Ground-Source Heat-Pumps

January 2009

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Overview

- Technology
- Economics
- Environment
- Diffusion

A Familiar Technology

source:http://www.sellortrade.biz/buttons/Lge%20GE%20refrig%20005%20copyfinal.jpg
http://images.lowes.com/product/883049/883049017747.jpg

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Energy Losses: in conversion & delivery

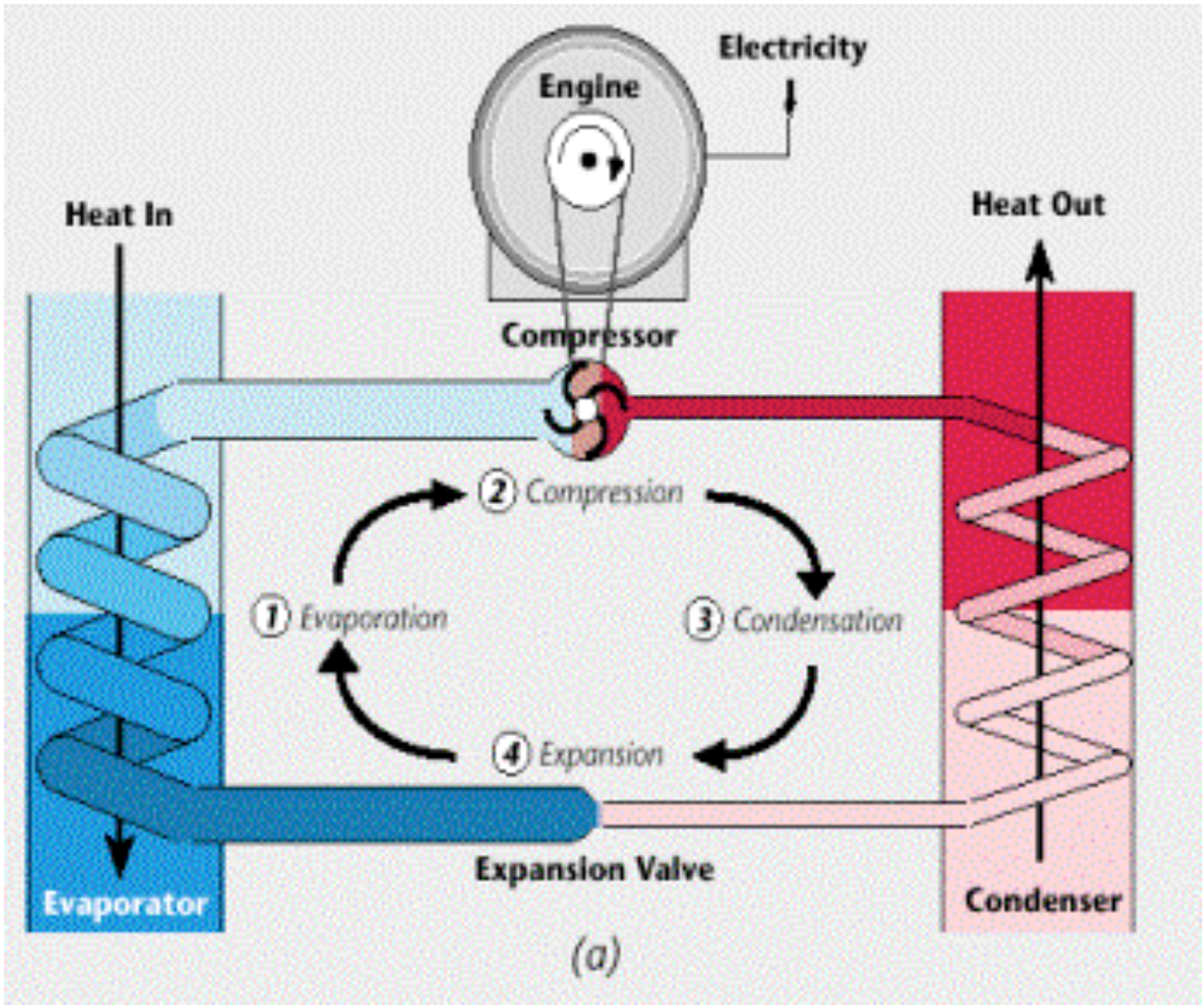
- The most efficient boilers using fossil fuels deliver 90% of the energy in the fuel as an energy service -- more typically we get 65-75%.
- Electric radiant heat can be 99% efficient, but 2/3 of the fossil energy is lost in producing and delivering the energy to the point of use.
- Heat pumps are a familiar product, we use them in refrigerators. They use as little as 1 unit of electricity in delivering 5 units of heat -- more typically 350% efficiency.
- Ground-source heat pumps are also 30 to 50% more efficient than conventional air conditioning.
- *Most consumers use both heat and air conditioning. Investing in GSHP allows greater efficiency in delivering both services, saving more than 50% in energy costs.*

Heat-pumps

A heat pump can move heat against the gradient of temperature -- e.g., cooling the inside of a refrigerator.

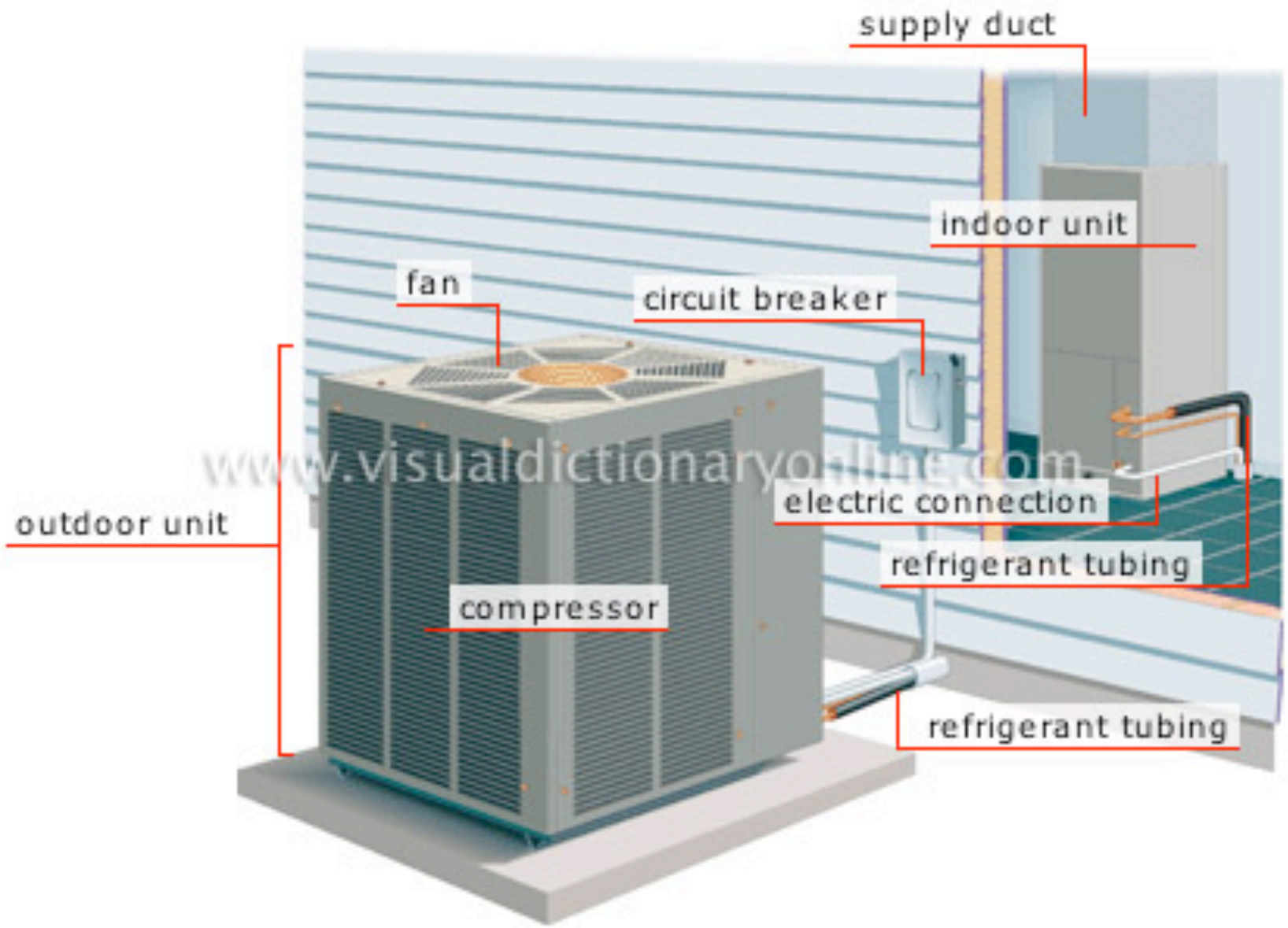
In this diagram, heat is taken from a cooler source and dispersed into a warmer environment -- e.g., heating your home.

Heat-pumps can be reversible, working to move energy in both directions



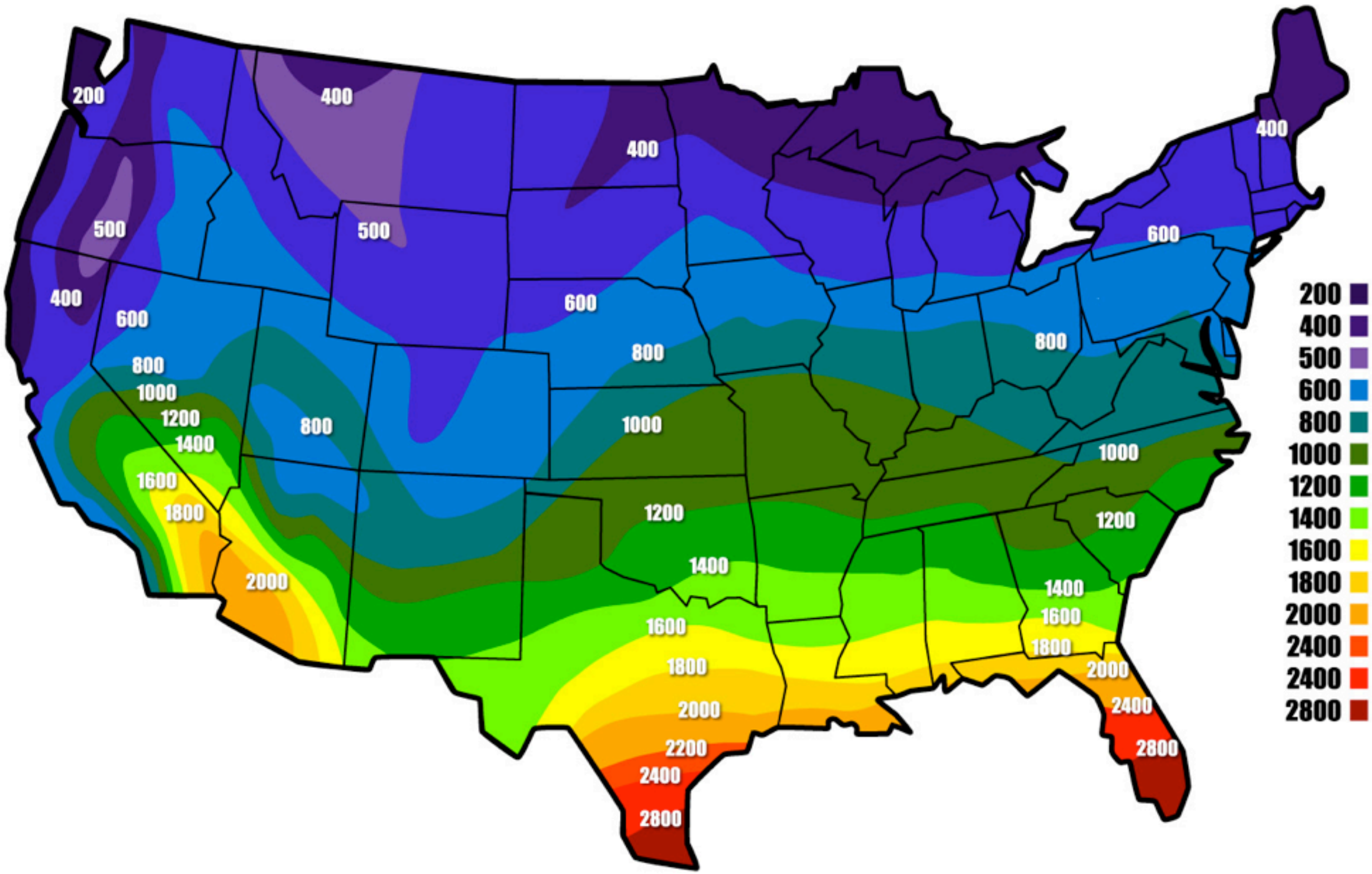
http://www.esru.strath.ac.uk/EandE/Web_sites/01-02/heat_pump/hpexplain.gif

Air to Air Heat Pumps



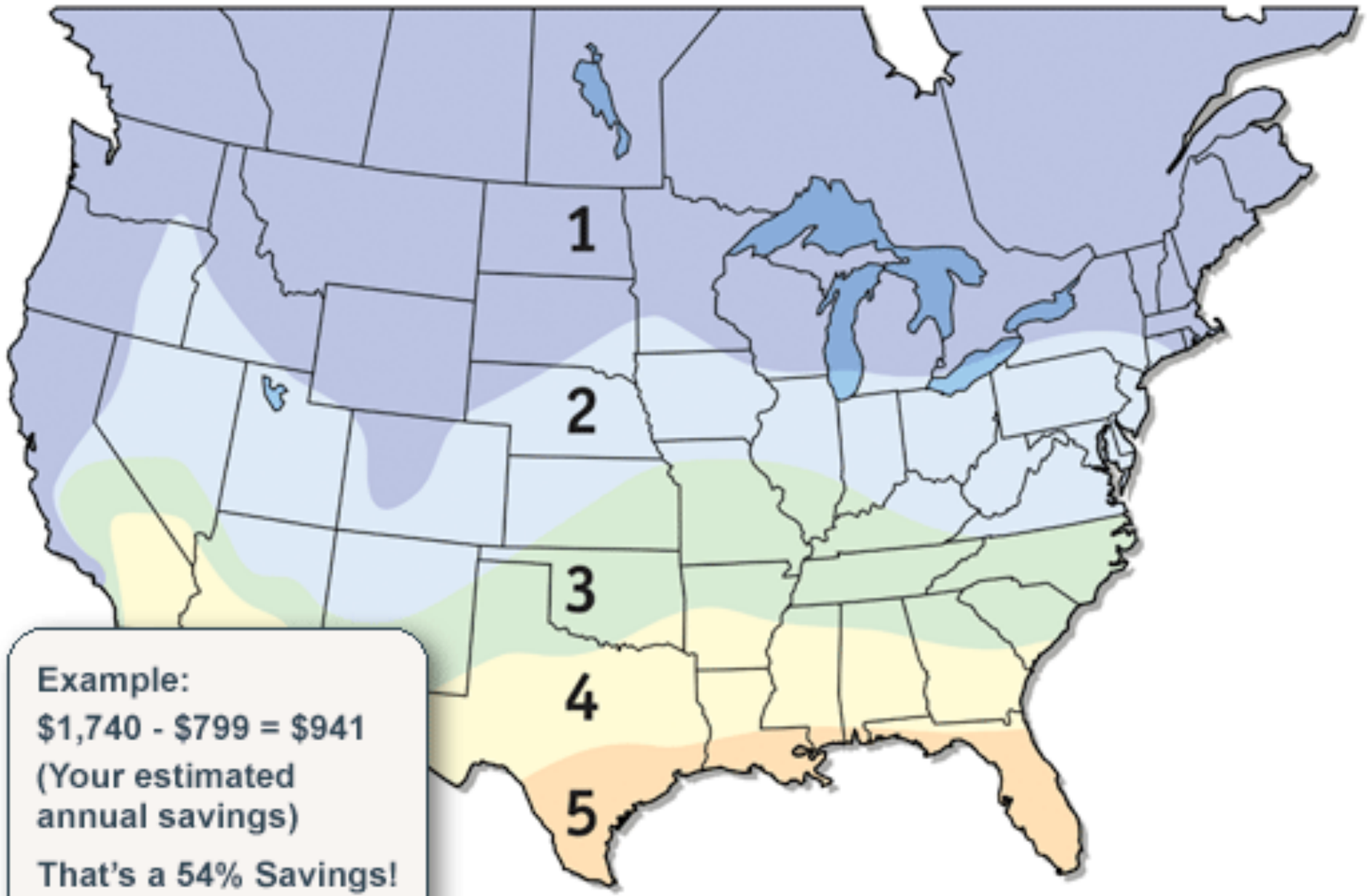
source: http://visual.merriam-webster.com/images/house/heating/heat-pump_2.jpg

