CO2 Storage Potential in Canada

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Natural Resources Canada
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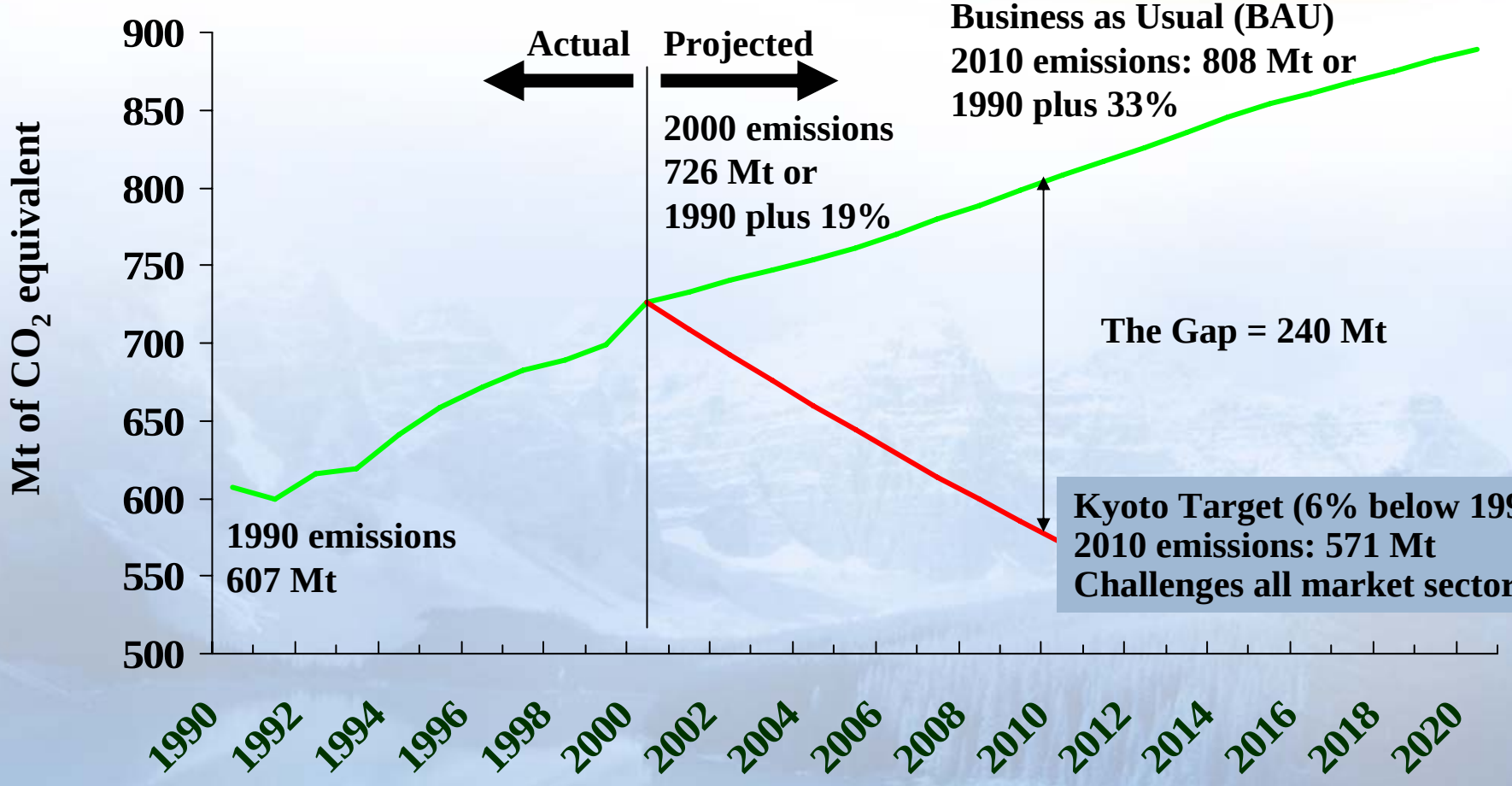
Canada

Outline

- CCS Overview
- CO_2 Capture and Storage
- Storage Issues
- CO2 Storage Capacity Estimates
- The Canadian Atlas for CO2 Storage Capacity

Canada's Climate Change Challenge - The Gap



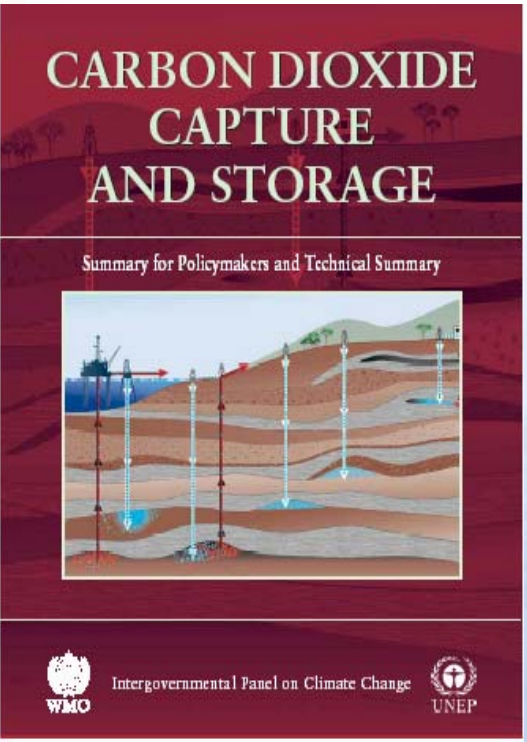
The Climate Change Challenge

GHG emission constraints require new approaches

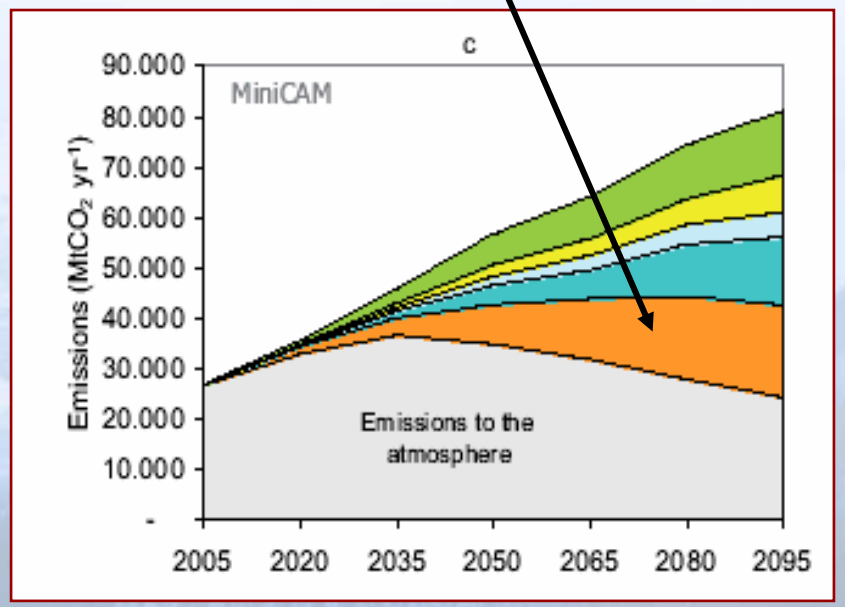
- Energy Efficiency
- Fuel Switching
- Carbon Management
  - Capture and storage – geological & ocean
  - Sequestration – ocean & biomass

Highlights:

- Carbon Capture and Storage (CCS) will plays a significant role in GHG mitigation.



- Conservation and Energy Efficiency
- Renewable Energy
- Nuclear
- Coal to Gas Substitution
- CCS



CCS Defined

What is CO_2 Capture & Storage (CCS)?

