



**Western Interstate
Energy Board**

Project Update Part II: International CCUS Development Efforts

NARUC-WIEB Carbon Capture,
Utilization, and Storage Workshop

FRIDAY, OCT. 9, 2020 | 1 – 2 PM ET

SPEAKERS

- **Jeff Erikson**, General Manager, Client Engagement, Global CCS Institute
- **C. Beth Hardy**, Vice-President, Strategy & Stakeholder Relations, International CCS Knowledge Centre



Western Interstate
Energy Board

INTERNATIONAL CCUS DEVELOPMENT EFFORTS

**WIEB + NARUC CCUS WORKSHOP SERIES
OCTOBER 9, 2020**

JEFF ERIKSON, GENERAL MANAGER – CLIENT ENGAGEMENT



**GLOBAL CCS
INSTITUTE**

THE GLOBAL CCS INSTITUTE



International
think tank

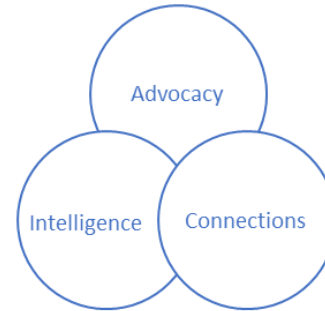
Backed by governments,
businesses and NGOs



Mission: To accelerate
deployment of CCS

76 MEMBERS

6 locations

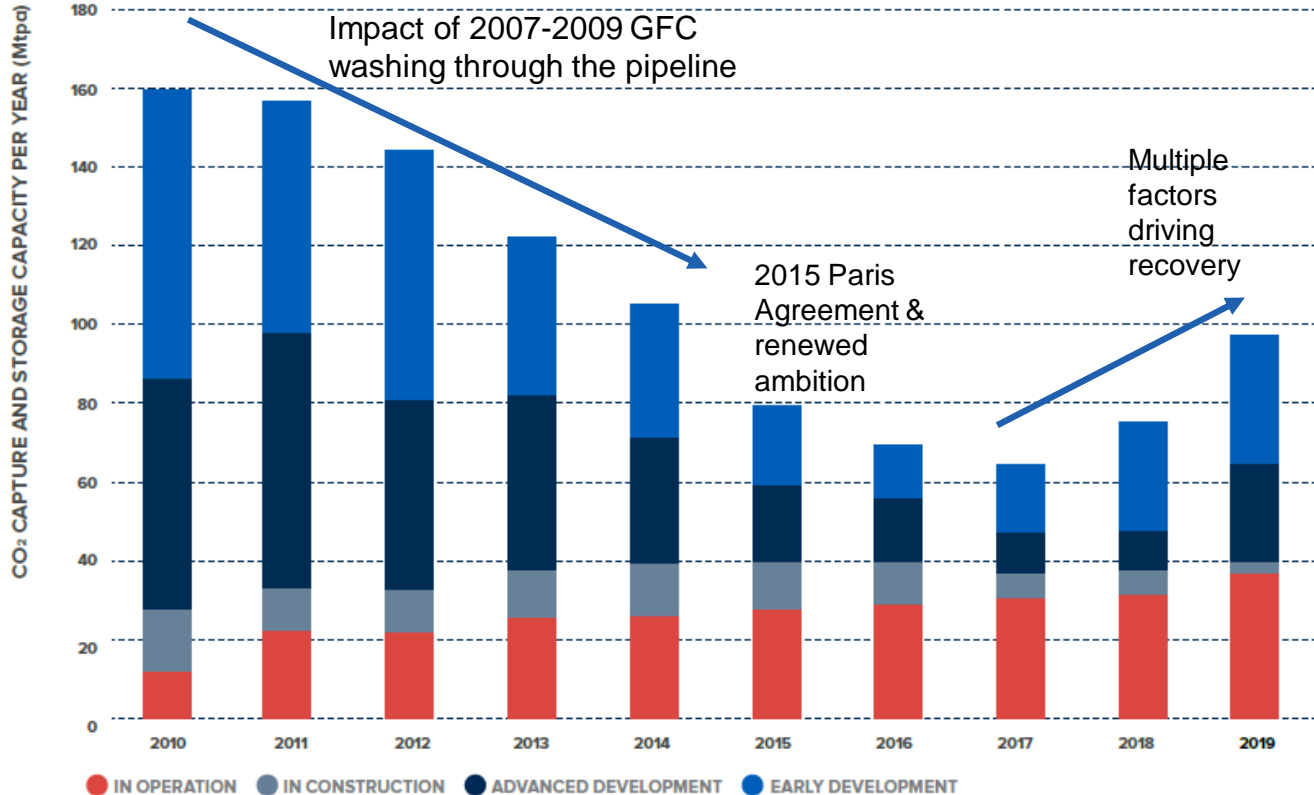


MOMENTUM

1. Broad acceptance of reality of climate change
2. Wider understanding of carbon capture's role
3. Deployment required under any net zero scenario
4. Mature technology, deployed globally
5. Cost competitive today
6. Complements renewables
7. Blue hydrogen cost well below green hydrogen
8. The need for carbon dioxide removal



