Cenovus EnCAID approval
#10440L
Performance presentation

Alberta Energy Regulator offices
Calgary
February 2017
Cenovus EnCAID* introduction and overview

This presentation was prepared in accordance with AER Directive 054 - Performance presentations, auditing, and surveillance of in situ oil sands schemes

Subsurface issues related to resource evaluation and recovery

• Directive 054, Section 3.1.1

Surface operations, compliance, and issues not related to resource evaluation and recovery

• Directive 054, Section 3.1.2

* Canadian patent CA2594413 (C)
AER Dir 054 Section 3.1.1

Subsurface issues related to resource evaluation and recovery
Subsurface issues: table of contents

- Background
- Geology/geoscience
- Drilling and completions
- Instrumentation
- Scheme performance
- Future plans
Scheme background

Directive 54
Subsurface section 1

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2016 annual performance presentation
Background

• The EnCAID project is an enhanced recovery scheme which displaces natural gas with combustion gases that are the result of combustion of residual bitumen in gas cap.
Project overview

- Combustion of residual bitumen in gas cap
- Allows for displacement and re-pressurization of gas zone
- 100% Cenovus Energy Inc.
Geological/geoscience

Directive 54
Subsurface section 2

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## Summary of Wabiskaw gas properties

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth</strong></td>
<td>465 TVD</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>5 m</td>
</tr>
<tr>
<td><strong>Average porosity</strong></td>
<td>~36%</td>
</tr>
<tr>
<td><strong>Average gas saturation</strong></td>
<td>~50%</td>
</tr>
<tr>
<td><strong>Average water saturation</strong></td>
<td>~30%</td>
</tr>
<tr>
<td><strong>Average bitumen saturation</strong></td>
<td>~20%</td>
</tr>
</tbody>
</table>
Wabiskaw stratigraphic cross-section

Regional WBSK

WBSK B Valley Fill

WBSK D Valley Fill

MCMR

Depositional Edge

Bottom water
Drilling and completion

Directive 54
Subsurface section 3

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Well layout
Drilling and completion

- No new wells were drilled
- No recompletions
- No workovers

Requirements under subsection 3.1.1 3c – wellbore schematics are included in the appendix
Instrumentation

Directive 54
Subsurface section 5

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Instrumentation in wells

Observation Well: 102/05-10-73-6W4
• Equipped with three piezometers
• Equipped with 10 thermocouples

Observation Well: 100/6-10-73-6W4
• Equipped with one piezometer
• Equipped with 10 thermocouples

Requirements under subsection 3.1.1 5a – wellbore schematics 5c and 5d are included in the appendix
Observation wells bitumen pressure
102/05-10-073-06W4 – Temp history
102/05-10-073-06W4/0
Observation well temperature
Scheme performance

Directive 54
Subsurface section 7

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2016 annual performance presentation
## Project performance history

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>June - Ignition and start-up</td>
<td></td>
<td></td>
<td></td>
<td>Feb - Startup of 00/6-6-73-6W4/00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oct - Primrose sales volumes flowing to Caribou gas facility</td>
<td></td>
<td>Mar- Shut-in 00/7-8-73-6W4/00</td>
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<tr>
<td>2007</td>
<td>Q1 – Nitrogen response at 00/14-9-73-6W4/00</td>
<td>2013</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Q2 – Nitrogen response at 00/2-16-73-6W4/00, 00/11-15-73-6W4/00, shut-in 00/14-9-73-6W4/00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>May – Nitrogen response at 00/1-17-73-6W4/00</td>
<td>2014</td>
<td></td>
<td>Dec – Startup 00/10-12-73-7W4/00</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>Jan – Gas production shut-in due to 00/6-18-73-6W4/00 segregation repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jun – Nitrogen response at 00/7-8-73-6W4/00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct – Injectivity decrease observed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Q1– 00/5-10-73-6W4/00 injector stimulation treatment</td>
<td></td>
<td></td>
<td></td>
<td>Feb – Abandoned 00/11-15-73-6W4</td>
</tr>
<tr>
<td></td>
<td>Q4 – Shut-in 00/1-17-73-6W4/00, 00/2-16-73-6W4/00, 00/11-15-73-6W4/00. Removal of 00/5-10-73-6W4/00 thermocouple string and perform pressure fall off tests</td>
<td></td>
<td></td>
<td></td>
<td>Jul - Startup 00/10-11-73-7W4/00</td>
</tr>
<tr>
<td>2011</td>
<td>Q1 - 00/5-10-73-6W4/00 injector stimulation treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mar/Apr – 00/11-15-73-6W4/00 flowed N₂ 85%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Production/injection summary

