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Carbon Capture and Storage in Saskatchewan – Past, Present & Future

Saskatchewan Mining Week Breakfast – May 31, 2022

Conway Nelson, VP Project Development and Advisory Services

Agenda

- What is CCS/CCUS?
- Past
- Present
- Future

What is CCS/CCUS?

CCS KNOWLEDGE CENTRE

WE ARE UNIQUE IN THE CCS SPACE:

Unbiased advocate for the **deployment of CCS** to reduce global CO_2 emissions across **all Industries** using **all Technologies**

Technical Experience from the Boundary Dam 3 CCS Facility, Shand 2nd Gen CCS Feasibility Study, and ongoing **Feasibility & Feed Studies** on CCS across **all Industries**

Technical Advice for planning, design, construction, start-up and operation of CCS facilities to **Reduce Risk** based on unique real-world experience

Actively **Engage** with **Financiers**, **Policy Makers**, **Decision Makers**, and business case partners.

- **Expert Technical Advisory Services** to all Industries
- **Owner's Engineer** role
- **Reduce** CCUS project and operations **Risk**

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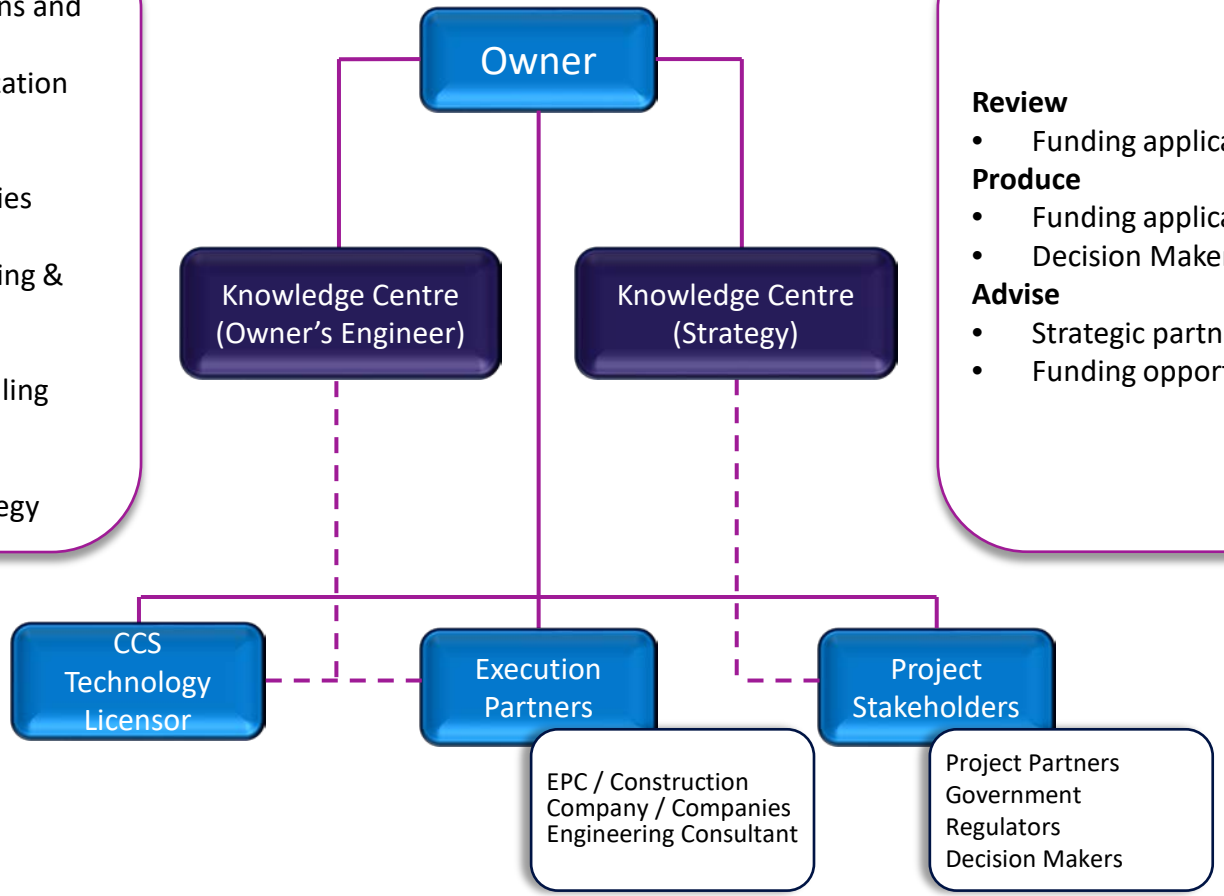
At the International CCS Knowledge Centre, we take climate action seriously

ROLE OF THE KNOWLEDGE CENTRE IN A CCS PROJECT

Review
- Equipment Specifications and Selection
- Process Design Optimization
- Overall Design

Produce
- Feasibility & FEED Studies
- Technical Reports
- CCS Technology Screening & Selection
- Process Modelling
- Thermodynamic Modelling