CCS FACILITY CAPACITY

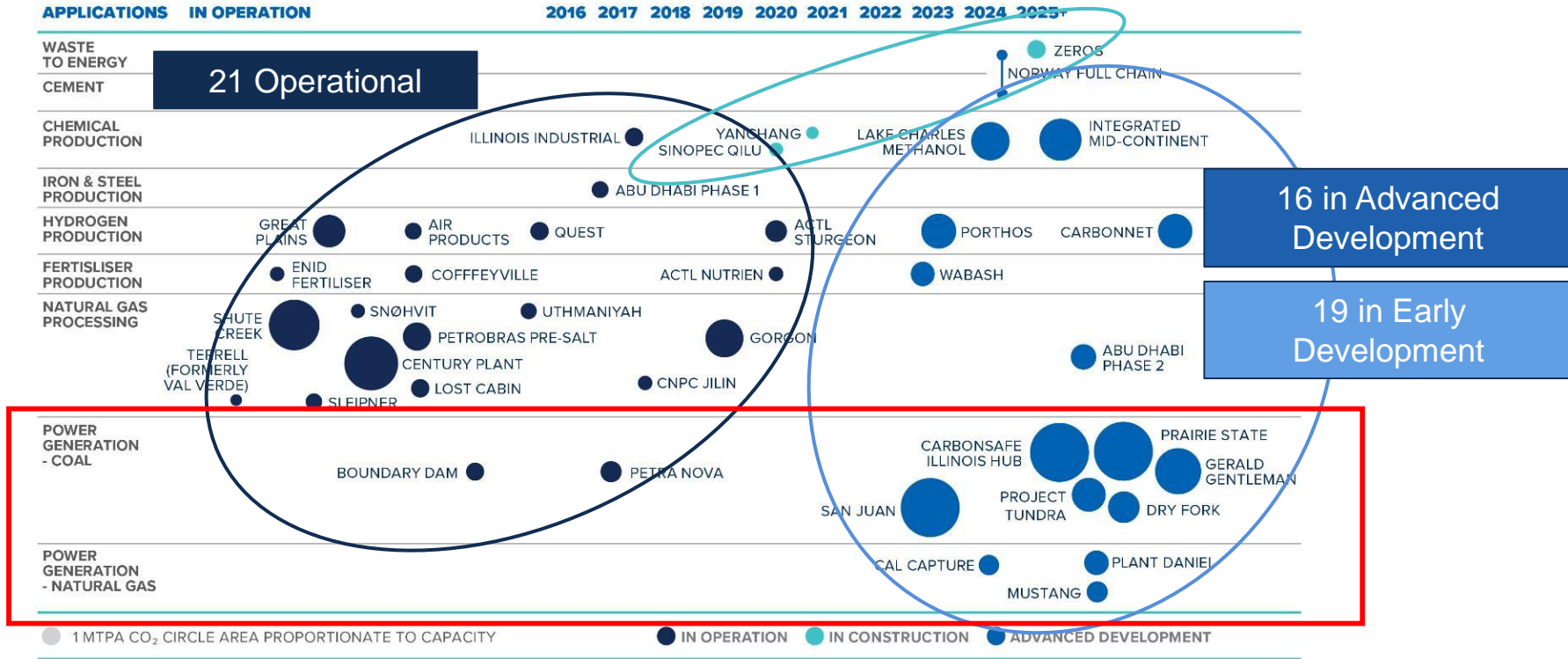


- 40 million tpa
- 260 million tonnes to date



59 COMMERCIAL CCS FACILITIES

3 in Construction



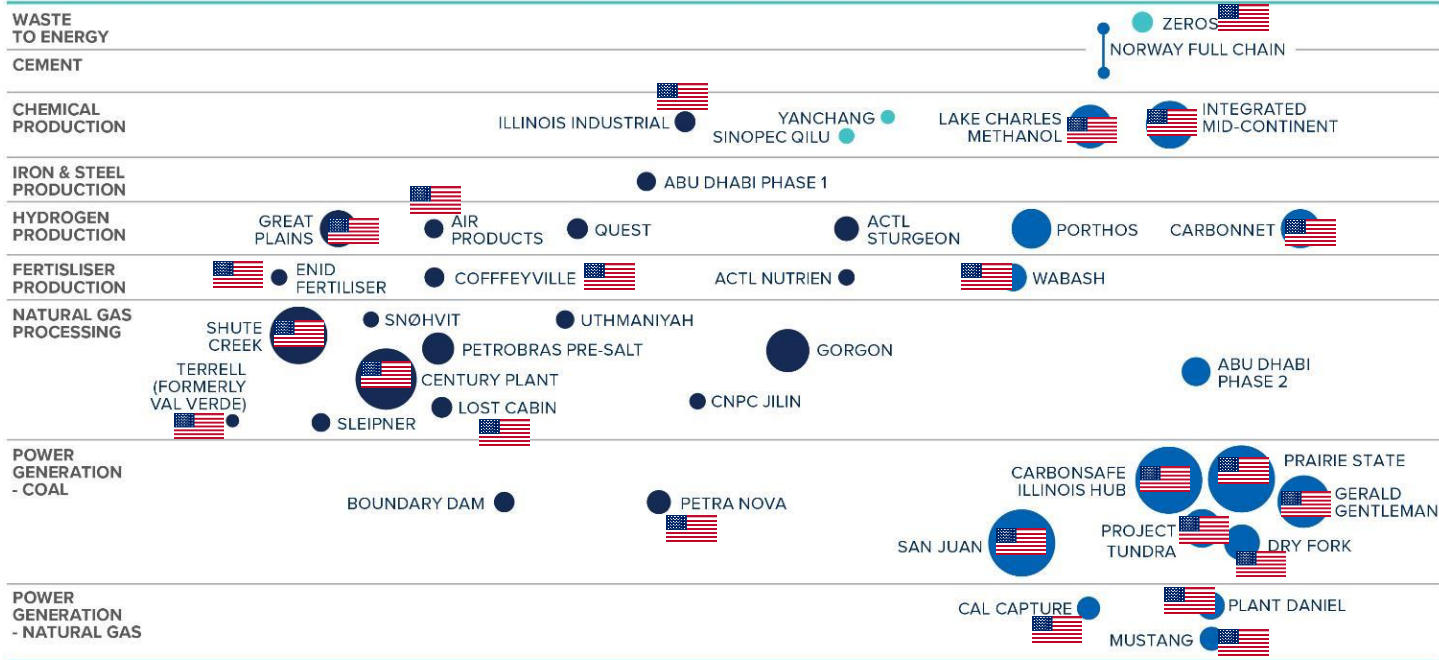
Source: Global CCS Institute



USA REMAINS THE LEADER

APPLICATIONS IN OPERATION

2016 2017 2018 2019 2020 2021 2022 2023 2024 2025+

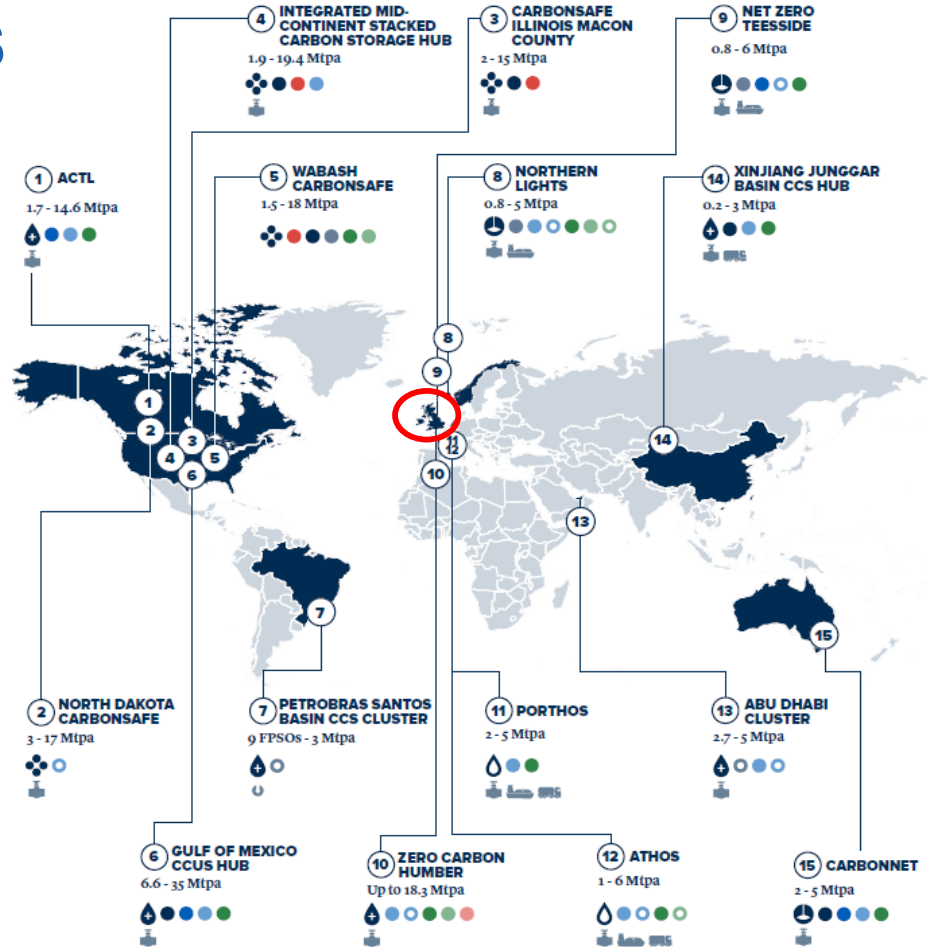


● 1 MTPA CO₂ CIRCLE AREA PROPORTIONATE TO CAPACITY ● IN OPERATION ● IN CONSTRUCTION ● ADVANCED DEVELOPMENT

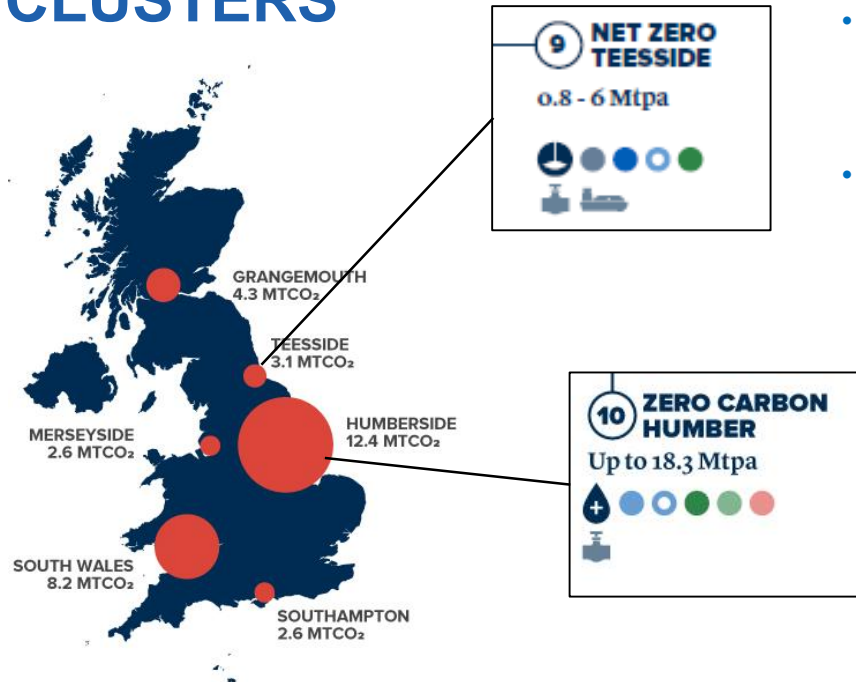
Source: Global CCS Institute



CCS HUBS/CLUSTERS



CCS HUBS/CLUSTERS



