

DETAILED EXECUTIVE SUMMARY OF THE S.T.E.P.S STRATEGIC PLAN

INTRODUCTION

This summary of the Sustainable Technologies for Energy Production Systems (STEPS) Strategic Plan highlights the proposed vision, mission and goals of the STEPS Business-Led Network of Centres of Excellence (BL-NCE), and provides a summary of the proposed research program, business plan and financial breakdown for the new Network.

Funding of \$10.5 million over four years was granted to the Petroleum Technology Research Centre (Regina, Saskatchewan) by the BL-NCE Secretariat in March 2009 after the PTRC successfully competed with 38 original applicants through a full year-long, two-stage application process. STEPS has been established to develop advanced technologies to assist in the recovery of hydrocarbon resources that are difficult to access and monetize, while doing so in a more environmentally and economically responsible manner. The initial funding is being supplemented by the Saskatchewan Government (which is contributing \$10.3 million over four years) and a significant number of industry partners. Ultimately, it is expected that STEPS will have a budget in excess of \$53 million during its first four years of research.

VISION

“Through research, development, and demonstration of advanced technologies, the business-led STEPS network will be the national focus for leading-edge scientific and engineering innovations that address hydrocarbon energy production sustainability challenges for resources that are difficult to access and monetize, thereby ensuring a secure and affordable supply of clean energy to Canadians.”

MISSION

“Accelerate the pace of energy technology RD&D for small-scale, low-quality in-situ hydrocarbon deposits”

As a network of distributed expertise, STEPS will achieve its mission by leveraging the necessary talents from a variety of centres of excellence, nationally and internationally. The network’s foundation point will be Saskatchewan’s enhanced oil recovery (EOR) RD&D capacity - already well established by the Petroleum Technology Research Centre (PTRC), industry, various research organizations, and governments.

STRATEGIC OBJECTIVES

“Ensure that Canada’s heavy and extra-heavy oil production expands to keep pace with domestic and international demands, while developing the technological means to achieve this objective in a way that leaves the smallest possible environmental footprint”.

Saskatchewan's hydrocarbon production will have a necessary role in attaining this objective and maintaining that level of production well into the middle of the 21st century. Such sustainability requires that new production technologies also reduce greenhouse gas emissions below current levels. STEPS can bridge the technological gap by facilitating the changes necessary to maintain Canada's position as a strong international competitor and supplier of choice to its own and the world's burgeoning economies.

STEPS GOVERNANCE PRINCIPLE

STEPS is a performance-based program governed by the PTRC Board of Directors, which is an Industry-led Board, and operating under the principles of the BL-NCE Program

ORGANIZATIONS PROVIDING FUNDING

PRIVATE SECTOR FUNDING PARTNERS (as of June 2009):

- BP (Alaska), CNRL, ConocoPhillips, Devon Energy Trust, Husky Energy, Nexen Inc., PennWest Energy Trust, Shell, Total

PUBLIC SECTOR FUNDING PARTNERS

- BL-NCE SECRETARIAT (SSHRC and NSERC), Enterprise Saskatchewan, Natural Resources Canada, Saskatchewan Ministry of Energy and Resources, Western Economic Diversification Canada

STRATEGIC MEASURABLE OUTCOMES

In its first four years, STEPS will be focused on developing advanced energy production technologies leading to the following five specific outcomes:

- A complete design for a sophisticated, **portable, in-situ, field-demonstration** facility for Heavy Oil reservoirs to enable scientists and engineers to go “where the action is”.
- A complete design for a sophisticated, **portable, in-situ, field-demonstration** facility for Bitumen reservoirs to enable scientists and engineers to go “where the action is”. Either this facility or the Heavy Oil facility may also be usable in Light/Medium Oil reservoirs.
- Significantly enhanced understanding **of future resource assets such as unmineable coal seams and oil shales** by providing detailed analyses of the size, extent and economic viability of these assets. These analyses will also include clear research paths to increase the quality of products from these resources and reduce environmental impacts on air, land and water.
- A suite of synergistic engineering options for co-location of heavy oil and bitumen production, refining, upgrading, and service operations that will optimize energy and environmental impacts. A detailed model for an integrated petrochemical complex to serve the southern Western Canadian Sedimentary Basin will be part of these synergistic options. A full appreciation of **complete systems by integrating operations** is essential to effective management of challenging sustainability constraints.

- **Effective enabling technologies** including a functioning and improving **Super Database (SDB) for detailed analysis of increased recovery options**. A critical component of the Enabling Technologies Funding Area will be an expansion of the number of researchers involved in the other Funding Areas of the STEPS Program and a clear demonstration of enhanced human capacity development.