## Production operations

<table>
<thead>
<tr>
<th>Operating for</th>
<th>Air injected</th>
<th>Bulk gas recovered</th>
<th>Formation gas recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;10 years</td>
<td>~ 270 e⁶m³</td>
<td>~ 190 e⁶m³</td>
<td>~ 167 e⁶m³</td>
</tr>
</tbody>
</table>

## Approved producers

<table>
<thead>
<tr>
<th>UWI</th>
<th>Status</th>
<th>UWI</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>00/06-05-073-06W4/0</td>
<td>Flowing ~ 52% N₂</td>
<td>00/02-16-073-06W4/0</td>
<td>Shut-in ~ 84% N₂</td>
</tr>
<tr>
<td>00/06-06-073-06W4/2</td>
<td>Flowing ~ 17% N₂</td>
<td>00/01-17-073-06W4/0</td>
<td>Shut-in ~ 85% N₂</td>
</tr>
<tr>
<td>00/06-07-073-06W4/2</td>
<td>Flowing &lt;1% N₂</td>
<td>00/10-11-073-07W4/0</td>
<td>Flowing &lt;1% N₂</td>
</tr>
<tr>
<td>00/07-08-073-06W4/0</td>
<td>Shut-in &gt;90% N₂</td>
<td>00/10-12-073-07W4/0</td>
<td>Flowing &lt;1% N₂</td>
</tr>
<tr>
<td>00/11-15-073-06W4/0</td>
<td>Abandoned</td>
<td>00/14-09-073-06W4/0</td>
<td>Shut-in ~ 86% N₂</td>
</tr>
</tbody>
</table>
K3 pool production

- K1 - K3 Boundary
- K1 Pool Boundary
- Injection Well
- SI K1 or L3 Pool

- ~15 e3m3/d
- ~29 e3m3/d
- ~14 e3m3/d
- ~8 e3m3/d
- ~12 e3m3/d
History production
Voidage replacement ratio (VRR) - 2016

January and April
Steady high air injection rates

May to October
Reduce air injection rates due to higher ambient temperatures

October to December
Steady high air injection rates
## VRR

<table>
<thead>
<tr>
<th></th>
<th>Monthly VRR</th>
<th>Cumulative VRR</th>
<th>VRR regulatory approved limit (Min monthly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.10</td>
<td>1.47</td>
<td>0.90</td>
</tr>
<tr>
<td>February</td>
<td>1.20</td>
<td>1.48</td>
<td>0.90</td>
</tr>
<tr>
<td>March</td>
<td>1.13</td>
<td>1.50</td>
<td>0.90</td>
</tr>
<tr>
<td>April</td>
<td>1.11</td>
<td>1.51</td>
<td>0.90</td>
</tr>
<tr>
<td>May</td>
<td>1.00</td>
<td>1.53</td>
<td>0.90</td>
</tr>
<tr>
<td>June</td>
<td>1.16</td>
<td>1.54</td>
<td>0.90</td>
</tr>
<tr>
<td>July</td>
<td>1.08</td>
<td>1.55</td>
<td>0.90</td>
</tr>
<tr>
<td>August</td>
<td>1.20</td>
<td>1.57</td>
<td>0.90</td>
</tr>
<tr>
<td>September</td>
<td>1.15</td>
<td>1.58</td>
<td>0.90</td>
</tr>
<tr>
<td>October</td>
<td>1.22</td>
<td>1.60</td>
<td>0.90</td>
</tr>
<tr>
<td>November</td>
<td>1.20</td>
<td>1.61</td>
<td>0.90</td>
</tr>
<tr>
<td>December</td>
<td>1.22</td>
<td>1.63</td>
<td>0.90</td>
</tr>
</tbody>
</table>
VRR performance

