

# Alberta Clean Technology Road Map



Driving new market opportunities that address the global transition to a lower-carbon economy



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# A Cleaner Environmental Future for Alberta

Worldwide, there is a concerted movement towards a lower-carbon economy. Alberta is no different. Our clean technology (cleantech) sector is foundational to Alberta's economy, generating world-class capabilities in the province that will spur long-term investment and support the evolution and growth of knowledge-based industries. Cleantech solutions help diversify and grow the economy, create long-term jobs and promote responsible and sustainable industrial development. Our province is spearheading the development, commercialization, deployment and adoption of cleantech across all social, commercial and industrial sectors and organizations.

To advance cleantech innovation, the Alberta Government is taking a strategic, coordinated, and collaborative approach with industry, government and other relevant partners. After consulting with stakeholders, we have created this **Clean Technology Road Map (CTR)**. The CTR is guided by the Alberta Research and Innovation Framework (ARIF) and is informed by the Climate Change Innovation and Technology Framework (CCITF). The first phase of action is a flexible and responsive approach for investing in clean innovations to mitigate climate change, such as the reduction of greenhouse gas (GHG) emissions. Investments will also contribute to economic development. Other phases of program development under the CTR will emphasize clean technology opportunity areas that address air quality issues, water and land management, as well as climate change adaptation.

Actions under the CTR will establish Alberta as an international leader in cleantech innovation and support an innovation environment focused on solutions for improving performance, adapting to change, and building for the future. Initiatives support all elements of the innovation system, including: basic and applied research, capacity development and training, company creation and growth, and market development and investment attraction. Promising pathways identified to transition Alberta to a lower-carbon economy, have potential to create long-term job opportunities, diversify the economy, capture local and international market opportunities, and promote responsible and sustainable industrial development. The CTR sets the path forward for sustainable economic growth, resulting in positive environmental outcomes. The CTR also supports bold ventures, particularly emerging technologies that will help transition Alberta to a lower-carbon economy. To illustrate the variety of cleantech opportunities in Alberta, this document contains "snapshots" of Alberta cleantech small and medium-sized enterprises (SMEs).

**Cleantech** Applies advanced technologies, processes or know-how to positively impact economic and environmental performance, crossing multiple industries and sectors from industrial to consumer levels.

**Circular Economy** Restorative and regenerative: relies on system-wide innovation to maximize the value from resources while in use, recover and regenerate products and materials at the end of service life, and maximize negative environmental impacts.

## Why a Road Map?

Innovation and technology are critical to advancing Alberta's response to climate change. The Climate Change Advisory Panel (2015), provided guidance on Alberta's Climate Leadership Plan (CLP). After engaging with a wide range of Albertans, including the public, farmers, Indigenous communities, academia, non-governmental organizations and industry, the panel recommended taking a portfolio approach to supporting climate change innovation. Clean, innovative technologies are central to successfully addressing climate change and to growing a clean economy. The CTR helps set a course towards development of a robust, growth oriented and solutions-focused provincial cleantech sector, offering coordinated and impactful initiatives across multiple sectors. It sets out **seven pathways** to a cleaner future and supports a portfolio-funding approach to ensure investment across the innovation continuum from research to deployment.

Programs and initiatives to support clean innovation will be delivered through provincial ministries, agencies, academic and research institutions. Alberta has made significant investments in research and development (R&D) infrastructure capacity, commercialization and deployment in all regions. Existing networks and partnerships with the federal government and regional and international stakeholders, help Alberta technology developers to access international markets and supply chains.

The Government of Alberta is investing carbon levies into programs supporting more innovative and competitive Alberta industries through the Climate Leadership Plan (CLP). Support will enable Alberta's industries to compete, diversify and grow the low-carbon economy. This is one of the mechanisms that will enable action under the CTR.



## CTR Strategic Outcomes

The CTR outlines actions required to establish new or align existing programs, infrastructure, policies and regulations, and other resources (financial or non-financial) to develop, commercialize and adopt clean technologies across multiple sectors. Working with partners, stakeholders and program delivery agents, the Government of Alberta will implement actions to achieve effective outcomes, aligned with initiatives, such as Alberta's Climate Leadership Plan and the Alberta Jobs Plan.

### ENVIRONMENTAL SUSTAINABILITY AND RESILIENCE

Clean innovation contributes to Alberta's circular economy and the decoupling of economic activities from resource use and associated environmental impacts (air, water and land).



### OPTIMIZATION AND TRANSFORMATION OF INDUSTRY

Traditional, carbon-intensive industries actively pursue development and adoption of breakthrough innovations that generate superior value and environmental performance.

Emerging clean industries scale-up operations and contribute increasingly to Alberta's low-carbon economy and electricity system transition.



### ECONOMIC DIVERSIFICATION

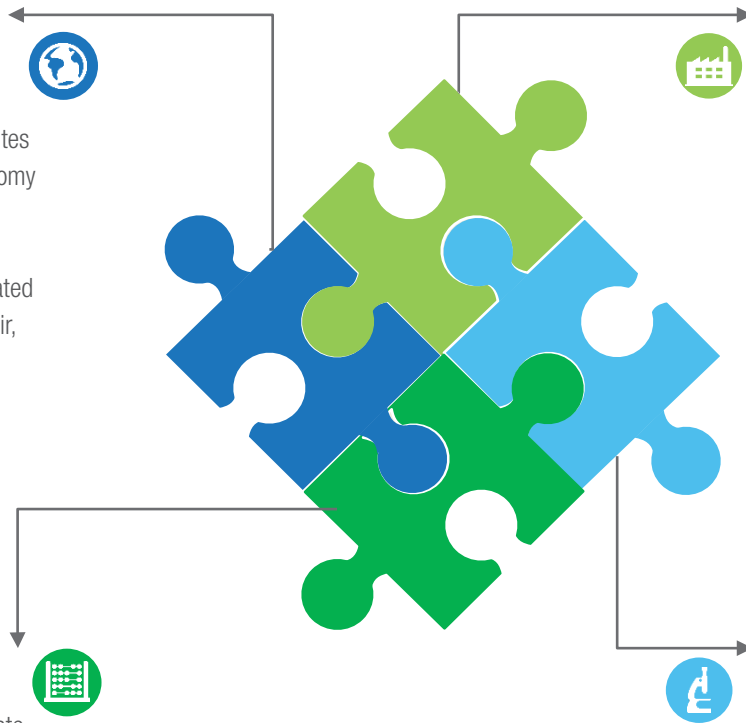
Alberta companies innovate to leverage existing and future opportunities in the cleantech sector, contributing to regional and international market development, investment attraction and job creation.