- NG power, biomass power, hydrogen production, carbon-intensive industry
- Ramp to 10 million tpa by 2030

- 18 million tpa by 2040
- Biomass power (Drax), hydrogen production, carbon-intensive industry

INDUSTRY SECTOR

- COAL FIRED POWER
- NATURAL GAS POWER
- NATURAL GAS PROCESSING
- FERTILISER PRODUCTION
- HYDROGEN PRODUCTION
- IRON AND STEEL PRODUCTION
- CHEMICAL & PETROCHEMICAL PRODUCTION
- CEMENT PRODUCTION
- WASTE INCINERATION
- ETHANOL PRODUCTION
- BIOMASS POWER

STORAGE TYPE

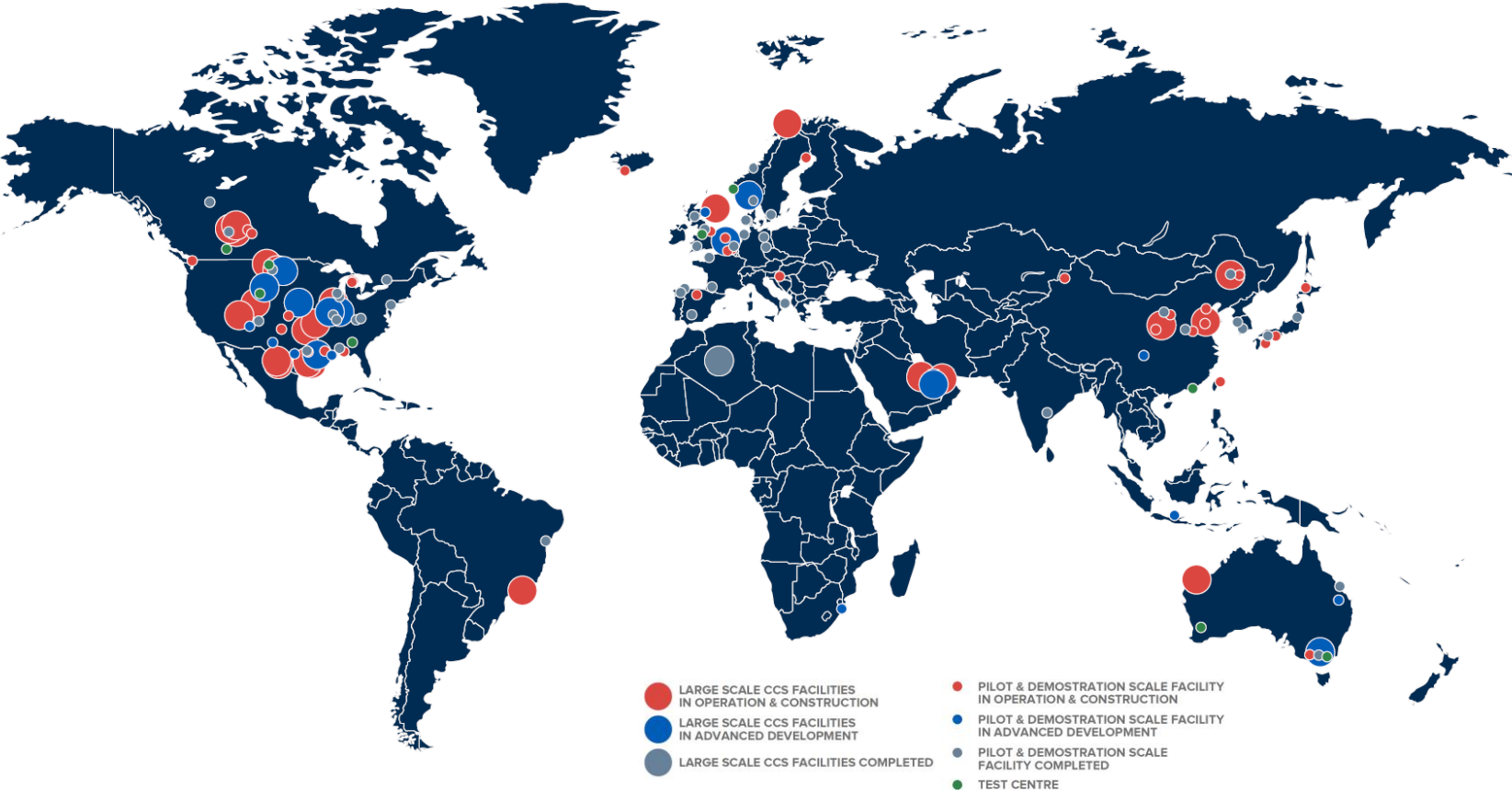
- DEEP SALINE FORMATIONS
- ENHANCED OIL RECOVERY
- DEPLETED OIL AND GAS RESERVOIRS
- VARIOUS OPTIONS CONSIDERED

