

2015-2018 BUSINESS PLAN

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Alberta Innovates – Energy and Environment Solutions



**Alberta
Innovates**
Energy and
Environment Solutions

Alberta 

TABLE OF CONTENTS

CONTENTS	
Executive summary	3
A climate for innovation	9
Business planning context.....	13
Seizing opportunities and accelerating innovation	17
Research and innovation priorities	23
Alignment of goals, outcomes, performance measures and research and innovation initiatives	25
Budget and resource requirements	32

EXECUTIVE SUMMARY

“Alberta’s research and innovation system is essential for creating the economy of the future. Our mission: To generate new ideas and adopt best practices and transform them into innovative products, services and processes.”

The Alberta Research and Innovation Plan – February 2015

Alberta Innovates – Energy and Environment Solutions (AI-EES) is a part of Alberta’s research and innovation system, a collaborative built on a strong legacy and proven success. As 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 2014, as part of AI-EES’ mandate, and in conjunction with Portfolio Advisory Committee (PAC) Ministries and Alberta Innovates corporations, five key collaboratories were established: energy; environment; health; food; and fibre. The Energy and Environment collaboratories are set up to better focus government’s research and innovation priorities and to ensure alignment between the Alberta Innovates Corporations and Government. The collaboratories will be guided by the Alberta Research and Innovation Plan’s (ARIP) priorities. AI-EES will work to raise the bar on innovation to support Alberta’s priorities and take a proactive team approach.



Figure 1: 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.

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

BUSINESS PLANNING CONTEXT

In 2015, 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. However, it is in the area of greenhouse gas (GHG) emissions that Canada is most 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. For this reason, AI-EES' business model for advancing innovation is more important than ever. With these environmental concerns, as well as low commodity prices and continued competition seriously affecting the value of Alberta's bitumen resources, bringing competitors together with government, research agencies and academia will be a strategic advantage as we work together to address issues central to Alberta's competitive position in the world.

Our **core business** is to support Alberta's priorities of enabling cost effective production of our 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 to the Canadian economy, contributing 26 per cent to the country's Gross Domestic Product (GDP)². At the same time, agriculture, industrial and household 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.

As a technology organization our focus is on innovation -- to scrutinize market intelligence while putting science and engineering to work to address the 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, research intensive organizations, industrial knowledge transfer.

RESEARCH AND INNOVATION PRIORITIES

Taking bold and accelerated actions to position Alberta to achieve superior environmental performance while growing and diversifying the energy economy is our top priority. Considering all possibilities, the AI-EES team has identified its 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 to gain a competitive advantage and enhanced social acceptance.

² Statistics Canada, Centre for Energy, McKinsey Electric Power and Natural Gas (EPNG) and Sustainability and Resource Productivity, 2012.

Figure 2: This illustration shows AI-EES’ priority program areas. For a view of all focus areas, see Figure 11 on page 24.



AI-EES 2030 TARGETS

AI-EES developed the 2030 targets that will guide the selection of its initiatives and creation of the enabling strategies to assist in delivering the desired provincial outcomes. AI-EES also develops outcomes criteria and indicators to monitor the stewardship of these initiatives to ensure these 2030 targets and outcomes are met.

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 25.

AI-EES 2030 Targets

GREEN HOUSE GAS EMISSIONS REDUCTIONS	PRODUCTION AND VALUE ADDED	WATER AND LAND
<p>50% intensity reduction in Alberta’s GHG emissions</p> <p>50% of total production in bitumen and heavy oil is produced sustainably (GHG emissions and water use)</p> <p>20% of Alberta’s electrical generation will come from renewable sources; energy storage capacity equivalent to 2.5% of total generation</p> <p>One or more coal power plants in Alberta at natural gas equivalent emissions</p>	<p>50% reduction in organic waste to landfill</p> <p>20% of in situ production is partially upgraded to improve quality and reduce the diluents required for transportation</p> <p>Production of oil and gas from challenging reservoirs is 15% of total production</p> <p>Development of technologies to add value to gas, including at least one gas-to-liquid demonstration plant</p>	<p>Alberta will have safe, secure and reliable water resources for six million people while maintaining or enhancing the health of aquatic ecosystems</p> <p>Improve the overall efficiency and productivity of water use in Alberta by 30% from a 2010 baseline</p> <p>100 million m³ reduction from legacy mature fine tailings over and above government directives</p> <p>Habitat restoration rates that meet or exceed disturbance on lands affected by resource development</p>

The following is a summary of the priorities AI-EES will address in the 2015 - 2018 planning cycle:

THE CHALLENGE:

Sustainable production / climate change / social acceptance: Alberta offers "technology oil" yet it is perceived as "dirty oil"

THE SOLUTION

Emissions reduction & water efficiency

- Develop improved extraction innovations that will reduce greenhouse gas emissions and fresh water use
- Pilot and scale up water treatment technologies in SAGD operations that reduce energy use and maintain high water recycle rates

Tailings management

- Pilot and scale up technologies that can economically dewater oil sands tailings as they are created as well as legacy tailings
- Better understand the performance of end pit lakes and characteristics of oil sands process affected water
- Support development of water discharge regulations

Integrated land management

- Develop practices to improve reclamation and restoration of linear features on the landscape
- Improve understanding of parameters that may limit reclamation success
- Address best practices and identify appropriate targets for both land and wetland reclamation
- Increase knowledge on key species requirements for re-establishment during reclamation

- Improve understanding of peatlands and what are the correct initial conditions to reclaim or restore them
- Understand the potential impact of climate change on individual species fitness and the health of communities and ecosystem

GHG capture

- Provide technical support to the CCEMC program
- Develop low cost, game changing CO₂ capture technologies that integrate well with Alberta's industrial sector
- Improve understanding of fugitive gas emissions and how they can be reduced

Increase renewables

- Improve understanding of Alberta's renewable resources and how they can be economically accessed
- Develop energy storage to increase the amount of renewables that can be integrating into Alberta's power grid

Scout for emerging technologies

- Partner with international organizations to identify new promising technologies that can be applied in Alberta to meet Alberta's energy and environmental needs

THE CHALLENGE:

Market diversification/
value addition/product
quality: increasing
the value and market
competitiveness of
Alberta's resources
is critical to the
province's prosperity

THE SOLUTION

Addressing product competitiveness

- Competitiveness study that will identify global market needs and priorities to increase the value and competitiveness of Alberta bitumen
- Minimize the capital and operating requirements to produce products that better fit global refineries

- Understand how to increase the value of bitumen by developing designer crudes tailored for each market
- Develop partially upgraded products that will reduce the need for diluent and maximize pipeline capacity

THE CHALLENGE:

Safe drinking water /
efficient water use /
healthy watersheds /
climate change

THE SOLUTION

Safeguarding water resources

- Develop an integrated risk management framework to support management of municipal drinking water, wastewater, stormwater and urban watersheds
- Improve assessment of and reporting on the concentrations in groundwater of potentially harmful contaminants
- Identify trends and opportunities to help develop, maintain, or improve river flows to meet environmental needs
- Improve understanding of the behavior and impact of dilbit when spilled in aquatic environments to support improved transportation management and spill response strategies

- Better understand the natural and industrial contributions of contaminants into groundwater and surface in complex managed systems like NE Alberta
- Improve understanding of future climate variability and its impact on water supplies and water quality
- Improve understanding of impact of industrial activities in headwater regions and their impact on water supplies downstream
- Support basic research on water safety and water quality after treatment to help inform policy/regulation for water recycle
- Work with stakeholders, industry and government to address best practices

OVERALL ACHIEVEMENT OF LONG TERM TARGETS - BUSINESS TRACKING

AI-EES uses ProGrid, a five-step methodology developed to measure the impact of research and innovation programs over the long term. 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 -- plotting the results on a grid that shows AI-EES' progress toward reaching its 2030 goals.

