Turns out, what you know (about oils sands) is *actually* so.

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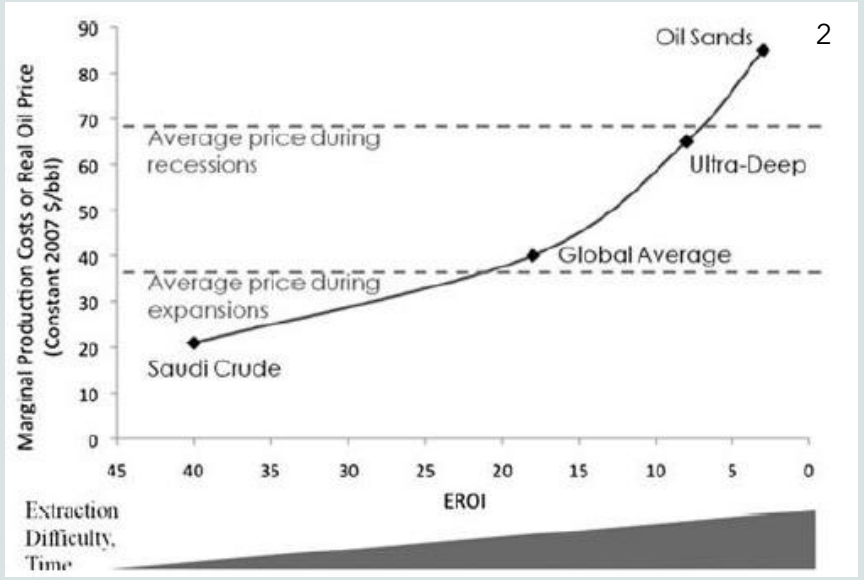
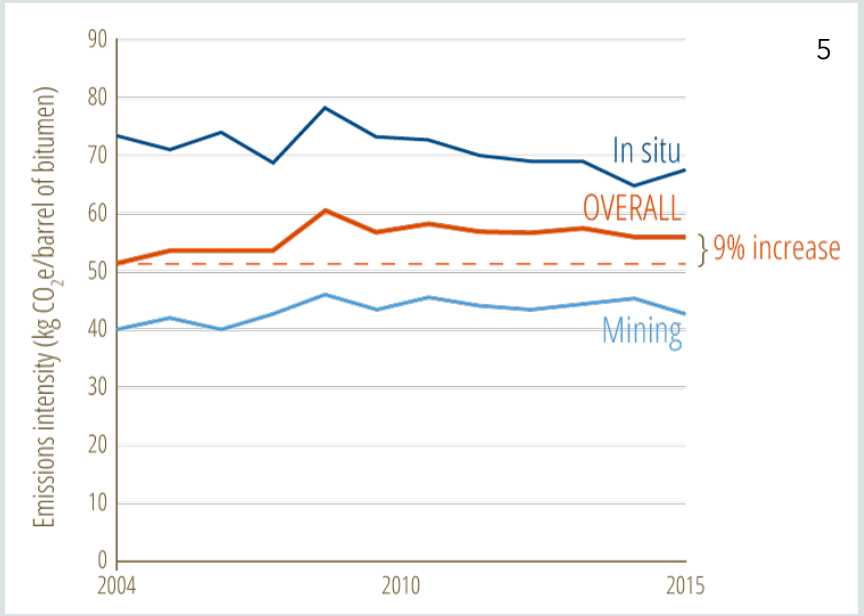
Claim: "Canadian oil is cleaner than other oil"

MYTH BUSTED

- **Oil sands consumes 30% of Canada's total natural gas use** [1]
  - *Massive fugitive methane emissions (greater warming potential than CO_2)*
- **Energy Return On Investment (EROI)**
  - *Canadian oil sands EROI [2] ≈ 3:1*
  - *Global avg. for conventional crude EROI [2] ≈ 18:1*
- EROI does even not account environ. impacts or emissions
  - **>1.4 trillion litres of** (*leaky*) **toxic tailings** [3]
  - 2024 ECCC study shows oil sands **emissions underreported by 19-63x by industry** [4]
- Most accessible oil already used; EROI will go down
  - *Might already happening…* [5]





1 – Canada Energy Regulator; 2 – Murphy and Hall, 2011; 3 – Alberta Energy Regulator; 4 – He et al., 2024; 5 – National Inventory Report (ECCC)

* - see appendix slide (slide 11)

Claim: Carbon Capture and Storage (CCS) = carbon neutral fossil fuels

The claim relates largely to Enhanced Oil Recovery (EOR)