### INNOVATION SYSTEM PERFORMANCE

Alberta's innovation system is aligned to support growth of the cleantech sector throughout the innovation lifecycle.

Clean innovation programming supports the development of targeted innovation capacity (people, infrastructure, networks and partnerships, innovation environment).





## Innovation Sector Pathways

The seven sector pathways represent principal opportunities to transform Alberta to a lower-carbon, innovation-intensive economy. They are established channels through which to transition the province's traditional resource-based industries to lower-carbon intensity processes and scale up emerging technology industries. Key opportunities have been identified and highlighted in the following diagram. Sector pathways for cleantech opportunities will be pursued through programs contained within other strategies such as the CCITF, Water for Life: Alberta's Strategy for Sustainability, and the Land-Use Framework.

## Alberta's Lower Carbon Economy - Pathways to a Cleaner Future



## Cleantech Sector Critical Functions

The CTR puts forward actions that provide targeted support for entrepreneurs, SMEs, infrastructure, networks and partnerships, and the innovation environment to strengthen the clean innovation system. CTR initiatives address challenges and opportunities in Alberta's transition to a lower-carbon economy and enable firms to capitalize on regional and international market opportunities. The CTR will use a portfolio-driven funding approach to accelerate the commercialization and adoption of technologies at varying stages of their development and to ensure that Alberta's innovation system continues to stimulate long-term and foundational economic growth and diversification.

## Strategic Action Areas

### Develop and Grow Alberta's Cleantech Sector

Improve innovation system coordination, alignment and performance

Elevate Alberta's cleantech sector profile

Create a supportive policy environment



#### Research & Innovation

Invest in expertise and research capacity

Develop regional clusters and networks

Support commercialization and demonstration



#### Company Creation & Growth

Support business innovation and scaling

Encourage skills transition and business skill growth

Improve access to capital



#### Market Development & Investment Attraction

Develop domestic and international technology partnerships

Enable market adoption and deployment

Facilitate access to international markets





## Alberta Cleantech Pathway Profiles

### Low-Carbon Electricity System: Renewable and Alternative Energy

Policy direction established by the CLP has started to transform Alberta's energy system. The Renewable Electricity Program (REP), managed by the Alberta Electric System Operator (AESO), will encourage the installation of 5,000 megawatts (MW) of new renewable energy capacity to support CLP objectives of phasing out coal and sourcing 30 per cent of Alberta's electricity consumption from renewable sources by 2030. The REP is expected to generate roughly \$10 billion in new private-sector investment and more than 7,000 new jobs by 2030. Lowest cost qualifiers will receive support through an indexed Renewable Energy Credit Payment Mechanism in order to deliver sustainable costs to consumers, incent competition among suppliers and create investor certainty. The first round of competition under the REP saw three successful bids with a weighted average price of 3.7 cents per kilowatt hour, the lowest renewable electricity price in Canada.

Alberta will also transition to a capacity and energy market system by 2021, where there will be a market for providing ability to produce energy and a market for the actual production and delivery of energy. A capacity market pays electricity generators for having the ability to reliably make power available regardless of how often they sell energy onto the grid. System changes are expected to result in a more efficient, stable and sustainable electricity market and allow for a smoother transition to cleaner power.

As of December 1, 2017, Alberta's installed solar microgeneration capacity was 22 MW. Additionally, the Brooks 1 Solar Facility project, launched in December 2017, is the first utility scale solar facility in Western Canada, with 50,000 solar panels and capacity to power 3,000 homes. The project developer, Elemental Energy, received a \$15 million grant from Emissions Reduction Alberta. Provincial wind farms currently power roughly 625,000 homes, representing five per cent of Alberta's electricity demand or 1,500 MW of generation capacity. Alberta's wind and solar industries may benefit from niche opportunities related to cold-weather applications in manufacturing and operations and maintenance. The geothermal sector has historically been limited by capital-intensive installations; however, drilling expertise from the oil and gas sector and emerging low-temperature geothermal applications may represent opportunities to diversify power and heating capacity.

There are also opportunities to develop cleaner electricity infrastructure, distributed energy components, renewable energy micro-grids hybrid smart systems, and cold-weather testing and applications. Energy Efficiency Alberta currently supports the development of micro-generation and small-scale energy systems. Alberta also has far-reaching expertise in platform technology areas, such as artificial intelligence, sensors and instrumentation, and advanced materials, which can be leveraged and applied to technology development for smart grids and grid modernization. According to Export Development Canada, Alberta's 2030 target of 30 per cent renewable electricity may lead to a 25 megatonnes (Mt) reduction in GHG emissions. Some of these gains will be attributable to the development and deployment of new technology created through research and innovation from within Alberta's innovation system.



*Alberta Spotlight*

Eguana Technologies designs and manufactures high performance residential and commercial energy storage systems. Eguana has more than 15 years of experience delivering grid edge power electronics for fuel cell, photovoltaic and battery applications, and delivers proven, durable, high-quality solutions from its high capacity manufacturing facilities in Europe and North America. With thousands of its proprietary energy storage inverters deployed in the European and North American markets, Eguana is the leading supplier of power controls for solar self-consumption, grid services, and demand charge applications at the grid edge.

The company has received support from Alberta Innovates and the Alberta-Germany Collaboration Fund managed by the German-Canadian Centre for Innovation and Research (GCCIR).

