PETROLEUM TECHNOLOGY ALLIANCE CANADA

Resources Emissions Management Action Plan

Final Report

July 29, 2011

Table of Contents

Resource Emissions Management Action Plan (REMTAP) Final Report

Executive Summary

Purpose

Air emissions from the petroleum industry are constantly in the public eye. New, complex and tougher emissions regulations are rolling out provincially, federally and internationally. Oil and gas production companies are challenged with measuring, reporting, controlling and reducing emissions to meet goals of resource conservation, environmental protection, and regulatory compliance. The challenge is to find suitable processes and technologies to produce commercial products while conserving natural resources, minimizing the environmental footprint, and managing the cost of regulatory compliance.

The Resource Emissions Management Technology Action Plan was launched to answer this challenge. REMTAP documented the issues and identified opportunities for energy efficiency, emissions measurement and reduction, best practices and management. Innovation, collaboration and the application of technology are key to transform these challenges into opportunities.

REMTAP was facilitated by PTAC and governed by a Steering Committee composed of funding participants. The project unfolded over approximately 15 months, but the implementation of the action plan will continue over a number of years as technology projects are jointly funded, executed and delivered.

Action Plan Projects

As of July 31, 2011, 6 action plan projects are at different stages of implementation. These projects are the visible outcome of the REMTAP project which broadly solicited solutions from technology developers, evaluated 30 submissions and short-listed 12 for detailed discussions. The 6 action plan projects will all involve the installation and demonstration of an innovative technology to reduce emissions at an operating site of one or more participating oil and gas company. The projects are listed below and discussed in more details in this final report.

- Pressure Let Down to Compress Instrument Air (from Blair Air Systems)
- Dry Selective Catalyst for Emissions Reductions for Natural Gas Engines (from Global Emissions Systems)
- PEEK Membrane for Natural Gas Treatment (from Porogen Corporation)
- Modified Small Wind Turbine to Generate Power (from PowerStack)
- Efficiency and Reliability Improvements for Waukesha GL Natural Gas Engines (from REM Technology)
- Small Energy Efficient Compressors (from Trido Industries)

REMTAP Milestones

REMTAP was a fact-based facilitated process involving motivated stakeholders from industry and government willing to pool financial resources, assets and human capital. The project began with a Technology Information Session in May 2010, which was followed by the REMTAP workshop in September. These events provided for a review of existing studies and technologies followed by a gap analysis and the identification of areas with high potential for breakthrough improvements. A Request for Technologies to fill the identified gaps was issued and completed during January and February 2011. Thirty submissions were received, analyzed and shortlisted to 13 promising opportunities. These were reviewed with the proponents during the March Technology Showcase and follow up meetings. Finally, 6 action plan projects were selected for funding and implementation by the Steering Committee. These projects have been scoped and are in the process of implementation, thereby creating a technology action plan for significantly reducing resource emissions through technology innovation.

Action Plan Projects

The 6 action plan projects are summarized in this section. Hyperlinks are provided to access the detailed project proposal.

Pressure Let Down to Compress Instrument Air (from Blair Air Systems)

This technology offers the elimination of methane emissions at gas and oil well locations, and could be implemented as a Zero Emission Technology globally. The technology provider is a western Canada small and medium enterprise (SME), and will benefit from their technology being demonstrated, verified, and commercialized in the oil and gas industry. Specifically, the technology utilizes presently wasted pressure letdown energy to pressurize instrument air, allowing producers to stop using methane for instrument purposes and eliminating the associated methane emissions. REMTAP participants will demonstrate this technology at a commercial site.

The project proposal can be accessed here.

Dry Selective Catalyst for Emissions Reductions for Natural Gas Engines (from Global Emissions Systems)

The technology provider has conducted over ten years of research and development in creating and patenting their proprietary advanced emission reduction technology. The technology has been tested and verified in many applications from as small as a gas powered lawn mower engine up to as large as a 2500hp natural gas co-generation plant, in locations all around the world. REMTAP participants will demonstrate at a commercial site the applicability of the dry selective catalyst for NOx emissions reductions from natural gas engines.

The project proposal can be accessed here.

PEEK Membrane for Natural Gas Treatment (from Porogen Corporation)

PEEK is the acronym for the polymer poly (ether ether ketone) which can now be used to produce robust gas treatment membranes. The specific application for REMTAP participant is natural gas dehydration. Using PEEK membranes would result in lower emissions than existing processes. REMTAP participants will demonstrate this dehydration technology at a 1 million standard cubic feet per day commercial site.

The project proposal can be accessed here.

Modified Small Wind Turbine to Generate Power (from PowerStack)

This technology is a wind power system that does not rely on wind but on stack gas exit velocity. As such, it generates power from waste energy while providing a stable power system for on and off grid operations. The technology provider is a western Canada SME which will benefit from their technology being demonstrated, verified and commercialized in the oil and gas industry. REMTAP participants will demonstrate this technology at a commercial site.

