

# Full Chain Carbon Capture & Storage With Source Sink Infrastructure



Presented By: Michael Monea, President & CEO

## Our Organization

### THE INTERNATIONAL CCS KNOWLEDGE CENTRE



Facilitates in an  
advisory role  
Based on expertise  
and lessons learned



Mandate: Advance the understanding  
and use of CCUS as a means of  
managing greenhouse gas emissions

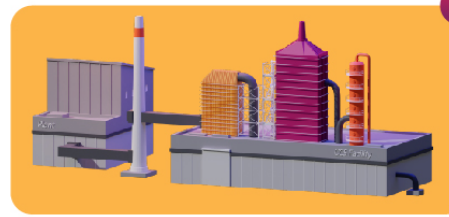


Sponsored jointly by global resource  
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SaskPower

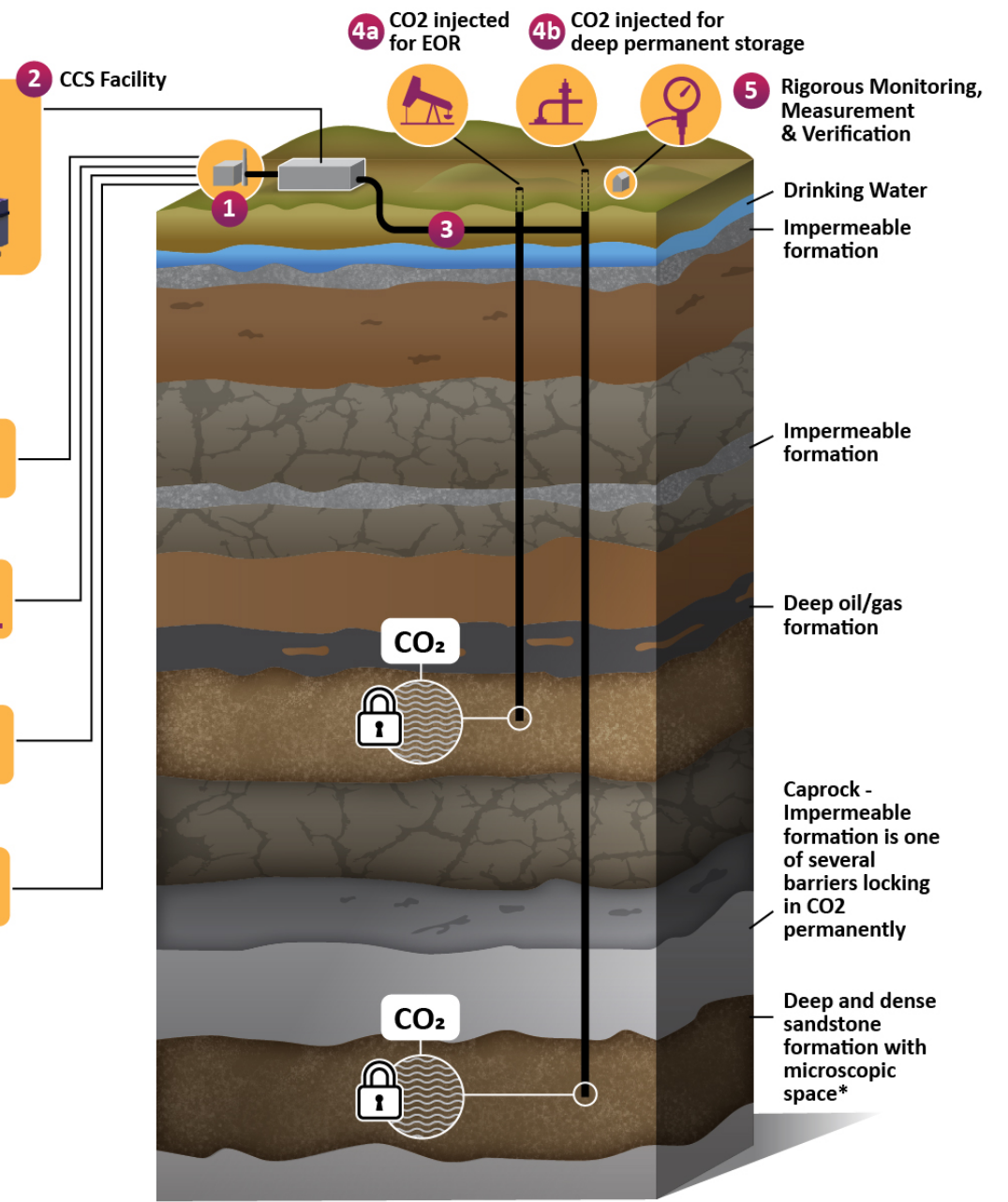
# Carbon Capture Storage at a Glance

## Accelerated CO<sub>2</sub> Emission Reduction

- 1** Source of carbon dioxide (CO<sub>2</sub>) emissions from industrial or energy plants. With carbon capture and storage (CCS), large amounts of CO<sub>2</sub> will be captured, recycled and permanently stored.
- 2** Up to 90% of CO<sub>2</sub> is captured and is then compressed into a dense phase liquid for easy transport.
- 3** The CO<sub>2</sub> is transported by pipeline. The CO<sub>2</sub> may also be transported by truck, rail or ship, depending on the needs specific to the region where the CCS project is located.
- 4** The CO<sub>2</sub> is sent deep underground for:
  - a** Use in Enhanced Oil Recovery (EOR) – where CO<sub>2</sub> is recycled and eventually permanently stored safely in depleted oil/gas formations.
  - b** Permanent storage into the microscopic space in a dense porous-rock formation\* – where the depth ranging from 1km-3km and layers of impermeable rock formations ensure the CO<sub>2</sub> remains there indefinitely. Over time the CO<sub>2</sub> calcifies and becomes solid.
- 5** Measurement, Monitoring & Verification (MMV) - rigorous and sensitive MMV procedures are put in place that can detect even the smallest changes in CO<sub>2</sub> pressure. As well, routine system monitoring is done and reported for atmosphere, ground water, and ground soil to ensure CO<sub>2</sub> remains permanently stored.



- Cement**
- Steel**
- Natural Gas**
- Coal Power**



\*The deep sandstone formation has microscopic spaces between its individual sand grains, or porosity, which allows it to hold high salinity water – that is 10 times more salty than the ocean. Due to the presence of this very salty brine, geologists refer to this type of formation as an aquifer.



## Introduction: The BD3 ICCS Facility

- World's first post-combustion coal-fired CCS project **fully integrated** with a power station.
- **Aided by \$240 CAD million dollar federal grant.**
- Favored by economics at the time.
- Executed as a two-part project:
  - Power island upgrade
  - CCS retrofit
- Life extended the 45 year old Boundary Dam Unit 3.
- **Capture operations began October 2014.**
- CO<sub>2</sub> used for EOR or stored in the Aquistore Project.

