The Canadian Perspective: Test Methods for Residential Air Conditioners (and Heat Pumps)

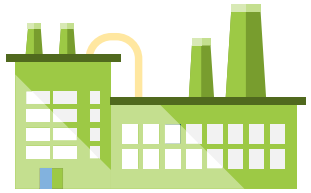
Kim Curran, Natural Resources Canada

Outline

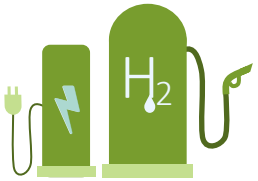
- Canada's Pan Canadian Framework
  - Energy Use and GHG emissions
- Regional Considerations
  - Climate
  - Electricity emission intensity
  - Energy costs
- Finding near term opportunities
- Work underway
  - Canadian Standards Association EXP-07
  - Heat Pump Coalition
  - Laboratory and Field testing

Canada's Pan-Canadian Framework – Energy Efficiency

BUILD SMART: CANADA'S BUILDINGS STRATEGY



INDUSTRIAL EFFICIENCY & ENERGY MANAGEMENT



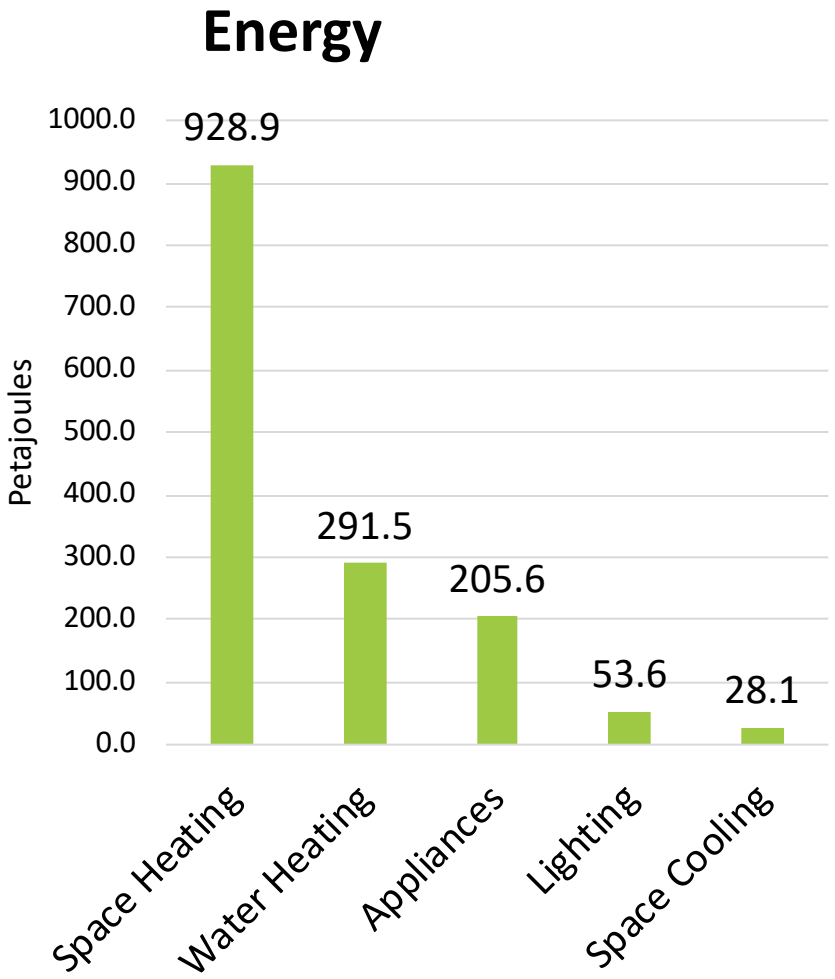
LOW-CARBON TRANSPORTATION & ALTERNATIVE FUEL