DELIVERY

- PIPELINE
- SHIP
- ROAD
- DIRECT INJECTION



CURRENT CCS FACILITIES AROUND THE WORLD

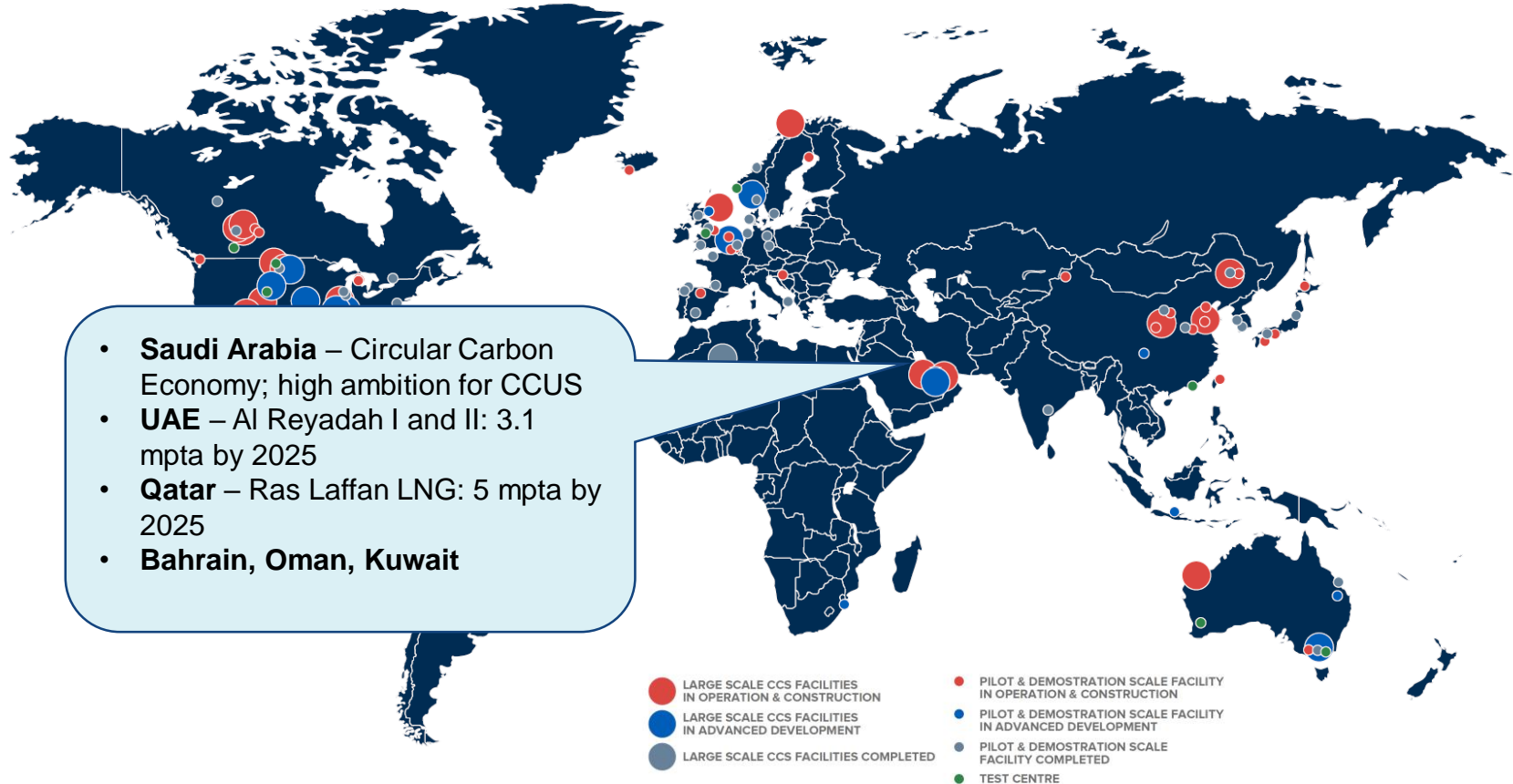


EUROPE – CLIMATE NEUTRAL BY 2050

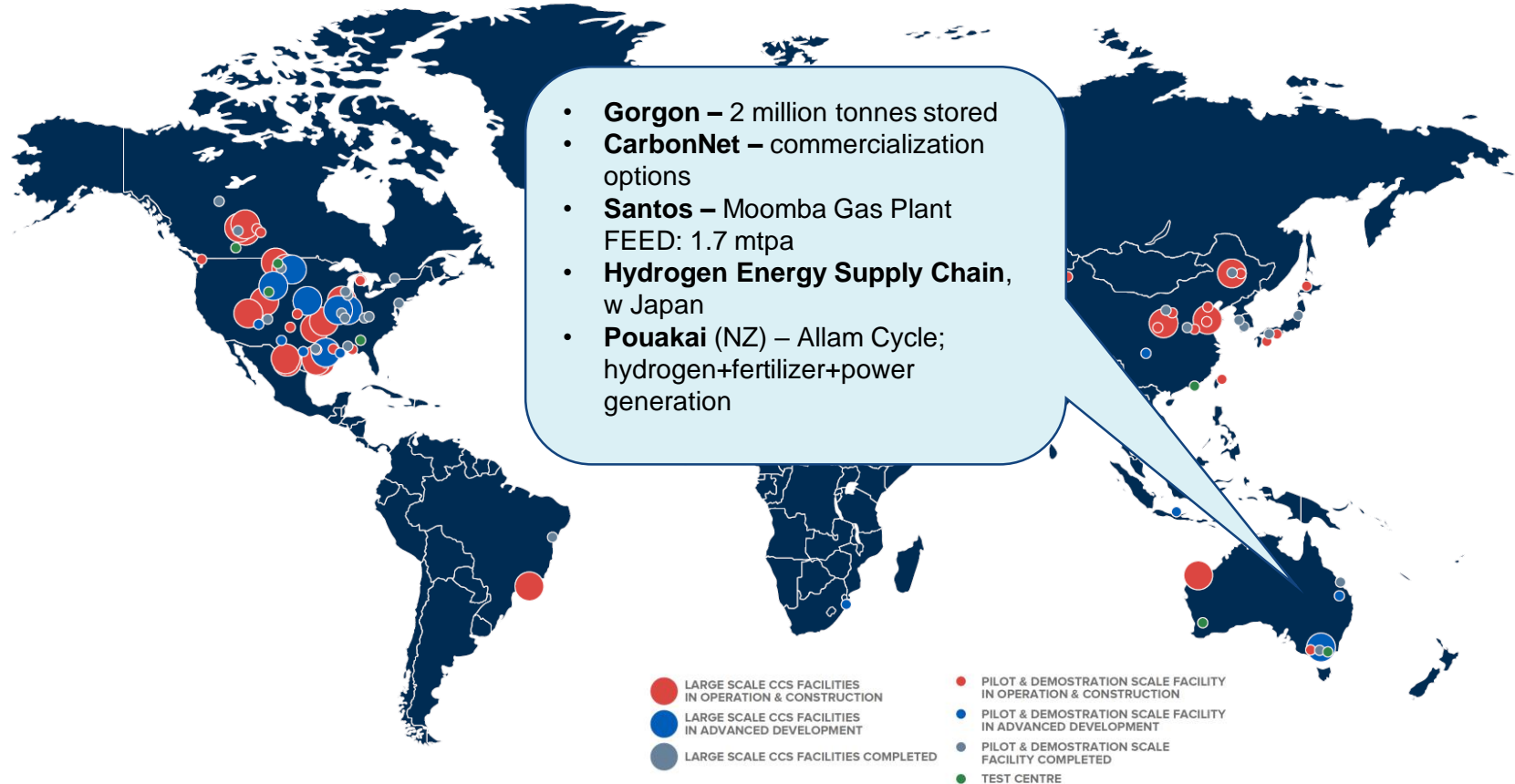
- **London Protocol** – transboundary shipment of CO₂
- **Norway** – LongShip FID
- **UK** – Net Zero Teeside, Humber, Acorn, etc
- **Netherlands** – PORTHOS: 100 million from EU; FID in 2021
- **Italy** – Port of Ravenna
- **Denmark, Sweden, etc.**



MIDDLE EAST – SEEING A LOW-CARBON FUTURE









AUSTRALIA/NEW ZEALAND – POLICY PROGRESS



- **Gorgon** – 2 million tonnes stored
- **CarbonNet** – commercialization options
- **Santos** – Moomba Gas Plant FEED: 1.7 mtpa
- **Hydrogen Energy Supply Chain**, w Japan
- **Pouakai (NZ)** – Allam Cycle; hydrogen+fertilizer+power generation





Policies & project characteristics		 Carbon tax	 Tax credit or emissions credit	 Grant support	 Provision by government or SOE	 Regulatory requirement	 Enhanced oil recovery	 Low cost capture	 Low cost transport and storage	 Vertical integration	
US											
Carbon tax	Terrell						○	●	●		
	Enid Fertiliser						○	●	●		
	Shute Creek	→				●	○	●	●		
	Century Plant		●				○	●			
	Air Products SMR		●	○			○	●			
Tax credit or emissions credit	Coffeyville		●				○	●			
	Lost Cabin	→	●				○	●			
	Illinois Industrial		●	○				●	●	●	
	Petra Nova		●	○			○	●			
Grant support	Great Plains						○	●			
	Canada										
	Boundary Dam			○	●	●	○		●		
	Quest		●	○						●	
Provision by government or SOE	ACTL Agrium			○			○	●			
	ACTL Sturgeon			○			○	●			
	Brazil										
Petrobras Santos	→			●			○	●	●	●	
Regulatory requirement	Norway										
	Sleipner	●			●			●	●	●	
	Snøhvit	●			●	●		●		●	
	UAE										
Abu Dhabi CCS	→			●			○		●		
