AI-EES BUSINESS PLAN

2016-2019

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Alberta Innovates Energy and Environment Solutions

Alberta

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AI-EES Mandate

Alberta Innovates - Energy and Environment Solutions (AI-EES) is the lead agency for advancing energy and environmental technology innovation in Alberta. AI-EES serves as a catalyst for the development of innovative, integrated ways to convert Alberta's natural resources into market-ready, environmentally responsible energy, and the sustainable management of Alberta's water resources.

Vision

Alberta leads the world in developing innovative energy and environmental technologies building on our natural advantages to achieve a socially responsible, diversified and prosperous economy.

Mission

To increase Alberta's capacity to develop, adapt and commercialize innovative technologies that maximize the value of the province's natural and renewable resources while protecting the environment and Alberta's water resources.

Values

Innovation – Entrepreneurship – Leadership – Collaboration– Trust – Respect

EXECUTIVE SUMMARY

> **"Alberta's research and innovation system generates remarkable discoveries, creating jobs for today and positioning Alberta for continued success."**
>
> **The Alberta Research and Innovation Framework**

Alberta Innovates – Energy and Environment Solutions (AI-EES) is the ***"… research, innovation and technology implementation arm of the Government of Alberta ministries in energy and environment,"***[1] AI-EES' focus is to bring together decision makers from government and industry, as well as research and innovation technology organizations, to develop solutions for the key challenges facing Alberta's energy, environment and water sectors, while taking advantage of the province's enormous resource opportunities.

In 2016-17, the Alberta Innovates system will see an amalgamation of the four corporations into a single entity. In the meantime, AI-EES will continue to be aligned to the Alberta Research and Innovation Framework, Climate Leadership Plan, and other Government of Alberta strategies and priorities.

BUSINESS PLANNING CONTEXT

The planned consolidation of Alberta Innovates, the release of the Climate Leadership Plan and a renewed focus on job creation are factors that have been considered in the development of this Business Plan.

In 2016, the province is being impacted by global economic uncertainty and unprecedented risks due to commodity volatility and limited market access. This challenge is exacerbated by a fast-growing environmental consciousness and push toward clean energy, clean water and sustainable development. For this reason, AI-EES' business model for advancing innovation is more important than ever. Bringing government, industry, research agencies, and academia together will be a strategic advantage as we work to address challenges central to Alberta's competitive position in the world.

Our **core business** is to support Alberta's priorities of enabling cost effective production of, and adding value to, our energy resources, mitigating environmental impacts and driving toward a diversified energy economy. This will ensure that Alberta is positioned to lead the country in exports, job growth and wealth generation. Energy remains vitally important, contributing over 25 per cent to the province's Gross Domestic Product (GDP)[2]. At the same time, agriculture, industrial and domestic water demands and impacts are increasing. Addressing these impacts requires a holistic approach to water resource planning, the development of adaptive management strategies, and innovative tools.

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[1] Mandate and Roles Document - http://ai-ees.ca/media/7985/mandate_and_roles_of_ai-ees_100331_final.pdf.

[2] Highlights of the Alberta Economy 2015, Alberta Economic Development and Trade, https://www.albertacanada.com/files/albertacanada/SP-EH_highlightsABEconomyPresentation.pdf.

RESEARCH AND INNOVATION PRIORITIES

As a technology organization, our focus is on accelerating innovation to leverage science and engineering to address desired societal outcomes, including:

Economic Impact: value added, market access, diversification, accelerating commercialization

Competitiveness: reducing costs of producing and converting fossil and renewable energy

Environmental Performance: emissions, water use, land and biodiversity

Innovation Capacity: science informing policy, market intelligence, industrial knowledge transfer.

The AI-EES team has identified a number of priority programs (Major Focus) aligned to the Government of Alberta's vision. This is the area where our organization, working with government peers, sees the greatest potential and is investing most heavily to help Alberta gain a competitive advantage and enhanced social acceptance.

Figure 1: This illustration shows AI-EES' priority program areas. For a view of all focus areas, see Figure 5 on page 16.

AI-EES 2030 TARGETS

AI-EES' 2030 targets are intended to guide its investment decisions to enable the Corporation to deliver results that will contribute to the strategic outcomes of the Province. In late 2015, AI-EES revised its 2030 targets in direct response to the Climate Leadership Plan.

Table 1: Represents AI-EES 2030 targets for GHG emission reductions, production and value added and water and land. AI-EES invests in technologies that will assist Alberta's industry and communities in reaching these targets. More detail is provided on Page 18.

A CLIMATE FOR INNOVATION

MANDATE

The mandate[3] given to AI-EES states that:

AI-EES will serve as the research, innovation and technology implementation arm for Government of Alberta ministries in energy and environment, applying world-class research and innovation management strategies to preserve and enhance Alberta's economic, environmental and social well-being.

As the Alberta Innovates corporations are consolidated, a new mandate will be developed by the Government. AI-EES' assumption for the purposes of this plan is that the core element of the current mandate (i.e. research and innovation driving economic, environmental, and social well-being in Alberta) will remain.

ALBERTA INNOVATES CONSOLIDATION

In Budget 2016, the Government of Alberta announced it is consolidating the existing Alberta Innovates corporations (Energy and Environment Solutions, Bio Solutions, Technology Futures and Health Solutions) into one corporation called Alberta Innovates. The consolidation and integration of the existing agencies will help to more efficiently fund and drive research and accelerate great ideas into innovations to improve the lives and economy of Albertans.

The streamlining of the research and innovation system through the consolidation is intended to help Alberta compete globally in key sectors with made-in-Alberta solutions to complex questions and problems. It will make it easier for researchers, companies and partners to access and navigate the opportunities and supports available to them. From exploratory research that may identify future opportunities to expertise to solve immediate industry challenges, the new Alberta Innovates corporation will provide more integrated capacity to support Alberta researchers and companies. It will also align with government direction and priorities set out through a soon-to-be released Alberta Research and Innovation Framework (ARIF). The new corporation will continue to focus on Alberta's strengths in emerging technologies, environment, energy, food, fibre/bio industry and health.

SUPPORTING INNOVATION COLLABORATORIES

In 2014, five key focus area "collaboratories" for energy, environment, health, food, and fibre, were established to help provide better focus for the government's research and innovation priorities. The collaboratories also ensure greater alignment between the Alberta Innovates Corporations and government departments. The collaboratories are guided by the priorities established in the ARIF and take an integrated approach to:

[3] http://ai-ees.ca/media/7985/mandate_and_roles_of_ai-ees_100331_final.pdf.

- Create sustainable mechanisms for improved coordination and alignment across PAC Ministries, and in further course, the research and innovation system;
- Bring together the best expertise within defined key focus areas to provide input into the collaborative process and leverage and access support from existing resources and initiatives underway for efficiency;
- Provide a mechanism to clearly articulate intended outcomes, and determine the support needed for achieving these outcomes;
- Identify performance indicators to gauge whether outcomes are being achieved as intended; and
- Create clarity of roles and responsibilities among the relevant Alberta Innovates corporations, and relevant government ministries to build on existing strengths and relationships.

