## Higher Value Use of Low Grade Heat

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<th>SOLUTION DESCRIPTION:</th>
<th>CHALLENGE SPONSOR:</th>
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<td>Technologies that create value from excess low grade heat resulting from Steam Assisted Gravity Drainage (SAGD) oil sands production and/or related surface facility operations.</td>
<td>COSIA’s GHG EPA is sponsoring this challenge. Our aspiration is to <strong>produce our oil with lower greenhouse gas emissions than other sources of oil.</strong></td>
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**CREATED:** March 2015

All projects are evaluated and actioned as they are received.

COSIA has four Environmental Priority Areas (EPAs): Water, Land, Tailings, and Greenhouse Gases (GHGs).

For more information on this COSIA Challenge please visit [www.cosia.ca](http://www.cosia.ca)

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Canada’s Oil Sands Innovation Alliance (COSIA) accelerates the pace of environmental performance improvement in Canada’s oil sands through collaborative action and innovation. COSIA Members represent more than 90 per cent of oil sands production. We bring together innovators and leading thinkers from industry, government, academia and the wider public to identify and advance new transformative technologies. Challenges are one way we articulate an actionable innovation need, bringing global innovation capacity to bear on global environmental challenges.
WHAT TO SUBMIT TO COSIA

COSIA requires sufficient non-confidential, non-proprietary information to properly evaluate the technology.

Some items that will be especially important to present in your submission are:

• Concept and basic unit operations
• Technical justification for the approach (e.g. laboratory batch or continuous experiments; pilot or demo plants; process modeling; literature precedent)
• Describe quantities and qualities of utilities and consumables that are required
• Energy inputs – quantity and type(s)
• Capital and operating cost estimates if available based on described capacity targets
• 3rd party verified comparison of your proposed technology against an MEA baseline. 3rd party verifiers should be reputable, independent engineering companies if possible
• Basis of cost estimation, including estimation scope, contingency, etc.
• IP status of your proposed technology
• What operating environment restrictions might your technology face:
  – Explosive atmospheres
  – Severe weather
  – Power fluctuations

FUNDING, FINANCIALS, AND INTELLECTUAL PROPERTY

COSIA Members are committed to identifying emerging technologies and funding the development of the technologies to the point of commercialization, while protecting the Intellectual Property (IP) rights of the owner of the technology.

Successful proposals can receive funding from COSIA members to develop and demonstrate the technology in an oil sands application. Multiple technologies may be funded, at the discretion of the Members.

HOW TO SUBMIT TO COSIA


Please note: ETAP is a staged submission process. The initial submission requires only a brief description and limited technical information. Upon review by COSIA, additional information may be requested. Instructions for submission are provided on the ETAP site.

All information provided is non-confidential. COSIA will respond to all submissions.
DETAILED SOLUTION DESCRIPTION

The COSIA GHG Environmental Priority Area Steering Committee seeking leading edge technologies that create value from excess low grade heat resulting from Steam Assisted Gravity Drainage (SAGD) oil sands production and/or related surface facility operations.

The successful technology will:

• Be implementable within a SAGD oil sands Central Processing Facility (CPF) and/or with SAGD well bores
• Upgrade low grade heat (<60-80°C) to higher value heat (>130°C) OR convert low grade heat to electricity at >10% efficiency
• Function successfully in existing SAGD oil sands operations with high reliability
• Require lower energy inputs than the higher heat value or electricity produced
• Break even over installation and capital costs in less than 4 years

Technologies at all stages of technical maturity are of interest

BACKGROUND

The most common recovery process employed for producing from oil sands reservoirs is known as SAGD. In this process, steam is generated at a Central Processing Facility (CPF), transported to well pads, and injected below ground into a horizontal well bore within the reservoir. The heat supplied by the steam warms the heavy oil in the reservoir allowing it to flow via gravity drainage into a second underlying wellbore that captures the oil/water mixture and produces it to the surface.

Once at the surface, the mixture of oil and water is cooled from 130 - 2000°C down to around 800°C prior to separation. Once separated, the produced water is treated and recycled for steam generation. The resulting oil is treated and delivered into a pipeline for shipping. This cooling process generates significant amounts of low grade heat at 60-80°C.

COSIA would like to identify technologies that can create value from this by-product by converting it to higher value heat for use either within the CPF or SAGD wellbores, or by converting it to electricity at >10% efficiency rate. Existing technologies to upgrade waste heat are not widely used due to associated high capital expenses.