Initially Used for Cooling



source: http://www.northernac.com/seerChart.htm

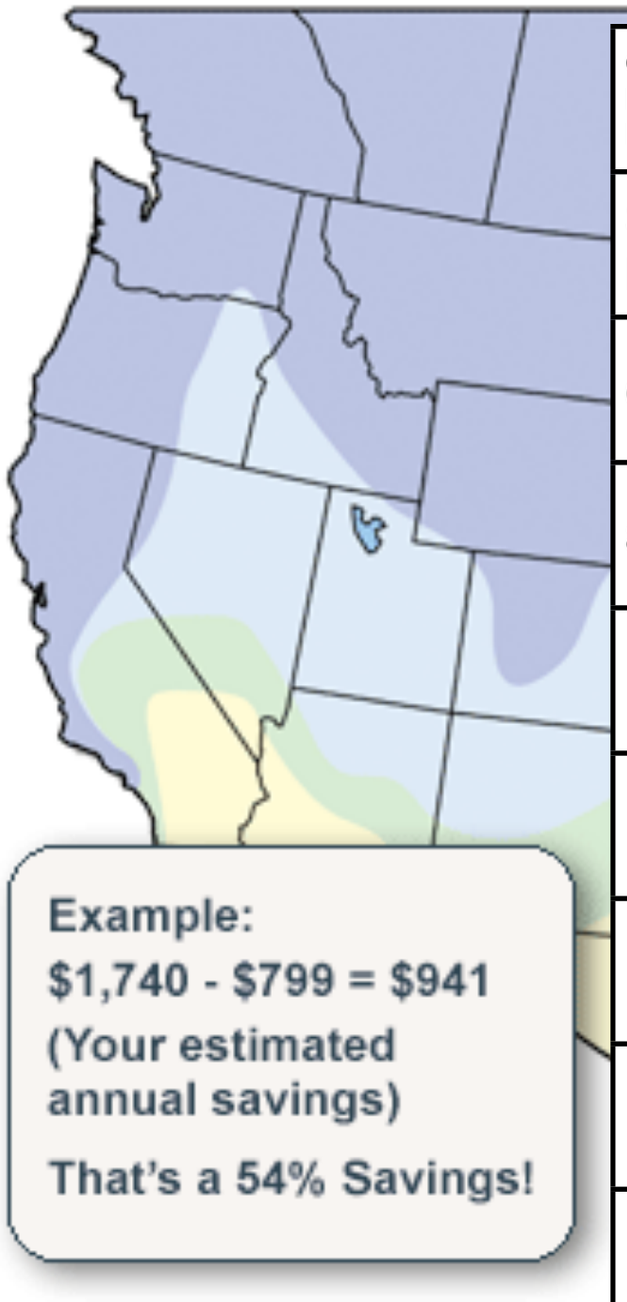
Now for Heating & Cooling



Example:
$1,740 - $799 = $941
(Your estimated annual savings)

That's a 54% Savings!

Now for Heating & Cooling



Cooling/ Heating Efficiencies	Approximate Annual Cooling/Heating Operating Costs				
SEER/ HSPF	Zone 1	Zone 2	Zone 3	Zone 4	**Zone 5**
6/6.0	$1,803	$1,672	$1,731	$1,723	**$1,740**
8/6.0	$1,591	$1,450	$1,470	$1,458	$1,398
10/7.5	$1,358	$1,229	$1,294	$1,280	$1,151
12/8.0	$1,246	$1,118	$1,114	$1,101	$1,004
13/8.5	$1,174	$1,025	$1,046	$1,034	$939
14/9.0	$1,101	$985	$978	$966	$873
15/9.25	$1,053	$936	$921	$908	**$799**

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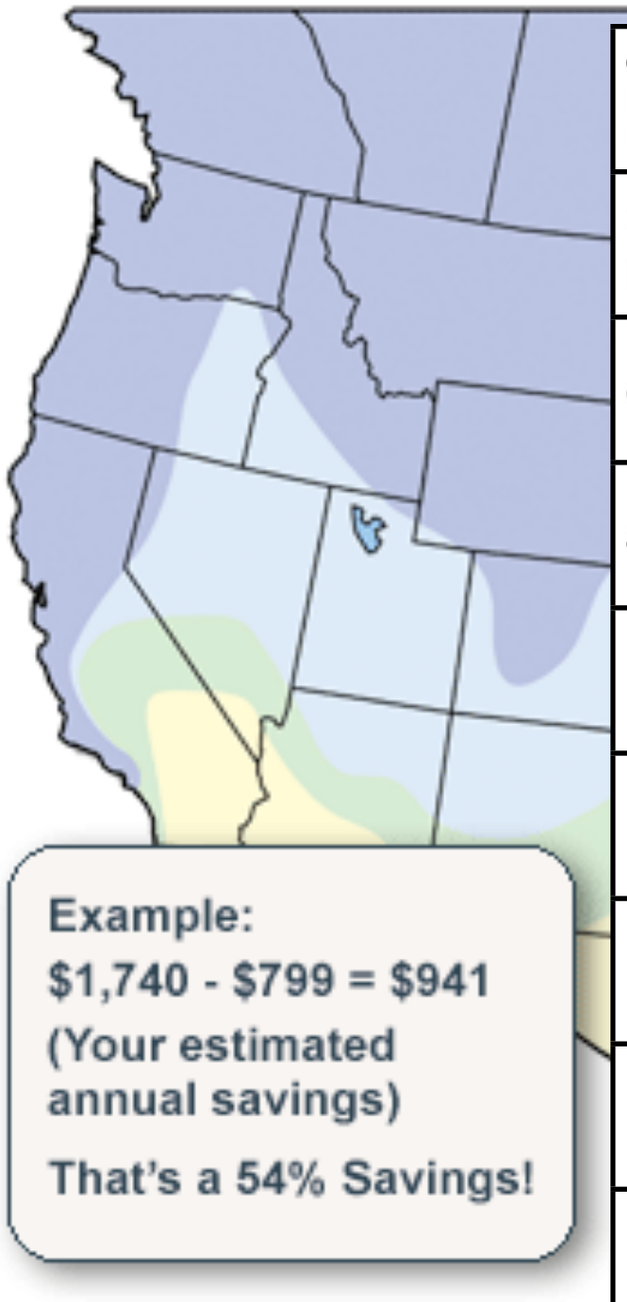

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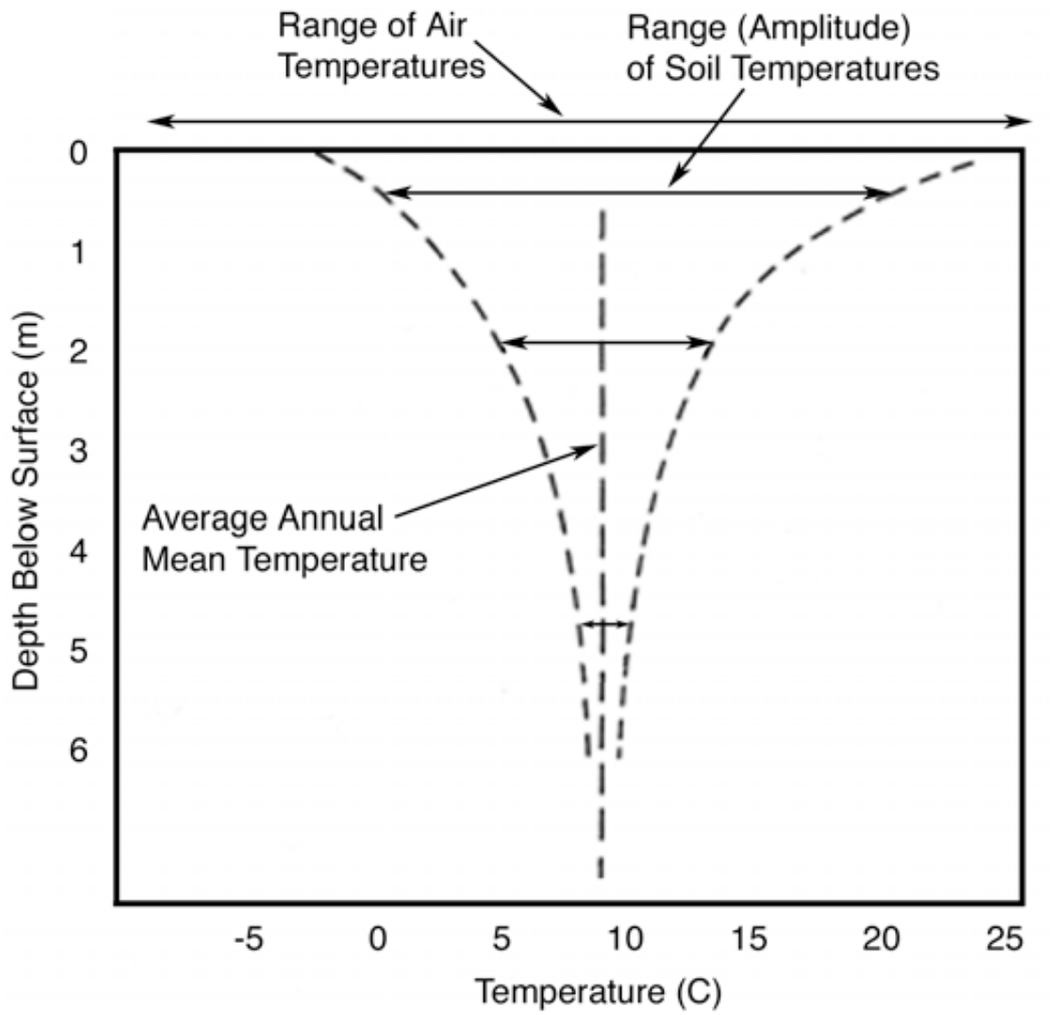
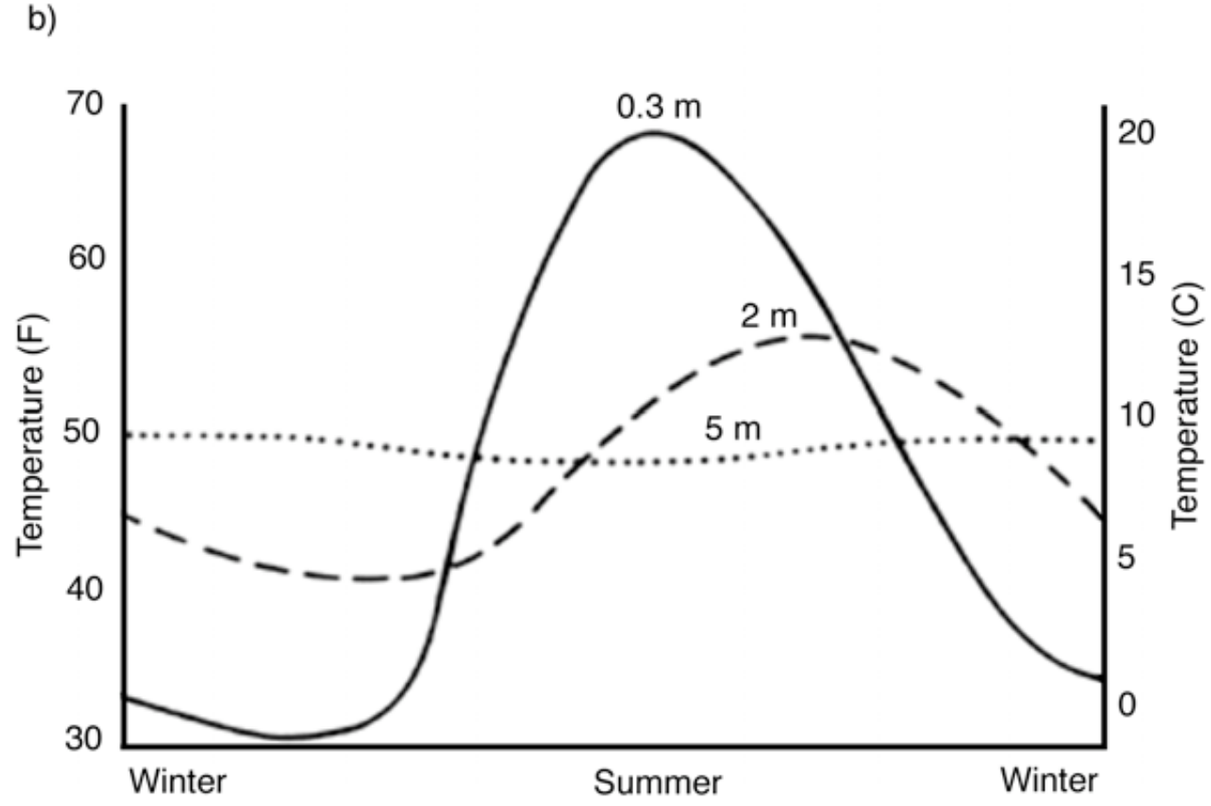
Compressor Icing

