

Canada: On the Road Towards CCS Implementation

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

Clean Coal Day in Japan 2010
International Symposium
Tokyo, 7-9 September 2010



**Natural Resources
Canada**

**Ressources naturelles
Canada**



Presentation Overview

❑ Background

- Importance of CCS to Canada
- Opportunities and Challenges

❑ Overview of Canada's CCS Initiatives

- Research, Development and Demonstration
- Public Engagement and Knowledge Sharing
- Legislation and Regulations
- Collaboration with Domestic and International Partners

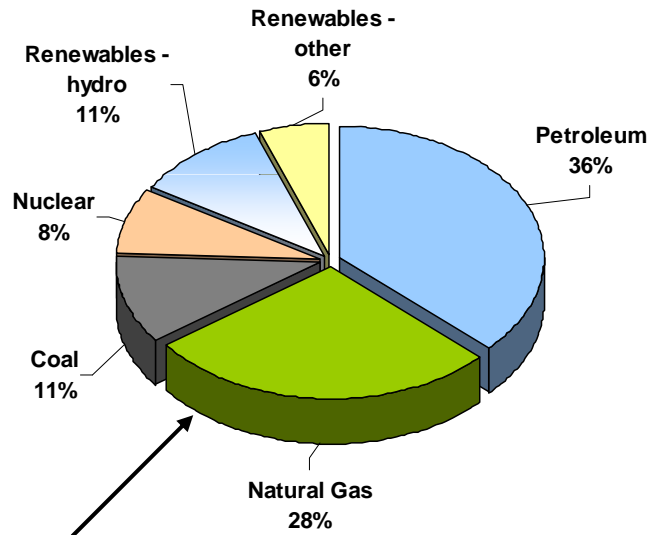
❑ Summary



Background - Importance of CCS

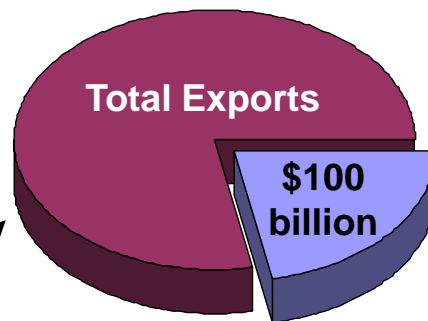
- ❑ Energy production is one of the cornerstones of the Canadian economy, but also leads to significant GHG emissions
- ❑ Canada has ambitious GHG reduction targets
- ❑ Our challenge – reconciling an economically important energy sector with climate change objectives
- ❑ Carbon Capture and Storage (CCS) is one key element to help balance Canada's energy, environmental and economic goals

**Primary Energy Consumption in 2007
(total of 12,480 PJ)**

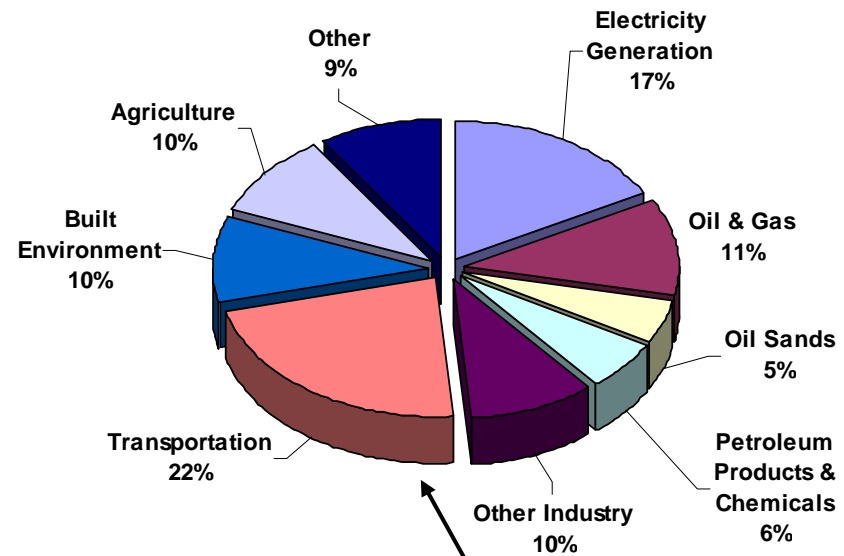


Fossil fuels provide 75% of Canada energy requirements (including energy needed for fossil fuel extraction and processing)

Canada's primary energy exports (oil, gas and electricity) comprise nearly 25% of our total exports (2008)