STRATEGIC APPROACH

AI-EES achieves its mission by:

- Promoting collaborative research and development along the entire innovation chain, in partnership with industry, academia, other funding organizations, and venture capital organizations
- Working closely with the Alberta Innovates corporations and government departments to strengthen the province's energy and environmental sectors
- Taking a strategic view that links knowledge and market needs, and acquires the technology intelligence that is vital to maintaining Alberta's global leadership in energy and the environment.

Figure 2: An illustration on how AI-EES will deliver on its mission.

GLOBAL OUTLOOK

To help AI-EES focus in the areas that promise the greatest opportunity for Alberta, it's important to consider the global energy and policy outlook.

Fossil fuels are expected to remain important as a global energy source through 2035, with renewables contributing an increasing share[4, 5]:

- Fossil fuel energy consumption is expected to continue to increase by an average of 1.4 per cent per annum (p.a.), although slower than more recent trends (2.4 per cent p.a.)
- New technology development is allowing access to previously inaccessible unconventional resources (e.g., oil sands in Canada, shale gas and tight oil in the U.S.)
- Renewable power generation costs continue to fall and there is rising interest in energy storage as an adjunct to solar and wind projects. In 2015, renewable energy set records for investment and new capacity added; more than half of all added power generation came from renewables[6]. In order to keep global temperature rise below 2 degrees, this shift towards renewable energy is projected to accelerate.

Environmental factors are expected to increasingly impact energy production:

- Resource companies will need to more actively monitor and improve their effect on the environment to mitigate against reputation risk.
- Growing concerns over greenhouse gas emissions and declining technology costs are expected to drive forward capital expenditure growth more heavily towards renewables and low-emitting technologies.

With fossil fuels expected to remain an important component of global energy supply, the declining price of oil remains an important consideration:

- Supply of oil has been increasing at a faster rate than demand; especially non-OPEC supply from U.S. tight oil but also from Russia. Gulf States, and especially Saudi Arabia, are determined to preserve their market share.
- Economists[7] expect oil prices (WTI) to average about $50 /bbl for the next two to three years; however, for the past several months the price has been much lower.

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[4] National Energy Board, Energy Supply and Demand Projections to 2035 "Canada's Energy Future to 2035", November 2013.

[5] BP Energy Outlook 2035, February 2015.

[6] Frankfurt School-UNEP Centre, "Global Trends in Renewable Energy Investment 2016," 2016.

[7] Source: World Bank Commodity Forecast Price data, October 2015.

KEY PROVINCIAL CHALLENGES

Alberta is facing significant challenges in the management of its water resources. The province has the fastest growing population in Canada, and must balance demands for safe, reliable drinking water and sustainable economic growth (including increasing water use in the agricultural and energy sectors) coupled with the need to maintain healthy ecosystems. These efforts are complicated by increased variability and impacts from climate change.

In the aftermath of the 21st Conference of the Parties in Paris, countries around the globe agreed to an increased effort to tackle climate change. Meeting the global climate change goals requires transitioning away from high carbon emitting fossil fuels.

Greenhouse gas (GHG) emissions are an area that Canada and Alberta are particularly vulnerable. Canada's total GHG emissions have grown by 18 per cent above 1990 emissions; the growth was driven primarily by increased emissions from the fossil fuel industries and transportation. In its National Inventory Report[8], Environment Canada affirmed that oil and gas production now accounts for one quarter of Canada's GHG emissions. The increased emissions mostly came from Alberta, the primary source of Canada's oil sands reserves— largely due to an oil sands production increase of 107 per cent since 2005.

Even as Canada and the world act on climate change there will be a continued and steadily growing demand for oil and gas for transportation, heat and power. The opportunity for Alberta is to be carbon-competitive and transition to be a low-emissions supplier of energy resources. Given the quality of its resources, this is a huge challenge that cannot be met without innovative technological solutions. As Figure 3 shows, a substantial share of Alberta's emission is from the oil and gas sector including significant fugitive emissions primarily from natural gas and conventional oil sources.

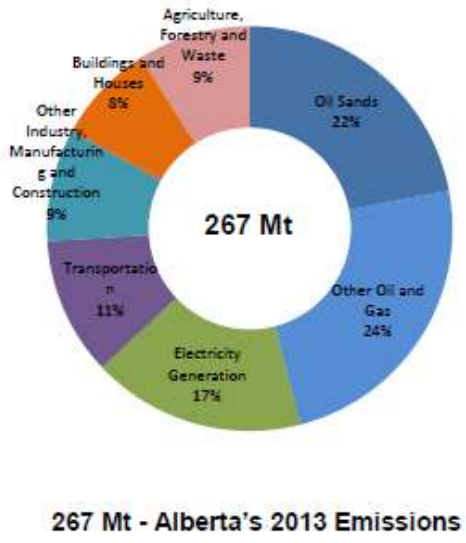

Figure 3: Breakdown of AB emissions, Climate Leadership Report. (Source Environment Canada)

[8] National Inventory Report 1990-2013, Greenhouse Gas Sources and Sinks, The Canadian Government's Submission to the UN Framework Convention on Climate Change, Environment Canada (2015).

Despite the climate change challenge, energy remains vitally important to the Alberta economy, contributing by far the largest part of our total export revenues of $121.4 Billion in 2014 ($100.1 Billion in energy related product exports)[9]. Realizing the full potential of energy technology goes hand in hand with addressing climate change while continuing to drive GDP and job growth.

There are a number of unique characteristics and challenges related to the development of energy and environment technologies in Alberta:

- Low oil prices, relatively high production costs, and lack of pipeline capacity are negatively impacting Alberta's oil and gas industry and investment capacity;
- Projects require high capital investments (multi-billion $ for major plants) and require long term payouts (10 – 20 years)
- Investments are high risk and subject to:
    - Energy price volatility
    - Shifts in supply and demand
    - Policy uncertainty, environmental risks and challenges to social acceptance of operations.

CLIMATE CHANGE POLICY CONTEXT

To help address Alberta's climate change challenge, the Government released its Climate Leadership Plan[10] in November 2015. The Plan is intended to position Alberta as a leading-energy producing jurisdiction while demonstrating credible leadership on climate change. Desired outcomes of the Plan include:

- Creating an environmentally responsible, sustainable and visionary Alberta energy industry
- Creating green jobs and green infrastructure
- Protecting human health
- Diversifying the economy and improving market access.

Key themes of the government's Plan include:

- An accelerated phasing out of coal-fired electricity generation by 2030 and a shift to renewable forms of energy
- Placing a 100 Mt per year limit on emissions from oil sands
- Reduction of methane emissions from O&G operations by 45 per cent from 2013 levels by 2025

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[9] Highlights of the Alberta Economy 2015, Alberta Economic Development and Trade, https://www.albertacanada.com/files/albertacanada/SP-EH_highlightsABEconomyPresentation.pdf.