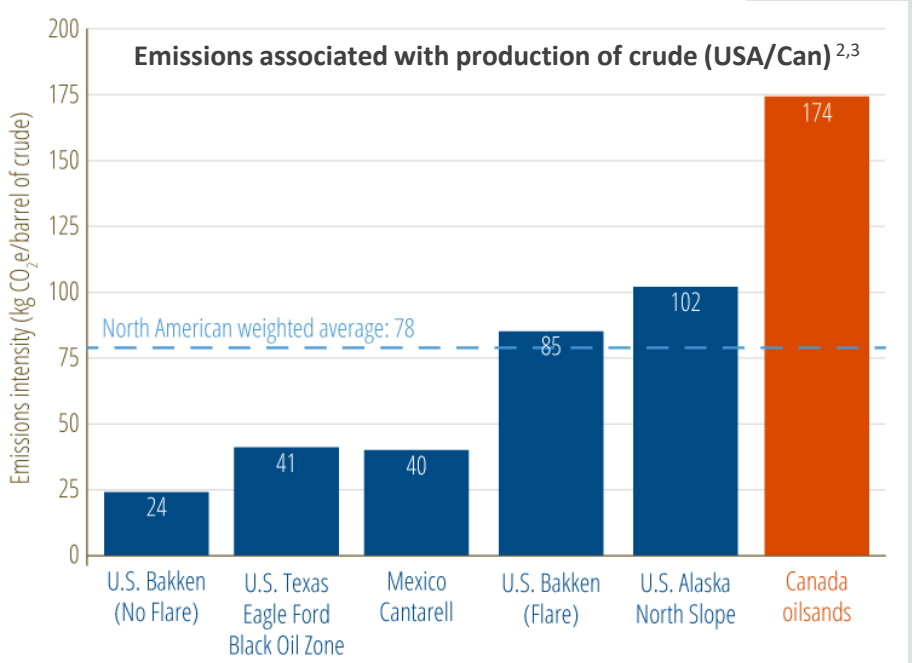
- Injecting CO_2 to enhance oil production (73% of all CCS is used for EOR) [1]
- This means more oil, and more emissions --> weird climate solution, no?

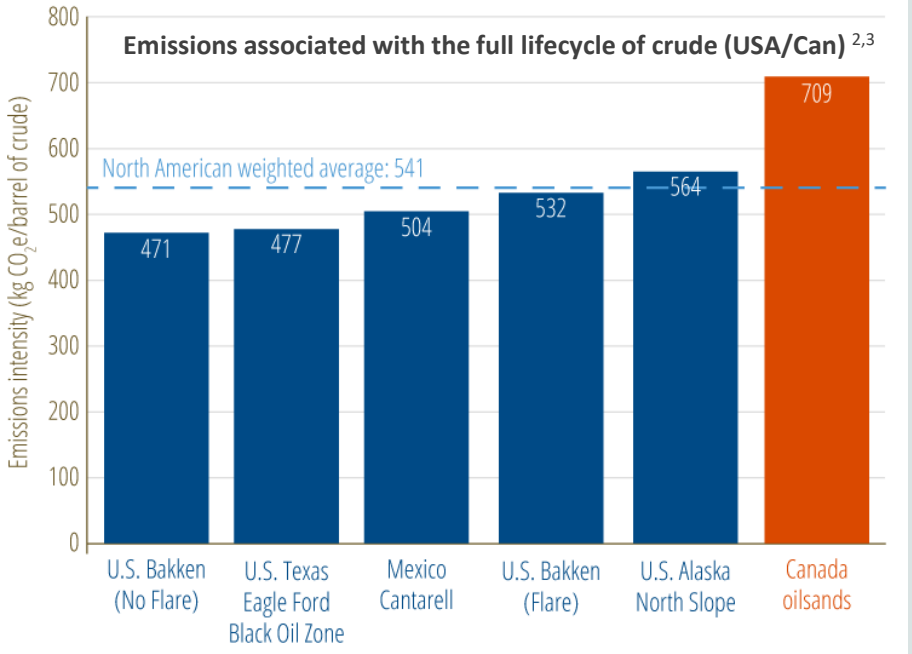
But, *IN THEORY*, it is possible

- Avg. of 541 kg of CO_2 emitted per barrel of crude oil in North America [2,3]
- 300 – 600 kg of CO_2 can be injected in EOR per barrel of crude oil [4]
  - At optimal efficiency --> potentially carbon neutral…

Reality: CCS EOR not a viable option for oil sands

1. ↑ oil sands costs & emissions = **at best reduced net emissions** (not neutral)
2. CCS EOR **not possible for surface mining** (no overlying impermeable layer)
3. CCS EOR **not viable for deeper *in-situ* mining*** (steam injected to fill pores)
   - CO_2 cannot push-out heavy bitumen in costly/polluting *in-situ* (SAGD) mining





1 – Institute for Energy Economics and Financial Analysis (IEEFA); 2 – Pembina Institute; 3 – Oil Climate Index; 4 – International Energy Agency (IEA);

