

North American Perspectives – Canada –

Carbon Storage Program Infrastructure Annual Review Meeting

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Dr. Frank Mourits
Office of Energy Research and Development
Natural Resources Canada (NRCan)



Natural Resources
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Ressources naturelles
Canada



Presentation Overview

❑ Background

- Importance of CCS to Canada

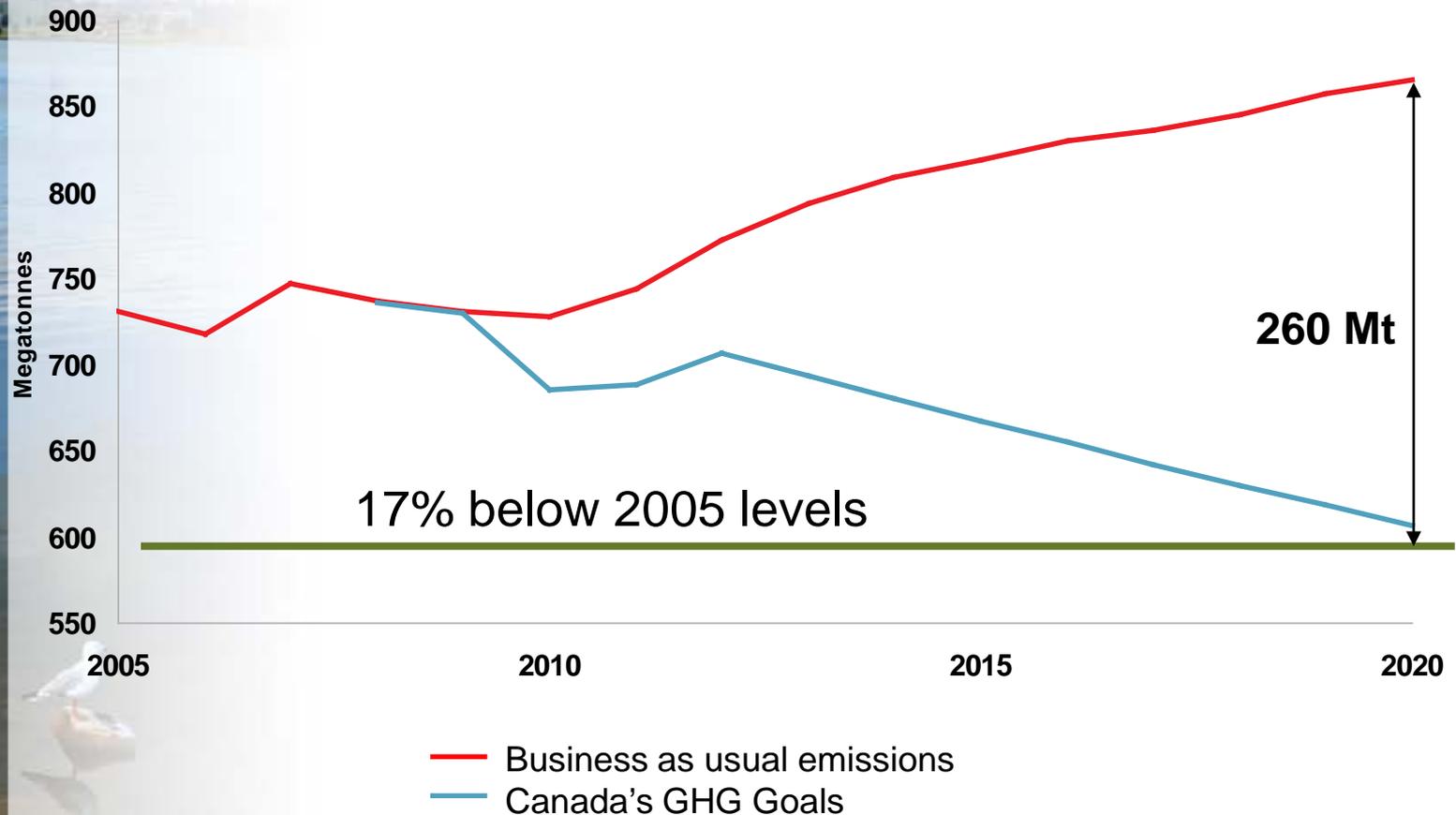
❑ Status of Canada's CCS Initiatives

- Research and Development
- Large Demonstration Projects
- Other initiatives

❑ Summary

Reducing GHG emissions in Canada (I)

Committed to 17% reduction below 2005 by 2020



Reducing GHG emissions in Canada (II)