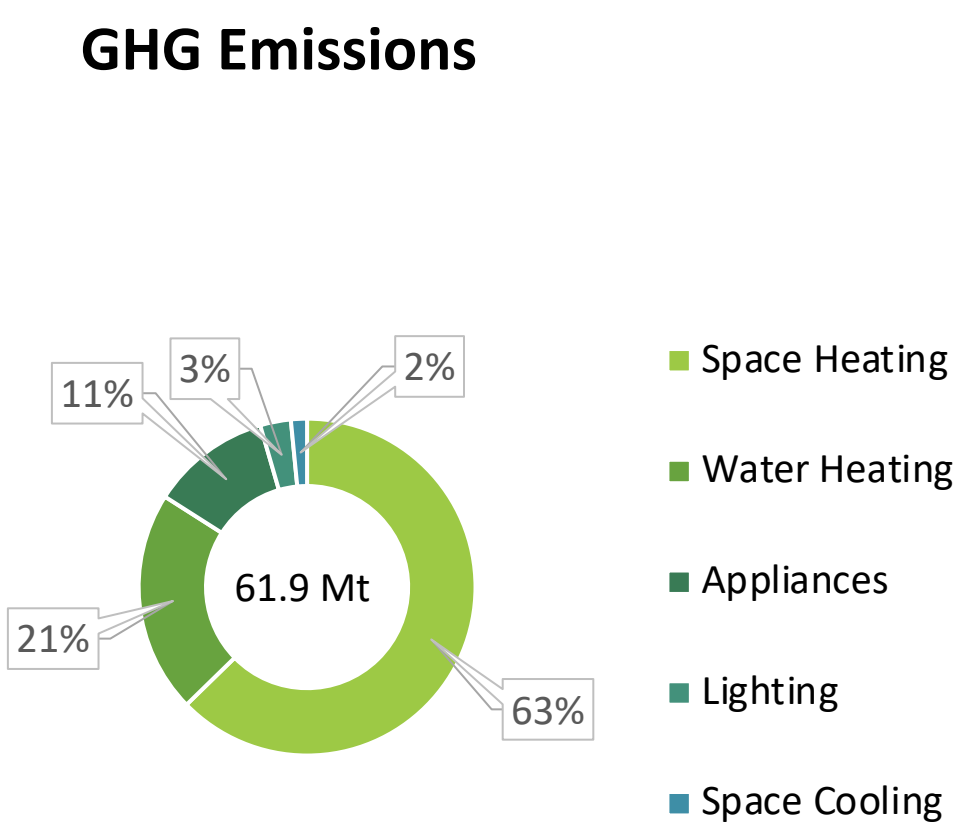
GREENING GOVERNMENT

SOCIAL INNOVATION & DIGITALIZATION

Investments through the PCF drive advancement in all sectors

Energy use and GHG emissions - Residential End-Use

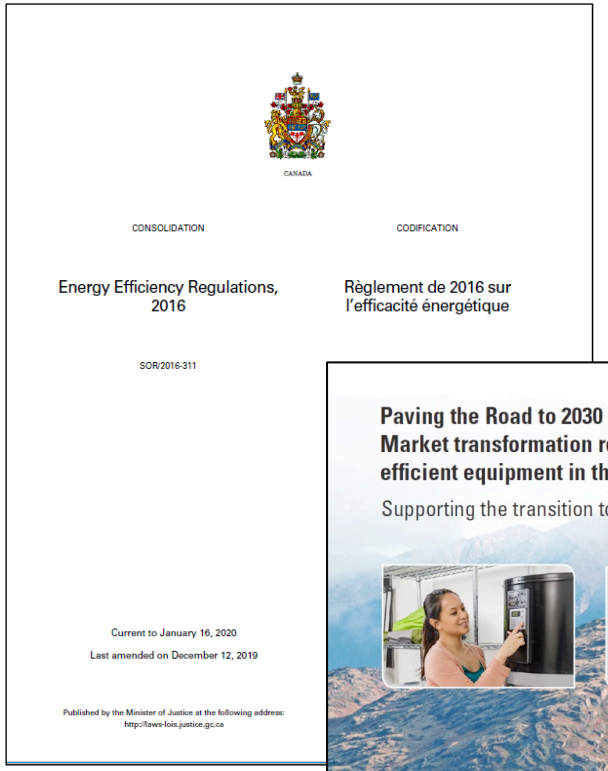


