The Canadian Energy Systems Simulator (CanESS):

A Reference Scenario to 2060 for Exploring Alternatives for Canada's Energy Future

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INTRODUCTION

The Canadian Energy Systems Simulator (CanESS), developed by whatIf? Technologies Inc. [1], is an integrated, multi-fuel, multi-sector model of Canada's energy system that accounts for the sources and uses of energy and the resulting GHG emissions.

When used to explore energy futures that will result from technology or policy choices, the projections are typically compared to a **Reference Scenario** that assumes 'Business as Usual' (BAU) conditions combined with current planned developments (Fig. 1). This paper describes the Reference scenario.

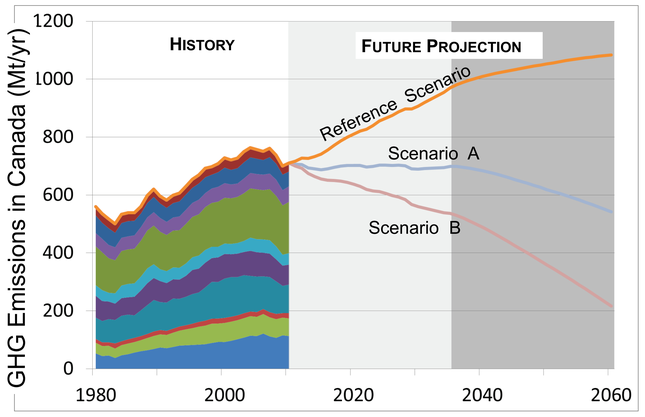


Fig. 1. Historical data and 3 future scenarios for GHG emissions.

METHODOLOGY

A reference scenario in CanESS is built from trend lines obtained from 30+ years of historical data on hundreds of variables that define provincial energy systems. As shown in Fig. 2, each model variable is either constant (A), follows a historical trend (B), or matches a projection from a respected source (C).

Future trends can be modified if there are in place clearly defined policies, regulations (e.g. fuel standards) or technology choices (e.g. 'off coal').

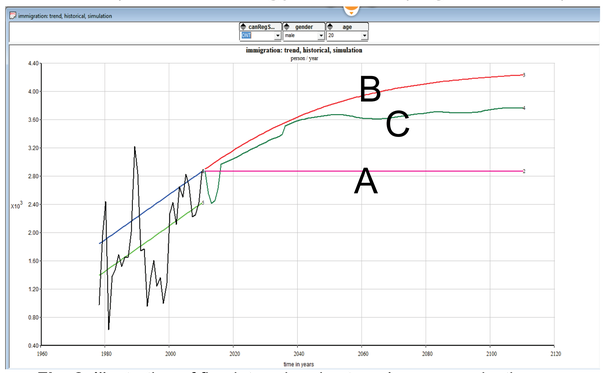


Fig. 2. Illustration of fixed, trend and external source projection.

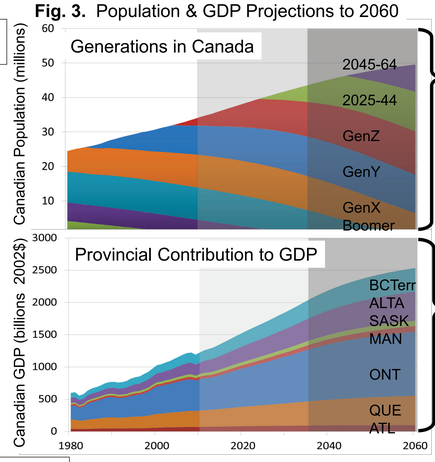
BUILDING THE REFERENCE SCENARIO

A. Population & Economy

Assumptions about population and economic growth of provinces are the two primary drivers for energy demand in CanESS (Fig. 3).

In the reference scenario, National Energy Board projections to 2035 [2] were used, followed by a saturated trend.

Fig. 3. Population & GDP Projections to 2060



NOTE:

- The CanESS model includes historical data and can project future demographic shifts (e.g. age, sex, generations).
- GDP per capita projections result in a doubling of GDP by 2060.

B. Setting Other Major Drivers

There are many other major drivers of Canada's energy systems that must be defined in the CanESS model to define a future energy system.

In the Reference scenario, the projections shown in Fig. 4 were developed based on either historical trends, and planned developments in the foreseeable future *(e.g. for oil/gas [2,3], CAFE standards [4]; biofuel blending standards [5]; power generation capacity [2], lighting regulations [6])*.

