# Clean Coal: A Compendium of Canada's Participation

**Dubravka Bulut**

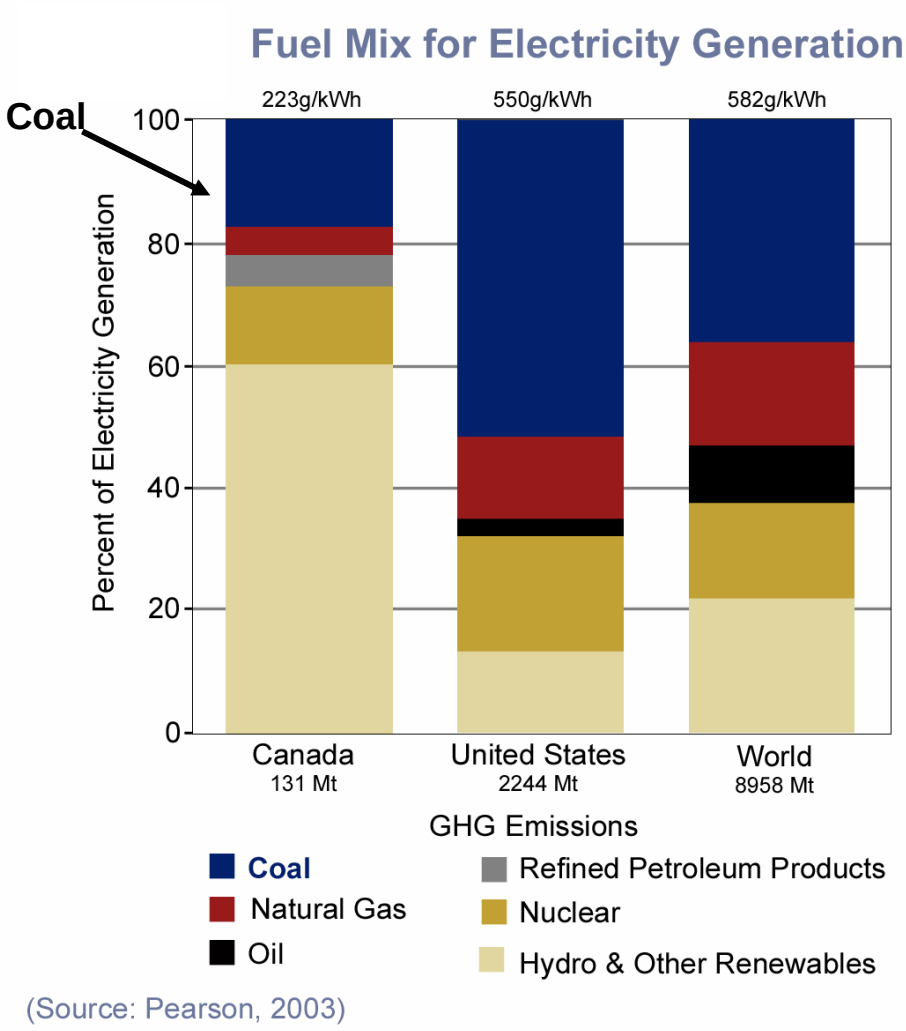
**Office of Energy Research and Development**
**Natural Resources Canada**

**15-17 May, 2007**
**Sardinia, Italy**

# Outline of Presentation

- The Role of Coal in Present and Future Energy Mix
- Key Coal Challenges, Opportunities and Drivers
- Clean Coal: A Compendium of Canada's Participation
- Clean Coal Compendium Summary