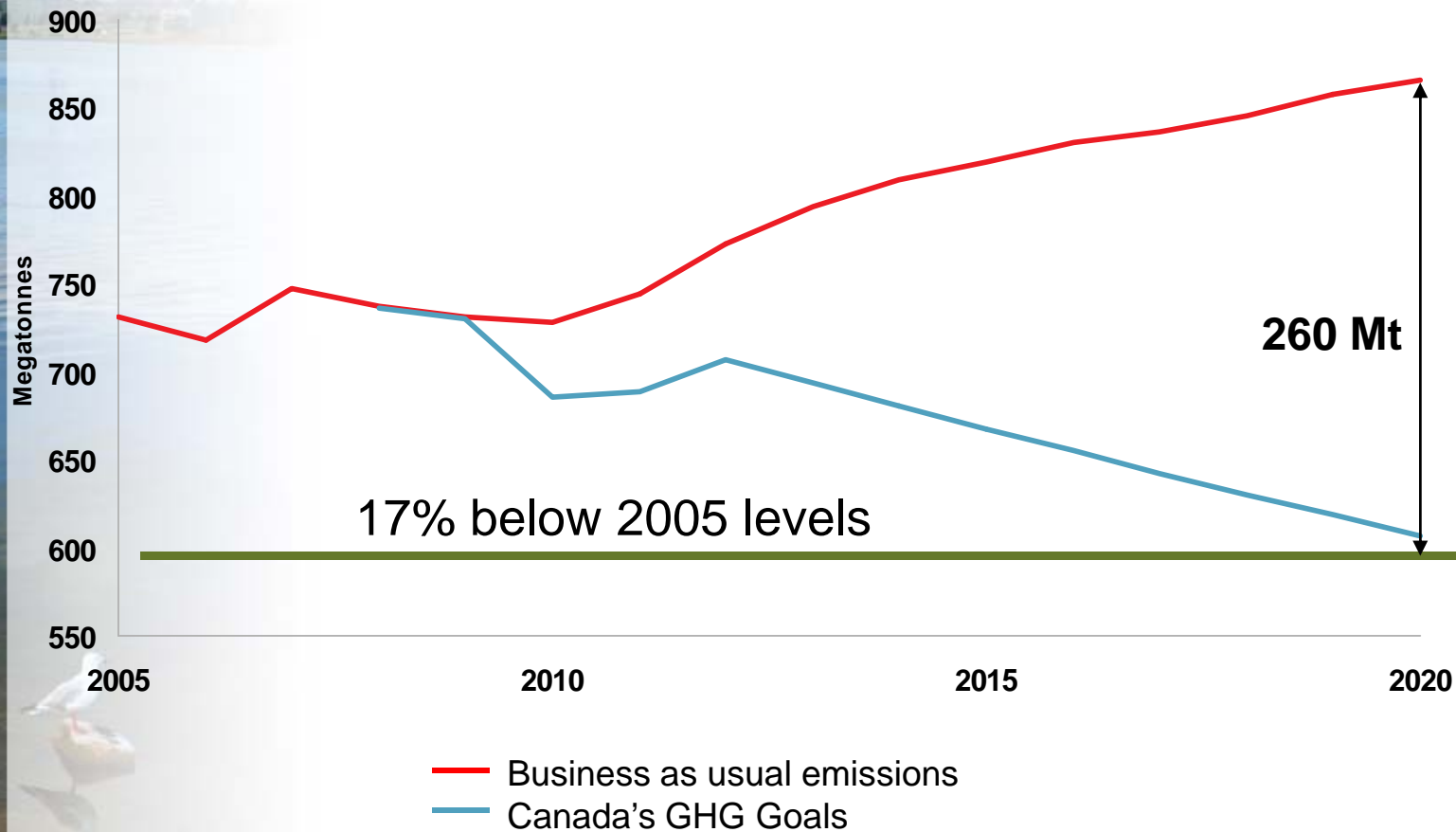
**GHG Emissions by Sector in 2007
(total of 747 Mt)**



Close to half of Canada's GHGs are emitted by large stationary sources, situated in areas where CCS may be applicable

