

Alberta Energy Research Institute Annual Report 2003-04 A Year in Review

Overview

The Alberta Energy Research Institute is an unincorporated board established under the *Alberta Science and Research Authority Act* and comprised of representatives from industry, academia and government. AERI provides strategic direction to position Alberta for the future in energy development, and invests in innovation and technology to enhance the sustainable development of the province's abundant energy resources.



Message from the AERI Board

It has been a momentous year for the Alberta Energy Research Institute (AERI) with the Challenge Dialogue Process and the development of Energy Innovation Network (EnergyINet) undertaken to implement the Alberta Energy Innovation Strategy released in 2002-03. Through active consultation with industry, federal and other provincial governments, we have successfully provided the framework for an integrated energy network to create value from Alberta's abundant resources, improve environmental performance and build a strong economy.

The EnergyINet initiative is focusing on six strategic innovation program areas: oil sands upgrading, clean coal/carbon, and carbon dioxide (CO₂) management, improved recovery of conventional oil and gas; water management, and alternative and renewable energy. In 2003-04, EnergyINet innovation programs were launched in oil sands upgrading, clean coal/carbon, and CO₂ management. Considerable momentum has also taken place in developing the improved recovery and alternate and renewable energy innovation programs. All these innovation areas support the development of clean energy and address climate change.

The AERI staff lead by Dr. Eddy Isaacs have worked exceptionally hard to create opportunities for research and innovation in energy and manage research programs while building complex relationships and trust with industry, governments, and the research community. We applaud their efforts.

We would like to also thank Bob Church, now Chair Emeritus of the Alberta Science and Research Authority for his advice and support for energy research over the past number of years. His participation and encouragement has been critical to our goal of research excellence in Alberta.

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Denis Ducharme, M.L.A.
Co-Chair

Original Signed

Len Bolger
Co-Chair

June 25th, 2004

Challenges and Opportunities

The AERI mandate is research into all sources of energy of importance to Alberta aimed at creating commercial value. The intent is to centralize and focus all of the government-supported energy research and innovation to respond effectively to the opportunities and risks associated with global energy markets. Strategic investments in energy research and technology programs and innovation systems will ensure the utilization of existing and new energy resources to their fullest potential and Alberta will grow as the premier energy region in North America. The “prize” for responding well represents billions of dollars of value for Alberta, and for Canada.

The Alberta Energy Utilities Board, in its Statistical Series 2002-98, identified that conventional oil and natural gas reserves are depleting. At current rates of production and without large drilling programs, Alberta has about 7 years remaining in oil and 9 years in natural gas. New technology is required to unlock the large remaining conventional reserves. Of major importance is the fact that given the right technologies, bitumen, coal and coal bed methane have hundreds of years of production remaining. Production of those reserves is dependent on finding effective solutions and the technologies to address major risks including:

- o Production costs (steam generation) affected by rising cost of natural gas.
- o The cost of hydrogen needed for upgrading of bitumen to higher valued products.
- o Availability of natural gas liquids used as feedstock for the growing petrochemical sector.
- o Bitumen and synthetic crude have market limitations and will lose value as additional production comes on stream.
- o Addressing air emissions, land access, and water management issues is critical to ensuring continued “access to resources”.
- o CO₂ emissions need to be addressed in the context of climate change.

To respond to these risks, and take advantage of the enormous resource opportunities, AERI has developed a transformative strategy that is being implemented through integrated and collaborative networks. The direct involvement and guidance of industry and the innovative capacity of the research community are imperative. AERI is working closely with these partners in developing networks to turn these risks into opportunities and ensure the continued prosperity of Albertans. AERI also has for several years now recognized that the status quo and continued fragmentation in funding, research delivery and in common goals, would not achieve our ambitious energy vision.

AERI developed the Alberta Energy Innovation Strategy to position Alberta for the future in energy and provide an integrated and collaborative framework. It was adopted by ASRA and recommended to government in June 2002. The strategy, in its entirety, became the technology and innovation component of Alberta’s Climate Change Action Plan in October 2002. In February 2004, the strategy became official Alberta Government policy and was highlighted in the Speech from the Throne.

Key Activities

Activities undertaken by AERI over the 2003-04 fiscal year support the directions established by the Alberta Science and Research Authority, and also support the Alberta Innovation and Science Business Plan 2003-06, **GOAL 2:**

“To support energy research that will contribute to Alberta's sustained prosperity and quality of life.”

AERI has undertaken a number of initiatives throughout the past year that will lead to a fully integrated and collaborative research network in Alberta and across Canada. The main thrust has been to establish the Energy Innovation Network (EnergyINet) and to have the base strategy developed by AERI adopted and adapted by this larger network.