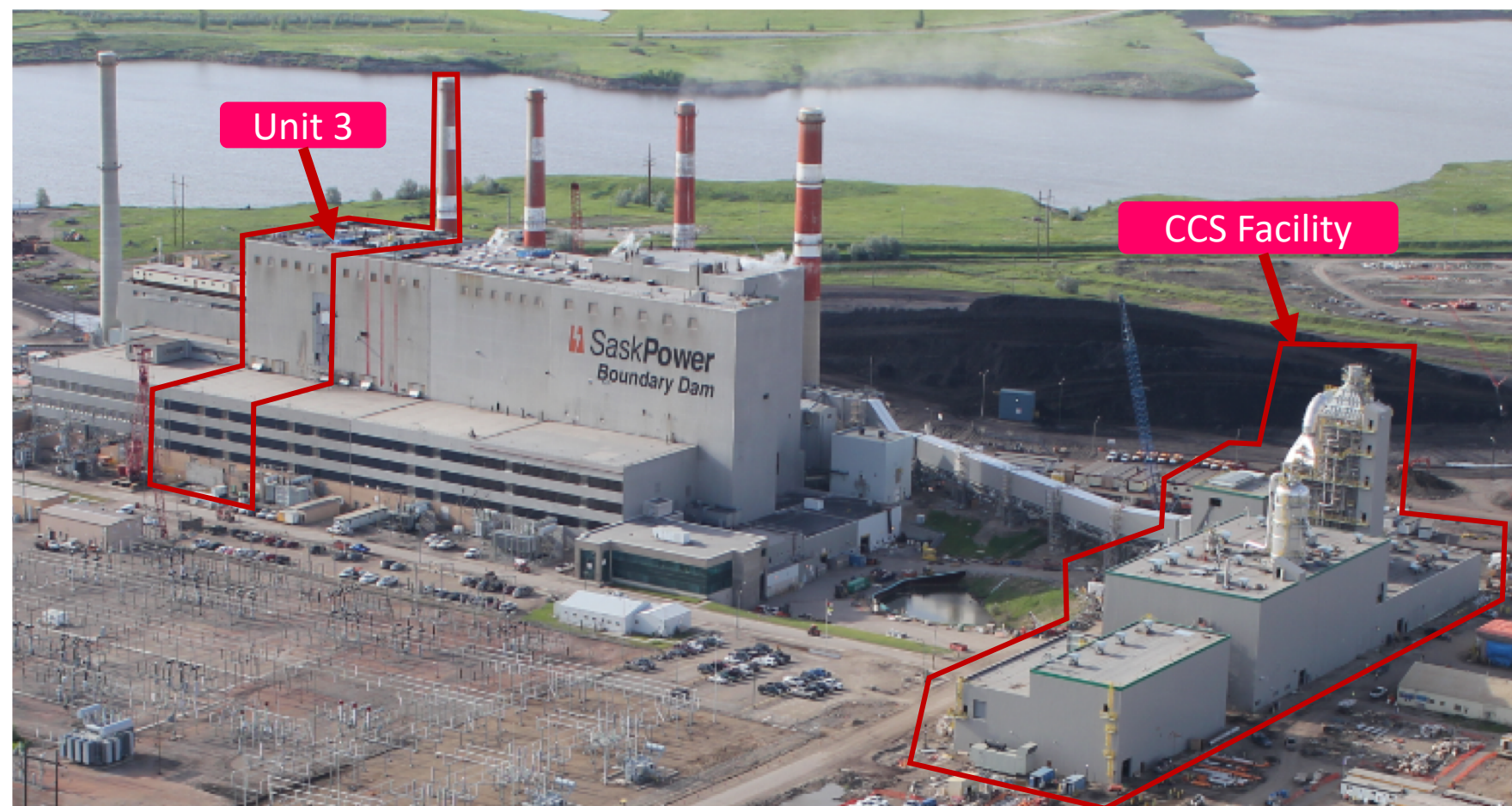


Figure 1. Boundary Dam Power Station and the ICCS Facility



## Performance: Exceeding Current Federal Coal Regulations

- **Regulation** on emissions **anticipated** but unknown at time of decision.
- *The Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations* which came into effect **July 1, 2015** set a stringent performance standard for new coal-fired electricity generation.
