

# Alberta Energy Research Institute

## “Leading in Clean Energy Innovation”

### Annual Report 2008-09 A Year in Review

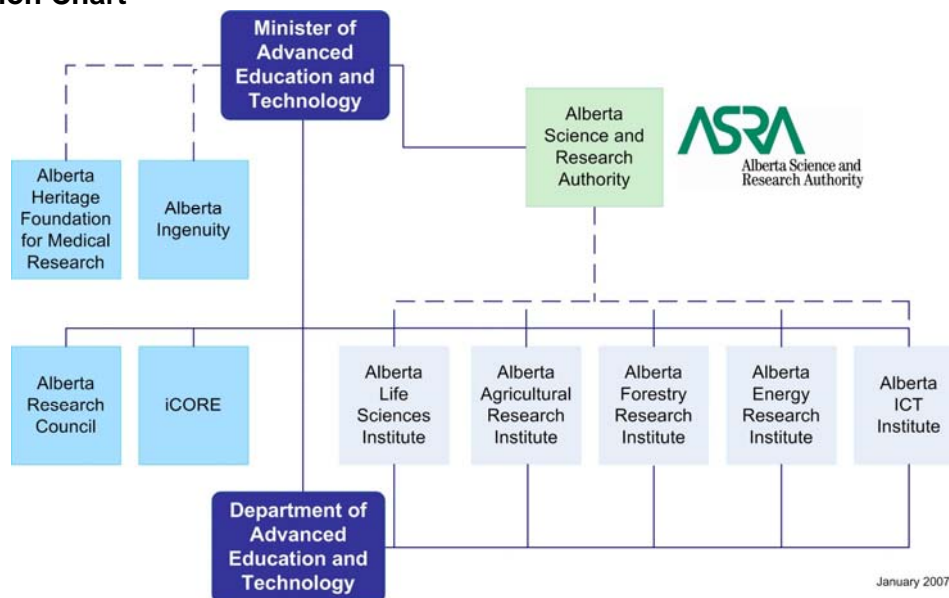
#### Overview

The Alberta Energy Research Institute (AERI) is an unincorporated board established under the *Alberta Science and Research Authority (ASRA) Act*. Its mandate covers research and technology development and demonstration in all forms of energy of importance to Alberta. AERI works closely with other Alberta government departments (Energy, Environment, and Finance and Enterprise) to accomplish its mandate and goals, and to ensure alignment with other government strategies. AERI also works with other Research Institutes and business areas within Advanced Education and Technology.

The Alberta Energy Innovation Strategy and AERI’s business plan are designed to position Alberta for the future in energy and environment so as to create value and build a strong Alberta economy. Alberta has a unique combination of resources which allow an integration strategy that maximizes synergies, protects the environment, and aids in the development of coal, oil sands, heavy oil, refining, petrochemicals, and alternate energy resources.

New technologies are the key to assuring Alberta’s global competitiveness, whether with Saudi Arabia and Russia in oil and gas production, with the US Gulf Coast in refined products and petrochemicals, or with the rest of Canada in renewable energy. New technology implementation will require long-term research and technology development efforts, which will in turn require dedicated and patient investment on the part of AERI and its partners in industry and other governments.

#### Organization Chart



January 2007

## **AERI Board (as of March 31, 2009)**

Mr. Eric Newell, Co-Chair  
Mrs. Genia Leskiw, Co-Chair, MLA Bonnyville-Cold Lake  
Mr. Jim Ellis  
Mr. Aaron Falkenberg  
Mr. Charlie Fischer  
Mr. Paul Galachiuk  
Dr. David Lynch  
Dr. Robert Mansell  
Ms. Patrice Merrin Best  
Mr. Peter Watson

## **AERI Staff**

Dr. Eddy Isaacs, Executive Director

### ***Professional Staff:***

Dr. Ted Cyr, Special Advisor, Energy Projects  
Dr. Duke du Plessis, Special Advisor, Clean Carbon/Coal  
Les Little, Program Director, Improved Recovery  
Dr. Shunlan Liu, Program Director, Bitumen Upgrading  
Richard Nelson, Program Director, Alternate & Renewable Energy  
Dzung Nguyen, Senior Advisor, Emerging Energy Opportunities  
Dr. Surindar Singh, Program Director, CO<sub>2</sub> Management  
Kate Wilson, Program Director, Technology Platforms  
Ken Brown, Special Advisor, Improved Recovery