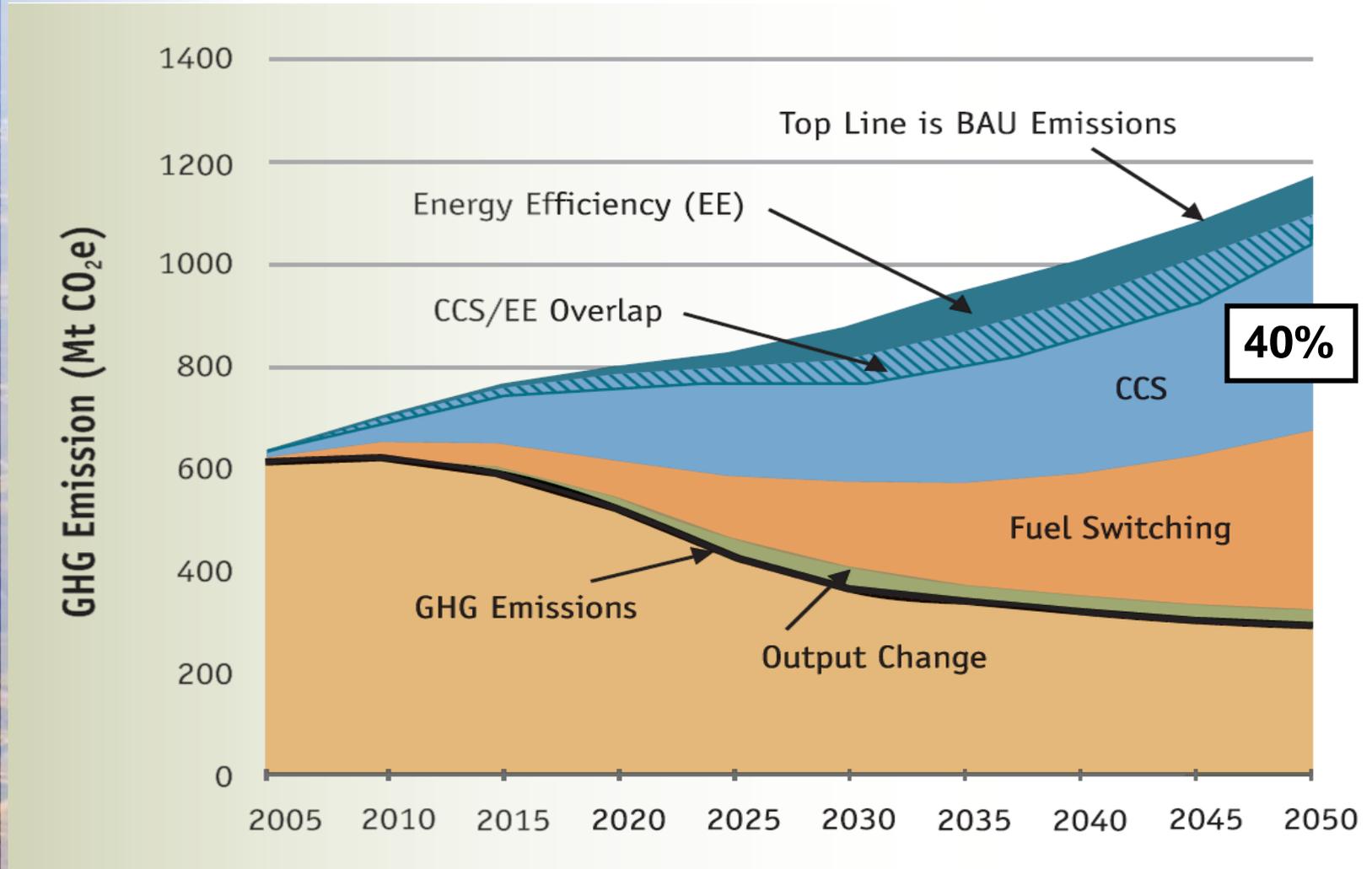
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Federal GHG Targets and Measures

- ❑ Committed to 17% reduction below 2005 by 2020 (aligned with U.S.) through a sector-by-sector approach
- ❑ Proposed regulations for coal-fired electricity generation plants announced in August 2011; will come into effect in July 2015:
 - *Applies to new coal-fired units and units that have reached the end of their economic life*
 - *Must meet stringent performance standard based on parity with emission performance of high-efficiency natural gas generation (375 tonnes of CO₂ per GWh)*
 - *Units that commit to implementing CCS could, under specific circumstances, receive exemption up to 2025*
- ❑ Reduction of emissions from electricity sector projected to be 31 Mt between 2005 and 2020

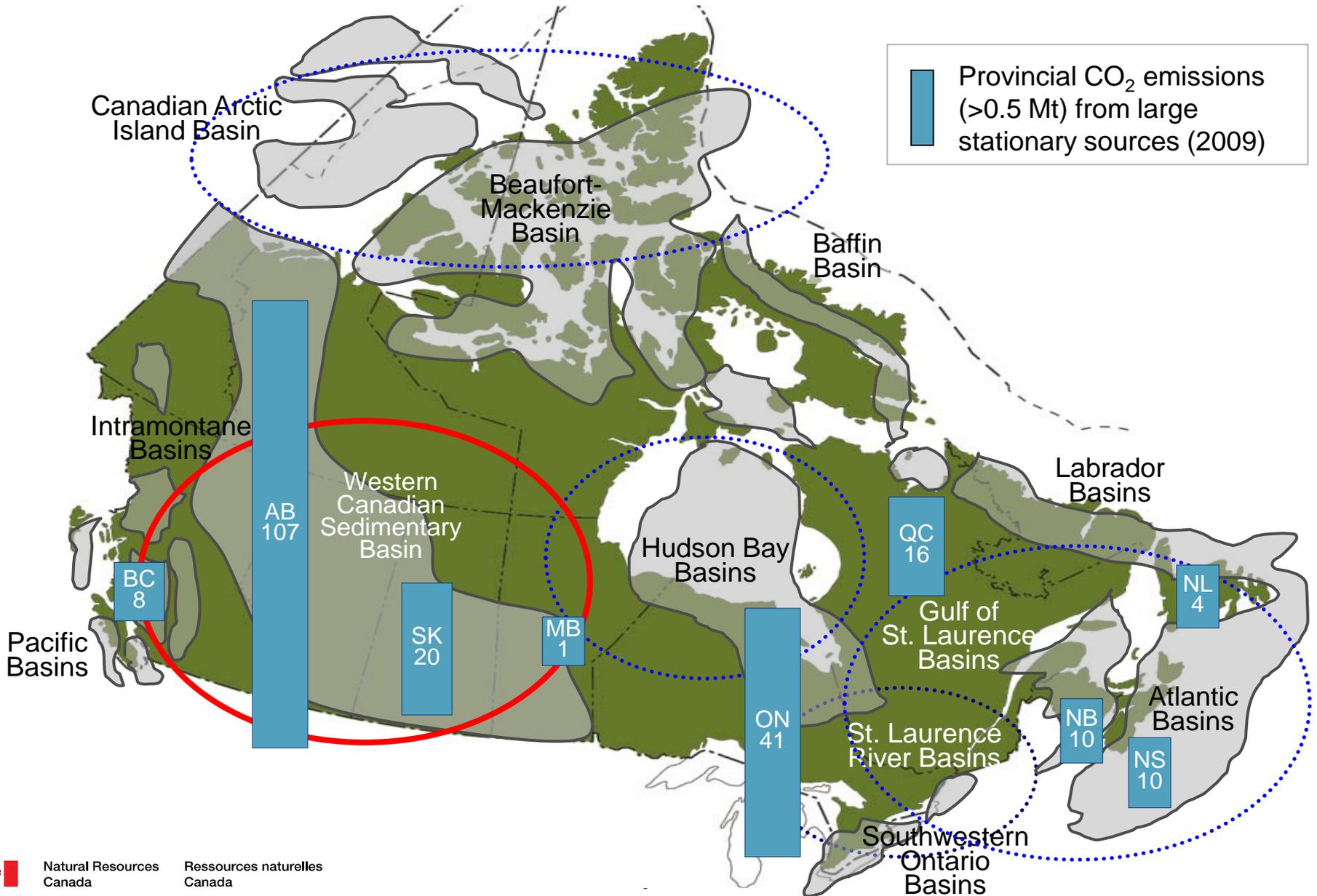
GHG reduction “wedges” - potential for CCS