China	Saudi Arabia									●	
	Uthmaniyah			●			○	●	●	●	
	Australia										
	Gorgon			○		●		●	●	●	

Enhanced oil recovery

Low cost capture

Low cost transport and storage

Vertical Integration

LOOKING AHEAD

Trends	Tea Leaves
Climate change awareness	Impact of Covid/Economy
Net Zero Emissions	The future of fossil fuels
ESG	Geopolitics
Hydrogen	The color of hydrogen
Continued US leadership on CCUS	Revenue model?
Western Europe building quickly	Will any country leave it in the ground?
Middle East investment	Middle East pivot?
Japan exporting technology	India
Southeast Asia – gas fields, power	China Net Zero Commitment?



Developing CCS Projects in Texas

October 21-22

Register at globalccsinstitute.com

The Global Status of CCS 2020

December 2

Download at globalccsinstitute.com



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INTERNATIONAL
CCS KNOWLEDGE
CENTRE



**Carbon Capture and Storage
Commercialization & Deployment**

Beth Hardy, VP Strategy & Stakeholder Relations

The International CCS Knowledge Centre is a non-profit organization founded by BHP and SaskPower.

Mission:

To accelerate the understanding and use of carbon capture and storage as a means of managing GHG emissions

- Staff are available to provide experience-based considerations for CCS projects.
- Guidance for planning, design, construction and operation.
- Active engagement with financiers, decision makers, and business case partners.



BOUNDARY DAM

THE LEARNING STARTS HERE
WORLD'S 1ST LARGE SCALE POST-COMBUSTION CCS FACILITY

Over 3 million tonnes of CO₂ captured & stored since 2014



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.**
- CO₂ used for EOR or stored in the Aquistore Project.

