Advancing Clean Energy Technology in Canada

Presentation to the Canadian Nuclear Society

Annual Conference

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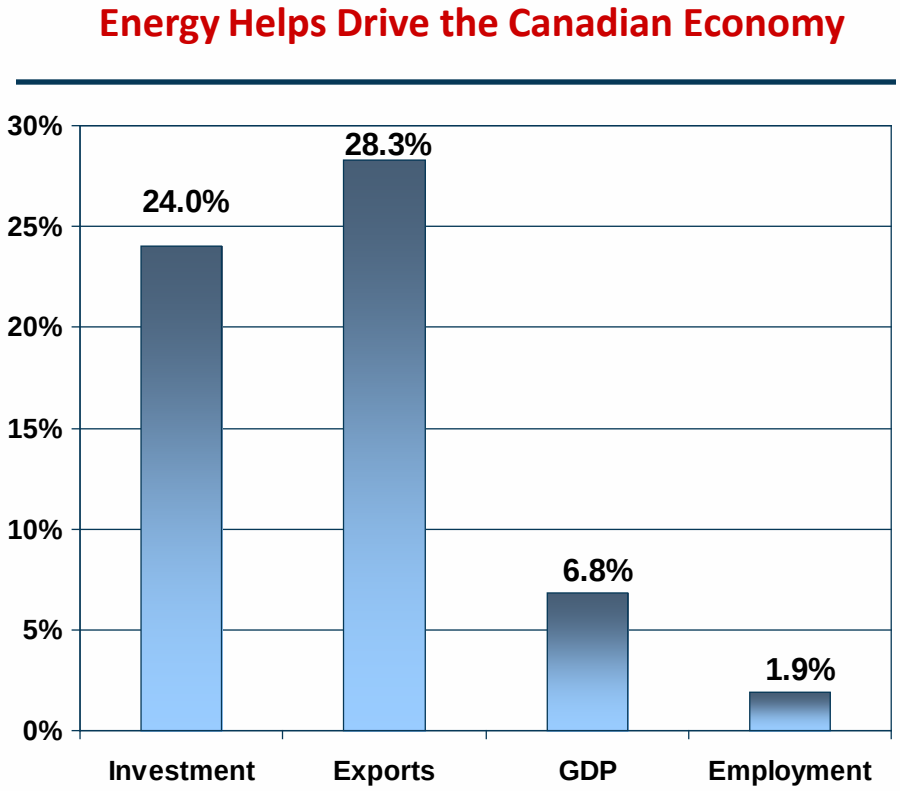
Geoff Munro

