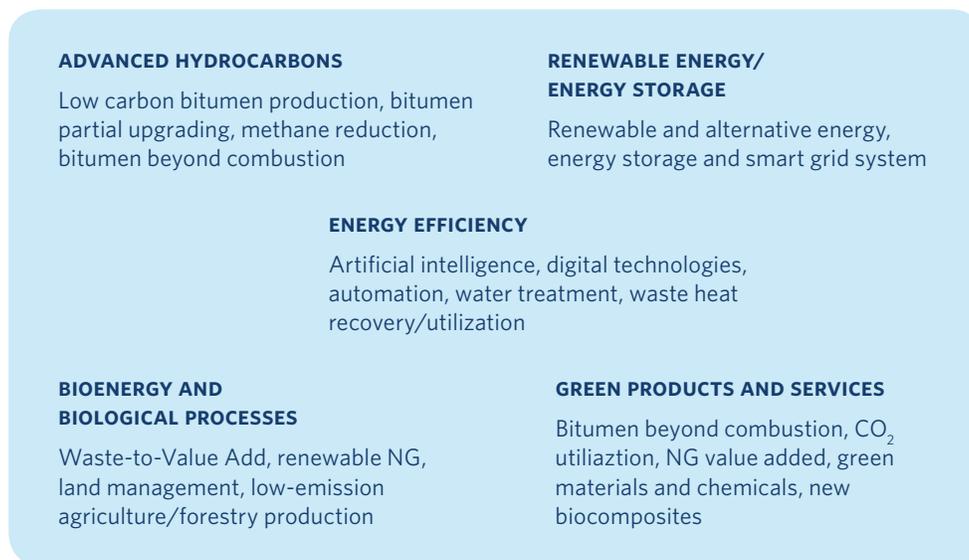
- **MicroGrid and Grid Modernization Centre:** The purpose of the facility is to support research for the design, operation, capability and impact of distributed generation and microgrids. The facility also provides a development and testing platform for researchers, technology developers and utilities working to advance technologies applicable to grid modernization. To achieve this, it is necessary to have a facility that allows both simulation systems and hardware demonstrators.
- **Methane Emissions Reduction Test Facility:** This will be a dedicated testing facility in Alberta to demonstrate technologies that can detect, quantify and reduce methane emissions. It will attract innovators to the province to develop technologies and ensure they are suitable to meet Alberta's unique methane challenges.

- **Oil Sands In Situ Technologies Test Facility:** This will be an industry-led facility to test new in situ recovery technologies that improve efficiency, reduce GHG emissions, and increase value and market access. The facility will allow new technologies to be deployed quickly in the field without disrupting operations at individual production sites and may accelerate the innovation required to move the needle on environmental performance. To be effective and efficient, this kind of facility should be industry-led with government support to ensure access and knowledge dissemination across industry.

3.2 TECHNOLOGY PROGRAMS

AI has identified five clean technology programs that can have significant impacts on GHG emissions reduction, economic development, and diversification in Alberta (Figure 6). Each program consists of multiple projects and initiatives. The programs are meant to be dynamic, with new projects coming and old ones going when appropriate.

Figure 6. Alberta Innovates programs for Climate Leadership Plan



Program 1: Advanced Hydrocarbons

GOAL: Advanced Hydrocarbons program covers the innovation from production to the end use of hydrocarbons. The program goal is to develop technologies that will:

- Accelerate solutions to reduce methane emissions by 45 per cent by 2025
- Improve oil sands production efficiency: reducing GHG emission intensity and fresh water use by 50 per cent, and supply cost of bitumen to be globally competitive by 2030
- Commercialize new value-added products to increase the market value of Alberta’s oil and gas exports by 25 per cent by 2030.

KEY ACTIONS: To achieve the program goal, AI will take following key actions:

- Accelerate the development and deployment of technologies in oil sands production. The focus will be on solvent-based (for both surface mining and in situ), steam-solvent hybrid (for in situ), or solvent-water hybrid (for surface mining) technologies. Electromagnetic heating and direct contact steam generation technologies will also be pursued. Technology innovation has the potential to reduce GHG emissions in in situ oil sands production by more than 15 megatonnes (MT) by 2030

(Final Report to the Government of Alberta - OSAG Recommendations on Innovation in the Oil Sands Sector, 2017). It will also make bitumen production more cost competitive and reduce water use.