AERI also works to integrate projects across the research development continuum and ensure that fundamental research has a chance to move through to development and commercial implementation. The AERI staff has identified several key platform technologies that can link various innovation program areas.

EnergyINet: AERI moved the Energy Innovation Strategy to an implementation stage through pro-active dialogue with industry, federal government and other provincial government participants from across Canada to establish a collaborative and integrated network, EnergyINet, that would create value from our energy resources, improve environmental performance and build a strong economy. This resulted in the launch of the “EnergyINet” innovation programs in oil sands upgrading, clean coal/carbon, carbon dioxide (CO₂) management, natural gas & conventional oil and alternative & renewable energy.

EnergyINet’s Vision:

An abundant supply of environmentally responsible energy, creating economic prosperity and social well-being for Canadians

For each of the Innovation Programs, long-term visions and goals are set. Each Program is examining the current state of the industry and the business drivers and developing strategies and tactics to address the technology gaps and reach the long-term goal. Therefore, not only are the technological needs of industry and government examined, but also global intelligence and capacity building will be integrated into each Program.

- **Feasibility Studies:** To further develop the integrative and collaborative nature of energy research in Alberta, AERI and its partners have commissioned several feasibility studies that detail the gaps that need to be addressed and serve as the framework for the innovation programs. For example, AERI working with Alberta Energy identified a need to accelerate technology deployment in natural gas and conventional oil. AERI contracted with the Petroleum Technology Alliance of Canada to study existing and future needs of the industry. This resulted in the study titled “*Spudding Innovation.*” The findings from this report have formed the basis for the development of the Innovative Technologies Royalty Program (led by Alberta

Energy) and the Natural Gas and Conventional Oil Recovery Innovation Program (under EnergyINet).

AERI initiated or participated in several other energy technology road mapping and feasibility studies including:

- Results from the Alberta Chamber of Resources “*Oil Sands Technology Roadmap: Unlocking the Potential*” and the AERI/Nova “*Petrochemicals from Oil Sands*” study are being integrated and have encouraged research projects in Alberta, China and Germany that look at increasing the value of and finding new potential markets for the oil sands resources. A task force to build a business case for an integrated upgrading/ refining/ petrochemical complex in Alberta has also been launched under the leadership of Alberta Energy and Alberta Economic Development.
 - CCPC Feasibility Study: The Canadian Clean Power Coalition (CCPC) completed its Phase 1 evaluation of technologies for generating clean power, including carbon dioxide capture, from 3 typical Canadian coal types. Gasification was selected as the most promising technology and polygeneration (production of power, hydrogen and heat) from coal and coal/coke mixtures were identified as the most promising and cost effective process schemes for demonstration plants. This has led to the development of a Phase 2 project that will determine optimal gasification technologies, integrate the capture and use of CO₂, and develop business cases for the optimal development of products resulting from gasification. Other studies on hybrid gasification options, hydrogasification application to oil sands and coal beneficiation are being integrated into this work.
 - In the area of Alternative and Renewable Energy, AERI commissioned a report on Fuel Cells and Hydrogen Opportunities, Fuel Cells to Grid and Bio-Energy. These studies will be used as the basis for an innovation program focused on alternative and renewable energy.
- **University Chairs:** AERI supported four University Chairs – in advanced coal combustion, petroleum thermodynamics and upgrading at the University of Alberta and a chair in drilling at the University of Calgary.
 - **Catalyst Development Network:** AERI led the development of a network of catalyst research expertise in Alberta by co-funding key upgrading projects with industry to increase the value of Alberta bitumen via catalysis.
 - **VAPEX Field Pilot:** AERI continues to participate with nine leading Canadian oil and gas producers (the DOVAP consortium) in a field pilot to test the economic, environmental and technical viability of a new recovery technology, which has the potential to lower greenhouse gas emissions and reduce water consumption from oil sands and heavy oil reservoirs.
 - **Gas-Over-Bitumen:** AERI and the Alberta Department of Energy co-founded the gas-over-bitumen technical committee. Working with industry, AERI developed and provided technical and financial support for three projects to develop novel gas-over-bitumen technologies.

- **CO₂ Royalty Credit Program:** AERI worked closely with the Alberta Department of Energy to develop their CO₂ Royalty Credit Program and participated in the selection of the CO₂ enhanced oil recovery field projects in Alberta.
- **NAIT Fuel Cell:** AERI supported the installation of the largest fuel cell demonstration unit in western Canada, at the Northern Alberta Institute of Technology. This 200-kilowatt fuel cell has been successfully commissioned and an interpretive centre is being built to showcase the first high-voltage, commercially operated fuel cell in Canada.
- **Bioenergy:** A feasibility study supported by AERI provided significant detail on feedstock availability, technologies and markets and prioritized the bioenergy opportunities for Alberta.