The project proposal can be accessed here.

Efficiency and Reliability Improvements for Waukesha GL Natural Gas Engines (from REM Technology)

Most of the Waukesha GL engines in the western Canada oil and gas industry use a hydraulic governor and a natural gas carburetor. Engine efficiency can be improved by reducing the throttle loss and by turbo-charger control to reduce the need for site adjustments with load changes, and this project will focus on replacing the pre-combustion chamber with a chambered spark plug. This technology will reduce the pressure loss encountered with moderately or lightly loaded GL engines, thus improving the efficiency by an anticipated 5%. The technology provider will perform the replacement of the pre-combustion chamber, PCC, with the chambered ECO-plug recently introduced for Waukesha GL engines. This plug does not require a fuel source for the chamber, which will improve fuel efficiency, reduce operating costs, and potentially reduce vent gas. The technology provider is a western Canada SME, and the company will benefit from their technology being demonstrated, verified and commercialized in the oil and gas industry. REMTAP participants will demonstrate this technology at a commercial site.

The detailed project proposal will be available in the fall of 2011.

Small Energy Efficient Compressors (from Trido Industries)

The technology provider has developed a compressor powered by a small, very efficient, permanent magnet motor that is small enough to be driven by solar energy. The first compressor prototype is in test and results are encouraging. The compressor is capable of compressing approximately 400 standard cubic feet of air to 35 lbs in a 24-hour period using solar power in northern Alberta. The technology provider has developed three concepts for using compressed air to replace fuel gas in powering gas processing instruments such as valve actuators, pressure indicates etc. Each concept is aimed at a particular set of user needs and was developed to maximize the effectiveness of the compressor in that situation. The technology provider is a

western Canada SME, and will benefit from their technology being demonstrated, verified, and commercialized in the oil and gas industry. REMTAP participants will demonstrate this technology at a commercial site.

The project proposal can be accessed here.

REMTAP Milestones

This section of the Final Report summarizes the major milestones of the REMTAP project which led to the selection of the Action Plan projects. Detailed documentation was issued at the time of each events and this documentation remains available on request.

REMTAP Technology Information Session

REMTAP was launched on May 28, 2010 by a Technology Information Session (TIS) held in the ConocoPhillips Amphitheatre and attended by 32 representatives of government organizations and companies. The lunchtime presentation provided an overview of the proposed project scope. Cenovus Energy, ConocoPhillips Canada, Devon Canada, Encana, Nexen and the Alberta Department of Energy partnered to support REMTAP and worked with PTAC to finalize the project scope.

REMTAP Workshop

The REMTAP workshop held as follows:

Date: September 1, 2010

Location: ConocoPhillips Canada

Attendance: 72 people from industry, government, academia and NGOs.

The purpose of the workshop was to explore ways to improve the performance of emissions management by examining current regulations, challenges and to identify areas with high potential for breakthrough improvements through collaborative technology projects.

During the workshop, government representatives delivered presentations about currents regulations and future outlook. Industry representatives presented summaries of current challenges faced by the industry and priority areas for improvement. Breakout sessions followed for the technical domains listed below:

- Engine Controls and NOx
- Dehy Optimization and Benzene Reduction
- Power Generation from Alternative Sources (Pressure Drop, Waste Heat)
- Vent Gas and Fugitive Emissions
- Process Optimization
- GHG Reporting and CO_2 Credits

The breakout sessions unfolded in two steps. A first breakout group discussion led to the identifications of the impacts of present regulations, industry challenges and technology gaps. The second breakout group discussion focused on identifying opportunities for with high potential for breakthrough improvements through collaborative technology projects.

After the workshop, PTAC validated workshop outputs with the REMTAP Steering Committee and issues a Request for Technologies to fill the gaps identified by the workshop. REMTAP sponsors received the workshop report.

Request for Technologies

The Request for Technologies (RFT) was issued and completed during January and February 2011 in response to the gaps and opportunities identified during the workshop. Technology providers were invited to submit summary proposals addressing one or more of the targets.

The 35 proposals received in response to the RFT are listed in the following table which provides hyperlinks to each proposal document.