Chief Scientist & Assistant Deputy Minister

Natural Resources Canada

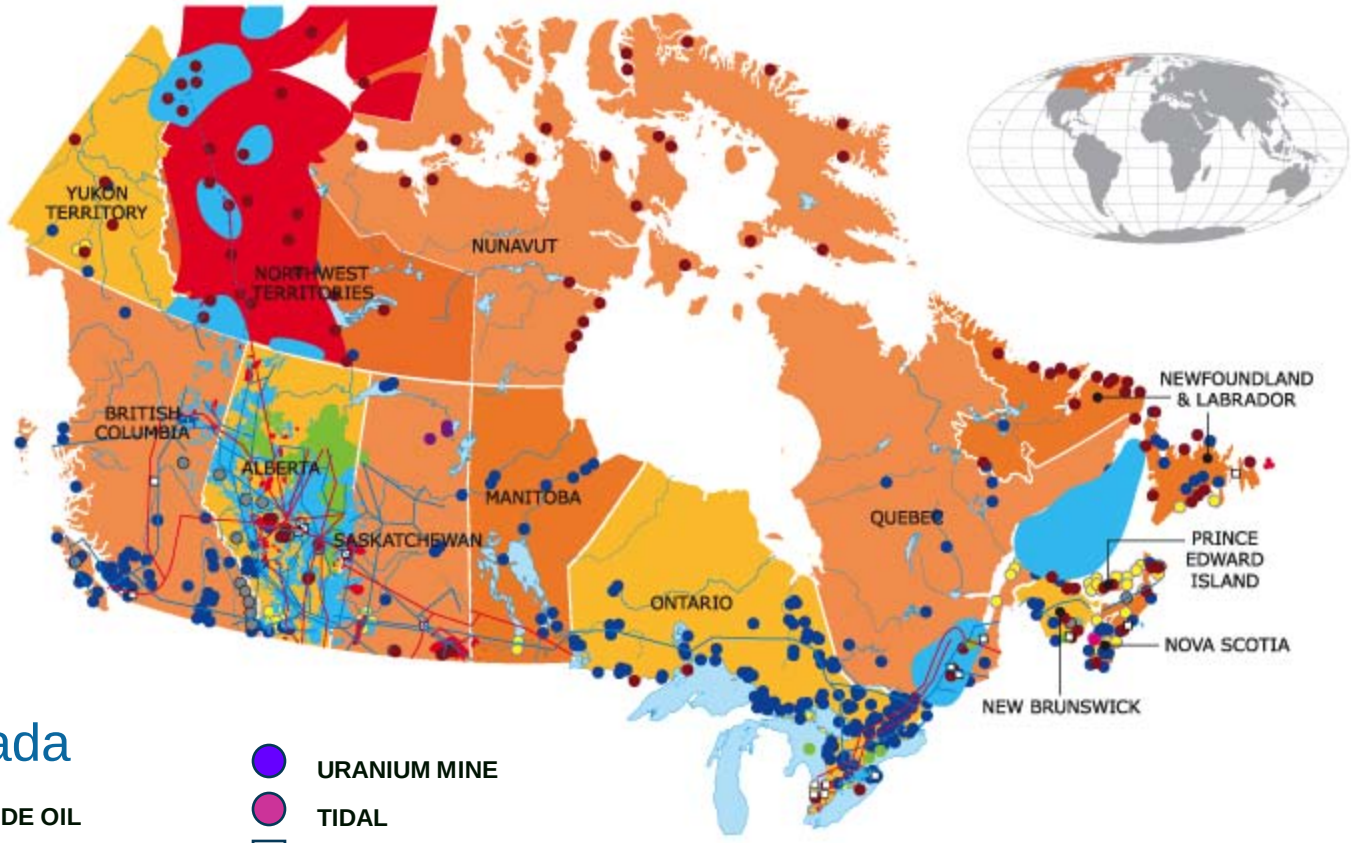
Energy is a major source of Canadian prosperity

- Energy means more to Canada than any other industrialized country
  - Only OECD country with growing oil production
  - Stable and secure energy supplier
  - Major consumer
- $137 billion in exports (2008), primarily oil and gas:
  - 28.3% of total exports (2008)
- In 2008, energy represented 6.8% of GDP, with direct employment of over 260,000 people



Source : Statistics Canada (2008) CANSIM table 228-0003

Canada's energy endowment stretches across the country …



Canada

- CRUDE OIL
- NATURAL GAS
- OIL SANDS
- CRUDE OIL PIPELINE
- NATURAL GAS PIPELINE
- NUCLEAR
- URANIUM MINE
- TIDAL
- REFINERY
- HYDRO ELECTRIC PLANT
- COAL MINE
- WIND FARM
- THERMAL ELECTRIC FACILITY

Source: Centre for Energy Information, 2009.