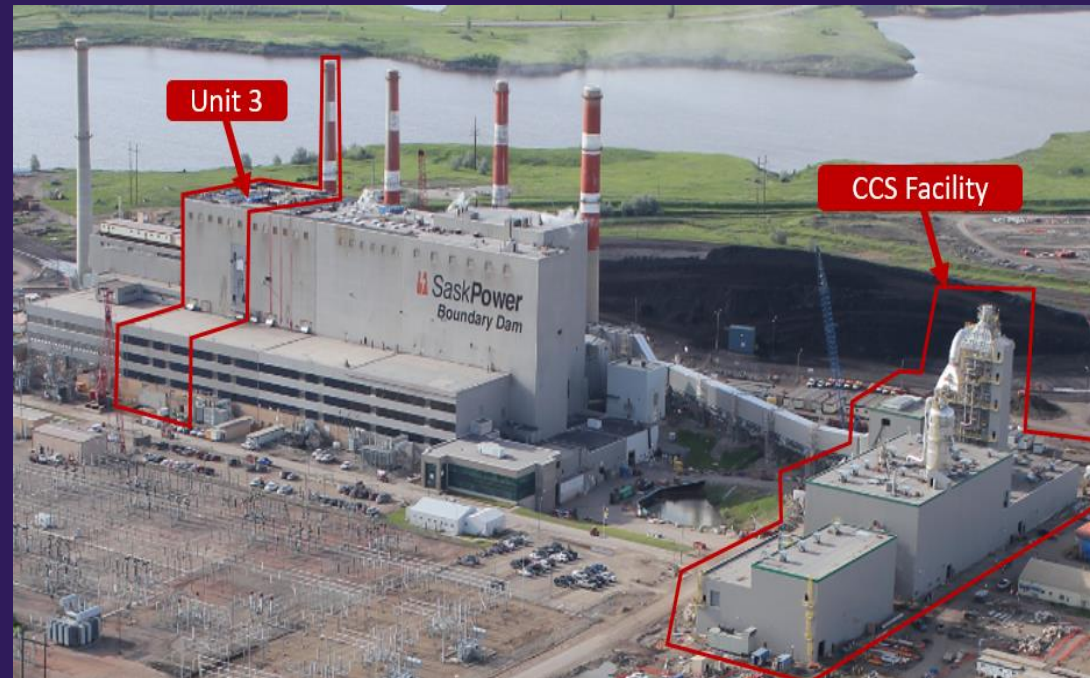
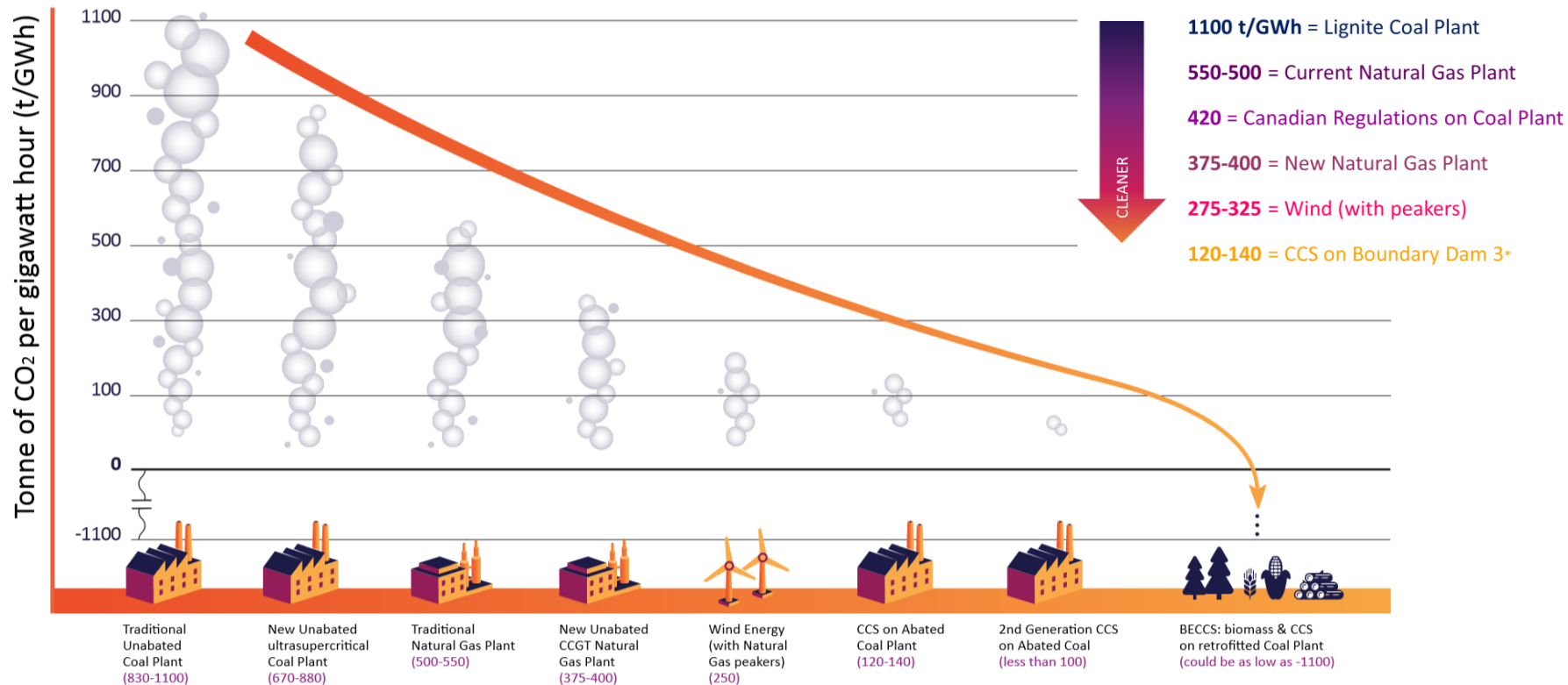


Figure 1. Boundary Dam Power Station and the ICCS Facility

Performance: Exceeding Standards

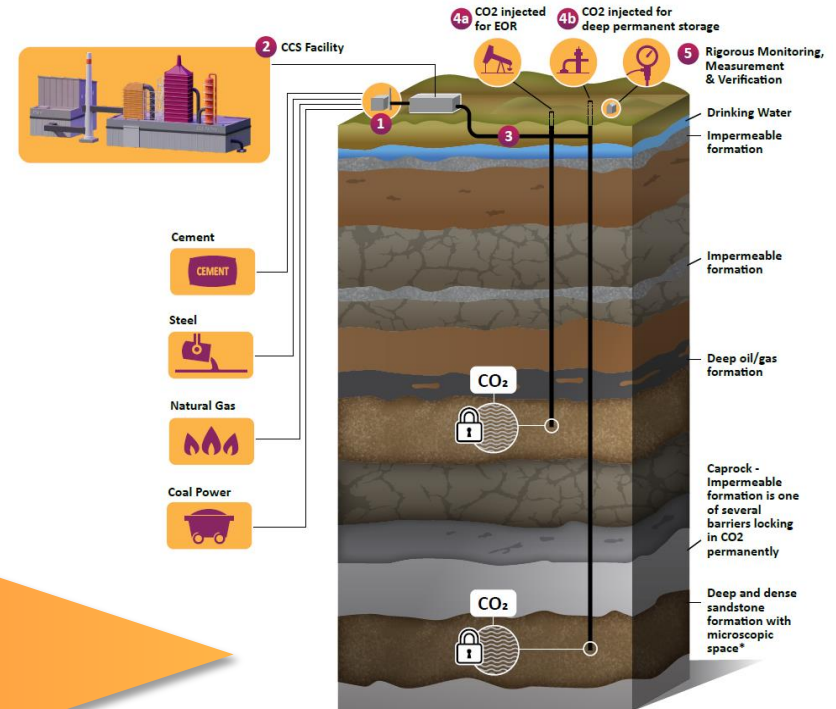


Saskatchewan Lessons Learned

Full Chain Experience for carbon capture and storage

- Retrofitted existing coal unit
- Capture CO₂ and other particulates
- Transport via pipeline
- Sale & use of CO₂ for enhanced oil recovery
- Sale of other by-products
- Storage site for CO₂ at Aquistore
- Regulation, policy and royalty structures