Technology	Company	Address	Link to Proposal
Waste Heat	AB Technologies /Geotrend	Calgary, AB	REMTAPP10
Power Generation from Pressure Drop	AB Technologies /Geotrend	Calgary, AB	REMTAPP11
Newly developed Catalyst to convert syngas to higher alcohols	BKS Energy	Santa Maria, CA	REMTAPP31 Supplemental Information: REMTAPP31-2
Elimination of Methane Emissions at Well Locations	Blair Air Systems	Morrin, AB	REMTAPP08
Solar Electric Control System for Emission Reduction	Calscan Energy Ltd.	Edmonton, AB	REMTAPP14
Systems for Capturing Vent Gas as Fuel	Canada Chemical Corp. and Verdis Synthetic Fuels	Calgary, AB and UAE	REMTAPP01
Atmospheric Emissions Removal through Sequestration of Charcoal in Soil	Computare	Lethbridge, AB	REMTAPP04 Supplemental Information: REMTAPP04-2
Reliable and Cost Effective	Global Emissions	Whitby, ON	REMTAPP06

Engine Emissions Technologies	Systems Inc.		
GHG Offset Data Management System	Golder Associates	Calgary, AB	REMTAPP16
Accurate Evaluation of Fugitive Gas Emissions	Harper Consulting	Watkinsville, GA	REMTAPP05
Fugitive Emissions Management, Reporting and Automation	Insight Emissions Management Inc.	Calgary, AB	REMTAPP26
Novel Approaches in Using Electricity	INSOIL CANADA LTD	Calgary, AB	REMTAPP18 Supplemental Information: REMTAPP18-2
Reliable and Cost Effective Engine Emissions Technologies	Kathan Designs Inc.	Edmonton, AB	REMTAPP20 Supplemental Information: REMTAPP20-2
Low NOx Natural Draft Exhaust Recycle (FGR) Burner System	Kenilworth Combustion	Lloydminster, AB	REMTAPP22
BTEX Burner System, VRU Burner System, Low Pressure Flame Scavenger Burner System	Kenilworth Combustion	Lloydminster, AB	REMTAPP21
VRU Burner System	Kenilworth Combustion	Lloydminster, AB	REMTAPP24
Low Pressure Flame Scavenger Burner System	Kenilworth Combustion	Lloydminster, AB	REMTAPP23
Recovering Waste Heat in Heavy Oil Production	Newco Tank Corp	Lloydminster, AB	REMTAPP12
Reliable and Cost Effective Engine Emissions Technologies	Oasis Emission Consultants Inc.	Calgary, AB	REMTAPP25
Reduction of NOx and SOx emissions with Electron Beam Flue Gas Treatment (EBFGT) at SaskPower ECRF located at the Poplar	PAVAC Industries Inc.,	Richmond, BC	REMTAPP29

Coal Power Plant			
Reduction of NOx and SOx emissions with Electron Beam Flue Gas Treatment (EBFGT) - Economical Scalable Solution for In-Situ Operations	PAVAC Industries Inc.,	Richmond, BC	REMTAPP28
Zero Emission Membrane Based NG Dehy System	PoroGen Corporation	Woburn, MA	REMTAPP02
Pinwheel on Exhaust	PowerStack	Alberta	Proposal
Fuel Flexible Gas Clean-up System for the Production of Combined Heat, Power, and Greenhouse Quality Carbon Dioxide Exhaust from an Internal Combustion Engine	Quadrogen Power Systems, Inc.	Vancouver, BC	REMTAPP27
Zero Emission Dehys, Waste Heat Recovery in Small and Large Scale Operations	Questor Technology Inc.	Grand Prairie, AB	REMTAPP32 Supplemental Information: REMTAPP32-2
Zero Emission Dehys	Questor Technology Inc.	Grand Prairie, AB	REMTAPP33
Systems for Capturing Vent Gas as Fuel, Reliable Cost Effective Engine Emissions Technologies, Design for low pressure raw gas inlet fuel sources for NG engines.	REM Technology Inc.	Calgary, AB	REMTAPP30
Zero Emission NG Dehys	Schaffer's Custom Welding	Whitecourt, AB	REMTAPP19
Flue Draft Control and Thermal Efficiency for Boilers	Stackdraft Solutions Inc.	Framingham, MA	REMTAPP34

Zero Emission Dehys	SUSTOR and Geotrend	Houston, TX and Calgary, AB	REMTAPP09
Reliable and Cost Effective Engine Emissions Technologies	Thermophysics Tech./AB Technologies	Sugar Land, TX, and Calgary, AB	REMTAPP13
Power Generation from Pressure Drop - Waste Heat Utilization	Trans Pacific EnviroEnergy Inc	Calgary, AB	REMTAPP03
Solar Electric Power for Compressors	Trido Industries	Calgary, AB	REMTAPP07
Waste Heat Utilization	Veresen Inc.	Calgary, AB	REMTAPP15
JATCO Shell & Tube BTEX Eliminator System	ZIRCO LTD and Jatco Inc.	Calgary, AB	REMTAPP17 Supplemental Information: REMTAPP17-2

The REMTAP Steering Committee reviewed all 35 proposals and invited a shortlist of 13 organizations to presentations and discussions during the Technology Showcase.