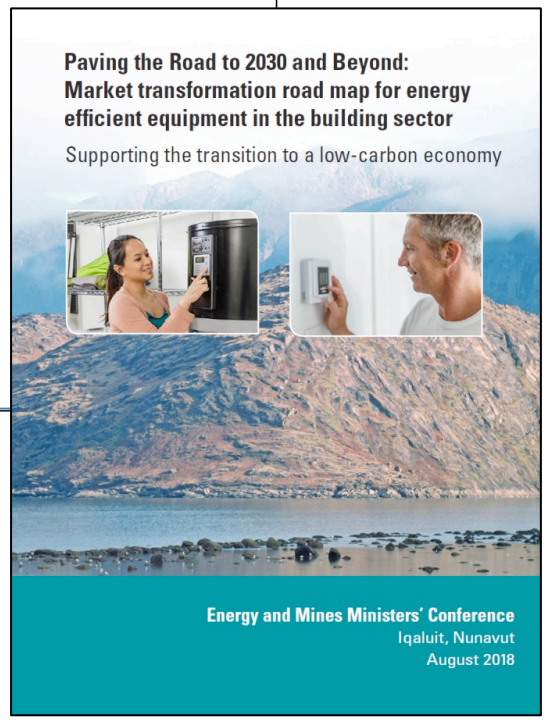


Source: Natural Resources Canada – National Energy Use Database (2017 data), GHG Emissions include Primary Energy Use

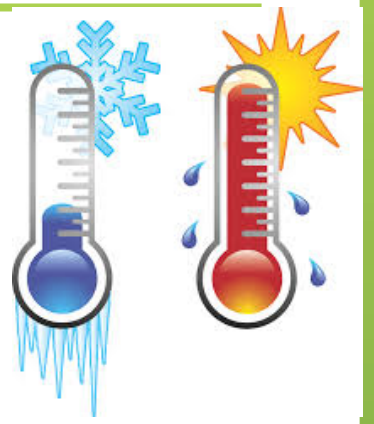
Natural Resources Canada – Office of Energy Efficiency