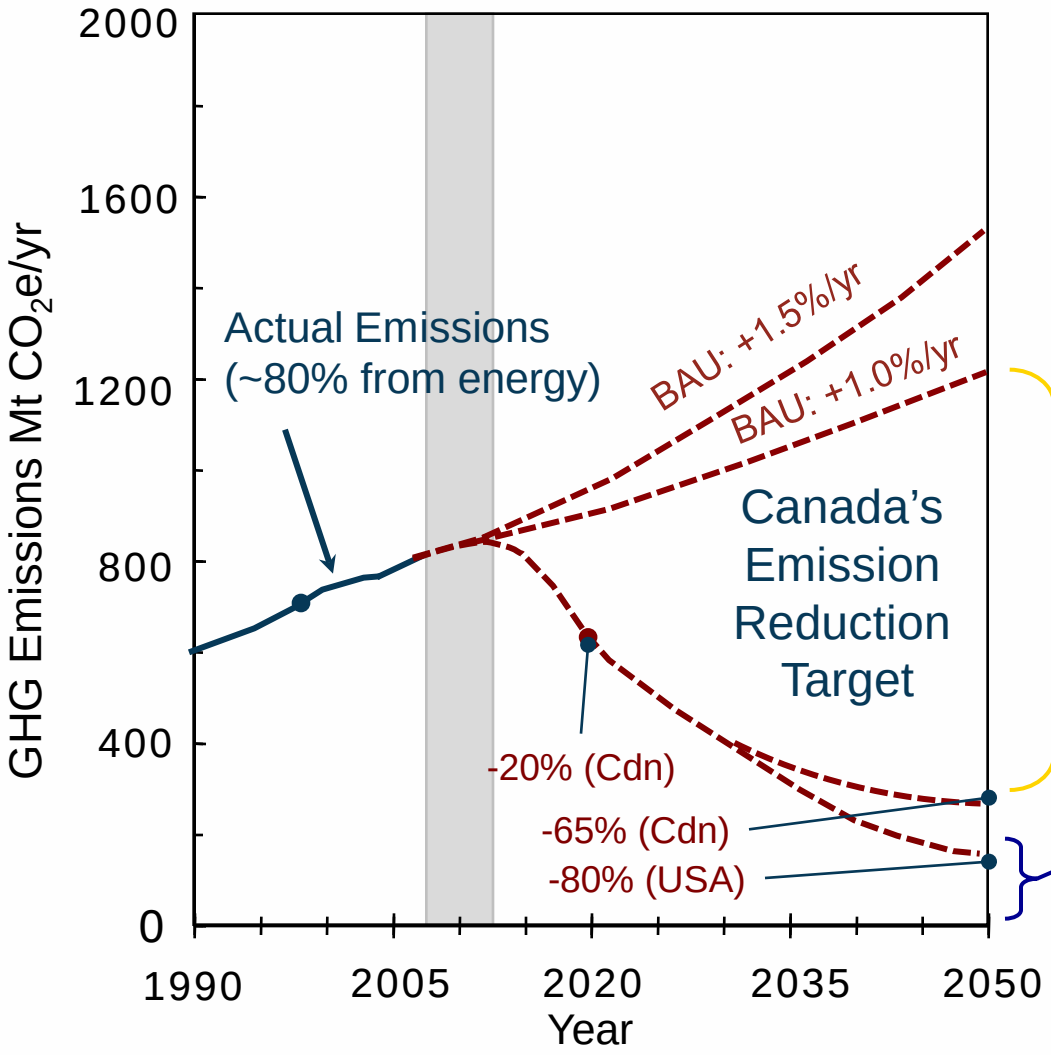
Canada's Challenge

- Reduce Canada's GHG emissions by 17% below 2005 levels by 2020, with further significant reductions by 2050 and beyond

- Achieve 90% of Canadian electricity from non-emitting sources by 2020

Canada's Challenge (2)

David Layzell, Ph.D., *Institute for Sustainable Energy, Environment & Economy*
University of Calgary, AB



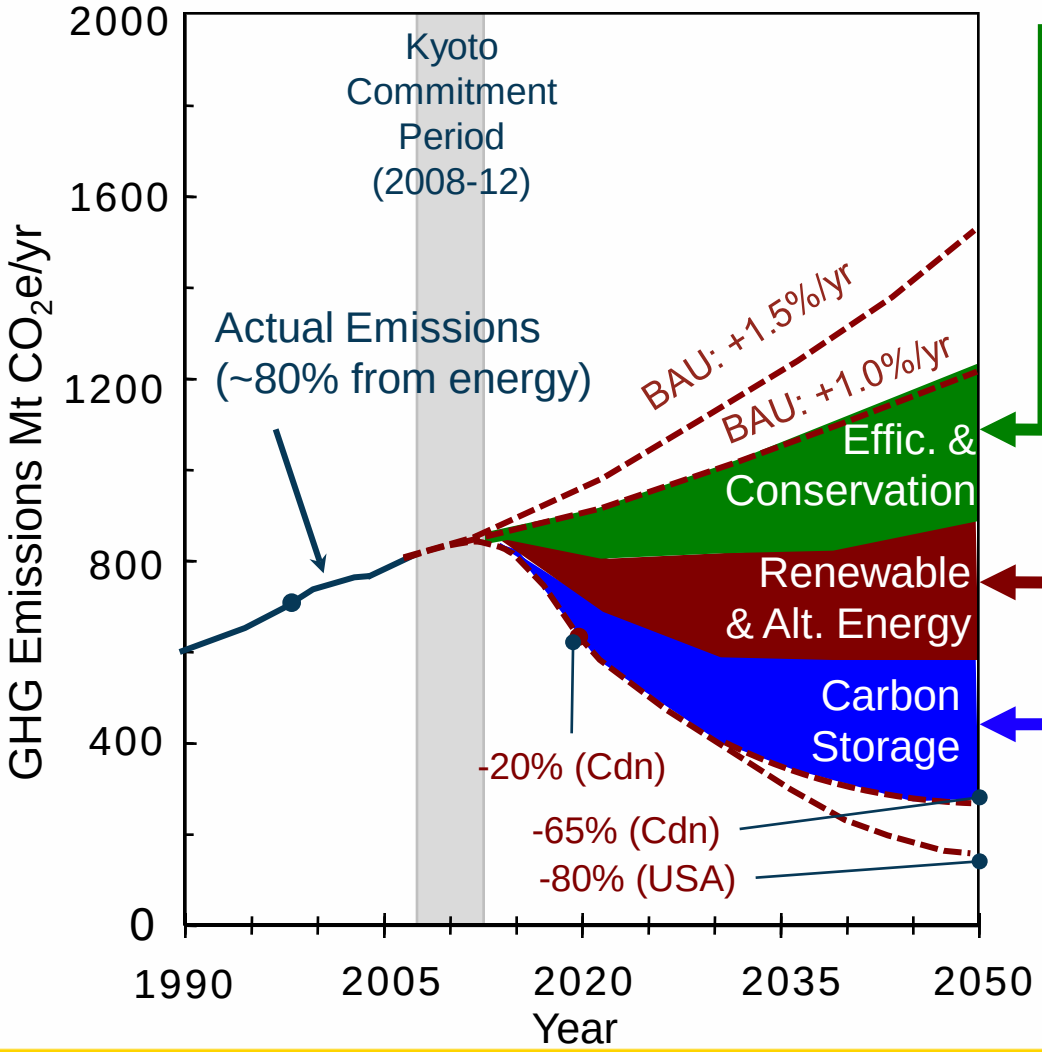
GHG reduction challenge:
~900+ Mt CO2e/yr by 2050