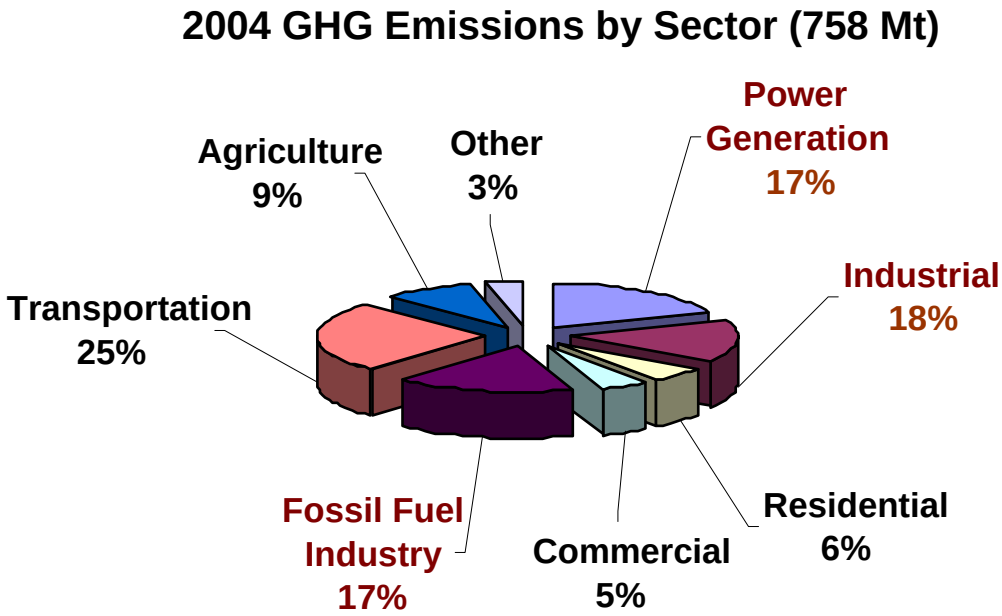
# Comparing Fuel Mixes – Canada, World




(Source: Pearson, 2003)

- Canada's GHG emission intensity for electricity generation is very low relative to the rest of the world, primarily because of abundant hydroelectricity
- Forecasts show a significant increase in the use of fossil fuels for new generation in Canada

# Three Sectors Account for 50%+ of Canada's Share of GHGs




- Power generation (17%), industrial end-use (18%), fossil fuel supply (17%) dominate Canada's GHG inventory
- Largely point sources
- Major challenge, and an opportunity for Clean Coal Technologies and $CO_2$ Capture and Storage

NRCan: Canada's Energy Outlook *The Reference Case 2006*

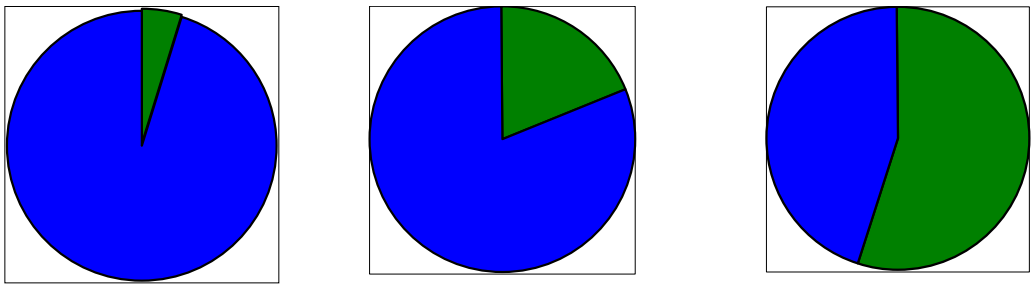
# Key Coal Challenges

- Emissions of concern?

| | |
|---|---|
| Acid gas emissions | NOx and SOx |
| Particulate emissions | Ash, unburnt carbon, fine condensates |
| Air toxic emissions | Mercury |
| GHG emissions | $CO_2$ (primarily) |

# Key Coal Opportunities

- About half of Canada's existing installed coal-fired capacity is over 25 years old




**By the year 2025:**

| | |
|---|---|
| **New Demand Capacity:** | **46GWe** |
| **Decommissioned Coal:** | **14GWe** |
| **Total New Capacity:** | **60GWe** |

Opportunity at hand for moving towards more efficient, lower-cost clean coal technologies with carbon capture and storage:

**Near-Zero Emission Fossil Fuels Technologies**

# Key Clean Coal Technologies Drivers
## New Regulatory Framework for Air Emissions

- **Outlines regulatory approach for both GHGs and (Criteria Air Contaminants) CACs from industry**

- **Sectors include:**
  - **Electricity from combustion**
  - **Forest products / pulp and paper**
  - **Iron and steel**
  - **Cement, lime**
  - **Oil and gas**
  - **Smelting and refining**
  - **Selected mining (titanium, others)**
  - **Chemicals (including fertilizer)**