- Carbon dioxide capture and storage is a process for reducing GHG emissions into the atmosphere by first extracting CO_2 from gas streams typically emitted during electricity production, fuel processing and other industrial process.
- Once captured and compressed, the CO_2 is transported by pipeline or tanker to a storage site, often to be injected into an underground storage site (or geological formation), where it will be safely stored for the long-term.

CCS in Canada

CO_2 Capture & Storage in Canada

- CCS is important on a global scale because of the potential to disconnect the relationship between economic growth and global GHG emissions rates

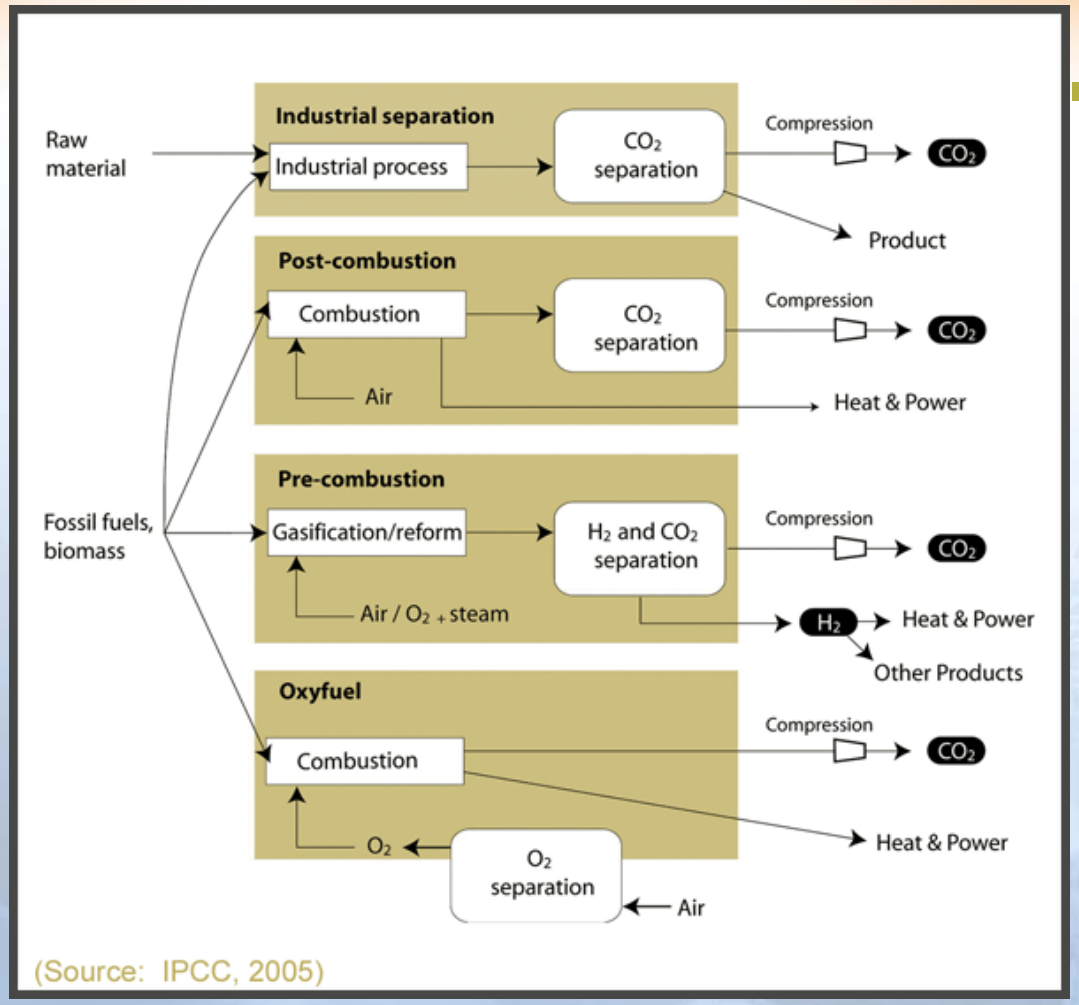
CCS matters domestically because Canada:

- Depends on its vast fossil fuel resources
- Is a top industrial producer and exporter of fossil fuels
- Has enormous CO_2 storage potential in a variety of regions across the country
- Has the potential to be a global leader in CCS knowledge and expertise

Leading CO_2 Capture Technologies

- Capture of CO_2 from flue gases:
  - Post-combustion capture
- Burning fuel in oxygen instead of air:
  - Oxy-combustion
- Conversion of fuel to H_2 (and CO_2) before combustion:
  - Pre-combustion capture
- Capture of CO_2 at non-combustion plants
  - Separation of CO_2 from natural gas
  - CO_2 capture from fermentation processes etc

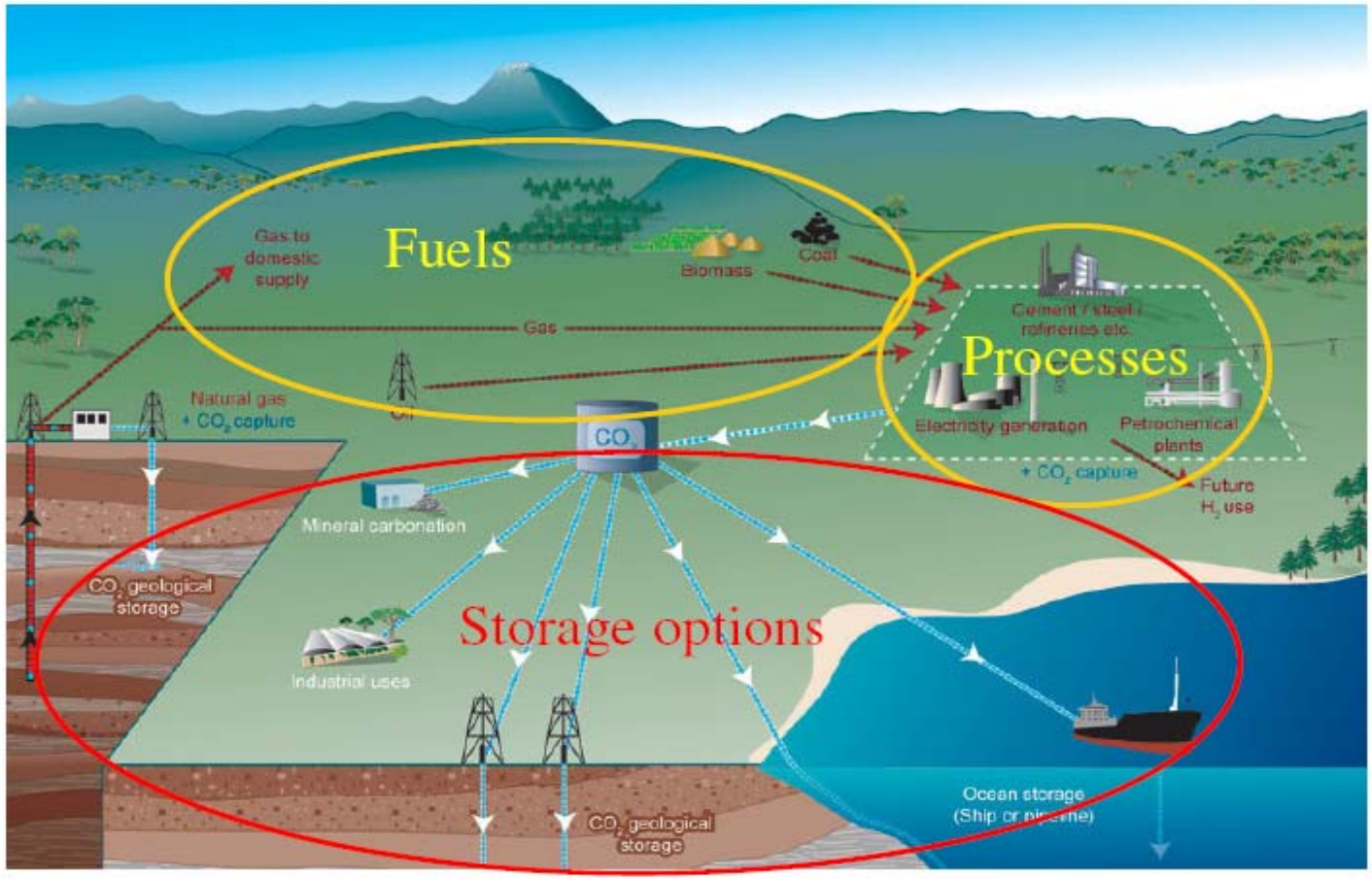
Capture Processes



(Source: IPCC, 2005)