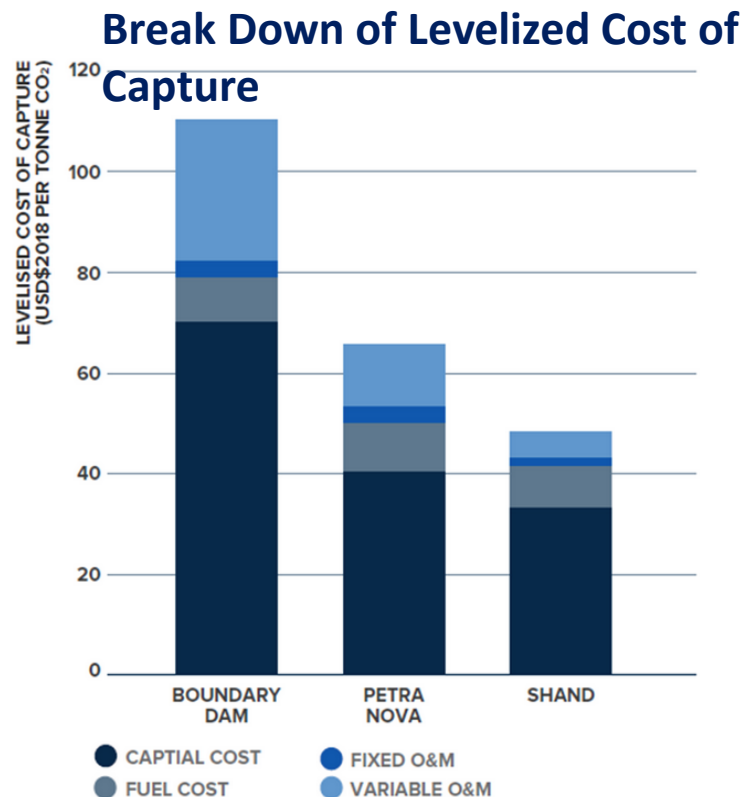
Canada, with its world-class geological storage potential for CO₂, is doing its part to demonstrate CCS technology. The Weyburn project in Saskatchewan was launched in 2000.



About the Shand Feasibility Study

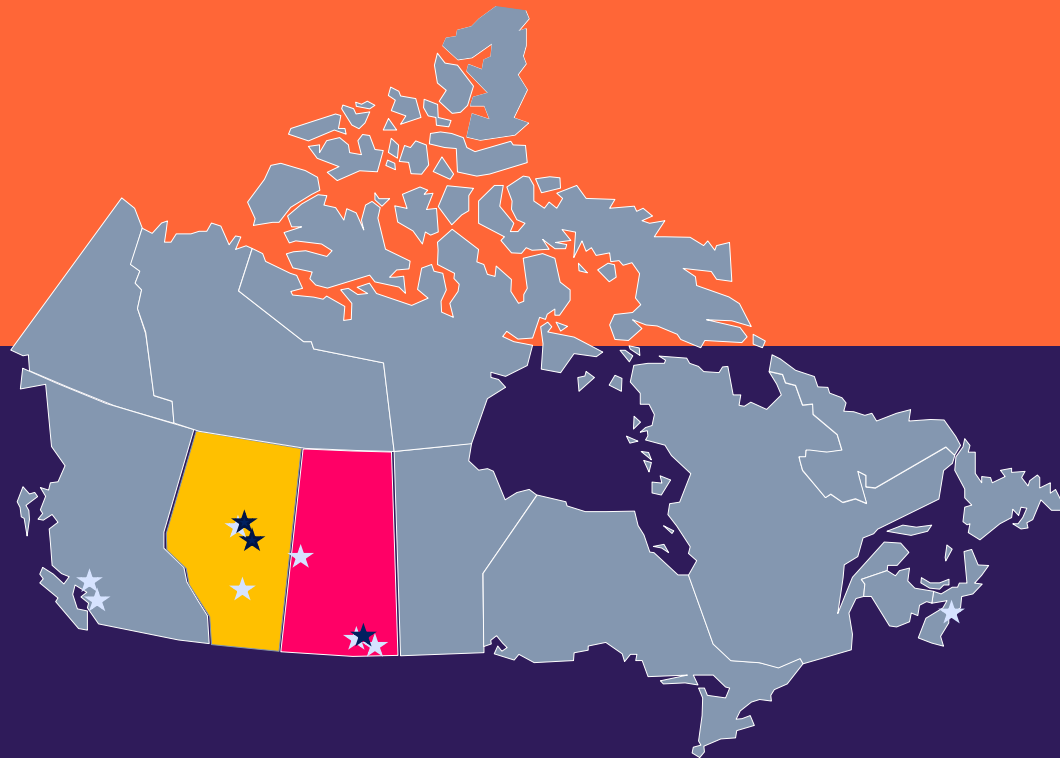
Key findings of feasibility study evaluates the economics of CCS on a 300MW coal-fired power plant in Saskatchewan

- Projected capture capacity of **2Mt/yr**
- Capital cost to be **67% less** per tonne of CO₂ captured
- Cost of capture at **\$45US/t CO₂**
- Capture rate can reach **up to 97%** with reduced load (i.e. renewables on grid)
- Fly ash sales can further reduce CO₂ (potential 125,000t CO₂/yr reduced)



Canada Current CCUS Activities

Boundary Dam, Shell Quest and two Alberta Carbon Trunk Line projects are notable large-scale CCS actions in Canada.