Claim: Carbon Capture and Storage (CCS) = carbon neutral fossil fuels

Reality: Scale, Scope and Costs

- Current CCS captures ≈40 Mt/yr; net-zero by 2050 **needs >5000 Mt/yr** [1]
- Only 15% of CCS CO_2 used in USA/Can EOR is from industrial sources [2]
    - 85% from existing, natural, buried terrestrial sources (CO_2 emissions often not near areas of extraction)
    - Already sequestered, needs extraction and re-sequestering
- There are **seven active CCS projects** in Canada (5 in oil/gas)
    - Capture ≈0.05% of Canada's carbon emissions [3]
    - **Suboptimal efficiency common**: Longest operating CCS (Boundary Dam) only **≈ 50% of emissions captured** [2]
    - Only remove emission from production (***≈15% of total emissions from oil life cycle***) [4]
- Most CCS **Life Cycle Analysis (LCA)** doesn't account for full ***cradle-to-grave*** emissions or financial costs [5]

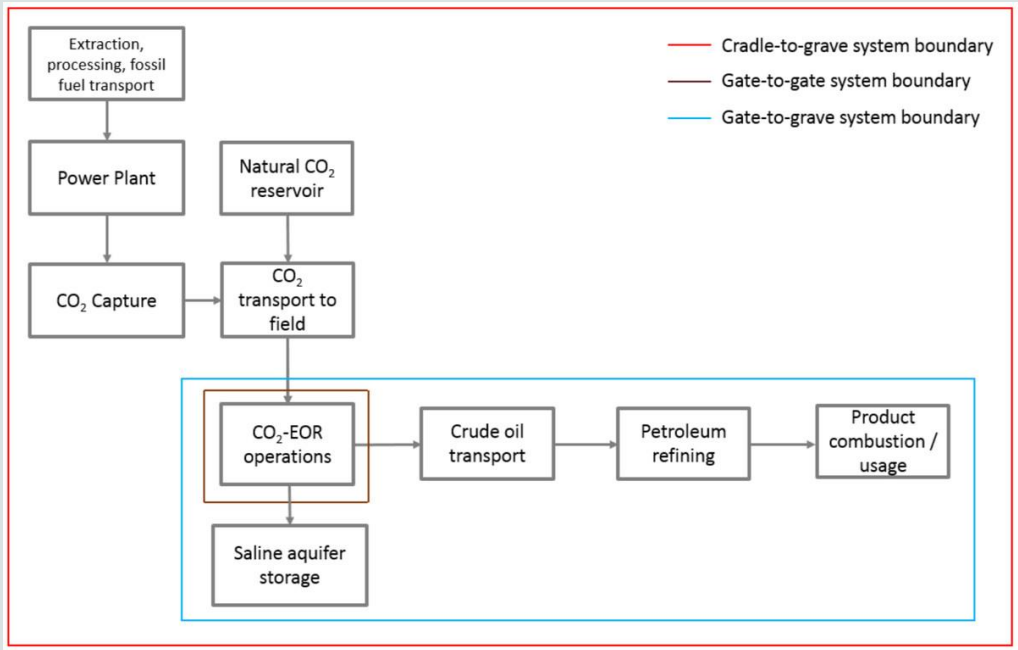


Figure 4. Lifecycle analysis CCUS boundaries. Adapted from Nuñez-López et al., 2019.

1 – IEA; 2 – IEA; 3 – International Institute for Sustainable Development (IISD); 4 – IEEFA; 5 – Nuñez-López et al., (2019)

Claim: Carbon Capture and Storage (CCS) = carbon neutral fossil fuels

- **Carbon is an externality to the oil industry**
  - CCS does not make money, so industry doesn't do it because they don't have to
  - **CCS adds 15-25% more energy** use by industrial facilities (high-end for Oil sands) [1,2]
    - *330-420 kWh needed per tonne of CO_2 captured*
    - *Cost CA$100-200 per T of CO_2 captured*
  - **Oil and gas sectors want delay & <u>more</u> taxpayer subsidies for CCS** [3,4,5]
    - Without a fixed carbon price or strong political sanctions there is no incentive
    - With current lobbying, how could there be? [6,7]


Amid record profits, tar sands companies want more subsidies for carbon capture [3]

Published on 05/05/2022, 5:02pm

Canadian oil producers MEG Energy and Cenovus say the government's $2.6 billion plan to support carbon capture and storage is not enough


The Narwhal

INVESTIGATION

Oilsands giants pushed feds to delay and weaken emissions cap rules [4]

Through the Pathways Alliance, an organization of some of Canada's largest oil producers, high-level bureaucrats were asked for long lead times and a 'flexible, non-regulatory approach' to usher in a limit on the sector's air pollution

By Carl Meyer
July 5, 2023 15 min. read

The Pathways Alliance plastered Toronto streetcars and Vancouver billboards with optimistic messages about its plan to slash pollution and help Canada meet its climate goals. Behind the scenes, the coalition of fossil fuel producers struck a different tone.