- CO_2 capture systems are often classified under four types:
  - post-combustion
  - pre-combustion
  - oxy-fuel combustion
  - industrial processes

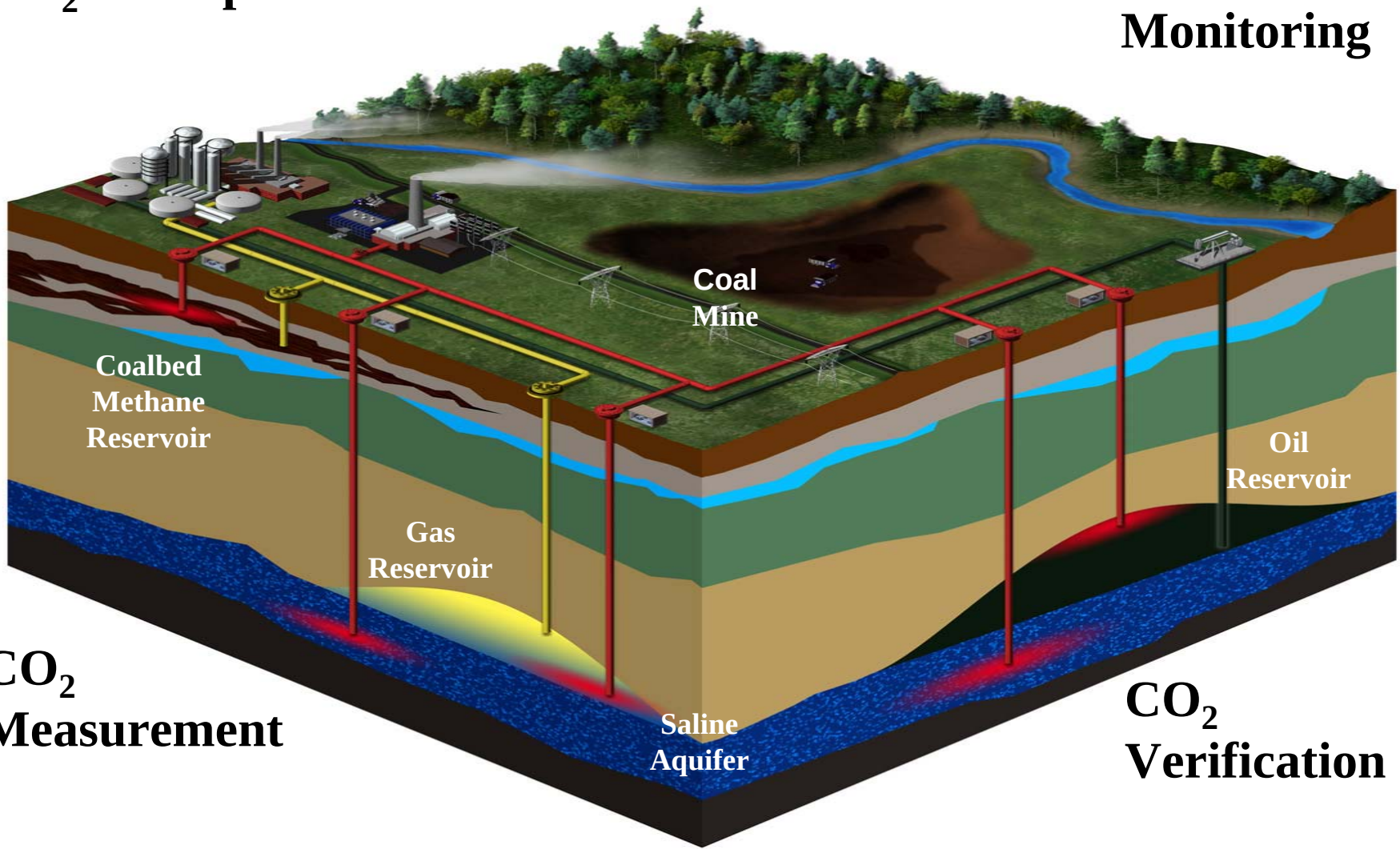
CO_2 capture and storage system



CO_2 Storage Options

CO_2 Transport

CO_2 Monitoring



CO_2 Measurement

CO_2 Verification

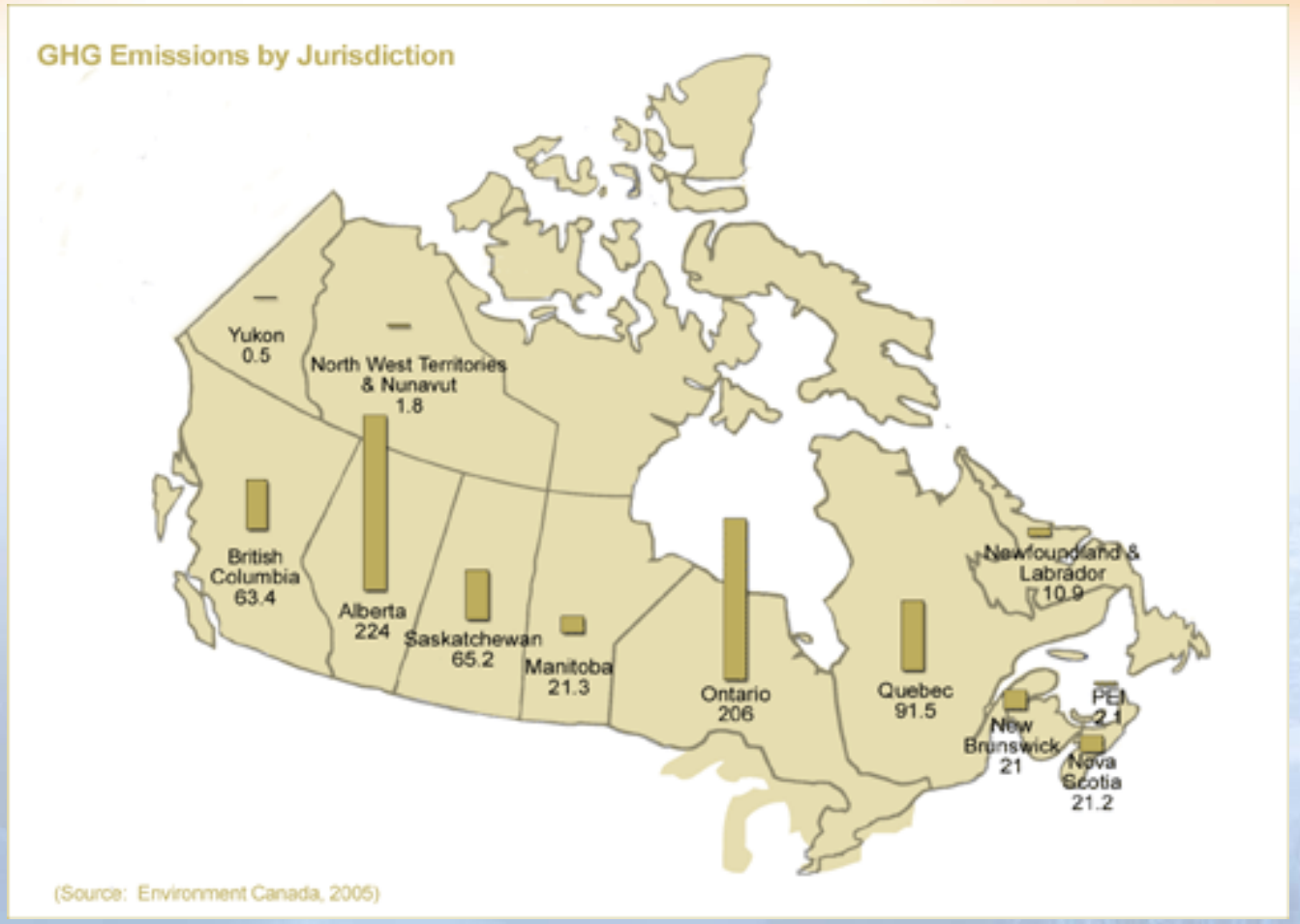
Storage Opportunities

- Enhanced Oil Recovery
- Enhanced Gas Recovery
- Enhanced Coalbed Methane Recovery
- Acid Gas Injection
- Gas over Bitumen
- Temporary Storage
- Depleted Oil and Gas Pools
- Deep Saline Aquifers