### ***Operations Staff:***

Alice Barr, Manager, Strategic Planning and Operations  
Aleksandra Bizon, Technical Information Officer, AOSIS  
Marta Bor, Administrative Support, Edmonton  
Susan Emilsson, Administrative Support, Calgary  
James Fan, Systems Intern  
Donna Kostuik, Administrative Support, Calgary  
Janet Lilly, Records Administrator  
Lindsey Mosher, AOSIS Technical Intern

## Message from the Board

The 2008-2013 Strategic Business Plan itemized specific initiatives that should be undertaken to support the Government of Alberta's key priorities, including “*sustainable development of Alberta's energy resources*” and “*value-added innovation and a skilled workforce*” as priorities. Technology development is the key to maximizing the value gained from Alberta's natural energy resources and ensuring that competitiveness and environmental performance are balanced in delivering on these priorities.

AERI is the strategic energy technology arm of the Alberta Government. AERI develops and implements the energy innovation strategy for Alberta and, in partnership with industry and other government agencies, invests in collaborative applied research, technology development, and pilot demonstrations along the entire innovation chain.

AERI's six strategic programs areas are: Bitumen Upgrading, Clean Carbon/Coal, Improved Recovery, Renewables, CO<sub>2</sub> & Emissions, and Water Use.

AERI's investments are focussed on technology platforms that include:

- Carbon capture and storage
- Gasification
- Catalysis
- Hydrogen generation
- Separation technologies
- Advanced *in-situ* processes
- Advanced and nano materials

AERI's research and technology thrusts align well with “*Alberta's Provincial Energy Strategy 2008, Launching Alberta's Energy Future*”, *Responsible Actions: A Plan for Alberta's Oil Sands*” (Feb. 2009), “*Alberta's 2008 Climate Change Strategy*” (Jan. 2008), and “*Water for Life – A Renewal*” (Nov. 2008).

The AERI Board has extensive expertise in energy technology and economics, and the business acumen to assess and undertake large technology projects. These are important competencies which provide strong oversight and ensure that Alberta's energy strategy is managed effectively.

AERI's staff are internationally recognized in energy and environmental technologies and have developed considerable expertise in the objective and systematic evaluation of technologies, projects, and project partners. AERI has an established track record and reputation, and is viewed as a valued and trusted partner within both the private and public sectors. The AERI Board places considerable importance on this expertise and reputation, and believes that the acquisition and application of credible and objective information on technical options and their implications must inform government policies and actions.

While AERI's programs are focussed on key technology platforms such as gasification, carbon capture and storage, upgrading, and advanced recovery, AERI also maintains an extensive watch on emerging technologies that could be significant to longer term

energy supply and environmental performance, such as bio-energy, geothermal, nuclear (fission and fusion), nanotechnology, carbonate resources, and underground coal gasification. In this regard, AERI is well positioned to play an advisory role to government in terms of the progress on emerging technology.

AERI has played a significant role in promoting innovation in the energy sector, particularly in the oil sands and power industries. AERI has an excellent reputation in the industry as an open, transparent, and flexible partner. The AERI Board therefore strongly recommends that its role be strengthened to become the primary vehicle for developing and implementing Alberta's research and innovation strategy in energy and environment.

Moving beyond 2008-09, AERI faces some new challenges, but also has significant new opportunities. We have reached the end of the Energy Innovation Fund envelop, which provided significant enhancements to programs in renewable energy, clean coal, carbon capture and storage, and value-added hydrocarbon upgrading. Offsetting this are the ecoTrust funding envelope and the Climate Change and Emissions Fund, which AERI has been asked to manage, and which will provide significant new resources to advance technologies on greenhouse gas emission reduction and clean energy.

In the coming year, AERI will be transitioning to a new provincial corporation focussed on energy and environment as part of the restructuring of Alberta's innovation system, which will affect all provincially funded research organizations in the province. AERI Board and staff look forward to the new mandate, and are excited about the changes, the challenges, and the opportunities that the new corporation will bring. We are committed to work as hard as ever on behalf of Albertans, to partner with industry, and to continue to develop the robust capacity needed in industry and universities to create and maintain a sustainable and diversified energy economy.