- A broad **carbon tax** that would increase over time, ultimately reaching **\$50/tonne by 2022** for all emissions exceeding 370 tonnes/GWh for coal plants.

### CO<sub>2</sub> Emissions - Significantly Reduced with Carbon Capture & Storage (CCS)

CO<sub>2</sub> emissions are significantly reduced with large-scale CCS – which is further reduced with 2<sup>nd</sup> generation CCS and shows negative emissions with BECCS.

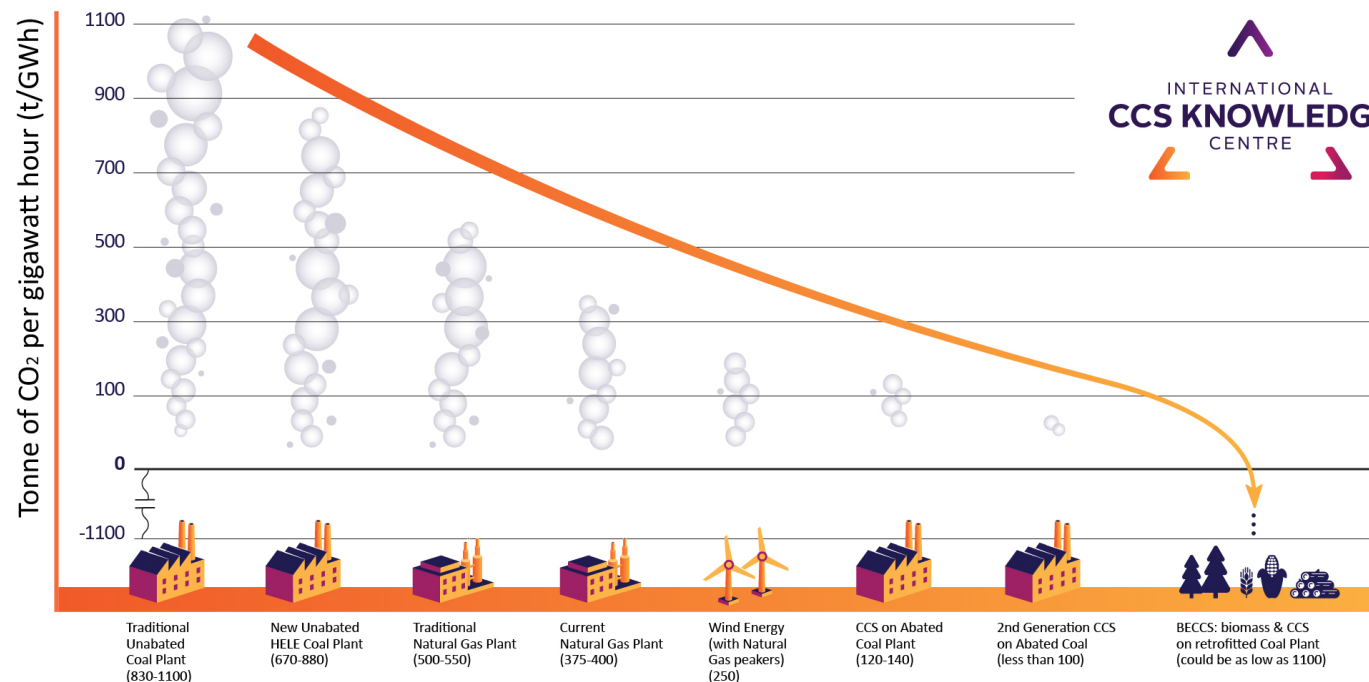


Figure 2. Summary of Actual CO<sub>2</sub> Emissions by Electricity Generating Source