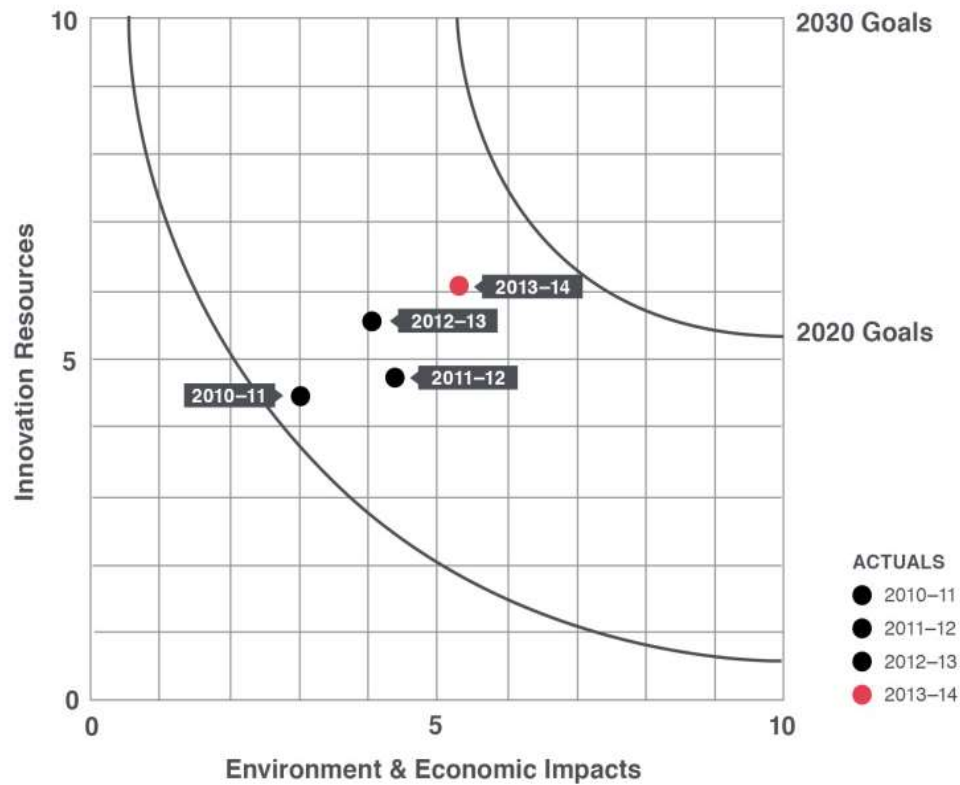


Figure 3: The overall corporate results indicate the performance level of the AI-EES organization (2013-14). See page 25, Alignment of goals, outcomes, performance measures and research and innovation initiatives for a thorough explanation of the AI-EES' pathway to achieve these targets

A CLIMATE FOR INNOVATION

VISION

Alberta leads the world in developing innovative energy and environmental technologies building on our natural advantages to achieve a socially acceptable, 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

Our values serve as the foundation to guide how we work together and for our province. These values exemplify our organization's culture and its people.

Innovative

We see opportunities where others see issues. Breaking down barriers to develop solutions for the biggest issues facing the energy and environment sectors is what we do best.

Entrepreneurial

We gather and tap into market intelligence that keeps us ahead of the curve. To innovate, you must be able to recognize innovation. Fast on our feet, we find the partners and resources to capitalize on all the possibilities for a clean energy future.

Leaders

With the clean energy and environmental goals for our province top of mind, we have the courage it takes to foster game-changing innovation.

Collaborative

It's about moving beyond our own ideas to see the broadest view. We work to build a community, forging partnerships that bridge the gap between organizations and ideas. We bring the right people, organizations and policy makers together to change the game for Alberta and Canada.

Trusting and Trustworthy

Working with integrity, we strive to do the right thing and are accountable for outcomes.

Respectful

Debate leads to good decisions and we believe everyone contributes to a discussion. Treating one another with the respect and dignity, giving individuals a chance to learn and grow and savoring unique voices, matters and makes a difference.

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

MANDATE

The Mandate and Roles Document for Alberta Innovates – Energy and Environment Solutions (“AI-EES”) has been developed collaboratively between the Minister of Innovation and Advanced Education and AI-EES to reflect a common understanding of roles and responsibilities.³ The mandate 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.

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

The Government of Alberta has given AI-EES the following responsibilities as set forth in the *Alberta Research and Innovation Regulation*:

- To support, for the economic and social well-being of Albertans, energy and environment research and innovation activities aligned to meet Government of Alberta priorities, including, without limitation, activities directed at the development and growth of the energy and environment sectors, the discovery of new knowledge and the application of that knowledge.

In accordance with AI-EES' original mandate, the mandate letters of Innovation and Advanced Education (IAE), the Energy, and Environment and Sustainable Resource Development make reference to the importance of collaboration with AI-EES as follows:

- Ensure alignment and co-ordination of the separate Alberta Innovates corporations with the key focus areas of Alberta (energy, environment, food, fibre, and health).
- Coordinate cross-government initiatives relating to innovation and research to diversify and strengthen Alberta's future.
- Enable research based partnerships with energy focused institutions and Alberta Innovates – Energy and Environment Solutions.
- Update Alberta's Climate Change Strategy in consultation with Alberta Energy, Alberta Innovates – Energy and Environment Solutions and the Climate Change and Emissions Management Corporation and ensure collaboration to achieve maximum greenhouse gas reductions and the effectiveness of policy and funding decisions.

As a key player in the innovation network, AI-EES will create value through:

- Increased effectiveness and integration of planning, funding and delivery of research and innovation programs
- Alignment of programs and investments toward priority areas and outcomes
- Improved facilitation of knowledge, intellectual property, technology and skill transfer within the system, and between academia, industry and government
- Improved accountability and outcomes through integrated performance monitoring and continuous improvement processes
- An integrated and disciplined research and innovation process to inform government policy and regulations for sustainable development.

ACTIVELY SUPPORTING NEW COLLABORATORIES

In 2014, as part of AI-EES' mandate, and in conjunction with (PAC) Ministries and Alberta Innovates corporations, five key focus area collaboratories for energy, environment, health, food, and fibre have been established. The Energy and Environment collaboratories were set up to better focus government's research and innovation priorities and to ensure alignment between the Alberta Innovates Corporations.

The “collaboratories” will be guided by the Alberta Research and Innovation Plan’s (ARIP) priorities and based on a collaborative team approach to:

- Create sustainable mechanisms for improved coordination and alignment across PAC departments, and in further course, the research and innovation system
- Bring together the best expertise within the 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
- Through a collaborative approach, create clarity of roles and responsibilities among the relevant Alberta Innovates corporations, and relevant government ministries to build on existing strengths and relationships.

The 2015 deliverables will include:

- Developing the terms of reference and a work plan that identifies innovation and research priorities
- Working on increased communication and establishing increased clarity of roles and responsibilities among Collaboratory members
- Identifying existing initiatives and determining the ideal methodology and approach to adopt in evaluating and communicating opportunities and priorities
- Developing performance measures and indicators necessary to measure success in achieving identified outcomes
- Produce a report that summarizes priorities, methodology, outcomes and performance measures and the work of the Collaboratory.

INNOVATION IN AN UNCERTAIN ENVIRONMENT

For 2015-2018, AI-EES strategic approach for advancing innovation will be more important than ever. With low commodity prices and continued competition seriously affecting the value of Alberta's energy resources, bringing competitors together with government, research agencies and academia will be a strategic advantage as we work together to address competitiveness issues such as:

- Global oil supply increasing faster than demand
- Increasing fuel quality standards that require ongoing innovation in production, transportation and refining
- Limited pipeline infrastructure and refinery capacity
- Alberta's oil and gas products are sold at a discount
- The growing Alberta population will have a profound influence on water supplies.