CCS

- Although storage is one of the last steps in the CCS process it is one of the first to be considered when developing a strategy to roll-out CCS infrastructure and systems.
- There is no benefit to capturing CO_2 unless it can be stored and thus the total storage capacity and its location is an important constraint on how much CO_2 can actually be managed.

Domestic Emissions

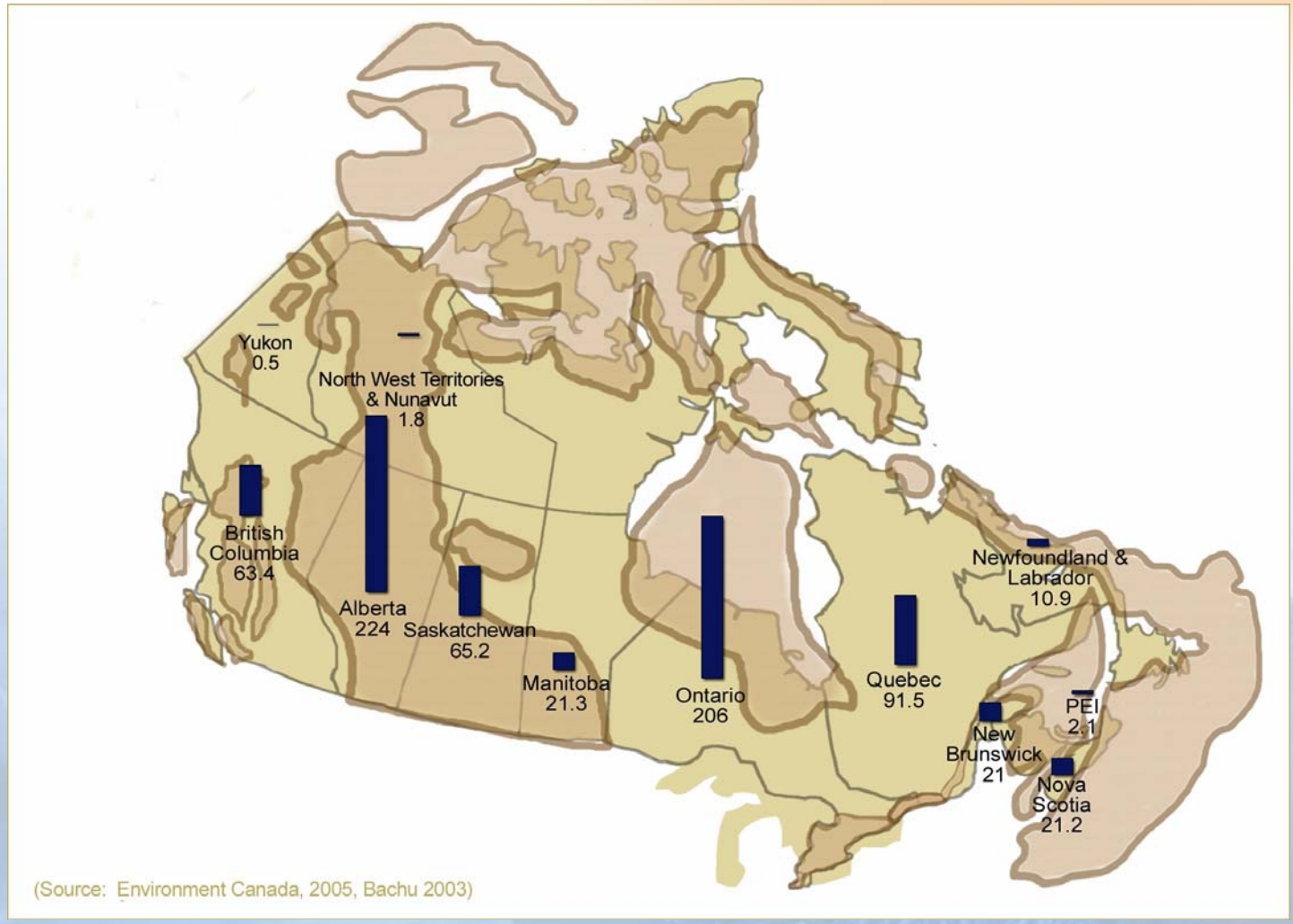


- CCS will contribute to Canada's emissions reduction efforts,
- Many large point sources of CO_2 are located near potential storage sites.