## BD3 Availability Improvements



## SECOND GENERATION DESIGN



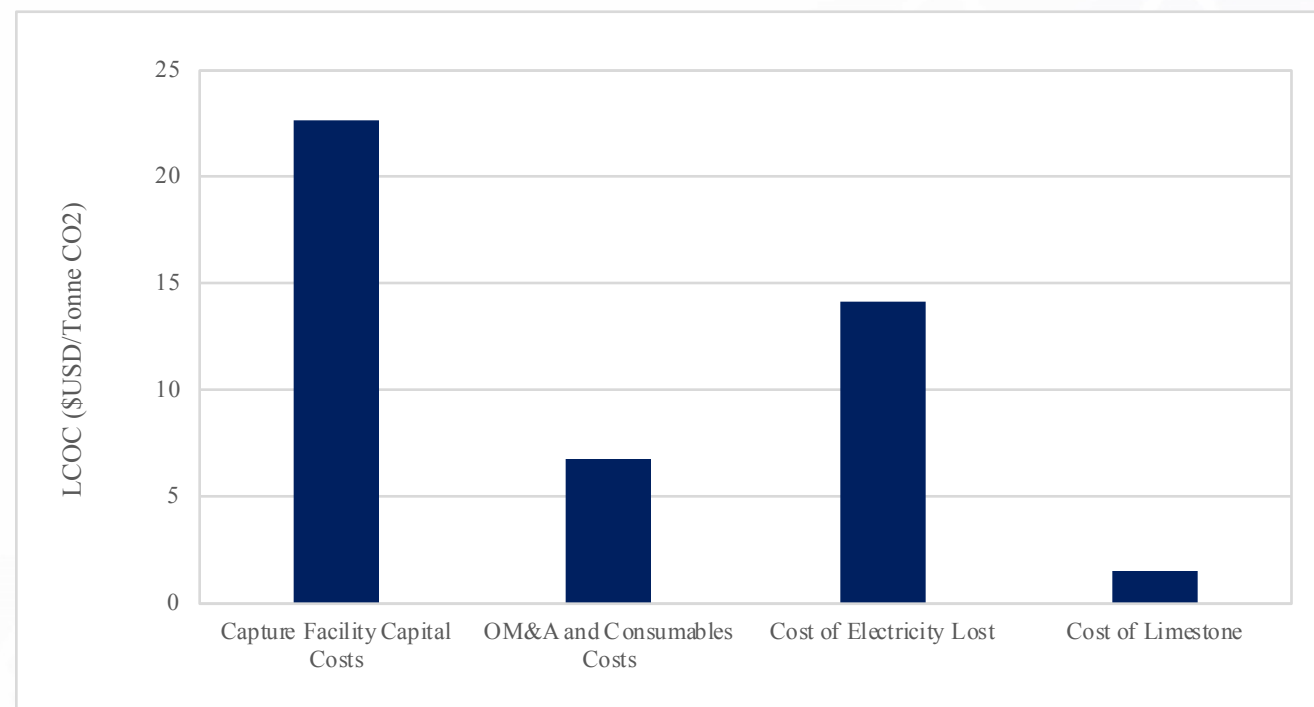
- Designed to capture 2Mt
- 67% capital cost reduction (per tonne CO<sub>2</sub>)
- Cost of capture at USD\$45/t CO<sub>2</sub>
- Can capture up to 97% while integrating with renewables
- Fly ash sales can further reduce CO<sub>2</sub> – net-negative emissions
- No new water



## The Cost of CCS

The Calculated Cost of Capture from the Shand CCS Facility would be **\$45US/tonne of CO<sub>2</sub>**

- **Economies of scale** contribute to cost savings realized by moving to the larger 300 MW unit
- Factors considered when calculating the **Levelized Cost Of Capture (LCOC)** included:
  - 30-year sustained run-time of the power plant
  - capture island capital costs
  - capture island OM&A and consumables costs
  - power island modifications costs
  - cost of the power production penalty assuming purchasing of power lost due to CO<sub>2</sub> capture-related generation losses at costs consistent with new Natural Gas Combined Cycle (NGCC) power supply



**Figure 4. Cost reduction of the Shand 2nd generation CCS facility as compared to the BD3 CCS Facility**

## Drivers for CCS Implementation and Key Findings of the Study

### CO<sub>2</sub> Market

- CO<sub>2</sub> EOR opportunities exist within 100 km of Estevan, Saskatchewan
- Economical development of these opportunities is key to a successful CCS retrofit
- Opportunity exists to join the Shand CO<sub>2</sub> pipeline to the BD3 pipeline; this would increase reliability of CO<sub>2</sub> supply and reduce penalties associated with delivery challenges
- CO<sub>2</sub> from BD3 that is currently not sold to off-taker(s) could be used to develop the CO<sub>2</sub>-use market prior to the completion of the Shand CCS facility
- Excess CO<sub>2</sub> capture volumes could be sequestered within the capacity of the existing Aquistore dedicated geological storage project.