FUNDING AREAS AND PROJECTS

Heavy Oil/Bitumen Funding Area

Heavy Oil - Projects Transferred from the pre-existing PTRC Enhanced Oil Recovery (EOR) Program

In 2009-10 there are 17 new and 7 continuing projects being conducted in five focus areas. All projects are clearly defined and are managed by contracts with specific payments and deliverables.

The following are the five areas, including a list of the ongoing projects:

1. **Heavy Oil (Post) Cold Production**

This area is studying late stage cold-flow production technologies and potential enhancements to cold flow processes. The projects in progress are:

- CHOPS Optimization
- Cyclic solvent stimulation
- Air injection pilot
- Utilization of CO₂
- Carryover project – The Pyrolysis Kinetics of Oxidation Residues

2. **Enhanced Waterflooding**

This area is studying enhancements to heavy oil waterfloods. The projects in progress are:

- Optimized Surfactant Polymer
- Improving Conformance Control
- 2D Modelling Study of Chemical Flooding
- Optimizing the Emulsion Flow Regime
- Success of Waterfloods – Factors and Predictions
- Inexpensive Monitoring of Low Yield (High Watercut) Oil Wells

3. **Solvent Vapour Extraction (SVX)**

This area is studying cold solvents processes for viable, low cost, low energy-use EOR in heavy oil reservoirs. The projects in progress in this focus area are:

- Numerical Simulation of SVX Processes
- Evaluation of SVX Processes
- Asphaltene Precipitation Basic
- Asphaltene Precipitation Extension to Year Two
- Solvent Dispersion Effect on the VAPEX Heavy Oil Process
- Sonar for Shape and Growth of Vapour Chamber

4. Gas Flooding (Miscible/Immiscible)

This area is using the broad expertise of PTRC's research partners in gas-flooding technology to study miscible CO₂ injection in light oil reservoirs in southeast Saskatchewan, conversion of hydrocarbon miscible floods to CO₂, and in immiscible injection of CO₂ and flue gas in Lloydminster area heavy oil reservoirs. The projects in progress are:

- Maximizing Performance of Immiscible Gas Flooding
- Phase Behaviour of Solvents
- Three Phase Relative Permeability in Gas Flooding

5. Improving Heavy Oil Predictability

In this focus area studies involve ascertaining basic heavy oil properties to enable enhanced recovery methods/projects to be screened more accurately. The projects in progress are:

- Three Phase Relative Permeability of Native Reservoir Fluids
- Equation of State Characterization
- Simultaneous Thermal/Chemical Flooding
- Solubility and Diffusion Coefficients

Heavy Oil - New Projects

In addition to the foregoing projects, the following work will be undertaken:

- Use the Super Database for Improved Reservoir Characterization/Best Practices manual for Optimization of Oil Pools
- Expand the existing 'CHOPS Fundamental Understanding of Oil Flow Mechanisms' project
- Extensive gap analysis of JIVE and SOLVE programs to develop and demonstrate solvent-vapour, thermal, gas, hybrid, and chemical technologies to improve recovery
- Initiate Phase 1 of a project to house all available worldwide technical information on Heavy Oil and Oil Sands through one source
- Study of Operational Practices to improve techniques and reliability of information available to operating heavy oil wells and systems

Bitumen - New Projects

This is a new area of research for STEPS:

- First Phase of a project to assess the size, extent, and quality of Saskatchewan Oil Sands
- Develop and adapt advanced technologies for subsurface recovery of bitumen from thin pay zones without ready access to fresh water
- A hydrogeological study of Saskatchewan's oil sands to understand the relationship of water sources to the oil zones. Also establish the size, extent and quality of the water zones
- Monitor the oil sands SOLVE project to develop and demonstrate promising technologies for bitumen recovery
- Develop potential technologies for in-situ conversion of residual, non-recoverable oil to lower density hydrocarbons, building synergies with geothermal energy recovery

systems. Initial phase is to review existing technology and projects and consider a technology roadmap for development of a new process

- Project to participate in several key upgrading projects currently being proposed or in progress at NCUT

Light/Medium Oil Funding Area (Note: this area is not being considered in the first RFP of 2010-11)

- Review available and promising techniques to enhance recovery from unconventional hydrocarbon sources. This includes an assessment of best practices in Saskatchewan's Bakken play, evaluating CO₂ flooding of shale oil reservoirs and evaluating ECBM potential in Saskatchewan
- Use the Super Database to prioritize advanced waterflood production strategies – chemical, polymers, etc. - to reduce water cycling, costs, fresh water usage
- Use the Super Database to identify opportunities to apply optimized waterflood production technologies to smaller oil pools
- Assess gas driven EOR processes for residual oil zone and transition zone potentials (a model for this study has been created by a recent USDOE report)
- Review and update previous studies to create a public database of available EOR solvent sources and potential sequestration sites

