Canadian Context

- Very large energy user and per capita GHGs.
- Signed on to Kyoto, did virtually nothing.
- Conservative government pulled out in Dec., 2011: Wished to “harmonize” with the U.S.
- Jurisdictional (provincial-federal) problems.
- Aspirations to be an “Energy superpower”.
- Pipeline proposals from Alberta.
- CCS seen as the major strategy by the Alberta and Canadian governments.
- Will miss all targets by a wide margin, despite effects of climate change: polar ice melt, fires, ice storm, floods, pine beetle.
Canada’s Greenhouse Gas Emissions

Figure S1: Canadian Emissions in 1990–2011

- Missed Kyoto target
- Business as usual
- 2050-target range

Canada’s Greenhouse Gas Emissions
“Wells-to-wheels” CO$_2$ emissions

Kg CO$_2e$ emitted for every bbl of crude oil produced (extraction, processing, distribution and combustion).

Full-life cycle, well-to-wheels, including combustion.

Source: Cambridge Energy Research Associates, 2009
Blue shows saline aquifers in Canada and the US.
Pipeline Proposals

- Keystone XL ↓ 830,000 bbls/day
- Northern Gateway ← 550,000 bbls/day
- Kinder Morgan (Trans Mountain) ← additional 590,000 bbls/day
- Eastern Energy → (Mackenzie) ↑ 1,100,000 bbls/day

3,070,000 bbls/day
IEAGHG Weyburn Project

History: Launched in 2000 and ran to late 2011; stored ~8000 t/day of CO$_2$ transported 330 km from Beulah, North Dakota

Company: Cenovus (formerly Pan Canadian, EnCana)

Usage: CO$_2$ used for enhanced oil recovery (EOR) in Weyburn and Midale reservoirs

In 2008 it was the world’s largest CCS project. Generated considerable data on site characterization, wellbore integrity, monitoring and verification

2011 leakage claims proven false.

Overall capacity: 20 Mt CO$_2$
Quest Project

Companies: Shell, Chevron, Marathon Oil
Location: Fort Saskatchewan, Alberta
CO$_2$ Source: Oil Sands Bitumen Upgrader
Capacity: 1.2 Mt CO$_2$/year
Capture process: Amine solvents
Storage: Deep saline aquifer
Public funding: $745M Alberta, $120M Cdn gov’t
Total cost: $1.33B (includes 10 yrs of operation)
Expected start date: 2015
Alberta Carbon Trunk Line

Company: Enhance Energy
Location: Northern Alberta
Description: 240 km pipeline to gather, compress and transport CO$_2$ from industrial area in North Alberta to Lacombe area where it will be injected for EOR (enhanced oil recovery)
Capacity: 14.6 Mt CO$_2$/year (called the world’s largest CCS project)
Public funding: $495M Alberta, $63M Cdn Gov’t
Boundary Dam, Saskatchewan

Company: SaskPower (utility)
Location: Coal (lignite)-fired power plant near Estevan, Saskatchewan
Funding: $1.3B with $240M from Cdn Gov’t
Capacity: 1 Mt CO$_2$/year to be used for EOR
Also building $60M facility for testing capture technologies
Cancelled Projects

**Project Pioneer**: Despite $436M from Alberta & $342M from Ottawa, cancelled in April 2012. Due to economics: willing to pay $15/t penalty. TransAlta coal-fired power station. Issued a statement saying “We still believe there is a future for CCS.”

**Swan Hills**: Cancelled in February 2013 despite $285M from Alberta. Was to have captured and used CO$_2$ for EOR from Coal-to-Syngas plant north of Edmonton. Blamed low price of natural gas.