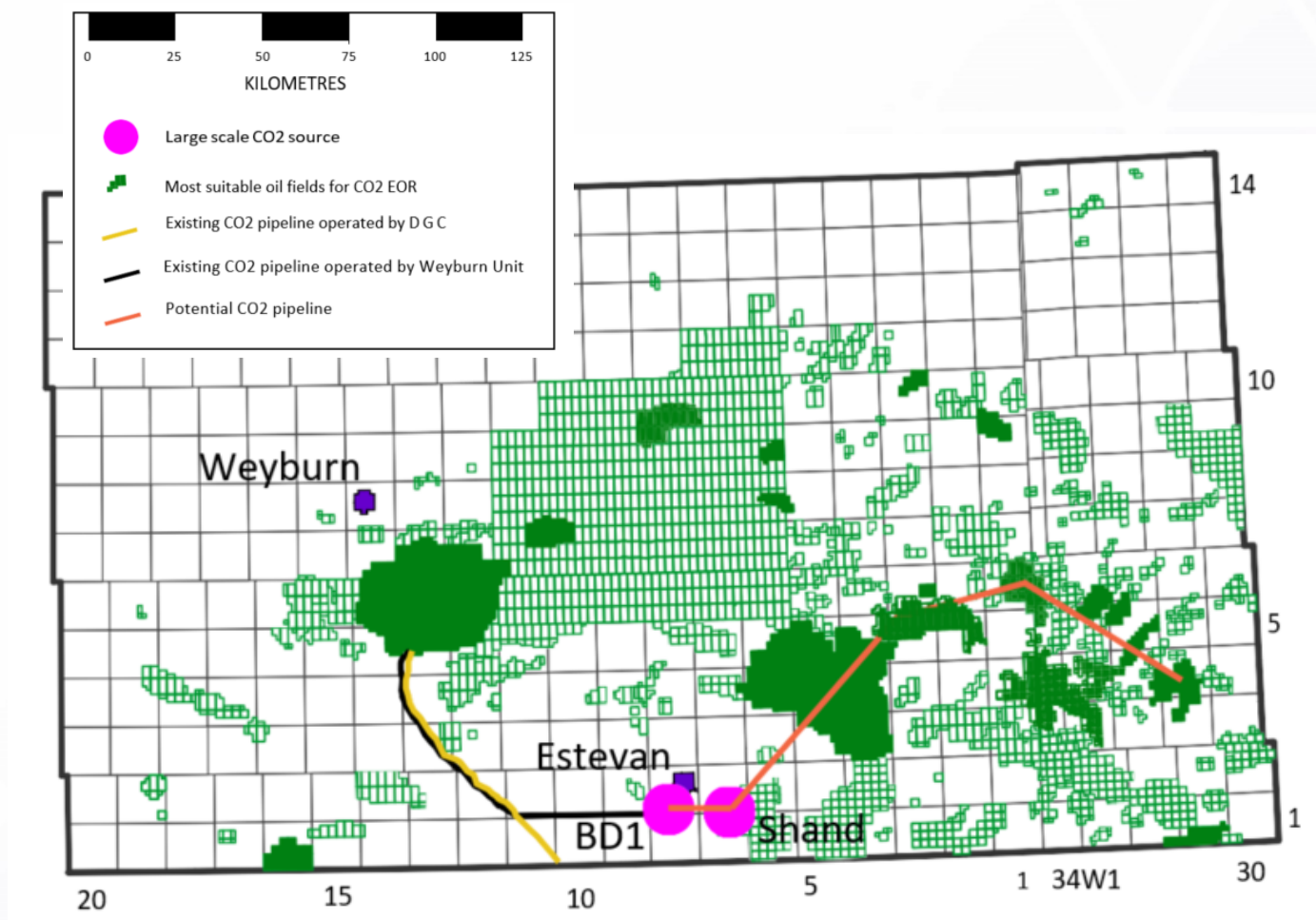
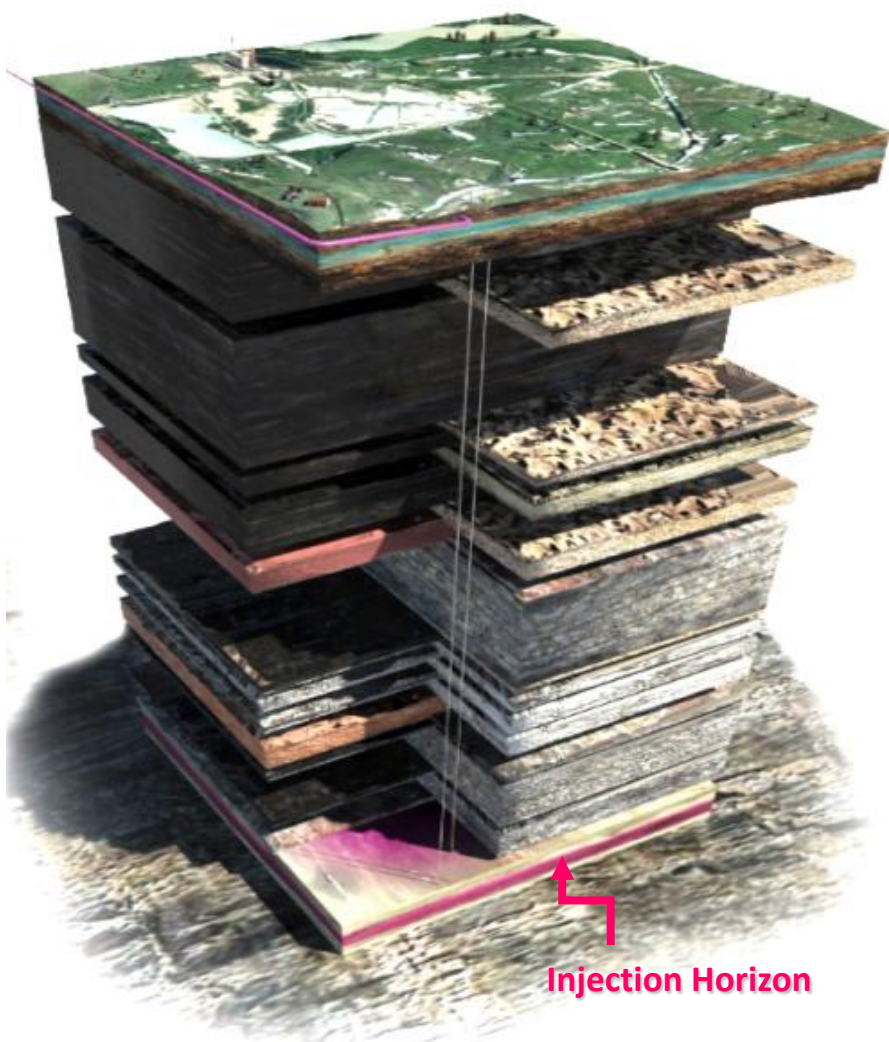