- **GHG obligations – existing facility emission intensity based targets**
  - **6% annual Emissions Intensity (EI) reduction required for existing facilities for 2007, 08 and 09**
  - **2% annual EI reduction required for subsequent years**
  - **By 2010, 20% reduction in EI for combustion related GHG emissions**
  - **Compliance mechanism – Technology Investment Fund**
    - **2 components – (1) deployment and infrastructure and (2) R&D**
    - **Deployment and infrastructure contribution limit declines over 2010 to 2017**
    - **R&D limit of 5 MT per year**
    - **Compliance units @ $15/tonne for 2010**

- **CAC emissions reductions – absolute national caps on emissions by 2012/15**
  - **Compliance mechanisms**
  - **Domestic trading for $NO_x$ and $SO_x$**
  - **Will pursue discussions on Canada/US trading for both $NO_x$ and $SO_x$**

# Clean Coal Among NRCan's Top Energy S&T Priorities

**Clean Coal is high on our list of technology priorities**

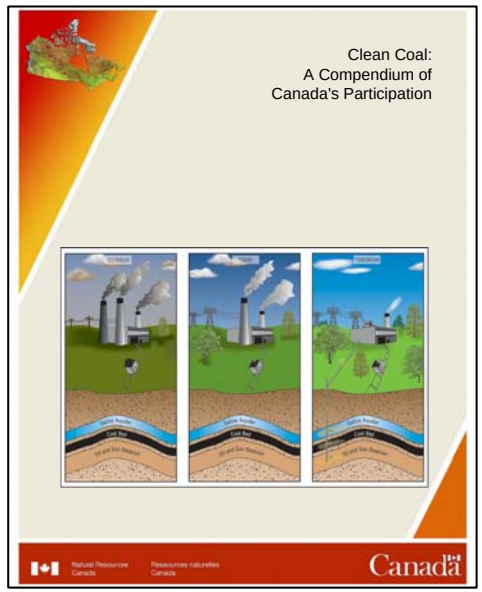
- **In addition to existing energy S&T funding, ecoENERGY Technology Initiative announced recently**
  - **Targeted investment of $230m/4year in research, development and demonstration of clean energy technologies**
  - **Key priorities identified, to be confirmed through consultation with industry, provinces**
    - **$CO_2$ Capture and Storage**
    - **Clean Coal**
    - **Bioenergy**
    - **Clean Oil Sands Production**
    - **Renewable energy, other clean energy sources**
    - **Advanced vehicles – pHEVs**
    - **Next generation nuclear**
  - **Action through projects based on public-private partnerships**
- **Additional program details at:**
  **http://www.ecoaction.gc.ca/ecoenergy-ecoenergie/index-eng.cfm**

# Clean Coal Compendium

- **Designed to bring us up to date on Clean Coal projects and parallel-running activities in Canada**