The above challenges are exacerbated by a fast-growing environmental consciousness and push toward clean energy, clean water and sustainable development. It is in the area of greenhouse gas (GHG) emissions that Canada is most vulnerable, though it should be noted Canada accounts for two per cent of the world's GHG emissions⁴. However, 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. As shown in Figure 5, oil and gas, transportation and electricity sectors alone accounted for over 60 per cent of the emissions⁵.

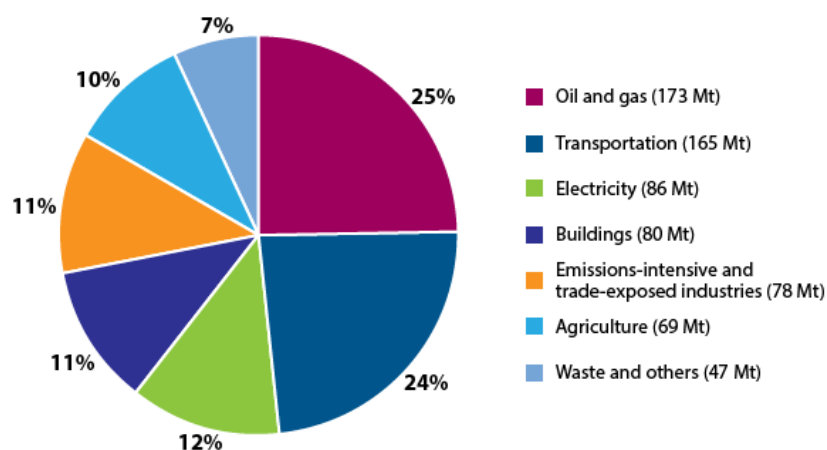


Figure 5:
Illustration of
Canada's emissions
by economic sector
in 2012. The total
emissions is 699Mt
CO₂ eq.

⁴ United States Environmental Protection Agency, Global Greenhouse Gas Emissions Data, <http://www.epa.gov/climatechange/ghgemissions/global.html>

⁵ Environment Canada, Canada's Greenhouse Gas Emissions in 2012, <http://ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=F60DB708-1>

In its National Inventory Report⁶, Environment Canada affirmed that the oil and gas production now accounts for one quarter of Canada's GHG emissions, narrowly beating transportation. 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.

THE IMPACT OF LOWER OIL PRICES

- Supply has been increasing at a faster rate than demand and especially non-OPEC supply from U.S. tight oil but also from Russia. Gulf States and especially the Saudi's are determined to preserve their market share.
- Economists expect oil prices (WTI) to average \$65 /bbl for the next two years; however, lower differentials and a weak Canadian dollar are offsetting price declines.
- In response to price volatility, Alberta has to be concerned about revenue but is in a position to survive low pricing over an extended period and manage the province's budget responsibly.
- The heavy oil to light differential is a combination of increased refining costs due to high vacuum resid, sulfur and Total Acid Number (TAN) content for Alberta heavy crudes and bitumen, such as Western Canadian Select, and as such trade at a lower price. Other factors that reflect price discounts are excess supply due to winter maintenance schedules of refineries and transportation bottlenecks.

LONG-TERM GLOBAL OUTLOOK

To ensure AI-EES is focused in the areas that promise the greatest opportunity for Alberta, it's important to consider the global energy outlook for 2030⁷.

Fossil fuels remain important as an energy source through 2035⁸:

- New technology development allows access to previously inaccessible unconventional resources (e.g., oil sands in Canada, shale gas and tight oil in the U.S.)
- Coal remains an important resource in Asia.

Renewables are a small, but increasingly important power source by 2035:

- Technologies are maturing and coming down the cost curve quickly, making them competitive in select geographies (e.g., solar for peak generation in sunny climates, wind for offshore areas and islands)
- While installed base is mostly fossil fuels, forward capital expenditure (capex) growth is heavily renewables
- Adoption is also driven by emissions related targets and anticipation of increased regulations
- Adoption in Canada of new renewable technologies for electricity (solar, wind, biomass) will be slower than other countries due to existing hydro, natural gas and nuclear power generation capacity.

⁶ National Inventory Report 1990-2012, Greenhouse Gas Sources and Sinks, The Canadian Government's Submission to the UN Framework Convention on Climate Change, Environment Canada (2014)

⁷ McKinsey Global Energy Perspective Model, McKinsey Resource Revolutions Report, McKinsey EPNG and SRP Practices, 2012.

⁸ National Energy Board, Energy Supply and Demand Projections to 2035 "Canada's Energy Future to 2035", November 2013.

Energy demand is driven by a new middle class in developing countries, but is offset partly by efficient technologies:

- Emergence of three billion middle class in Asia driving increased demand for cars, buildings and other consumers products
- Demand increase is partly offset by stricter fuel efficiency standards (which in turn has driven innovation in fuel-efficient transportation), increase in biofuel use, development of hybrid and electric vehicles, causing a significant decrease in fuel demand in Canada and U.S.
- Demand is also reduced by development and adoption of energy efficient technologies for both buildings and industrials, particularly in developed economies.

Environmental factors will increasingly constrain resource production:

- Resource companies will need to more actively monitor and improve their effect on the environment to mitigate against reputation risk
- Biodiversity loss associated with resource production will increasingly have economic implications
- Stress on freshwater resources and productive land will increase creating conflicts with resource production.

CANADIAN OUTLOOK

Figure 6 and 7 provide projections of oil and gas production rates to 2035 respectively based on the National Energy Board's (NEB) "reference case". The growth in oil production is dominated by an increase in bitumen production (Figure 6) and the resurgence in natural gas production is dominated by tight and shale gases (Figure 7).

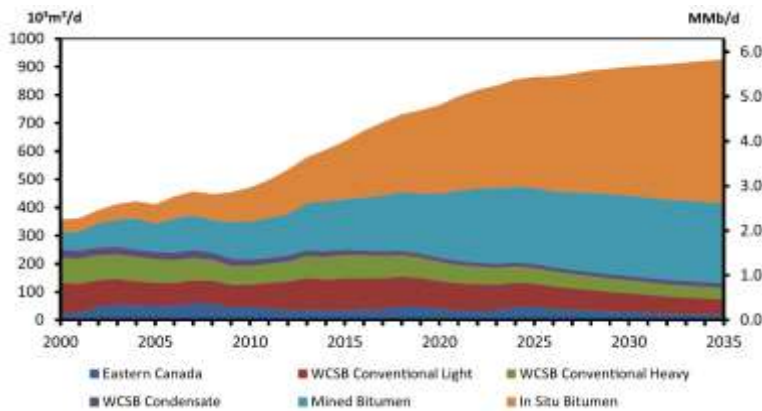


Figure 6: Canada's crude oil production by type. Oil production increases by 75% to 2035 in the NEB reference case.

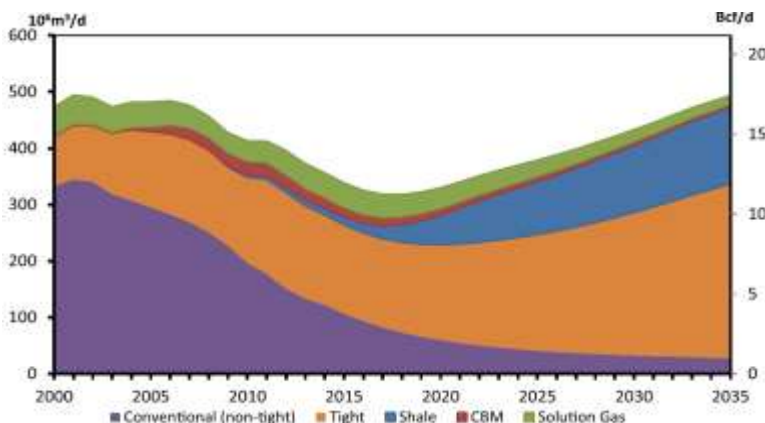


Figure 7: Canada's natural gas production by type. Natural gas production increases by 25% to 2035 in the NEB reference case.