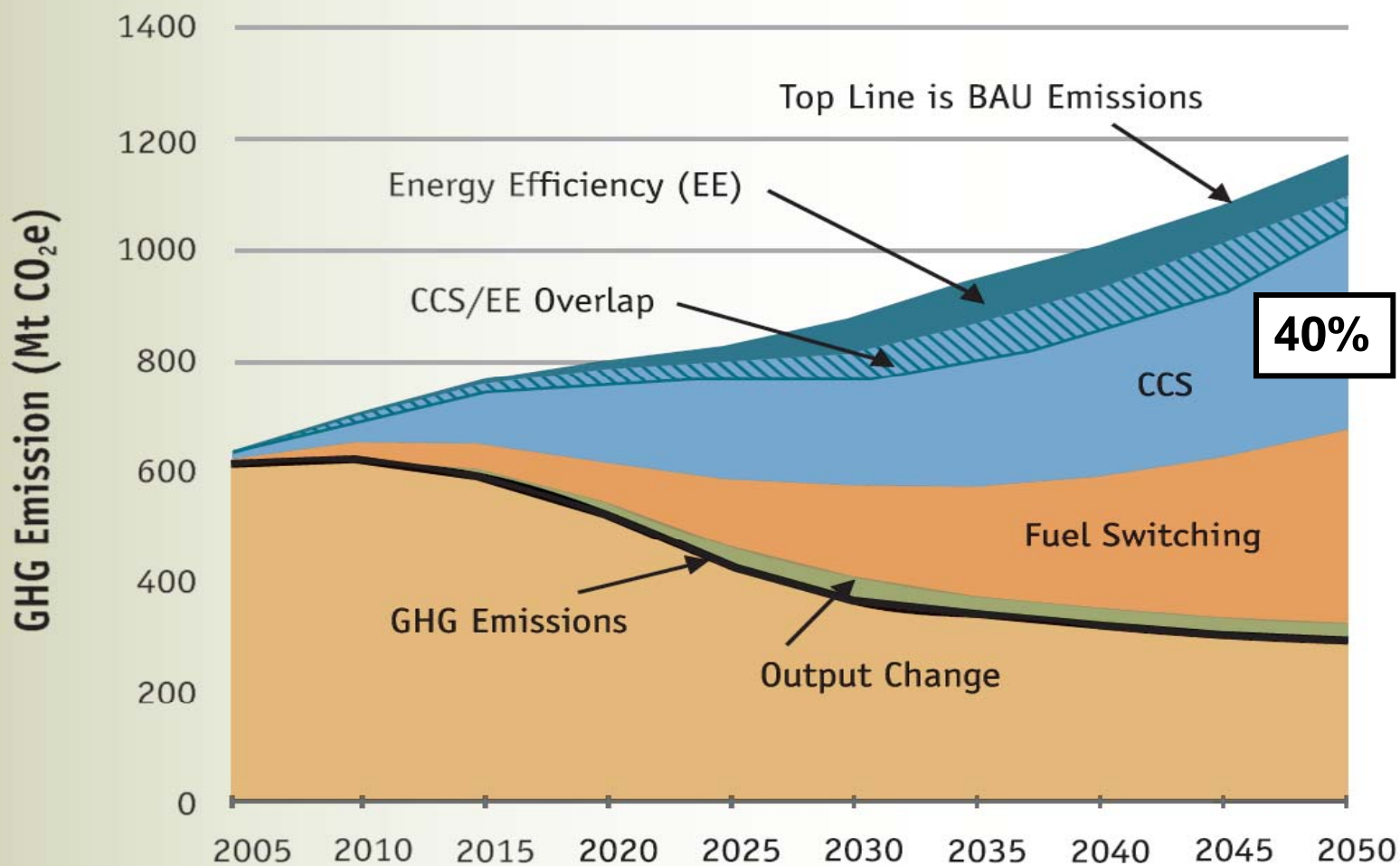
Reducing GHG emissions in Canada (I)

Committed to 17% reduction below 2005
by 2020 and 60-70% by 2050



GHG reduction “wedges” for 20% reduction by 2020 and 65% reduction by 2050

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



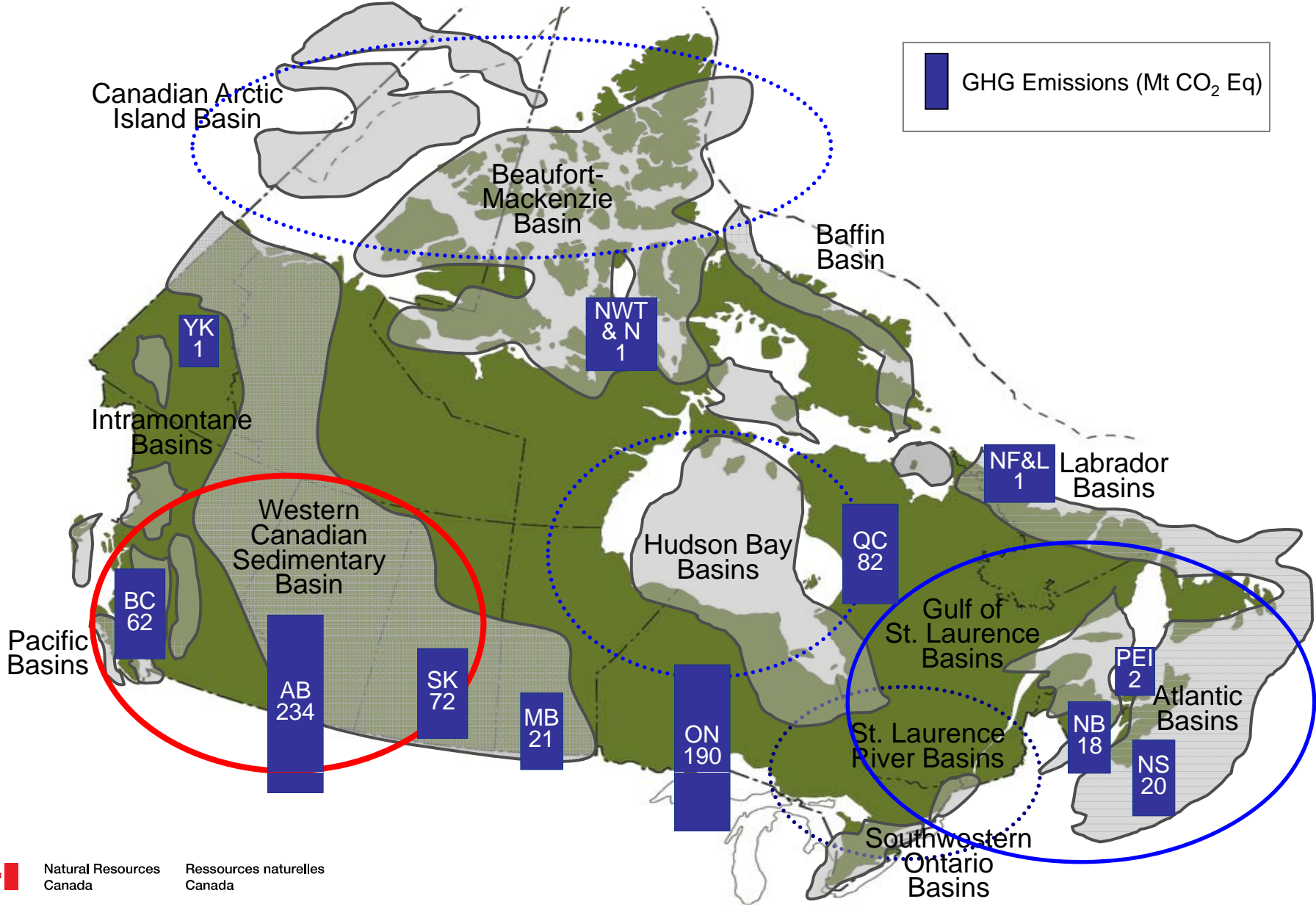
* From report: "Getting to 2050: Canada's Transition to a Low-Emission Future (Nov. 2007)"