## Energy Efficiency: Industrial Digital Solutions

Energy efficiency relates to reducing energy use and emissions per unit of production or activity. This can be achieved by integrating multiple technologies to enable systems-based, automated resource and operations management in a wide variety of areas. Canadians are among the highest per-capita consumers of energy in the world, but we are improving. Nationally, energy efficiency has improved by 24 per cent from 1990 to 2013 for a total cost savings of \$37.6 billion and estimated GHG abatements of 85.4 Mt. Alberta 2013 reported emissions from industrial sectors are depicted to the right.

Energy Efficiency Alberta (EEA) focuses primarily on commercially available solutions for immediate use in the residential, commercial and industrial sectors. Alberta Agriculture and Forestry is using energy assessments to increase energy efficiency on farms.

There is also a significant need for research and industrial process demonstrations to explore new technologies. Energy and process efficiency innovations may include:

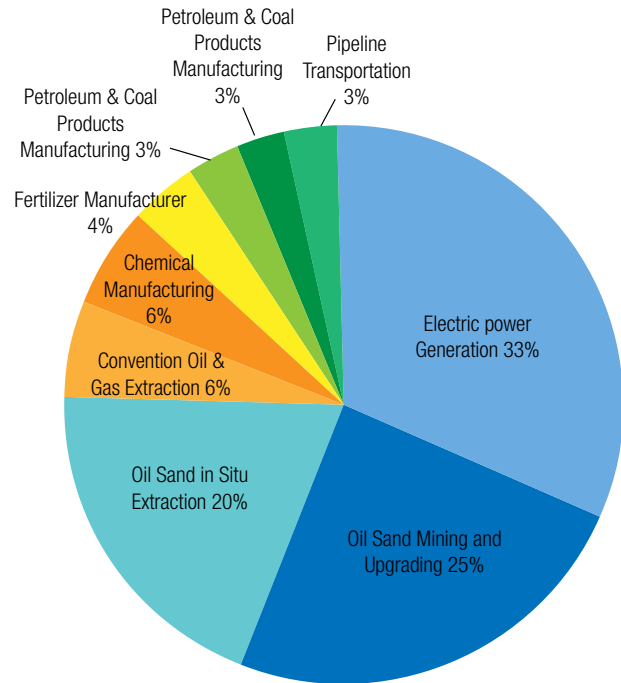
- High-efficiency equipment
- Waste heat utilization
- Fuel switching and electrification
- Process optimization and improvements and combined heat and power

Based on ongoing research at the University of Alberta, energy efficiency opportunities, including operational, project and technology improvements, in the surface and in situ mining sector, may result in up to 9 Mt of GHG emission reductions per year. Energy efficiency opportunities in upgrading may result in up to 5 Mt of GHG emission reductions per year.

Industrial Digital Solutions draws on Alberta's existing strengths and investments in micro- and nano-technology, advanced sensors, artificial intelligence, data analytics, machine learning and geomatics.

Innovation in this area will enable Alberta's traditional economic sectors such as oil and gas, mining, agriculture and manufacturing to be more energy efficient and competitive in a lower-carbon economy. Process optimization, predictive maintenance, and data-informed decision-making innovations will optimize emission regulation, energy and water consumption, and environmental management.

## Alberta Reported Emissions by Industrial Sector



Alberta Greenhouse Gas Reporting Program: 2013 Facility Emissions

zedi

Alberta Spotlight

Zedi is a leading oil and gas technology and services company exploring alternative applications for its industrial internet of things (IIoT) platform and Low-Power Wide-Area Network wireless technology in agri-food, retail food services, waste-water management and distributed renewable energy. Zedi's technology solutions provide accurate and real-time data from the field, helping customers optimize operations and reduce down-time. Zedi supports both NAIT and SAIT with IIoT Technology and funding and is a member of the Smart Agri-Food Super Cluster.

## Sustainable Waste Management: Value-Added Utilization

In 2014, according to Statistics Canada, Alberta generated the most municipal solid waste in Canada, at 997 kilograms per capita per annum, and diverted the least amount of materials, at 20 per cent. Subsidization of disposal infrastructure has made landfill disposal very economical for waste generators. In the current system, private and municipal landfills compete for waste, keeping tipping fees (disposal fees) low, which further encourages disposal over recovery. By 2025, a significant number of existing municipal solid waste landfills may be near capacity, requiring closure or expansion. Agriculture, forestry and municipal waste accounted for 24.8 Mt of CO<sub>2</sub>e in 2014, 9 per cent of Alberta's annual reported emissions, with additional associated environmental, social and human health costs.

Too Good to Waste, the Government of Alberta's provincial roadmap for waste reduction and management outlines several long-term strategies and actions, including the reduction of municipal solid waste in Alberta through updated standards for landfills and composting, policies for energy recovery from waste, and technical networks to support selection of the best recovery technologies for Alberta's waste and resource streams. As a result, Albertans have decreased the amount of waste sent to landfill from 838 kilograms per capita in 2012 to 565 kilograms per capita in 2016. In addition, the Standards for Landfill in Alberta, provides clear minimum requirements for all new and laterally expanded landfills.

Economically feasible waste-conversion technologies that are compatible with small-scale applications are scarce. Emerging technologies have the potential to bolster Alberta's circular economy, converting municipal waste and industrial by-products from the agriculture and forestry industries into bioenergy products, including renewable fuels, biochemicals, biomaterials, and other bioenergy products. Technologies and processes that target waste reduction and reuse at the source are the primary target in waste management.

Innovations in this sector, including new technologies and processes related to source reduction and reuse, recycling and composting, and waste conversion may optimize processing costs and lead to increased waste diversion. By 2030, the deployment and optimization of waste conversion technologies may result in value-added products, an increase in provincial GDP of \$2.6 billion and the creation of 2,000 direct new jobs. Additionally, the sector has the capacity to reduce GHG emissions by up to 3.1 Mt of CO<sub>2</sub>e per year by 2050.