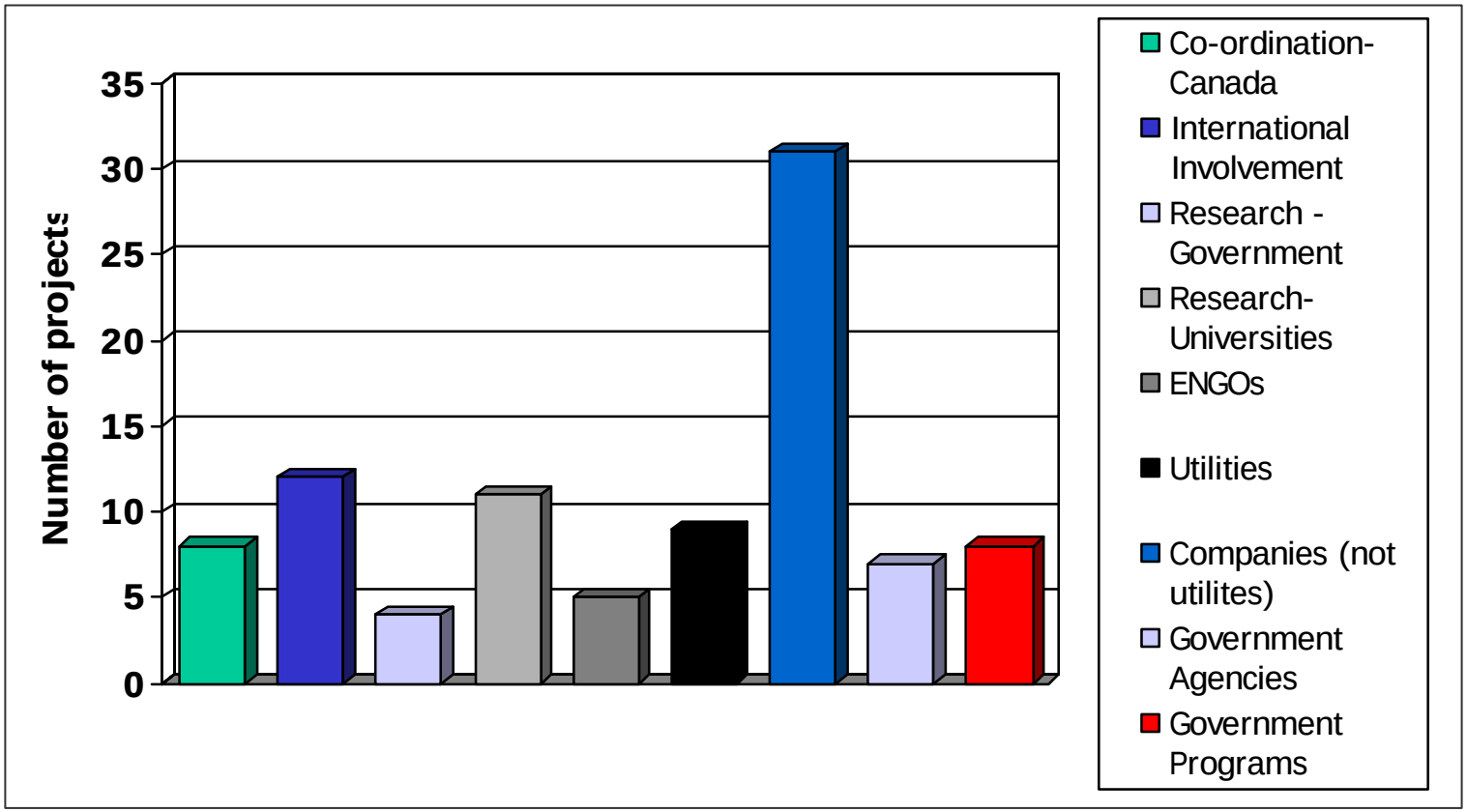
- **The Compendium is a broad compilation of current work and active participants, including not only scientific and engineering aspects, but also activities that address economics, implementation, public education and outreach, and regulation**

- **Four main components:**
  - A brief descriptions of the principal organizations engaged in CCT
  - A summaries of specific projects underway (as of early 2007) or recently completed (2004 or later)
  - A description of four documents that help define Canada's strategy of developing capacity in CCT
  - An overview of current coal-fired practice in Canada



