NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Carbon Capture and Storage (CCS) in Canada

CCS Technical Experts Meeting

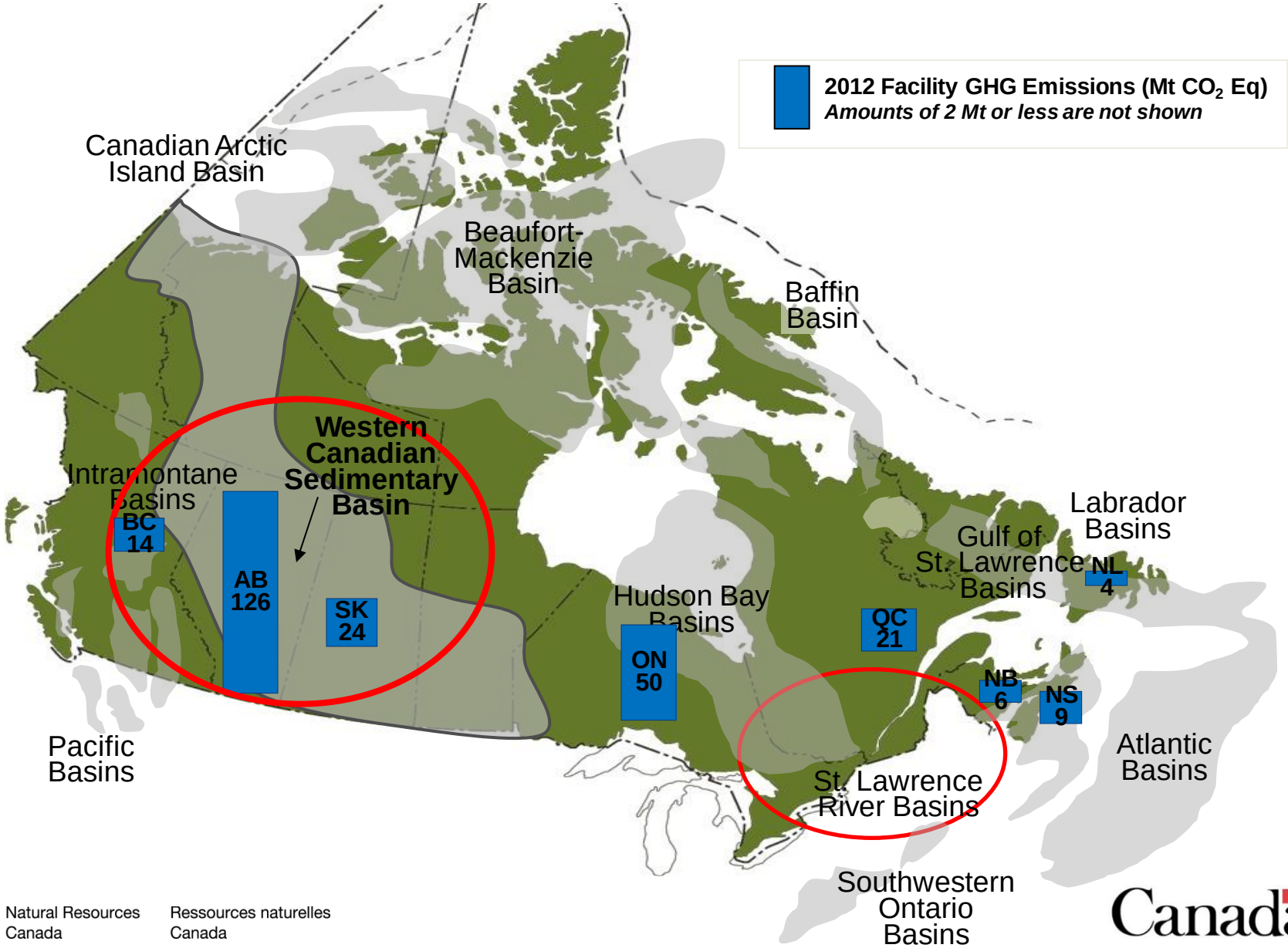
UNFCCC – Bonn, Germany

October 21, 2014

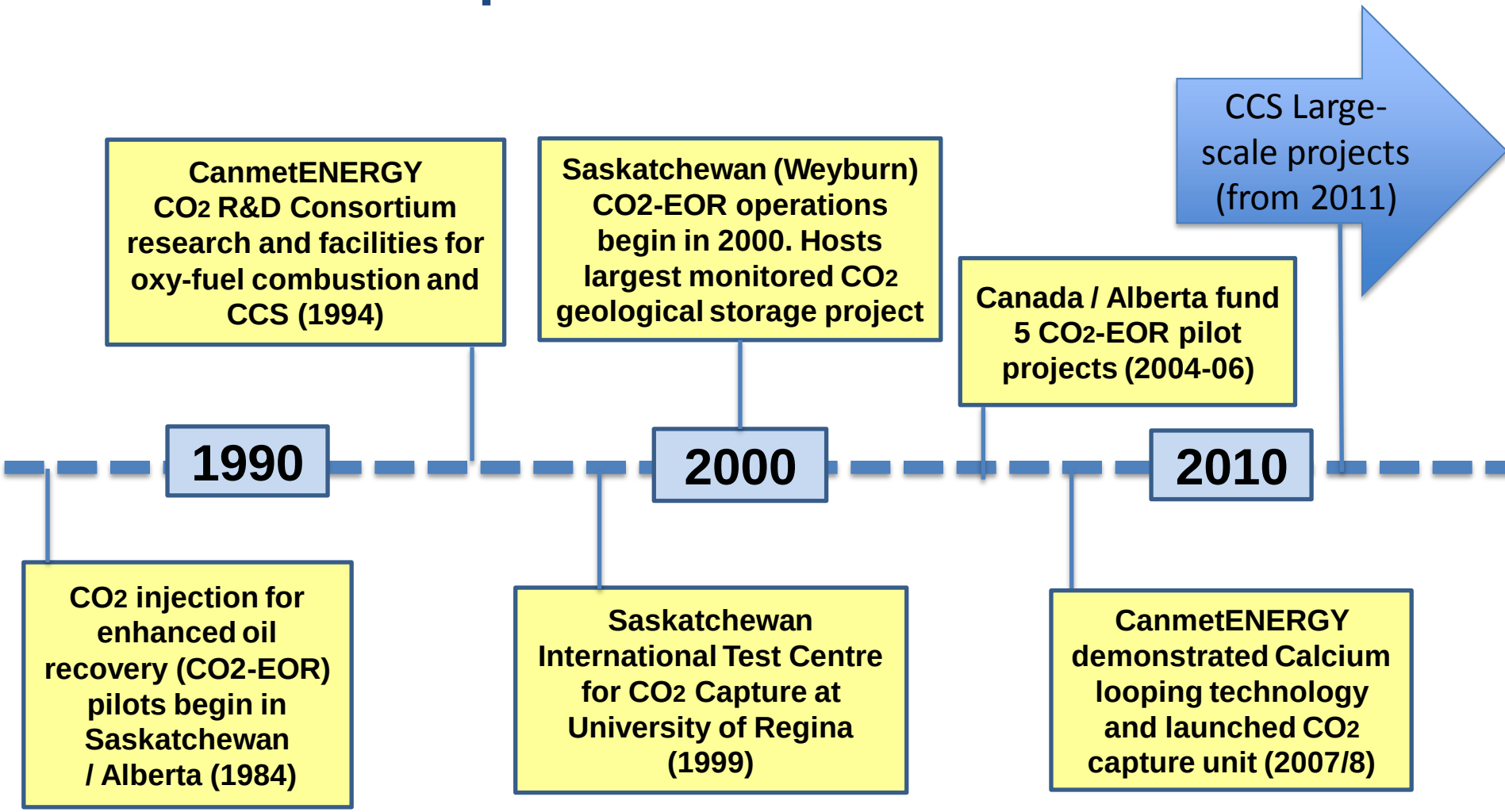
Canada's Approach on CCS

- Recognizing the potential of CCS to reduce GHG emissions from the production and use of fossil fuels, while enhancing energy security, and building on our natural advantage and R&D base, Canada's strategy includes:
  - Implementing large-scale demonstration projects to prove the technology while learning-from-doing;
  - Advancing CCS globally by sharing Canadian knowledge and expertise;
  - Improving the CCS business case by reducing technology costs through research and development of 2nd and 3rd generation technologies; and
  - Promoting innovation in Canada's clean energy technology sector.