A collection of internal government documents obtained by The Narwhal show how six major oil companies lobbied the federal government to weaken and delay plans to place a cap on heat-trapping pollution from the oil and gas sector.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Cenovus blasts Ottawa over lack of support for carbon capture [5]

'Stick-based approach with some carrots thrown in'


THE Breach

Investigations | Sep 11 2023

Poilievre's 'anti-elite' Tories stack top council with corporate lobbyists [6]

Nearly half of the Conservatives' new governing body are lobbyists for oil, pharma, real estate and anti-union companies

by Martin Lukacs


CANADA'S NATIONAL OBSERVER

Canada's oil companies won't do what they promise — instead, they bide their time, awaiting Poilievre [7]

By Max Fawcett | Opinion, Energy, Politics | September 27th 2022

1 – IISD; 2 – European Environment Agency (EEA); 3 – ClimateChangeNews; 4 – Narwhal; 5 – Financial Post; 6 – The Breach; 7 – National Observer

1 – IEEFA
2 – Abdulla et al., 2020
3 – Global Witness

Claim: Carbon Capture and Storage (CCS) = carbon neutral fossil fuels

- Underperformance

- High failure rate

Many existing projects have failed.

>80% of proposed projects have failed before they start [2]

(due to: high costs, dependence on subsidies, low technology readiness, poor financial return)

Carbon Capture and Storage (CCS) projects' poor report card [1]

Project	Capacity (MtCO2 p.a.)	Performance
Natural Gas processing		
1986 Shute Creek	7	Lifetime under-performance of 36%
1996 Sleipner	0.9	Performing close to the capture capacity
2004 In Salah	1.1	Failed after 7 years of operation
2007 Snøhvit	0.7	Performing close to the capture capacity
2019 Gorgon	4	Lifetime under-performance of ~50%
Industrial sector		
2000 Great Plains	3	Lifetime under-performance of 20–30%
2013 Coffeyville	0.9	No public data was found on the lifetime performance.
2015 Quest	1.1	Performing close to the capture capacity
2016 Abu Dhabi	0.8	No public data was found on the lifetime performance.
2017 Illinois Industrial (IL-CCS)	1	Lifetime under-performance of 45–50%
Power sector		
2014 Kemper	3	Failed to be started
2014 Boundary Dam	1	Lifetime under-performance of ~50%
2017 Petra Nova	1.4	Suspended after 4 years of operation

Source: IEEFA. The Carbon Capture Crux: Lessons learned. September 2022.