AER VRR Targets:
- Monthly Min 0.9
- Annual Min 1.0
- Cumulative 1.1 to 2.0

2016 YTD Average VRR ~1.18
2016 Cumm VRR ~1.63

Monthly VRR over due to Production shut-in

Maintenance

Inj to Prod Ratio
VRR history
K3 pool pressure

Bottomhole Pressure in kPa

Jan 2016: Insufficient shut-in time prior to
gradients run on 10-12-73-W4 & 10-11-73-W4
result was lower than expected reservoir pressure

ERCB Approval Minimum Pressure 700 kPa
Observation 6-10 well temperature
Composition of injected/produced fluids

- EnCAID does not currently sample air injected
- EnCAID captures gas samples for analysis on the schedule located to the right and monitors compositional changes for each well
- Cenovus samples selective wells on more frequent basis than required under Approval 10440L

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Sampling Frequency</th>
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</thead>
<tbody>
<tr>
<td>00/01-17-073-06W4/0</td>
<td>Annual</td>
</tr>
<tr>
<td>00/02-16-073-06W4/0</td>
<td>Annual</td>
</tr>
<tr>
<td>00/06-05-073-06W4/0</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>00/06-06-073-06W4/2</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>00/06-07-073-06W4/2</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>00/06-10-073-06W4/2</td>
<td>Annual</td>
</tr>
<tr>
<td>00/06-18-073-06W4/0</td>
<td>Annual</td>
</tr>
<tr>
<td>00/07-08-073-06W4/0</td>
<td>Annual</td>
</tr>
<tr>
<td>00/10-11-073-07W4/0</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>00/10-12-073-07W4/0</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>00/10-36-072-07W4/2</td>
<td>Annual</td>
</tr>
<tr>
<td>00/11-17-073-06W4/0</td>
<td>Annual</td>
</tr>
<tr>
<td>00/14-09-073-06W4/0</td>
<td>Annual</td>
</tr>
</tbody>
</table>
Nitrogen response

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Wabiskaw K-3 Pool material balance

Original Pressure – 2050 kPaa (300 psia)

Pressure Dec 03 = 662 kPaa or 96 psia
OGIP = 1129 e^6 m^3 (39.9 Bcf)
Gas prod = 877 e^6 m^3 (31.0 Bcf 77% RF)
Post-EnCAID RF ~ 85 - 87%

Pre-EnCAID

EnCAID

Dec/2016
Cum Prod 1,063 e^6 m^3 (37.8 bcf)
RF 94%
Subsurface key learnings

**Presence of more than one oxidation front indicates**

- fuel remaining in the region swept by the combustion front
- could be either residual oil left behind first oxidation front, or re-saturation with oil from adjacent rock or, possibly from flammable vapor produced from the oxidation and cracking reactions

**Continues to be strong correlations between air-injection rate and temperature changes**

- first oxidation zone at the bottom of the gas cap was truncated by a reduction in injection rate
- increase in injection rate performed in early 2013 resulted in ignition and combustion of the top of the bitumen
Future plans

**Subsurface section 8**

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Future plans

- No changes in overall recovery strategy are planned at this time
AER Dir 54 Section 3.1.2

Surface operations, compliance and issues not related to resource evaluation and recovery
Surface operations: table of contents

1. Facility overview/modifications
2. Measurement and reporting
3. Environmental issues
4. Compliance statement
5. Future plans
Facility overview/modifications