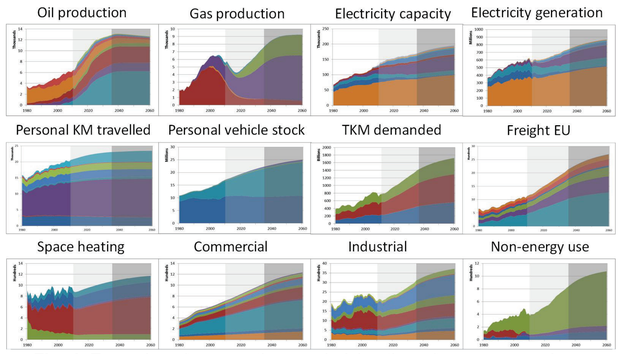


Fig. 4. Examples of assumptions underlying the reference scenario.

C. Calculating Energy Flows and GHG Emissions

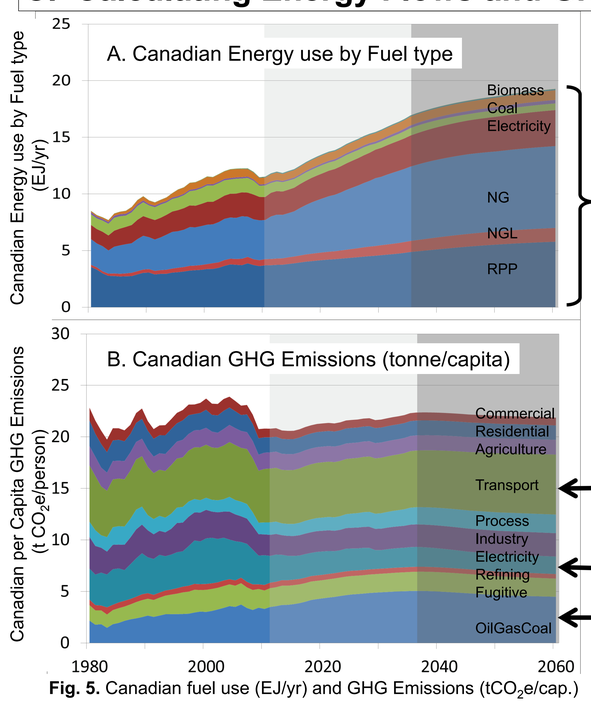


Fig. 5. Canadian fuel use (EJ/yr) and GHG Emissions (tCO_2e/cap.)

The CanESS model integrates all previous assumptions for the Reference Scenario to calculate the energy flows from sources to services, and the resulting fuel and electricity demands (Fig 5A) plus GHG emissions (Fig 5B).

- Energy use is projected to increase from 12 EJ/yr in 2014 to 19 EJ/yr in 2060.

The Reference projection results in Canada's total emissions rising from 700 Mt CO2e in 2014 to **1084 Mt CO_2e in 2060** (Fig. 1).

- CAFE standards balanced by increase in person km travelled and increase in freight
- Electricity cleaner with coal phase-out
- Oil and Gas growth is major source of increase in per capita GHGs

DISCUSSION / CONCLUSIONS

The Reference scenario represents Canada's energy systems in a "Business as Usual" world.

It provides a 'benchmark' to assess alternative energy futures that may result from changes in :

- Assumed rates of pop'n or GDP growth;
- Technologies associated with energy harvesting, or service demand;
- Policy instruments that affect behaviour.

CanESS is a powerful tool to assess scenarios that will inform policy and investment decisions by government as well as industries from a wide range of sectors.

REFERENCES

[1] whatIf? Technologies Inc., 2014. Canadian Energy Systems Simulator (CanESS) - version 6. www.caness.ca

[2] NEB, 2013. Canada's Energy Future 2013 - Energy Supply and Demand Projections to 2035 - An Energy Market Assessment.

[3] AER, 2014. ST98-2014; Alberta's Energy Reserves 2013 and Supply/Demand Outlook 2014–2023.

[4] Canada Gazette, 2012. Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations.

[5] USDA Foreign Agricultural Service, 2013. Canada Biofuels Annual 2013.

[6] NRCan, 2014. Amendment to Canada's Energy Efficiency Regulations for Lighting Products.

ACKNOWLEDGEMENTS

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