Sedimentary Basins

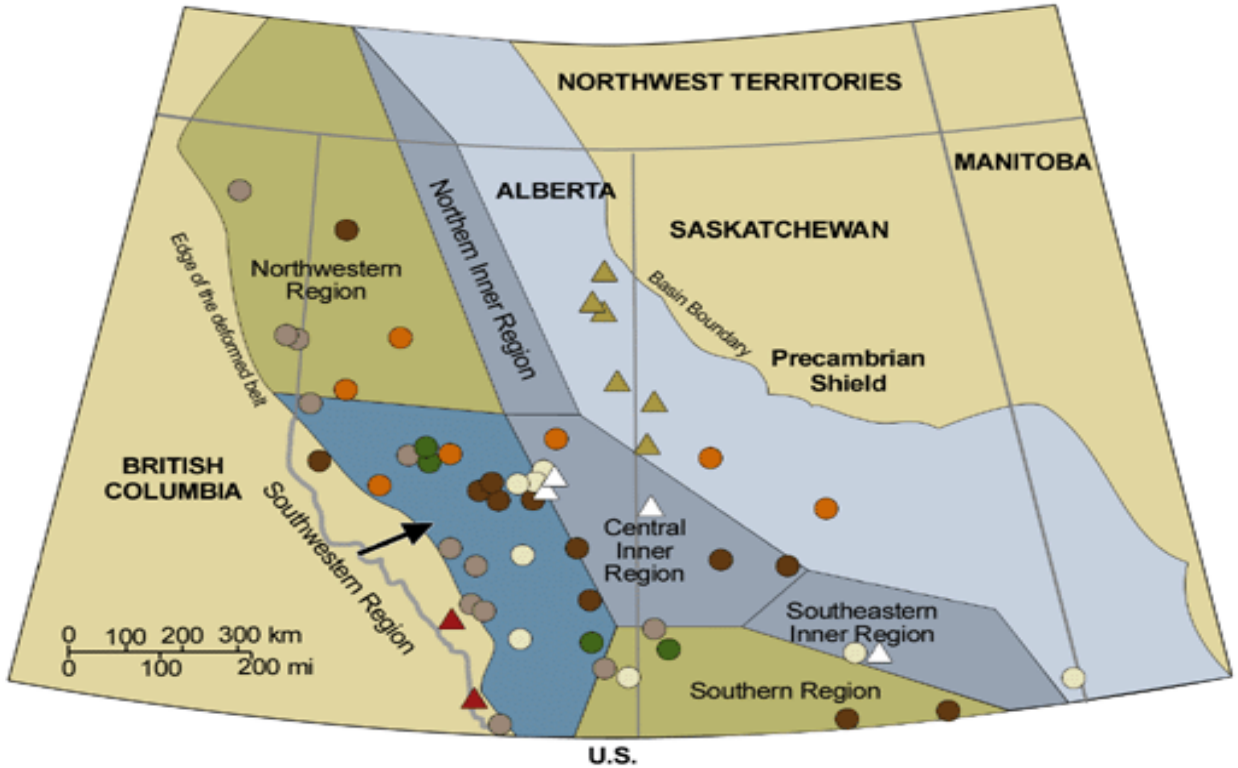
- Canada has 68 individual sedimentary basins
- Three local regions could be capturing nearly 3.4 MtCO2/yr today for storage
- The WCSB has 3,762 $MtCO_2$ of storage potential (in oil and gas reservoirs alone)
- A low-emissions Canadian fossil fuel industry is the ultimate goal, gaining ground in CCS R&D and deployment would be advantageous for the nation

Sources and Sinks



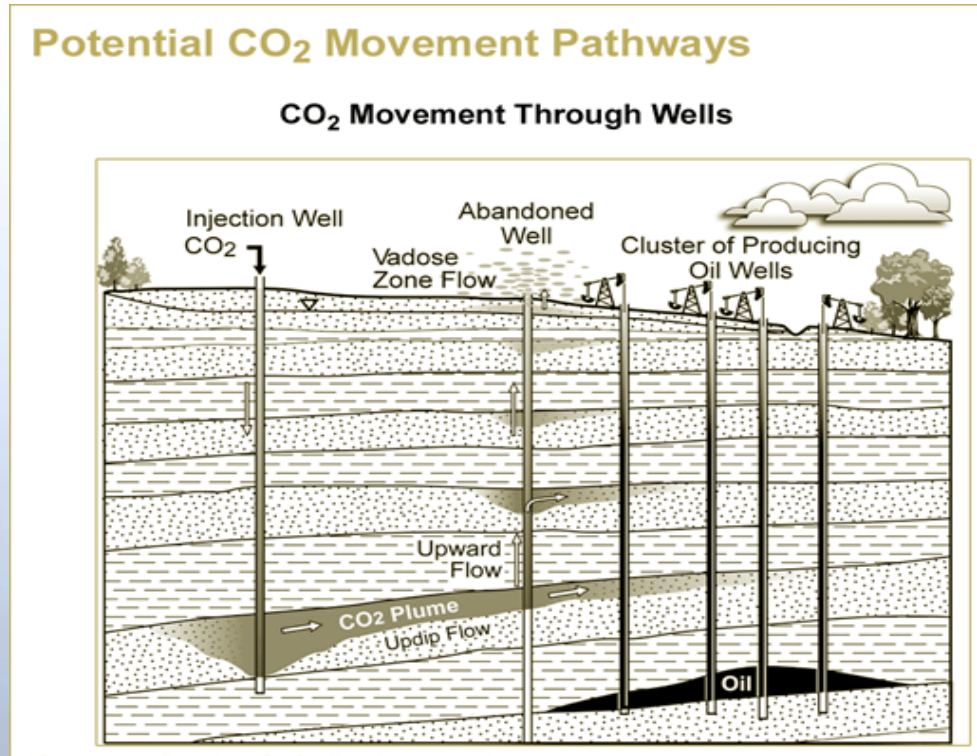
CCS Opportunities in Western Canada

Major CO_2 Sources in the Western Canada Sedimentary Basin



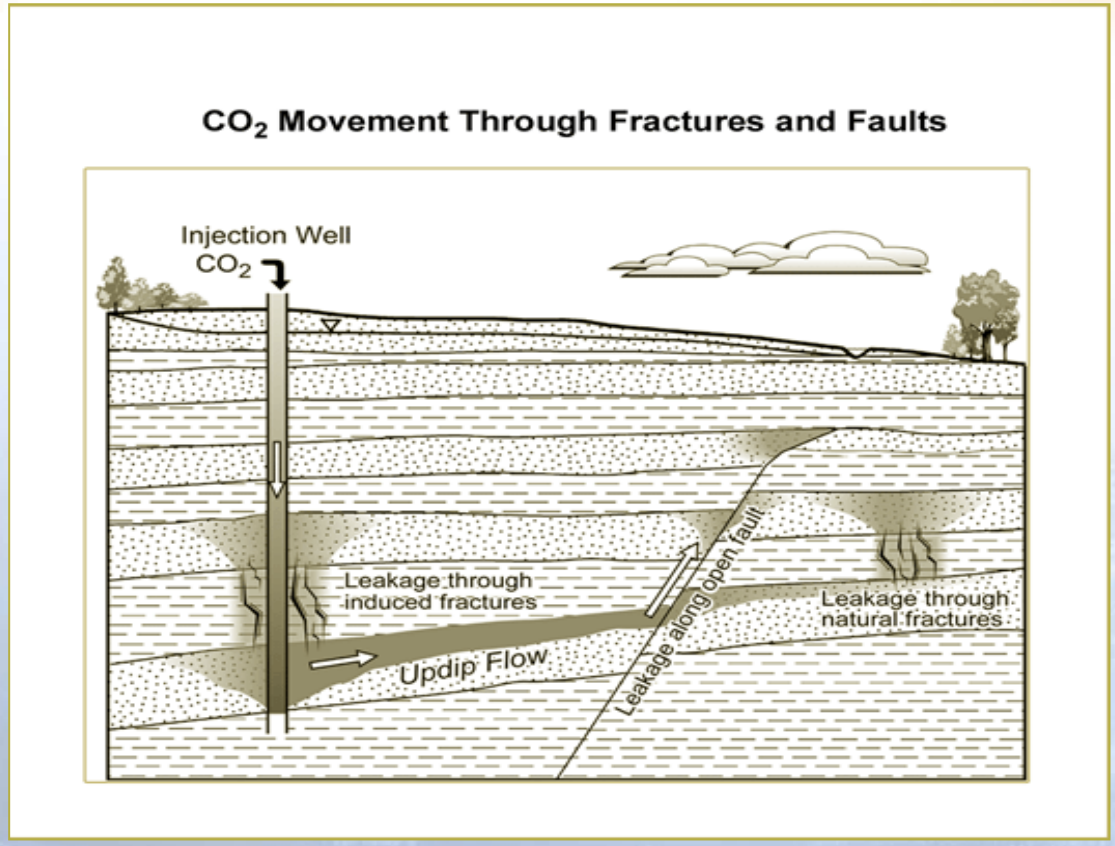
(Source: Bachu and Steward, 2002)