Sincerely,



Eric Newell  
Industry Co-Chair



Genia Leskiw  
MLA, Co-Chair

June 2009

## **AERI's Vision:**

Alberta leads the world in developing innovative technologies that build on our natural advantages to achieve a prosperous, environmentally sustainable, and diversified energy economy.

## **AERI's Mission:**

To increase the energy and environment industries' capacity to develop and adapt innovative technologies that maximize the value of Alberta's natural and renewable resources.

## **AERI's Strategic Intent:**

AERI achieves its mission by promoting collaborative research and development along the entire innovation chain, in partnership with industry and other funding organizations. AERI works closely with the Alberta Ministries of Energy, Environment, and Finance and Enterprise to strengthen the province's energy and environmental sectors. AERI takes a strategic view for acquiring, advancing, and integrating the knowledge vital to Alberta's global leadership in energy and the environment.

## **Focus Areas and Global Leadership**

AERI's success is founded on its strategy of viewing the energy sector as an "integrated energy economy." Rather than looking at distinct research gaps in each area of oil, coal, emissions, or water, AERI surveys the bigger picture and captures the opportunities that are found through perceiving the energy sector as an integrated whole. To do this efficiently, AERI focuses on "technology platforms", areas of major research competencies which serve as the foundation for a series of research initiatives and programs to achieve Alberta's energy goals. AERI's technology platforms are:

Carbon capture and storage	Gasification
Catalysis	Hydrogen generation
Separation technologies	Advanced in-situ processes
Advanced and nano materials	

AERI's main areas of research are divided into six programs. AERI first identified these programs in the 2004 *Alberta Energy Innovation Strategy*, developed goals for 2012 and 2020 for each program, and defined targets by which the rate and extent of investments could be measured. We believe clear potential exists for Alberta to realize both jurisdictional advantage and global leadership through each of these programs:

Bitumen Upgrading	Clean Carbon/Coal
Improved Recovery	Renewable Energy
CO <sub>2</sub> and Emissions	Water Use

## **2008-09 Key Activities – Highlights**

This was the final year for funding from the Energy Innovation Fund sponsored by Alberta Energy. In total, this fund provided \$76.7 million for 16 projects from 2006-07 to 2008-09. AERI added its own funds to this amount, and a total of \$103.1 million will be invested in these projects by 2011-12.

AERI has been working on a number of major initiatives that are helping to achieve Alberta's clean energy goals, including:

- The Hydrocarbon Upgrading and Demonstration Program (HUDP)
- Genesee Integrated Gasification Combined Cycle (IGCC) Project
- Carbon Capture and Storage (CCS)
- Gasification of Municipal Waste
- Water Management in Oil Sands Applications
- Life Cycle Analysis of Crude Oil's entering US refineries
- Environmental Projects
- The Energy Innovation Platform of Alberta – A Knowledge Management and Technology Transfer System

These initiatives are aligned with and integrated within AERI's programs. A description of each follows.

### ***The Hydrocarbon Upgrading and Demonstration Program (HUDP)***

This program addresses two key needs identified in the February 2005 Hydrocarbon Upgrading Task Force workshops: the need to demonstrate new upgrading technology, and the need for trained personnel in the downstream oil and gas industry. Eight HUDP projects were approved in 2007-08 including:

- **Great Point Energy:** This project is pilot-testing a catalytic gasification technology to convert Alberta's pet coke and coal to synthetic natural gas in a single step, producing a sequestration-ready CO<sub>2</sub> byproduct.
- **ETX System Cross-flow Coking:** This project involves pilot testing of a process designed to more efficiently convert bitumen to lighter products.
- **Pratt & Whitney Rocketdyne:** This advanced gasification technology for generating hydrogen steam and electricity is based on rocket engine design concepts. It has the potential to significantly reduce the size and capital cost associated with gasification plants.
- **Nova Chemicals:** This project involves the development and scale-up of technologies for converting bitumen fractions to petrochemical feedstocks.
- **OPTI:** This project is an engineering design and costing of retrofitting to enable the capture of CO<sub>2</sub> from the Opti-Nexen Long-Lake oil sands plant producing premium synthetic crude oil.
- **UOP:** This project involves the development of an advanced upgrading technology using slurry phase hydro-cracking to increase the yield and quality of synthetic crude oil.
- **AlterNRG:** This project involves the design of an advanced plasma gasification demonstration plant to produce electricity and chemicals from biomass and waste feedstock.
- A solvent de-asphalting process based on new concepts developed in Phase 1 of HUDP.