Enerkem Alberta Biofuels is the world's first commercial biorefinery to use non-recyclable, non-compostable mixed municipal solid waste to produce methanol and ethanol and recently received registration approval from the US Environmental Protection Agency to sell ethanol under the US Renewable Fuel Standard.

Enerkem's patented technology chemically recycles the biogenic and non-biogenic carbon contained in waste and residues to create a pure synthesis gas, which is converted into biofuels and renewable chemicals using commercial catalysts.

In 2017, Enerkem received \$3.5 million from the Government of Canada Western Innovation (WINN) Initiative to build the final phase of the Edmonton facility. It will have the capacity to process 100,000 metric tons of solid waste annually and produce over 40 million liters of fuel grade, cellulosic ethanol.

## Cleaner Oil and Gas Development: Clean Hydrocarbon Production

Oil and gas and mining accounted for roughly 20 per cent of Alberta's total GDP in 2016, and crude petroleum products accounted for \$43.2 billion of the \$78.8 billion total exports realized. The CTR will provide support for innovation in oil and gas in the upstream sector due to the large-scale GHG emission reduction opportunities. According to Environment and Climate Change Canada's National Inventory 1990-2015: Greenhouse Gas Sources and Sinks in Canada, oil sands production has the highest GHG intensity after heavy oil at 83 kg of CO<sub>2</sub> per barrel, while conventional oil and natural gas have intensities of 58 and 54 kg of CO<sub>2</sub> per barrel, respectively.

There are a variety of technologies currently under development that offer significant opportunities to reduce GHG intensity in the extraction stage of oil and gas production. For in situ bitumen, this includes partial-solvent-based, pure-solvent and electromagnetic-in-situ innovations, among others. The Canadian Oil Sands Innovation Alliance (COSIA) projects that advanced in-situ solvent-based recovery technologies may reduce GHG and water-use intensity by 60 to 90 per cent, depending on the technology deployed.

Numerous pilot and demonstration projects for other developing technologies, such as bitumen partial upgrading, are being supported by Sustainable Development Technology Canada (SDTC), Natural Resources Canada, Emissions Reduction Alberta, and Alberta Innovates. These technologies still require government support to reach commercialization stages quickly, due to the capital intensity and financial risk associated with commercial-scale demonstration, but could add considerable value, reduce GHG intensity and increase pipeline capacity.



*Alberta Spotlight*

Nsolv provides a made-in-Canada solution to many of the challenges of heavy oil extraction. Its patented warm-solvent technology for in-situ extraction uses zero water; produces a partially upgraded, cleaner oil product requiring much less diluent for transportation; and reduces greenhouse gas emissions by approximately 80 per cent compared with steam-assisted gravity drainage (SAGD). Nsolv's process results in 20 per cent less waste for each extracted barrel, leading to a higher yield of valuable refined products. After over three years of successful operation at Suncor's Dover site, Nsolv completed its pilot plant operation in May 2017 and is ready for commercial deployment. Over the course of the pilot, Nsolv received \$10 million in funding support from Emissions Reduction Alberta and \$13 million from Sustainable Development Technology Canada.



MEG ENERGY

*Alberta Spotlight*

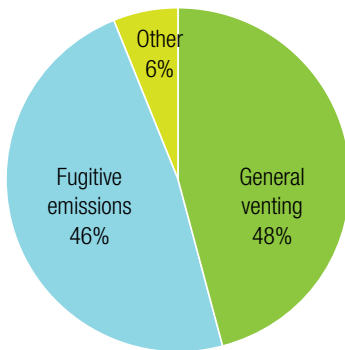
MEG Energy is currently advancing an innovative suite of technologies to decarbonize the barrel, including HI-Q, a process that improves the quality of heavy oil and may reduce or even eliminate the need to dilute with light hydrocarbons for pipeline shipment. In 2017, MEG, Cenovus Energy and Field Upgrading invested \$43.3 million in commercial demonstration and received \$26.2 million in support from Natural Resources Canada and Alberta Innovates.



## Cleaner Oil and Gas Development: Methane Reduction

Oil and gas, agriculture, forestry, and waste management represent the top industries with opportunities to reduce methane emissions. The CLP seeks to reduce methane emissions from oil and gas operations by 45 per cent from 2014 levels by 2025, as the sector has historically been the largest provincial source of emissions. Regulatory pressures are driving shorter innovation lifecycles and accelerating deployment of existing innovations. In addition, there are several Alberta agriculture carbon offset protocols for methane reduction, including anaerobic decomposition of agricultural materials.

**Canadian Methane Emission Sources from Oil and Gas**



*Alberta Government: Reducing Methane Emissions Website*

Nationally, methane emission sources from the oil and gas industry break into three main sources. General venting and fugitive emissions account for the vast majority of methane emissions in the sector.

Deployment and adoption of technologies that target venting and flaring can be supported through the development of innovative business processes that reduce measurement, and monitoring and reporting (MMR) costs. Methane conversion technologies also promise to add more value through non-fuel applications such as plastic and fertilizer production, but they are early in development and will likely require more extensive field trials.

The Alberta Government is currently working with multiple stakeholders including industry, the Alberta Energy Regulator (AER) and the federal

government to develop cost-effective provincial methane regulations for new and existing facilities in oil and gas. In September 2016, a multi-stakeholder Methane Reduction Oversight Committee was established to inform regulatory development. It is expected that existing facility standards will progressively improve emissions performance over time, while standards for new facilities will be more stringent.

Federal regulations on fugitive emissions and pneumatics are expected to come into effect in 2020 and 2023, respectively, while work to enhance provincial standards is currently being led by the AER. Under the Methane Emissions Reduction Initiative, Alberta Energy is exploring emerging emission reduction opportunities in Alberta, such as revised leak detection and repair (LDAR) standards, and new requirements for existing and new facilities. Compliance is expected between 2020 and 2023. The Alberta Climate Change Office (ACCO) has multiple offset protocols available to credit early action to reduce methane.