- Accelerate the development and commercialization of bitumen partial upgrading (BPU) technologies. BPU adds value to bitumen in Alberta and reduce GHG emissions on well-to-tank life cycle. BPU increases market access of bitumen, and reduces or eliminates the need for diluent for transportation. BPU technologies have the potential to increase Alberta's GDP by billions of dollars and at the same time reduce GHG emissions by 2-5 megatonnes by 2030.
- Support our partners in the development and deployment of methane detection, monitoring, and emission reduction technologies. The partners include ERA, Petroleum Technology Alliance of Canada (PTAC), Natural Resources Canada (NRCan), and Canadian Gas Association (CGA). About 70 per cent or 20 MT CO₂ equivalent of total methane emission in Alberta comes from oil and gas sector.
- Lead the development and demonstration of natural gas value added technologies. AI is currently working on methane to benzene and hydrogen technology.
- Lead the development, demonstration, and deployment of bitumen beyond combustion (BBC) technologies. BBC has a synergy with BPU in short and medium terms, and may create an entire new industry in a low carbon economy for Alberta's bitumen and heavy oil resource.
- Explore innovation opportunities in tight oil and gas development to ensure development is sustainable.

In total, the Clean Oil and Gas Production Program has the potential to deliver over 35 MT GHG emissions reduction per year by 2030.

Program 2: Renewable Energy and Energy Storage

GOAL: Alberta's CLP mandates 30 per cent of electricity will be generated by renewable energy.

The goal of the Renewable Energy and Energy Storage program is to ensure technologies are available so with 30 per cent or more renewable energy, Alberta's electric system remains reliable and cost-competitive. In addition, locally generated geothermal energy, energy storage, and smart grid technologies will contribute to economic diversification in Alberta.

KEY ACTIONS: AI will take following key actions to achieve program goals:

- Accelerate the development and deployment of energy storage technologies. This will include energy storage technologies for introducing more renewable energy into Alberta's electricity system. It will also include the development and commercialization of energy storage materials, devices, and systems for export.
- Accelerate innovation in smart grid systems, grid modernization, and distributed generation.
- Develop geothermal and biomass energy technology for based load renewable electricity and for district and industry heating.
- Explore alternative energy sources, such as nuclear. Small modular nuclear reactors have potential in Alberta and require support for development and commercialization.

In total, the Renewable Energy and Energy Storage programs will ensure over 20 MT GHG emission reduction per year through coal phase-out by 2030.

Program 3: Energy Efficiency

GOAL: AI's Energy Efficiency program will focus on industry processes and commercial facilities. Its goal is to significantly improve the energy efficiency of Alberta's key industries (resource development, chemicals and petrochemicals, manufacturing, etc.) and commercial facilities.

KEY ACTIONS: AI will take following key actions to achieve program goals:

- Demonstrate and deploy artificial intelligence, automation, and digital technologies to take industrial energy efficiency into another level. AI's industrial energy efficiency programs will focus on applying these new digital technologies to improve efficiency in the entire value chain. For example, in the oil and gas sector, digital technology can improve drilling and completions, reservoir planning, production optimization, facility optimization, and pipeline operation. The same can be done in water treatment, petrochemical, chemical, and other manufacturing processes.
- Accelerate the deployment of energy efficiency technologies in commercial facilities.

The GHG emission reduction potential of the Energy Efficiency program is yet to be quantified. It is expected to be greater than five megatonnes per year by 2025.

Program 4: Bioenergy and Biological Processes

GOAL: This program will focus on technologies using biological materials or processes for efficient biomass utilization, food production, and biological waste conversion. The program goal is to develop a value-add industry based on biomass, bio-waste, and solid waste in Alberta. At the same time, GHG emission can be reduced.

KEY ACTIONS: AI will take following key actions to achieve program goal:

- Accelerate the development and deployment of Waste-to-Value-add (W2VA) technologies in Alberta. Waste feeds include municipal solid waste, bio-solids, forest waste, agricultural and agri-food waste. Products include electricity, heat, liquid fuel, biochar, biofertilizers and other marketable products.
- Support ground breaking innovations for renewable biofuels production. Alberta has some of the leading innovators in microbial and artificial photosynthesis.
- Modify agriculture and forestry production process and system to reduce GHG emissions and sequester CO₂.

The Bioenergy and Biological Processes program has the potential to reduce GHG emission by more than 10 MT CO equivalent per year.