source: ee-hi.com/cooling.htm

Average Air and Ground Temperature

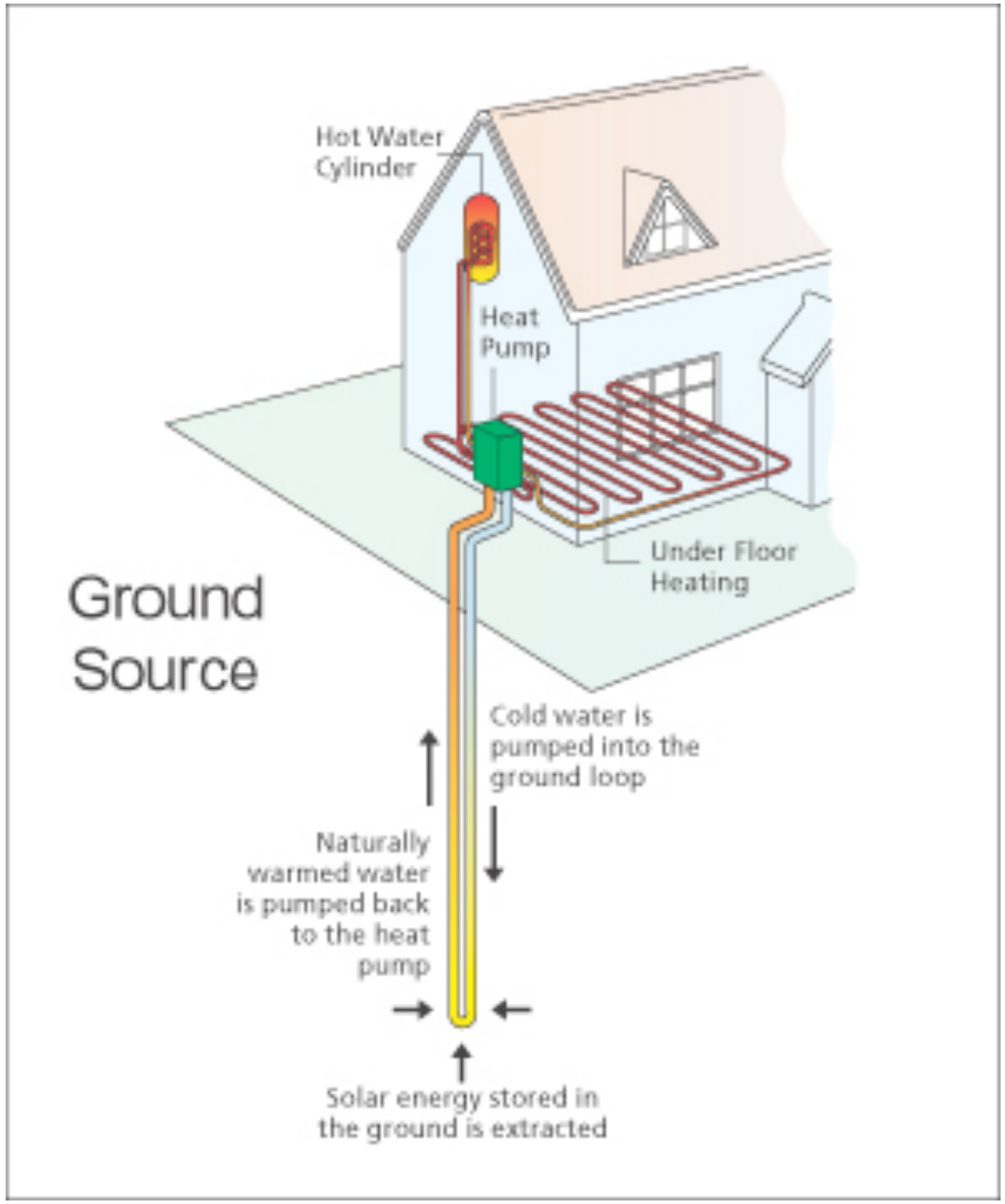




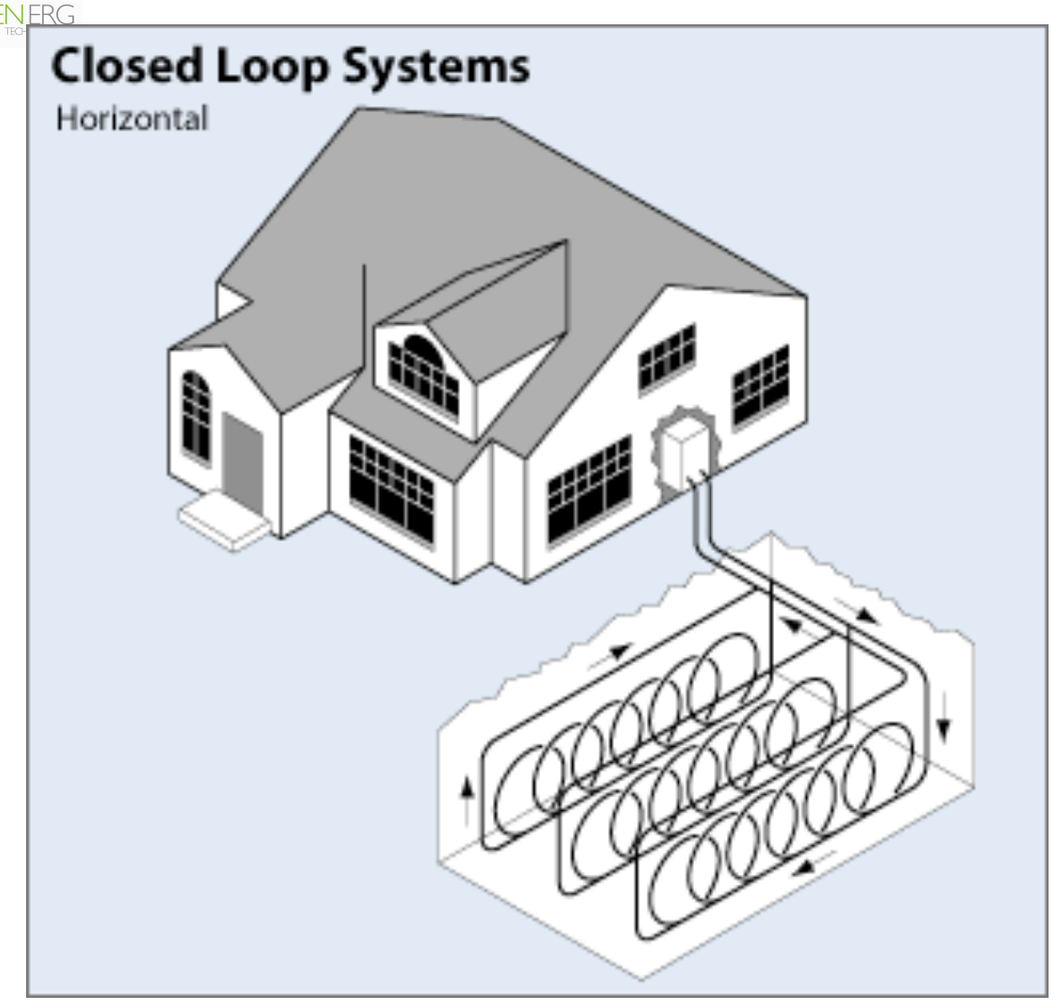
The ground averages out the air temperature of a region. At 5 meters depth, the ground temperature is at the average annual temperature. Heat exchange coils at that depth can draw on thermal reservoirs that are much cooler than the air in the summer and much warmer in the winter.

Ground-source heat-pumps

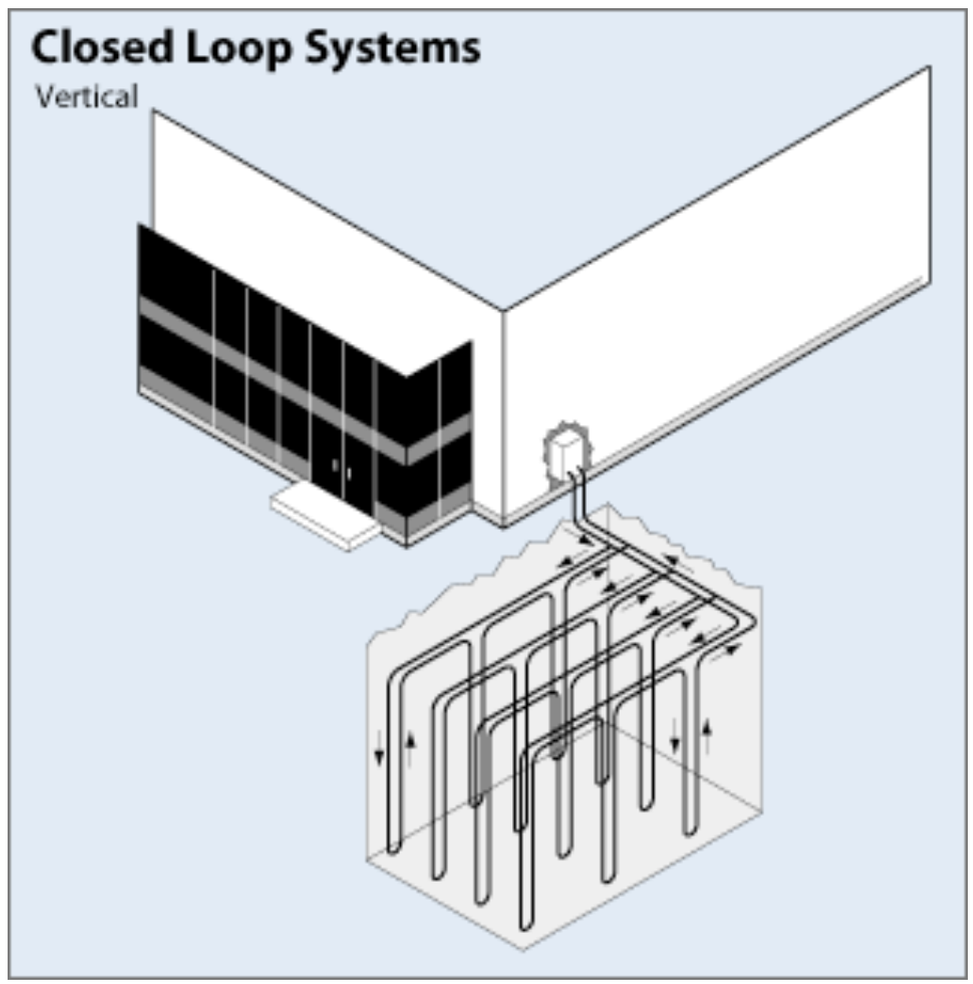
Ground-source heat-pumps use the ground as the source or sink for heat.



Ground heat exchange loops



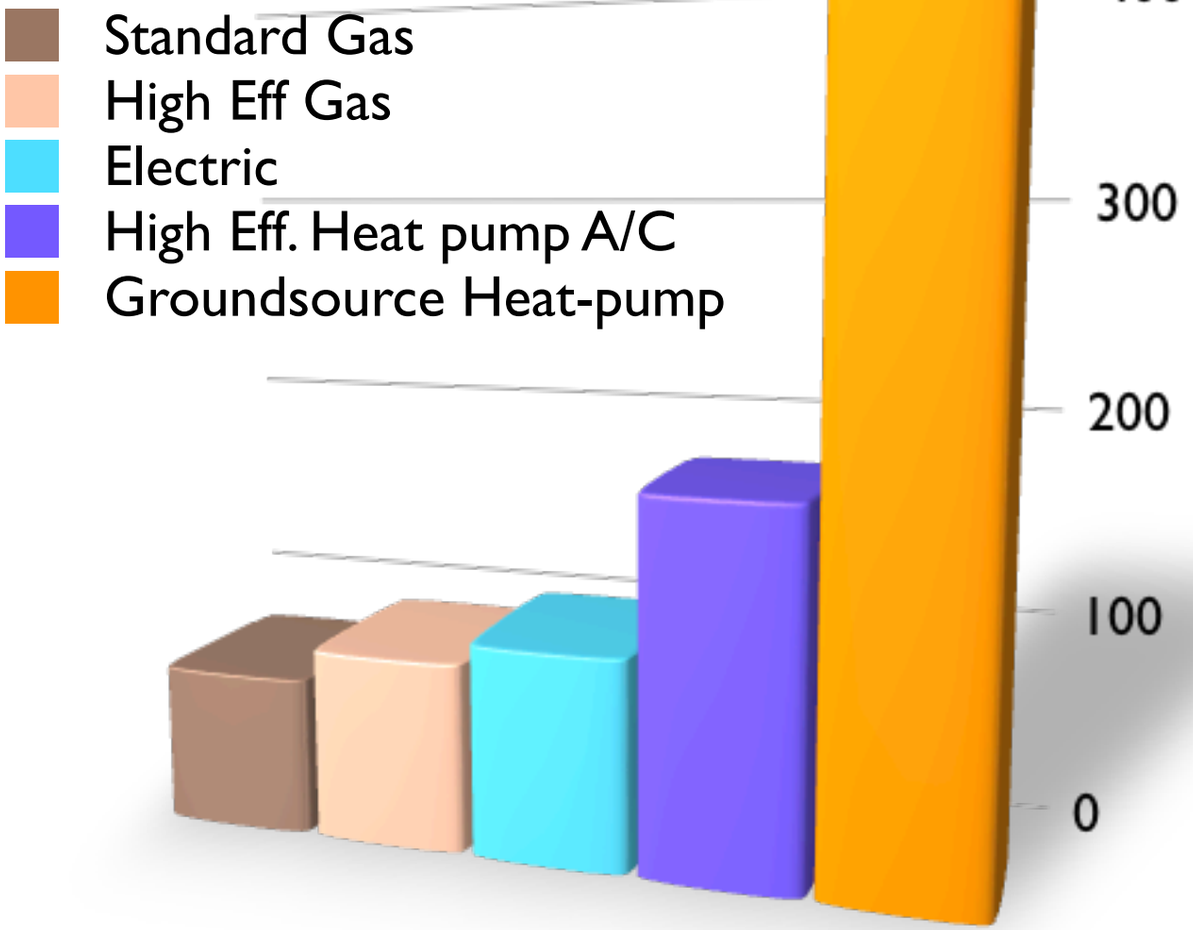
Where there is access to sufficient land, horizontal loops can be employed. These cut the cost of installation significantly



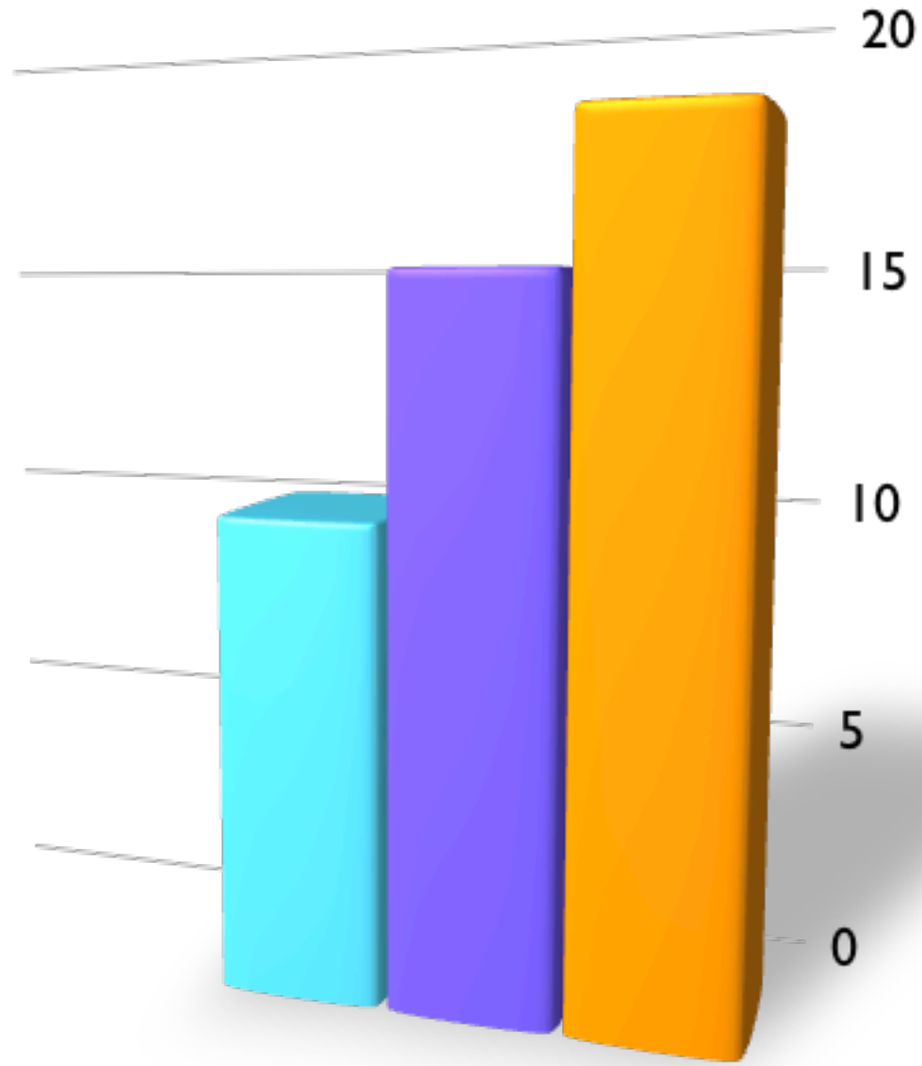
Where there is less land, deep bore-holes are needed to achieve the same exchange volume. Bore-holes typically account for 50% of installation costs.