Canada's natural CCS advantage



Canada is a CCS pioneer with over 3 decades of R&D



Support by Governments in Canada (since 2008)

- Federal (over $580M), including:
  - Budget 2008 - $240M for SaskPower's Boundary Dam CCS project
  - Clean Energy Fund (CEF) – $150M for 2 large-scale CCS projects in Alberta
  - ecoENERGY Technology Initiative - $112M for industry-led CCS initiatives
  - ecoENERGY Innovation Initiative - $26M for 2nd and 3rd generation technologies

- Provincial (over $1.2B), including:
  - Alberta CCS Fund – $1.24B for 2 large-scale CCS projects in Alberta
  - Funding also provided through Alberta's Climate Change and Emissions Management Corporation (CCEMC), Saskatchewan's Go Green Fund, etc.

As a result, Canada has enhanced its CCS leadership

- With four large-scale projects operating / under construction

1. Weyburn-Midale Project (2000)
2. SaskPower Boundary Dam (2014)
3. Quest project (2015)
4. Alberta Carbon Trunk Line (beginning in 2016)

Federal-Provincial investments in CCS RD&D of over $1.8B with potentially up to $4.5B in public-private investment in CCS initiatives

Policy objectives that underpin our investments

- Prove the technology at commercial-scale;
- Provide a stable regulatory framework;
- Improve the CCS business case by advancing 2nd and 3rd generation technologies that drive down CCS costs;
- Improve public education and engagement;
- Contribute to international effort to advance CCS; and
- Profile Canadian expertise and sharing experiences.

Our investments are already paying off

World's first commercial coal-fired power plant with CCS now a reality!

Julio Friedmann, Deputy Assistant Secretary, Clean Coal, US Department of Energy: *"This project is a culmination of a dream. Projects like this show the world that this is not only a viable technology but a required technology."*

Bellona President: *"Finally, people cannot say that this is unproven technology. It will be much harder to reach climate targets without CCS."*

IEA Executive Director: *"Getting Boundary Dam up and running is a great example of how Canada is a leader in CCS... I wish the plant operator every success in showing the world that large-scale capture of CO2 from a power station is indeed not science fiction, but today's reality."*

Lessons also learned from unsuccessful projects

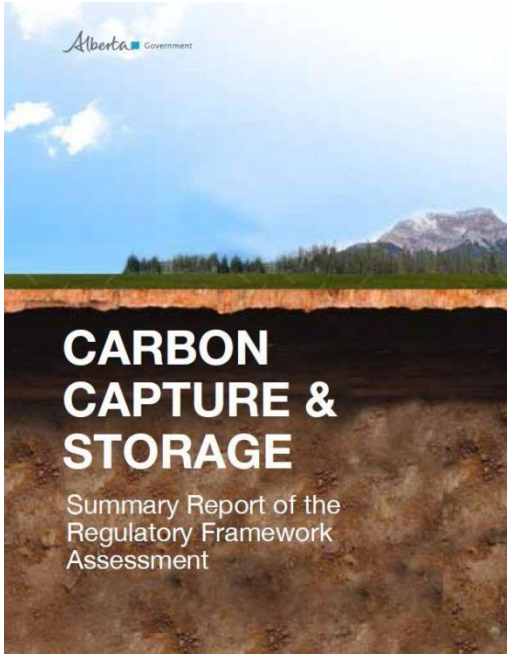
- Many factors must align for a viable business case, such as:
  - Market incentive to capture CO_2
  - Risk sharing in commercial frameworks among multiple parties
  - Regulatory permits, legal access, public acceptance
  - Schedule slippage must be within government funding profile
- Certainty over costs, risks, and timelines requires a lot of ‘front-end’ work and investment
- Risk tolerance will vary between projects / proponents / marketplace conditions