Program 5: Green Products and Services

GOAL: The goal of this program is to diversify Alberta's economy through developing and exporting "green" products and services.

KEY ACTIONS: AI is still actively exploring the green products and service opportunities. Key actions will evolve over time. At this point, following opportunities have been identified:

- CO capture and conversion technologies
- Green materials and chemicals, and green building materials including massive building components
- New composites, nanocomposites, and biocomposites
- Renewable energy services including geothermal well completions.

The economic impact and GHG emissions reduction potential of this program are yet to be quantified. However, this program could be one of the most effective programs to achieve CLP objectives. An open innovation process will be used to encourage entrepreneurs and SMEs to innovate.

3.3 ENTREPRENEUR AND BUSINESS SUPPORT

AI provides support to help entrepreneurs and SMEs in Alberta to develop and deploy new product and service ideas. These include access to the Technology Development Advisors (TDAs), a group of dedicated coaches and mentors who guide SMEs to the appropriate levels of support regardless of who offers the program or service. The Regional Innovation Network (RIN) offers supports throughout the province in the form of access to programs and services, local networks and innovations system wide supports. Specific industry funding programs include the:

- **Innovation Vouchers** - up to \$100,000 to engage a service provide to help along the path to commercialization
- **Industry Associates** - an employment subsidy where AI will augment the salary of a C-Suite level manager, senior sales support or research specialist for up to two years
- **Product Demonstration Program** - up to \$300,000 to support a demonstration project with a defined end user
- **Global Partnerships Program** - priority jurisdictions that the Government of Alberta has identified for access to regional markets around the globe
- **Alberta Small Business Innovation and Research Initiative (ASBIRI)** provides Alberta's SMEs access to real industry problems. Through partnerships with industry, SMEs gain direct access to market needs and resources that will support the commercialization of novel technological solutions while simultaneously generating material risk-weighted returns to Alberta based on economic, social and environmental metrics.

Although these programs are not specific for GHG reduction, they support entrepreneurs and SMEs in clean technology space.

4. ACCELERATING INNOVATION FOR CLIMATE LEADERSHIP

Alberta Innovates (AI) will accelerate innovation with a focus on commercialization, which is particularly aligned with Alberta’s world-class strengths, contributing tangible outcomes that offer value to Albertans. Related to innovation for Climate Leadership Plan (CLP), AI will focus on:

- Innovation programs that will generate significant greenhouse gas (GHG) emission reductions, GDP growth, and economic diversification
- Capacity building, and entrepreneurial and business supporting systems that will support innovations to achieve the previous three key outcomes.

AI has identified a set of key operational principles and approaches to accelerate innovations for climate leadership, which are described below.

4.1 MARKET-CENTRIC AND USER DRIVEN

AI takes a responsive, market/user-driven approach that enables Alberta’s innovators across current and emerging sectors. The needs of currently strong market sectors, such as energy and petrochemicals, are important but those of emerging sectors, such as cleantech and digital, are equally important. AI will provide an “any entry point” system to meet a range of needs such as:

- Network/partners across the research and innovation continuum
- Funding
- Business/technical expertise and applied research services to de-risk and accelerate research and innovation to the next level for impactful application
- Building capacity of Alberta’s next generation of innovators.

4.2 PORTFOLIO APPROACH

AI takes a portfolio approach to innovation development. We ensure that we have short, medium, and long-term strategies in place, and that we have a continuous stream of innovation in the pipeline. We look at all sectors of the economy for both challenges and solutions. We are considering both renewable and non-renewable resources for successes to the climate change issues. And we know that not all innovations are breakthrough; a series of incremental changes can be as impactful as a new technology. However, this doesn’t imply that AI will do anything and everything. Indeed, AI will target innovations in the key program areas identified in the last section. A portfolio approach will take in these programs. Targeted innovation is an open innovation process applied to a specific program area with clearly defined program goals.