10-20% of human caused emissions will be very difficult or impossible to eliminate:

- Fertilizer N_2O;
- Animal CH_4 & N_2O
- Some fugitive CH_4.

There is no ‘silver bullet’. We need ‘silver buckshot’

David Layzell, *University of Calgary, AB*



- Conserve and use energy & CO_2 more efficiently; *(transportation & building systems, conversion & storage technologies, fuel cells, co-generation, coal > NG, societal & behavioural changes…)*
- Increase market share for renewable & alt. energy; *(Improvements in technologies [esp. cost, reliability] for wind, solar, biomass, geothermal, **nuclear** etc.; integration w/ FF, grid infrastructure)*
- Keep fossil carbon out of the atmosphere. *(C capture and (geological) storage; Forest and agricultural sinks [e.g. biochar])*

Conserve and use energy & Co2 more efficiently

RETScreen

- Decision-support software (free, used internationally) to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of Renewable-energy and Energy-efficient Technologies (RETs)
- Developed by government, industry, academia.

evTRM

- Electric Vehicle Technology Roadmap: led by industry and coordinated by a federal government secretariat
- Identifies critical energy technology requirements, gaps and milestones needed to advance electric vehicles in Canada.

Cool Solutions

- Specialized set of refrigeration technologies and practices to address common problems in ice rinks (Vancouver 2010 Olympics) and grocery stores
- Combines advanced practices and technologies to upgrade heating, ventilation and air conditioning systems and refrigeration equipment (avg 50% reduction in energy consumption)

Increase market share for renewable and alternative energy

Renewables

- Wind Technology Roadmap: Industry-led, government-supported – identifies key issues and recommendations for the growth of the wind energy industry in Canada.
- Drake Landing Solar Community – 1st in North America, the community is heated by a district system designed to store solar energy underground during the summer months and distribute the energy to each home for space heating needs during winter months. Solar energy will provide over 90% of space heating requirements for 52 homes - saving up to 5 tonnes of GHG emissions per home.

Smart Grid

- Understanding and addressing barriers to integration of renewables into the central power grid. Application of smart grid technologies in the built environment to reduce peak electrical demand growth

Bioenergy

- Use of biomass for heat and electricity including co-firing
- Development of 2nd and 3rd generation transport biofuels (cellulosic ethanol, bio-diesel, biobutanol, green hydro-carbons)
- Use of energy crops and residues (forest & agricultural waste, marine, biomass)
- Biorefineries for energy, materials and chemicals to maximize economic viability

Keep fossil carbon out of the atmosphere

Energy-efficient technologies for oil sands processes
- Gasification, CCS, novel in-situ recovery and upgrading (GHG intensity reduced by 32% between 1990 and 2006)

Water management in oil sands processes
- Target 30% improvements of water use efficiency by 2015
- Increased warm water recycling (75% - 90% of water use is recycled)

Tailings management for oil sands
- Non-aqueous extraction, hydrocarbon capture from tailing, CO_2 for consolidated tailing

Novel capture technologies (pre-combustion, post-combustion, oxy-fuel combustion) to decrease the cost of capture

Research on new materials and fundamental chemistry for capture technologies

Long term monitoring, measurement and verification

To be a Clean Energy Superpower…

…business as usual is not an option…need to transform to meet 2020 and 2050 GHG reduction objectives.