KEY PROVINCIAL CHALLENGES

With only 2.2 per cent of Canada's fresh water being in Alberta, the role and importance of water to Alberta's economy and quality of life cannot be underestimated. AI-EES approach to knowledge in water system security will be decisive for "well-informed policy, management decisions, and water management practice"⁹.

The province is also affected by global economic uncertainty and unprecedented risks due to increasing commodity volatility (low global oil price) and market access. These challenges are exacerbated by growing population, an expanding economy and higher expectations for environmental performance. All of these realities will have a profound influence on cleaner energy and sustainable development and water supplies and how we use them. The market challenges that Alberta faces due to growing competitive energy supplies, access to refineries and declining demand for transportation fuels in developed nations illustrates the need to grow the innovation capacity in an era of challenging markets and changing societal values.

ADDRESSING CHALLENGES

Energy remains vitally important to the Alberta economy, contributing the large part of our Gross Domestic Product (GDP)¹⁰. Realizing the full potential of energy technology goes hand in hand with environmental sustainability and drives GDP and job growth.

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

- 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
- The sector is multi-faceted and complex: technologies develop from many basic science areas; and the sector encompasses many unrelated industries, companies and stakeholders
- Variations in geography, climate, and the hydrologic cycle create regions of water disparity and complicate the management of water resources.

As a technology organization our focus is on innovation -- to scrutinize market intelligence while putting science and engineering to work to address the key provincial challenges -- improving environmental performance, building innovation capacity, maximizing economic impact and advancing Alberta's competitiveness.

⁹ Alberta's Water Research and Innovation Strategy 2014: A Renewal
(<http://iae.alberta.ca/media/427167/ab%20water%20research%20innovation%20strategy%202014.pdf>)

¹⁰ Statistics Canada, Centre for Energy, McKinsey Electric Power and Natural Gas (EPNG) and Sustainability and Resource Productivity, 2012.

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 of ecosystem 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.

Networks/Developing market and technology intelligence: AI-EES gathers market intelligence and 'scouts' for technologies internationally to identify opportunities that advance Alberta's competitive position. Working with industry, academia and international collaborators, AI-EES identifies and designs a fit-for-purpose research and technology approach to help the province meet its goals to seek the highest value for our natural resources, reduce GHG emissions and conserve precious water resources.

Support R&D to marketplace: Most AI-EES projects involve industry partners. AI-EES staff work with industry to develop ideas for research and innovation projects and co-funding opportunities. AI-EES Board members have significant industry and business experience and provide strategic leadership and oversight. Board members and staff are often called upon by provincial, national and international organizations to provide advice and are in a position to influence industry and government directions in research and technology.

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, Natural Resources Canada and the Canadian 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.

ALIGNMENT

Alignment with the Government of Alberta

AI-EES has a Technology Informing Policy Memorandum of Understanding (MOU) with Alberta Energy, Environment and Sustainable Resource Development and Innovation and Advanced Education. 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 and Storage, Advanced Recovery Pilots, Bitumen Royalty In Kind, Life Cycle Analysis and ecoTrust.

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

- *Alberta Research and Innovation Plan* (updated annually)
- *Provincial Energy Strategy* (being updated in 2015)
- *Renewed Water for Life Strategy*
- *Tailings Management Framework* (in development)
- *Land Reclamation Framework* (in development)
- *Responsible Actions: A Plan for Alberta's Oil Sands*
- *Climate Change Strategy* (AI-EES is involved in current review process)
- *Land-use Framework*
- *Alberta Nanotechnology Strategy*
- *Directive 074 – Tailings Performance Criteria and Requirements for Oil Sands Mining Scheme*
- *Shaping the Future*, Report of the Premier's Council for Economic Strategy.

CAPACITY BUILDING

Federal government alignment

AI-EES and Natural Resources Canada are working together on the development and funding of national programs. 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.

Building research capacity at universities connected to pilots and pre-commercial demonstration

AI-EES has focussed its efforts on partnering with industry and 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
- Petroleum thermodynamics
- Oil sands engineering
- Bitumen upgrading
- Reservoir simulation
- Water quality management
- Tailings water treatment
- Energy and environmental systems engineering
- Petroleum microbiology
- Reservoir geomechanics
- Biodiversity conservation
- Oil sands tailings geotechnique.

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

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

Working alongside Alberta Innovates – Technology Futures (AITF):

For over 40 years, AI-EES and its predecessors AERI and AOSTRA, have been the main investors in the Alberta Research Council (now the ARC division of AITF). AI-EES currently works with AITF on the following projects:

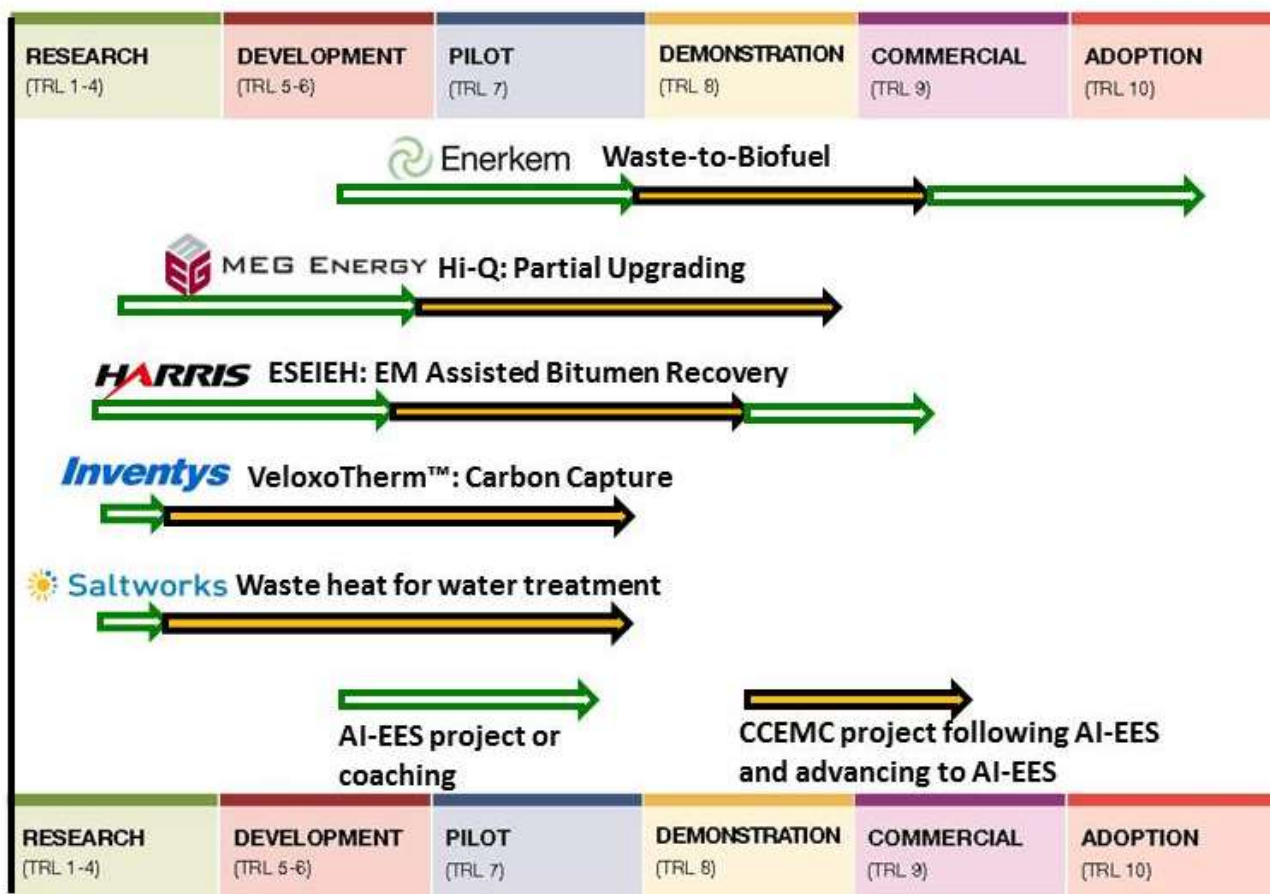
- Lethbridge landfill: drill sample methane potential measurements and molecular characterization
- Feasibility analysis of a geothermal based steam/electricity generation application in Alberta
- The effect of weathering on dilbit and conventional crude in fresh water systems
- Laboratory examination of residual bitumen impacts on geotechnical performance of oil sands mature fine tailings.