Reducing GHG emissions in Canada (II)

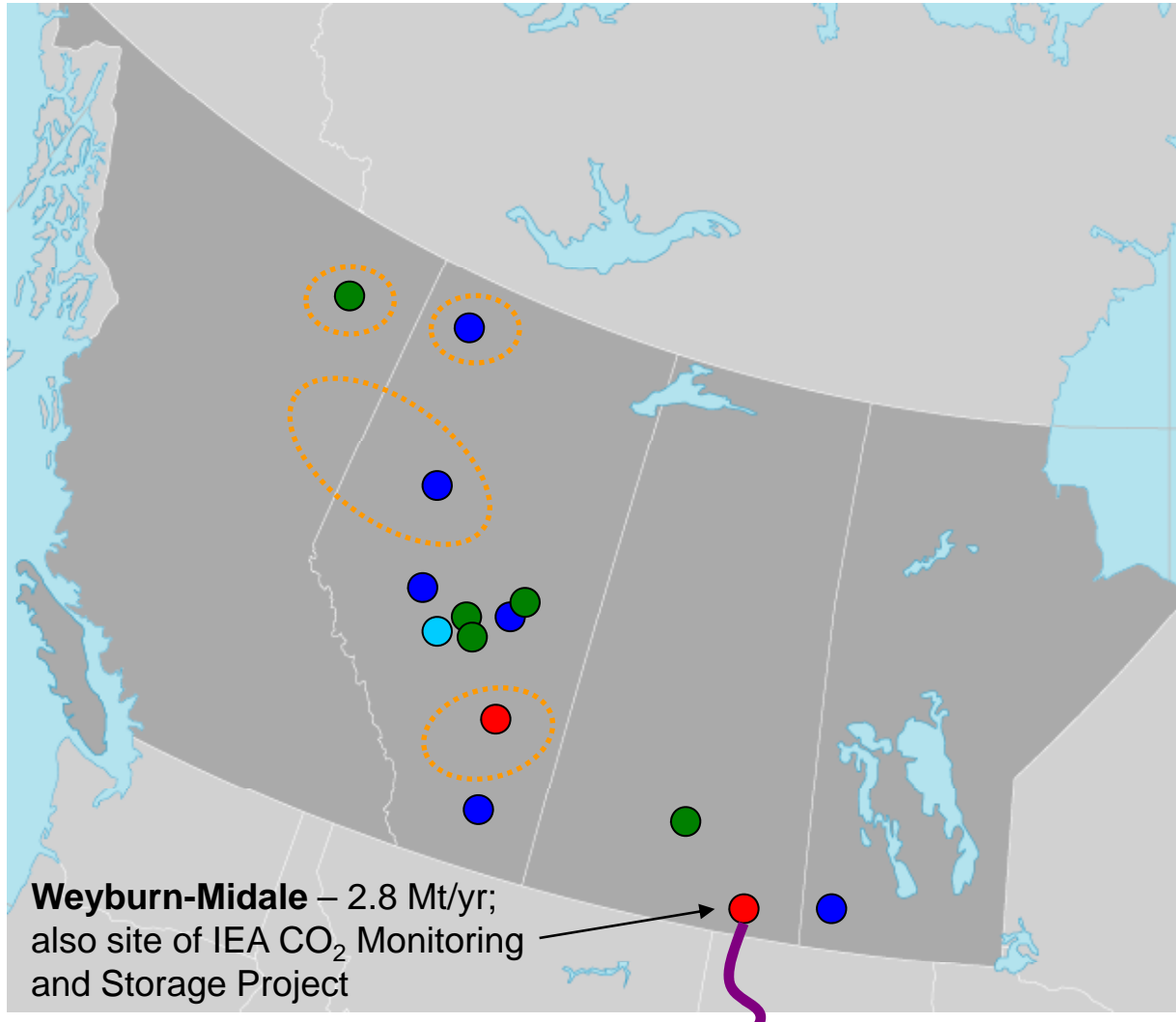
Federal GHG Targets and Measures

- ❑ Committed to 17% reduction below 2005 by 2020 and 60-70% by 2050 (aligned with U.S.)
- ❑ Committed to achieve 90% of electricity from non-emitting sources by 2020, which include fossil energy-based plants with CCS
- ❑ Regulation to be introduced in 2011:
 - *New coal-fired plants built after 2015 and units that have reached the end of their economic life must meet emission performance standard equivalent to Natural Gas Combined Cycle (NGCC) technology (performance of average coal-fired plant capturing 70% of its CO₂ emissions)*
 - CCS-ready coal plants to be exempted until 2025

Canada has a natural CCS advantage...



...and has already considerable experience with CO₂ injection and storage



- **Commercial Enhanced Oil Recovery (EOR) using CO₂**