(National Round Table on the Environment and the Economy*)



* From report: "Getting to 2050: Canada's Transition to a Low-Emission Future (Nov. 2007)"

Canada has a natural CCS advantage



CCS Policy Approach in Canada

A suite of interdependent initiatives to create the environment for implementing CCS

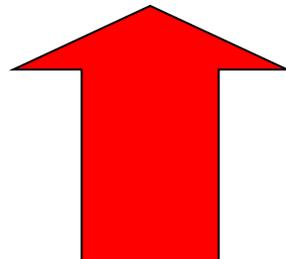
**Research and
Development**

**Pilot and
Demonstration
Projects**

**National / International
Collaboration**

- Knowledge Sharing
- Public Outreach

**Legislation and
Regulation**



CCS Research and Development in Canada

Capture

- Natural Resources Canada / CanmetEnergy
- University of Regina - International Test Centre

Storage

- Petroleum Technology Research Centre (PTRC)
 - IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project
 - Aqistore Project
- Natural Resources Canada / CanmetEnergy
- Universities of Calgary, Alberta and Saskatchewan
- Alberta Innovates -Technology Futures (AITF)
- University of Quebec / INRS
- St. Francis Xavier University

CCS Evaluations, Analyses, Assessments, Networks

- International Performance Assessment Centre for Geological Storage of Carbon Dioxide (IPAC-CO₂)
- Institute for Sustainable Energy, Environment and Economy (ISEEE)
- Carbon Management Canada (CMC)
- University of Waterloo
- CCS Nova Scotia

North American Carbon Storage Atlas

– a collaboration by Canada, U.S. and Mexico –

- Goal is to develop a comprehensive understanding of the potential for CCS in North America through:
 - Identification of major sources and potential geologic reservoirs for storage of CO₂
 - Resource estimation for CO₂ storage in promising reservoirs
 - Use of common methodologies based on agreed approaches
 - Limited to oil and gas reservoirs, deep saline formations and unmineable coal seams

- Timelines:
 - Completion date: April 2012

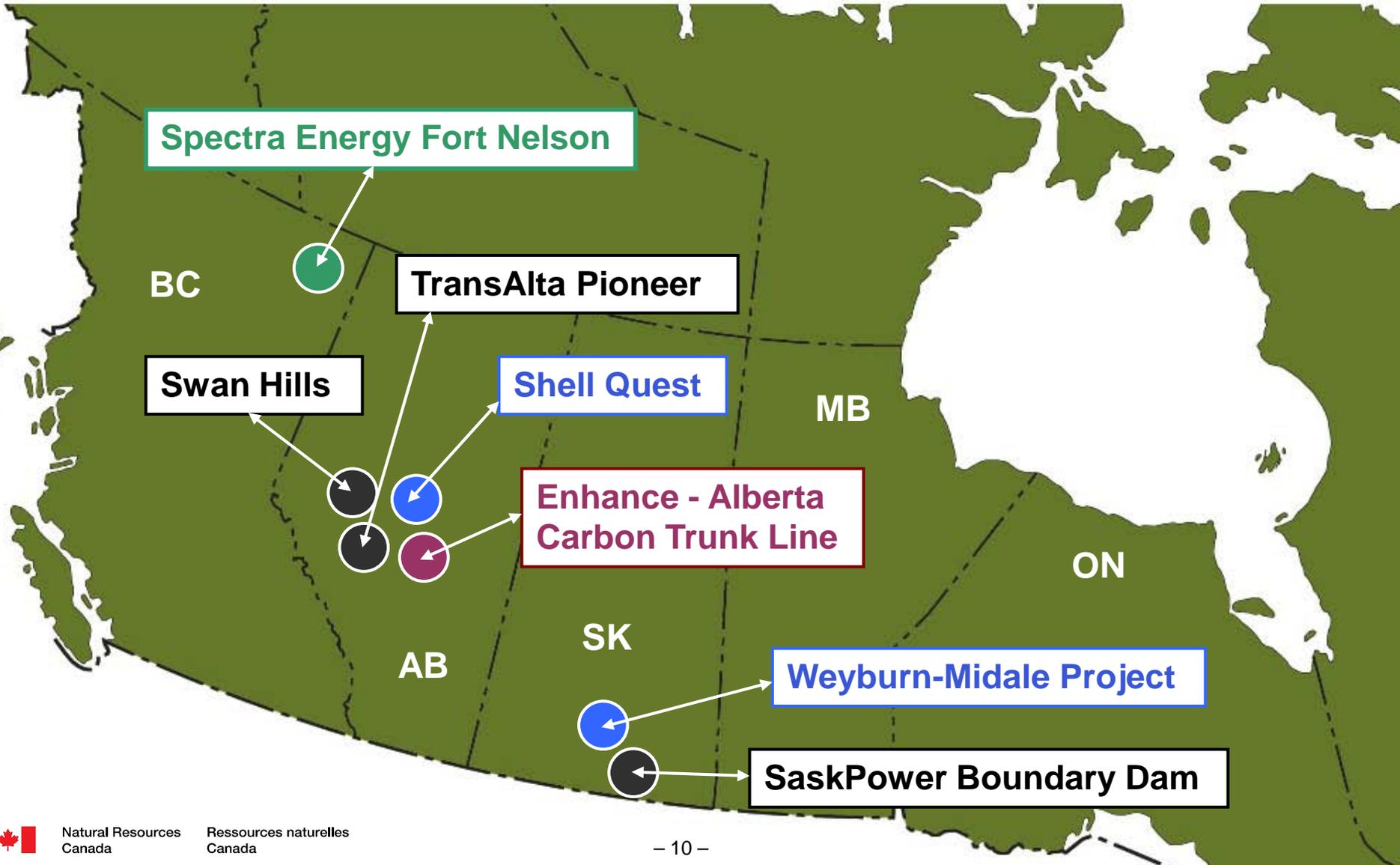
- Deliverables:
 - Printed Atlas
 - Dedicated website with downloadable maps