Climate Change Action Plan: In 2003-04, the Alberta Government provided \$30 million for investment in sustainable energy technologies over a 3-year period. This funding, \$10 million per year is shared between the AERI and Alberta Environment. AERI invests these funds in the six major priority areas of the Alberta Energy Innovation Strategy. AERI maintained close relationship with Alberta Environment to ensure these funds are invested in technologies and innovations that will promote the goals of “*Albertan’s and Climate Change – Taking Action*”. In fiscal 2003-04 investments were made in the following projects that are described above and included:

- The Canadian Clean Power Coalition (CCPC) Phase 2.
- The Northern Alberta Institute of Technology (NAIT) fuel cells.
- The Dover Vapex (DOVAP) Field Pilot.

Other projects that have been funded and have a significant potential to reduce greenhouse gases and environmental emissions include:

- **Suncor Enhanced Coal Bed Methane (ECBM) pilot:** Selection of pilot involving CO₂ displacement of natural gas from coal bed seams is in progress. Initial studies commenced on a seismic program to develop techniques to assess and monitor in-situ CO₂ migration after injection into a coal bed for the enhanced production of natural gas.
- **Research Chair in Advanced Clean Coal:** The 5-year industrial Research Chair at university of Alberta in advanced coal cleaning and combustion is aimed at reducing mercury emissions.
- **AERI/ARC Core Industry Research Program:** Several new process concepts have been developed and some technologies are undergoing field-testing. A recently patented hybrid steam-solvent process showed an increase in oil production by 19% over Steam-Assisted Gravity Drainage (SAGD) with about half the water use.
- **Enhanced Reservoir Simulation Model:** To help accelerate the implementation of commercial CO₂ storage projects and allow for more accurate predictions for the injection of CO₂ and flue gas in enhanced oil and gas recovery.
- **Acid Gas Injection** – Characterization of some 40 sites in Alberta and B.C.

- **Assessing the coal bed methane (CBM) potential and producibility in Alberta.** A three-year study that included a preliminary database of coal seams in targeted areas of Alberta that describes coal-quality, permeability, and groundwater chemistry was completed.

New Projects Launched in 2003-04

Improved Recovery Innovation Program

Technology development aimed at improved recovery from conventional and non-conventional resources while reducing energy intensity. This program is focused on creating the right mix of technology innovation and business imperatives to significantly increase the amount of natural gas, conventional oil and bitumen recovered from known sources. The benefits include the secure supply of clean fuel to meet Canadian needs and sustain our reputation as a reliable supplier to North American markets.

A listing of new project titles in this area includes:

- *Alberta Chambers of Resources Oil Sands Technology Roadmap Initiative*
- *AERI/ARC Core Industry (AACI) Research Program is in its fourth year of the current 5-year program to develop significantly improved in situ bitumen recovery*
- *Analysis and Scale Up of Cold Production and Predictions for Post Cold Production Heavy Oil Recovery*
- *Analysis of R&D Priorities for Enhanced Recovery of Conventional Oil and Gas*
- *Development of Novel Microfluidic Platforms for Rapid Screening of De-Emulsifying Agents for Bitumen Extraction Processes*
- *Enhanced Gas Recovery and CO₂ Storage for Alberta Pools*
- *Evaluation of Low Pressure SAGD Performance at Surmont*
- *Project aimed at Improving Permeability in Tight Gas Reservoirs for Enhanced Production*
- *Novel Enhanced Gas Recovery Pilot Feasibility Study*
- *Laboratory Testing of Artificial Lift Systems for Low Pressure SAGD Applications*
- *Low pressure SAGD Performance Test at Jocelyn SAGD Project (Gas-Over-Bitumen Application)*
- *Oil Sands Bitumen Extraction and Froth Treatment*
- *Surmont Gas Pool Production and Pressure Data Analysis*
- *Understanding Seismic Anisotropy: Development of Database Techniques and Controls*

Upgrading Innovation Program

The goal is to improve the upgrading process by reducing energy intensity, making synthetic oil acceptable to a higher percentage of the refinery diet and providing higher valued products to realize maximum economic benefits. Achieving these goals will

involve reducing the industry's reliance on natural gas, reducing greenhouse gas emissions from the upgrading processes, improving the quality of synthetic crude produced from bitumen to open up wider markets and taking advantage of the opportunity to use by-products from upgrading as raw materials for value-added production in the petrochemical industry.