To succeed we must invest in dual tracks today:

1. Accelerate development and demonstration of technology for 2020
2. Support increased RD&D for breakthroughs for 2050

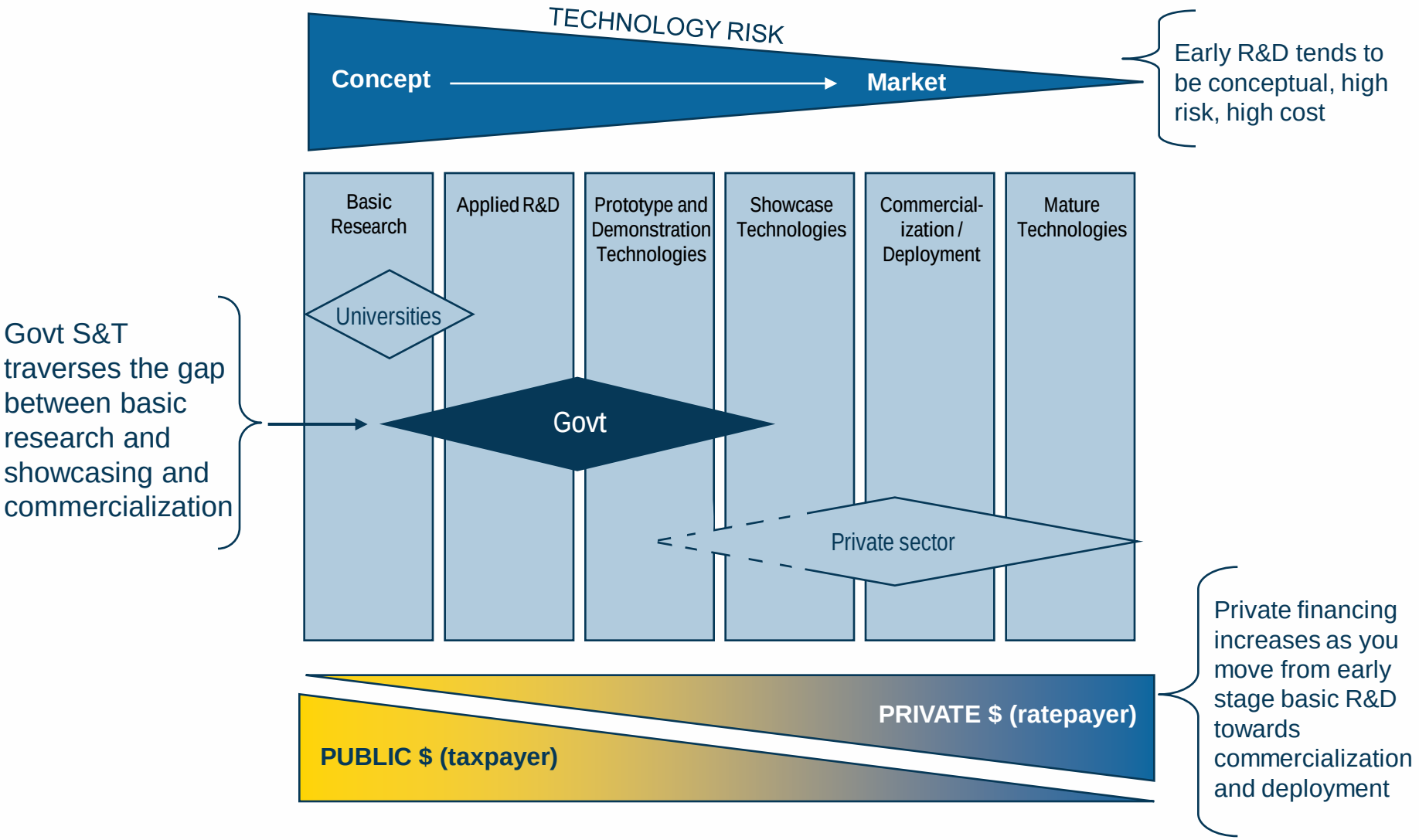
Essential that Government:

- De-risk RD&D in strategic areas of technology:
  - Drive the national RD&D agenda; mobilize RD&D community; align priorities
  - Pioneer new frontiers by performing and funding public good and high-risk RD&D
  - Strengthen priority-driven partnerships by co-funding demonstrations and encouraging RD&D collaboration
  - Provide appropriate conditions and resources
- Capitalize on unique federal capacity, knowledge, facilities

Innovation →Competitiveness →Economic growth, Public good

Government has a leadership role and is uniquely positioned in the innovation system

Government's Role in the Innovation System



What have we learned…..