Large Integrated Demonstration Projects (> 1 Mt / yr)

⇒ \$7 billion total investments

⇒ >\$3 billion in public funding





SaskPower Boundary Dam Integrated CCS Project

One of the world's first commercial-scale coal-fired power plants with integrated CCS

- Re-build (110 MW) of existing unit #3: boiler and turbine upgrades, integration of FGD and CO₂ capture
- Cansolv (subsidiary of Shell Global Solutions) to provide amine-based capture system
- Will capture 1 Mt of CO₂ annually
- CO₂ to be used for enhanced oil recovery in nearby oilfields
- Status:
 - Final investment decision announced April 2011
 - construction underway
 - commissioning scheduled for 2014
- Total project cost \$1.24 billion; public funding: \$240 million (federal); provincial funding through SaskPower

Boundary Dam Integrated CCS Demonstration Project

CO₂ Capture Plant

Original Unit 3

- Pulverized coal (lignite)
- 12.4 MPa (124 bar); 538° /538° C
- Commissioned in 1968

Replacement Unit 3

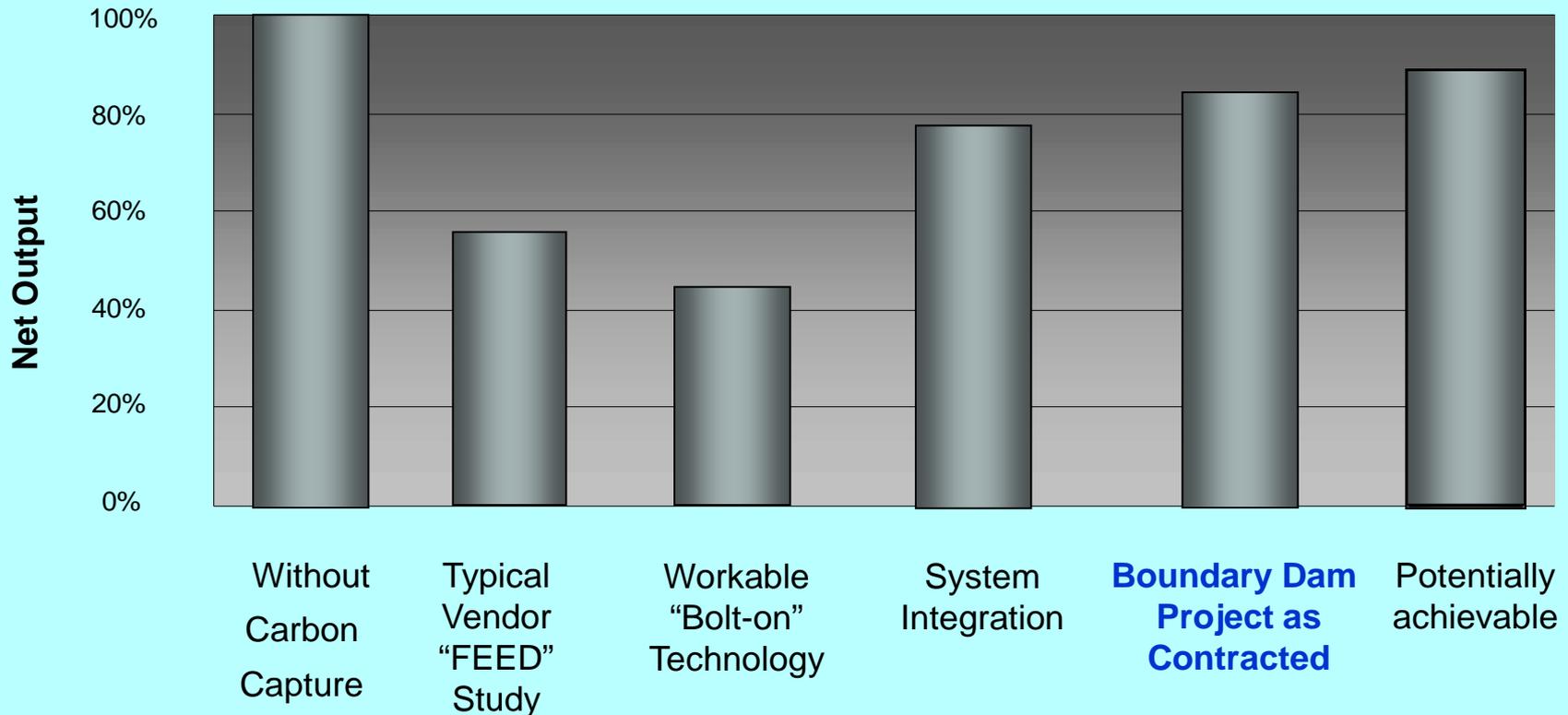
- New unit in an old box
- Carbon capture ready
- 12.4 MPa (124 bar); 566° /566° C
- 110 MW net with carbon capture
- To be commissioned 3rd quarter 2013