Will return to these two "good" stories…

Common lack of transparency from industry on capture efficiency

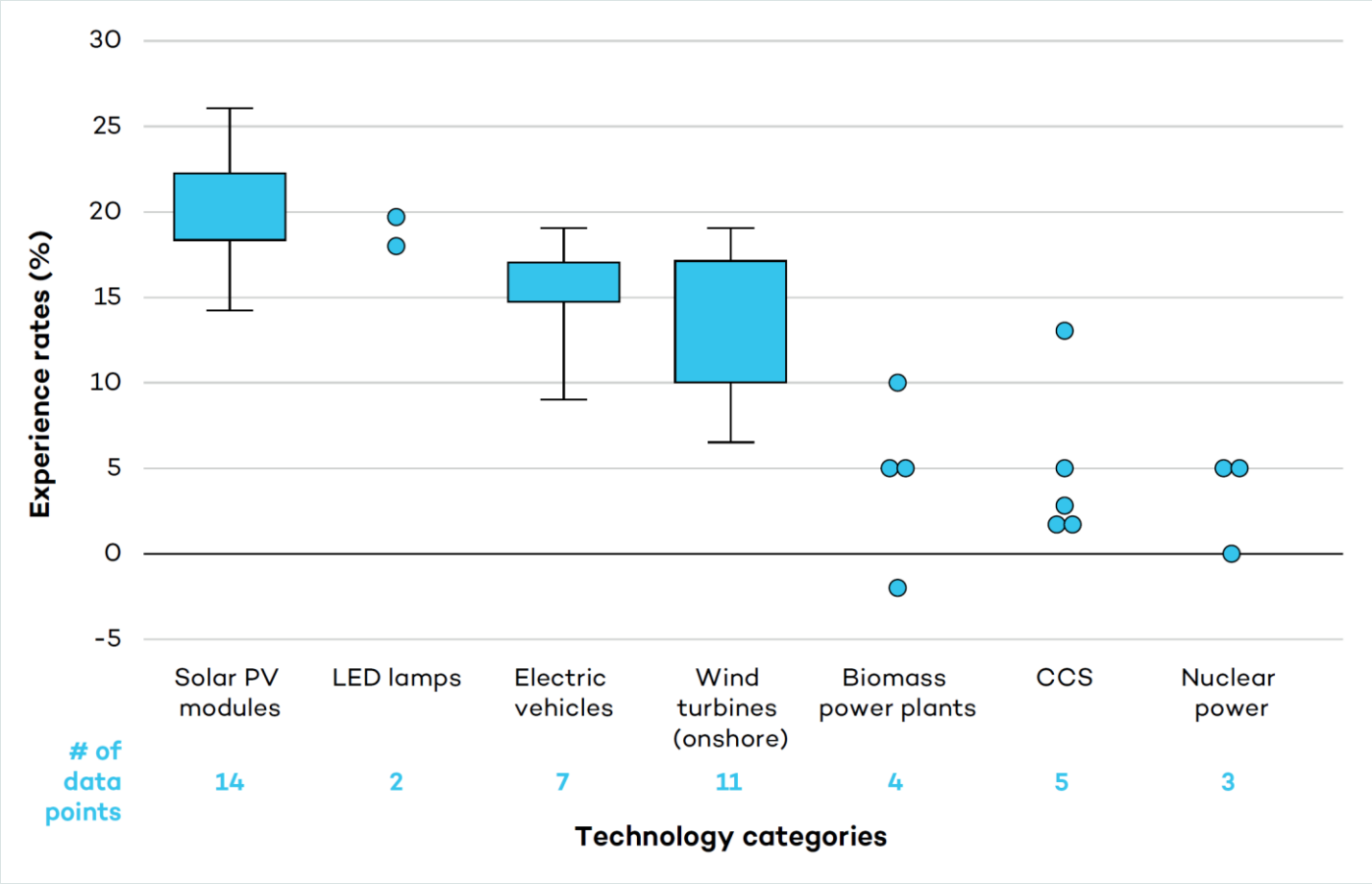
Quest captures CO_2 from hydrogen used in oil sands processing at near capacity. 2015-19: captured 4.8 M t, but plant emitted 12.5 M t. [3]

Claim: Carbon Capture and Storage (CCS) = carbon neutral fossil fuels

- **Low CCS "Experience Rates": costs not decreasing with time**
  - Experience rates are the rate which the cost of a technology decreases with development, investment and expansion.
  - CCS costs have decreased slowly compared to other energy techs, particularly renewables [1,2]

But hey, this could change…right?

- CCS is also not a new technology; tried & tested
  - EOR first applied in Texas in 1972 [3]



1 – International Institute for Sustainable Development; 2 – Malhorta and Schmidt, 2020; 3 – Ma et al., 2020

Claim: CCS is permanent and causes no geo-mechanical impacts

MYTH BUSTED

Geophysical Research Letters

Research Letter | Open Access

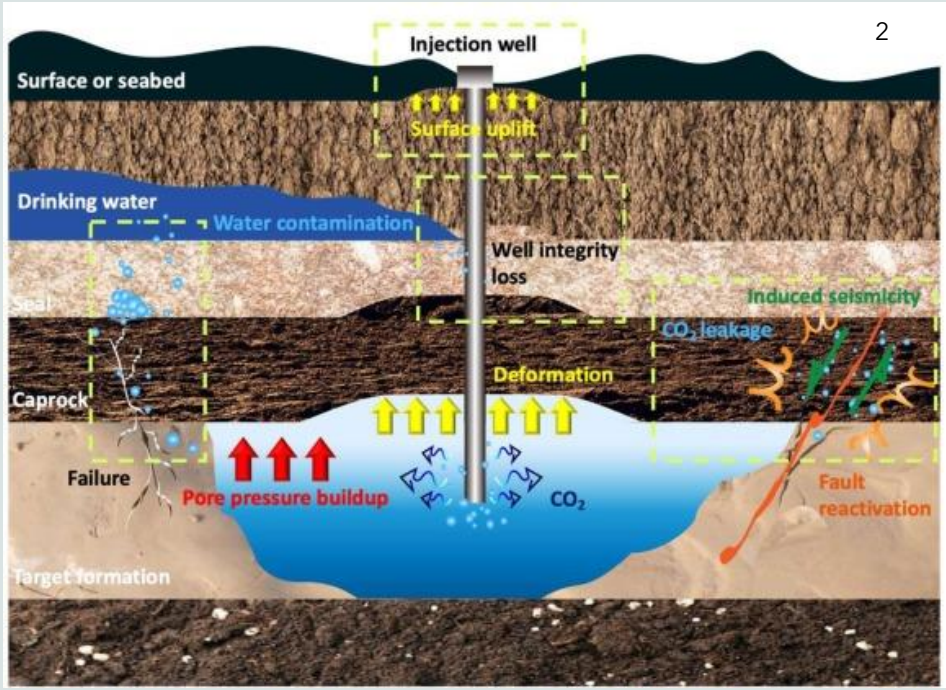
Disposal From In Situ Bitumen Recovery Induced the M_L 5.6 Peace River Earthquake [1]