- **Commercial acid gas injection from natural gas processing** – 50+ operations, 1 Mt/yr of CO₂ total
- **Pilot EOR** – injecting CO₂
- **Deep Saline Aquifer Storage** pilot projects – early stages; some initial test wells
- **Pilot Enhanced Coalbed Methane (ECBM)** – completed
- **CO₂ Pipeline**



...but there are numerous challenges to CCS implementation

- Costs
- Not yet commercially viable as an integrated system
- Few large-scale demonstrations exist
- Lack of infrastructure
- Regulatory frameworks not yet in place
- Public acceptance
- Time pressures: need to build new generating facilities and replace old ones

CCS Policy in Canada: an Overview

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

**Research and
Development
(R&D)**

**Demonstration
Projects**

**National / International
Collaboration**

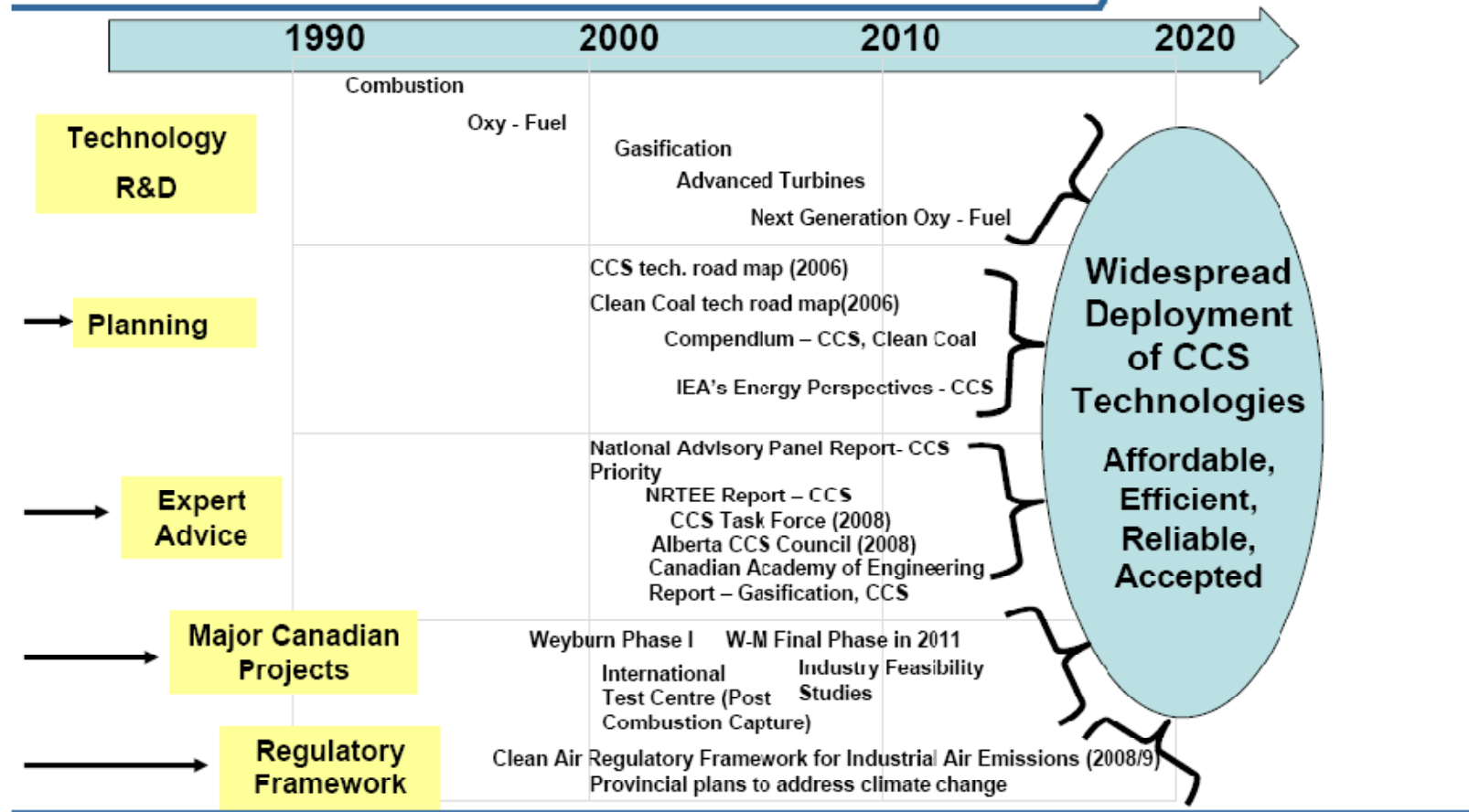
- R&D
- Knowledge Sharing
- Public Outreach