### ***Genesee IGCC Project***

This project involves the front-end engineering design (FEED) of a 275-megawatt Integrated Gasification Combined Cycle (IGCC) plant that will capture CO<sub>2</sub> and also reduce other emissions of concern. The project was launched in 2006 with funding from AERI and EPCOR; Natural Resources Canada has recently provided funds to enable its completion. It forms an

important part of Alberta's strategy to add value to our resources and to reduce greenhouse gases and other emissions of concern (NO<sub>x</sub>, SO<sub>2</sub>, particulate matter, and mercury). The results of the study will be available to the members of the Canadian Clean Power Coalition as well as other industries. The gasification technology has been selected, and detailed FEED work and plant permitting are under way.

### ***Carbon Capture and Storage***

AERI has undertaken a number of projects in this area. One major area of research is the sequestration of CO<sub>2</sub> in deep saline aquifers, which consists of four projects involving industry, university, and the Alberta Research Council. Work on the beneficiation of coal will allow western Canadian coals to be gasified more cleanly, resulting in less CO<sub>2</sub> production. The Pembina Cardium CO<sub>2</sub> Monitoring Pilot involved the monitoring, measurement and verification of carbon dioxide dispersion at PennWest's CO<sub>2</sub>-Enhanced Oil Recovery field pilot within the Cardium formation of the Pembina field. The tasks included geology and hydrogeology, reservoir modeling, reservoir surveillance, geochemical, geophysical and environmental monitoring, reservoir and seals and the potential for CO<sub>2</sub> leakage.

### ***Gasification of Municipal Waste***

This involves a piloting facility to demonstrate the production of synthetic gas, electricity, and bio-fuels – initially from municipal solid waste, and expanding to include agriculture and forestry biomass. The success of this project could have tremendous impact for municipalities in Alberta for their efforts to reduce waste going to landfills, and to produce valuable products from bio-wastes. Municipalities are facing increasing pressure as numerous landfills near their capacity, and a variety of issues makes the building of new sites more difficult. The demonstration plant is based on a fluid bed gasification test facility; it will be used in a plug-and-play fashion to test a variety of technologies to convert biomass and waste to valued products. Detailed design, permitting, and construction of the accompanying R&D facility are currently underway.

### ***Water Management in Oil Sands Applications***

This project is focused on the water use in oil sands tailings ponds and the accumulation of fine tailings. AERI initiated an investigation of alternative tailings treatment technologies and at the same time has been working very closely with the Energy Resources Conservation Board and Alberta Environment on developing a "Tailings Management Strategy" that integrates technology, regulation, and policy.

### ***Life Cycle Analysis of Crude Oils entering US refineries***

AERI initiated projects to understand treatment of oil sands versus other "conventional crudes" being processed in the US as currently represented in standard life cycle analysis (LCA) models, while developing a rigorous methodology to evaluate and compare specific crudes and pathways from production through motor fuel products. Preliminary results based on sound scientific and engineering principles have shown that GHG emissions for bitumen derived transport fuels are comparable to conventional crudes, especially when power co-generation is considered.

### ***Environmental Projects***

AERI has worked with Alberta Environment, the Petroleum Technology Alliance of Canada, and the Government of British Columbia over the last two years on the Energy Environment

Technology Fund program (EETF). The program provided funding for many environmental projects, including studies on biomass from mountain pine beetle infected wood, power from waste heat, oil sands tailings, beneficial use of produced water, wind forecasting, and geothermal energy.

A key project was the study to examine technology options that use solid and liquid fuels (alternatives to natural gas) for steam generation for the thermal recovery of bitumen. The results provided the economic conditions (natural gas and carbon prices) where alternative options to natural gas use may have an advantage.

Other EETF projects this past year have included: a collaboration with Clean Air Strategic Alliance on the best available pollution control technologies for the coal-fired electricity industry in Alberta; fugitive emissions capture and combustion on natural gas processing plants; the use of carbon isotopes to assess the potential of contamination of underground aquifers due to coal bed methane activity, and determining the optimal scenarios for energy use by the proposed upgraders for the Industrial Heartland.

AERI also advanced significantly this past year with a very exciting initiative to explore Alberta's potential for the gasification of deep underground coal resources to produce synthetic natural gas. The Swan Hills Synfuels project has progressed in construction to the point where start-up of the underground gasification process is scheduled to begin in the June-July timeframe of 2009.