Systems efficiencies compared

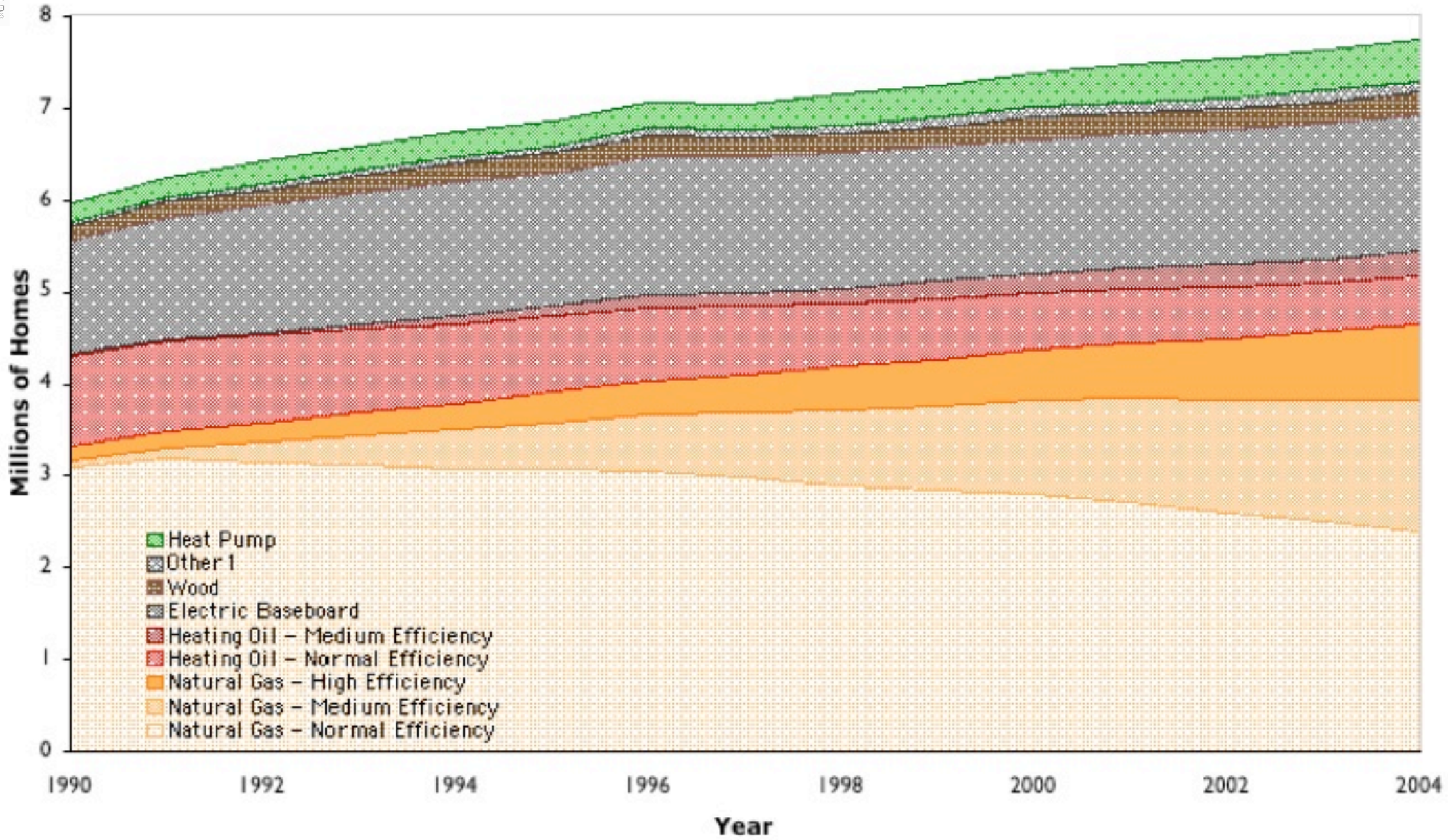
Heating Efficiency (COP)



Cooling Efficiency (EER)



The Trends So Far



Opportunities in Canada
units installed/yr

Region	Natural Gas	Electric Baseboard	Heating Oil	Heat Pump
Newfoundland		1,700	300	100
PEI		<100	300	< 100
Nova Scotia		500	1,200	500
New Brunswick		2,100	1,000	300
Québec	2,100	5,300	3,500	5,800
Ontario	76,000	900	4,100	10,000
Manitoba	6,300	700	700	400
Saskatchewan	7,200	<100	100	300
Alberta	30,000	600	400	800
British Columbia	15,000	800	800	1,400
Territories	100	< 100	200	

Carbon Intensity of Electricity Source

($gmCO_2/kWh$)

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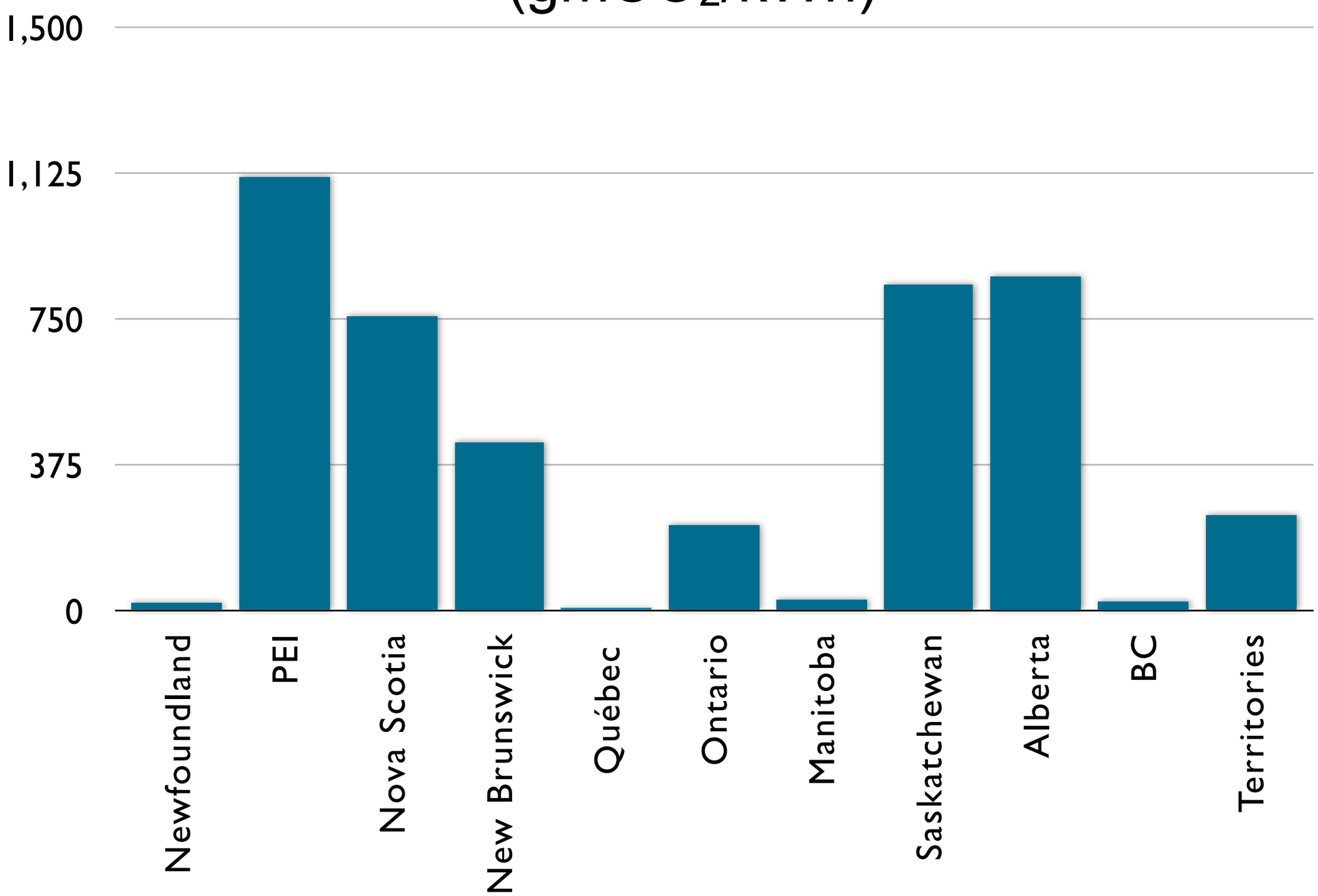
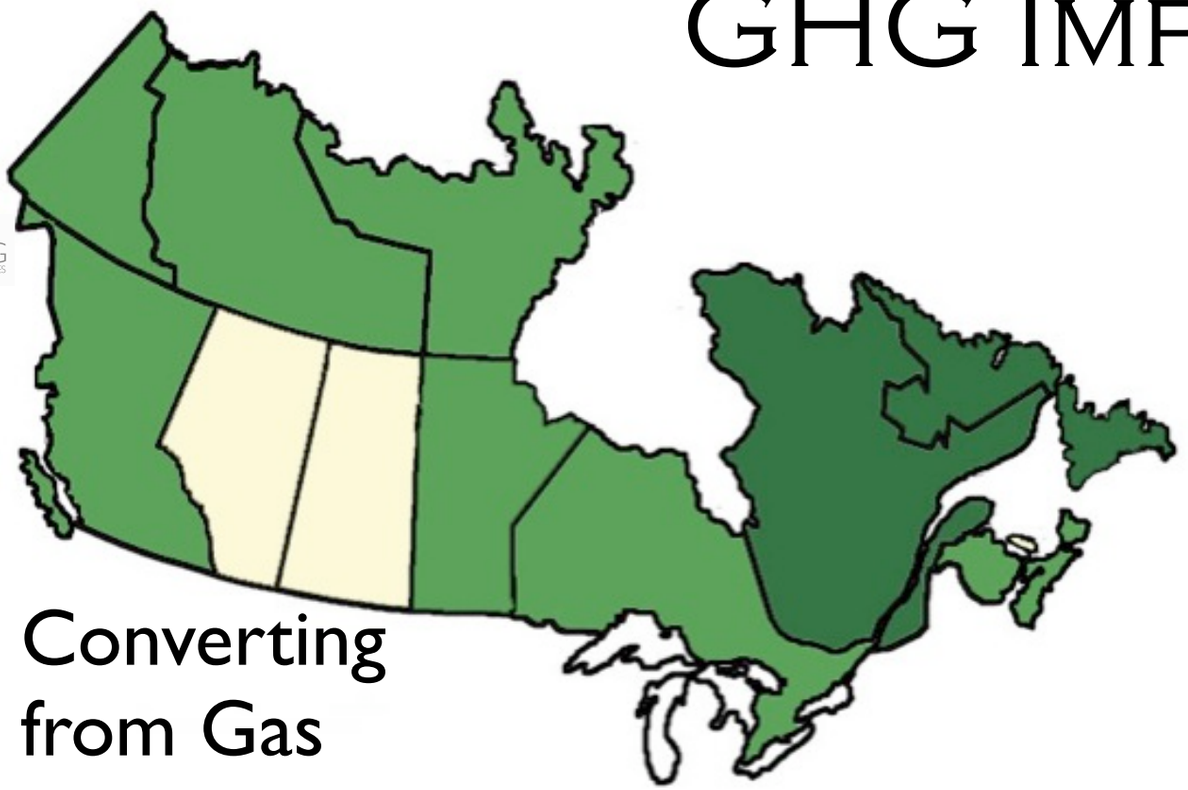