Advise
- Lessons Learned
- Project Execution Strategy



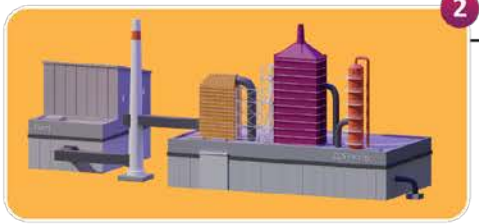
Review
- Funding applications

Produce
- Funding applications
- Decision Maker Reports

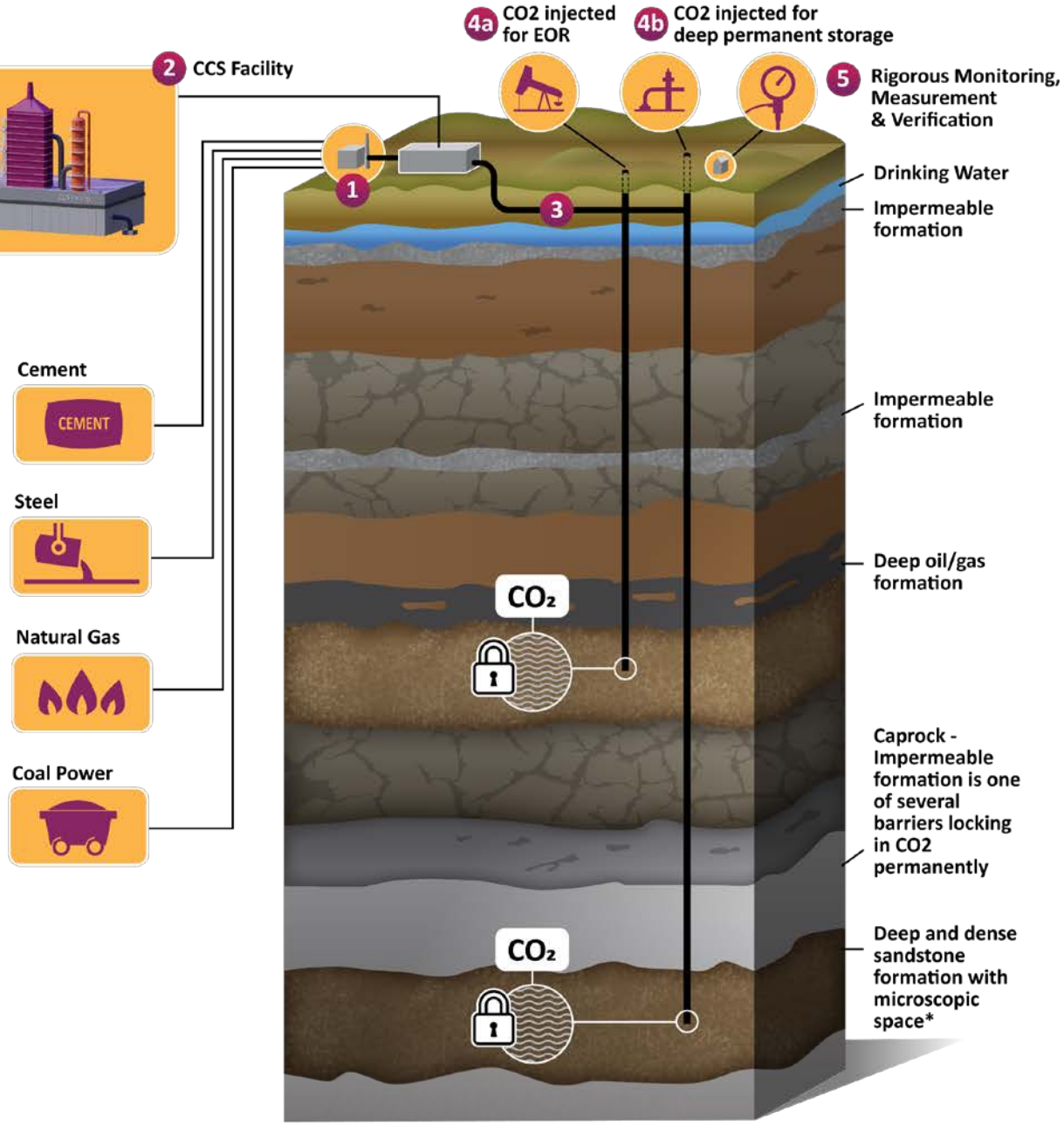
Advise
- Strategic partnerships
- Funding opportunities

Carbon Capture Storage at a Glance

Accelerated CO_2 Emissions Reductions



1	Source of carbon dioxide (CO_2) emissions from industrial or energy plants. With carbon capture and storage (CCS), large amounts of CO_2 will be captured, recycled and permanently stored.
2	Capture rates potentially exceeding 90% of the CO_2 in the flue gas, is captured and is then compressed into a dense phase liquid for easy transport.
3	The CO_2 is transported by pipeline. The CO_2 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_2 is sent deep underground for: a Use in Enhanced Oil Recovery (EOR) – where CO_2 is recycled and eventually permanently stored safely in depleted oil/gas formations. b Permanent storage into the microscopic spaces between grains in a porous reservoir rock formation – with depths exceeding 1km, and layers of dense impermeable "cap-rock" formations above it ensures that the CO_2 remains there indefinitely.
5	Measurement, Monitoring & Verification (MMV) - Rigorous and sensitive MMV equipment and procedures are put in place that can detect changes in CO_2 pressure and concentration in the subsurface to ensure the plume is growing within acceptable conformance limits and is staying within the injection formation permanently. As well, surface monitoring is completed regularly to ensure there is no CO_2 leakage into the atmosphere, groundwater, or soil, related to injection or surface CO_2 operations



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*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.