To be commissioned
in 1st quarter 2014



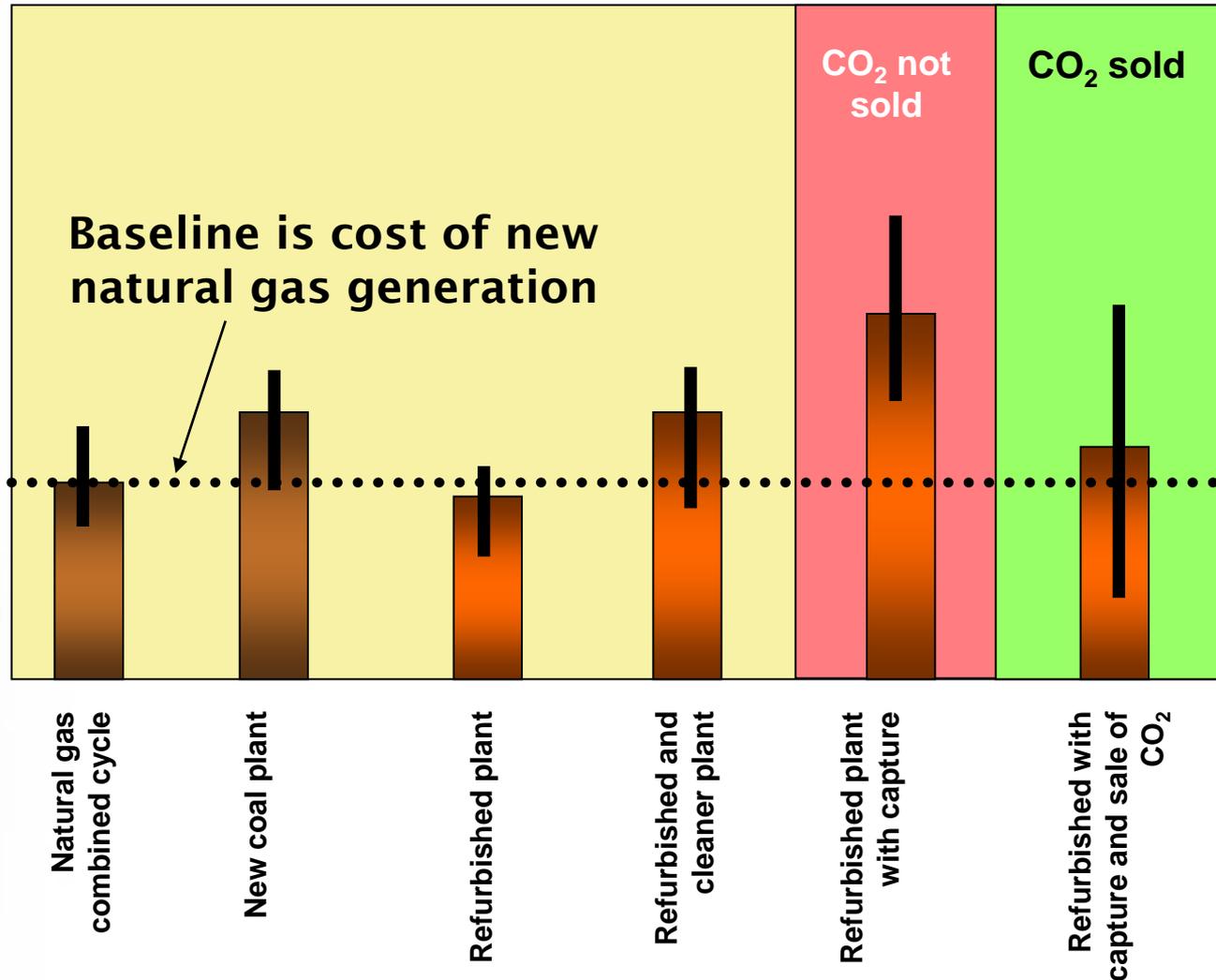
Boundary Dam ICCS

Impact of Knowledge and Experience on Plant Efficiency



Boundary Dam ICCS

Cost of Electricity



Weyburn-Midale Project

Weyburn, Saskatchewan

- ❖ Commercial CO₂-Enhanced Oil Recovery Operations
- ❖ IEAGHG Weyburn-Midale CO₂ Monitoring & Storage project

1. Enhanced oil recovery by Cenovus Energy (since 2000) and Apache Canada (since 2005):
 - injecting CO₂ to produce more oil from depleting carbonate reservoirs
 - CO₂ byproduct of coal gasification plant in U.S.; pipelined 320 km to Weyburn
 - Injecting 8000 tonnes CO₂ per day or 2.8 million tonnes annually
 - **20 million tonnes injected to date; no leakage has ever been reported**
2. *IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project* – world's largest CO₂ storage research project
 - Has been monitoring fate of CO₂ since 2000
 - Key deliverable: Best Practices Manual (delayed to January 2012)
 - Will provide protocols for the development, implementation and operation of storage projects in oil fields and other formations
 - Total project cost \$41 million; public funding: \$34 million (incl. 5 governments)



Shell Quest CCS Project

A fully integrated CCS (capture, transport & storage) project

Shell Scotford Oil Sands Upgrader (at Fort Saskatchewan, Alberta)

- Joint venture between Shell Canada (60%), Chevron Canada (20%) and Marathon Oil Sands (20%)
- CO₂ capture from 3 steam methane reforming units, using existing ADIP-X amine capture technology
- Will capture 1.1 million tonnes annually for 25 years, starting 2015
- CO₂ to be stored in a saline formation (Basal Cambrian Sands) at 2000 m depth
- Improves GHG performance of oil sands operations
- Total project cost \$1.35 billion (includes development, construction and 10 yrs of operation); public funding: \$120 million federal; \$745 million provincial