AI-EES supports the AACI Program focused on in situ recovery from heavy oil and oil sands, which has been in operation for 30 years. Though the AITF, ARC and AACI relationships are important to AI-EES, these programs' arms-length operation is critical as this provides AI-EES with an "oversight" role. This oversight is key to ensuring research projects stay focused on very specific challenges and solutions. AI-EES regards AITF as an important part of its strategic approach as AITF provides commercialization supports to SME's, including incubation space and laboratory services.

Climate Change and Emissions Management Corporation (CCEMC)

AI-EES provides strategic advice, technology adjudication and project management for the Climate Change and Emissions Management Corporation (CCEMC). 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.

Figure 8: The following illustration shows how projects transition from AI-EES to CCEMC and in some cases back to AI-EES at different stages of development.



Canadian Oil Sands Innovation Alliance (COSIA)

COSIA was launched two years ago 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

several projects. Below is a listing of the currently active projects:

- Industrial Research Chairs in Biodiversity and Conservation
- Restoring historic linear disturbances
- Natural and anthropogenic influences to groundwater and surface water environments in the Lower Athabasca Region
- In-line dewatering of oil sands tailings
- Electro-kinetic reclamation technology commercial scale-up testing
- Screening, evaluation and validation of chemicals for oil sands fluid tailings consolidation
- Industrial Research Chair in Oil Sands Tailings Geotechnique.

Partnering with Alberta Innovates – Bio Solutions (AI-Bio)

AI-EES and AI-Bio work closely together in the areas of bioenergy, reclamation and sustainability involving biological systems. AI-Bio expertise in biological conversion such as fermentation complements AI-EES expertise in thermo-mechanical conversion such as gasification and combustion. AI-EES and AI-Bio have established a formal protocol that identifies the working relationship and ensures full alignment between the two Corporations. Examples of joint initiatives include:

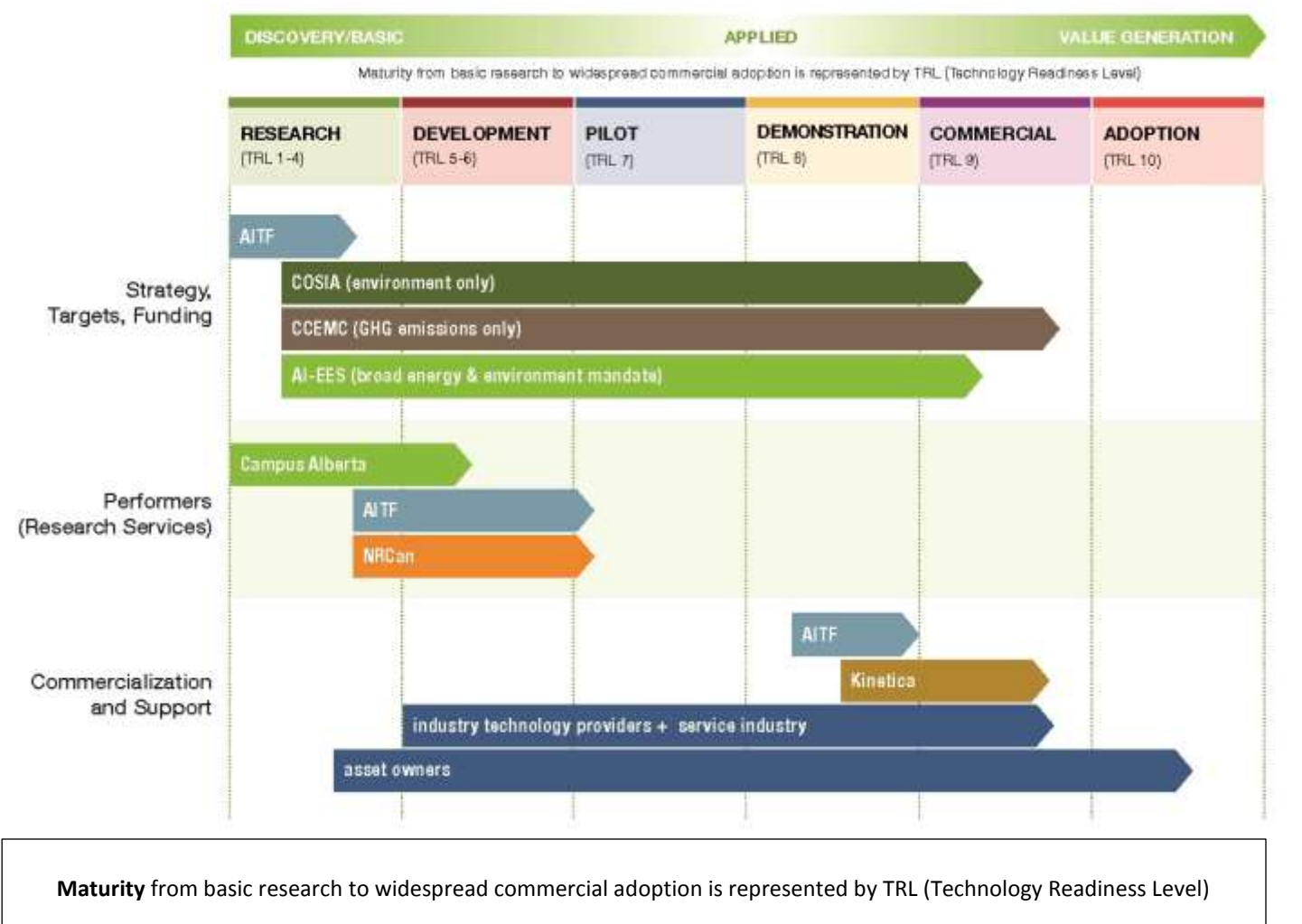
- Nutrient status and retention in reconstructed sandy soils for reclamation
- Industrial Research Chairs in Biodiversity and Conservation
- Industrial Research Chair in Systems Engineering
- Integrated source water management in Alberta
- Creating a predictive eco-site classification platform for Alberta.

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

AI-EES is a member of a variety of industry associations¹¹ 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.

¹¹ Examples include Alberta Chamber of Resources, Petroleum Technology Alliance of Canada, Carbon Management Canada and Alberta Water Council

Figure 9: An illustration of the key organizations working in the energy and environment space and their roles working along the innovation spectrum.



AI-EES has a long history of success as a catalyst to convert Alberta’s natural resources into market-ready, environmentally responsible energy. The figure below illustrates the criteria to assess and evaluate a wide range of initiatives and competitive opportunities for Alberta.

Selected Criteria for Illustration

MAJOR FOCUS AREA	Market Access	Value Added	Environmental Performance	Reduction of GHG Emission	Building Innovation Capacity	Accelerating Commercialization
GHG Capture	✓		✓	✓	✓	✓
Tailings Management			✓		✓	✓
Water Management			✓		✓	
Land Restoration			✓			✓
Bio-waste to fuels		✓	✓	✓		✓
Clean Power	✓		✓	✓		✓
Advanced Recovery		✓	✓	✓		✓
Partial Upgrading	✓	✓				✓

Figure 10: An illustration of some of the criteria used to quantify the impact of AI-EES’ major focus areas on key Alberta outcomes. For simplicity, achievability criteria are not shown.

Considering all possibilities, the AI-EES team has identified its Major Focus areas. This is the area where our organization, working with government peers, 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 not yet in pursuit of projects or programs.