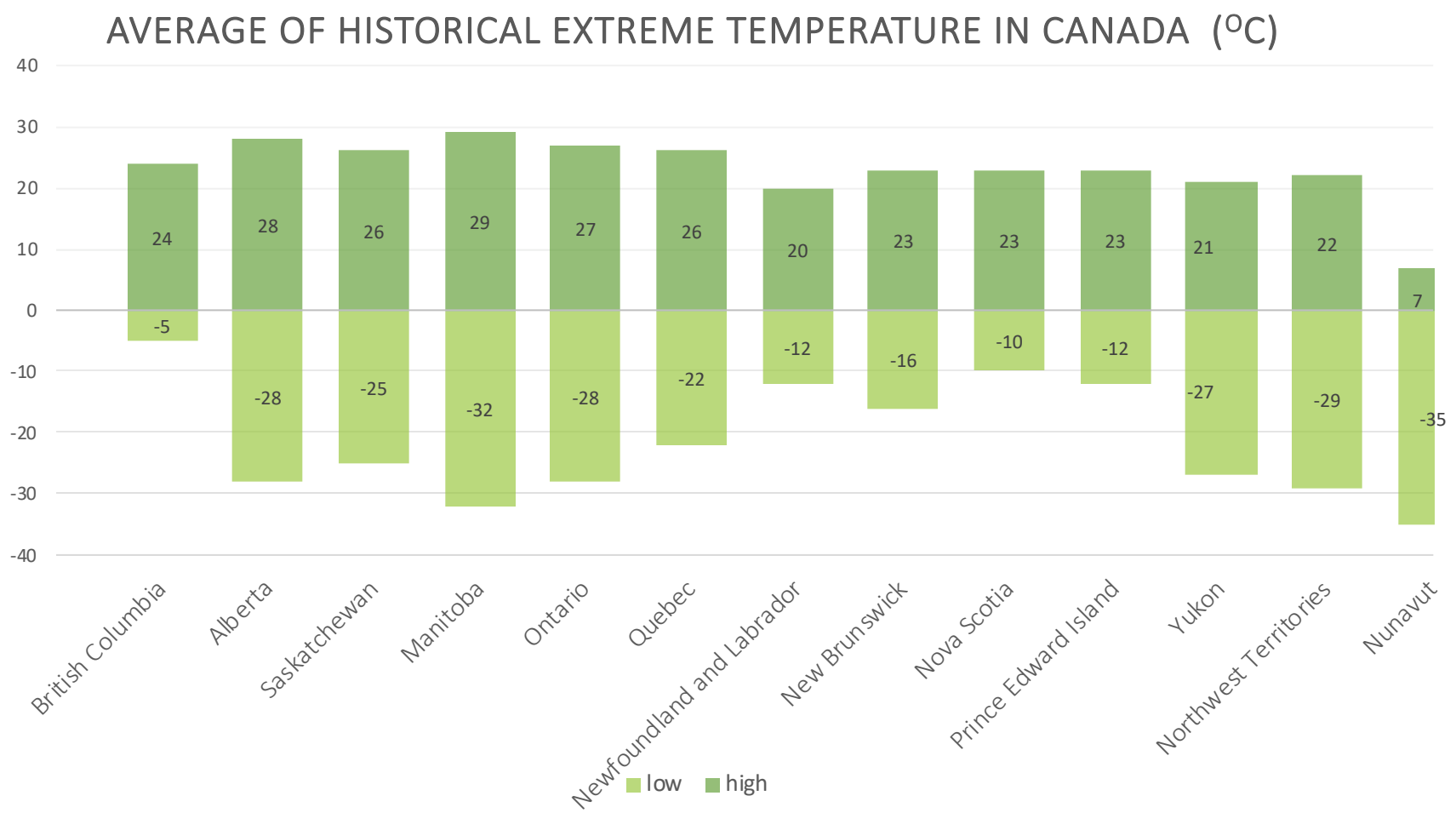
- Transforming the Equipment Market through:
- Energy Efficiency Regulations:
  - eliminate worst performers through regulated minimum energy efficiency requirements
- ENERGY STAR program:
  - promote high efficiency products through voluntary certification and labelling
- Market transformation roadmap implementation:
  - space heating, water heating and windows