**Legislation and
Regulation**

CCS Timeline 1990-2020

Towards an Integrated Package

(What's needed to implement a new technology)



Research and Development in Clean Coal and CCS

Federal Government

- CanmetENERGY (Natural Resources Canada)
- IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project (2000-2011)
- North American Carbon Storage Atlas Project (Canada, U.S. and Mexico)

Universities

- International Test Centre - University of Regina
- International Performance Assessment Centre for Geologic Storage of Carbon Dioxide – University of Regina
- University of Calgary
- Other Western Canadian universities
- CCS Consortium – Dalhousie University
- INRS – University of Quebec (QC)

Research Institutes

- Alberta Innovates



Front-End Engineering and Design (FEED) Studies and Pilot Projects

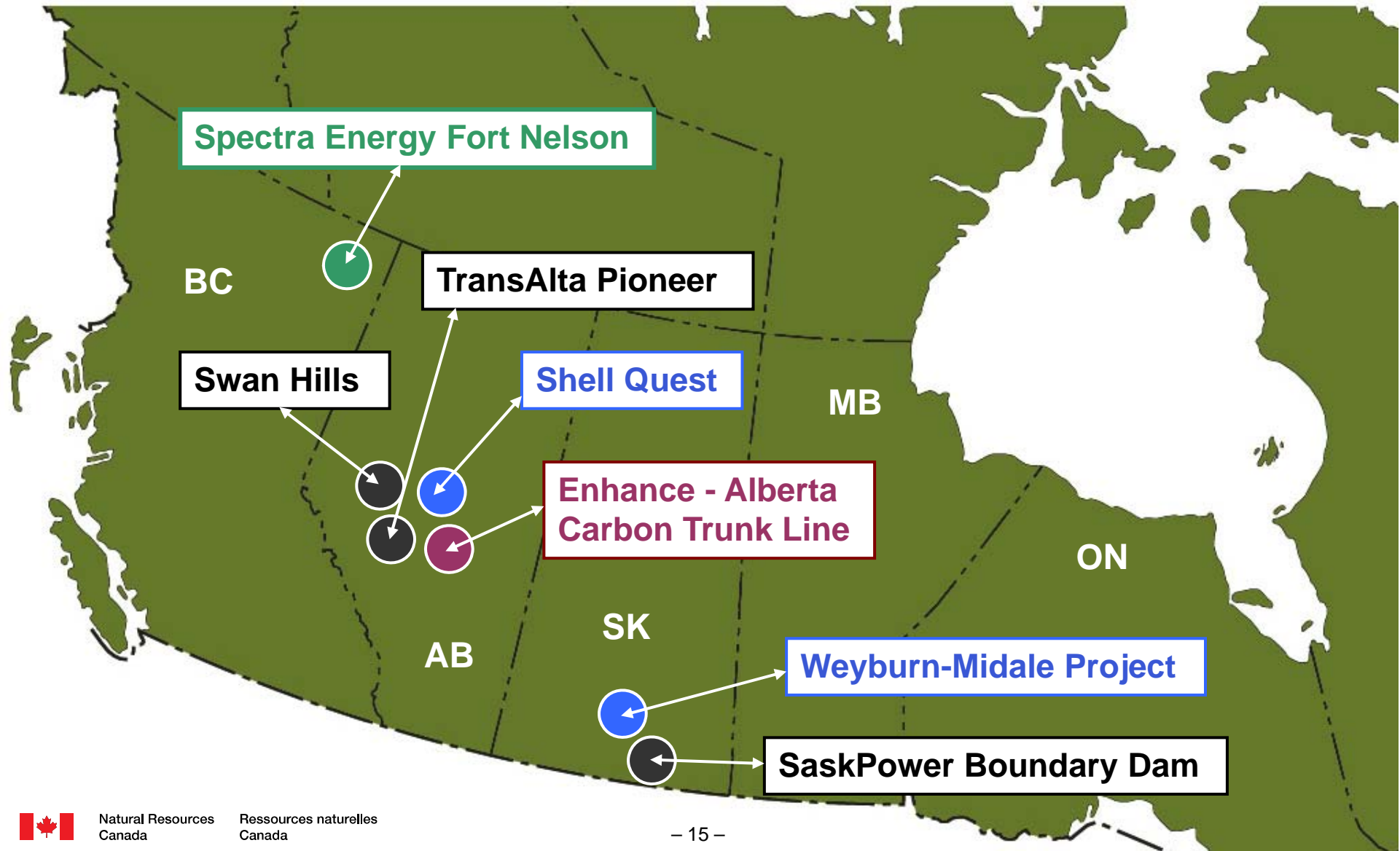
(project cost range \$33-68 million)