Ryan Schultz, Jeong-Ung Woo, Karissa Pepin, William L. Ellsworth, Howard Zebkar, Paul Segall, Yu Jeffrey Gu, Sergey Samsonov

First published: 23 March 2023 | https://doi.org/10.1029/2023GL102940 | Citations: 2

- **Even without CCS, *in-situ* (SAGD) Oil Sands mining impacting geology** [1]
  - Steam injection from **S**team-**A**ssisted **G**ravity **D**rainage (deeper "*in-situ*") mining caused one of Alberta's largest Earthquakes (2022) [1]
- **All gas and fluid injection into porous geological features increase pore pressure and induce *poroelastic* responses** [1,2]
  - Can manifest migration,[3,4] surface uplift,[5] leakage,[6] seismicity[7]
- Norwegian CCS plants, **Snøvhit** and **Sleipner**, heavily studied for Geology
  - At 18 months, ***Snøvhit*** CCS capacity dropped from 18 yrs to 6 months; massive overprediction of geological unit's capacity for CO_2 [3]

    Alternate injection site found at extensive cost (≈US$250M)
  - ***Sleipner***: significant upward CO_2 migration in strata *(a near surface unit is holding)* [4]
- **Many unknowns** relating to geological structures, processes, and long-term stability



1 – Schultz et al. (2023); 2 – Song et al. (2023); 3 – Hansen et al. (2013); 4 – IEEFA; 5 – Rinaldi et al. (2017); 6 – Su et al. (2023); 7- Ellsworth (2013)

And the tailings ponds?

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Imperial and Alberta regulator knew for years about oilsands tailings seepage, documents show

Test wells were finding tailings in groundwater as far back as 2020, reports show

Bob Weber · The Canadian Press · Posted: Oct 02, 2023 10:13 AM EDT | Last Updated: October 2, 2023

A tailings pond leaking into the groundwater has triggered a series of investigations and alarm from surrounding communities. (Alberta Innovates)

Documents filed by Imperial Oil Ltd. show the company and Alberta's energy regulator knew the Kearl oilsands mine was seeping tailings into groundwater years before a pool of contaminated fluid was reported on the surface, alarming area First Nations and triggering three investigations.

"They knew there was seepage to groundwater," said Mandy Olsgard, an environmental toxicologist who has consulted for area First Nations.

"The [Alberta Energy Regulator] and Imperial decided not to notify the public and just manage it internally."

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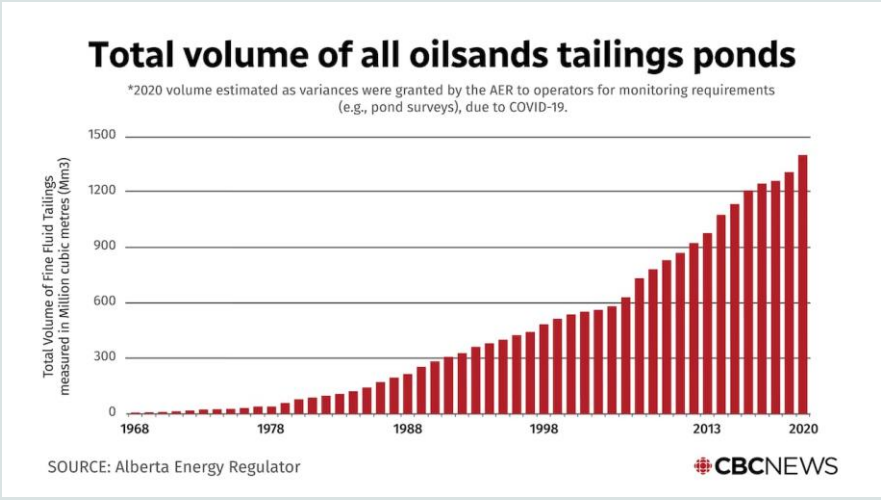
Business

Banned for decades, releasing oilsands tailings water is now on the horizon

Some Indigenous groups say they are stuck choosing between environmentally risky options

Kyle Bakx · CBC News · Posted: Dec 06, 2021 4:00 AM EST | Last Updated: December 6, 2021