Past

CANADIAN CCS EXPERIENCE TO DATE

SHELL QUEST

- In service 2015
- 1.2 Mtpa
- 6Mt stored to date

ALBERTA CARBON TRUNK LINE (ACTL)

- 240 km CO_2 pipeline
- 14.6 Mtpa capacity
- Currently running at ~10% capacity

ACTL STURGEON

- In service 2020
- 1.3 Mtpa
- Supplies CO_2 to Enhance Energy EOR

ACTL NUTRIEN

- In service 2020
- 0.3Mtpa
- Supplies CO_2 to Enhance Energy EOR

BOUNDARY DAM 3 (BD3) CCS FACILITY

- In service 2014
- 1Mtpa
- 4Mt stored to date
- Supplies Weyburn EOR and Aquistore sequestration site

WEYBURN EOR

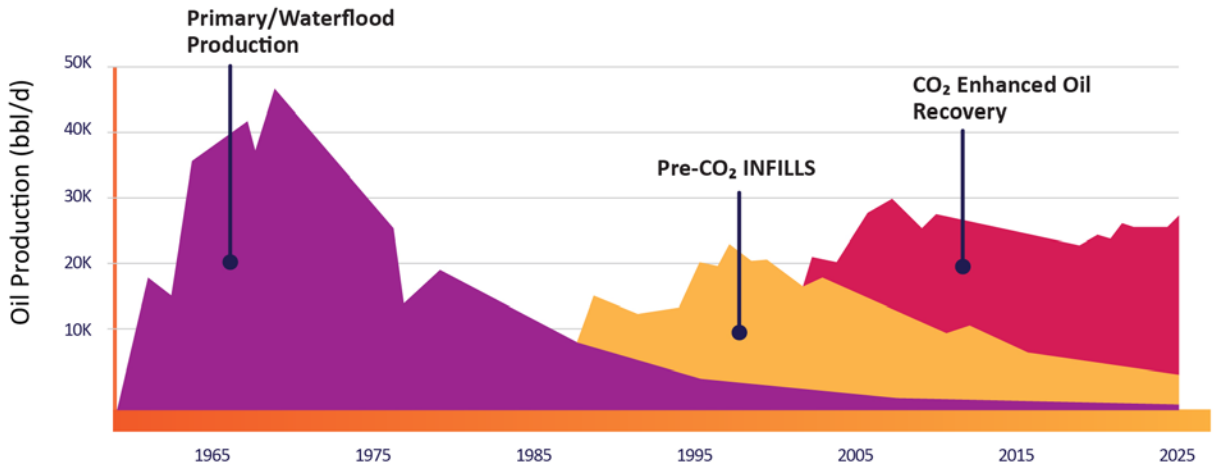
- ~25,000 bopd EOR project
- 2Mtpa
- >38 Mt stored to date

WEYBURN-MIDALE CO_2 MONITORING & STORAGE PROJECT

Largest Carbon Capture & Utilization Storage (CCUS) project in the world

- CO_2 injection commenced in October 2000
- Have safely captured more than 38 million tonnes of CO_2
  - An additional ~2 million tonnes of CO_2 are captured each year
- Estimated CO_2 storage potential of 55 million tonnes in the Weyburn Unit
- Site of an international research project, IEA GHG Weyburn- Midale CO_2 Monitoring & Storage Project; led by the Petroleum Technology Research Centre (PTRC) in Regina