Potential Leakage Pathways



- It is important to recognize that a small amount of CO_2 may leak

Potential Leakage Pathways



- Storage monitoring programs and response plans are required
- Mitigation techniques well established

Mitigation and remediation

- Most of the knowledge in remediation for geological storage comes from experiences in underground gas storage
- Generally repairing or plugging the leaking wells is sufficient to eliminate the problem
- If the leaks are not related to well damage (i.e., they are caused by high storage pressures or an inadequate geological framework), the pressure in the storage aquifer or reservoir might have to be reduced
- The best mitigation actions are a well designed, monitored and operated project, and proper well abandonment techniques

Monitoring, Measurement and Verification

- Site specific monitoring programs designed to track the migration of CO_2 and assess trapping mechanisms
- Establish operational, verification and environmental monitoring levels based on risk/performance criteria
- Establish suite of monitoring technologies for each stage of monitoring (short and long term)
  - Direct and indirect monitoring tools; combination
  - Tools exist
- Response plan, mitigation measures to minimize the impacts and extent of leak
- Current focus of R&D, demonstration and commercial projects world wide in different geological settings (deep saline aquifers, different geological media, deep coal beds)

Site Selection Criteria

- Fundamental importance in minimizing leaks, along with proper management of site
- Much work is done ‘upfront’
- Include but not limited to
  - conducting detailed site characterization that encompasses an assessment of the geological characteristics of the storage reservoir and caprock, including the existence and characteristics of fractures and faults
  - understanding the hydrogeology, geochemistry and geomechanics at the site
  - assessing the volume and permeability of the storage formation
  - understanding the site's geological trapping mechanisms
  - an assessment of whether abandoned or active oil/gas wells will compromise the integrity of the seal

Monitoring Technologies

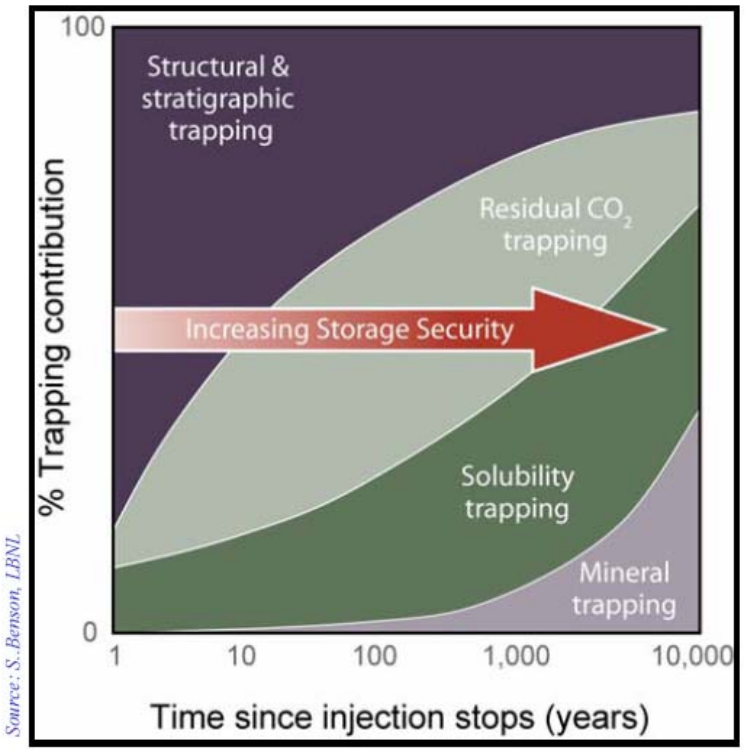
- Time lapse seismic
- Remote sensing
  - Techniques for measuring ground heave
  - Remote surface gas analysis
- Geochemical monitoring
  - Subsurface geochemistry
  - Surface and near surface geochemistry
- Non-seismic geophysical techniques
  - Electromagnetic surveys
  - Gravity techniques
- Vegetational surveys (hyperspectral imagery, etc)

- IPCC, 2005

Subsurface CO_2 Storage Mechanisms

Trapping Mechanisms Provide Increasing Storage Security with Time

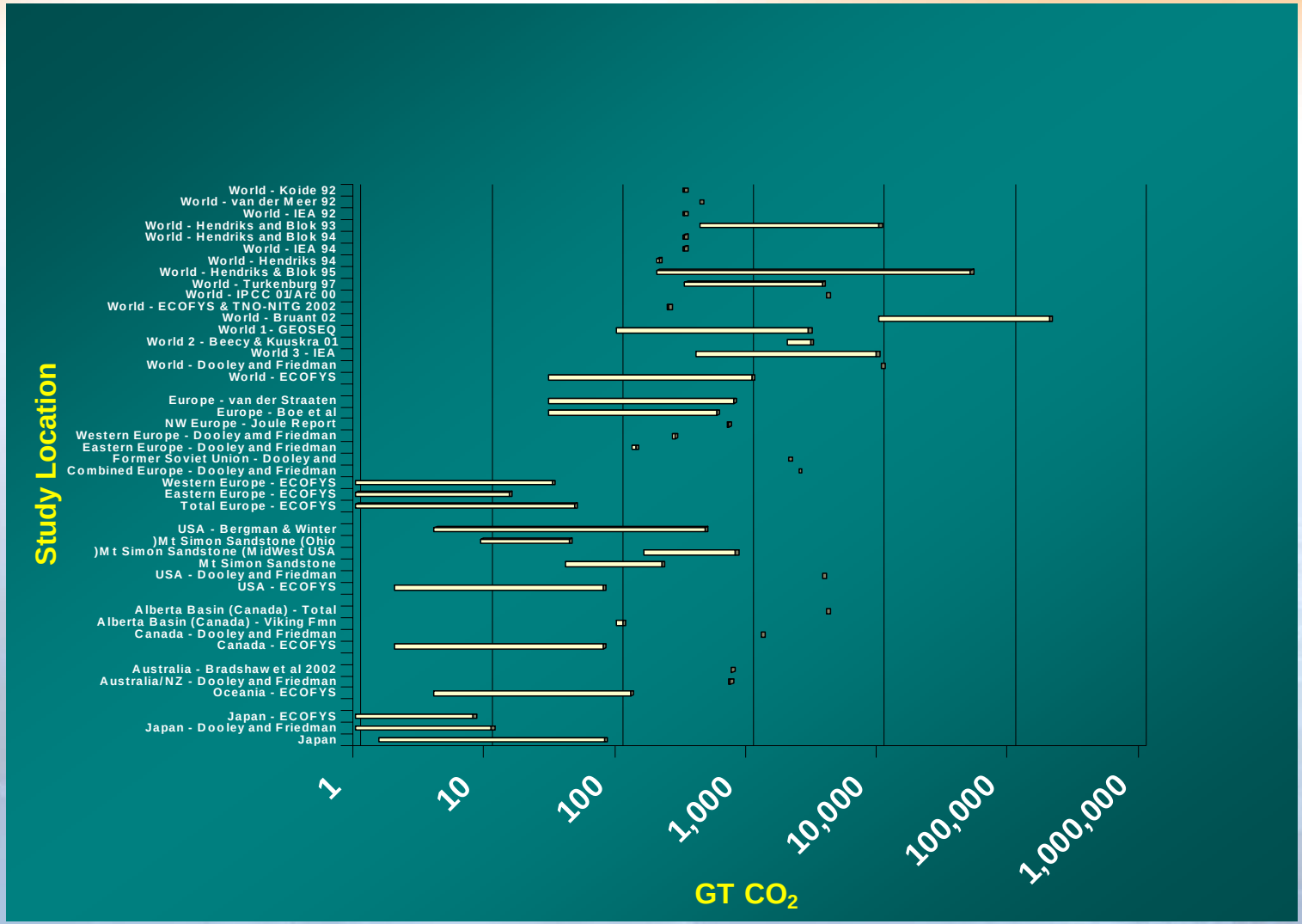
- Storage security depends on a combination of physical and geochemical trapping
- Over time, residual CO_2 trapping, solubility trapping and mineral trapping increase
- Appropriate site selection and management are the key to secure storage