REMTAP Technology Showcase

The Technology Showcase was an event where technology providers presented their proposal and engaged in discussion with the participating oil and gas producers. The purpose was to give technology providers the opportunity to fully describe and explain the benefits of their technology and to propose a practical demonstration project that could be implemented by one of the participating producer. A full day was dedicated to the Showcase. Furthermore, additional meetings were held with technology providers who were unable to attend on the initial event.

The following table summarizes the name of the technology providers invited to the Showcase and the technologies presented. Hyperlinks are provided to the proposals and the presentations.

Technology Provider	Proposed Technology	Hyperlinks to Documents
AB Technologies /Geotrend	Power Generation from Pressure Drop	Proposal Presentation
Blair Air Systems	Elimination of Methane Emissions at Well Locations	Proposal Presentation
Calscan Energy Ltd.	Solar Electric Control System for Emission Reduction	Proposal Presentation

Global Emissions Systems Inc.	Reliable and Cost Effective Engine Emissions Technologies	Proposal Presentation
Kenilworth Combustion Presentation	BTEX Burner System, VRU Burner System, Low Pressure Flame Scavenger Burner System	Proposal
	VRU Burner System	Proposal
	Low Pressure Flame Scavenger Burner System	Proposal
PoroGen Corporation	Zero Emission Membrane Based NG Dehy System	Proposal Presentation
Powerstack	Pinwheel on Exhaust	Proposal Presentation
Quadrogen Power Systems, Inc.	Fuel Flexible Gas Clean-up System for the Production of Combined Heat, Power, and Greenhouse Quality Carbon Dioxide Exhaust from an Internal Combustion Engine	Proposal Presentation
Questor Technology Inc. Presentation	Zero Emission Dehys, Waste Heat Recovery in Small and Large Scale Operations	Proposal
	Zero Emission Dehys	Proposal
REM Technology Inc.	Systems for Capturing Vent Gas as Fuel, Reliable Cost Effective Engine Emissions Technologies, Design for low pressure raw gas inlet fuel sources for NG engines.	Proposal
Saskatchewan Research Council		Proposal
Trans Pacific EnviroEnergy Inc	Power Generation from Pressure Drop - Waste Heat Utilization	Proposal Presentation
Trido Industries	Solar Electric Power for Compressors	Proposal Presentation

After the Showcase and follow up meetings, the Steering Committee analyzed and selected the following proposals as action plan projects.

- **PoroGen**
  - Application: PEEK membrane for natural gas treatment
  - Encana, Cenovus, CPC, Nexen and Devon interested – each will provide an application description and specification.

- PTAC will send the descriptions and specifications to PoroGen and request a proposal and estimated costs for further evaluation of each application.
- It was mentioned that Enerflex could be the OEM to incorporate PoroGen technology.

- **Global Emissions Systems**
  - Application: Dry selective catalyst for emissions reductions from engines
  - Low temperature for lean burns is interesting. Worth investigating.
  - PTAC will provide a couple of engine examples to GESI to obtain pricing information and cost of trial.
    - CPC and Encana to provide specs for the engines.
    - One engine would be a REMVue modified engine (CPC).
    - Another would be a non AFR lean burn engine, perhaps a 7042GL Waukesha.

- **Trido**
  - 1st Application: small compressor: Encana and Cenovus will provide specs for some of their small booster compressors, which PTAC will send to Trido for them to provide cost scenarios.
  - 2nd Application: electronic controller system for larger systems: CPC will provide specs and PTAC will forward to Trido.
  - 3rd Application: recompress and recycle instrument gas: PTAC will organize a meeting to scope out a demonstration.

- **Blair Air**
  - Application: Use pressure let down to compress instrument air
  - Pressure let down is intermittent and the well may benefit from the pressure cycle.
  - Applicable to wells that are choked back and Encana may have an application.
  - Blair Air has one installed unit and we could speak to the operator, which could be ConocoPhillips.
  - Encana will provide specifications for an application and PTAC will ask Blair Air for an estimate on what that would cost.

- **PowerStack**
  - Application: Modified small wind turbine to generate power from the velocity of flue gas above a stack
  - PTAC will call a meeting in a few weeks to determine if there is an interest in purchasing of installations for demonstration.

- **RTI**
  - 1st Application: Use of crankcase gas as fuel. It was felt that there is no need for this technology at this time.
  - 2nd Application: Use of low pressure raw gas. Safety when using hot gas is the critical issue and the technology exists commercially for low pressure, low heat content gas. No interest.
  - 3rd Application: Improved efficiency for Waukesha GL engines with a new spark plug technology. There was interest in doing a pilot installation and a third party verification report for this idea.
  - PTAC will ask RTI to provide a project proposal detailing a demonstration project for the Reliable Cost Effective Waukesha Engine Emission Technology (3rd application).