Weyburn Unit Oil Production

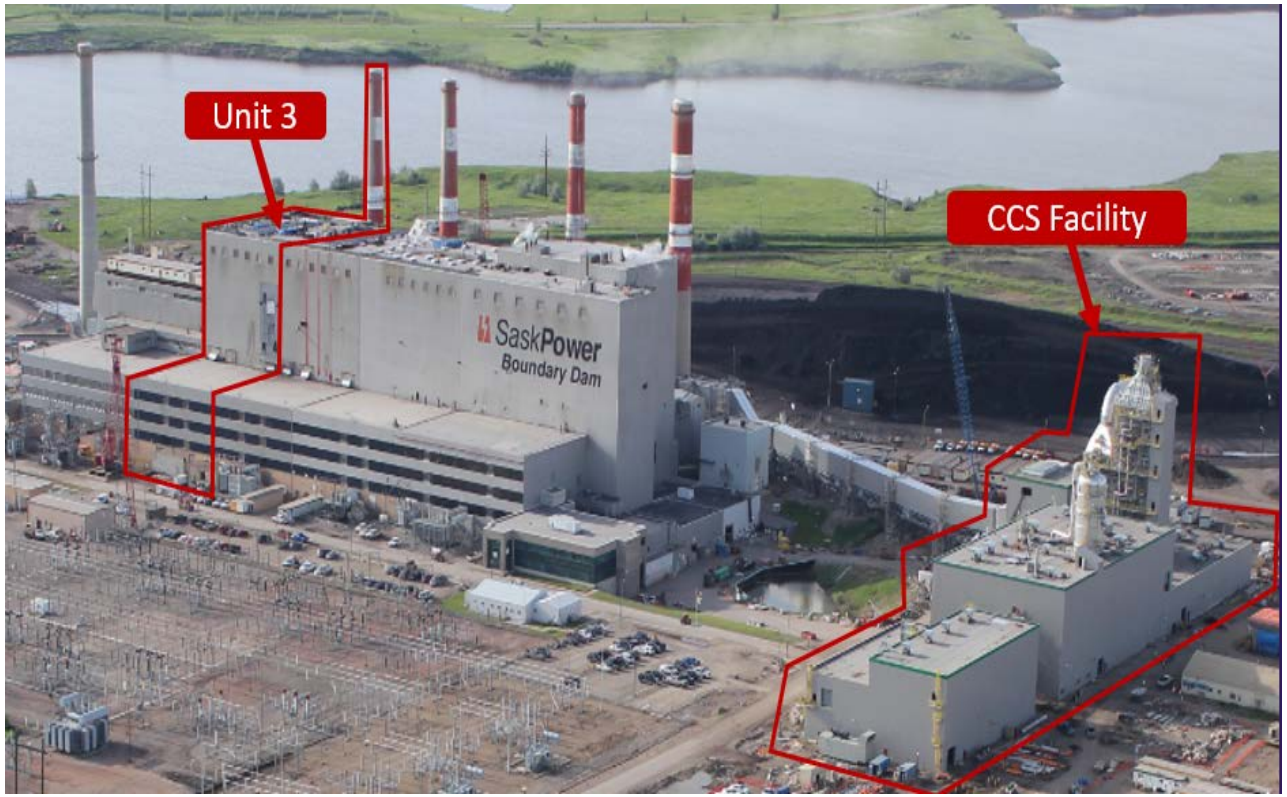


This graph shows that following both the tailing off of primary oil production in the 1990s, and that of additional 'infill' wells in the 2010s, there has been a significant and sustained jump in oil production upon the extraction of oil using CO_2.

Source: Whitecap Resources

THE BD3 ICCS PROJECT

- World's first post-combustion coal-fired CCS project fully integrated with a power station.
- Life extended the 45-year-old Boundary Dam Unit 3.
- Favored by economics at the time.
- Aided by $240 CAD million-dollar federal grant.
- Executed as a two-part project:
  - Power island upgrade
  - CCS retrofit
- Capture operations began October 2014.
- CO_2 used for EOR or stored in the Aquistore Project.