APPROACHES NOT OF INTEREST

The following approaches are not of interest:

• Organic Rankine Cycle

ADDITIONAL INFORMATION

Some items that will be especially important to present in your response are:

• Basic unit operations
• Provide reasons why you believe your approach will work (ie glassware experiments, process modeling, literature precedent)
• Describe utilities that might be required
• Capital and operating cost estimates if available based on described capacity targets
• IP status
• What operating environment restrictions might your technology face?
  • Explosive atmospheres
  • Severe weather
  • Power fluctuations
• Power generation: $E = \frac{(HVH-EC)}{Q}$
• Heat pump: $COP = \frac{HVH}{EC}$
#0012: Higher Value Use of Low Grade Heat

- \( E \) = Efficiency
- \( COP \) = Coefficient of Performance
- \( HVH \) = Higher Value Heat, GJ (electricity produced)
- \( EC \) = Energy Consumed, GJ (to produce HVH)
- \( Q \) = total waste heat available, GJ
**ENERGY FLOW DIAGRAM**

**Base Case: WLS - OTSG**

**Inputs Energy**

- **BFW**
  - HP BFW Pump: 4.8 GJ/h
  - LP BFW Pump: 0.8 GJ/h

- **Natural Gas**
  - HP BFW Preheater: 1.16 GJ/h
  - Tracing & Utility: 5.8 GJ/h
  - Utility Steam: 146 °C, 1538 GJ/hr

- **Electricity**
  - Electrical Power: 117.3 GJ/hr

**Output Energy**

- **Glycol**
  - Glycol Return: 125 GJ/h
  - Produced Gas Cooler: 51.1 °C, 40 °C, 63 GJ/h

- **Water**
  - Produced Water Cooler: 13.4 GJ/h
  - Blowdown Cooler: 79.3 GJ/h

- **Heat Input (LHV)**
  - Natural Gas: 30 GJ/hr

- **Direct CO2 Generation**
  - MT/day: 417.6 kg/m³ Bitumen

- **Indirect CO2 Generation**
  - MT/day: 62.5 kg/m³ Bitumen

- **Total CO2 Emissions**
  - MT/day: 473.1 kg/m³ Bitumen

**Stack Emissions**

- Direct Emissions from Combustion only
  - 17.9 GJ/hr

**Electrical Loads**

- **HP BFW Pump**
  - 4.8 MW

- **LP BFW Pump**
  - 0.8 MW

- **Utility Steam**
  - VRU Compressors: 2.1 MW

- **Misc Users**
  - 1.9 MW

- **OTSG**
  - 13.7 MW

- **BFW Preheaters WLS/Evaporator**
  - 0.5 MW

- **186 °C 86.7 GJ/h Glycol System**

- **Total 17.9 117.3 GJ/hr (LHV basis)**

**Reservoir Heat to Earth**

- 30 GJ/hr (based on 5°C Ground Temp)

**Reservoir**

- 104 °C

**Stack Losses**

- 19.0 GJ/hr (LHV basis)

**Radiation Losses**

- 51.1 °C 40 °C 63 GJ/h

**Total 1655 GJ/hr (LHV basis)**

**WLS**

- 43.9 GJ/h

**OTSG**

- 31.1 GJ/h

**OTSG Air Glycol Preheater**

- 24.0 GJ/hr

**OTSG Air Preheater (Flue Gas)**

- N/A

**Stack Losses**

- 19.0 GJ/hr

**Total 17.9 117.3 GJ/hr (LHV basis)**

**Make-up Water Glycol Heaters**

- 21.8 GJ/hr

**Make-up Water Glycol Heaters (two services)**

- 22.7 GJ/hr

**BFW Preheaters**

- 5.6 GJ/hr

- 21 GJ/hr

**Stack Emissions**

- Direct Emissions from Combustion only

- 17.9 GJ/hr

**Heat Exchangers**

- **Emulsion / BFW**
  - 136.9 GJ/hr

- **Dilbit**
  - 133 °C 43.9 GJ/h

- **Process to Process**
  - 129 °C

- **129 °C 106 °C 106 °C**

- **Reservoir**
  - 129 °C

- **Make-up Water Heater**
  - 131 °C

- **BFW Preheaters**
  - 32.1 GJ/hr
This is a generic and hypothetical mine and extraction facility developed by COSIA. While representative, it is not based on any one facility. Recovery and solvent loss is based on Alberta Energy Regulator requirements.
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