[10] Climate Leadership Report to the Minster, November 2015. http://www.alberta.ca/albertacode/images/Climate-Leadership-Discussion-Document.pdf.

- Investment of revenues from the carbon levy into renewable energy, innovation, public transit, and other measures that will reduce the carbon intensity of Alberta's economy.

Investment in innovation and technology are identified as key to achieving both the economic and environmental outcomes of the plan.

The Federal government has renewed its commitment to addressing climate change, underscored by its signing of the Paris Agreement on Climate Change in 2016. Prime Minister Justin Trudeau has joined with fellow heads of state and government to endorse a vision for pricing carbon as a means for reducing greenhouse gas emissions. The Federal government has also committed to working closely with provinces on the development and implementation of its climate change policy, and has constituted four working groups with provincial participation to focus on the following areas:

- Clean technology and Innovation
- Carbon pricing
- Mitigation (reducing GHG emissions)
- Adaptation.

ADDRESSING CHALLENGES

As a technology organization our focus is on innovation -- to scrutinize market intelligence while putting science and engineering to work to address key provincial challenges -- improving environmental performance, building innovation capacity, maximizing economic impact and advancing Alberta's competitiveness. AI-EES will work to identify innovative and technological solutions to address greenhouse gas emissions, cost and economic challenges and support value-added opportunities in the province.

SEIZING OPPORTUNITIES AND ACCELERATING INNOVATION

AI-EES is an entrepreneurial organization that has developed the requisite trust and credibility of working in partnerships with industry and government in resource development and environmental protection to advance the province's vision. Our relationships and track record in innovation position AI-EES to further a unique collaboration between private capital, technical expertise, project funding/support and external expertise to achieve innovation and diversification in Alberta's energy and environment sectors. Building a community partners to accelerate access to capital, deal flow and commercialization resources is an activity that we have been advancing since our Corporation's inception in January, 2010.

Figure 4: This illustration summarizes how AI-EES is building an innovation support network to address the environmental impacts related to energy activities and a water program that covers a breadth of water matters ranging from healthy aquatic ecosystems to reliable, quality water supplies.

STRATEGIC COLLABORATION

AI-EES has a unique history and culture inherited from its predecessor organizations, AOSTRA, AERI and AWRI. AI-EES is built on the fundamentals of independent thinking and relies upon networking and a collaborative approach that supports Alberta government priorities. The staff are technically experienced in the program areas of AI-EES and have the required core competencies of identifying, evaluating and selecting technologies and partners for initiatives that position Alberta for the future in energy and environment. AI-EES' staff are in demand by the Climate Change & Emissions Management Corporation (CCEMC), Alberta Government Ministries, Alberta Municipalities, Natural Resources Canada and the Canada's Oil Sands Innovation Alliance (COSIA), who look to the AI-EES team to provide technical validation of third-party technology to advance projects in the government and industries' interests.

AI-EES has also developed the management and evaluation tools, including engaging consulting engineering companies, to enable the Corporation to make rational decisions on how it deploys its internal resources and selects initiatives.

CAPACITY BUILDING

AI-EES has focussed its efforts on partnering with post-secondary educational institutions and industry and has built an impressive portfolio to support next generation technologies and environmental sustainability, which will contribute to the province's economic, environmental and social outcomes:

Managing Industrial Research Chairs in the following areas:

- Tight oil and unconventional gas (University of Calgary)
- Petroleum thermodynamics (University of Alberta)
- Oil sands engineering (University of Alberta)
- Bitumen upgrading (University of Calgary)
- Field upgrading and ashphaltenes (University of Alberta)
- Reservoir simulation (University of Calgary)
- Water quality management (University of Alberta)
- Oil sands process-affected water treatment (University of Alberta)
- Tailings water treatment (University of Alberta)
- Energy and environmental systems engineering (University of Alberta)
- Petroleum microbiology (University of Calgary)
- Reservoir geomechanics (University of Alberta)
- Alberta biodiversity conservation (University of Alberta)
- Oil sands tailings geotechnique (University of Alberta).

Providing technical advice/directions to three R&D Centres:

- Alberta Helmholtz Initiative
- Institute for Oil Sands Innovation
- Canadian Centre for Clean Coal/Carbon and Mineral Processing Technologies.

PARTNERSHIPS

Alberta Innovates

Over the past six years, AI-EES has worked closely with its partner corporations, AI-Bio Solution, AI-Technology Futures and AI-Health Solutions. A consolidated Alberta Innovates provides the opportunity to strengthen and formalize these connections, creating a renewed commitment to the integration of research and investments that will lead to an even greater impact in Alberta's agriculture, energy, environment, forestry and health sectors. This change will make it easier for Alberta companies, innovators and researchers to get opportunities and develop connections across the province and beyond.

Climate Change and Emissions Management Corporation (CCEMC)

AI-EES provides a full-suite of services to the Climate Change and Emissions Management Corporation (CCEMC), which includes strategic advice, technology adjudication and project management. As a member of the operations management committee, AI-EES is also involved in CCEMC's management and strategic

planning. In many cases, AI-EES has provided funding and strategic technical counsel to advance early project work, and then projects apply to CCEMC for the funds needed for larger scale pilots and pre-commercial demonstrations. This ensures AI-EES, CCEMC and government are well aligned in advancing technology toward commercial application.

Canada's Oil Sands Innovation Alliance (COSIA)

COSIA was launched as an alliance of oil sands producers focused on accelerating the pace of environmental performance in Canada's oil sands. AI-EES initiated collaboration with COSIA in developing and publically releasing the Tailings Technology Roadmap and Action Plan. The collaboration also involved Alberta Energy, Natural Resources Canada, Alberta Environment & Sustainable Resource Development and the Alberta Energy Regulator. Since that time AI-EES and COSIA have collaborated on GHG mitigation, SAGD water treatment, and applied biodiversity conservation chairs.

Networks/Industrial Associations and Non-Government Organizations (NGOs):

AI-EES is a member of a variety of industry associations[11] and provides advice through its membership and on boards. Staff members regularly interact with their peers in a variety of meetings, technology workshops and conferences, providing sector insight as well as market and technology intelligence. These interactions assist AI-EES to catalyze research and development opportunities with industry.

Federal government alignment

AI-EES works in close partnership with:

- SDTC to initiate the advancement of water related technologies to address municipal water treatment; advanced SAGD water treatment; oil sands mine water treatment; flow-back and produced water from hydraulic fracturing; agriculture and irrigation; and water distribution rehabilitation and repair.
- Natural Resources Canada to fund national programs in the areas of partial upgrading, non-aqueous extraction and pipeline transportation. The CanmetENERGY lab at Devon focuses on the development of cleaner fossil fuels and related environmental technologies with a focus on oil sands and heavy oil and has forged strong partnerships with stakeholders across the innovation spectrum, including our province, the Province of Saskatchewan, industry, research organizations world-wide and universities across Canada.