- Despite challenges, performing energy efficiency and deploying renewable energy sources generate multiple benefits
- Collaborative approach and leveraging of resources leads to greater outcomes
- Access to capital, strong partnerships and strong project management is essential to successful projects
- New technology offers opportunities for real-time energy management
- Capacity-building is essential to strengthen local technical support and maintenance of new technologies

…moving forward

Promoting clean energy is a priority to make progress on multiple areas:

- Reduce greenhouse gas emissions
- Leverage actions from provinces/territories, municipalities, industry and others
- Promote development of next generation technologies; encourage the uptake of clean technologies
- Create co-benefits (e.g. strengthen competitiveness; support innovation; improve air quality; support healthy communities)
- Advance alignment with US, including Clean Energy Dialogue

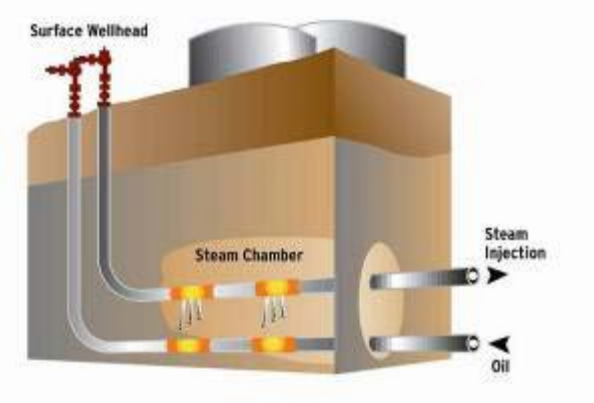
Thank You

ANNEX

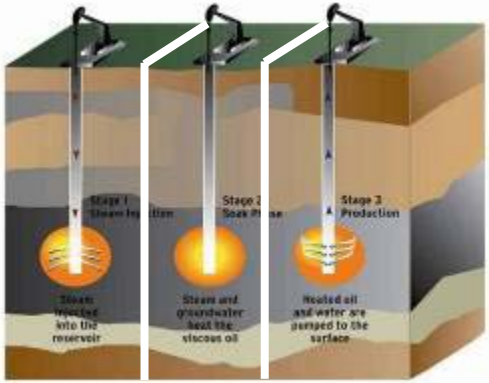
Oil Sands Production Technologies

In situ

Steam Assisted Gravity Drainage



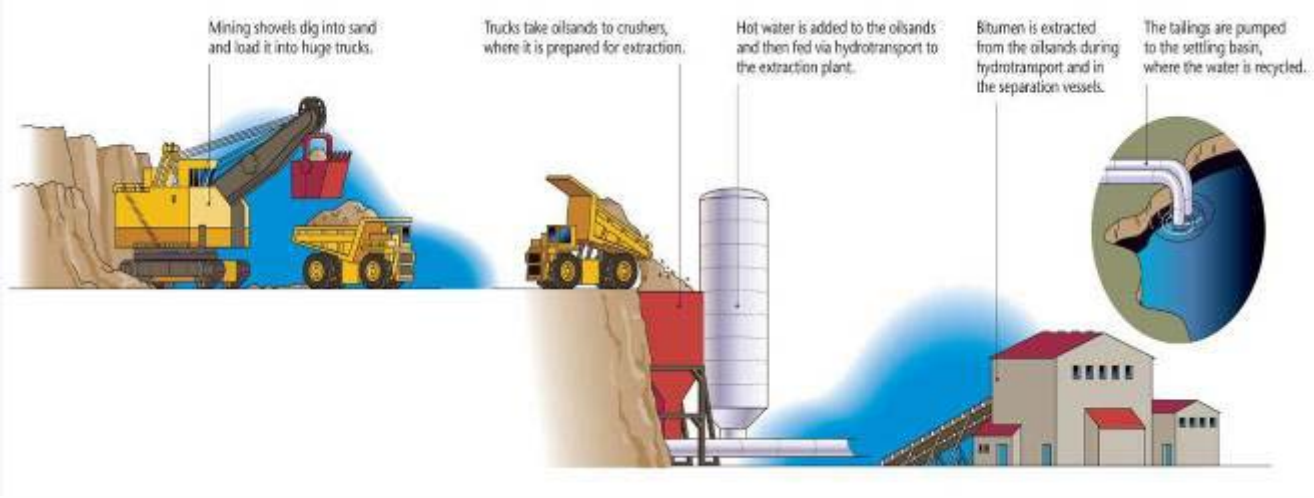
Cyclic Steam Process



In Situ:

- 80% of resource
- 45% of current production
- No tailings ponds
- No water drawn from the Athabasca River
- Smaller footprint

Mining



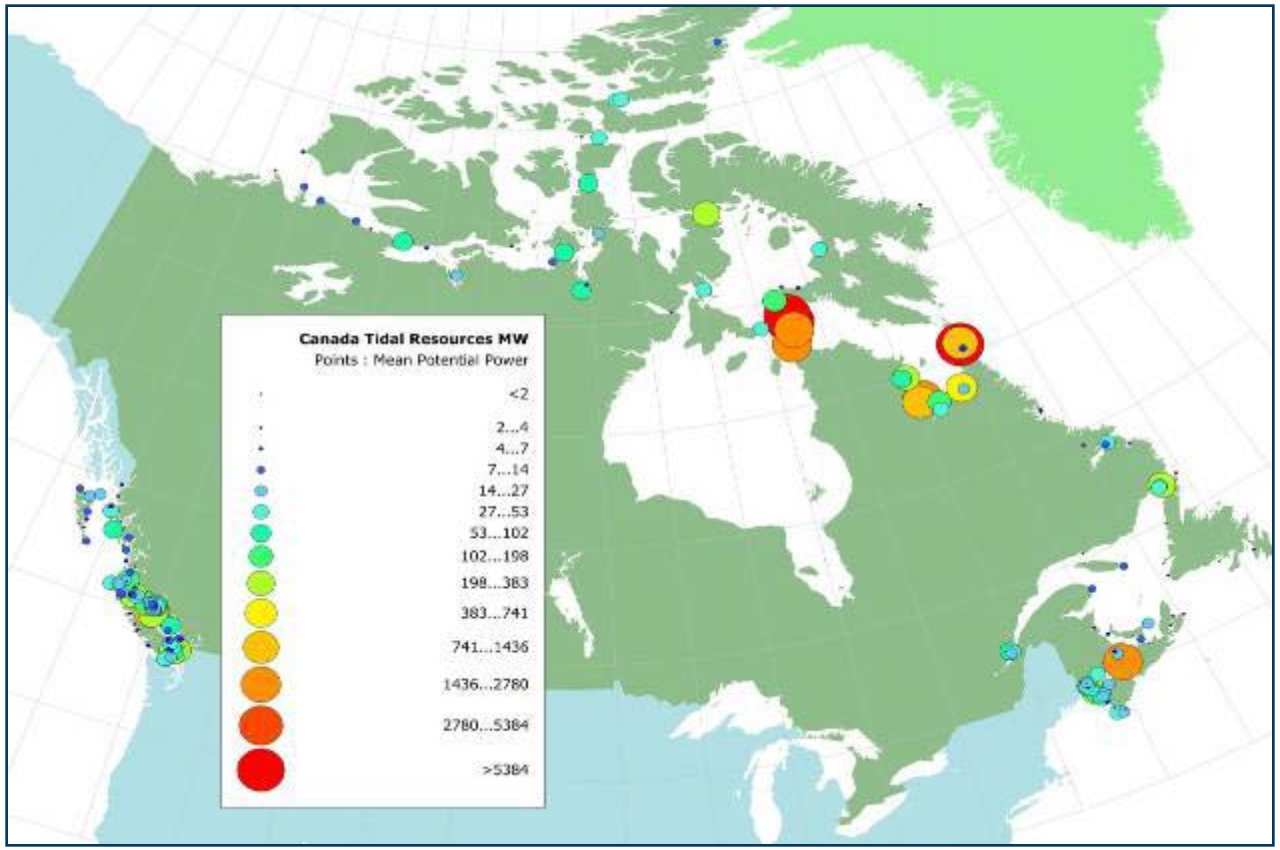
Mining:

- 20% of resource
- 55% of current production
- The mineable area represents 3% of the total oil sands area