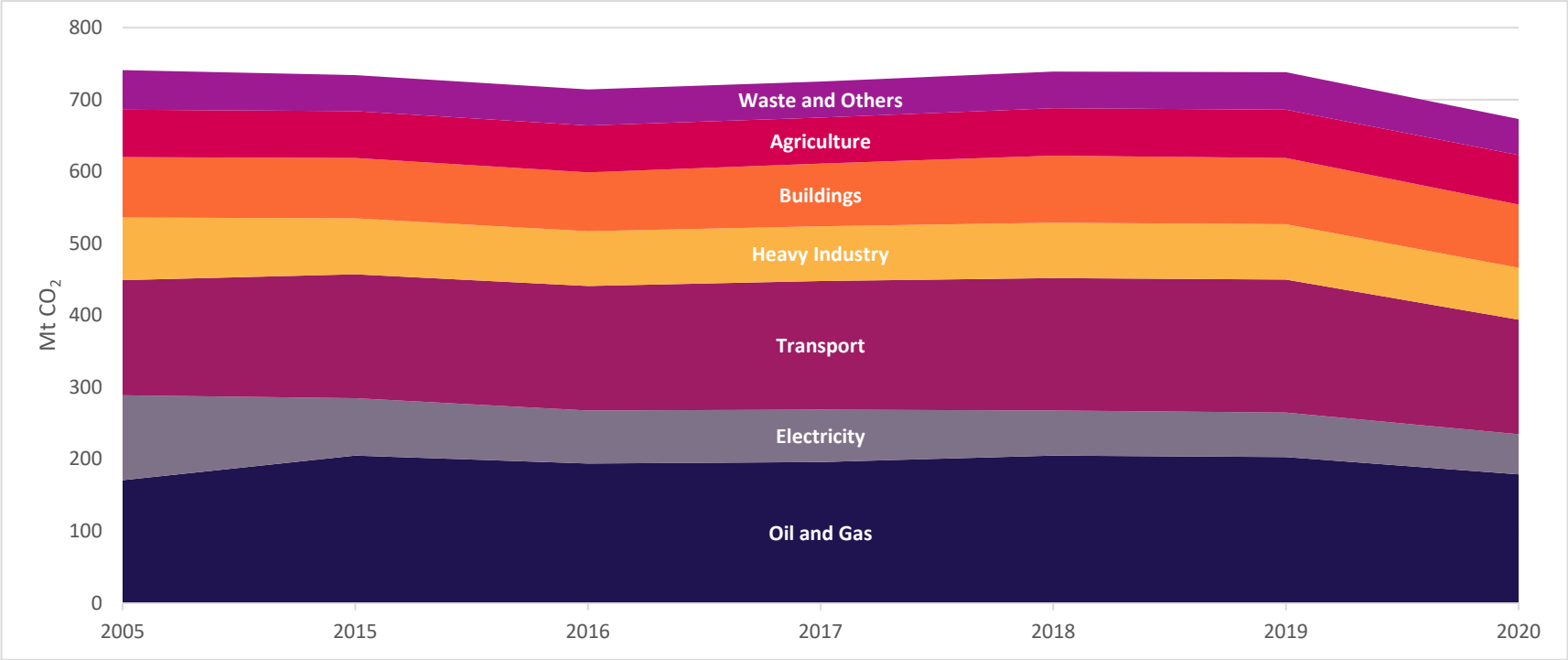


Boundary Dam Power Station and the ICCS Facility

Present

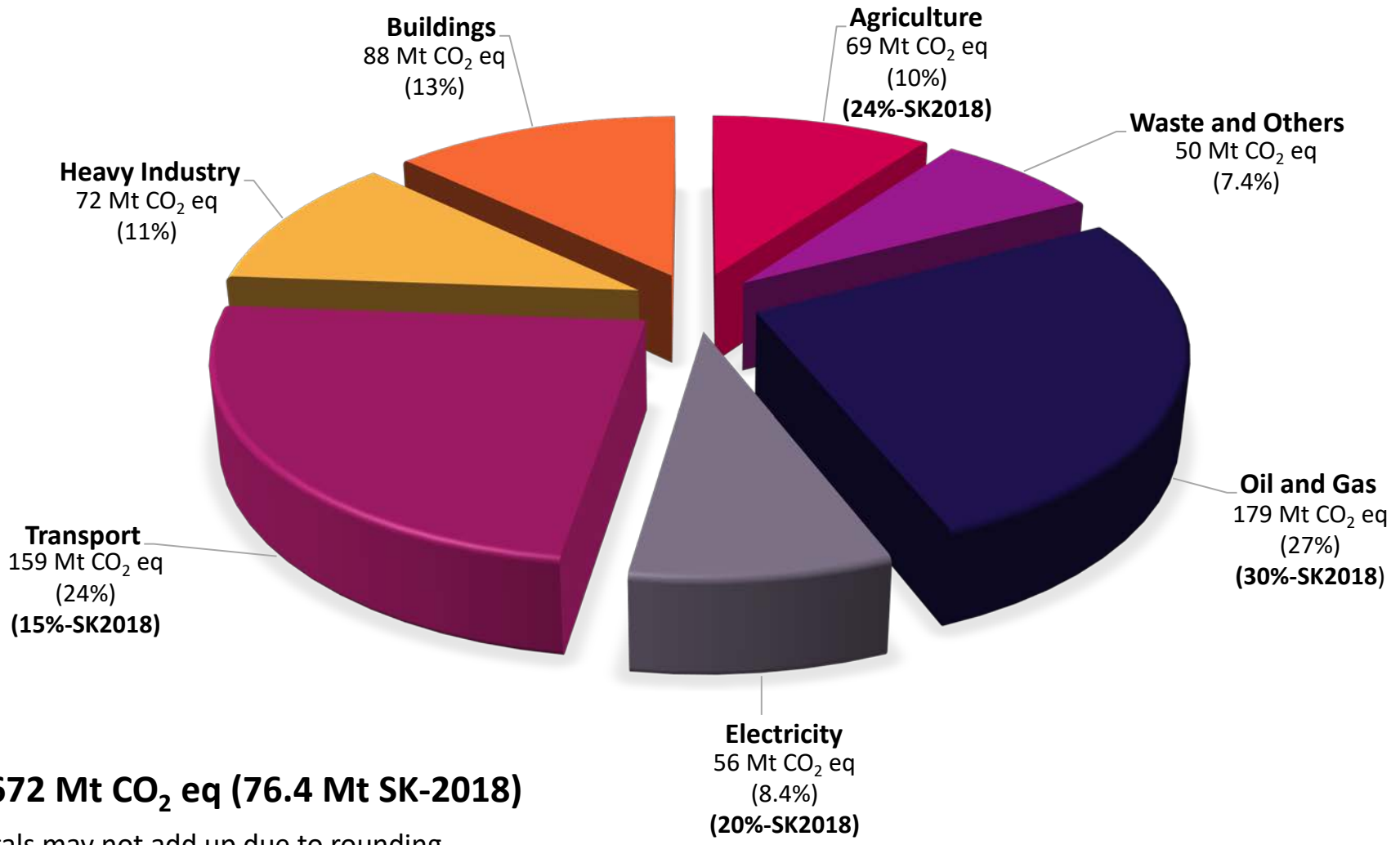
COMPARISON OF CANADA'S GHG EMISSIONS OVER TIME

Economic Sector	2005	2015	2016	2017	2018	2019	2020
National GHG Total	**741**	**733**	**715**	**725**	**740**	**738**	**672**
Oil and Gas	171	205	194	196	205	203	179
Electricity	118	80	74	73	63	62	56
Transport	160	172	173	179	184	185	159
Heavy Industry	87	78	76	76	77	77	72
Buildings	84	84	82	87	93	92	88
Agriculture	66	65	65	64	66	67	69
Waste and Others	55	50	50	50	51	52	50



Source: Environment and Climate Change Canada

CANADA'S BREAKDOWN OF GHG EMISSIONS (2020)



Total: 672 Mt CO_2 eq (76.4 Mt SK-2018)

Note: Totals may not add up due to rounding.

Source: Environment and Climate Change Canada

Flue Gas CO_2 Concentration From Industrial Sources

Industry	Flue Gas Source	CO_2 Concentration (%vol)
Coal-fired Power Plant	Coal Fired Boiler	10-15
Gas-fired Power Plant	Natural Gas Turbine	3-5
Natural Gas Combustion	Natural Gas Steam Boiler	7-10
Cement	Cement Kiln Stack	14-33
Iron and Steel	Power Station Blast Furnace Other Stacks	25-30 25 14-25
Oil Refining	Fluid Catalytic Cracker Process heaters stacks*	14-17 8-14
H_2 Production	Steam Methane Reformer	20-25
Pulp and Paper	Recovery Boiler	13