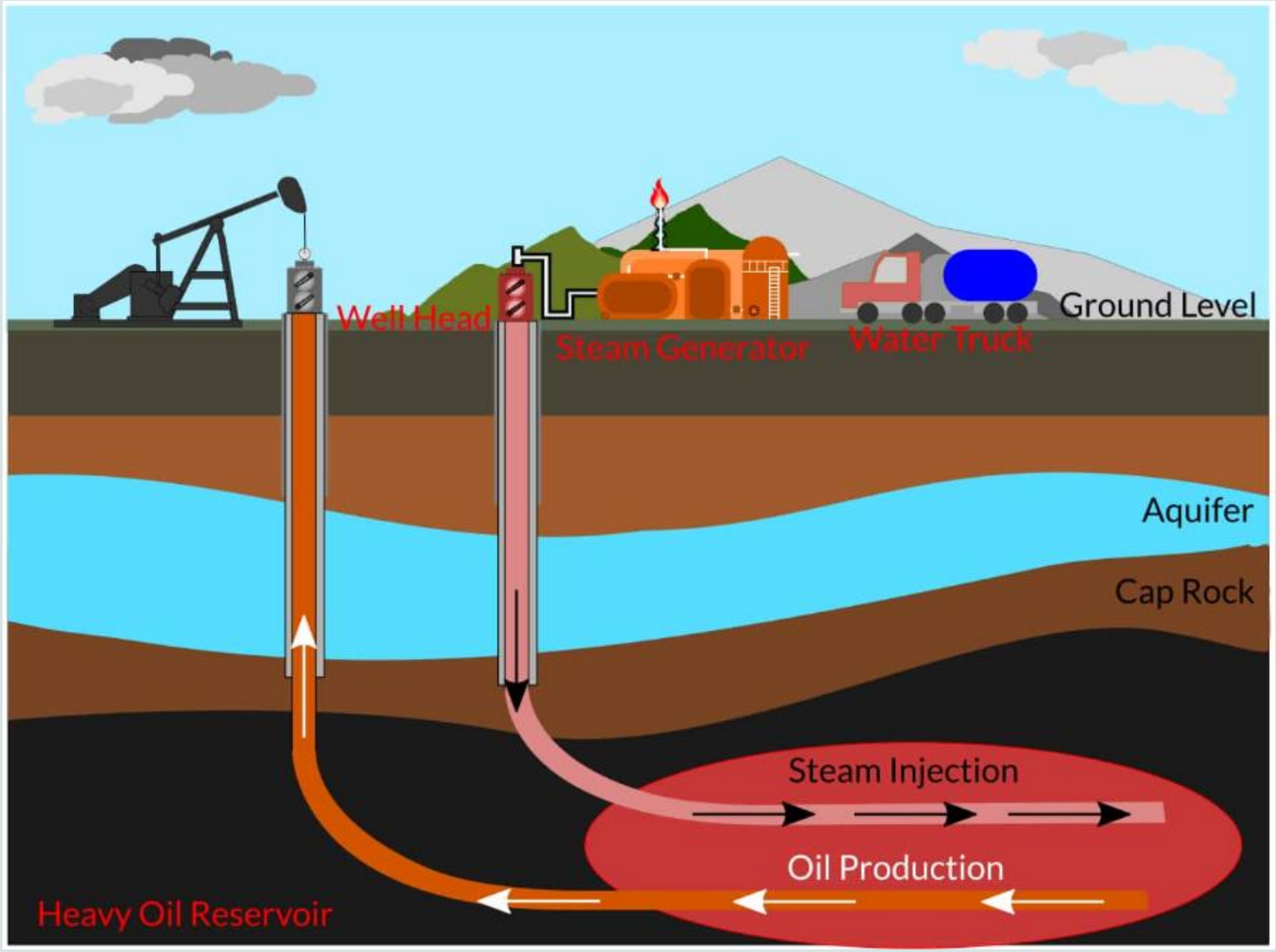
Tailings drain into a pond at the Syncrude oilsands mine facility near Fort McMurray, Alta. on July 9, 2008. That year, some 1,600 ducks died in one of the company's toxic tailings ponds. (Jeff McIntosh/Canadian Press)



Appendices

Steam Assisted Gravity Drainage (SAGD) is a thermal in-situ heavy oil recovery process. Essentially, steam is injected into an injection well forming a cone-shaped steam chamber. As the steam chamber expands, new bitumen is heated and replaced by steam; the heated bitumen lowers in viscosity and flows downward along the steam chamber boundary into a production well by way of gravity. The SAGD process was pioneered in 1978 by Dr. Roger Butler, holder of the Endowed Chair of Petroleum Engineering at the University of Calgary from 1983 to 1995.