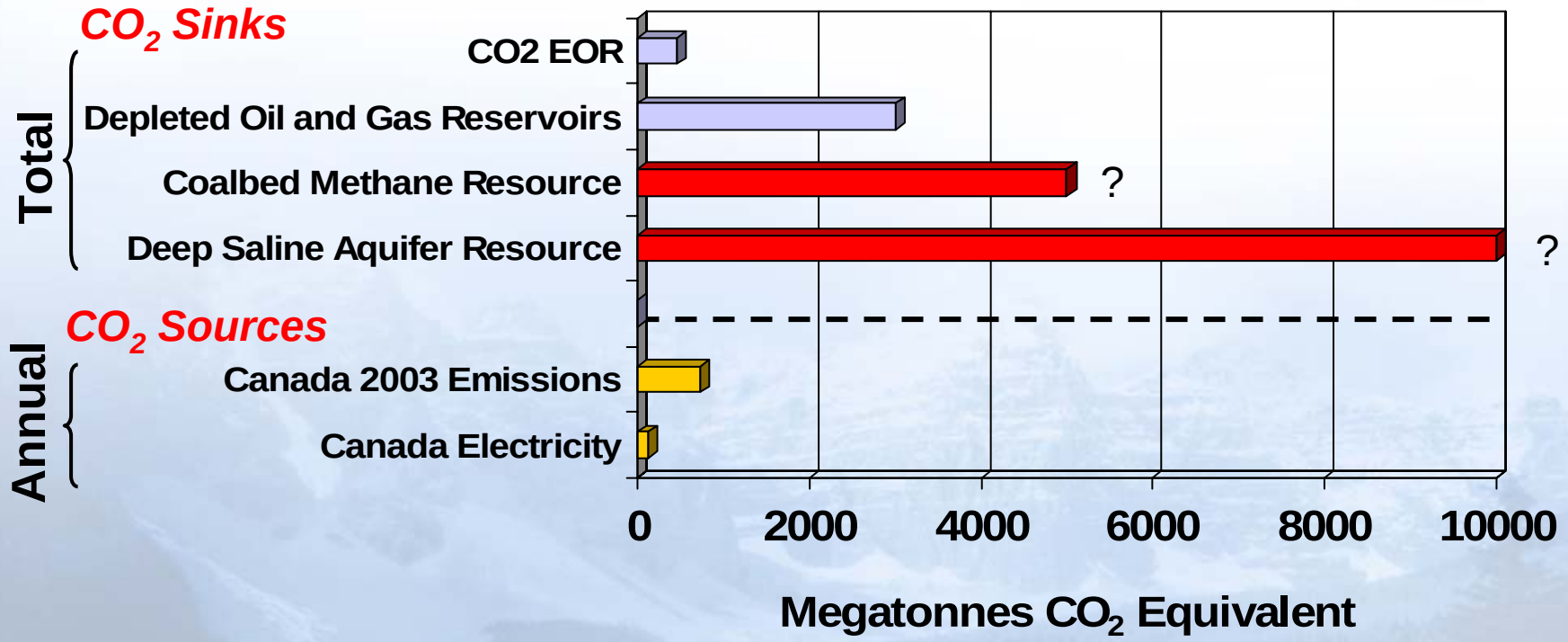
IPCC SRCCS

E.S.Rubin, Carnegie Mellon

Storage Capacity Estimates



Canada's Total CO_2 Storage Capacity



Note: This data is based on estimates for Western Canada Sedimentary Basin – Canadian storage potential would be larger

The Need for a National Atlas

- Identified as a critical factor in the Canadian CCS TRM
- Identified as a key recommendation of the Regulatory Group of the Canada-Alberta CCS Task Force
- Identified as a key recommendation in the G8 Gleneagles workshop series
- Large scale deployment of CCS will likely be sooner than later
- Important tool for industry, regulators and policy makers

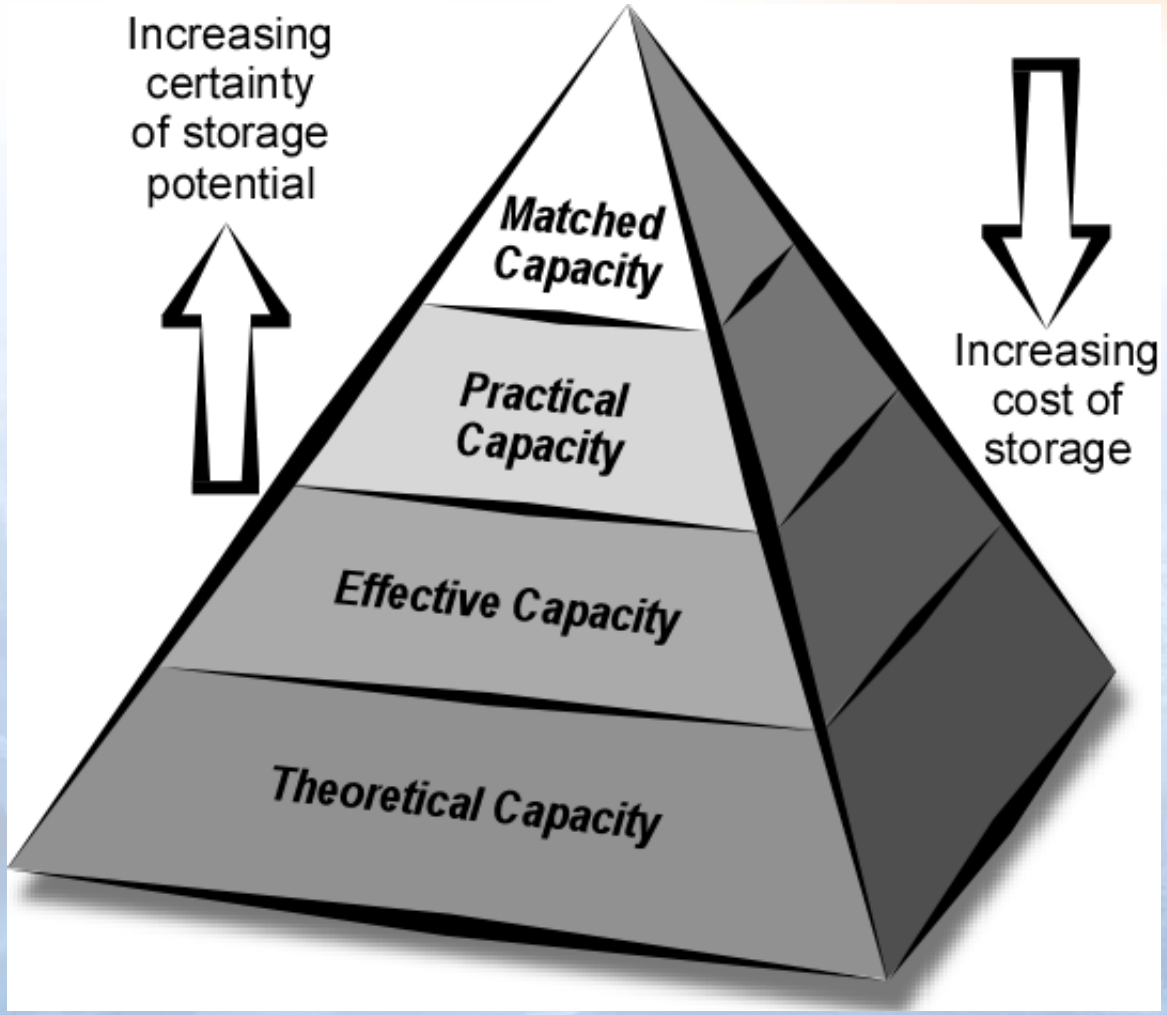
G8 Recommendation

- *3. Governments should use the CSLF Task Force of CO2 Storage Capacity Estimation methodology to develop primary mapping of prospective CCS regions, and to implement detailed geological storage capacity estimates to ascertain the location and potential capacity for CCS. Using this methodology, the mapping program should consider site selection, monitoring and remediation planning criteria along with source-storage matching assessments.*