4.3 COLLABORATIVE PARTNERSHIPS

AI will catalyze coordinated approaches to drive outcomes through partnerships across all orders of governments, the private sector (entrepreneurs, SMEs, and industry), academia, and other research and innovation stakeholders. In innovation for Alberta's CLP, AI's key partners include:

- **Emissions Reduction Alberta (ERA).** AI has a very strong partnership with ERA, providing ERA with technical expertise, program adjudication and project management service. AI provides technical advice and progress monitoring to 41 ERA projects and \$227M of ERA's investment. The partnership enables alignment of investment priorities, performance metrics, seamless project hand-offs, and a simplified approach for innovators and technologies to access Alberta innovation supports and resources.
- **Canada's Oil Sands Innovation Alliance (COSIA) and Petroleum Technology Alliance of Canada (PTAC).** AI has a strong partnership with COSIA and PTAC. Our collaborations focus on oil sands and methane reductions.
- **Natural Resources Canada (NRCan) and CanmetEnergy.** AI collaborates closely with NRCan in its Energy Innovation Program, and CanmetEnergy in bitumen partial upgrading, non-aqueous extraction, and oil sands tailings management.
- **Sustainable Development Technology Canada (SDTC).** AI and SDTC jointly fund many clean technology projects and a Water Technology program for SMEs.
- **Ecosystem Services and Biodiversity Network (ESBN).** ESBN represents a broad cross section of experts and players working to stimulate the economy, and improve the environment and human well-being using markets for appropriate ecosystem services and biodiversity, include carbon sequestration and storage. The ESBN is connecting stakeholders, sharing knowledge and building capacity in Alberta. AI leads and coordinates the ESBN.
- **Postsecondary institutions.** AI invests heavily in the Universities of Alberta and Calgary. Related to Climate Leadership, AI is working with both universities on their Canada First Research Excellence Fund (CFREF) programs.
- **The Clean Resource Innovation Network (CRIN) supercluster.** AI has been contributing to CRIN supercluster development. CRIN is a group of innovation practitioners committed to the success of the oil and gas sector, the people and communities that it involves, and supporting a strong, diversified Canadian economy. CRIN has a vision that Canada is the global leader in producing clean hydrocarbon energy from source to end use. It is highly aligned with Alberta's Climate Leadership Plan.
- **AI is also working with other federal departments and networks such as Department of Innovation, and Economic Development (ISED), Western Economic Diversification (WED), and Mitacs.**

In working through collaborative partnerships, AI will be able to leverage funding for cleantech innovations. AI and its partners will also facilitate effective handovers. The research from postsecondary institutions or ideas from entrepreneurs can be developed into technology development projects at AI, and then to ERA and industry for field piloting and demonstrations.

4.4 AGILE AND NIMBLE BUSINESS PROCESSES

AI will make it easier for researchers, SMEs, Campus Alberta and industry partners to collaborate and turn challenges into opportunities by:

- Making it easier to engage and partner with AI
- Continuously assessing its innovation investment portfolio and resource allocation decisions to ensure they remain relevant considering current market conditions and the contributions of other stakeholders
- Using a continuous intake system for funding to address industry opportunities as they emerge. AI will have grants competitions when required and we will reach out and develop projects with partners as necessary. Steps are being taken to ensure faster intake and evaluation and shorter negotiations of grant agreements.

4.5 RESOURCE ALLOCATION

Alberta has a strong and ambitious CLP. Innovation is one of top priorities for the Government of Alberta. Significant resources will be required for innovation to achieve the CLP goals. AI has allocated a significant portion of its base funding towards cleantech and climate leadership innovation. Through Corporate Investment branch and sectors, AI's total investment related to climate leadership and Cleantech Roadmap is estimated at about \$35 million per year. In addition, AI provides support to ERA's investment in this space. ERA invests about \$75 million per year. These investments are expected to continue. AI is also working closely with EDT on its CCITF and Cleantech Roadmap programs, which are substantively similar in scope to this plan. On December 5, 2017, the Government of Alberta announced \$1.4 billion funding for diversified, low-carbon economy, including \$225 million for "innovation across sectors". Under this program, AI will be responsible for delivering five CCITF programs totaling \$94.7 million over three years. While funding allocation into specific programs will not be discussed here, AI will make investments proportional to the impacts of its programs. All investments will have to help achieve GHG emission reductions, GDP growth, and economic diversification.

5. MEASURING SUCCESS

A Performance Management and Evaluation (PME) strategy is being developed to assess the performance of the Action Plan for Climate Leadership Innovation. The PME strategy (referred to as the “Strategy” for short), will be implemented upon review by Alberta Innovates’ (AI) PME Steering Committee and approval by Laura J. Kilcrease, CEO of AI. The Strategy will align with and cascade down from the overarching PME Strategy for AI (currently in development).