The alignment of these programs will lead to multiple benefits for Governments and industry on innovation and sustainable resource development.

Alberta municipalities

- AI-EES is working alongside municipalities to convert municipal solid waste into energy and other value added products in support of Alberta's new Climate Leadership Plan.

[11] Examples include Alberta Chamber of Resources, Petroleum Technology Alliance of Canada, and Alberta Water Council.

- AI-EES is collaborating with Alberta municipalities on a number of geothermal initiatives that could result in a geothermal field pilot that would provide combined heat and power to residents in municipalities along the foothills.

Research and innovation priorities

AI-EES has a long history of success as a catalyst to convert Alberta's natural resources into market-ready, environmentally responsible energy. The focus is on initiatives that align and contribute to achieving government priorities such as market diversification, value added, environmental performance, reduction of greenhouse gas emissions and building capacity to accelerate commercial deployment. Based on Alberta's priorities, criteria are developed to assess AI-EES' major focus areas that can then be used to evaluate a wide range of initiatives and competitive opportunities.

Considering all possibilities, the AI-EES team has identified its Major Focus areas. These are the areas where our organization, working with government colleagues, sees the greatest potential and is investing most heavily to help Alberta to gain a competitive advantage and enhanced social acceptance. The Emerging Areas identifies and supports project areas and programs that are being continuously nurtured and the Watching Brief area shows where we are gathering market intelligence, and small university-based projects.

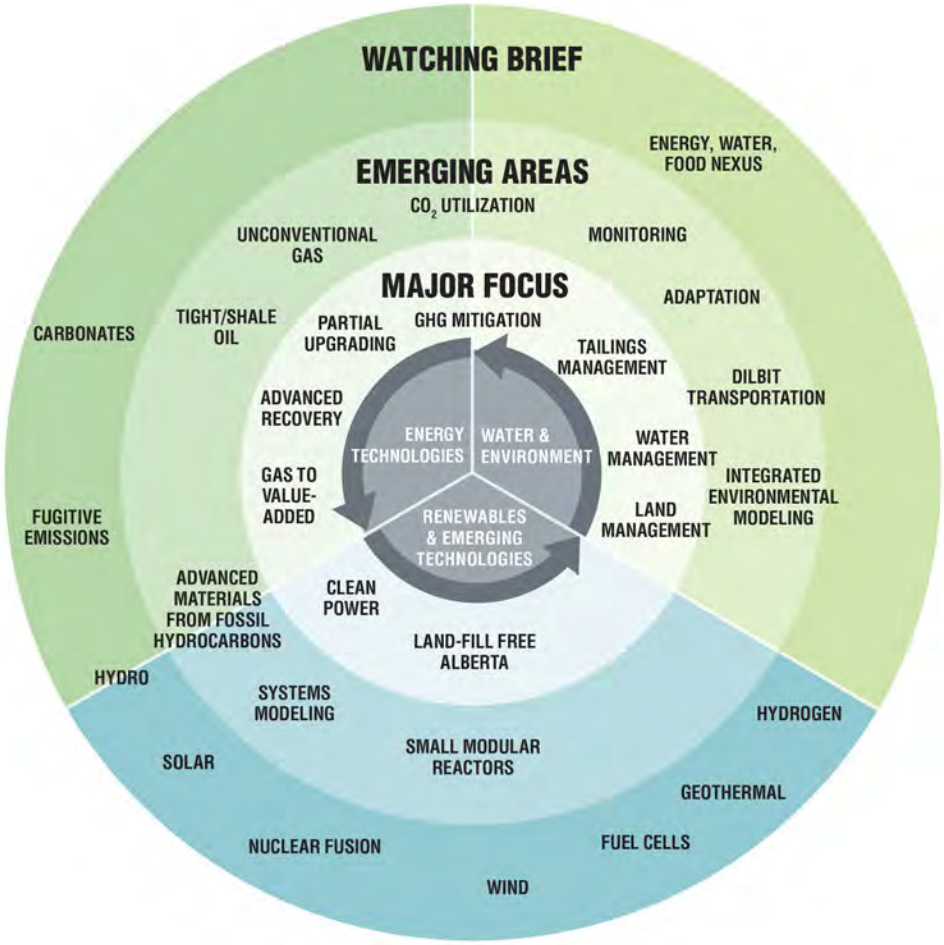


Figure 5: Illustrating the outcomes of the AI-EES' teams' portfolio analysis and selection of priority program areas. Note: energy efficiency is embedded in all of these focus areas.

ALIGNMENT OF GOALS, OUTCOMES, PERFORMANCE MEASURES AND RESEARCH AND INNOVATION INITIATIVES

Alignment with the Government of Alberta

AI-EES has a Technology Informing Policy Memorandum of Understanding (MOU) with the Alberta Ministries, Energy, Environment and Parks, and Economic Development and Trade. This MOU, which has already resulted in some 40 initiatives, provides the GOA with support in developing policy and strategic planning excellence.

Also, AI-EES staff meets regularly with GOA counterparts to discuss specific issues and opportunities involving energy and environment research and innovation and to develop projects that will benefit all parties. AI-EES has a strong track record of working with other departments on several initiatives, including Competitiveness Studies, Mitigation of Dilbit Spills, Gas to Liquids Study, Carbon Capture, Advanced Recovery Pilots, Bitumen Royalty In Kind, Life Cycle Analysis and the ecoTrust program.

AI-EES relies on the following relevant government *strategies* and initiatives for planning purposes:

- *Alberta Research and Innovation Framework*
- *Climate Leadership Plan*
- *Alberta Water Research and Innovation Strategy*
- *Provincial Energy Strategy* (being updated)
- *Tailings Management Framework*
- *Land Use Framework*
- *Provincial Reclamation Framework* (in development)
- Water for Life Strategy
- Alberta's Water Research and Innovation Strategy
- Our Water Our Future - A Plan for Action
- *Responsible Actions: A Plan for Alberta's Oil Sands*

The following pages describe the current initiatives and outcomes that AI-EES is developing for the 2016-19 planning cycle. It is organized to follow the AI-EES 2030 Innovation Targets.

Research and Technology Initiatives

AI-EES 2030 Targets

Focus areas and corresponding initiatives/ projects for 2016-2019

Energy Technologies

OBJECTIVES:

- Aid Alberta's transition to a low carbon economy
- Increase the value of Alberta's oil sands resources
- Improve oil sands production efficiency

GHG EMISSIONS REDUCTIONS

50%
sustainable
oil production

PRODUCTION AND VALUE ADDED

15%
production
from challenging
reservoirs

ADVANCED RECOVERY

Field Demonstration: (CCEMC funded):

- Cyclic Solvent Process (Imperial Oil)
- ESEIEH (Devon, Harris, Nexen, Suncor)
- N-Solv BEST Oil Sands Scale-up

University Research

- NSERC IR Chair in Oil Sands Engineering
- NSERC IR Chair in Petroleum Microbiology
- NSERC IR Chair in Petroleum Thermodynamics
- NSERC IR Chair in Reservoir Geomechanics for Unconventional Resources
- NSERC IR Chair in Reservoir Simulation
- Hydrocarbons in Nanochannels: Understanding Transport in Shale
- Tight Oil Consortium

Industry consortium: AACI 2016-2021

- A research and development program for novel technologies and existing process improvements focused on in situ recovery of heavy oil and bitumen with significantly reduced energy consumption and environmental impact. Industry participants have established four strategic areas for the program: improving well productivity, reducing energy intensity, developing new recovery processes & improving existing processes, and improving conformance at the well & pad levels.