A listing of new project titles in this area includes:

- *Bio-Upgrading for Heavy Crude Quality Improvement Phase II*
- *Chair in Advanced Upgrading of Bitumen*
- *Conversion of Heavy Aromatic Compounds and Gas Oils into Petrochemical Feedstock – Phase I*
- *Conversion of Heavy Aromatic Compounds and Gas Oils into Petrochemical Feedstock*
- *Due Diligence Examination of WRITE Upgrading Process Developed by the Western Research Institute*
- *Enzymatic Conversion of Petroleum Napthenic Acids*
- *Improving the Efficiency of Diluents for Pipeline Transportation of Heavy Oils*
- *New Alberta Feedstock and Chemical Chart*
- *Processability of Athabasca Bitumen-derived streams in Chinese Refineries*
- *Review of the Alchemix Corp. Hydromax Technology*
- *Study on Solvent Deasphalting for ConocoPhillips and AERI*
- *Testing of ARINO Catalysts for AERI and NOVA Chemicals Ltd.*
- *Synthetic Natural Gas Process Evaluation Study for TransAlta and AERI*
- *Turbulent Hydrodynamics of Bitumen-Coke Mixing*

Clean Coal/Carbon Innovation Program

The importance of coal in Canada's energy future cannot be overstated and the development of clean coal technologies, which includes CO₂ capture and storage, will be imperative to the necessary, continued use of this fossil fuel. The major research thrusts in this area were undertaken through the Canadian Clean Power Coalition (CCPC) and are aimed at adapting cleaner energy¹ technology to make coal acceptable for generating electricity, and in the process use coal and "opportunity" feedstocks to generate other products such as hydrogen, petrochemicals and steam.

A listing of new project titles in this area includes:

- *Critical Review of Coal Cleaning Technology*
- *Production of Hydrogen and Nanocarbons from Light Hydrocarbons Contained in Alberta Coal*

¹ In practical terms, "clean energy for electricity generation" means technology that is able to achieve environmental emissions standards equivalent to that of natural gas with the added benefit of CO₂ capture and storage.

CO₂ Management Innovation Program

This program is built on a commitment to addressing climate change and the firm belief that it is in Canada's strategic interest to develop environmentally sound and pragmatic approaches for the capture, transport and long term storage of carbon dioxide (CO₂) in geological formations. The benefits are both economic (enhanced oil and gas recovery) and environmental (reducing greenhouse gas emissions).

A listing of new project titles in this area includes:

- *Acid Gas Removal Using Ionic Liquids*
- *Canadian Network of Innovation in Carbon Geological Storage"*
- *Evaluation of CO₂ as a Vapex Solvent*
- *Simulation for CO₂ Storage*

Water Management Innovation Program

This program is in the initial stage of strategic development and will be part of the "Water for Life" strategy developed by Alberta Environment as well as cross-Ministry initiatives. The research and technology thrusts will support the development of technology to reduce fresh water use by the energy industry and to implement cost-effective water re-use and recycle systems.

A listing of new project titles in this area includes:

- *Production of Non-Segregatory Tailings (NST) from Cyclone Underflow (CU) and Thickened Fine Tails (TT)*
- *Recovery of Commercial Grade Kaolin from Oil Sands Fine Tailings*

Alternative and Renewable Energy Innovation Program

This program is built on the premise that the energy challenges of the next several decades will require power-generating technology that can make better use of existing energy resources, deliver power flexibly, and reduce greenhouse gas emissions. The goal is to develop new energy options based on hydrogen and renewable sources. It has three main areas of research focus: fuel cell technology; hydrogen and bio-energy.

A listing of new project titles in this area includes:

- *Acumentrics Solid Oxide Fuel Cell'*
- *Alberta Hydrogen and Fuel Cell Research and Business Development Cluster.*
- *Bio-energy opportunities for Alberta: Strategic Feasibility Study.*
- *Biomass Energy from Animal Waste in Alberta.*
- *Design and Control of Processes for "Eco-Efficiency".*
- *First Residential Fuel Cell Installation in Canada.*
- *Fuel Cell for the Conversion of Ethane to Ethylene.*
- *Fuel Cell Research and Demonstration Testing Centre.*
- *Hydrogen and Carbon Dioxide Production Concerns.*
- *Multi-Scale Modelling of Solid Oxide Fuel Cells.*

Financial Details

Table 1: Expenditure Budget 2002-03 to 2005-06

(thousands)	2002-03 Actual	2003-04 Budget	2003-04 Actual	2004-05 Estimates	2005-06 Target
AERI	6,855	6,940	5,455	8,160	12,420
Climate Change		5,000	6,607	6,000	7,000
Total	6,855	11,940	12,062	14,160	19,420

Table 2: Expenditures 2003-04 by Technology Area

Technology Area	Funds Expended (thousands)
Improved Recovery	6,681
Oil Sands Upgrading	2,145
Clean Coal/Carbon	743
Alternative and Renewable Energy	1,574
CO ₂ Management	765
Water Management	154
Total	12,062*

* As part of the Department of Innovation and Science, AERI was able to invest additional funds that were available in the department.

Chart 1: Expenditures by Area of Research - 2003 – 04