The Strategy will identify the approach for generating evidence to inform AI’s investment allocation decisions. The evidence will also provide critical information in relation to accountability, performance improvement opportunities through learning and innovating, and communications about the value of climate change (including greenhouse gas (GHG) emissions and economic and social outcomes for Albertans).

5.1 IMPLEMENTATION APPROACH

The goal is to continue embedding an evidence-informed culture within AI to inform better decisions for better outcomes (results). The approach using three main mechanisms will be used to assess the progress of the action plan:

1. Measure and monitor progress towards achieving climate change performance
2. Evaluate the climate change action plan
3. Review and renew the climate change action plan (as appropriate). Evidence generated through these mechanisms will be communicated with key stakeholders through performance reports.

Figure 8. Mechanisms for gathering evidence



Performance will be measured to monitor the progress and achievement of the climate leadership objective on a routine basis. An in-depth evaluation will be scheduled in the next three years to evaluate how well the action plan was implemented and to inform necessary revisions in the design, implementation or delivery of the action plan as required. Another evaluation will be conducted at year six to assess the impacts being achieved by the action plan.

5.2 MEASUREMENT – OUTCOMES FRAMEWORK

An outcomes pathway is being developed to show how AI resources, programs and action plan contribute to economic, environmental and social outcomes. The action plan described is a key initiative within AI that is focused on environmental outcomes and GHG emissions reduction. As several other initiatives in the province are also contributing to GHG emissions reductions, an important undertaking is the alignment of the action plan to both the CCITF as well as requirements from ACCO. This ensures that collective efforts and contributions are measured in a standardized way.

The outcome pathways have three main levels of outcomes that occur in different timeframes:

- **Ultimate outcomes (> 10 years):** long term outcomes and impacts that reflect the priorities of the Government of Alberta
- **System outcomes (5-10 years):** mid-term outcomes that demonstrate climate change at the research and innovation system level
- **Intervention outcomes (1-5 years):** short-term outcomes that result directly from program activities. See

The AI outcome pathways describes the anticipated outcomes and serves as a guide for developing appropriate and informative performance measures, evaluations and program reviews. Key performance indicators (KPIs) that align to the outcome pathways will be used to measure the performance of the action plan and its programs. To assess the GHG emission reduction potential and economic achievements along the pathways, an investment and outcome modelling approach will consistently be applied. The modelling will be used to inform metrics such as the emissions reduced per dollars spent and dollars saved (through innovation) per the percentage of renewable integration (placed on the Alberta grid). Baseline data, targets and benchmarks will be established once the action plan and the portfolio of programs are agreed upon.

5.3 REPORTING

A variety of reports will be developed to highlight and communicate the progress and achievement of intended outcomes. The format and frequency of reporting will be determined by the stakeholder needs and any contractual requirements from grant and service agreements with the Government of Alberta and our partners.

APPENDIX I – TECHNOLOGY READINESS LEVEL (TRL)

AI-CLEAN ENERGY

STANDARD DEFINITION

RESEARCH

Research is primarily done in the lab and ranges from fundamental, through to applied research and proof of concept testing. Analytical tools may be developed.

- 1 Basic principles of concept observed and reported
- 2 Technology concept and/or application formulated
- 3 Analytical and experimental critical function and/or characteristic proof-of-concept

DEVELOPMENT

The basic technological components are integrated for testing in a simulated environment and includes testing of prototypes.

- 4 Component and/or subsystem validation in a laboratory environment

FIELD PILOT

The prototype is tested in the field in an operational environment and is well integrated with other systems. 0.1 to 5% commercial scale needs to be demonstrated.

- 5 Component and/or validation in a simulated environment
- 6 System/subsystem model or prototype demonstration in a simulated end-to-end environment

DEMONSTRATION

The technology is being scaled up and tested in its final form and under expected conditions. Activities include the deployment of handbooks, documentation and maintenance. Typically greater than 5% of commercial scale.

- 7 System prototyping demonstration in an operational environment
- 8 Actual system completed and qualified through tests and demonstration in an operational environment

COMMERCIALIZATION

The first commercial application of the technology is established—the technology is ready for licensing and widespread adoption by others.

- 9 Actual system proven through successful deployment in an operational setting
- 10 Wide Scale Deployment

APPENDIX II - AI'S SIMPLIFIED OUTCOMES PATHWAYS FOR CLIMATE LEADERSHIP INNOVATION