GHG Impacts



Converting from Gas

>5 t /yr savings

1-5 t /yr savings

<1 t /yr savings

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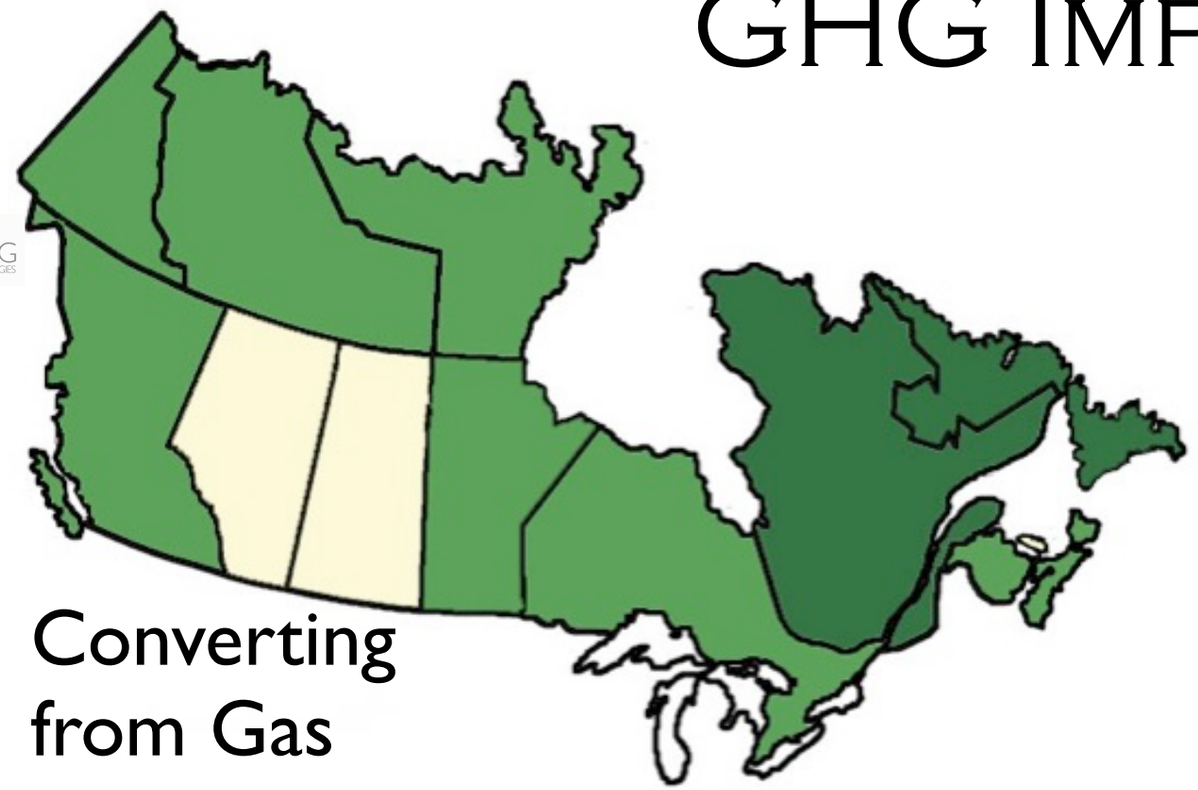

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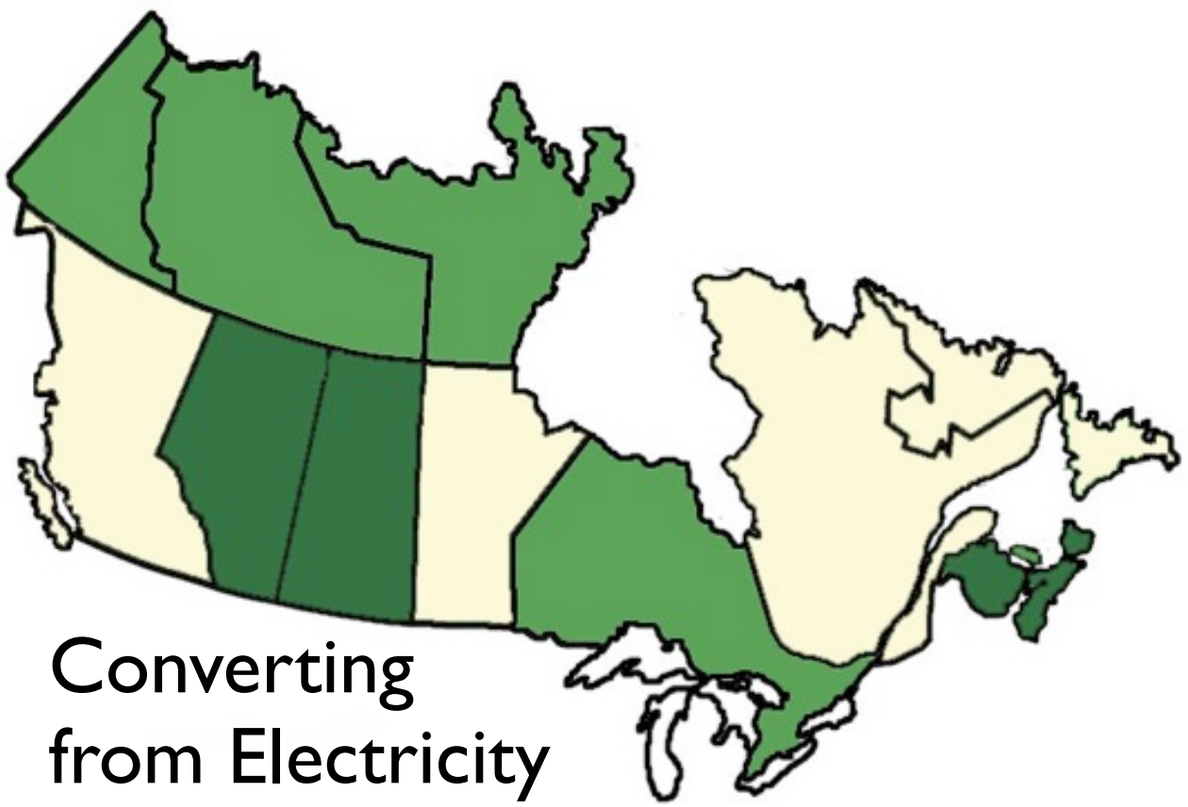

Converting from Electricity

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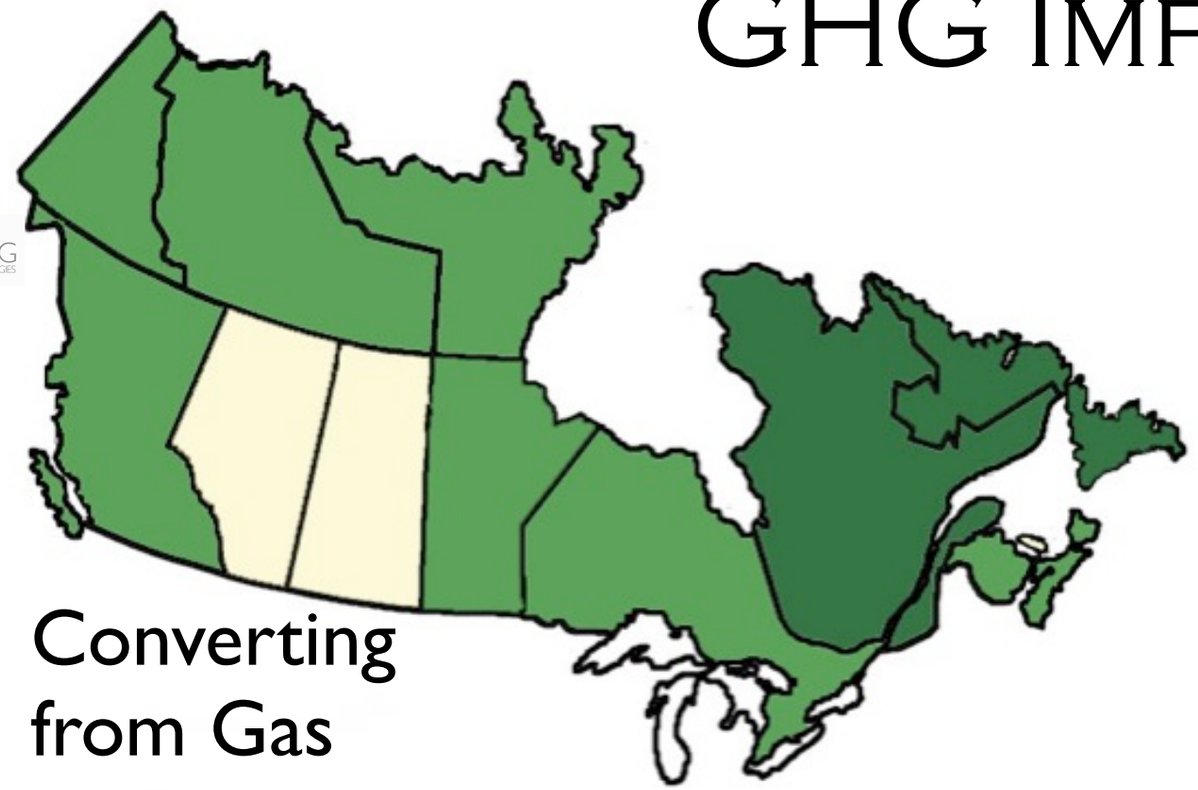

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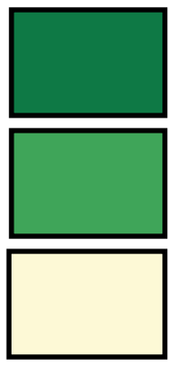

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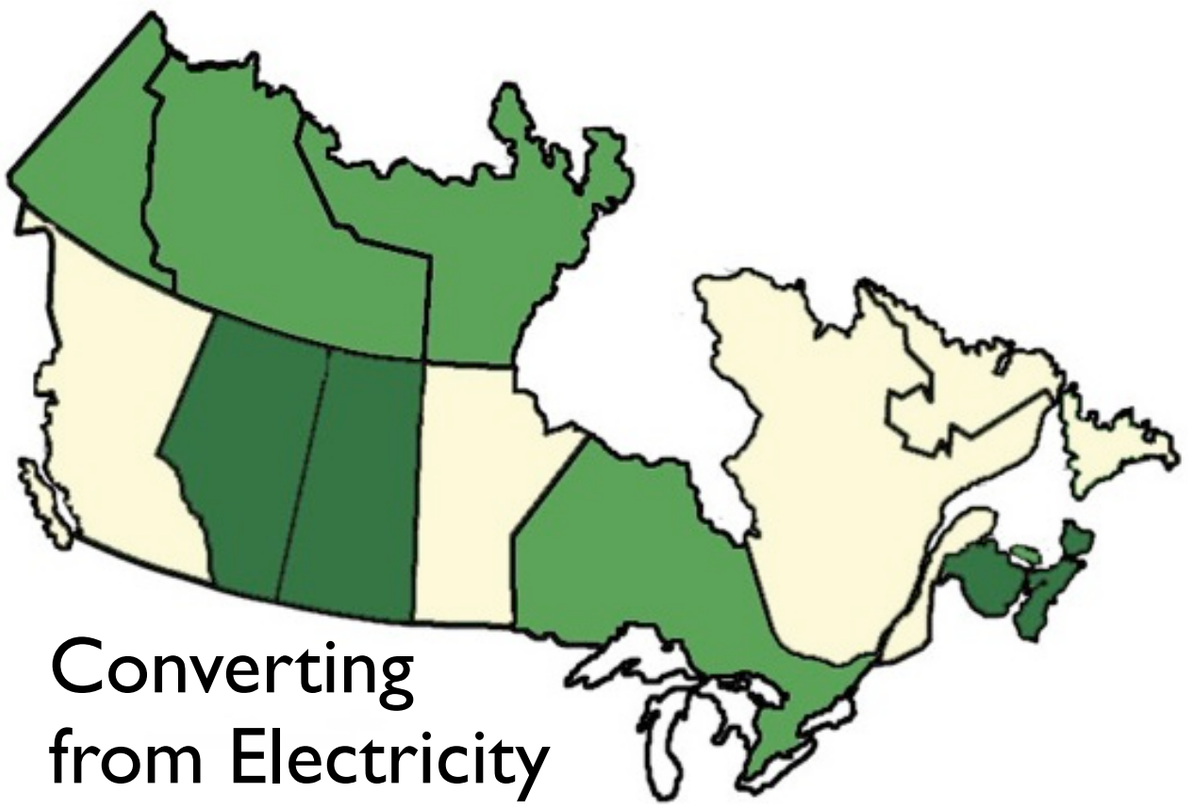

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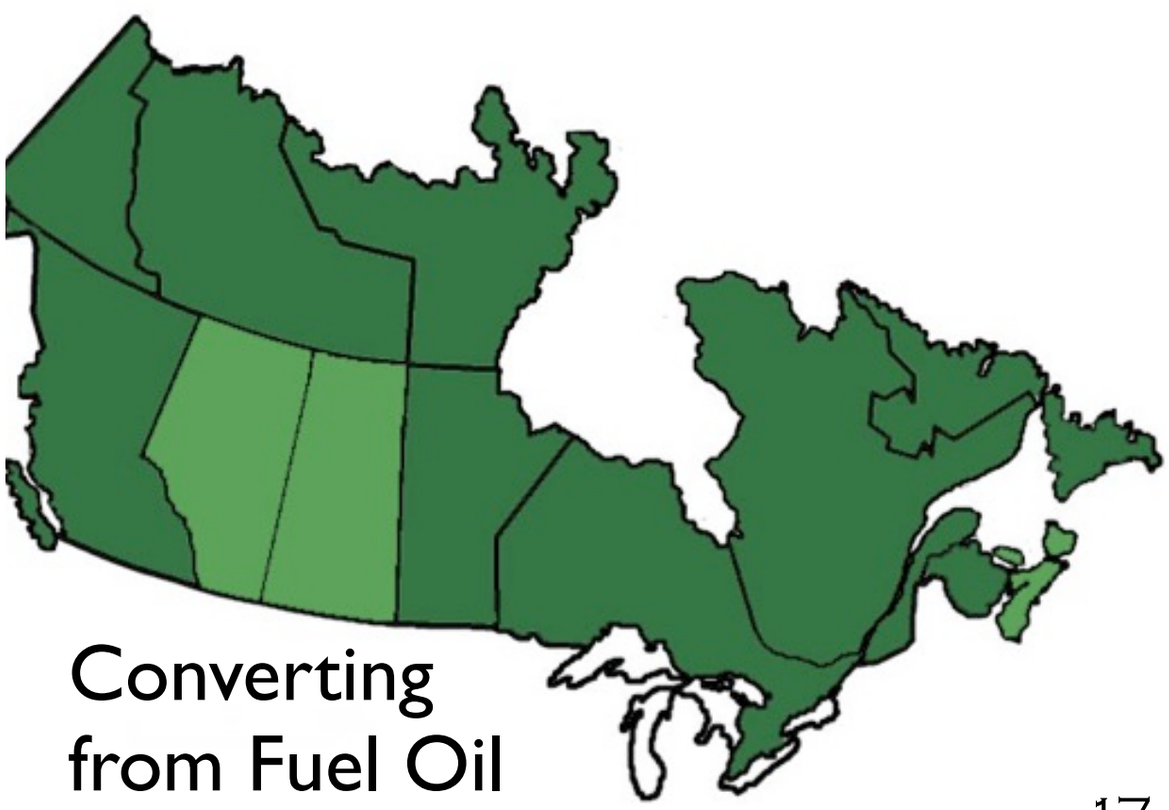
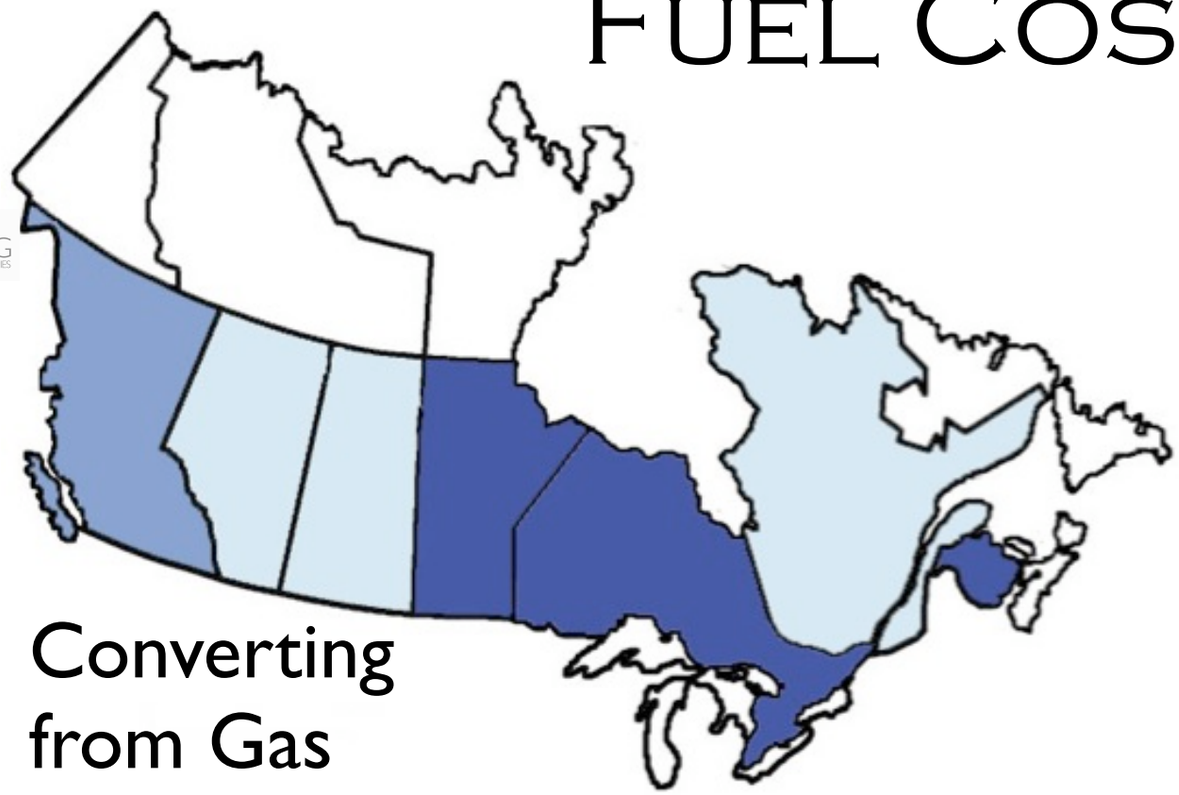