Figure 5. Location of potential CO<sub>2</sub> EOR in south east Saskatchewan

## AQUISTORE Project



- Storing CO<sub>2</sub> 3.2 km underground at SaskPower's Carbon Storage Research Centre (an injection well and a testing well)
- Saskatchewan has experiences with storage due to the Weyburn-Midale project. Approximately over 30 million tonnes of CO<sub>2</sub> stored and monitored since 2000.
- Storage is regulated by the Ministry of Environment

### SUCCESSES: THE NUMBERS

**240,000**  
CUMULATIVE TONNES  
OF CO<sub>2</sub> STORED



**0**  
INDUCED SEISMIC  
EVENTS



**30**  
MONITORING  
TECHNOLOGIES DEPLOYED



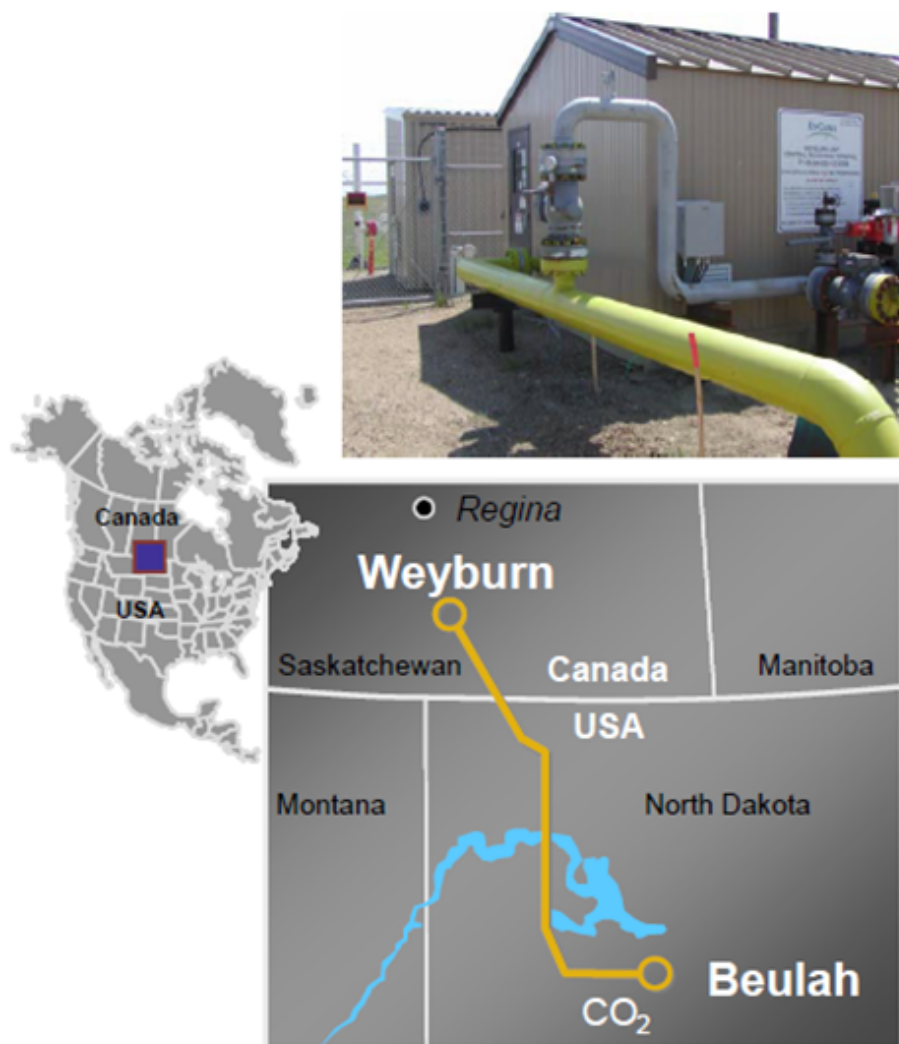
**2100**  
MAX INJECTION RATE  
TONNES/DAY