Renewable energy potential

- **Hydroelectricity** – underdeveloped but potential is significant for new generation and transmission lines.
- **Wind** – challenges remain due to high cost and economies of scale, but changes in wind/diesel integrated generation are promising.
- **Geothermal** –limited success due to cool ground temperatures, however good potential in old mines under City of Yellowknife, and between Fort Simpson and Hay River.
- **Biomass** – transportation and distribution not well developed however wood is a reliable source of energy for large-scale operations.
- **Solar electricity** –generally more expensive per watt to install than conventional diesel generators, however off grid applications of solar electricity are reliable.
- **Solar heating** – Mostly available in the spring and summer

Tidal Energy Resources



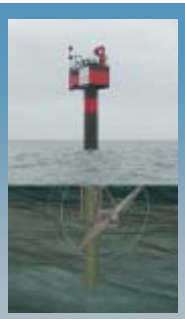
Estimated Power Potential: Up to 42GW

Source: NRC-CHC 2006

Tidal | Water Currents

Horizontal Axis Turbines

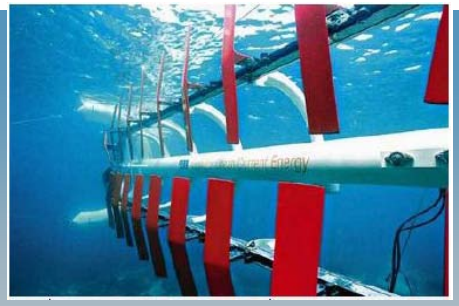
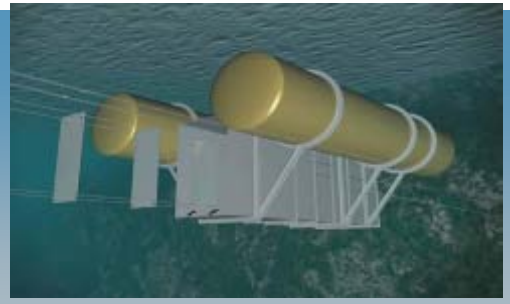





Vertical Axis Turbines




Hydrofoils


Wave Technologies

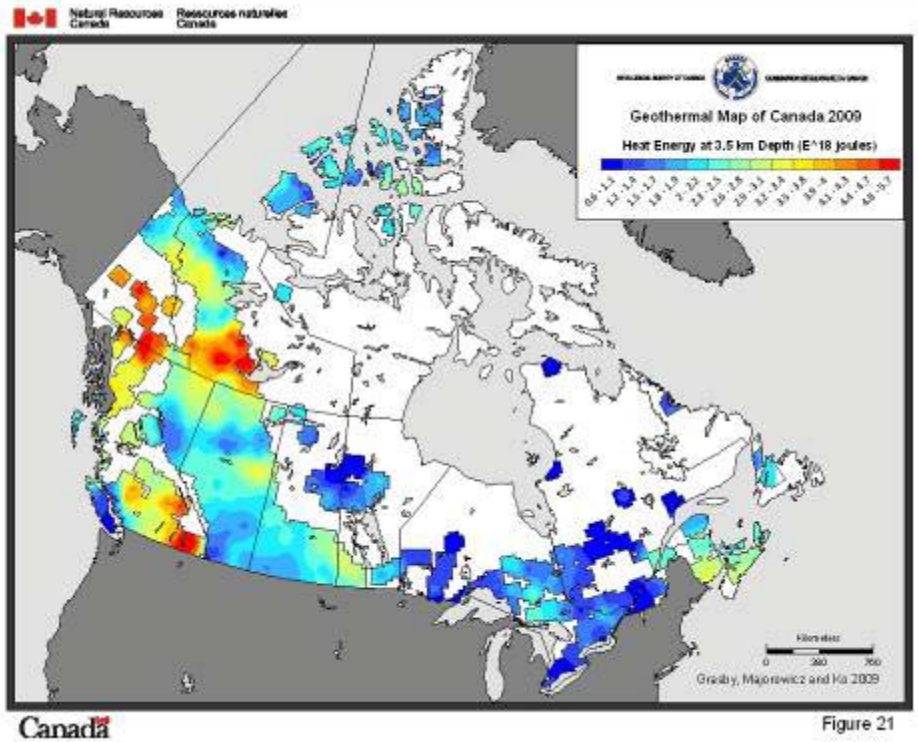
Oscillating Water Column (OWC)

Overtopping Devices

Oscillating Bodies (Point Absorbers & Surge Devices)

Emerging technologies could expand the use of geothermal energy for electricity generation across Canada

Enhanced Geothermal Systems (EGS)



Estimated in place heat energy at 3.5 km depth is 3.8 X 10^{11} GWh