**BOREAL**  
LASER

*Alberta Spotlight*

Boreal Laser provides laser-based gas detection solutions for a wide variety of gases and applications throughout the world. Its technology uses infrared light to count the number of absorbed molecules in its measurement path to accurately and reliably quantify the active trace-gas concentration. Open path monitoring provides continuous, real-time integrated emissions monitoring across facility boundaries. The Edmonton-based firm was formed in 1990 and now has installations in more than 45 countries. The company has received support from the German-Canadian Centre for Innovation and Research (GCCIR) for two projects with German partners.



## Cleaner Oil and Gas Development: Carbon Management and Utilization

The International Energy Agency (IEA) predicts that globally, Carbon Capture and Storage (CCS) could contribute around 13 per cent of total global energy-related CO<sub>2</sub> emissions reductions by 2050 and is particularly relevant to key industrial sectors, including oil and gas, power generation, chemicals, cement, and steel manufacturing. As a complement to CCS, CO<sub>2</sub> utilization technologies are an emerging solution for significant industrial decarbonisation and also present a technology platform that is capable of synthesizing useable products from CO<sub>2</sub>, such as chemicals, concrete, advanced materials, etc.

In April 2017, provincial and federal government funding was announced for the Alberta Carbon Conversion Technology Centre (ACCTC), located at the Shepard Energy Centre in Calgary. The centre will fill a key gap related to the scale-up and testing of industrial-scale carbon conversion and utilization technologies and enable innovators to develop usable products such as building materials, fuels and consumer goods.

The provincial government has also committed \$1.3 billion to two commercial-scale carbon capture and storage projects, the Quest project and the Alberta Carbon Trunk Line (ACTL) project, representing one of the largest public commitments to carbon capture, utilization and storage (CCUS) in the world. The Quest Project became operational in 2015. It captures approximately 1.08 million tonnes of CO<sub>2</sub> per annum from an oil sands upgrader and transports the CO<sub>2</sub> 65 kilometers north for permanent storage 2 kilometers below ground. ACTL will establish a 240-km pipeline to carry CO<sub>2</sub> from the Sturgeon Refinery and Agrium fertilizer plant to enhanced oil recovery projects. This project is projected to initially reduce emissions by 1.68 million tonnes per year, with total pipeline capacity of 14.6 million tonnes per annum.

Canada and the United States rank among the highest on the Global CCS Institute's readiness index, resulting from detailed CCS-specific legal, regulatory and policy frameworks; long-term, clear and targeted support for CCS technology; and operational or under-construction capture and storage projects. Technology development funding has been made available through several mechanisms, including the NRG COSIA Carbon XPrize and Emissions Reduction Alberta's Grand Challenge.



*Alberta Spotlight*

The Alberta Carbon Conversion Technology Centre (ACCTC), located adjacent to the Shepard Energy Centre (SEC) in Calgary, is a unique facility designed for testing and refining CO<sub>2</sub> conversion and utilization technologies. It will be operated at a near-commercial scale using real-life flue gas produced from natural gas combustion at the SEC. The ACCTC is owned and operated by InnoTech Alberta, a subsidiary of Alberta Innovates, and construction will be completed in early 2018. It will be fully utilized by NRG COSIA Carbon XPRIZE finalists until early 2020, after which it will be used for technology development and testing by other innovators.

## Sustainable Mobility: Advanced Low Carbon Fuels and Smart Transportation

In 2015, Alberta's transportation sector contributed 32.5 Mt of CO<sub>2</sub>e to GHG emissions, roughly 12 per cent of the provincial total, with 60 per cent of total transport emissions coming from freight transport. Nationally, transportation contributes 24 per cent of emissions, a close second to oil and gas at 26 per cent and emissions from transportation have increased 42 per cent since 1990.

With 2016 annual exports and imports valued at \$521.3 billion and \$547.3 billion, respectively, the freight sector is critical to maintaining the everyday lifestyles of Canadians. In Alberta, trucks move upwards of 60 per cent of all freight within the province and handle approximately \$9 billion of international exports. However, within the transportation sector, freight is the fastest growing segment and associated emissions are forecasted to eclipse passenger emissions by 2030. The federal government is in the process of developing several initiatives to reduce transportation-related emissions. In addition, the 2017 federal budget announced intentions to develop GHG regulations for marine, rail, aviation, and vehicle sectors.

Alberta efforts include the following:

- Alberta's carbon levy is applied to diesel, gasoline, natural gas and propane at the gas station and on heating bills to provide a financial incentive for families, businesses and communities to become more energy efficient. All revenue from the levy will be reinvested in Alberta's economy related to efforts to reduce emissions, rebates for Albertans to offset cost increases, renewable energy projects and green infrastructure, and research and innovation;
- The Alberta Renewable Fuels Standard Regulation establishes requirements for renewable fuel content by volume, as well as minimum carbon intensity thresholds for renewable fuels;
- Following a successful pilot program, coordinated by Alberta Transportation, Alberta now allows 455 mm new generation wide-base single tires on commercial vehicles to operate under a permit at the same weight currently allowed on dual tires in order to achieve fuel efficiency gains;
- Emissions Reduction Alberta's portfolio includes investment in the development of a natural gas "dual fuel" blending system for heavy-duty diesel vehicles and a "drop-in" renewable diesel that can displace regular fossil fuels in existing engines and fuel distribution systems;
- ACTIVE-AURORA, led by the University of Alberta Centre for Smart Transportation and the University of British Columbia, is Canada's first and only operational connected vehicle test-bed network. Connected vehicle technology enables vehicles to wirelessly "talk" to other vehicles and roadside infrastructure in real-time and the initiative has the potential to significantly enhance the capacity, efficiency and environmental performance of our transport system; and

- Emissions Reduction Alberta has approved up to \$10 million for advancement and testing of a unique manufacturing technology created by SBI BioEnergy to produce a drop-in renewable diesel fuel using provincially-grown non-food canola that is damaged by weather or in storage, as well as animal fat. Royal Dutch Shell plc, through its subsidiary, Shell International Exploration and Production B.V., has entered into an agreement with SBI, granting Shell exclusive development and licensing rights for SBI's biofuel technology.