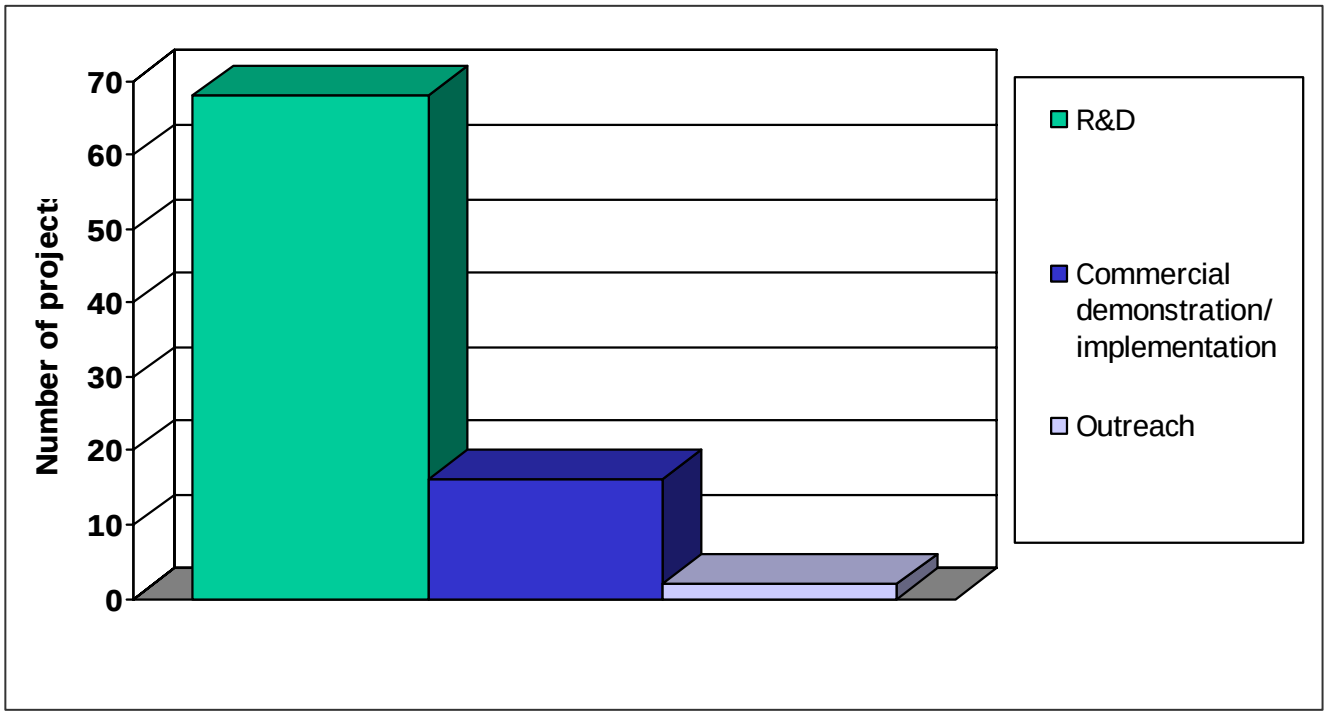
# Clean Coal Compendium - Highlights

**Figure 1: Distribution of 86 projects - 95 organizations involved in Clean Coal Technologies**



# Clean Coal Compendium - Highlights cont'd

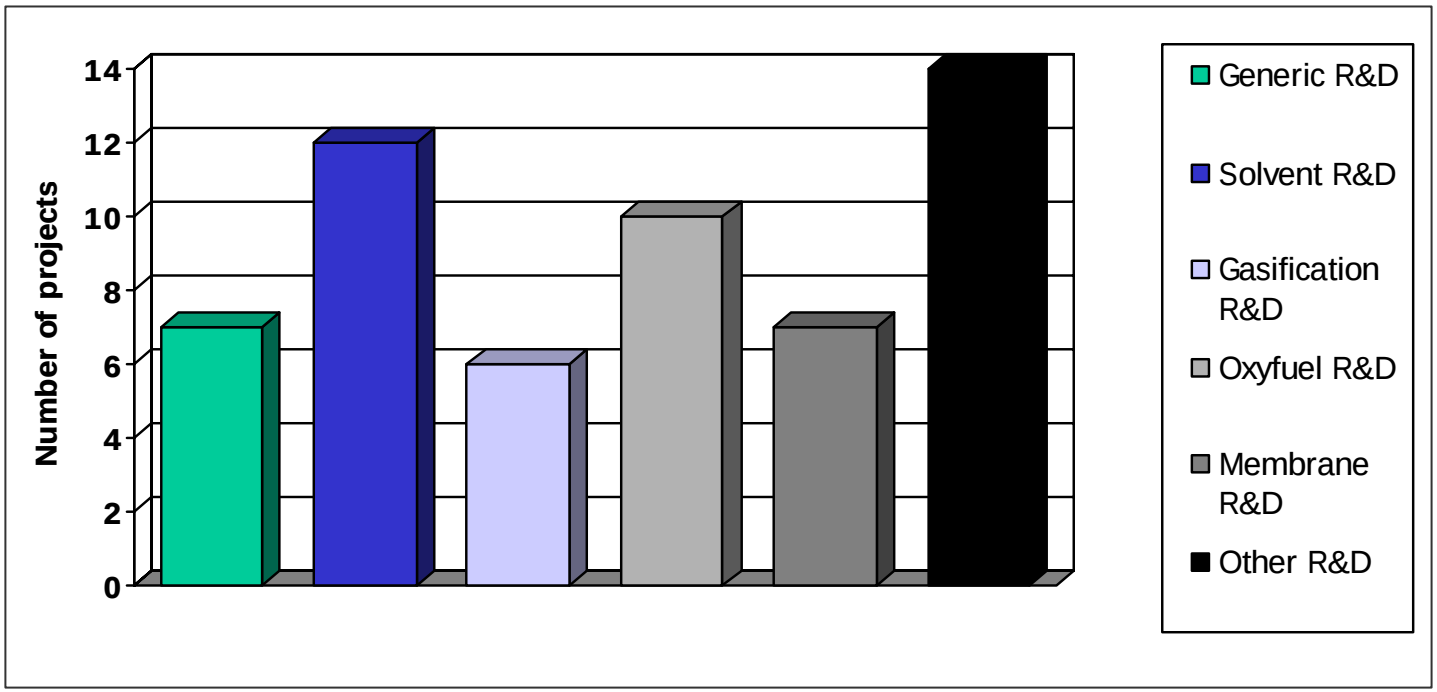
**Figure 2: Distribution of the 86 Clean Coal Technology related projects by the stage of innovation**