Another major project started this year will explore the production of a variety of "green" chemicals from syngas, using a range of catalytic strategies, novel reactor configurations, and purification techniques, and will yield the basic information required to assess the technical and economic potential of such processes.

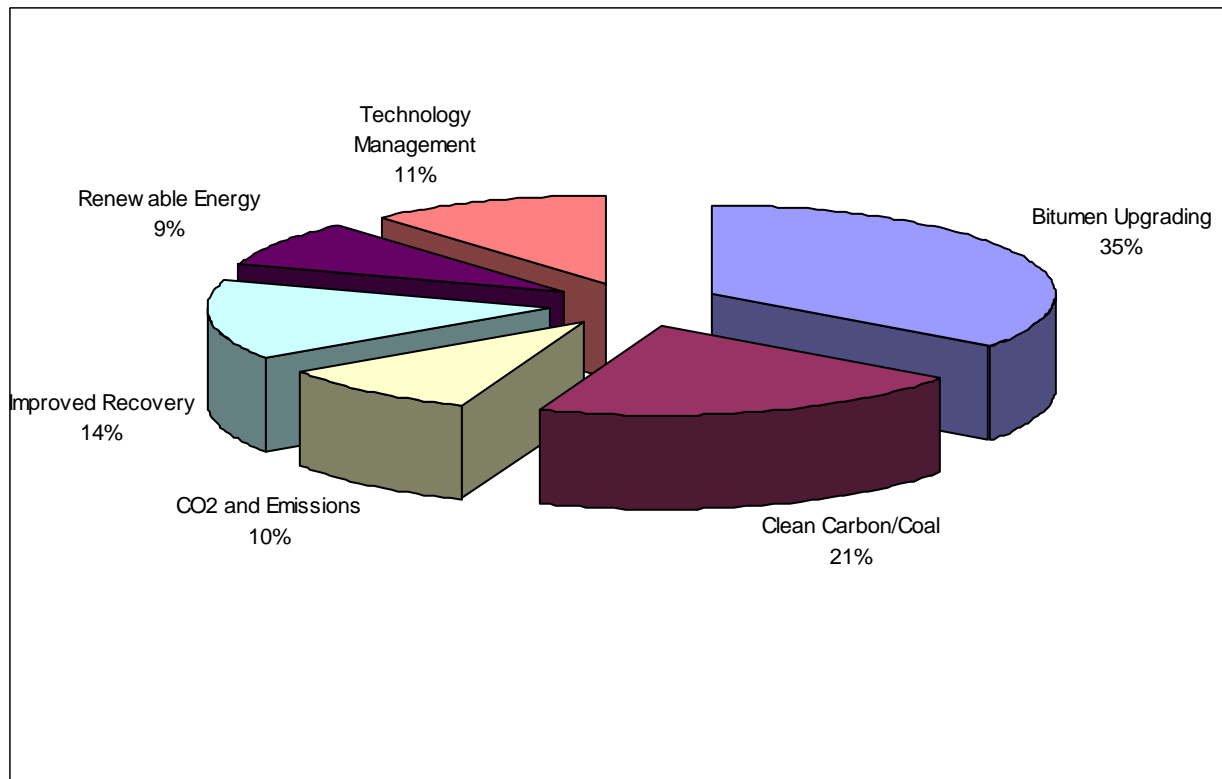
### ***The Energy Innovation Platform of Alberta***

AERI launched the Energy Innovation Platform of Alberta (EIPA), which is a web-based service allowing the public access to titles and abstracts of 35 years of government funded research projects. Work will continue on the development of the database, including scanning all research reports, so that the materials are more readily available. Plans include mining the data and developing technology seminars. EIPA is part of a larger departmental initiative called "Showcase Innovation Service", which will facilitate technology transfer and collaboration between government, industry, and academia.

## 2008-09 Investment Profile and Capacity Building

In total, \$25.2 million was invested in research and innovation projects through grants to various organizations, representing 89% of AERI's total program delivery budget. An additional \$3.2 million was spent on technology management areas which include independent consultants, commissioning of feasibility and economic studies, development of the website for the Energy Innovation Platform of Alberta, and independent reviews of project results.