- Weyburn EOR operations (SK)
- Direct Air Capture – Carbon Engineering (BC)
- Lehigh Cement feasibility study (AB)
- Lafarge CCU operations (BC)
- Svante-Husky testing (SK)
- Carbon Capture Test Centre (SK)
- XPRIZE (AB)
- Carbon Cure (NS)

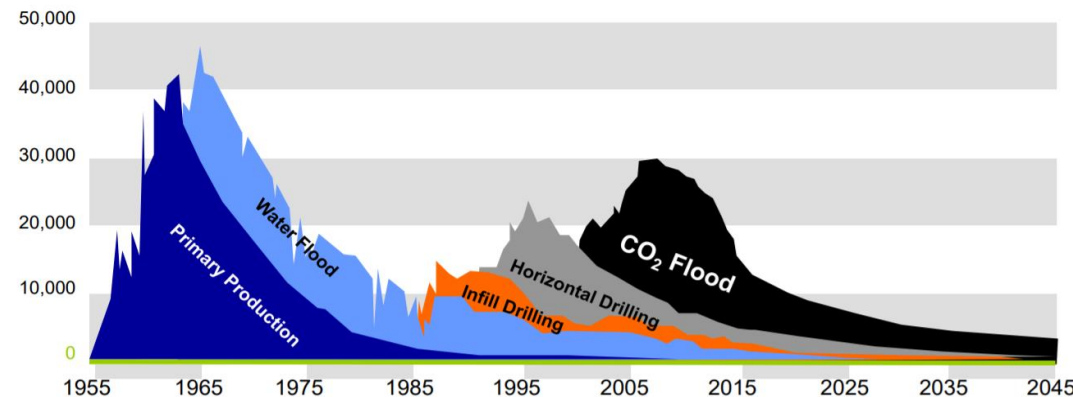
Weyburn-Midale CO₂ Monitoring & Storage Project

Enhanced Oil recovery using CO₂ from the US & Canada

- Site of an international research project, IEA GHG Weyburn- Midale CO₂ Monitoring & Storage Project; led by the Petroleum Technology Research Centre (PTRC) in Regina
- CO₂ injection commenced in October 2000
- Have safely captured more than 35 million tonnes of CO₂



Weyburn Production
bbl/d



QUEST – Blue Hydrogen in Alberta

To date, Quest has captured and stored over 5 million tonnes of CO₂

- One million tonnes CO₂ per year capacity
- Equivalent to emissions from ~250,000 cars
- 35% reduction of Scotford upgrader CO₂ emissions
- CO₂ capture at the upgrader from 3 hydrogen manufacturing units
- CO₂ transported by 12-inch pipeline to storage
- Permanent storage 2 km underground



The Alberta Carbon Trunk Line (ACTL) & Blue Hydrogen

The ACTL is a 240-kilometre CO₂ pipeline
CO₂ is captured from the Sturgeon Refinery &
Nutrien Redwater fertilizer

- the ACTL system captures industrial emissions and delivers the CO₂ to mature oil and gas reservoirs for use in EOR and permanent storage.
- the ACTL can transport up to 14.6 million tonnes of CO₂ per year; licensed for 5.5Mt CO₂/year.
- Able to unlock 1 Billion barrels of light oil (initially 30 Mt in Clive oil field)
- Storage of 2Gt CO₂



Thank You



For more information please visit our website at:

ccsknowledge.com



Contact us by email:

info@ccsknowledge.com



Don't forget to follow us on Twitter

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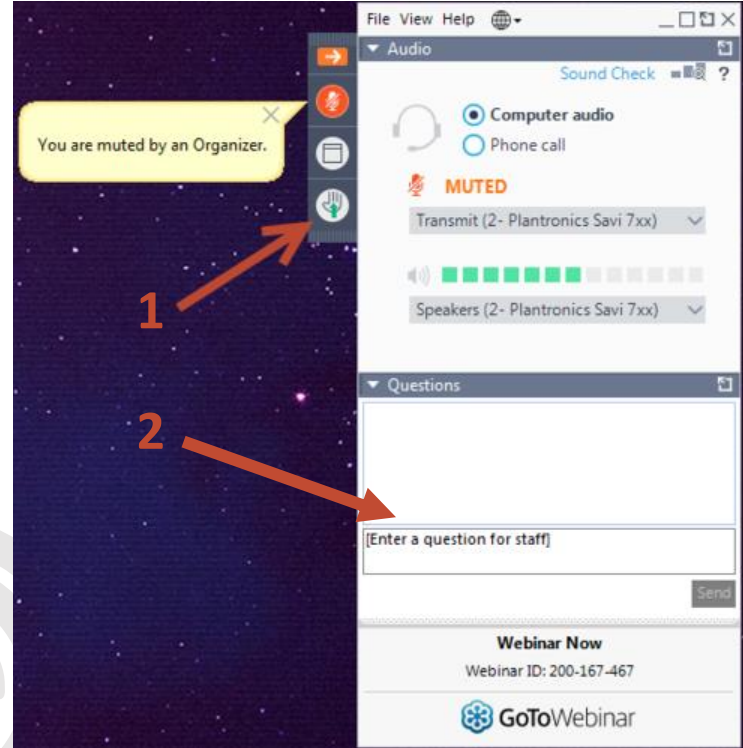


INTERNATIONAL
CCS KNOWLEDGE
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QUESTIONS

Submit questions two ways:

1. Raise your hand and the moderator will call on you to unmute your line
2. Type a question into the question box



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NARUC-WIEB CCUS WORKSHOP SCHEDULE

1. Sept. 11: The Case for Carbon Capture, Utilization, and Storage
2. Sept. 18: Breaking It Down: CCUS Technologies
3. Sept. 25: Financial Incentives and Investment Efforts
4. Oct. 2: Project Update Part I: Domestic CCUS Development Efforts
5. **Oct. 9: Project Update Part II: International CCUS Development Efforts**
6. Oct. 16: Regulatory Considerations and Policy Recommendations

[Full Agenda](#) | [Registration](#)

All webinars are held from 1:00 – 2:00 pm ET



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UPCOMING NARUC EVENTS

Innovation Webinars

- Oct 22, 3-4PM (ET): [Emerging Possibilities for Bulk Energy Storage](#)
- Nov 19, 3-4PM (ET): [Where the Wind Blows: Offshore Wind Outlook for State Regulators](#)

NARUC Annual Meeting – Nov 5-6 and 9-11

- Registration open
- <https://www.naruc.org/meetings-and-events/naruc-annual-meetings/2020-annual-meeting/>



UPCOMING WIEB EVENTS

Save-the-Dates

Fall 2020 JOINT CREPC-WIRAB MEETING Webinar Series

Fridays: October 23, October 30, November 6, and November 13, 2020

11:00 – 12:30 PM (MT) / 10:00 – 11:30 AM (PT)

You are invited to join us on Fridays this October and November for the Fall 2020 Joint CREPC-WIRAB Meeting Webinar Series, where western electric utility policymakers and regulators, industry experts, consumer advocates, and other stakeholders will explore and discuss current and emerging electricity trends, challenges, and opportunities for the Western Interconnection.

<https://westernenergyboard.org/>

Joint CREPC-WIRAB Meetings are conducted by the Committee on Regional Electric Power Cooperation (CREPC)—a joint committee of the Western Interstate Energy Board and the Western Conference of Public Service Commissioners—and the Western Interconnection Regional Advisory Body (WIRAB).



THANK YOU

Join us for the next webinar in the
NARUC-WIEB CCUS Workshop

Friday, Oct 16 1:00 – 2:00 pm ET

[Regulatory Considerations and Policy
Recommendations](#)

- Doug Scott, Vice President, Electricity and Efficiency, Great Plains Institute
- Kara Fornstrom, Chairman, Wyoming Public Service Commission



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