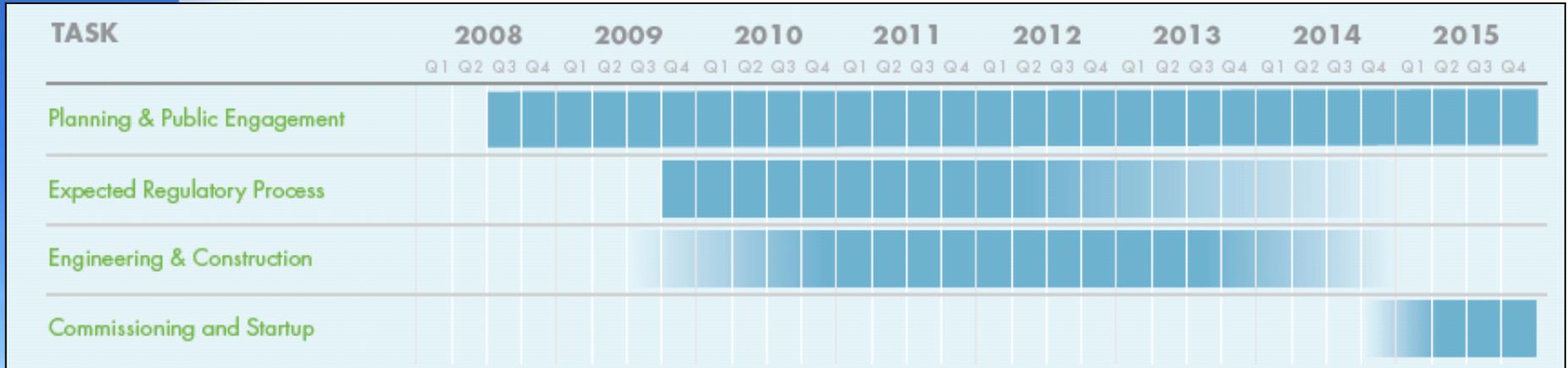
Shell Quest CCS Project

Scotford Site, Alberta – Upgrader and Refinery



Shell Quest CCS Project

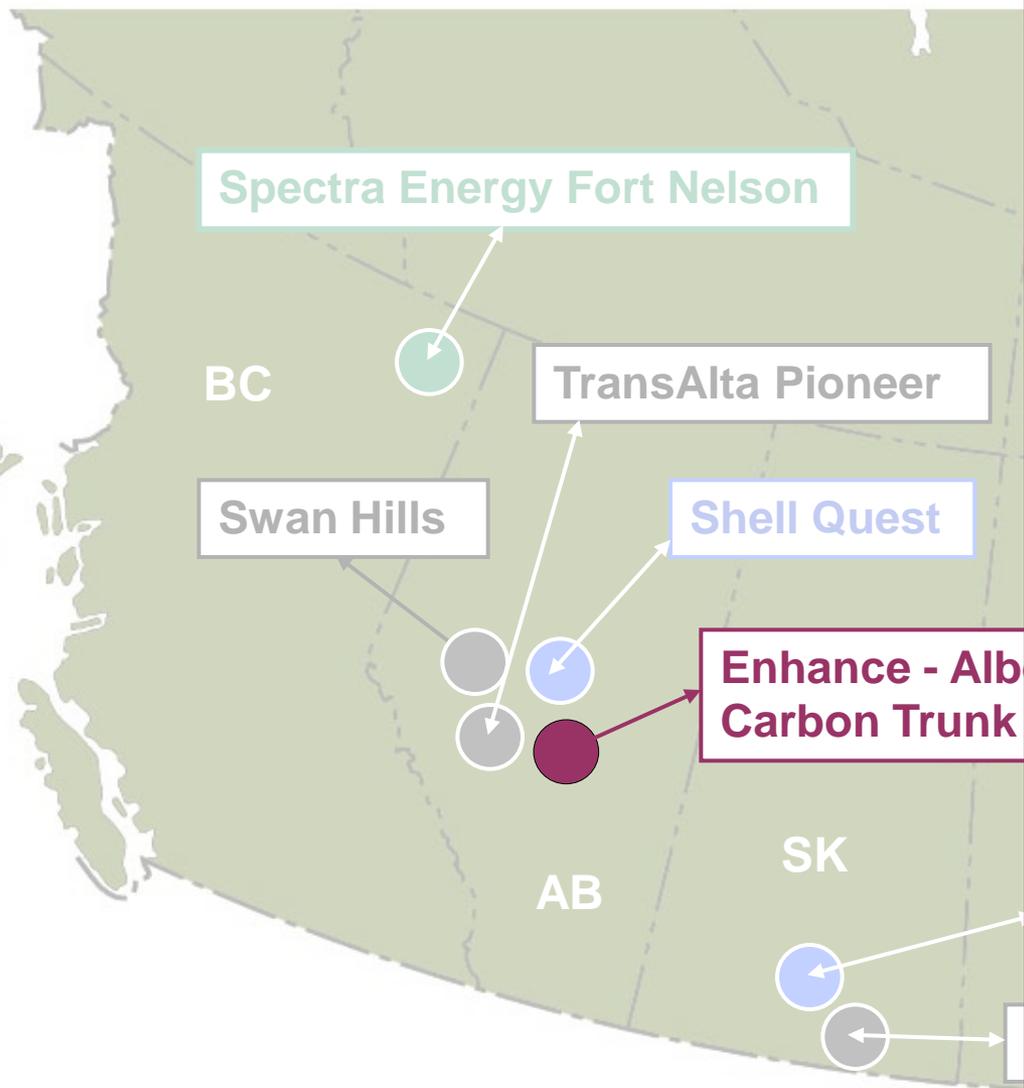
Schedule



Key milestones

- Nov. 2010 – regulatory application filed
- June 2011 – funding agreements signed with two governments
- Environmental assessment under review
- First half of 2012 – final investment decision
- 2012 - 2015 – procurement and construction
- 2015 – start-up