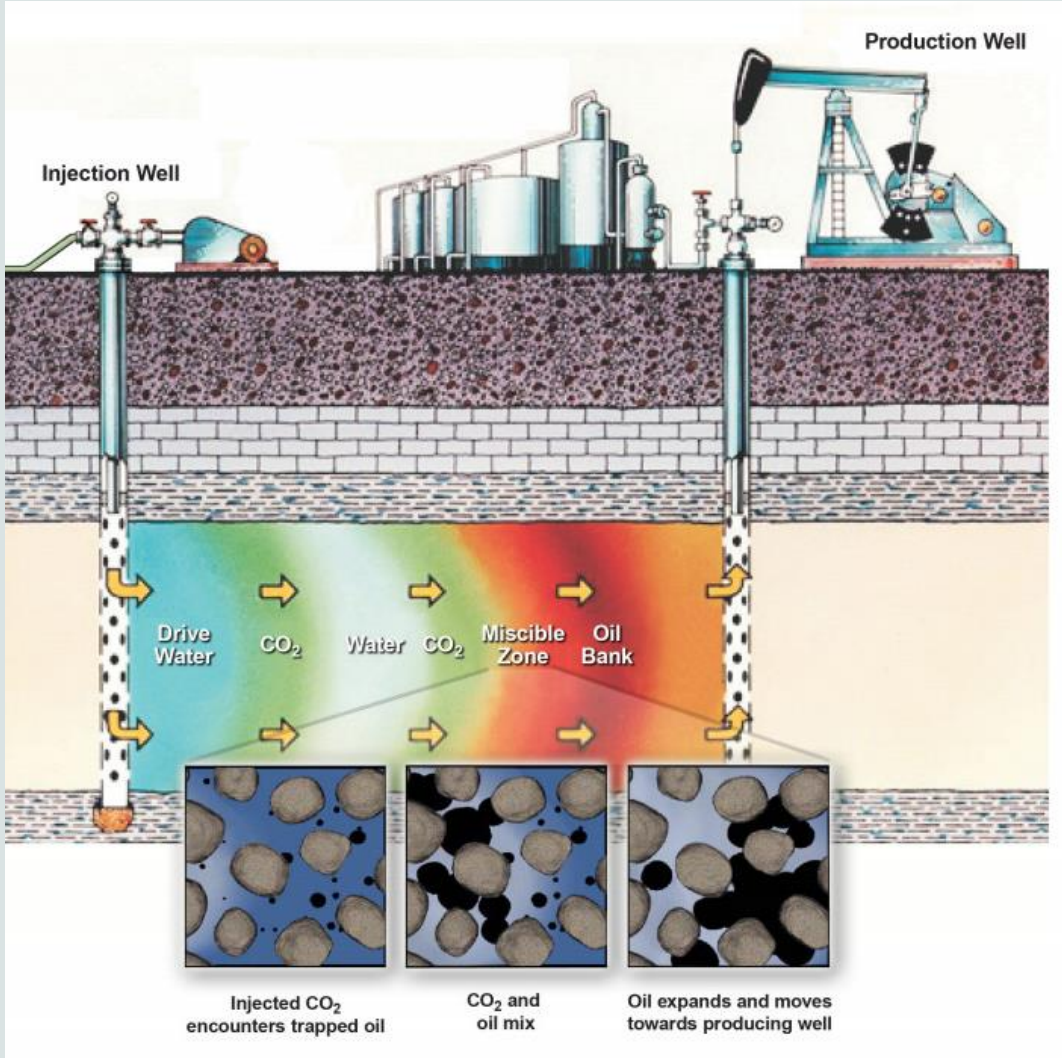
McLennan and Deutsch (2005)



Enhanced Oil Recovery

Let's review the basics of EOR. When oil companies dig wells, there are three phases of production. During primary production, the natural pressure built up within underground reservoirs pushes oil to the surface; about **10 percent of the oil** in the reservoir is recovered this way. During secondary production, a fluid, usually water or gas, is pumped through the reservoir to flush loose more oil; that can recover anywhere from 20 to 40 percent of the oil.

Tertiary production is anything done after that, including injecting any fluid not originally found in the reservoir. The most common form of tertiary production is EOR, whereby high-pressure CO2, sometimes alternated with pulses of water, is injected into wells to bond with the oil and carry more of it to the surface. EOR can recover up to 60 percent of the oil in a reservoir.



https://www.vox.com/energy-and-environment/2019/10/2/20838646/climate-change-carbon-capture-enhanced-oil-recovery-eor

Geomechanical concerns

Song et al. (2023)

…the [CCS] process is accompanied with geomechanical risks due to the unavoidable pore pressure buildup, such as caprock failure, reactivation of existing faults, poroelastic response of rock and well integrity loss. Not only may the risks lead to undesirable environmental concerns such as CO_2 leakage to the surface, induced seismicity, and surface uplift, but it also would disturb achieving the public's consensus on the CCS process.

https://doi.org/10.1016/j.cej.2022.140968