Other initiatives:

- Comparative Test on Oil Drainage Behavior Under In Situ Vapor Solvent Extraction
- Hybrid Aqueous/Non-Aqueous Bitumen Extraction
- Unconventional Oil and Gas Innovation Roadmap
- Permanent Magnet Electrical Submersible Pump for SAGD
- eMVAPEX Pilot
- Advanced Steam Additive Recovery Processes for Oil Sands

AI-EES 2030 Targets	Focus areas and corresponding initiatives/ projects for 2016-2019

Energy Technologies continued

PRODUCTION AND VALUE ADDED

20%
in situ production partially upgraded

PARTIAL UPGRADING

Field Demonstration (CCEMC funded)

- Hi-Q Field Upgrading Demonstration Project (MEG Energy)
- Molten Sodium Upgrading Pilot Plant (Field Upgrading)

Market Access

- Competitiveness of Oil Sands Products
- Eastern Canadian Market Access Study
- PU Product Market Entry Strategy

University Research

- Institute for Oil Sands Innovation
- NSERC IR Chair in Bitumen Upgrading
- NSERC IR Chair in Field Upgrading and Ashphaltenes
- Catalytic Light Olefin Upgrading

Research Initiatives through National Partial Upgrading Program: advancing next generation partial upgrading technologies

- Acid Enhanced Bitumen Visbreaking
- H-Donor Assisted Visbreaking
- Direct Olefin Removal
- Molecular Interactions and Interfacial Behaviour of Asphaltenes
- Increasing Pipeline Access by Addressing Olefin Fouling
- Partial Upgrading Impact Study

PRODUCTION AND VALUE ADDED

one
gas to liquids demo plant

GAS TO VALUE-ADDED

Application of New GTL Technologies to Reduce Emissions

AI-EES 2030 Targets

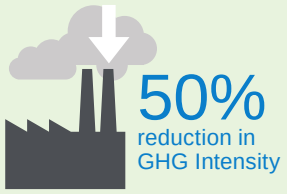
Focus areas and corresponding initiatives/ projects for 2016-2019

Renewables and Emerging Technologies (RET) Initiatives

OBJECTIVES:

- Support innovation in renewables and energy storage technologies for power and fuels
- Pursue emerging clean technology opportunities
- Collaborate with municipalities on waste to value-added demonstration initiatives in support of the government's *Landfill-free Alberta* vision

GHG EMISSIONS REDUCTIONS



CLEAN POWER

Renewable Energy

Feasibility Studies

- Deep-Dive Analysis of the Best Geothermal Reservoirs for Commercial Development in Alberta
- Geothermal workshop to identify potential sites for a geothermal pilot demonstration
- Stirling engine project

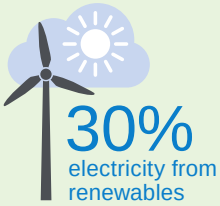
Technology Development

- Wavelength-Selective Solar Collectors (WSSCs) for Power Generating Greenhouses and Carbon Capture

Technology Intelligence & Systems Modelling

- Deployability of Small Modular Nuclear Reactors in Alberta's Oil sands and Power Sectors and in Remote Communities
- NSERC/Cenovus/Alberta Innovates Associate Industrial Research Chair in Energy and Environmental Systems Engineering

GHG EMISSIONS REDUCTIONS



Energy Storage

Next Generation Technology Projects

- Redox Flow Battery Innovation for Large Scale Electrical Energy Storage
- Zinc-Air Fuel Cell for Renewable Energy Storage

Commercial Demonstration

- Liverpool Wind and Regenerative Air Energy Storage Project
- Distributed Lithium-Ion Storage for Demand Charge Reduction and Renewable Energy Integration

AI-EES 2030 Targets

Focus areas and corresponding initiatives/ projects for 2016-2019

Renewables and Emerging Technologies (RET) Initiatives continued

GHG EMISSIONS REDUCTIONS

50%
reduction in GHG Intensity

PRODUCTION AND VALUE ADDED

50%
less organic waste to landfill

LANDFILL FREE ALBERTA

Technology Scale-up & Demonstration Projects

- Enerkem Alberta Biofuels Commercial Demonstration
- GrowTEC On-farm Waste to Renewable Energy Technology
- High Solids Anaerobic Digestion Technology at the Edmonton Waste Management Centre
- Waste into Value-Added Products in Alberta at the Advanced Energy Research Facility
- Pre-Front-End Engineering Design Study of the Conversion of Tri-Municipal Region Organic Waste to Bio-Energy
- Pre-Front-End Engineering Design Study of the Conversion of St. Paul region's Organic Waste-to-Value-Added Products

Waste Characterization

- Assessment of Municipal Solid Waste (MSW) Utilization for the Town of St. Paul
- Lethbridge Landfill Drill Sample Methane Potential Measurements and Molecular Characterization

Technology Intelligence

- Feasibility of Plasma Gasification to Convert Municipal and Industrial Solid Waste into Value-Added Products in Alberta
- Solid Organic Waste Technology Intelligence Study
- Development of a Waste to Energy Decision Analysis Model for a Municipality in the Province of Alberta

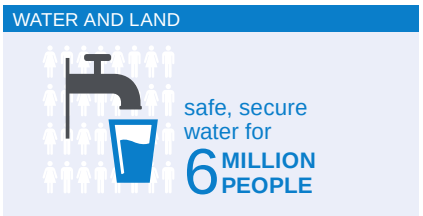
AI-EES 2030 Targets

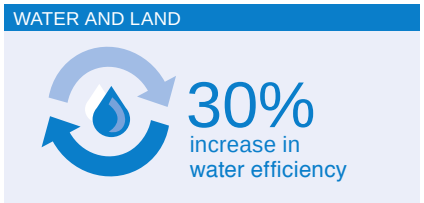
Focus areas and corresponding initiatives/ projects for 2016-2019

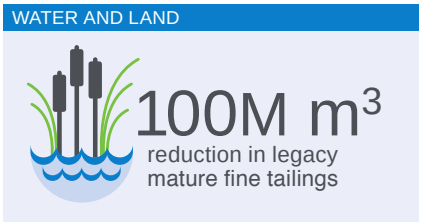
Water and Environmental Management

OBJECTIVES:

- Reduce the footprint of industrial activities
- Increase biodiversity intactness for native species and their habitats
- Reduce fugitive emissions from venting and flaring
- Safe, secure drinking water for 6 million, while enhancing aquatic ecosystems







WATER INNOVATION PROGRAM (WIP)

AI-EES WIP 2016 Grant Competition

- AI-EES developed the 2016 Water Innovation Program funding opportunity to match with emerging priorities of the Government of Alberta as well as policy and strategies including the Water for Life Strategy, Alberta Water Research and Innovation Strategy, and Our Water, Our Future: A Plan for Action in 2015. At the same time, key government, industry and water community stakeholders were consulted directly to understand their priorities for water technology and knowledge development. We anticipate an additional investment of up to $8 million in the Water Innovation Program through this opportunity with final funding decisions to be made in April 2016.