Other Large Integrated CCS Demonstration Projects

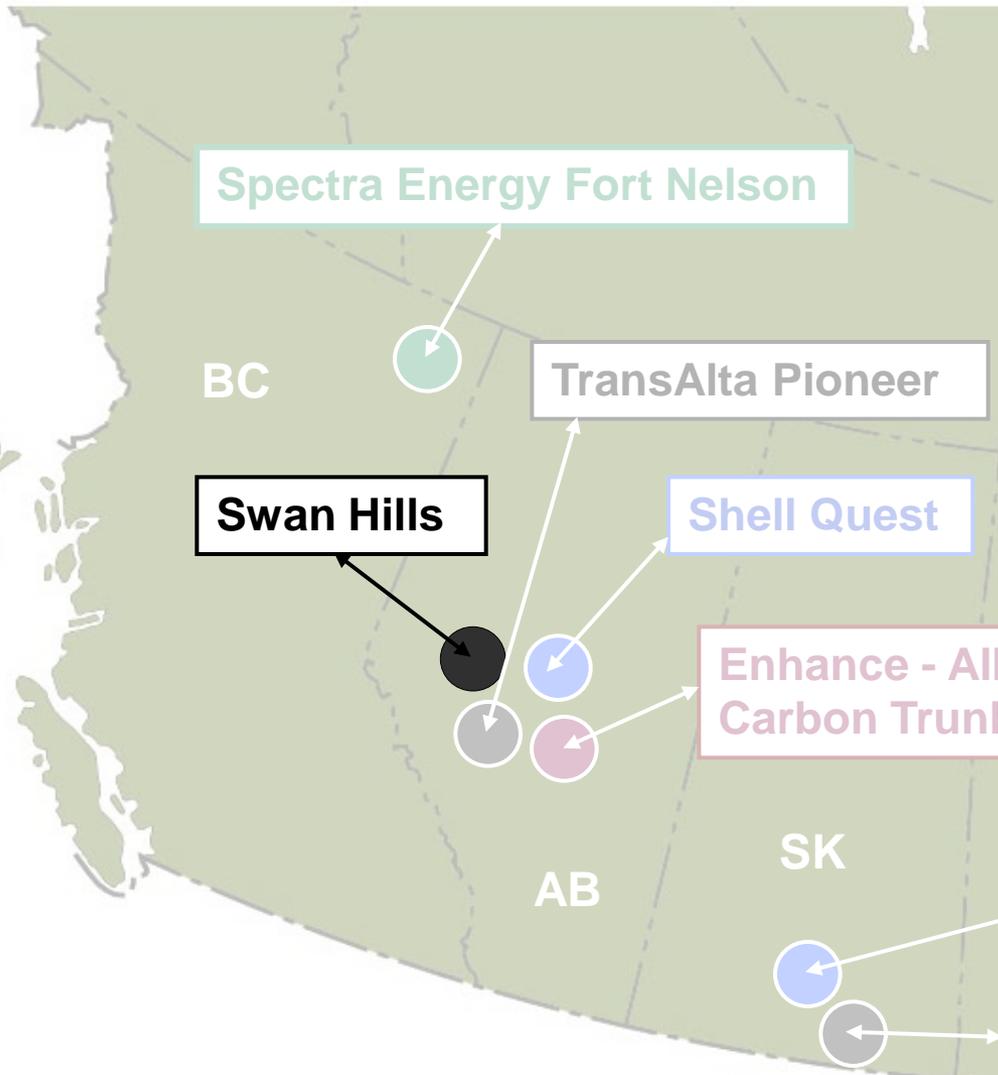


Enhance Energy – Alberta Carbon Trunk Line Project

Construction of 240-km CO₂ pipeline in central Alberta

- Deployment of proven pipeline technology to gather, compress and transport CO₂ to EOR storage sites in south-central Alberta
- Up to 1.9 Mt/yr of CO₂, with long-term potential of 14.6 Mt/yr
- Initial supply of CO₂ from Agrium fertilizer plant and new North West Upgrading oil sands upgrader (2014)
- Status:
 - Environmental assessment completed
 - Final investment decision taken
 - Detailed engineering procurement and construction underway
- Pipeline completed 2013; first capture 2014
- Total project cost ~\$1.2 billion (incl. opex); public funding: \$63 million federal; \$495 million provincial

Other Large Integrated CCS Demonstration Projects

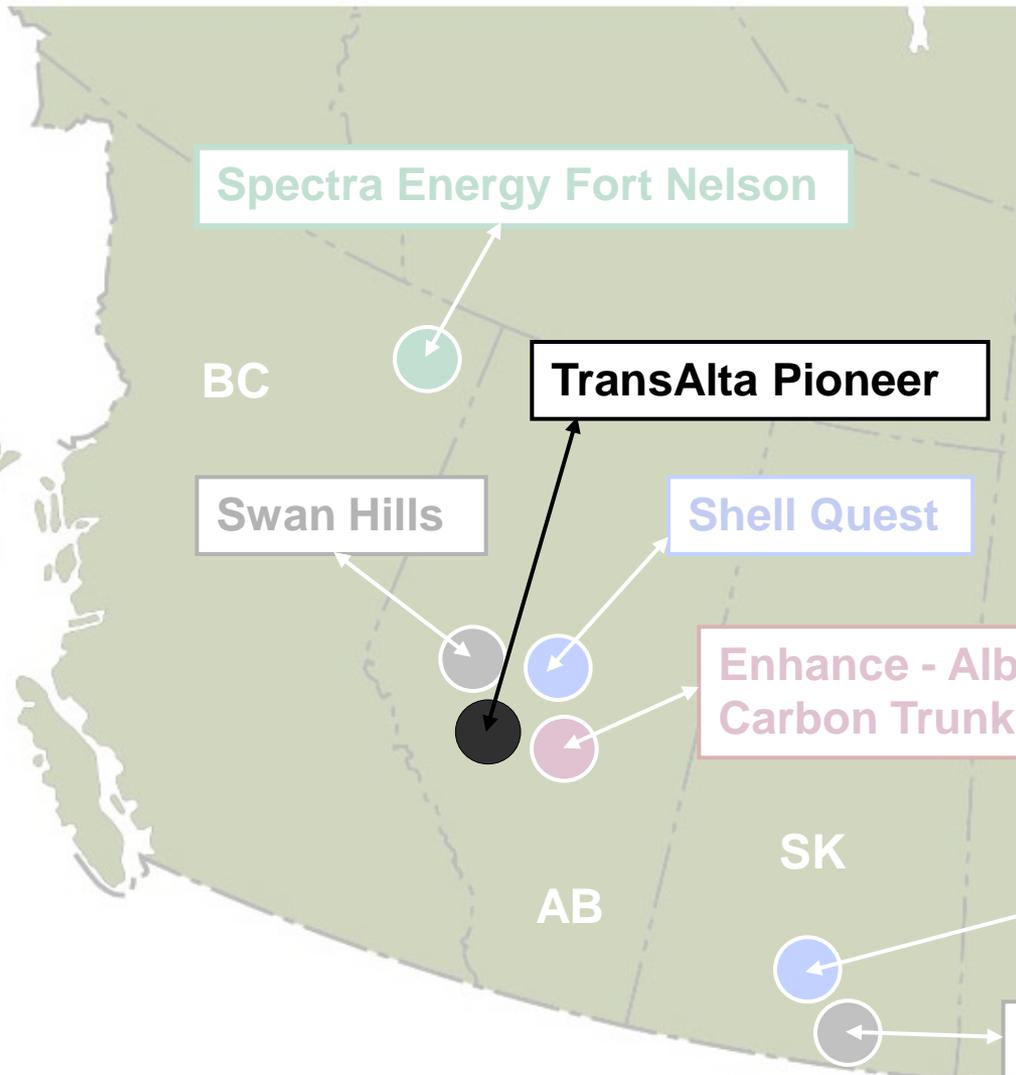


Swan Hills Synfuels Project

Underground coal gasification and power generation

- Deep underground in-situ coal gasification (1400 m)
- Raw gas processed in gas plant with CO₂ removal to produce clean syngas
- Syngas pipelined to 300-MW combined-cycle power plant
- 1.3 Mt/y CO₂ used for EOR or stored in burned-out coal seams
- Project start-up in 2015
- Total project cost ~\$1.5 billion; public funding: \$285 million provincial