- ❑ **ARC Resources – Heartland Area Sequestration Project (HARP)**
 - Project to demonstrate feasibility of safe storage of CO₂ from industrial plants in saline formations
- ❑ **Enbridge – Alberta Saline Aquifer Project (ASAP)**
 - Project to demonstrate technical feasibility of injecting large volumes of sour CO₂ into deep saline formations
- ❑ **Husky Oil (Heavy Oil CO₂ – EOR Project)**
 - Assessment of heavy oil CO₂-EOR potential in Lloydminster area
- ❑ **PTRC – Aqstore Project**
 - Project involves capturing CO₂ from refinery and injection it into nearby deep saline formation
- ❑ **Capital Power Corp**
 - **Completed.** FEED study of 400-MW IGCC coal-based power plant at Genesee, Alberta
- ❑ **Wabamun Area CO₂ Sequestration Project (WASP)**
 - **Completed.** Comprehensive characterization of large-scale CO₂ storage opportunities and analysis of potential risks

Large (> 1 Mt / yr) Integrated Demonstration Projects

⇒ \$7 billion total investments

⇒ >\$3 billion in public funding



TransAlta Project Pioneer

Retrofit of TransAlta Keephills-3 supercritical coal-fired power plant (central Alberta)

- Base plant (450 MW) under construction; will come online in 2012
- Pioneer project comprises retrofit with Alstom's Chilled Ammonia post-combustion CO₂ capture technology
- Will capture 1 million tonnes annually, starting 2015
- CO₂ to be used for EOR or to be stored 2,800 metres into a deep saline formation, also
- Total project cost over CAD \$1 billion; federal and provincial government support: CAD \$778.8 million



SaskPower Boundary Dam Project

Launched in March 2008 by SaskPower

- One of the world's first and largest (140 MW) integrated CCS demonstration projects at a lignite-fired power plant (located near Estevan, Saskatchewan)
- Re-build of existing unit: boiler and turbine upgrades, integration of FGD and CO₂ capture
- SNC Lavalin – Cansolv (Shell subsidiary) to provide the CO₂ capture system (amine-based)
- Will capture 1 Mt of CO₂ annually starting 2015
- CO₂ to be used for enhanced oil recovery
- Total project cost CAD \$1.4 billion; federal support: CAD \$240 million



Swan Hills Synfuels Project

Underground coal gasification (UCG) project in Alberta to provide clean syngas for power plant

- Unique combination of technologies:
 - Very deep underground coal gasification (1400 m)
 - Coal gas to be processed in conventional gas plant with CO₂ removal to produce clean, low-carbon syngas
 - Syngas pipelined to 300-MW combined-cycle power plant
 - Project start-up in 2015
- Will capture 1.4 Mt of CO₂ annually
- CO₂ to be used for EOR or stored in coal seams depleted by UCG
- Total project cost CAD \$1.5 billion; provincial support: CAD \$285 million



Shell Quest 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 steam methane units, which produce hydrogen to upgrade bitumen to synthetic crude oil
- Will capture 1.1 million tonnes annually, starting in 2015
- CO₂ to be stored in a deep saline formation
- Two injection wells in test phase
- Total project cost CAD \$1.35 billion; federal and provincial government support: CAD \$865 million

Weyburn-Midale Project

Commercial CO₂-Enhanced Oil Recovery (EOR) Operations IEA GHG Weyburn-Midale CO₂ Monitoring and Storage project

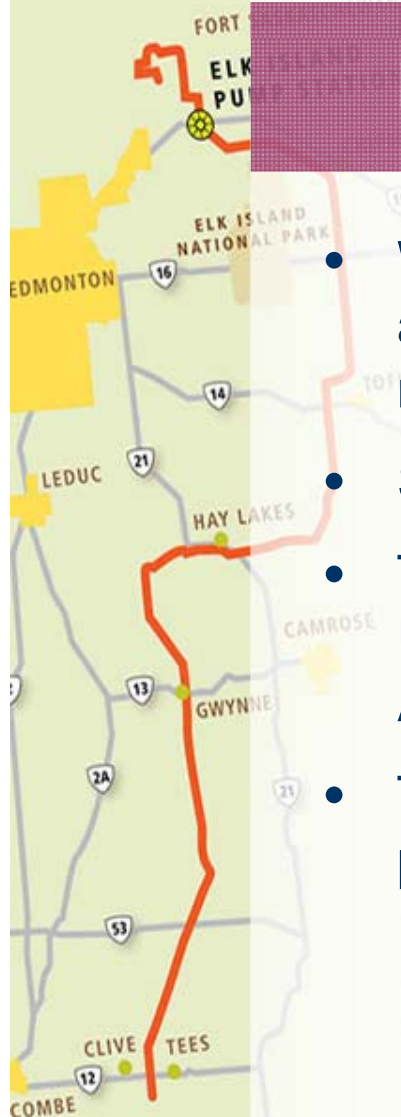
1. Enhanced oil recovery (EOR) operations, injecting CO₂ to produce more oil from depleting oil reservoirs in Saskatchewan:
 - Cenovus: 6500 t/d or 2.4 Mt/yr (stored to date: 15 Mt)
 - Apache: 1250 t/d or 0.5 Mt/yr (stored to date: 1.9 Mt)
 - Commercial operations, no government support
2. IEA GHG Weyburn-Midale Project – world's largest research project to examine long-term storage of CO₂ in depleting oil fields
 - Key deliverable: Best Practices Manual (Sep 2011)
 - Will provide protocols for the development, implementation and operation of storage projects in oil fields and other formations
 - Direct public support: \$34 million; private sector support: \$7 million