Alberta-based non-profit and technology commercialization centre, ACAMP, is leading an effort to help Alberta technology companies to capitalize on the emerging global market for smart vehicle technologies. With support from the Alberta government, they are coordinating efforts to pioneer new technologies that are in demand globally, including novel antennas, LIDAR systems and siren detection technologies. Autonomous or connected cars and trucks could reduce pollution by reducing idling, optimizing routes, reducing vehicle weight and improving performance of braking and acceleration.



## Green Products and Services: Green Buildings

Internationally, Alberta is recognized for building and construction innovation, with many companies spearheading innovation in the areas of automated construction, advanced materials, innovative visualization and collaborative construction. In Alberta, buildings account for seven per cent of total GHG emissions and roughly half of emissions generated in urban areas.

The four primary innovation trends in green building construction are heating, ventilation and air-conditioning (HVAC); energy-efficient insulation; “green” lighting; and incorporating renewable energies. Green buildings reduce GHGs by integrating advanced materials, technologies, and design and process tools in construction, resulting in:

- Lower-energy requirements for heating and cooling
- Reduced electricity demands
- Reuse of deconstruction materials
- Reduced embodied energy of materials
- Reduced or eliminated waste and methane emissions.

Ecological Homes, in partnership with the SAIT Green Building Technology Program, is designing, modelling and building Canada’s first certified Zero-Carbon Emission pilot home in the Foothills Municipal District. The pilot home will be used to help develop a new Zero Carbon Emission residential building standard. In addition to developing a new market niche, the project is intended to support national and provincial carbon reduction targets. SAIT’s GBT Lab and Demonstration Centre was Calgary’s first net zero energy commercial building. Facility highlights include Building Integrated Solar photovoltaic and solar thermal labs; a cold climate mechanical testing lab for high performance; and structural and environmental testing for new building envelope performance compliance.

With targeted investment, new technologies by industry could reduce emissions from buildings by approximately 6 Mt CO<sub>2</sub>e by 2030 and grow the sector’s GDP from an estimated \$2.5 billion in 2014 to \$3.71 billion by 2030. Other environmental benefits include land and water conservation, as well as waste reduction. Technology and regulatory changes could further drive the development of green products and services, including the implementation of policies that promote the “design for the environment” concept, as well as green procurement requirements for government. The sector also represents a promising opportunity for Alberta to grow highly skilled jobs in the trades, engineering, design and manufacturing sectors. Based on current enrollment in NAIT and SAIT green building-related programs, it is projected that the sector could augment the training of more than 500 students, annually by 2022, in innovative green building techniques.

Transportation infrastructure, as well as heavy civil and industrial projects may also benefit substantially from the innovation trends occurring in green building due to the considerable land-use and substantial long-term investment associated.

### “GREEN BUILDING” DEFINED:

A building that is energy and water efficient and addresses improved indoor air quality and/or material resource conservation.

**Canada Green Building Council**



*Alberta Spotlight*

MAGpro Insulated Panel System’s MGO Structural Insulated Panel (SIP) provides a complete building envelope. The system offers a fast, energy-efficient and fire-resistant alternative to conventional building.

The MGO SIP system is ideal for construction applications; residential, agricultural, commercial and special-purpose structures. Panels perform exceptionally well for basements and above grade walls, floors and roofs. The MGO SIP is mold and mildew resistant and is virtually VOC-free, creating optimal indoor air quality and comfort.

## Green Products and Services: Environmental Services

Alberta's continued drive for economic growth and diversification requires innovation and action in multiple areas supporting land-use. Alberta companies spend more than \$6.5 billion each year on environmental services, including over \$700 million annually on land remediation and reclamation. This has spurred the creation of specialized programs at Alberta's post-secondary institutions, whose graduates are employed by over 1,600 Alberta-based environmental service companies. These firms, whose expertise includes more than just land-related work in the oil and gas sector, are well positioned to serve broader sectors in domestic and international markets. Alberta has significant industrial land disturbances; over 400,000 oil and gas well sites, industrially contaminated lands, and thousands of kilometers of linear disturbances with many of these disturbances located on agricultural lands. As a result, the province has significant experience and expertise in ex-situ site remediation; the knowledge of which can support significant business opportunities for the environmental services industry in other jurisdictions currently tackling related issues.



ROYAL NAIT  
BOREAL RESEARCH INSTITUTE

*Alberta Spotlight*

The Boreal Research Institute, located in Peace River, addresses present and emerging knowledge gaps in management and reclamation of disturbed landscapes. The institute has received funding from NAIT and the provincial and federal governments, as well as industry support from Shell Canada and Penn West Petroleum. It has partnered with small, medium and large corporations, including ConocoPhillips Canada and Imperial Oil to provide new, scientifically-proven, and cost-effective reclamation products and processes.

Alberta is also looking at opportunities for land-use planning and management such as precision farming technologies to be adapted for monitoring and assessing industrial activities throughout their lifecycle. Pursuit of innovative modelling systems and data analytics is moving forward to enhance awareness of both ecosystem services and the impacts on biodiversity. New investments into the development of in-situ technologies and best practices also have the potential to reduce liability to Alberta and other jurisdictions from contaminated sites, creating immediate economic benefits. Innovative approaches for the reclamation and restoration of land to alternative end-land uses requires the integration of existing and new knowledge in remediation and reclamation activities along with exploration of research, policy development and best practice deployment. Alberta's Remediation Certificate Program as well as the Tier 1 and 2 Soil and Groundwater Remediation Guidelines are a few examples of how the province continues to address land disturbances.