## R&D Activity Dominates, implementation Growing

# Clean Coal Compendium - Highlights cont'd

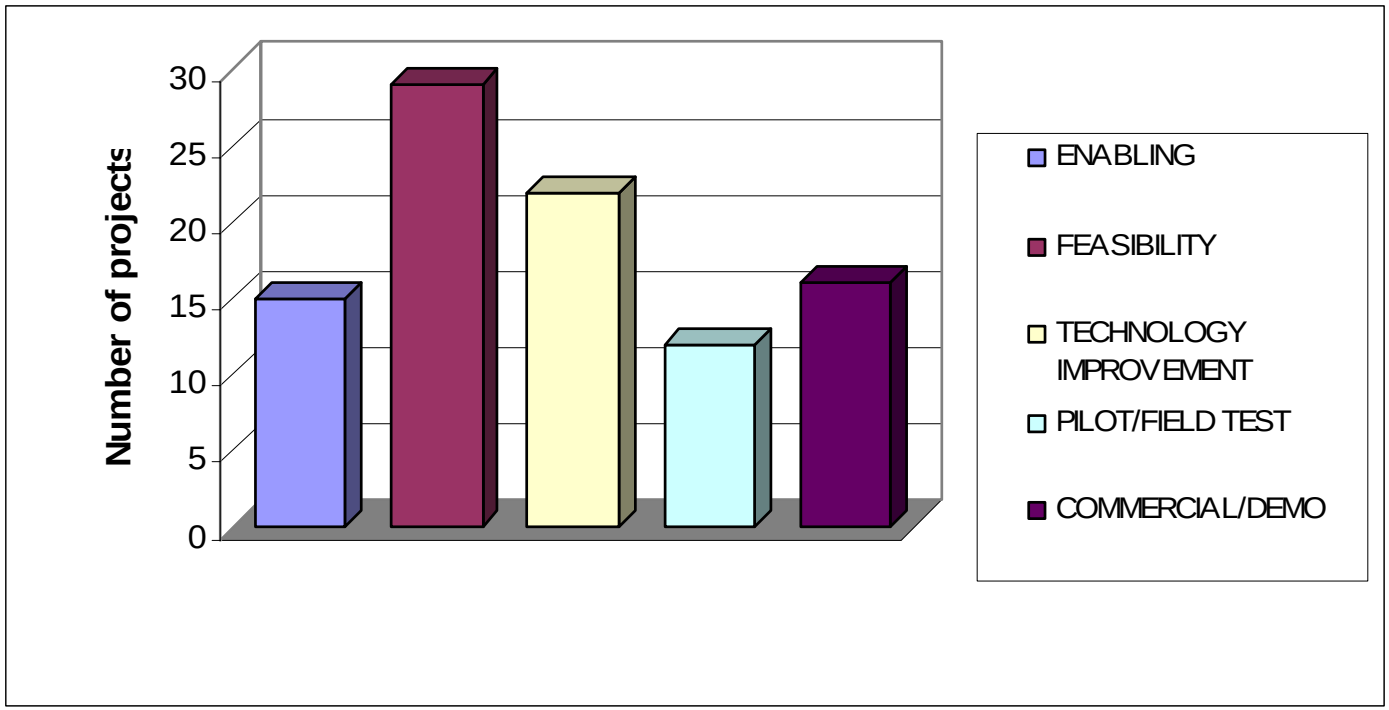
**Figure 3: 54 R&D projects with $CO_2$ capture as major element - distribution of technologies**