AI-EES WIP/STDC Grant Competition

- AI-EES and Sustainable Development Technology Canada (SDTC) announced in March 2016 a joint funding call for Expressions of Interest (EOI) for Water Technology Projects. Through this EOI, AI-EES and SDTC are offering small and medium-sized businesses access to a streamlined, harmonized model to access two pools of money through one application. Collectively, there is $8 million available to invest in projects that advance technologies to address water treatment in the following areas: municipal; steam assisted gravity drainage (SAGD); oil sands mining; flow-back and produced water from hydraulic fracturing; agriculture and irrigation; and water distribution rehabilitation and repair.

On-going WIP Projects

Water Supply and Watershed Management

- Sustainable Water Management in the Athabasca River Basin Initiative
- Quantifying Groundwater Recharge for Sustainable Water Resource Management
- Predicting Alberta's Water Future
- Towards Integrated Source Water Management in Alberta

Healthy Aquatic Ecosystems

- Functional Flows: A Practical Strategy for Healthy Rivers
- Assessing the Ecological Impacts of Water Extraction on Stream Hydrology and Alberta's Fish Community Structure and Function

AI-EES 2030 Targets	Focus areas and corresponding initiatives/ projects for 2016-2019
Water and Environmental Management continued	
	· Natural and Anthropogenic Influences to Groundwater and Surface Water Environments in the Lower Athabasca Region · Sustainable Wetland Habitat: Reclamation Targets, Design Criteria and Wetland Policy Implementation Water Use - Conservation, Efficiency, Productivity · Development of De-Oiling and Pre-Concentration Solutions for SAGD Produced Water · Development of a High Efficiency Mechanical Vapor Compression Evaporator for SAGD Application Water Quality Protection · Expanding Wastewater Reuse in Alberta Through Application of a Quantitative Microbial Risk Assessment Framework · Investigation of the Occurrence of Pesticides in Groundwater of Southern Alberta · Perceptions of Water Quality Among Rural Albertans and Association with Livestock · Advanced Approaches Dealing with Water Treatment Disinfection Byproducts · Enhancing Accessibility and Use of Alberta's Natural Water Recreation Areas Through Prevention of Swimmer's Itch Transmission · Arsenic in Rural Alberta's Ground Water · Baseline Isotope Geochemistry of Alberta Groundwater · Mammalian and Zebrafish Toxicty of Raw and Physico-Chemcially Treated Oil Sands Process Affected Waters · Assessing Water Quality, Microbial Risks and Waterborne Pathogens in Rural Alberta Using a One Health Framework University Research: NSERC Industry Research Chairs (IRCs) and Centres: · Oil Sands Process-Affected Water Treatment · Development of Chair to Respond to RSC and NAS Reports New Projects: · Impacts of Dilbit Spills on Aquatic Ecosystems · Development of Treatment Wetlands to Remediate Oil Sands Process Water
	LAND MANAGEMENT Biodiversity · Alberta Biodiversity Conservation (ABC) Chairs Program · Predictive Ecosite Mapping · Integrated Environmental Modelling

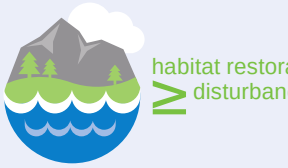
AI-EES 2030 Targets

Focus areas and corresponding initiatives/ projects for 2016-2019

Water and Environmental Management continued

WATER AND LAND

WATER AND LAND



Reclamation

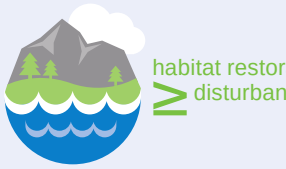
- Soil Carbon Dynamics and Nutrient Retention in Reclaimed Sandy Soils
- Remote Sensing in Support of Reclamation
- Reclamation of Riparian Plants using Cultural Keystone Species
- Development of a Research Chair Focused on Peatland Restoration
- Climate Adaptation and Species Selection for Reclamation/Restoration
- Improving Ecological Resilience in Reclaimed and Restored Lands
- Advances in Wetland Reclamation

Contaminants and remediation

- Atmospheric Metal Disposition in NE Alberta: Background Values and Industrial Contribution of the Past 60 Years
- Atmospheric Deposition of Organic Contaminants in NE Alberta: Background Values and Industrial Contribution of the Past 60 Years
- Berries to Beavers – Understanding Contaminants in Native Ecosystems
- Fracturing Operation Flowback Emissions Study

WATER AND LAND

WATER AND LAND



TAILINGS MANAGEMENT

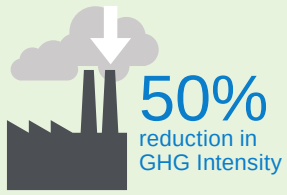
Demonstration Projects:

- Electro Kinetic Remediation (EKR) Dewatering Pilot
- In Line Dewatering of Oil Sands Tailings Pilot
- Advanced Froth Treatment Tailings Treatment
- Pit Lake Demonstration Research

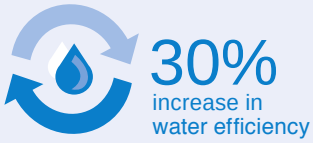
University and Proof of Concept Research:

- Oil Sands Tailings Geotechnique Chair
- Titania Membrane for Oil Sands Process-Affected Water Treatment
- Instrumented Watershed Fine Tailings Reclamation

GHG EMISSIONS REDUCTIONS



WATER AND LAND



GHG MITIGATION

(This program overlaps with initiatives in the Energy Technologies area)

Methane Reduction (AI-EES and CCEMC funded)

- Methane and Vent Gas Capture/Reduction
- Permanent Sealing of Well Gas Leaks (Seal Well)
- Evaluation of Methane Reduction Technologies for Cold Heavy Oil Production with Sand
- CO_2 Capture (AI-EES and CCEMC funded) NTNU PVAm Membrane
- Molten Carbonate Fuel Cell (MCFC) for carbon capture in SAGD
- Advanced Membranes for Syngas Clean-up and CO_2 Capture
- Oxy-Fired Pressurized Fluidized Bed Combustor