## Case Study – Weyburn Enhanced Oil Recovery



### Largest CO<sub>2</sub> EOR project in Canada

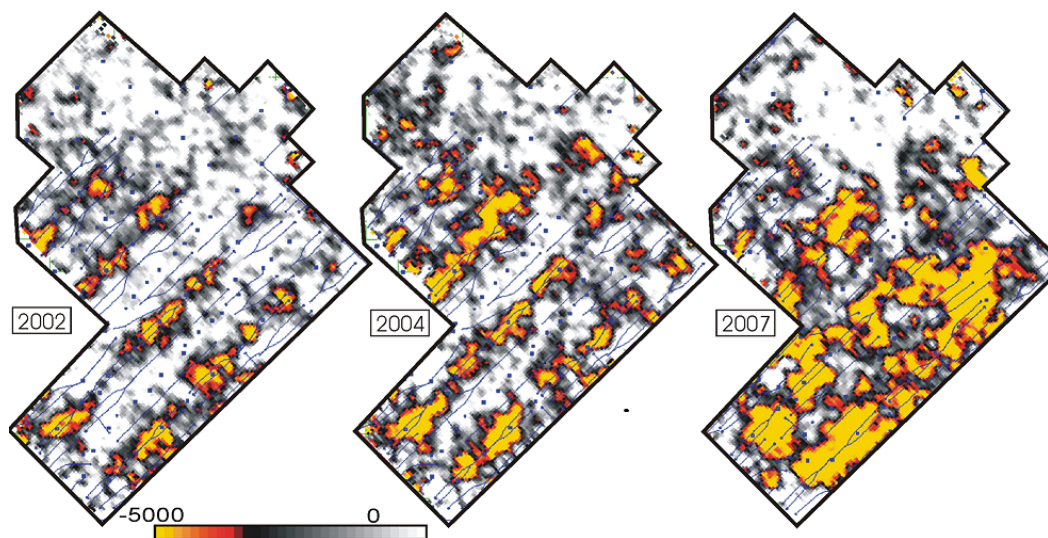
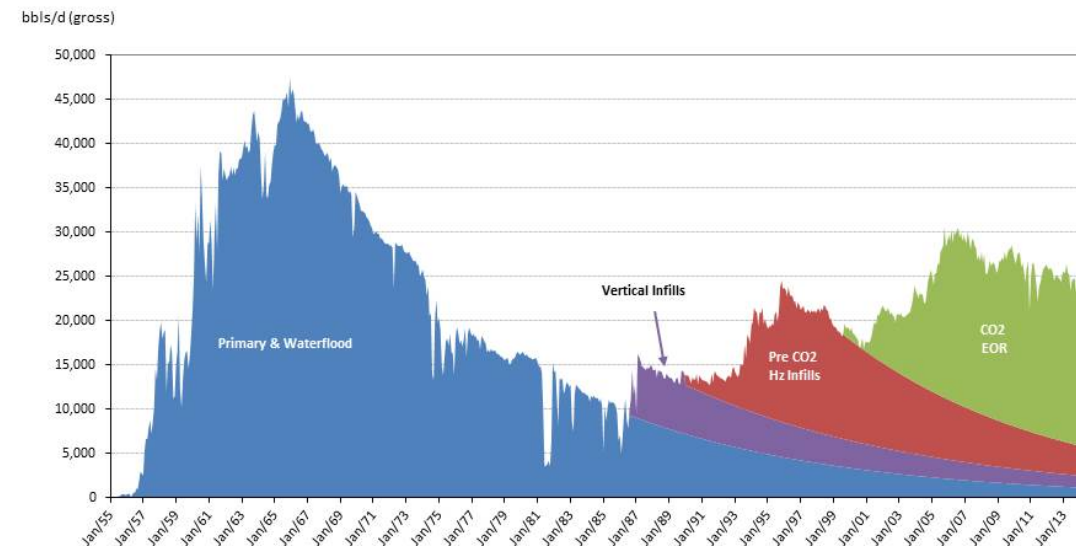
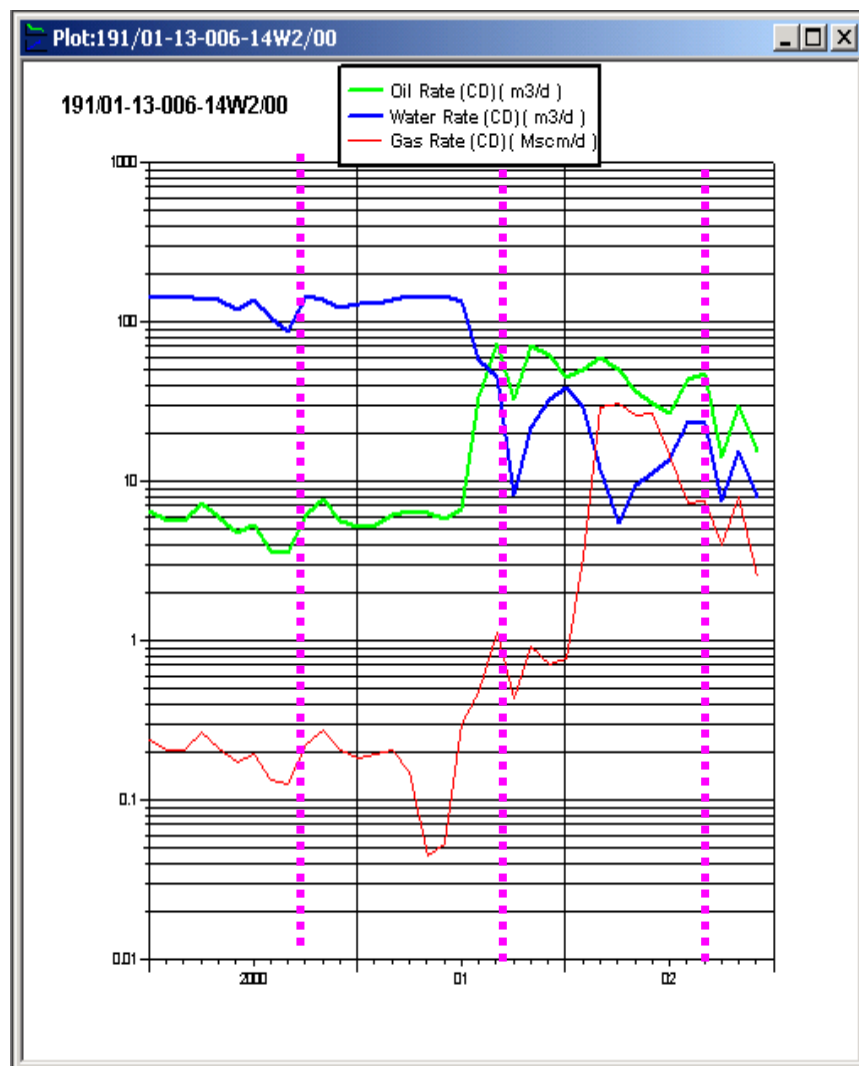
- OOIP 1.4 Bbbls
- 160 Mbbbls incremental