Directive 54
Subsurface Operations section 1

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Plant performance - 2016

Facility is operating as expected

- Steady air injections
- Some weather related reductions
Gas usage

Usage is as fuel gas for air compressor operations

- Gas source Primrose plant fuel gas
- Total 2016 usage 2,061 e³m³
## Green house gas emissions

<table>
<thead>
<tr>
<th>Month</th>
<th>2016 (tonnes)</th>
<th>2015 (tonnes)</th>
<th>2014 (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>477</td>
<td>522</td>
<td>477</td>
</tr>
<tr>
<td>February</td>
<td>463</td>
<td>439</td>
<td>472</td>
</tr>
<tr>
<td>March</td>
<td>476</td>
<td>478</td>
<td>519</td>
</tr>
<tr>
<td>April</td>
<td>443</td>
<td>461</td>
<td>498</td>
</tr>
<tr>
<td>May</td>
<td>412</td>
<td>482</td>
<td>521</td>
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<tr>
<td>June</td>
<td>446</td>
<td>456</td>
<td>504</td>
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<tr>
<td>July</td>
<td>484</td>
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<td>August</td>
<td>498</td>
<td>335</td>
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<td>September</td>
<td>487</td>
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<td>October</td>
<td>511</td>
<td>457</td>
<td>511</td>
</tr>
<tr>
<td>November</td>
<td>501</td>
<td>413</td>
<td>484</td>
</tr>
<tr>
<td>December</td>
<td>513</td>
<td>431</td>
<td>538</td>
</tr>
</tbody>
</table>
Surface facility key learnings

- Safe operation of production and injection wells
- Geographical location provides challenges for instrumentation operations utilizing solar panels during the winter season
- Purity of injection gases plays key role in maintaining injectivity
- Marginal economics to operate in today's pricing environment
Measurement and reporting

Directive 54
Surface Operations section 2

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Measurement reporting

Field Operations record daily flow variable and volume for air injection and compressor fuel usage

EnCaid Daily Volume Report Spreadsheet

Production Accounting Activities
1) PA updated gas analysis in PAS.
2) PA enter air volume and fuel usage volume from EnCaid Daily Volume Report into PAS EnCaid injection facility.
3) Well production PVR data upload to PAS.
4) PAS generates PRA submission.
5) PA manually update the gas fuel usage into PRA.

Gas analysis - Maxxam

Gas well gas meters loaded to PVR via SCADA system

PVR
Environmental issues

Directive 54
Subsurface Operations section 7

EnCAID
Approval #10440L
2016 annual performance presentation
Environmental compliance

No environmental non-compliance events occurred related to EnCAID occurred in 2016
Compliance statement

Directive 54
Subsurface Operations section 8

EnCAID Approval #10440L
2016 annual performance presentation
Compliance confirmation

No other non-compliance events related to EnCAID occurred in 2016
Non-compliance discussion

Directive 54
Surface operations section 9

EnCAID
Approval #10440L
2016 annual performance presentation
Non-compliance confirmation

No non-compliance events related to EnCAID occurred in 2016
Future plans

Directive 54
Subsurface Operations section 10

EnCAID
Approval #10440L
2016 annual performance presentation
Future plans

- No major initiatives or plans that may require submission of an application are being contemplated at this time
- No changes to overall plant design or amendments are anticipated at this time
- Operate the project until it is economic
Appendix
Gas composition 00/1-17-73-6W4/0
Gas composition 00/2-16-73-6W4/0
Gas composition 00/6-5-73-6W4/0
Gas composition 00/6-6-73-6W4/0
Gas composition 00/6-7-73-6W4/0

![Graph showing mole percent of various gases over time.](image-url)
Gas composition 00/7-8-73-6W4/0
Gas composition 00/10-11-73-7W4/0
Gas composition 00/10-12-73-7W4/0
Gas composition 00/14-9-73-6W4/0
Gas composition 00/6-18-73-6W4/0
Downhole instrumentation layout
100/05-10-073-06W4 wellbore schematic
102/05-10-073-06W4 wellbore schematic
103/05-10-073-06W4 wellbore schematic
Thank you