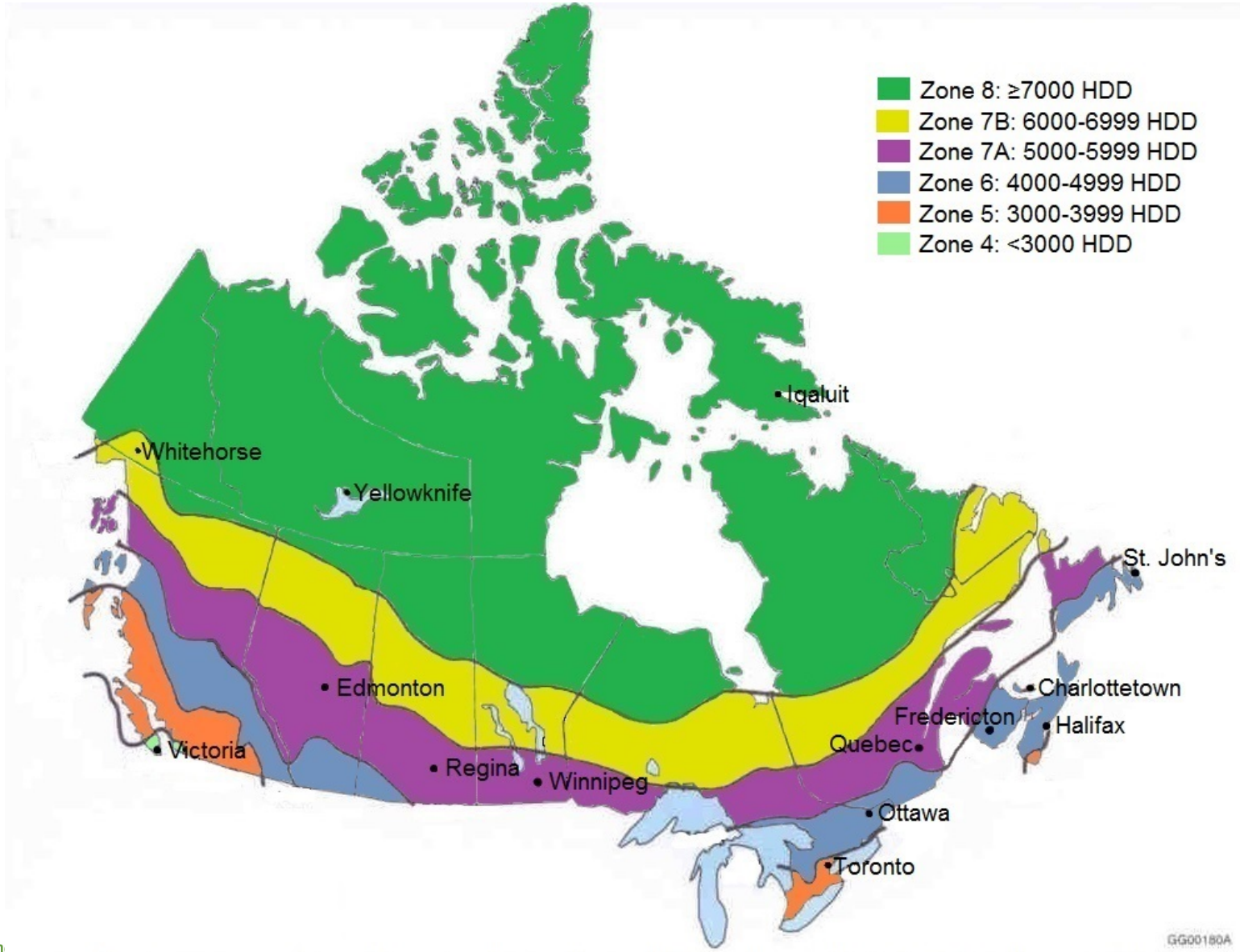
Regional considerations



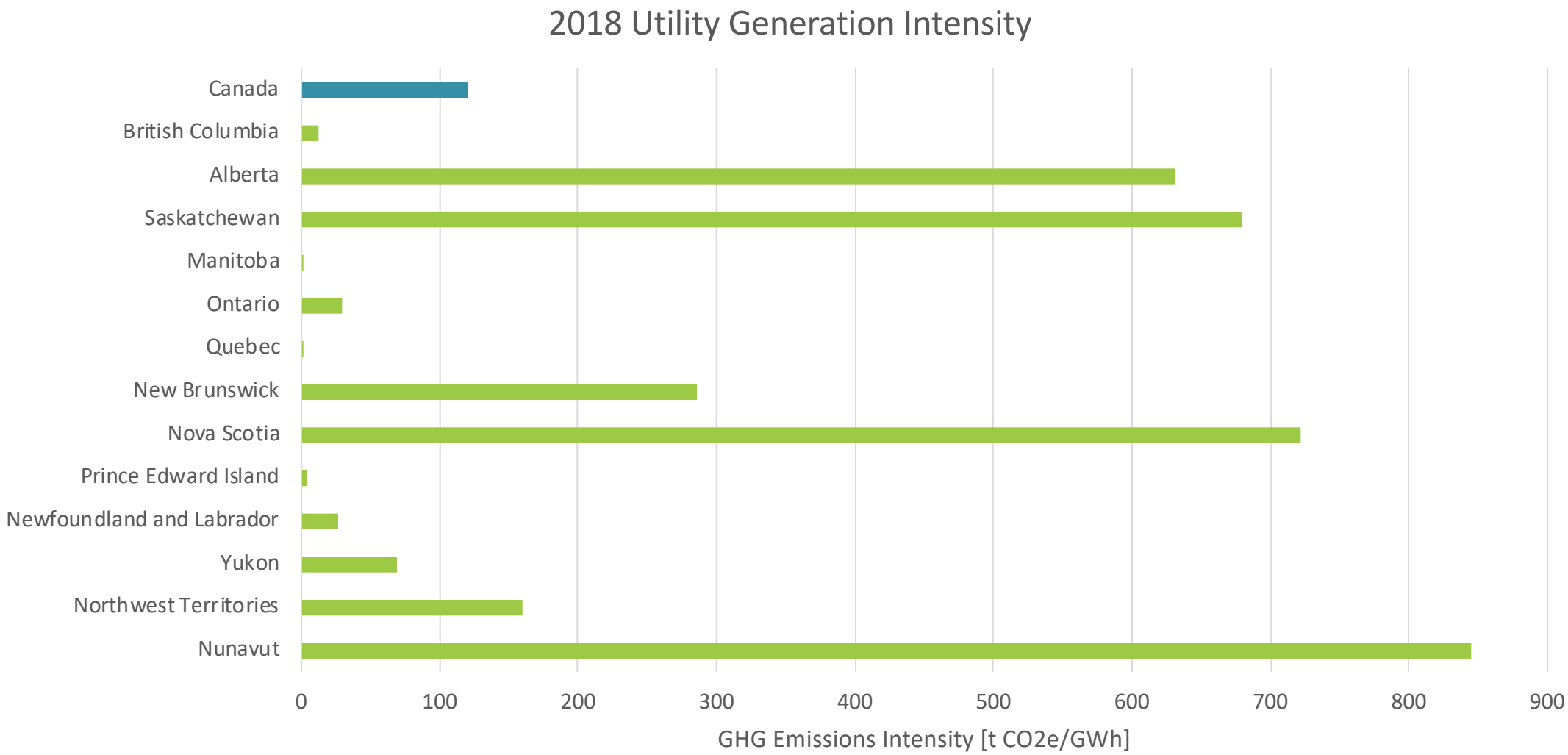


Source: climate.weather.gc.ca

Climate – multiple climate zones



Electricity emission intensity – by region

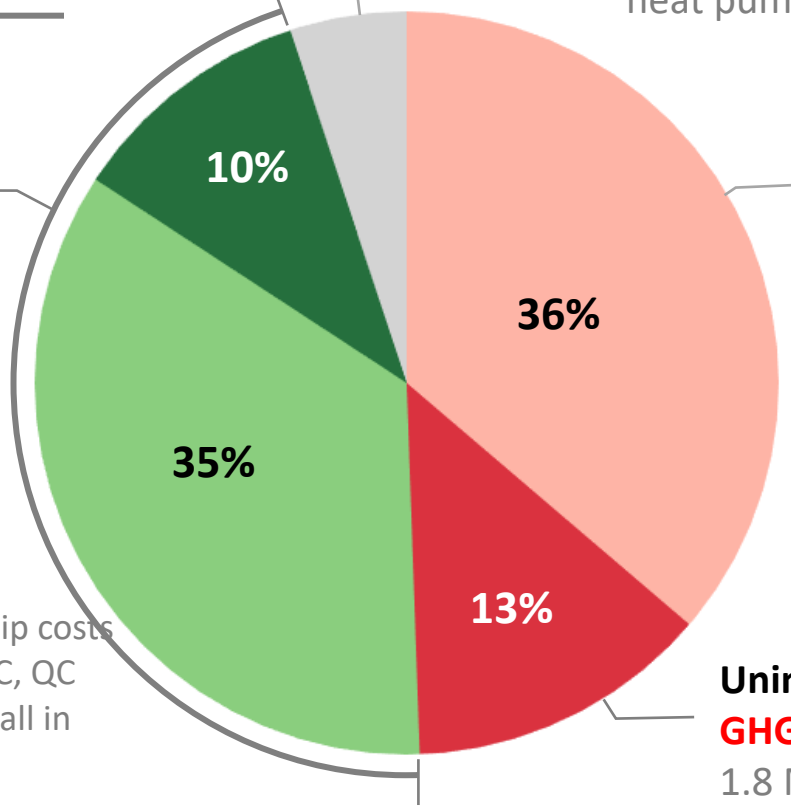


Source: Environment and Climate Change Canada - National Inventory Report 1990–2018

Energy costs play a role

Today, cold-climate electric heat pumps can be cost effective, save energy in 45% of Canada's homes. To a lesser extent there are also opportunities now to reduce GHG emissions.

Electric heat pump opportunities for Canada's 14 million homes:



Low-hanging fruit + the cost-effective alternative:
Costs ↓ in 6.4 M homes;
GHGs ↓ in 2.8 M of those homes*

The toughest nut to crack:
GHGs ↓, Costs ($) ↑
5.1M gas-heated homes

Unintended consequences
GHGs ↑, Costs ($) ↑
1.8 M gas-heated homes

* Electric heat pumps will lower ownership costs in 3.6 M electrically heated homes in BC, QC and MB, but the GHG impacts will be small in these clean electricity markets.

Where heat pumps make sense

- Heat pumps are a very efficient alternative to oil, gas and electric resistance heating.
- When deployed in regions with non-emitting power generation (“clean” grid power), they can also cut carbon emissions.
- New, cold-climate heat pump technology works better in cold temperatures, making the technology more suitable in northern climates.
- In Canada, heat pump potential depends on regional context.