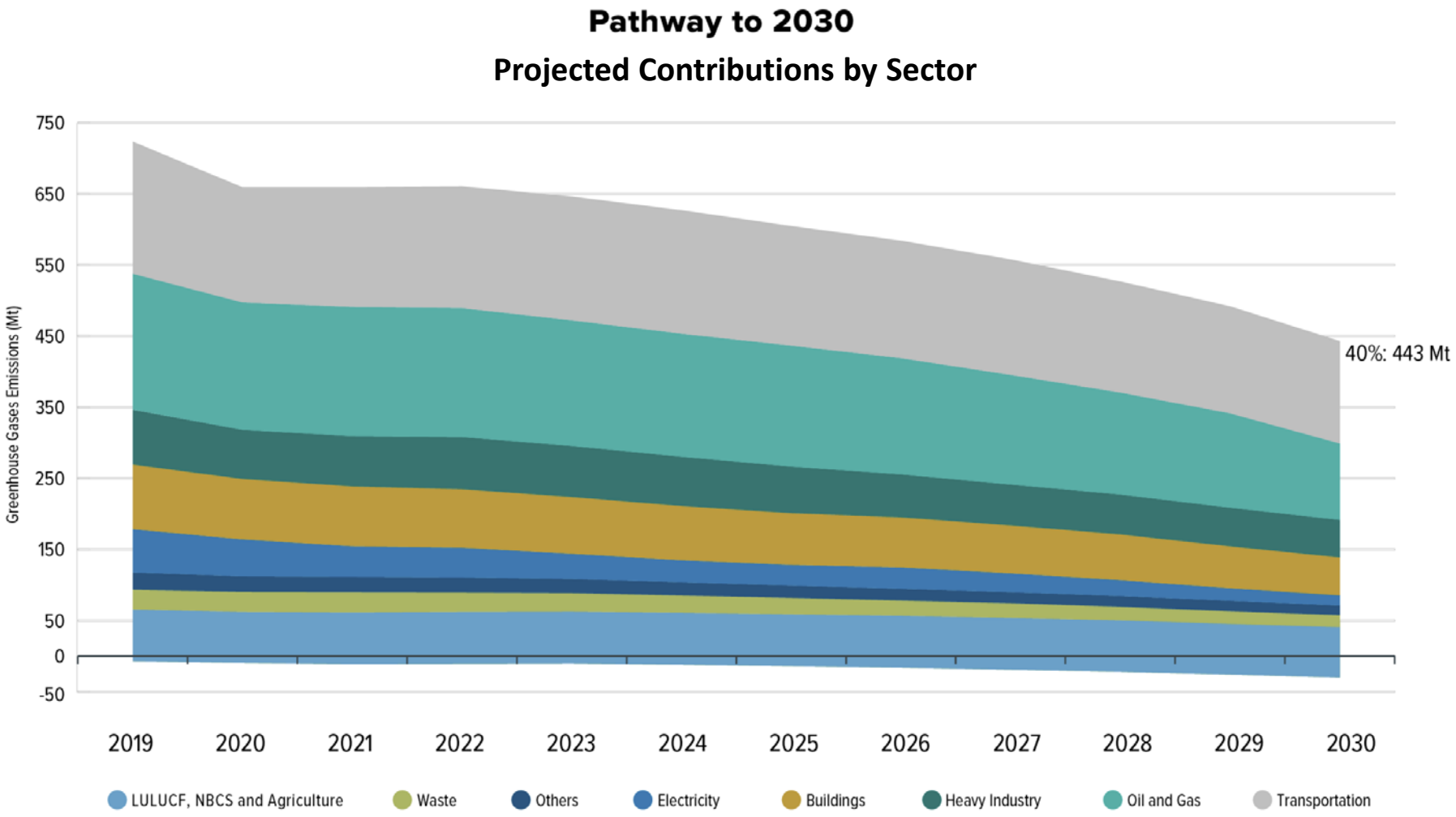
*Flue gases from different process heaters vented through the same stack

Adapted from: *Towards improved guidelines for cost evaluation of carbon capture and storage*, p. 78, by Roussanaly et al., March 2021, Towards improved guidelines for cost evaluation of carbon capture and storage | Zenodo

CO_2 Capture Technologies – Post Combustion Capture (PCC), p. 5, Global CCS Institute, January 2012, Microsoft Word - CO2 Capture Technologies - Section 2 (globalccsinstitute.com)

Future

CANADA'S 2030 EMISSIONS REDUCTION PLAN



LULUCF (Land Use Land Use Change & Forestry Sector)
NBCS (Nature Based Climate Solutions)

Source: Canada-2030-Emissions-Reduction-Plan-eng.pdf

SUPPORT FOR FUTURE CCS DEVELOPMENTS IN CANADA

Policy and Regulation needed to support the business case for investment

- Recognition that transportation and storage of CO_2 is a "public good"
  - Government involvement is a necessity
- Clarity and long-term certainty critical
  - Billion dollar plus investments

Canadian Evolution

The "Sticks"