**2008-09 Expenditures by Area of Research**



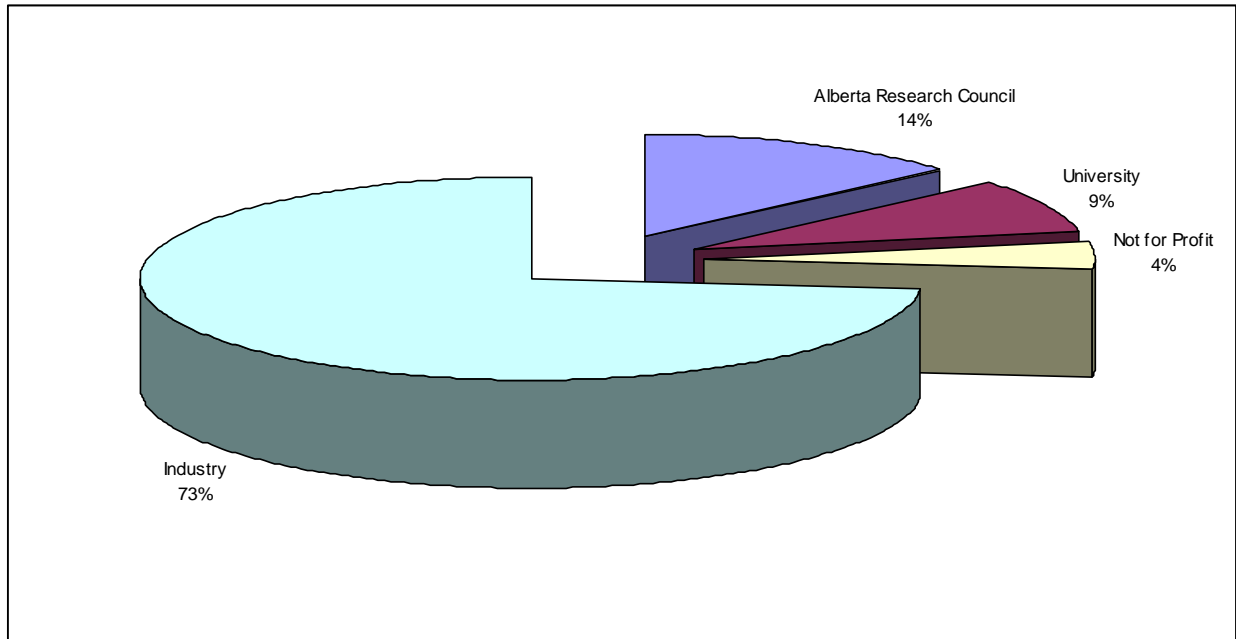
AERI continues to work with the universities in order to build research capacity in Alberta. In 2008-09, AERI provided funds for six Chairs:

- Petroleum Thermodynamics, University of Alberta (Shaw)
- Drilling, University of Calgary (Hareland)
- Oil Sands Engineering, University of Alberta (Xu)
- Petroleum Microbiology, University of Calgary (Voordouw)
- Tight Gas, University of Calgary (Aguilera)
- CMG Foundation, University of Calgary (Chen)

AERI also supported 39 projects at the universities: 12 projects at the University of Alberta for a total of \$751,059; and 25 projects at the University of Calgary for a total of \$1,390,433. The large discrepancy in funding is due to a large upfront payment to the COSI project at the University of Alberta last year. In total, in 2008-09, AERI provided \$2.2 million to university based projects.

AERI continued its support in 2008-09 for the National Centre for Upgrading Technology, which is jointly funded by the Government of Alberta and Natural Resources Canada, to develop and maintain a world-class centre of excellence for bitumen upgrading in Alberta. AERI continues to partner with the Alberta Research Council (ARC) and twenty energy companies in the AERI/ARC Core Industry (AACI) program to develop and improve heavy oil and bitumen recovery technologies. In total, AERI supported ARC on 15 projects with total expenditures of \$3.4 million.

### 2008-09 Expenditures by Performer



### Conclusion

Looking forward, AERI is excited about the changes that have been proposed under the *Alberta Research and Innovation Act*. AERI is looking forward to the changes that will be required under the new legislation. The new energy and environment group will have an expanded mandate with greater emphasis on environmental research; greater responsibility and accountability for investments; and greater opportunities to work with other departments and funds such as *ecoTrust* and *Climate Change and Emissions Management Fund*. This will allow the new entity to strengthen its role as the technology implementation arm for Alberta in energy and environment.