AI-EES 2030 Targets	Focus areas and corresponding initiatives/ projects for 2016-2019
Water and Environmental Management continued	
	CO_2 Utilization · CCEMC Grand Challenge: In 2013, CCEMC launched a $35 million competition seeking innovative technologies to convert CO_2 emissions into new carbon-based products. Over three rounds, the field of competition is narrowed advancing the most promising technologies towards commercialization. · Round I: 24 active projects were awarded $500,000. These projects will be completed in spring 2016 · Round II: five of the most promising projects with will be selected for a $3 million grant to further advance their technologies · Round III: one project will be awarded $10 million to commercialize their technology in Alberta Energy Efficiency · NetZero Home Design and Demonstration · Best Operating Practices in Oil & Gas · Energy and Water Recovery from Boiler Flue Gas · Novel Once Through Heat Recovery Steam Generators (OTSG) Burner Design (Husky) · SAIT NSERC Chair in OTSG Fouling · High Temperature Membrane for SAGD water treatment · Natural Gas Dual Fuel Blend System for Heavy Duty Vehicles · Economic Analysis and GHG Benefits of Cogeneration at a SAGD Facility University Research and Industry Consortium · Canadian Centre for Clean Coal/Carbon and Mineral Processing Technology · Canadian Clean Power Coalition Phase 5

OVERALL ACHIEVEMENT OF LONG TERM TARGETS - BUSINESS TRACKING

ProGrid is a five-step methodology used to measure intangibles, such as the results of long-term research and innovation programs. This methodology provides a way to measure assets that do not necessarily show up on a balance sheet -- the effectiveness of staff, their relationships, and the Corporation's strategies.

Five Step Methodology[12]:

1. Identifying the Overarching Objectives
2. Defining an Evaluation Matrix™ of Criteria
3. Establishing metrics through Language Ladders based on 2030 Targets
4. Evaluating the intangible
5. Plotting the results on an Evaluation Grid.

Using criteria as shown in the table below, initiatives for each criterion are evaluated and scored. The scores are input into the ProGrid program and the R value for the corporation as a whole is calculated. The R value measures the progress in percentage to achievement of all 2030 goals for the corporation.

Level 0 – The Organization

Innovation Resources	Strategies	Environmental and Economic Impacts
Management Capacity	Energy Strategies Response	Energy Technologies
Partnerships	Water Strategies Response	Renewables and Emerging Technologies
Finances	Environment Strategies Response	Water and Environmental Management

	2013-14 Actual	2014-15 Actual	2015-16 Forecast*	2016-17 Target	2017-18 Target	2018-19 Target	2019-20 Target	2029-30 Target
Progress to 2030 targets in the % to meet the targets (R value in ProGrid)	56.8	57.6	59.0	61.0	63.0	65.0	67.0	100

*Evaluation for 2015-16 is not yet complete.

[12] Much of the text is from the book by Bowman, C. W. (Clem), "Intangibles, Exploring the full Depth of Issues", 2005 published by Grafiks Marketing and Communications, Sarnia, Ontario, Canada.

TECHNOLOGY READINESS LEVELS (TRL)

AI-EES evaluates projects and tracks their success by assessing their TRL relative to progress and milestones achieved (Figure 7 provides a simplified TRL). This performance indicator allows AI-EES to maintain a balanced portfolio of projects along the pathway towards commercialization; keeping a number of projects entering the spectrum at the early ideas stage and developing technology transfer strategies when projects move closer to commercialization. CCEMC projects are included because AI-EES provides project evaluation and project management to ensure promising technologies are progressing toward commercialization.

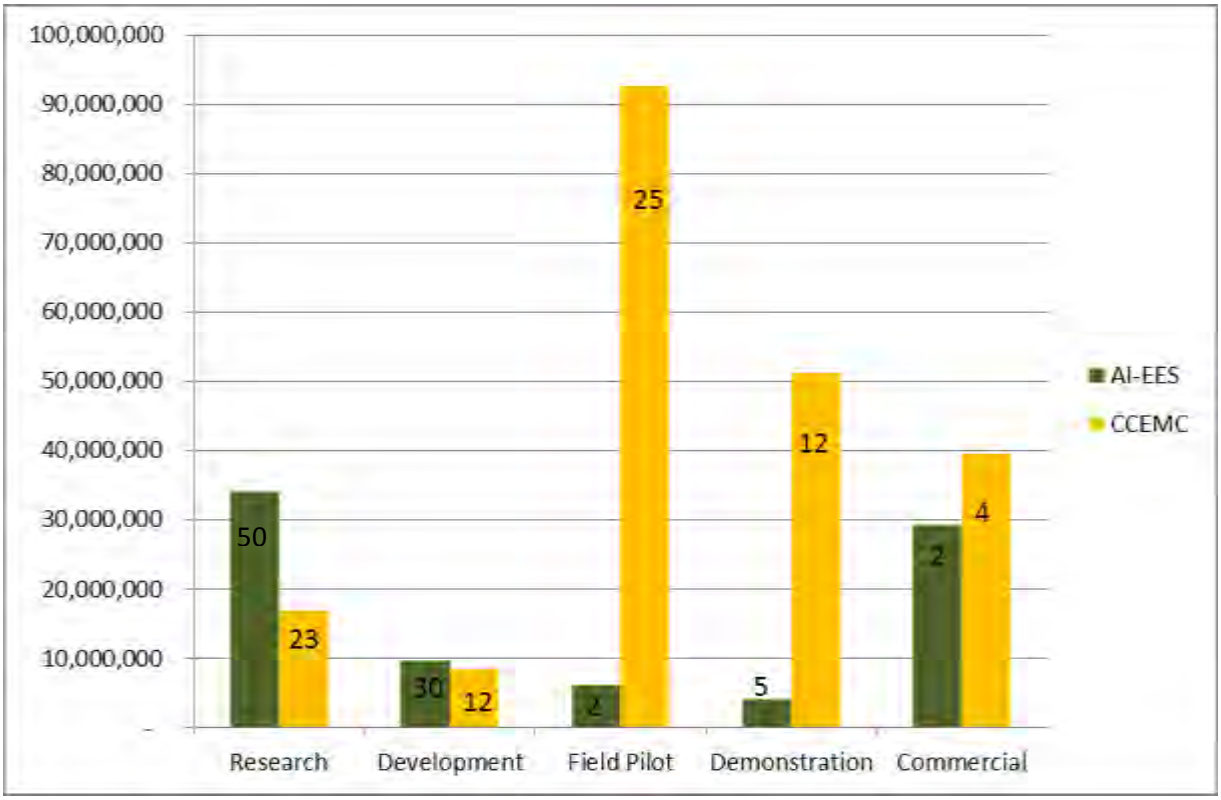


Figure 6: 2014-15 Mapping AI-EES' active projects along the innovation path. Number of projects in each level is noted on the bar. The vertical axis (Y) denotes the dollars invested.