Federal government GHG regulations, including specific provisions for CCS

- Federal Government focused on an approach to GHG regulations that will reduce emissions while continuing to create jobs and encourage growth of the economy
- As of July 1, 2015, coal-fired power units which are new or have operated for 50 years must meet a regulated emissions performance standard
  - Currently, CCS is the only technology option to meet the standard if units continue to use coal
  - If CCS will be incorporated, units have until 2025 to comply

Provinces are advancing CCS regulations with Alberta at the forefront globally

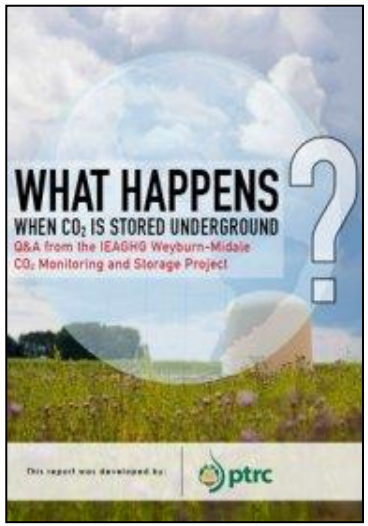
- **2009-11** – Alberta overcame major policy barriers with new legislation / regulation
- **2011-12** – Alberta's CCS Regulatory Framework Assessment (RFA)
- **2014:**
  - Developing quantification protocol for CCS carbon offset credits.
  - International experts working group for Post Closure Stewardship Fund.



Continuing to address RFA recommendations over the next 3-4 years….

Public engagement efforts are ongoing

- Public confidence facilitated by oil and gas / industrial experience.
- Public opinion poll in Canada (2011) showed Saskatchewan has highest awareness of CCS in country and also most comfortable
- NRCan-funded study by Pembina Institute has lessons / best practices (http://www.pembina.org/pub/ccs-stakeholder-engagement)
- Project proponents in Canada, like Shell, set best practices



International Engagement

- Multilateral mechanisms
  - Carbon Sequestration Leadership Forum, IEA GHG R&D Program, etc..
- Bilateral mechanisms
  - **Canada-U.S.** (Clean Energy Dialogue, Enhanced Energy Collaboration)
  - **Canada-UK** Joint Statement on CCS
  - Canada also maintains bilateral CCS-related arrangements with government entities in **Japan, China, South Korea, Mexico**, etc.
- Natural Resources Canada's collaborative CCS R&D Activities
  - **CanmetENERGY CO2 R&D Consortium** related to oxy-fuel combustion
  - 20 years of collaboration with power generation sector in **China**
  - Collaborated with Foster Wheeler toward CCS demonstration in **Spain**

International Engagement (cont'd)

- A variety of CCS international efforts in Canada outside of NRCan
  - Alberta is co-leading development of world's first **ISO CCS standard** as well as a quantification protocol for carbon offset credits
  - Alberta's CCEMC launched an **international $35M Grand Challenge** to find innovative uses for carbon.
  - SaskPower - **CCS Global Consortium**, **MOUs** across many countries, **International CCS Test Centre Network** member
  - Petroleum Technology Research Centre (PTRC)
    - Managed **IEA GHG Weyburn-Midale CO2 Storage project** (completed)
    - **Aquistore Project** is bringing together internationally recognized expertise
  - Carbon Management Canada collaborating with leading researchers and research groups globally (UK, Australia, etc.)

In Summary:

- Canada has parlayed its natural CCS advantage and strong R&D foundation into a position of global leadership;
- Canada is proving CCS at scale while learning-from-doing;
- Canada is contributing to the global effort to advance CCS; and
- Going forward, focus is on strengthening the CCS business case through continued R&D, while remaining active internationally.