### Outstanding EOR response

### World's largest geological CO<sub>2</sub> sequestration project

- 30 million tonnes stored to date

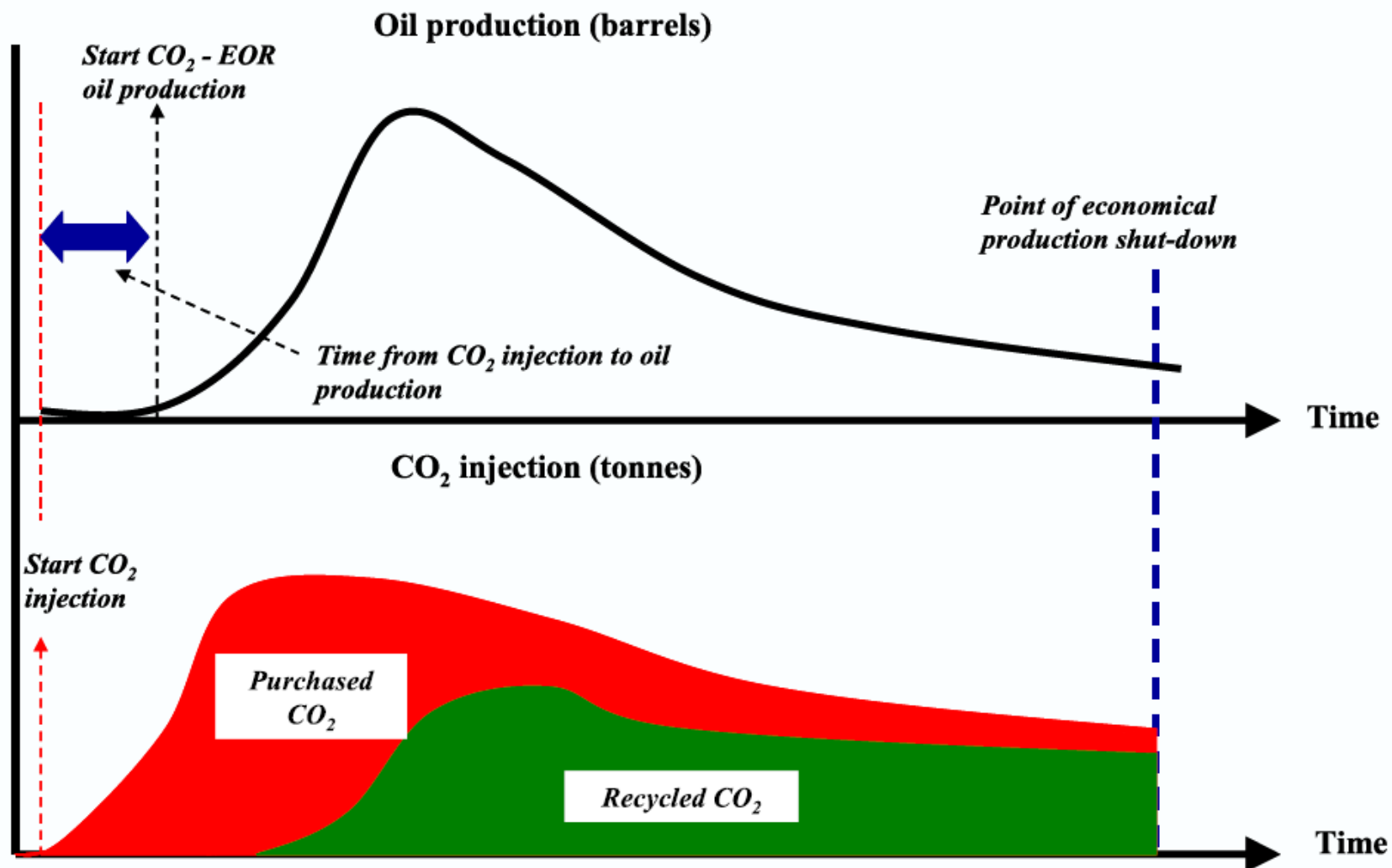
## Weyburn Oil Production



September 30, 2014



## Purchased vs Recycled CO<sub>2</sub>



# Thank You



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visit our website at:

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Contact us by email:

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