Converting from Fuel Oil

Fuel Cost Savings



Converting
from Gas

>$1000/yr

$500-1000/yr

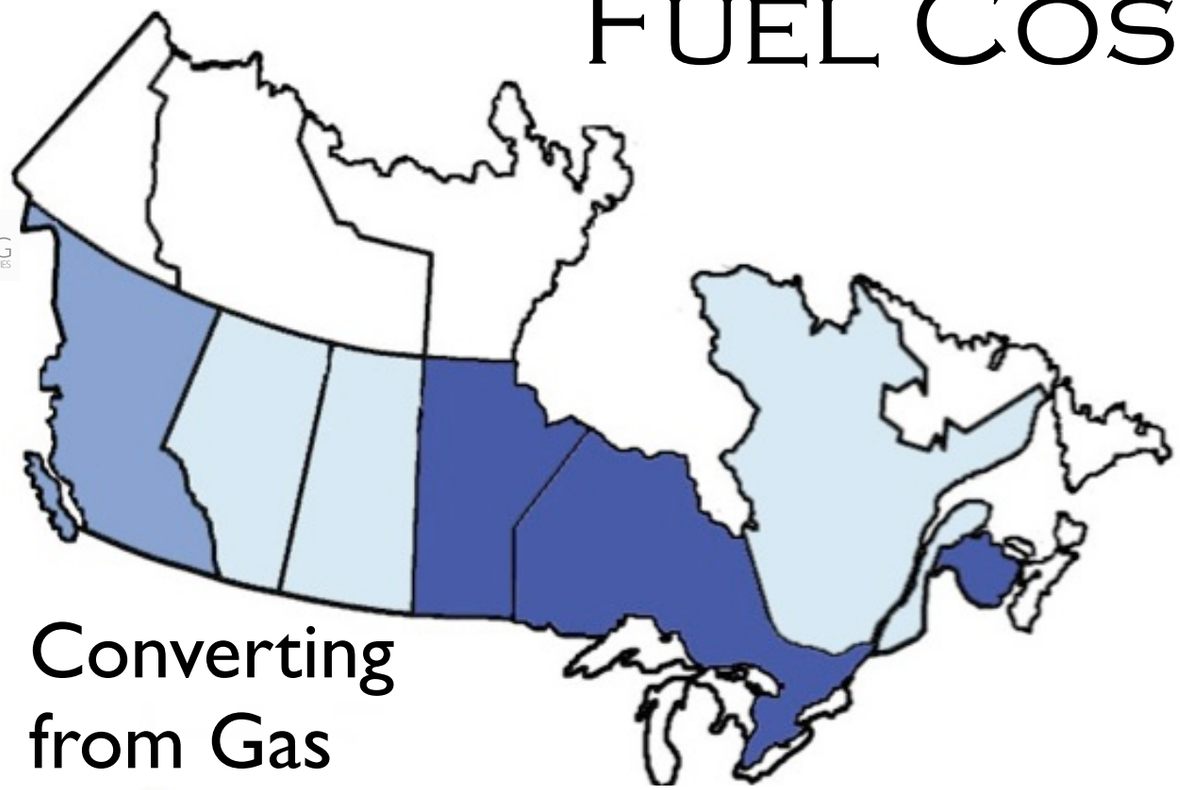
$1-500/yr

not applicable

Converting
from Electricity

Converting
from Fuel Oil

Fuel Cost Savings



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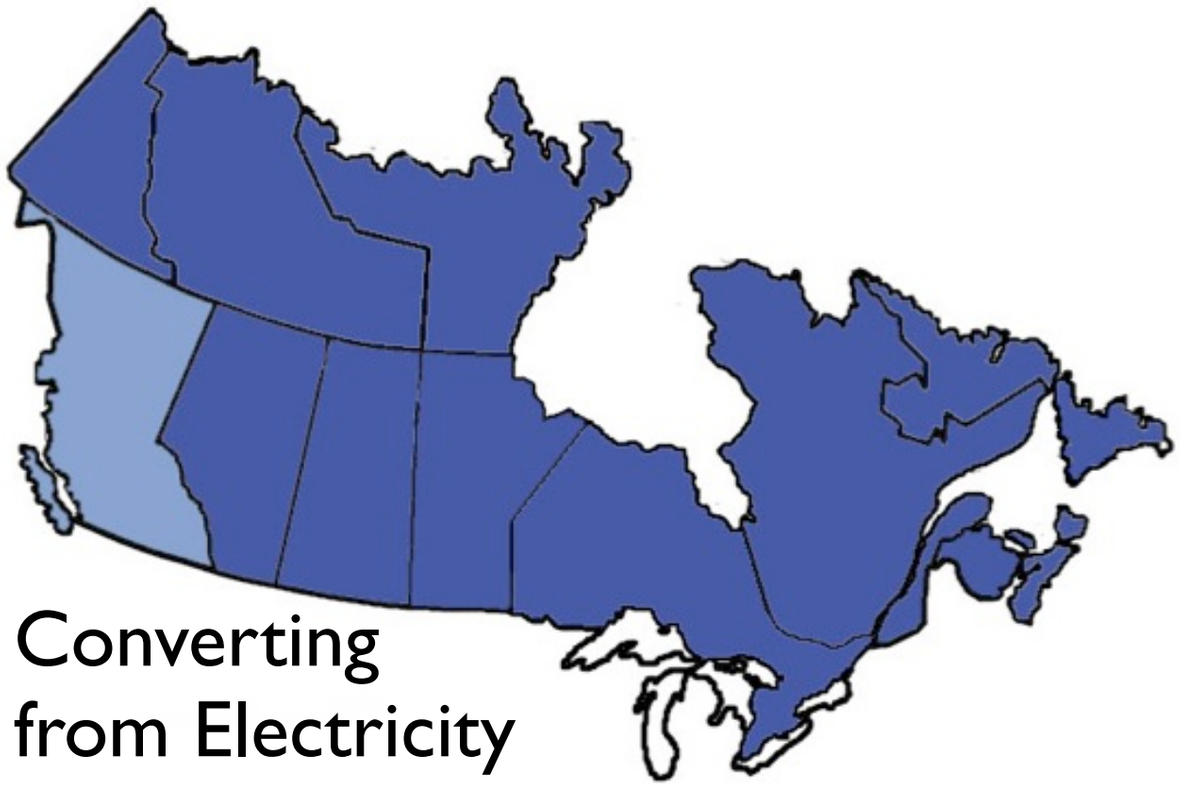

Converting from Electricity

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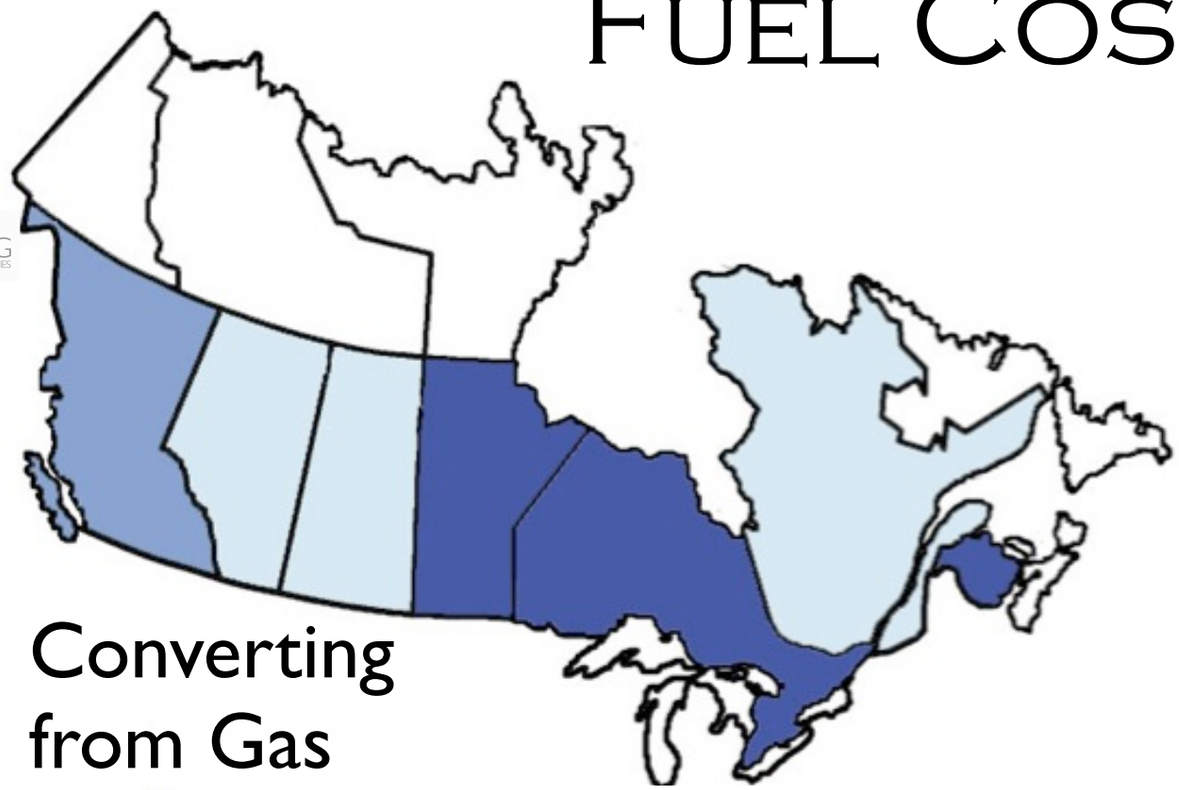
not applicable

Converting from Fuel Oil

Fuel Cost Savings



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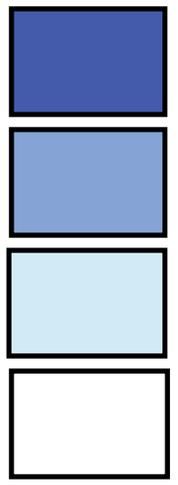

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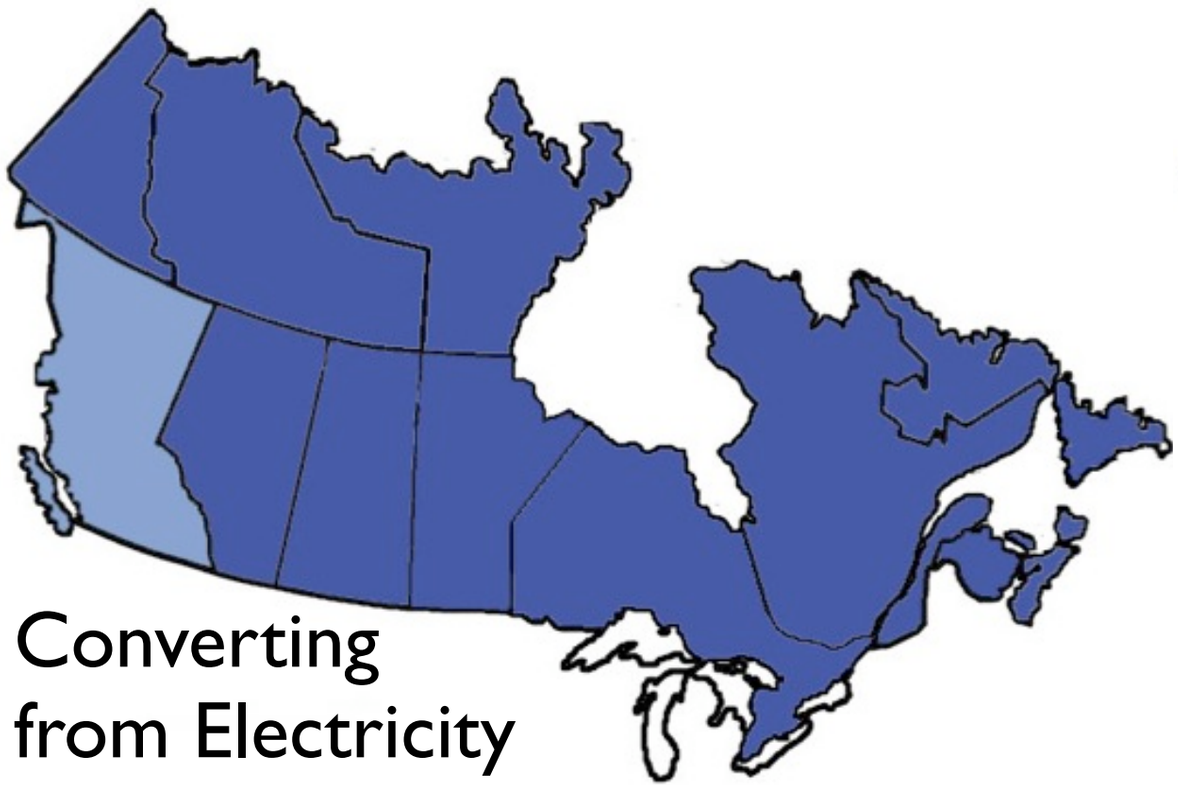