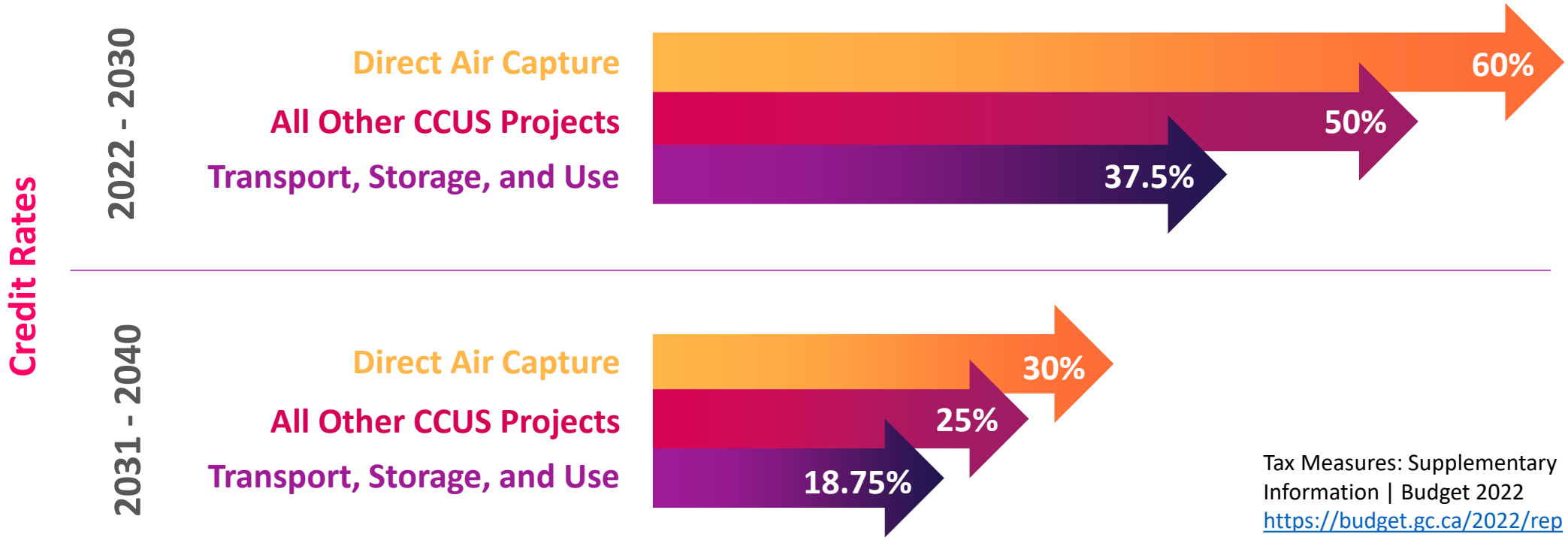
- Carbon Tax
- Clean Fuel Standard
- Clean Electricity Standard

The "Carrots"

- Investment Tax Credit (ITC)
- Carbon Contracts for Difference (CCfD)

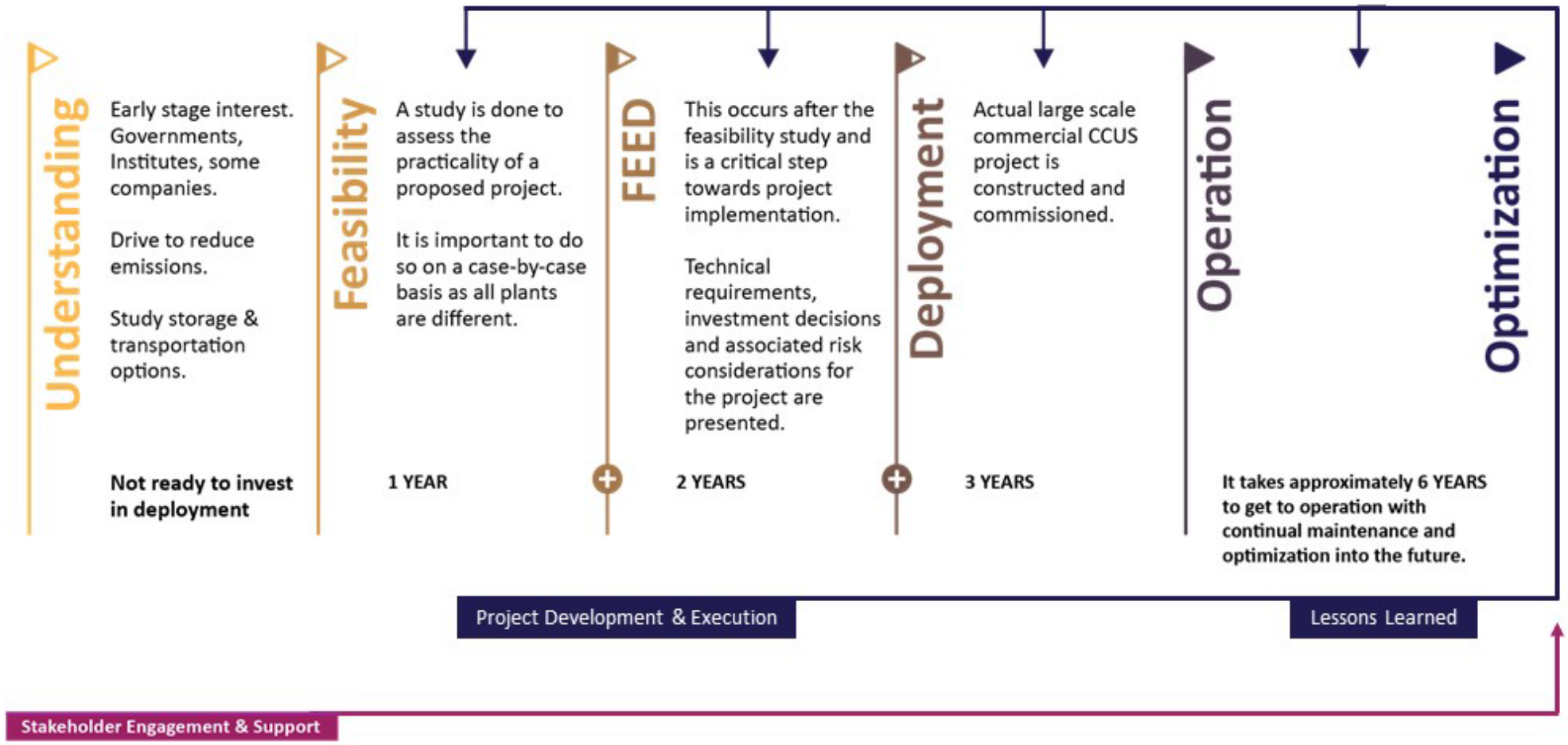
2022 CANADIAN FEDERAL BUDGET – INVESTMENT TAX CREDIT FOR CCUS