There is a growing global need to reduce barriers to technology adoption and deployment for land-use planning, management, remediation, reclamation and restoration. The expertise of Alberta's environmental services industry combined with its diverse and complex working landscape provides a variable testbed for testing and validation of cross-cutting technologies for multiple sectors. Access to several industrial sectors can further support assessing potential technology uptake and implementation, enabling Alberta's ability to provide deployable technologies to meet domestic and international needs. The Alberta Land-Use Framework sets out the responsible management of provincial lands and a path forward for mitigating cumulative effects on the land and through a portfolio-driven approach, the clean technology roadmap can help support these objectives.



## Holistic Water Management

Alberta has significant expertise and infrastructure in water and wastewater management research and innovation, servicing the oil and gas sector as well as municipal and industrial wastewater treatment. Smart water solutions include enterprise asset management, supervisory control and data acquisition systems, and meter data management.

Historically, revenues from water-related products and services have contributed only a small portion of Alberta's economy; however, some industry estimates indicate that the Alberta oil industry spends roughly \$1 billion annually on water handling. Edmonton's Gold Bar Wastewater Treatment Plant, opened in 1956, remains at the forefront of wastewater treatment technology. The facility is one of Canada's largest Class IV wastewater treatment plants, treating more than 100 billion litres annually. It features membrane-based technology used to supply local industry with reclaimed water. Additionally, Advancing Canadian Wastewater Assets, a research partnership based at the University of Calgary, focuses on addressing global remediation challenges. Under the partnership, scientists collaborate directly with municipal wastewater operators to replicate environmental water problems at full-scale municipal wastewater treatment plants. Research themes include wastewater research and demonstration, public health protection, and removal of biologically active compounds, among others.





Water for Life: Alberta's Strategy for Sustainability, originally developed in 2003 and renewed in 2008, accelerates effective provincial actions to safeguard regional water sources. The strategy helps ensure safe, secure drinking water, healthy aquatic ecosystems, and reliable, quality water supplies. Aligned with the strategy, in 2016, Alberta Innovates allocated \$6.9 million in funding for 18 new projects through their Water Innovation Program developed to deliver on Water for Life priorities. Projects relate to future water supply and watershed management, healthy aquatic ecosystems; water use, conservation, efficiency, and productivity, and water quality protection. Additionally, in December 2016, Alberta Innovates announced joint funding of \$6.2 million with SDTC to seven companies for the development and demonstration of new and innovative water technologies related to water treatment for municipalities, hydraulic fracturing and oil sands operations. In 2017, Alberta Transportation allocated \$105 million in grants for water projects across the province, allowing municipalities to compete for federal funding and move forward with 15 major drinking or waste water treatment projects.

The principles of Alberta's Irrigation Strategy – A Strategy for the Future also align with Water for Life, emphasizing sustainable and responsible water resource use through increased primary and value-added productivity; improved efficiency; conservation; secured water supply; and sustained environmental stewardship. For example, improved on-farm irrigation technologies and best practices may increase irrigation application efficiencies from the 78 per cent realized in 2012 to 85 per cent by 2025.

In March 2015, the Government of Alberta released the Lower Athabasca Region: Tailings Management Framework for Mineable Athabasca Oil Sands (TMF). The objective of the TMF is to minimize the accumulation of fluid tailings by ensuring that fluid tailings are treated and reclaimed progressively during the life of the project and that all fluid tailings associated with a project are ready to reclaim within 10 years of the end of mine life of that project. The TMF affirms the provincial environmental principles of achieving economic growth and prosperity in an environmentally responsible manner, the importance of integrating environmental protection and economic decisions in the earliest stages of planning, sustainable development, and continuous improvement and use of the best available technologies. As part of implementing the TMF, the Alberta Energy Regulator (AER), released Directive 085: Fluid Tailings Management for Oil Sands Mining Projects under the Oil Sands Conservation Act (OSCA). The directive sets out requirements for managing fluid tailings volumes for oil sands mining projects, including performance evaluation, compliance and enforcement. To date, Alberta oil sands operators have invested \$1.2 billion in tailings-reduction technologies.



*Alberta Spotlight*

FREDsense is a Calgary-based biotechnology venture, developing novel tools for water chemistry analysis. Using a unique combination of biology and electrochemistry, FREDsense creates portable devices that allow for easy and accurate analysis of discrete contaminants onsite. With the ability to tune the sensors to a variety of contaminants, FREDsense offers custom sensor solutions. FREDsense's products have the potential to dramatically reduce costs and accelerate safe water treatment across a variety of industries such as utilities, mining and well monitoring.

FREDsense is currently participating in the Alberta-Zhejiang Global Partnership Program managed by Alberta Innovates.



## Government of Alberta Guiding Strategies

The development of the CTR was influenced by the CLP and the Alberta Jobs Plan. Clean innovation is supported in Alberta through a variety of programs, some of which are listed below.

### Alberta's Climate Leadership Plan (CLP)

Announced in 2015, this strategy is designed to diversify the economy, create jobs and reduce greenhouse gas emissions that cause climate change. Key aspects of the plan include:

1. An economy-wide price on carbon, phased in at \$20/tonne in 2017 and increased to \$30/tonne on January 1, 2018
2. A legislated cap on emissions from oil sands facilities of 100 megatonnes (Mt) per year
3. A commitment to incrementally phase out all coal-fired electricity pollution
4. A firm target of 30 per cent of energy consumption from renewables like wind, solar and hydro by 2030
5. Plans to reduce methane gas emissions from oil and gas operations by 45 per cent by 2025.

### Energy Innovation Fund

Alberta is investing roughly \$1.4 billion over 7 years, recycling carbon levies back into provincial industries to help them continue to be global innovation leaders.

#### Innovation Across Sectors

*Emissions Reduction Alberta Innovation Grants (\$80 million)*

*Climate Change Innovation and Technology Framework (\$145 million)*

Alberta Innovates and Economic Development and Trade guide a diverse portfolio of government investments in research, innovation and technology commercialization across a number of technology areas. Investments will improve Alberta's environmental performance and reduce GHG emissions, diversify the economy, support the transition towards a lower-carbon energy system and enhance aligned, efficient and open clean-innovation-system performance.