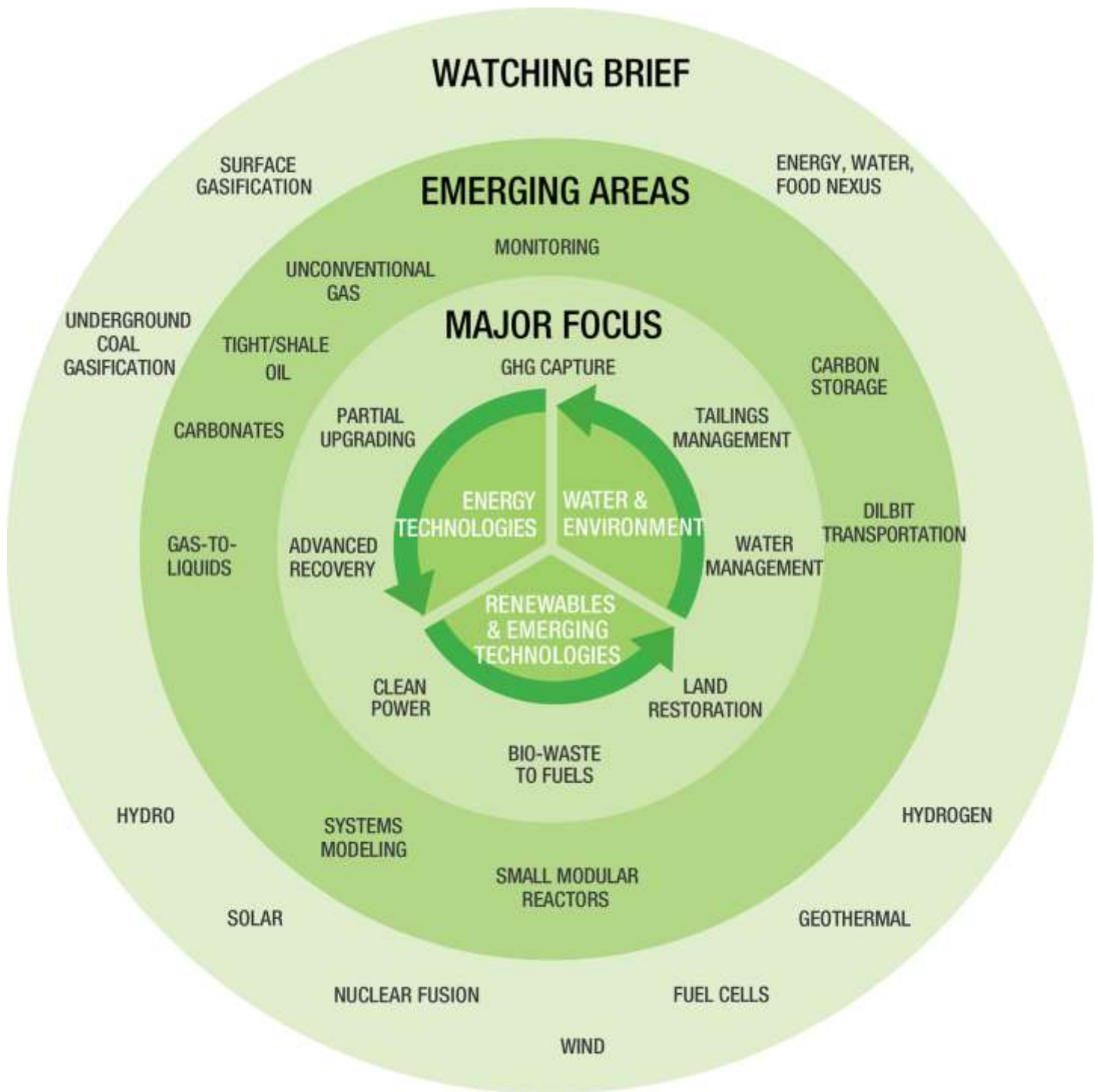


Figure 11: Illustrating the outcomes of the AI-EES' teams' portfolio analysis and selection of priority program areas. Note: energy efficiency is embedded in all of these focus areas.

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

For each Business Planning Cycle, AI-EES assesses the major focus areas to identify the enabling strategies that will lead to meeting the 2030 targets. These targets then guide the Corporation's selection of initiatives and partners to achieve the desired provincial outcomes. For each target, AI-EES also develops outcomes criteria and indicators to monitor the stewardship of these initiatives to ensure targets and outcomes are met.

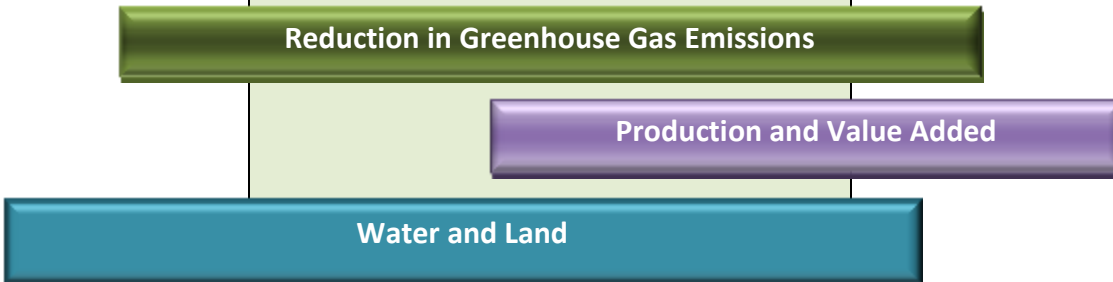
Table 2: Provides a detailed description of AI-EES' 12 targets and outcomes. For simplicity, the current situation is not listed in the table. The current situation can briefly be described as: AI-EES has developed technology initiatives and programs; capacity requirements; risk analyses; technical and commercial assessments; partnerships; and the appropriate milestones to ensure 2030 targets and goals can be met.

Area of Impact	2020 Outcomes and Indicators	2030 Outcomes and Indicators
Greenhouse Gas Reduction	Technologies involving carbon capture utilization and Storage, improving energy efficiency and cleaner energy production have been demonstrated to deliver on the GHG reduction 2030 targets and goals	GHG reduction technologies to achieve the 50% reduction per equivalent barrel basis are at a commercial stage and accepted by industry
Bitumen and Heavy Oil	Technologies have been demonstrated to deliver on advanced recovery to meet 2030 targets	AI-EES has assisted industry in achieving a 50% decrease in GHG emissions and greater than 30% reduction in water on a per barrel basis
Clean Power	Renewable energy technologies for Alberta's electricity sector have been demonstrated to deliver 12.5% of electrical generation and one grid-scale energy storage facility is operational	AI-EES has assisted industry in the commercial production of low-carbon electricity, achieving 20% of electrical generation and deployment of energy storage capacity equivalent to 2.5% of Alberta's generating capacity
Coal/Carbon Demonstration Plants	The technologies have been demonstrated for coal power at a scale to meet 2030 targets and goals	AI-EES has assisted in the development and implementation of one or more Coal/Carbon demonstration plants in Alberta, at natural gas equivalent emissions
Waste to Value-Added	Technologies for municipal solid wastes, agri-forestry residues and industrial wastes to value-added products have been demonstrated and 30% of organic waste has been diverted from landfill	AI-EES has assisted municipalities and industry in commercial production of waste to value-added, achieving a 50% diversion of organic waste from landfill