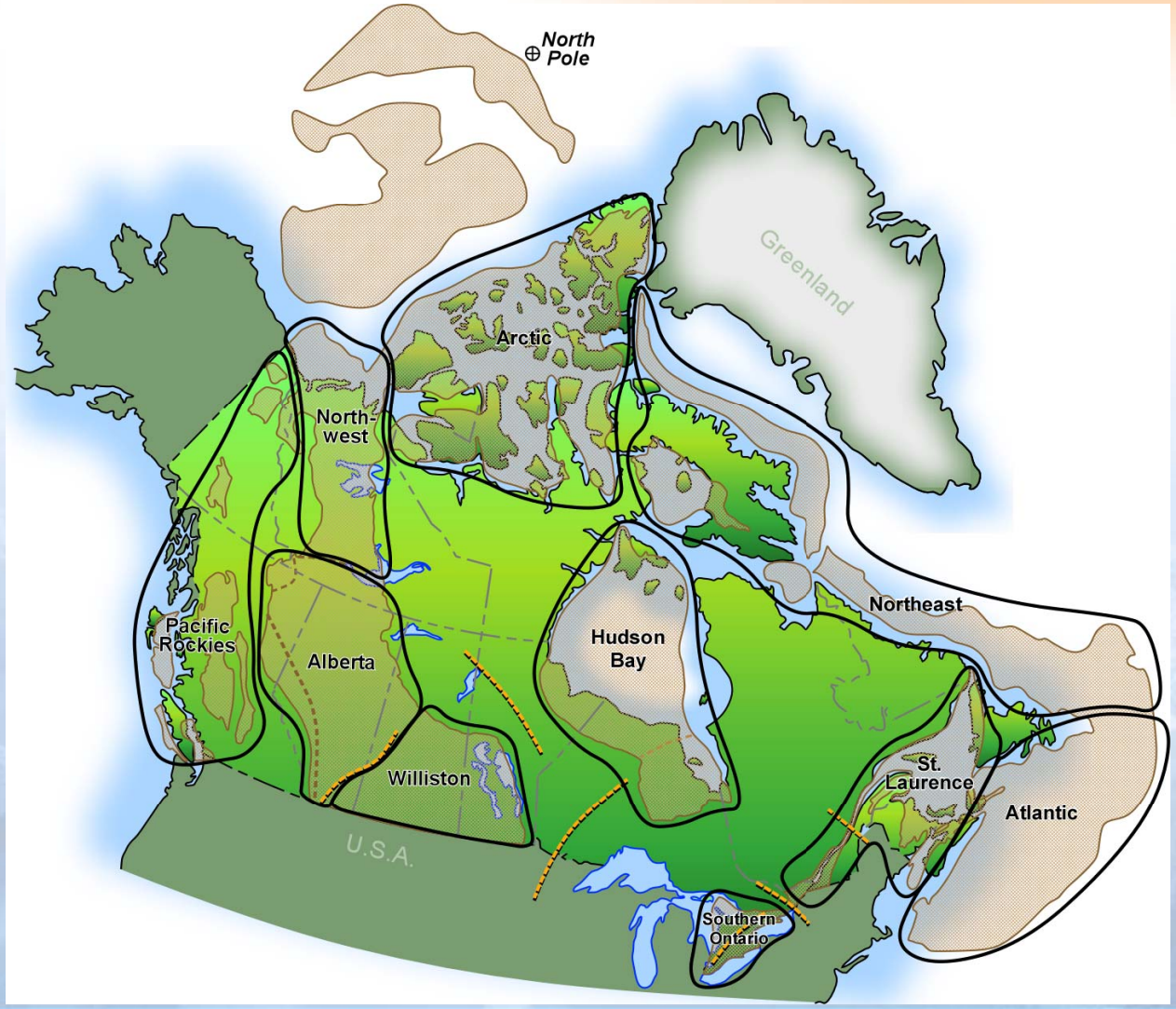
Canadian National Atlas

- 1st Workshop held in Calgary, November 2007
- Provincial GSC's invited, principally western provinces and Ontario attended
- Well received
- A roadmap has been developed and will provide the basis for the 2nd Workshop in March

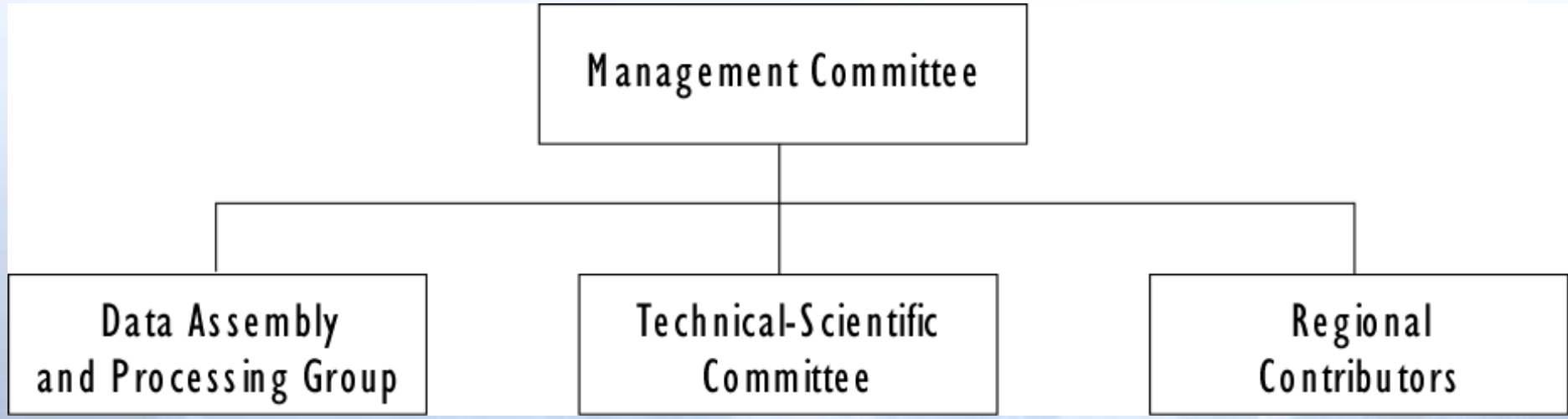
Capacity Concepts – Bachu et al - 2007



Regional Approach



Regional Approach cont'd



Vision

- The National Atlas for CO2 Storage will be an important tool and resource for industry, regulators and policy makers across the country
- Open source digital platform
- An evolving resource, to be refined as our experience grows
- An example for emerging economies around the world
- Potential for expansion to incorporate additional data segments
- A public resource

Roadmaps and Network

- Canadian Clean Coal Technology Roadmap www.cleancoaltrm.gc.ca

- Canadian CO_2 Capture and Storage Technology Roadmap www.co2trm.gc.ca

- CO_2 Capture and Storage Technology Network
- www.co2network.gc.ca

Questions?