1. Project objectives

**Research project funded by the NSERC of Canada**
- Build a multi-regional energy model for Canada
- Model new technologies and improve data (oil sands, biofuels, LNG, etc.)
- Calibrate the model to the new economic scenarios
- Analyze energy policies (2020) and climate policies (2100) for Canada

**Research project funded by the MDEIE of Quebec (link with REACCESS 7th FP-EU)**
- Characterize energy supply corridors for the integrated Canadian market
- Model these corridors in TIMES-Canada (focus on Quebec)
- Quebec electric transportation sector development analyses
- Couple the model with the world model TIAM
- Analyze energy security policies (2020) and climate policies (2100) for Quebec and Canada in the international context
2. TIMES-Canada

Regions: 13 provinces and territories

Base year: 2007
Horizon: 2030 (energy)
Horizon: 2100 (climate)

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Time slices
- 4 seasons: Spring, Summer, Fall, Winter
- 3 day periods: Day, Night, Peak

Primary Energy Supply  Conversion Technologies  End-Use Technologies  Demand for Energy Service  Demand Proj

Renewables
- Hydro, wave, Tidal
- Wind, Solar, Geo

Biomass
- Crop, Wood
- Biogas

Fossil fuels
- Crude oil
- Natural gas

Others
- Coal
- Uranium

Domestic trades
- Pipelines
- Transmission

International trades
- Crude oil, RPP
- Coal

Other techs

Refineries

Biomass
- Solid, Gaseous
- Liquid (biofuels)

Electric plants
- All existing units

Electric plants
- Conventional
- Renewables
- Nuclear

Heat plants

Cogeneration

Coke plants

Hydrogen

Capture & Storage

Liquefied Nat Gas

Ind Prod
- Steam boilers
- Machinery

Services
- Air conditioners
- Refrigerators

Dwelling
- Furnaces
- Light bulbs

Vehicles
- Gasoline Car
- Electric Train

Agriculture

IND (8)
- Iron & Steel
- Chemicals

COM (7)
- Cooling
- Lighting

RSD (20)
- Space heating
- Refrigeration

TRA (16)
- Cars
- Trucks

AGR (1)

Scenarios
Energy policies
Climate policies

Demand 2030
- Projections
- Price-elasticities

Demand 2100
- Projections
- Price-elasticities

Emissions
- GHG
- CAC

Done
In progress
To do
3. Oil prices for 3 reference cases, 1990-2030

Assumptions for reference case:

2011 to 2020: Oil prices will follow the BAU scenario, where governments will focus on economic development.

2020 to 2030: high prices will allow the penetration of new energy sources and technologies in a competitive way.

3. GDP growth projections, 2007-2030
3. Final energy consumption, 2007-2030 (PJ)

4. Electricity capacity and trade (3500 units)
5. Diversity of regional energy systems

- Canada is an important player on the world scene
  - The largest supplier of natural uranium (1/3 of the global demand) (SK)
  - An important coal heritage (BC, AB, SK, Atlantic)
  - A leader in hydroelectricity production and important exporters (BC, QC)
  - An important producer of oil and gas (AB, MB, Atlantic)
- New opportunities for producing provinces to generate additional revenues from exports (fossil fuels or renewable electricity)
- Energy security issues for non-producing provinces that depends on crude oil imports (for transportation)
- Interests to develop renewable energy sources in all provinces
- Take into account GHG emission reduction issues
- Lack of a national energy strategy to optimize the management of energy systems and the conception of climate policies.

5. Renewable potential – Cumulative (GW)

Hydro, Geo, Tidal, Wave

- Installed capacity
- Technical potential

[Graph showing cumulative potential for different regions and technologies]
5. Renewable potential – Annual (kWh)
Photovoltaic and Wind


Total reserves: 544 kt (365 EJ)

Uranium production in Saskatchewan (t)

- Cluff Lake
- Rabbit Lake
- McClean Lake
- Key Lake
- McArthur River

SK 72%
NU 17%
NL 11%
5. Coal reserves and production, 1989-2007

Coal recoverable reserves by province and by type, 2007 (PJ)

- Lignite (0.66 $/GJ)
- Subbituminous (0.52 $/GJ)
- Bituminous (2.12 $/GJ)
- Anthracite (2.44 $/GJ)

Coal production (PJ)

- BC Bituminous
- AB Sub-bituminous
- AB Bituminous
- SK Lignite
- NB Bituminous
- NS Bituminous

5. Oil reserves, 1970-2007

- Condensate
- Bitumen In Situ
- Bitumen Mined
- Synthetic
- Conv. Oil
6. New oil production in Canada, 1995-2030

6. New oil from East, 1995-2030 - By project
6. New oil from East, 2007-2030

6. New oil from West, 2005-2030 - By project
6. New oil from West, 2007-2030

Preliminary results from TIMES
7. Future works: Model developments

- Projection of the demand up to the 2030 horizon using the new Canadian Energy Outlook (CEO) to be published soon
- Building of three reference cases, illustrating low, moderate and high Canadian socio-economic growths
- Calculation of GHG from processes and CAC emissions
- Modeling of emerging technologies
  - Next generation biofuels
  - Liquefied natural gas (LNG)
  - Hydrogen economy
  - Carbon capture and sequestration (CCS)
  - Electrification of transportation
- Implementation of the energy corridors
- Coupling of the model with the TIAM world model
- Energy and climate policies analysis

7. Future works: Oil sector analysis

- From the three reference scenarios (2007-2030), compare costs and GHG emissions of conventional and unconventional oil production
- Perform sensitivity analysis on:
  - Short term evolution of crude oil prices.
  - Type of energy used for reserves extraction and transformation (natural gas, nuclear, etc.).
  - Domestic and international trade movements.
  - Offshore reserves and potential developments.
  - Provincial energy strategies (renewable targets).
  - Canadian climate policies.
  - Exogenous social and political constraints to illustrate the economic impacts of different choices on controversial issues (e.g. moratorium on nuclear, shale gas, etc.).
Thank you from the team

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