Area of Impact	2020 Outcomes and Indicators	2030 Outcomes and Indicators
Upgrading and Processing	Technologies have been demonstrated at a scale that will deliver on the partial upgrading 2030 targets and goals	AI-EES has assisted industry in partially upgrading 20% of bitumen to improve quality and reduce the diluents required for transportation
Tight Oil and Challenging Reservoirs	The technologies have been demonstrated to deliver on the tight oil and challenging reservoirs 2030 targets and goals	AI-EES has assisted industry in the development of technology to increase production of tight oil and challenging reservoirs by 25%
Value Added Gas Products	The technologies have been demonstrated to deliver on the 2030 targets and goals for products from natural gas feedstocks	AI-EES has assisted industry in the development of technologies to add value to gas, including at least one gas-to-liquid demonstration plant
Sustainable Water Resources	Projects that will fully deliver on 2030 targets have been demonstrated in urban and rural settings	AI-EES has played a key role in supporting the development of policies, practices and technologies that ensure Alberta has safe, secure and reliable water resources for six million people while maintaining or enhancing the health of aquatic ecosystems.
Water Conservation, Efficiency and Productivity	Projects that will fully deliver on 2030 targets have been demonstrated at a basin, watershed and/or commercial scale	AI-EES has played a key role in development of policies and cost effective adaptive management processes, practices and technologies to improve the overall efficiency and productivity of water use in Alberta by 30%
Oil Sands Tailings Management	Technologies have been demonstrated to stabilize the volume of legacy Mature Fine Tailings (MFT)	Progressive reclamation of MFT and process affected water is at a commercial stage and has become the standard industry practice, and legacy oil sands tailings is reduced by 100 million m ³ over and above government directives
Integrated Land Management	Technologies have been demonstrated at an operational scale to fully deliver on the goals of improving policies and practices for wetlands, land disturbance, ecosystem health, biodiversity, environmental monitoring, and restoration ecology	AI-EES has assisted industry in meeting or exceeding internationally recognized environmental sustainability in Alberta in water, land, air and biodiversity management, including habitat restoration rates that meet or exceed disturbance on a continual basis

As illustrated in Table 3, AI-EES targets are also well aligned with government of Alberta themes of investing in families and communities; advancing world-leading resource stewardship; and securing Alberta's economic future.

Table 3: Illustrating the alignment of AI-EES’ targets and initiatives with seven of the priorities described in Alberta Research and Innovation Plan (ARIP).

GoA Themes	Investing in families and communities	Advancing world-leading resource stewardship		Securing Alberta’s economic future
Triple Bottom Line	Social	Environment		Economic
Alberta’s Key Outcomes	Resilient Healthy Communities	Effective Resource and Environmental Management		Broadened Economic Base
Desired Societal Outcomes	Alberta’s innovation system enhances the health and well-being of Alberta	Alberta’s innovation system mitigates environmental impacts	Alberta’s innovation system enables the cost-effective development and production of natural resources	Alberta’s innovation system drives the growth and diversification of the economy
Relevant ARIP Priorities	<ul style="list-style-type: none"> • Environmental Health 	<ul style="list-style-type: none"> • Reduces GHG Emissions • Optimized water use and management • Integrated land use and management 	<ul style="list-style-type: none"> • Innovation and clean production technology • Waste streams to energy and value added products 	<ul style="list-style-type: none"> • Energy diversification
AI-EES Core business	Positioning Alberta to achieve superior environmental performance while growing and diversifying the energy economy.			
AI-EES Strategic priorities and targets aligned to GoA goals				

RESEARCH AND TECHNOLOGY INITIATIVES

To support the Government of Alberta Themes, AI-EES works in three strategic areas. Our research and innovation objectives and initiatives are listed on the following page.

ENERGY TECHNOLOGIES

Objectives:

- LOWER CARBON AND WATER USE IN DEVELOPMENT OF NON-RENEWABLE HYDROCARBON RESOURCES
- INCREASE MARKET VALUE AND PRODUCT DIVERSITY FOR ALBERTA'S HYDROCARBONS

Initiatives:

1. Pilot(s) advancing lower carbon intensive bitumen recovery technologies using steam, electromagnetic heating and solvents in sandstone and carbonate reservoirs
2. Field upgrading demonstration having high yields and reducing the need for diluents
3. Advancing non-aqueous extraction methods for oil sands
4. Promoting value added opportunities and technology adaptation for natural gas.

RENEWABLES AND EMERGING TECHNOLOGIES

Objectives:

- SUPPORT THE TRANSITION TO LOWER CARBON ELECTRICITY AND FUELS
- PURSUE EMERGING TECHNOLOGY OPPORTUNITIES

Initiatives:

1. Development of a waste utilization industry that contributes to Alberta's environmental benefits, greenhouse gas mitigation, and economic diversity through the production of fuels and energy products.
2. Development of a clean energy system through novel technologies including *next-generation* energy storage.
3. Technology Intelligence system which would identify fit-for-purpose technologies for deployment in Alberta.

WATER AND ENVIRONMENTAL MANAGEMENT

Objectives:

- TO MEET AND EXCEED INTERNATIONALLY RECOGNIZED ENVIRONMENTAL SUSTAINABILITY MEASURES IN WATER, LAND, AIR AND GREENHOUSE GAS, AND BIODIVERSITY MANAGEMENT

Initiatives:

1. Phased scale-up of commercial pilots that minimize produced and legacy tailings, including End Pit Lake (DLP) reclamation
2. Advance research and develop best practices for land reclamation and restoration, including wetlands
3. Identify targets for biodiversity and enable research for conservation and footprint management
4. Research and pilot scale-up for technologies that improve the conservation, efficiency and productivity of water use

5. Work with stakeholders and support research to improve modelling capacity and implement frameworks for safe, secure, reliable water supply
6. Maintain healthy aquatic systems, develop strategies for mitigating and responding to dilbit spills, and identify opportunities to develop, maintain or improve environmental flows
7. Advance best practices and support research and modelling that improve watershed management
8. Technology developments for fugitive gas capture, and influence policy incentives for CO₂ capture.

OVERALL ACHIEVEMENT OF LONG TERM TARGETS - BUSINESS TRACKING

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

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 Methodology¹²:

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.

The above information is input to the ProGrid program and Performance Grids are created. The goal for AI-EES is to get to the x=10, y=10 location on the grid by 2030. As the evaluation is completed each year, progress towards the upper right hand corner is shown.

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

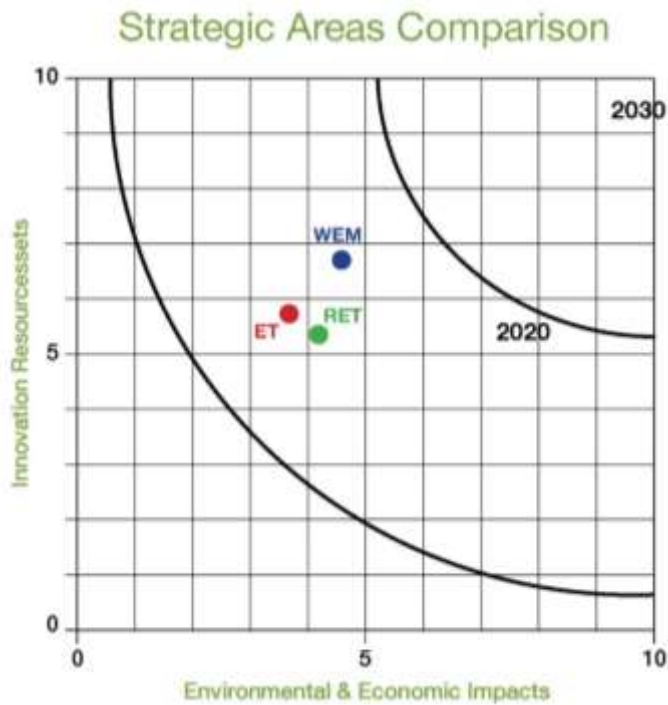


Figure 12: Water and Environmental Management is closest to achieving their 2020 targets. Energy Technologies and Renewable and Emerging Technologies are 10 to 15 per cent lower in their chart position. However, all AI-EES programs are on track to achieve 2030 targets (See page 25). Alignment of goals, outcomes, performance measures and research and innovation initiatives for a thorough explanation of the AI-EES' pathway to achieve these targets

TECHNOLOGY READINESS LEVELS (TRL)

AI-EES evaluates projects and tracks their success by assessing their TRL relative to progress and milestones achieved (Figure 13 provides a simplified TRL). This 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.