Enhance Alberta Carbon Trunk Line

Project to construct 240 kilometre CO₂ pipeline

- Will employ safe, proven technology to gather, compress and transport to storage sites up to 1.6 (Phase 1) 14.6 million tonnes of CO₂ annually
- Start-up in 2013
- The initial supply of CO₂ will come from North West Upgrading and Agrium (located northeast of Edmonton, AB)
- Total project cost over CAD \$1 billion; federal and provincial government support: CAD \$558.3 million





Spectra Energy Transmission *Fort Nelson CCS Project*



CCS at large natural gas processing plant

- Largest shale gas processing facility in region and largest acid gas (H₂S and CO₂) operation in North America
- Conventional, amine-based CO₂ separation technology
- Will capture 2.2 Mt of CO₂ annually, starting 2015
- CO₂ to be stored in a deep saline formation
- Feasibility study received CAD \$35 million in federal and provincial support



Public Engagement and Knowledge Sharing

□ Public engagement important component of CCS

- Need to acknowledge that the public does not fully understand CCS, so public engagement in CCS is crucial
- Goal is to gain public confidence in and acceptance of CCS
- Public engagement activities and development of national strategy underway
- Launch of national CCS website (www.CCS101.ca) essential first step in establishing access to CCS information (May 2010)

□ Importance of sharing knowledge widely recognized

- Natural Resources Canada creating knowledge-sharing framework for large CCS demonstration projects by end 2010
- Knowledge sharing also initiative under Canada - U.S. Clean Energy Dialogue (CED)
- Roundtables with industry held in 2008 and 2010
- Initiating collaboration with EU and GCCSI



Addressing Legal and Regulatory Issues

❑ Federal and provincial governments working to develop and refine their legal and regulatory frameworks

- Needed to enable commercial-scale CCS projects
- To address outstanding legal and regulatory gaps with shared responsibilities, e.g. MMV¹ requirements

❑ Provinces have a solid regulatory foundation for CCS

- Have jurisdiction over their natural resources, incl. subsurface, and thus have a leading role in regulating CCS projects
- Developing CCS regulations based on existing oil & gas regulations, which already adequately cover many CCS activities, incl. injection
- Most outstanding CCS legal/regulatory issues relate to pore space access/ownership and post-injection monitoring/long-term liability
- Alberta planning to announce CCS regulatory framework in near future; Saskatchewan reviewing situation

¹ MMV = Measurement, Monitoring and Verification



Canada Committed to Working with Domestic and International Partners on CCS

Federal – Provincial CCS Network

- Addresses CCS issues of common interest across Canada
- Public engagement and outreach
- Knowledge sharing
- Website: www.CCS101.ca

Clean Energy Dialogue (CED) with U.S.

- February 2009 agreement to work collaboratively on clean energy technology research, development and deployment, including CCS

Participating in / collaborating with:

- International Energy Agency (IEA)
- European Union
- Global CCS Institute (GCCSI)
- Carbon Sequestration Leadership Forum (CSLF)
- Asia Pacific Economic Cooperation (APEC)
- Asia Pacific Partnership on Clean Development and Climate (APP)
- U.S. Regional Carbon Sequestration Partnerships

Summary

- ❑ Energy production is a critical component of the Canadian economy
- ❑ CCS is of great strategic importance to Canada: deploying CCS will be key to reach our GHG reduction objectives
- ❑ However, there are still many challenges associated with implementation of CCS
- ❑ Both levels of government – federal and provincial – are collaborating to address these challenges through:
 - CCS research, development and demonstrations
 - implementation of CCS policies and regulations
 - public engagement and outreach
 - knowledge sharing
- ❑ Over \$3 billion in public funding allocated to CCS by federal, Alberta, Saskatchewan and British Columbia governments
- ❑ Canada is engaging internationally and among the world leaders in CCS



Thank You for Your Attention!

Dr. Frank Mourits
Natural Resources Canada
fmourits@nrcan.gc.ca
+1- 613-947-3482



Natural Resources
Canada

Ressources naturelles
Canada