**Ongoing work on looking at innovative technologies for clean coal**

# Clean Coal Compendium - Highlights cont'd

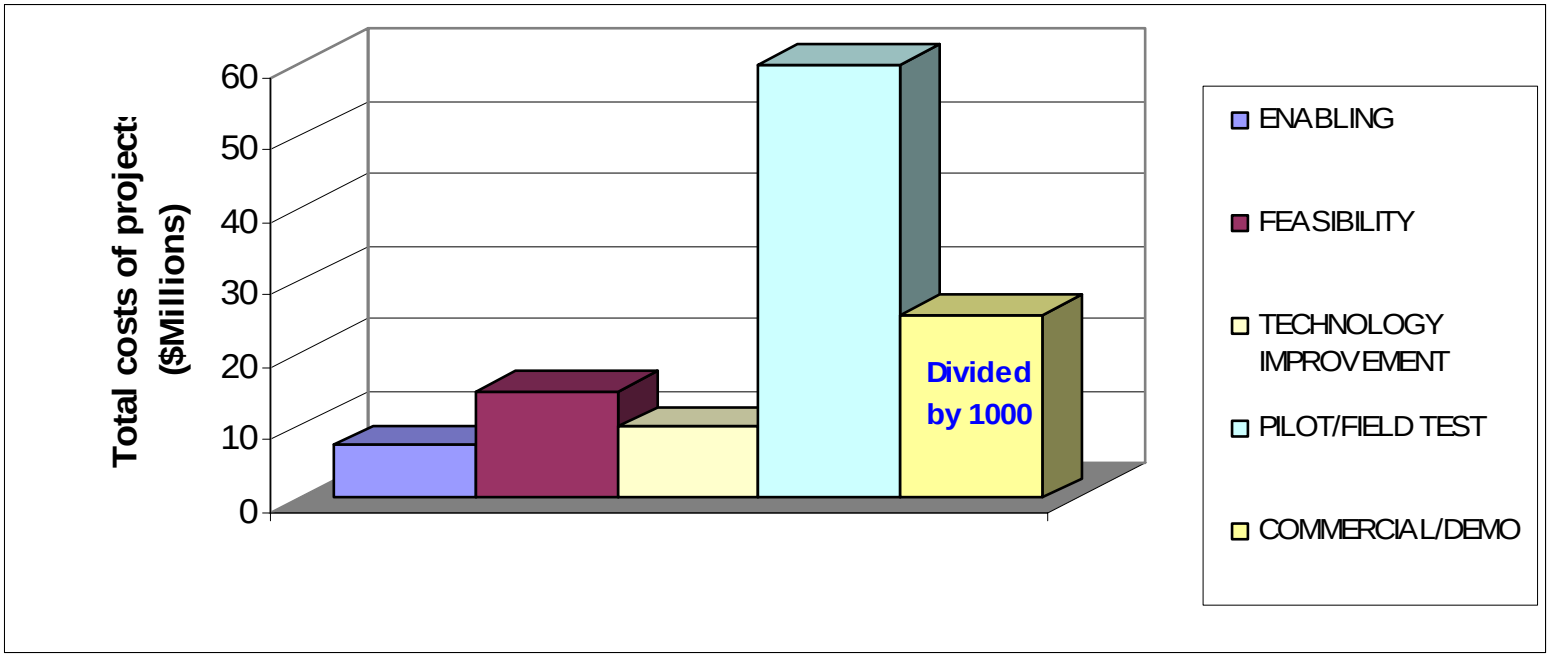
**Figure 4: Distribution of projects by category (position along technology development spectrum)**