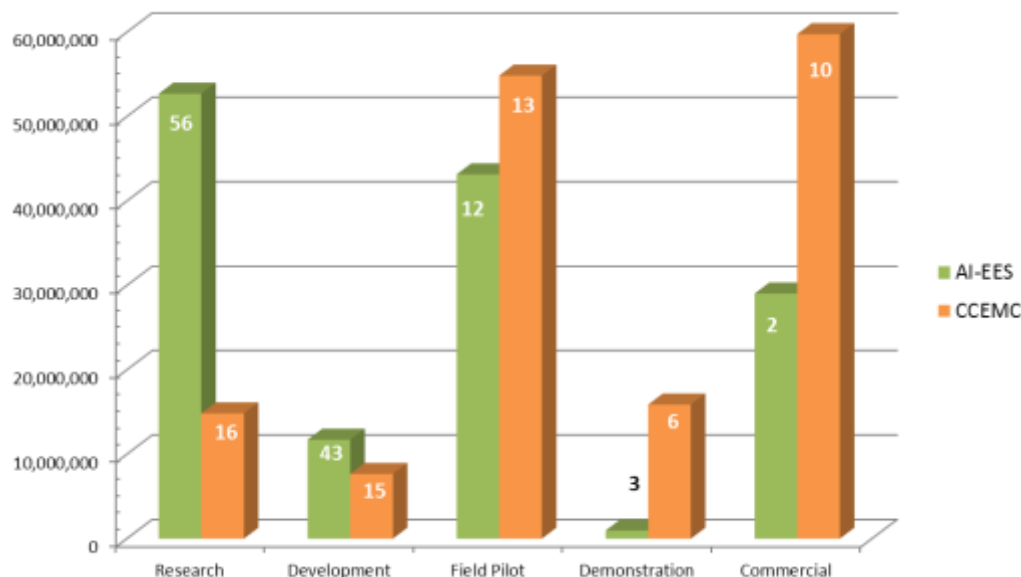


Figure 13: 2013-14 Mapping AI-EES' active projects along the innovation path. Number of projects in each level is noted on the bar. The vertical axis (Y) denotes the dollars invested.

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.

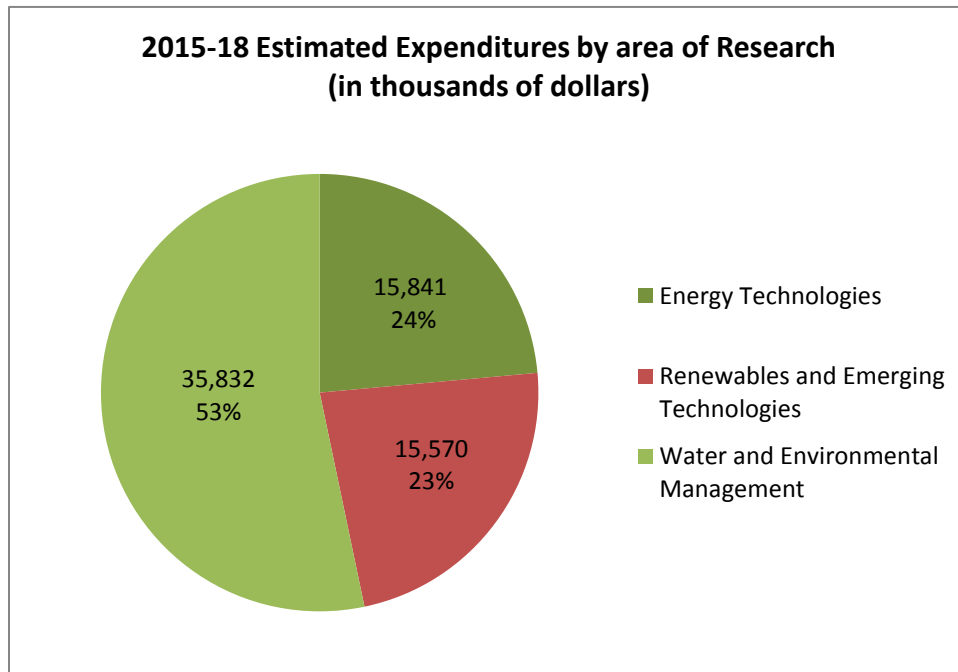


Figure 14: This chart shows the 2015 – 2018 estimated investment in each strategic area.

BUDGET AND RESOURCE REQUIREMENTS

Table 4

Three Year Budget

(thousands of dollars)	Comparable					
	2013-14*	2014-15		2015-16	2016-17	2017-18
REVENUE	Actual	Budget	Forecast	Estimate	Target	Target
Funding from Innovation and Advanced Education	14,385	14,385	14,385	13,445	13,445	13,445
Restricted Funds for AI Centres	600	2,240	2,240	2,049	2,049	2,049
Restricted Funds for Water and Tailings	3,324	6,694	6,463	3,859	1,943	
Restricted Funds for New Water Research				5,000	5,000	5,000
Restricted Funds for AWRI	1,947	2,781	2,095	2,515	557	
Funding from other GOA Ministries	53	2,030	1,080	2,600	3,000	4,600
Funding from other Government Sources	36		139			
Industry Funding	2,104	940	2,409	1,164	964	900
Investment Income	568	400	608	447	343	350
Intellectual Property Income	15	11	269	11	11	11
Other Revenue	115		27			
Total Revenues	23,147	29,641	29,715	31,090	27,312	26,355
EXPENSES						
Energy Technologies	4,739	7,339	5,085	6,007	4,749	5,504
Renewables and Emerging Technologies	485	6,437	3,178	5,764	6,628	8,610
Water and Environmental Management	2,983	4,878	2,811	3,544	2,679	1,243
Water and Tailings Grants	3,403	4,194	6,463	3,859	1,943	472
New Water Research				5,000	5,500	7,500
AWRI Research Grants	2,595	2,316	1,683	2,080	120	
Total Research	14,205	25,164	19,221	26,254	21,619	23,329

	Comparable					
	2013-14*	2014-15		2015-16	2016-17	2017-18
	Actual	Budget	Forecast	Estimate	Target	Target
Program Administration	4,887	4,212	4,878	4,988	5,089	5,223
Technical Support Services	1,106	4,157	1,374	1,998	1,595	1,250
Grand Total Expenses	20,198	33,534	25,473	33,240	28,303	29,802
Net Operating Results	2,949	(3,894)	4,243	(2,150)	(991)	(3,447)
Net Assets Beginning of Year	26,575	32,518	29,525	33,768	26,090	16,377
Add Net Operating Results	2,949	(3,894)	4,243	(2,150)	(991)	(3,447)
Less Total Projects - Applications		5,800		5,449	8,794	4,308
<i>Net Assets, End of Year, adjusted for pending applications</i>	29,525	22,825	33,768	26,169	16,305	8,622
Less Contingency Fund		6,504		1,000	1,000	1,000
Less Allowance for Wind Up Costs		1,900		1,900	1,900	1,900
Adjusted Net Assets, End of Year	29,525	14,421	33,768	23,269	13,405	5,722

*2013-14 expenses have been restated to show greater alignment of fee for service contracts with research areas.

Research and Innovation Priorities - Budget Allocations to Key Outcomes for 2015-16 Business Plans

Research and Innovation (RI) Priorities	Total 2015-16 Budget (\$'000)	Key Outcomes of the Alberta Research and Innovation System		
		Effective Resource and Environmental Management (\$'000)	Broadened Economic Base (\$'000)	Resilient, Healthy Communities (\$'000)
Energy Technologies	6,007	3,004	3,003	
Renewable and Emerging Resources	5,764	2,882	2,882	
Water and Environmental Management	3,544	1,772	1,772	
Water and Tailings Research	3,859	1,286	1,286	1,287
New Water Research	5,150	1,717	1,717	1,716
AWRI Research	2,080	693	693	694
Total	26,404	11,354	11,353	3,697