Heat pump performance testing – traditional units

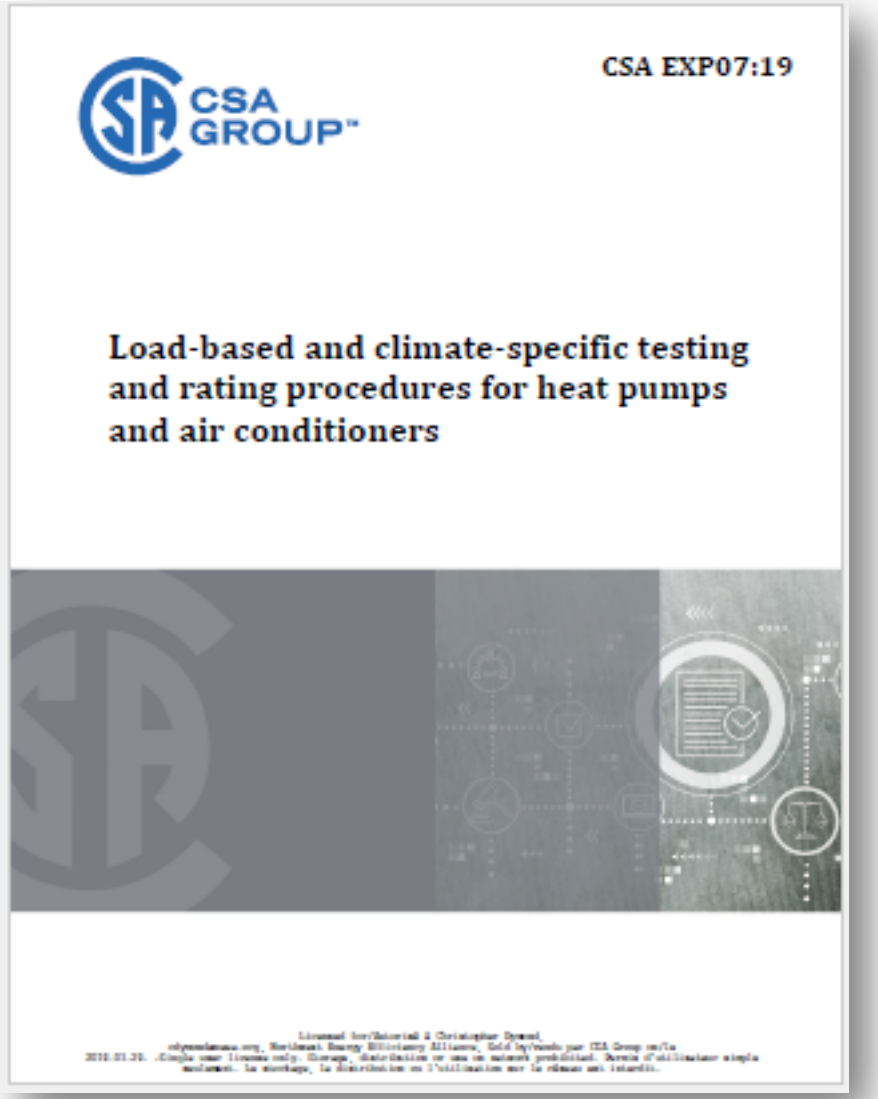
- Traditional testing procedures for heat pumps focus on single capacity unit types.
- Single capacity units are not ideal in low-temperature cold climates.
- Current traditional testing procedures are inadequate for cold climate variable heat pumps.

Heat pump performance testing – variable capacity units

- To ensure energy savings, dependable information regarding unit performance is required.
- Variable capacity heat pumps respond to extremes of low and high temperatures.
- Work is underway to develop a test procedure for a variable capacity heat pump.
- Enhanced procedure evaluates units under actual cold and hot operating conditions, load based test.
- Advantage – allows for dependable comparison of actual performance for units in the market

Standards Development

- Voluntary test procedure
- Variable capacity load based test
- Cold and hot climate specific
- Testing temperature range: -23 °C to 40 °C



The need to validate the new procedure - the three R's

- In the lab
  - **Repeatability** –ability to achieve consistent test results when tests are repeated on the same unit at the same laboratory
  - **Reproducibility** – ensuring test results can be replicated in different laboratories
- In the field
  - **Representativeness** – how laboratory results represent the performance from field tested units operating under real world conditions

Recent work

Repeatability and reproducibility

- Extensive support for laboratory testing – participated in testing of 19 units, with 10 units funded by Canada

Representativeness

- Collect field data for residential cold climate heat pumps in different climate regions of Canada
- Field testing projects across the country
- Collaborative efforts with provinces, utilities, industry

Resources

- NRCan's Air Source Heat Pump Sizing and Selection Guide – September 2020

Collaboration with Heat Pump Coalition

Federal Governments

- Natural Resources Canada
- US Environment Protection Agency

Regional organizations

  - Northwest Energy Efficiency Alliance,
  - Northeast Energy Efficiency Partnerships,
  - Midwest Energy Efficiency Alliance,

California Energy Commission

Utilities, non-profits, cities, and research organizations

Closing Remarks

- Collaboration is the key to finding solutions to complex problems.
- The increasing shift of heat pump technologies to variable capacity and use in cold climate conditions requires a test procedure that represents the true performance of the unit.
- Canada is working on a number of fronts to better understand the expected energy performance from these units.

Thank you

Kimberly Curran, MASc, P. Eng.

Chief Standards Development
Office of Energy Efficiency – Natural Resources Canada