**Types of Work Underway – Feasibility, Technology Improvement**

# Clean Coal Compendium - Highlights cont'd

**Figure 5: Comparing total costs of projects in specific categories**

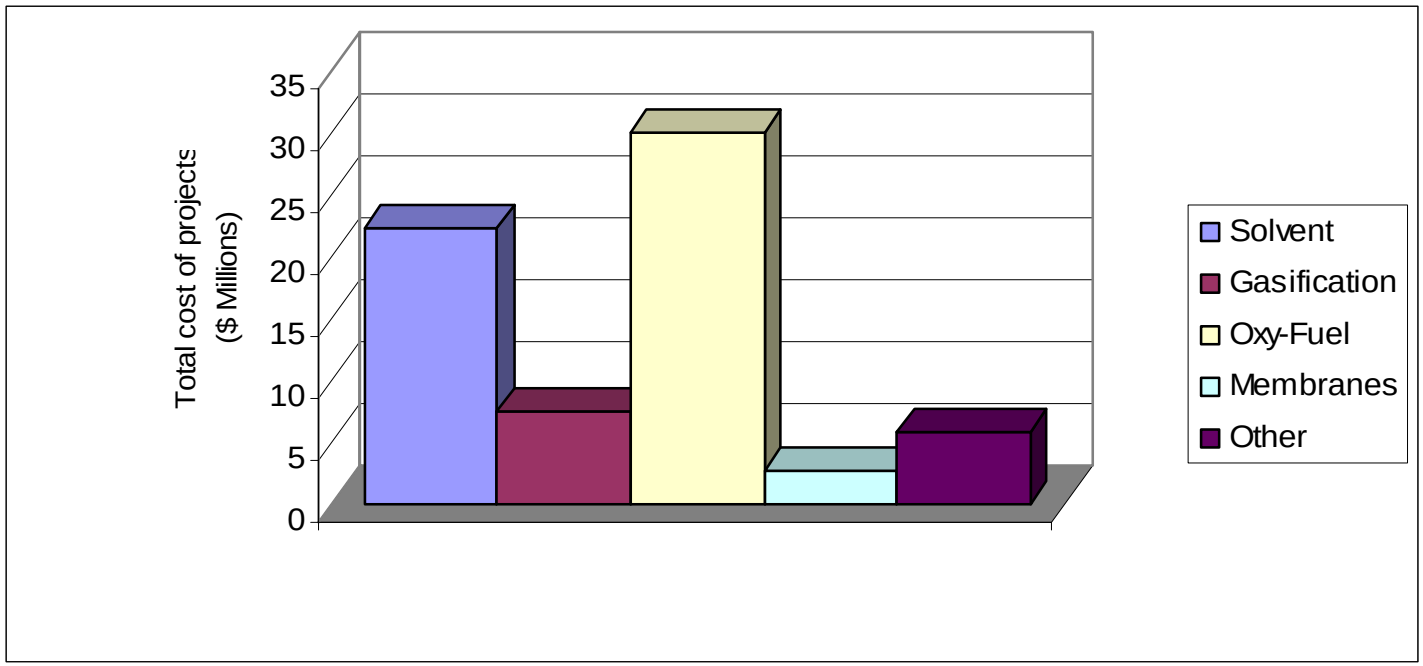



## Funding Across Activities- Commercial, Enabling, Field Testing

**The total cost of all projects other than the commercial/demo projects is approximately $92M**
**The total cost of all commercial/demo projects on the order of $25B**

# Clean Coal Compendium - Highlights cont'd

**Figure 6: Total costs of projects classified by $CO_2$ capture technology**




## Canadian expertise in two areas:

- advanced $CO_2$ separation technologies performed at International Test Centre for $CO_2$ Capture in Regina
- oxy-fuel combustion at the CANMET Energy Technology Centre in Ottawa

# Clean Coal Compendium
# Emerging Projects

**Many projects on the drawing boards, in progress**

- **Clean Coal with $CO_2$ Capture and Storage**
  - **EPCOR : Front End Engineering Design Study for a utility-scale (400 MW) coal gasification plant – announced 2006**
  - **SaskPower – Front End Engineering Design Study for a 300 MW oxyfuel plant – announced 2006**
  - **Sherritt Dodds Roundhill Plant – announced Jan 2007**
- **Clean Coal**
  - **TransAlta/EPCOR Keephills 3 Plant – announced Mar 2006**
- **$CO_2$ Capture**
  - **CanSolv Demo – announced Dec 2005**
  - **$CO_2$ Solutions Demo – announced Oct 2006**
- **Hydrocarbons**
  - **Suncor Voyageur Upgrader – announced Nov 2001**
  - **Nexen/Opti Long Lake Plant – announced Feb 2003**
  - **North West Upgrading Plant – announced Feb 2005**
  - **Peace River Bluesky Project – announced Dec 2005**

# Clean Coal Compendium - Summary

- Large number of commercial/demo projects on the drawing boards
- Many of the nearest term gasification-based plants will utilize by-product of oil sands processing and will be operated in a polygen mode
- The total cost of all commercial/demo projects on the order of $25B
- The total cost of all projects other than the commercial/demo projects is approximately $92M
- Ongoing work on looking at innovative technologies for clean coal

# Clean Coal Compendium – Next Steps

- It will enable all players in clean coal to be aware of the full range of activities in Canada, thereby serving as a basis for promoting collaboration and avoiding duplication
- Funding mechanisms can use the Compendium to identify potential gaps and priorities for additional work
- Regulators will be able to develop an understanding of the wide range of work underway to respond to the more restrictive standards anticipated