#### Oil Sands Innovation Fund (\$440 million)

The fund supports oil sands companies in upgrading and updating facilities in accordance with changes to the provincial legislation governing large emitters introduced under the Carbon Competitiveness Incentives regulation.

#### Industrial Energy Efficiency (\$240 million)

Funding covers a suite of activities to lower emissions and reduce costs in commercial and industrial sectors, including equipment and facility upgrades to lower energy use, energy audits and energy management systems to reduce on-site emissions. Large oil and gas, agricultural and manufacturing facilities are eligible, as well as institutions, commercial facilities, and not-for-profit organizations that meet relevant criteria.

#### Bioenergy Producer Program (\$63 million)

The existing program will be adjusted to provide grants to dedicated biofuel-producing facilities, including:

- Liquid biofuels, such as biodiesel, ethanol and pyrolysis oil;
- Biogas electricity production from farm-based anaerobic digesters; and,
- Electricity produced from biomass or wood by-products.

### **Green Loan Guarantees (\$400 million)**

The government will underwrite commercial loans for qualified organizations investing in energy efficiency and renewable energy to encourage additional investment in projects that reduce emissions and reduce lending risk for financial institutions.

## **Alberta Jobs Plan**

The Alberta Jobs Plan received dedicated funding under the Energy Innovation Fund to support clean innovations. Under this plan, the Alberta Government committed to the following investments:

### **Alberta Investor Tax Credit (AITC)**

- Targets investments in eligible Alberta-based small and medium-sized enterprises (SMEs).

### **Capital Investment Tax Credit (CITC)**

- Supports first-time acquisition of capital in value-added agriculture, manufacturing and processing, and other industries. Additional funds (above the \$75 million) will support venture capital firms, small business incubators and regional economic development initiatives.

### **Alberta Small Business Innovation and Research Initiative (ASBIRI)**

- Connecting industry to Alberta-based SMEs to solve systemic challenges using cleantech innovations.

### **Alberta Export Expansion Package (AEEP)**

- *The Export Support Fund* supports eligible Alberta SMEs looking to enter new international markets.
- *The Global Buyers and Investors Program* facilitates missions to the province by companies that demonstrate interest in partnering with or purchasing from Alberta companies.
- *The Export Readiness Program* informs Alberta businesses on how best to enter markets and forge partnerships.

## **International Technology Partnerships (ITPs)**

ITP programs support Alberta SMEs undertaking technology collaborations with SME or research partners in Germany, France, Zhejiang (China), and Jalisco (Mexico). These programs, delivered by the German Canadian Centre for Innovation and Research (France and Germany) and Alberta Innovates (China and Mexico) support Alberta's innovators to develop clean technology products that are globally relevant, while forging partnerships in target markets.

## **Water Innovation Program (WIP)**

WIP was designed to address provincial wide-ranging water-related challenges and opportunities such as population growth, economic expansion, agricultural production, increased energy development, as well as increasing importance of environmental performance and climate change. WIP is delivered by Alberta Innovates and is a key mechanism to support Alberta's knowledge and research needs for water. To date, the program has attracted direct investments of \$12.5 million from innovation system partners to support improvements in water management policy, planning, regulations and operational practices. Roughly 49 projects funded through WIP were active in 2017, with ten completed during the year. A third call for proposals is planned for 2018.



# ARIF

## ALBERTA RESEARCH AND INNOVATION FRAMEWORK

**ARIF sets out shared outcomes and aspirational innovation targets for government and provincially-supported research and innovation organizations. ARIF targets in line with the priorities of the CTR are:**



### Emerging Technologies

- Grow Alberta's green economy by sales revenue and global market share
- Increase the value of Alberta's manufacturing sector via advanced materials, instrumentation and repurposing jobs
- Alberta's digital economy enables the province to be the best in Canada for digital literacy and connectivity



### Energy and GHG Mitigation

- Accelerate a dynamic portfolio of innovations that will reduce methane emissions from oil and gas operations by 45 per cent of 2014 levels by 2025
- Increase the market value of Alberta's oil and gas exports and expand market access by supporting the commercialization of net innovations
- Renewable energy sources like wind and solar will contribute 30 per cent of Alberta's electricity consumption by 2030



### Fibre and Bioindustrial

- Exports from bioindustrial sectors increase, while maintaining environmental sustainability
- The value-added bioindustrial sector will attract additional private sector investment in Alberta
- Innovative technologies will reduce organic waste to landfill and produce value-added products



### Food and Agriculture

- Increase crop and livestock quality and productivity, while responsibly managing natural resources



### Environment and Climate Adaptation

- Reduce landscape disturbance intensity and accelerate reclamation of disturbed lands
- Enhance the health of aquatic ecosystems and improve overall water use efficiency to ensure safe, secure and reliable provincial water resources

**For more information on Alberta's CTR or CCITF, contact:**

[clean.innovation@gov.ab.ca](mailto:clean.innovation@gov.ab.ca)

**Or visit:**

- Alberta's Energy Innovation Fund: <https://www.alberta.ca/energy-innovation-fund.aspx>
- Alberta Innovates CCITF Funding: <https://albertainnovates.ca/climate-change-innovation-and-technology-framework-ccitf/>
- Invest Alberta: Cleantech Industry Profile: <https://investalberta.ca/industry-profiles/cleantech/>
- Climate Change Innovation and Technology Framework (CCITF): <https://open.alberta.ca/publications/climate-change-innovation-and-technology-framework-2017>
- Alberta Research and Innovation Framework (ARIF): <https://www.alberta.ca/alberta-research-innovation-framework.aspx>

**External Resources:**

- Alberta Innovates: <https://albertainnovates.ca/>
- Emissions Reduction Alberta: <http://eralberta.ca/>
- Energy Efficiency Alberta: <https://www.encyalberta.ca/>
- Alberta Clean Technology Industry Alliance: <https://www.actia.ca/>