A refundable credit for businesses that incur eligible expenses (CCUS equipment), that captures and permanently stores CO_2, or through an eligible use (not EOR)



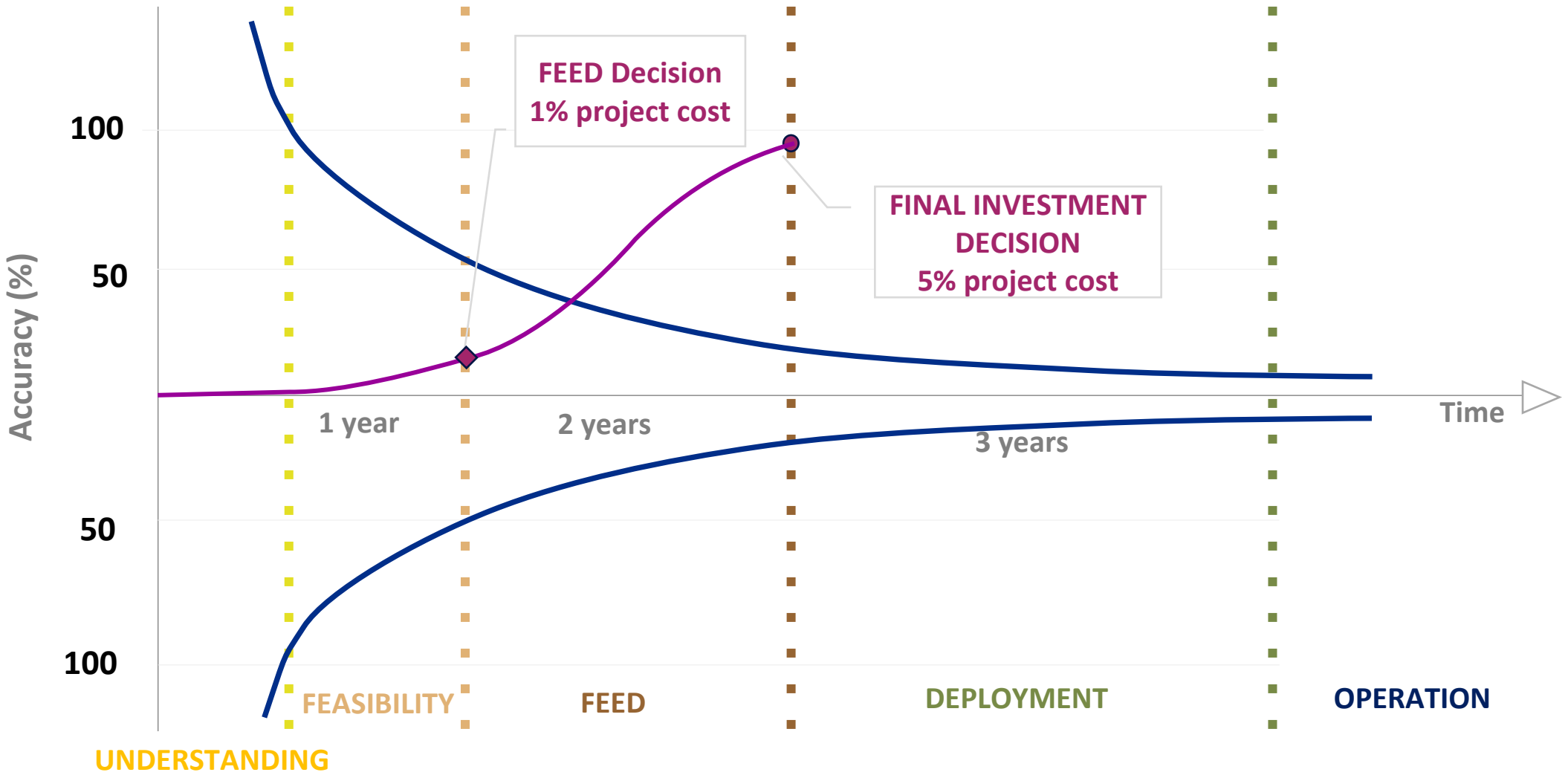
Tax Measures: Supplementary Information | Budget 2022
https://budget.gc.ca/2022/report-rapport/tm-mf-en.html#a3_2

CCS PROJECT LIFECYCLE



Source: International CCS Knowledge Centre (2021). The Need for FEED PowerPoint Presentation (ccsknowledge.com)

FUNNEL CURVE – COST CERTAINTY FOR MAJOR PROJECTS



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