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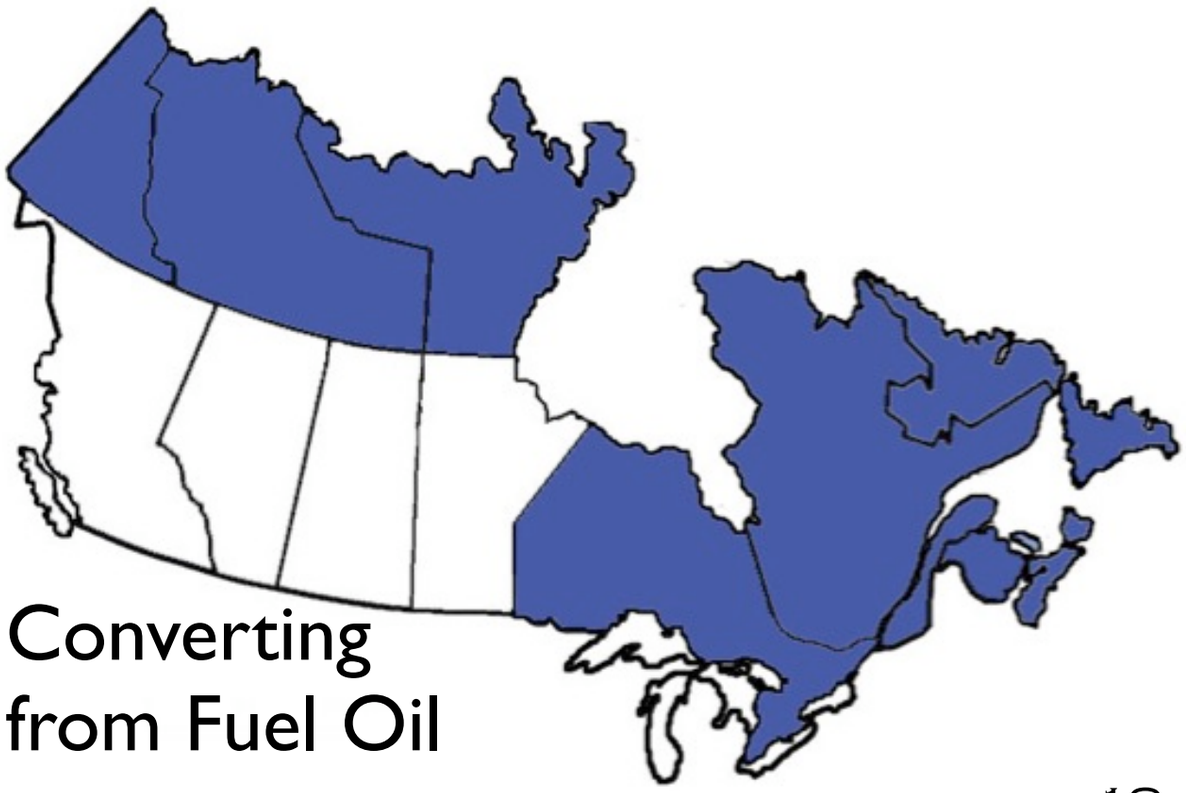

Converting from Fuel Oil

The Potential:
% of Heating Using Same Electric Energy Used in Radiant Heat

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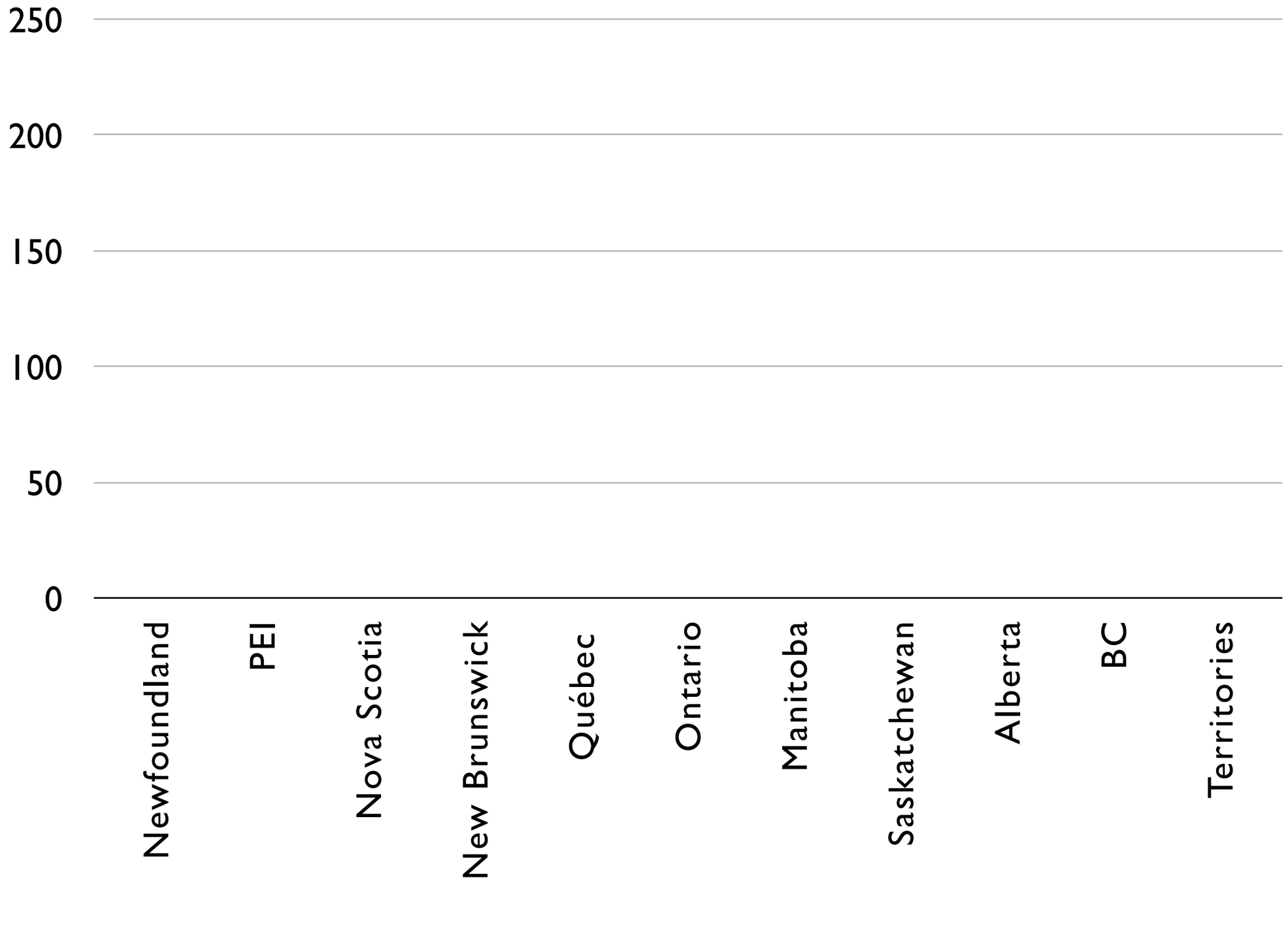

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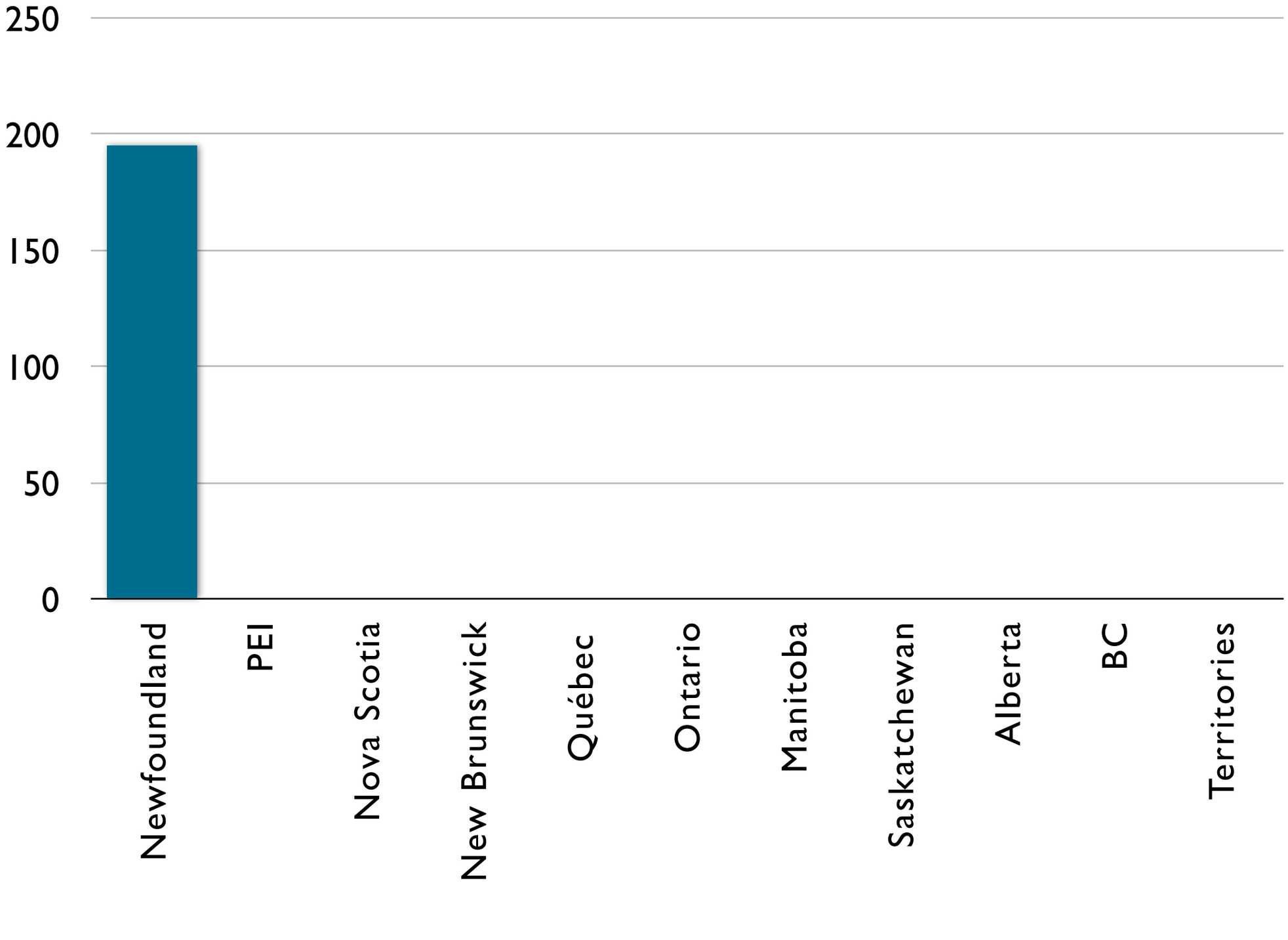

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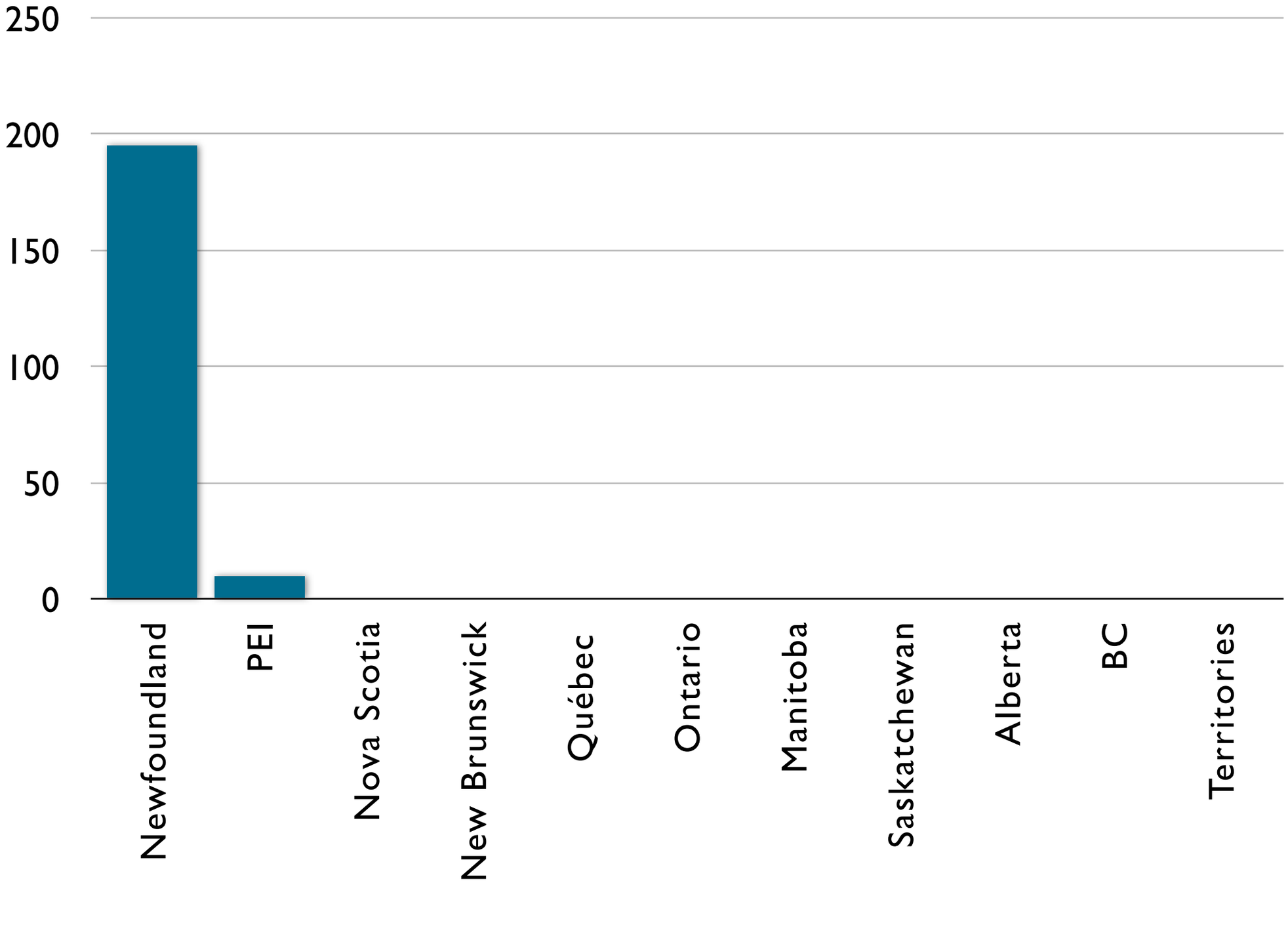