MAINTAINING A BALANCED PORTFOLIO

To maintain balance, our investments in three priority areas vary year-by-year. As projects progress through their life cycle, new projects begin, and others are completed. A balanced portfolio is best shown as a three year aggregation of investments.

2016-19 Investment Estimates by area

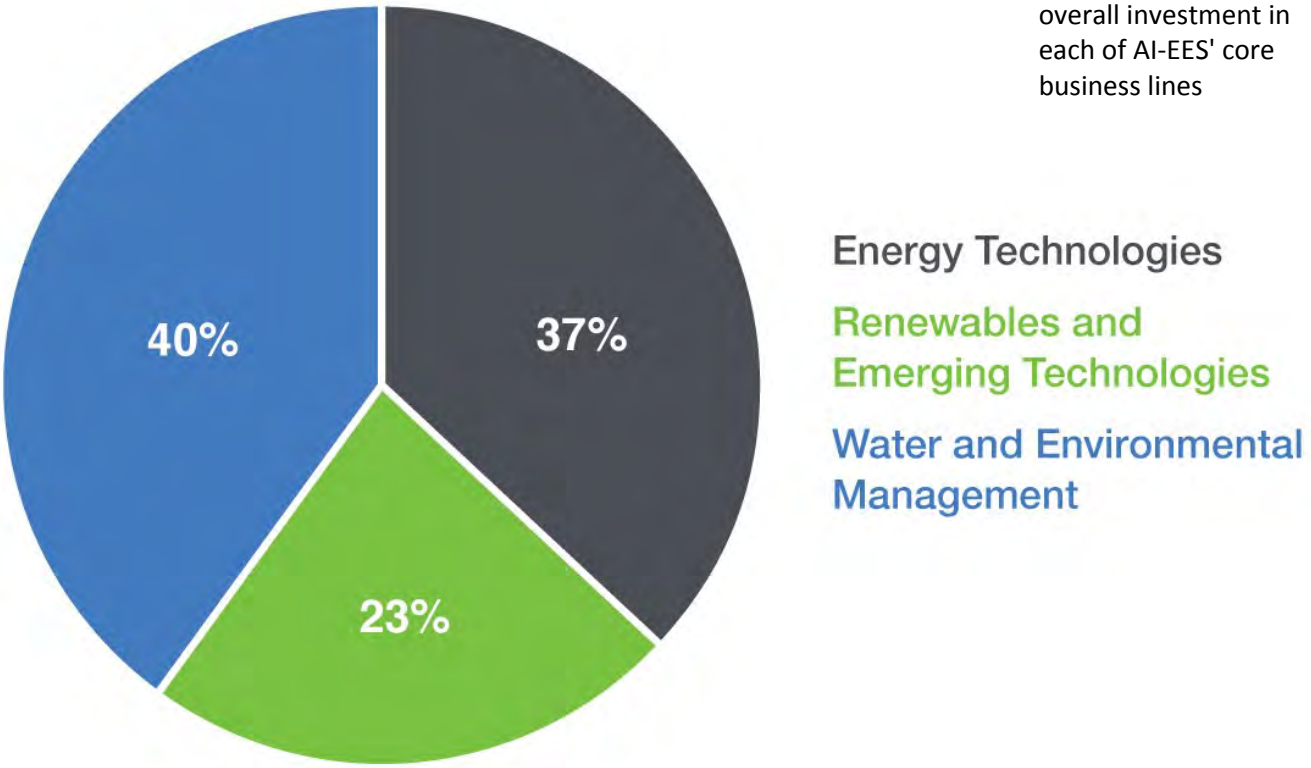


Figure 7: shows 2016-19 overall investment in each of AI-EES' core business lines

BUDGET AND RESOURCE REQUIREMENTS

	Comparable					
	2014-15 Actual	**2015-16 Budget**	**2015-16 Forecast**	**2016-17 Estimates**	**2017-18 Target**	**2018-19 Target**
REVENUE						
Funding from ED&T	14,985	13,445	13,445	5,644	15,494	15,494
Restricted Funds for AI Centres	2,240	2,049	2,049	0		
Recognized Revenue for Water and Tailings	3,550	3,859	1,865	2,505	2,438	400
Recognized Revenue for Water Innovation Program	0	5,000	128	2,316	5,127	4,919
Recognized Revenue for AWRI	1,749	2,515	802	2,434	491	0
Recognized Revenue from other GOA Ministries	970	2,600	1,916	0	0	0
Funding from other Government Sources	145	0	40	3,000	4,600	0
Industry Funding		1,164	1,056	1,485	964	900
Interest Income	705	447	525	296	200	140
Intellectual Property Income	260	11	2	11	11	11
Other Revenue	2,623	0	136	0	0	0
Total Revenue	27,226	31,090	21,964	17,690	29,324	21,863
EXPENSE						
Core Lines of Business						
Energy Technologies	4,990	6,007	4,819	8,750	9,144	7,858
Renewables and Emerging Technologies	3,236	5,764	2,473	3,101	5,524	6,600
Water and Environmental Management	2,618	3,544	2,279	3,746	1,668	1,730
Water and Tailings Grants	4,964	3,859	2,246	2,505	2,088	400
Water Innovation Program		5,000	227	2,515	5,123	4,919
AWRI Research Grants	1,684	2,080	432	620	1,624	226
Total Research	17,491	26,254	12,477	21,237	25,172	21,733
Program Administration	5,143	4,988	5,177	4,951	4,660	4,742
Technical Support Services	1,239	1,998	1,042	1,124	306	575
Total Expenses	23,872	33,240	18,695	27,312	30,137	27,050
ANNUAL OPERATING SURPLUS (DEFICIT)	3,353	(2,150)	3,268	(9,622)	(813)	(5,186)
Net Assets Beginning of Year	29,525	32,878	32,878	36,146	26,524	25,711
Add Annual Operating Surplus (Deficit)	3,353	(2,150)	3,268	(9,622)	(813)	(5,186)
Less Contingency Fund		1,000				
Less Allowance for Wind Up Costs		1,900				
Adjusted Net Assets, End of Year	32,878	27,828	36,146	26,524	25,711	20,525

Research and Innovation Initiatives - Budget allocations to Key Outcomes for 2016-19 Business Plans

Core Line of Business	Total 2016-17 Budget ($'000)	**Key outcomes of the Alberta Research and Innovation System**			
		Drives the growth and diversificatio n of the economy ($'000)	Enables the cost-effective discovery, development and production of natural resources ($'000)	Mitigates environmenta l impacts ($'000)	Enhances the health and well-being of Albertan's ($'000)
Energy Technologies	8,750	4,375	4,,375		
Renewables and Emerging Technologies	3,101	1,550		1,551	
Water and Environmental Management	3,746	749		2,248	749
Water and Tailings Grants	2,505			2004	501
Water Innovation Program	2,515	503		1,760	252
AWRI Research Grants	620		310	310	
Total	**21,237**	**7,177**	**4,685**	**7,873**	**1,502**