Enabling Projects Funding Area

- Implement the Super Database for Saskatchewan. It was identified previously in PTAC's 2008 Ramping Up Recovery Report
- Technical feasibility study of co-production of mineral and oil resources
- Phase 1 of an overall Western Canadian Sedimentary Basin (WCSB) Study of shale oil (or tight oil in general terms)
- Deep Unmineable Coal Seams - Assess the size, extent and quality of the WCSB resource. As well, STEPS will leverage partnerships to assess the potential and locations suitable for CO₂ storage in saline aquifers
- Develop and adapt advanced technologies for liquefaction or in-situ combustion of coal for conversion to low-density liquid hydrocarbons
- Assess the storage potential and technology needs for long-term sequestration of wastes such as carbon dioxide and other air pollutants in fully-depleted oil and gas reservoirs, including rigorous risk assessment for long-term impacts
- Adapt existing and develop new advanced technologies for the production of synthetic crude oil
- Synergist Systems Study to facilitate the development of new systems concepts through synergies with other energy operations – often referred to as 'process integration'. It includes using a multi disciplinary approach to assess full life cycle of the proposed Integrated Energy Complex at 'Belle Plain' in Southern Saskatchewan. It will also include examination of a petrochemical complex model for the Southern regions of the WCSB.

- Capacity Development project to expand research personnel involved in heavy oil and Saskatchewan oil sands

STEPS PROJECT MANAGEMENT

The PTRC project-selection model, which has proven successful for a number of years, will be used. Details follow.

Project Identification

Potential projects can be identified through a wide variety of mechanisms. These might include:

- Network members
- Government of Saskatchewan personnel who will monitor the STEPS Program to ensure their funding is used wisely.
- Industry funders and participants in other projects
- Existing and new researchers
- Networking discussions at conferences, forums, seminars
- Formalized workshops both sponsored and conducted by others
- Networks of subject experts
- Industry associations such as CAPP, CSUG, SEPAC
- Industry research facilitators such as PTAC
- University/technical schools that are not members
- Internal program staff

Project Screening

The STEPS Program will create a Technical Advisory Group (TAG) for each of the three Funding Areas – Heavy Oil/Bitumen, Light/Medium Oil, and Enabling Technologies. They will be established to support the Funding Area Leader and are responsible for:

- Advising the Network Director and Manager on general research priorities, direction and strategy
- Advising the PTRC on the allocation of funds to various research projects
- Assisting in the development of new research proposals with the Funding Area Leader

Each TAG includes a number of industry and international experts approved by the STEPS Board of Directors, together with representatives from the network members.

Each TAG will hold regular strategic meetings where existing projects are reviewed and feedback is captured regarding the focus areas industry is interested in. This feedback is used to prepare a request for proposals that is sent out to researchers/research organizations that may be capable of performing the research (existing or potential new Network Members).

Project Approval

Preliminary proposals from the PTRC screening process are circulated to all TAG members for their review prior to a project selection meeting. At the project selection meeting, preliminary

proposals are ranked in order of priority through discussions with industry. A final consensus is obtained, the budget is again reviewed, and the preliminary proposals are formally selected by the TAG for the researcher to develop a full proposal.

Once the full proposals are received, they are reviewed again to ensure there are no major changes or inconsistencies. Contracts are then drawn up and executed by both parties at which time the full proposal becomes a funded project.

Contracts cover all normal issues including IP, cost, specific deliverables, milestones, payment schedules, funders constraints (for example – Federal requirements for environmental statements and freedom of information).

Ongoing Performance Monitoring

The PTRC and the STEPS Network technical and management personnel have many years of successfully managing large and small research programs and projects. The project system that is in place has a strong performance management/deliverables/payment base, involving the following risk management practices:

- Once the project is fully contracted and work commences, it is formally monitored by regular monthly funding area team meetings.
- A final report with all deliverables, including summaries of the work, results, detailed costs, and evaluation of the success of the project including recommendations for ongoing work, is required. This final report is formally reviewed.
- Twice annually all research providers attend a meeting with the TAG and invited industry/government advisors to present a summary of their work to date and obtain feedback on the research progress.
- Annually the Board of Directors requests a presentation of ongoing PTRC research. This is normally done by the Executive Director (Network Director).
- If IP provisions allow, a significant number of projects are considered for publication in appropriate conferences and journals.

This extensive system of program and project reviews at all levels will ensure appropriate value is obtained for the program investments.