Other Large Integrated CCS Demonstration Projects

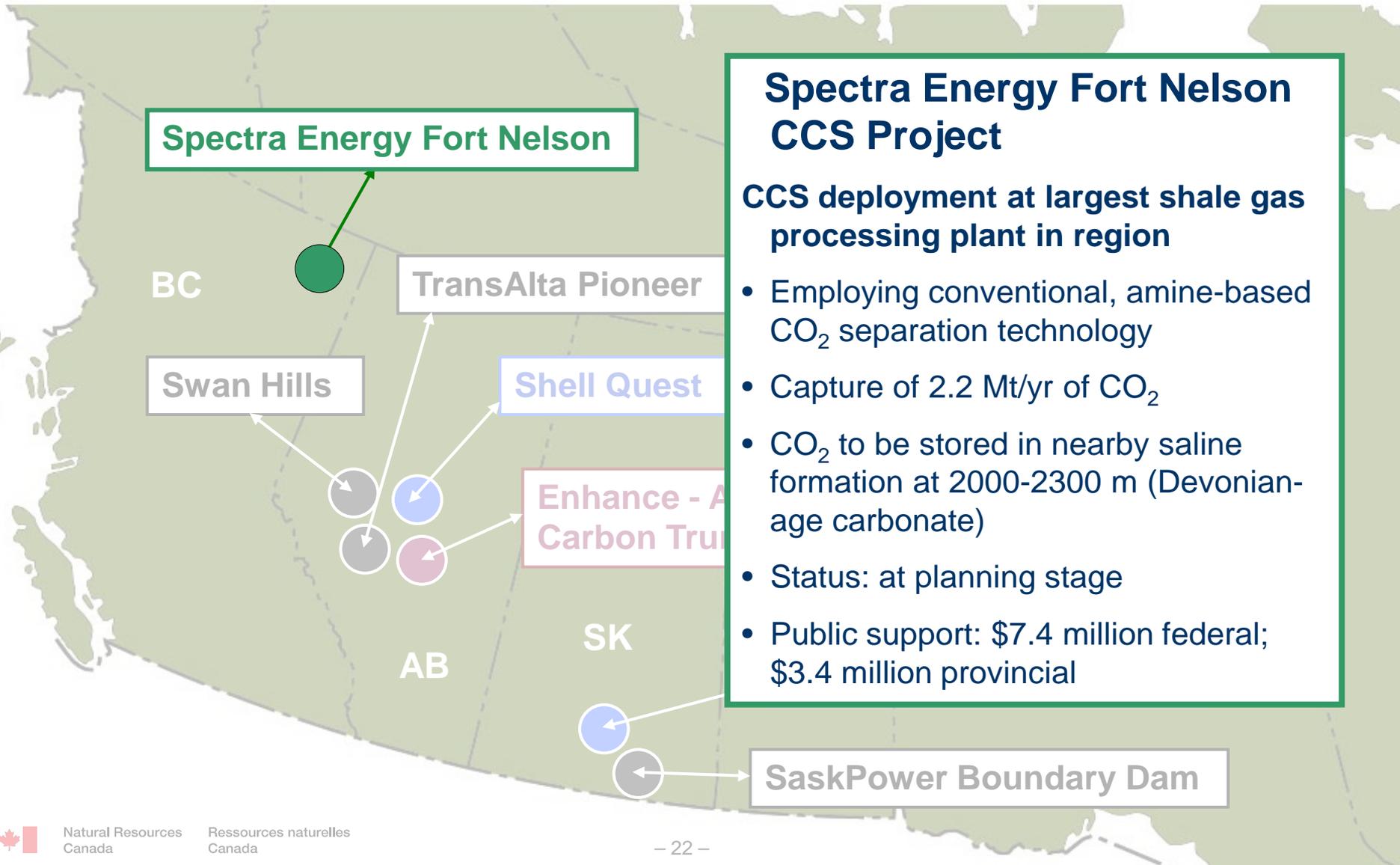


TransAlta Project Pioneer

Retrofit installation of post-combustion CO₂ capture technology

- New (2011), 450-MW supercritical coal-fired power plant (TransAlta Keephills-3)
- Capture of 1 Mt/y (amine process)
- Storage in deep saline (carbonate) formations (~1800 m) and/or CO₂ used for enhanced oil recovery
- Status:
 - Front End Engineering Design (FEED) for capture system underway
 - Storage site characterization work underway
 - Environmental assessment initiated
- Total project cost ~\$1.3 billion; public funding: \$343 million federal; \$436 million provincial

Other Large Integrated CCS Demonstration Projects





❑ Legal and regulatory issues

- Based on a solid regulatory foundation, provinces are refining their legal and regulatory frameworks to enable commercial-scale CCS projects:
 - **Alberta:** *CCS Statutes Amendments Act* passed in 2010. Currently undertaking Regulatory Framework Assessment to review CCS regulations
 - **Saskatchewan:** Amendments to *Oil and Gas Conservation Act* to expand and clarify regulatory authority around CCS to be proclaimed by March 2012
 - **British Columbia:** Currently developing CCS policy framework
- Federal regulations for coal-fired power plants introduced (2011)

❑ Public engagement key component of CCS

- Public knowledge and acceptance are crucial as lack of understanding can undermine CCS implementation.
- Public engagement activities include Open Houses near project sites, CCS website, information materials, focus group testing and surveys

❑ Sharing knowledge from large-scale demonstrations

- To facilitate rapid deployment of CCS, Canada is engaged in knowledge-sharing activities, both domestically and internationally

❑ International engagement

- Bilateral cooperation on CCS with US, EU and UK
- Multilateral fora: CSLF, IEA, GCCSI, MEF/CCUS, APEC, IEF

Summary

- ❑ CCS is of great strategic importance to Canada: deploying CCS will be key in reaching our GHG reduction objectives
- ❑ Both federal and provincial levels of government in Canada are collaborating to address the challenges of CCS through:
 - research, development and demonstrations
 - implementation of CCS policies and regulations
 - public engagement and outreach
 - knowledge sharing
 - international collaboration
- ❑ Over \$3 billion in public funds has been allocated towards 7 large-scale, fully-integrated CCS demonstration projects, leveraging over \$4 billion in private investments
- ❑ Three of these projects are currently at the construction stage, with the first few scheduled to be completed as early as 2014

Thank You!



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