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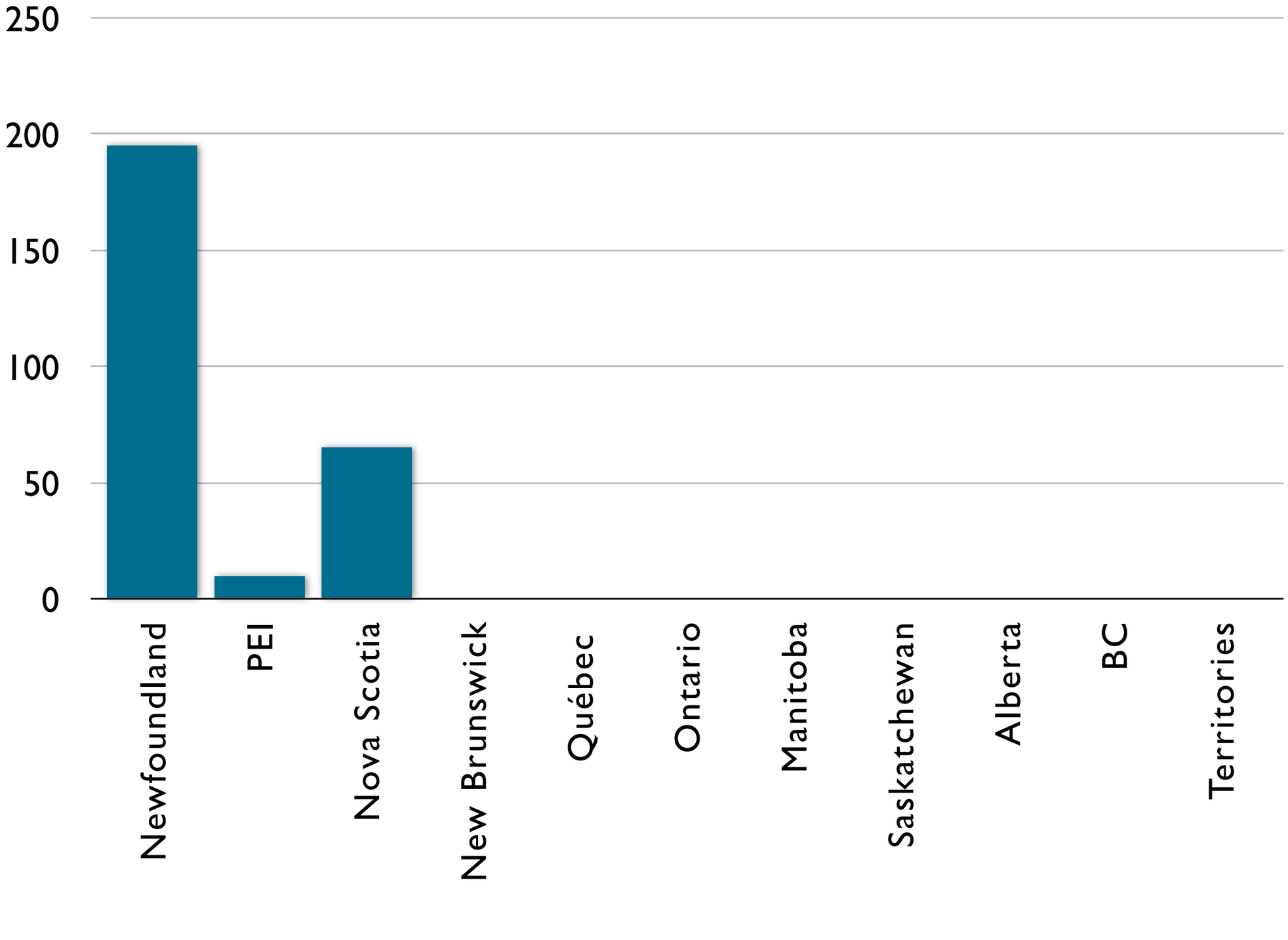

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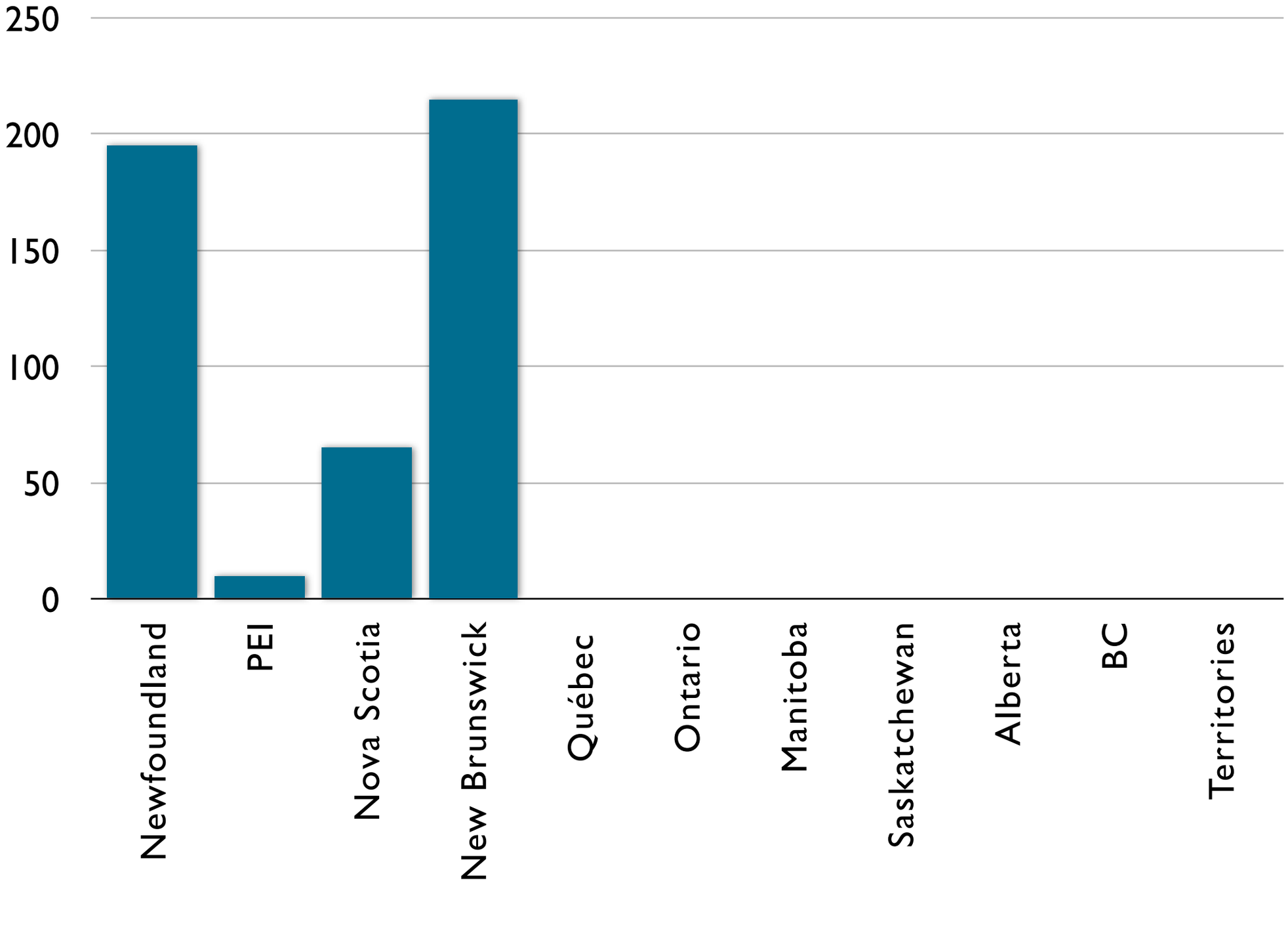

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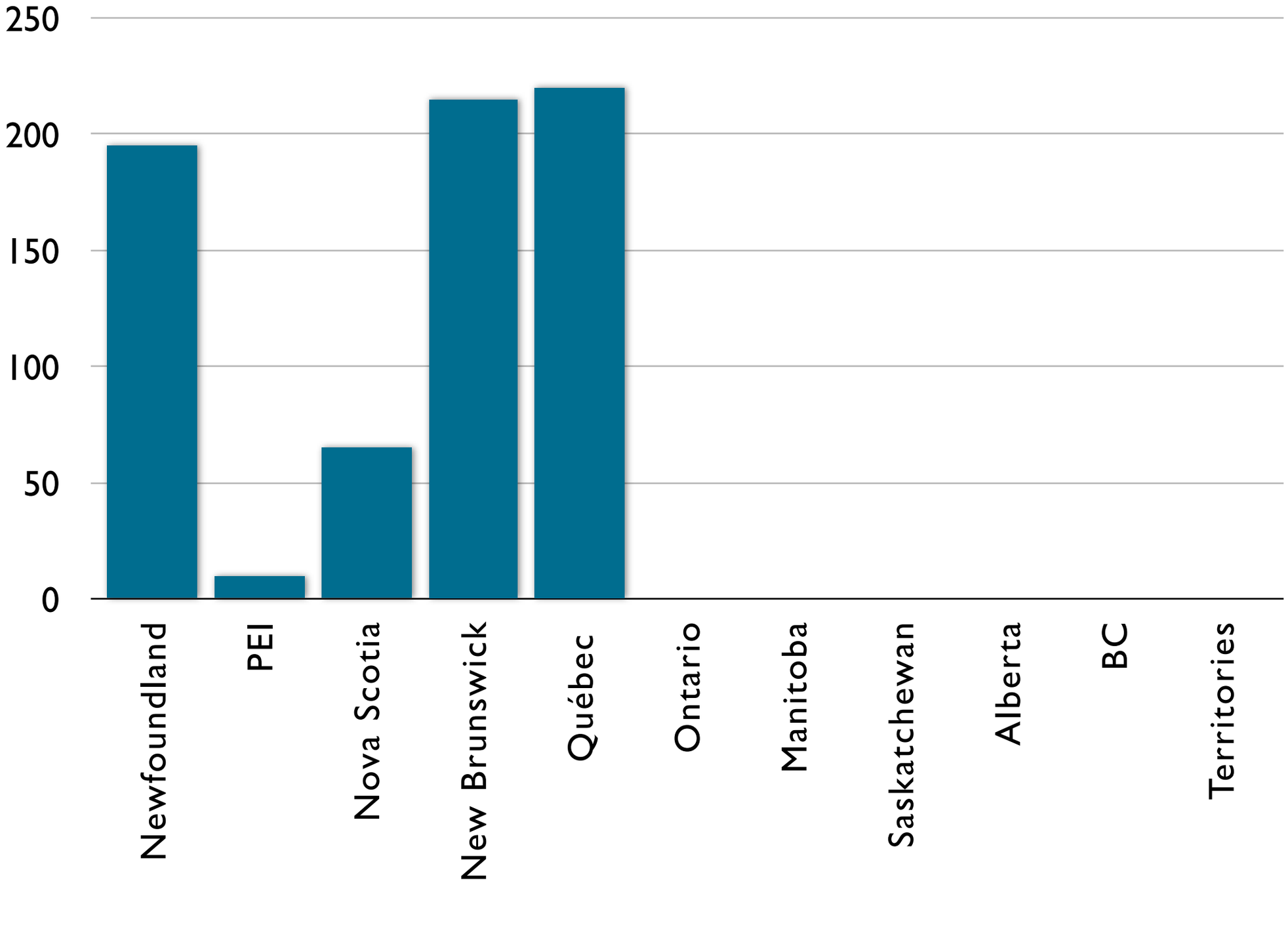

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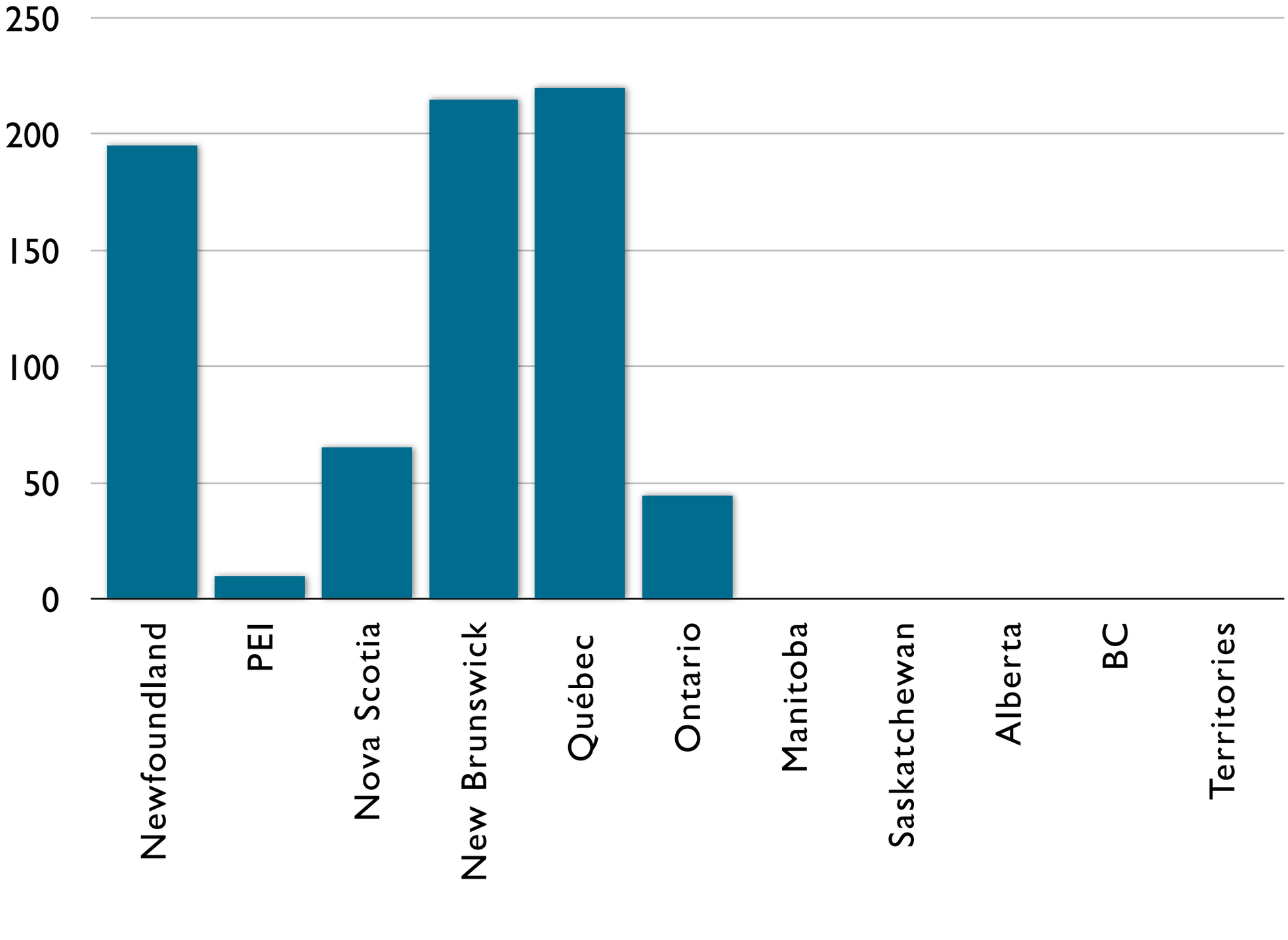

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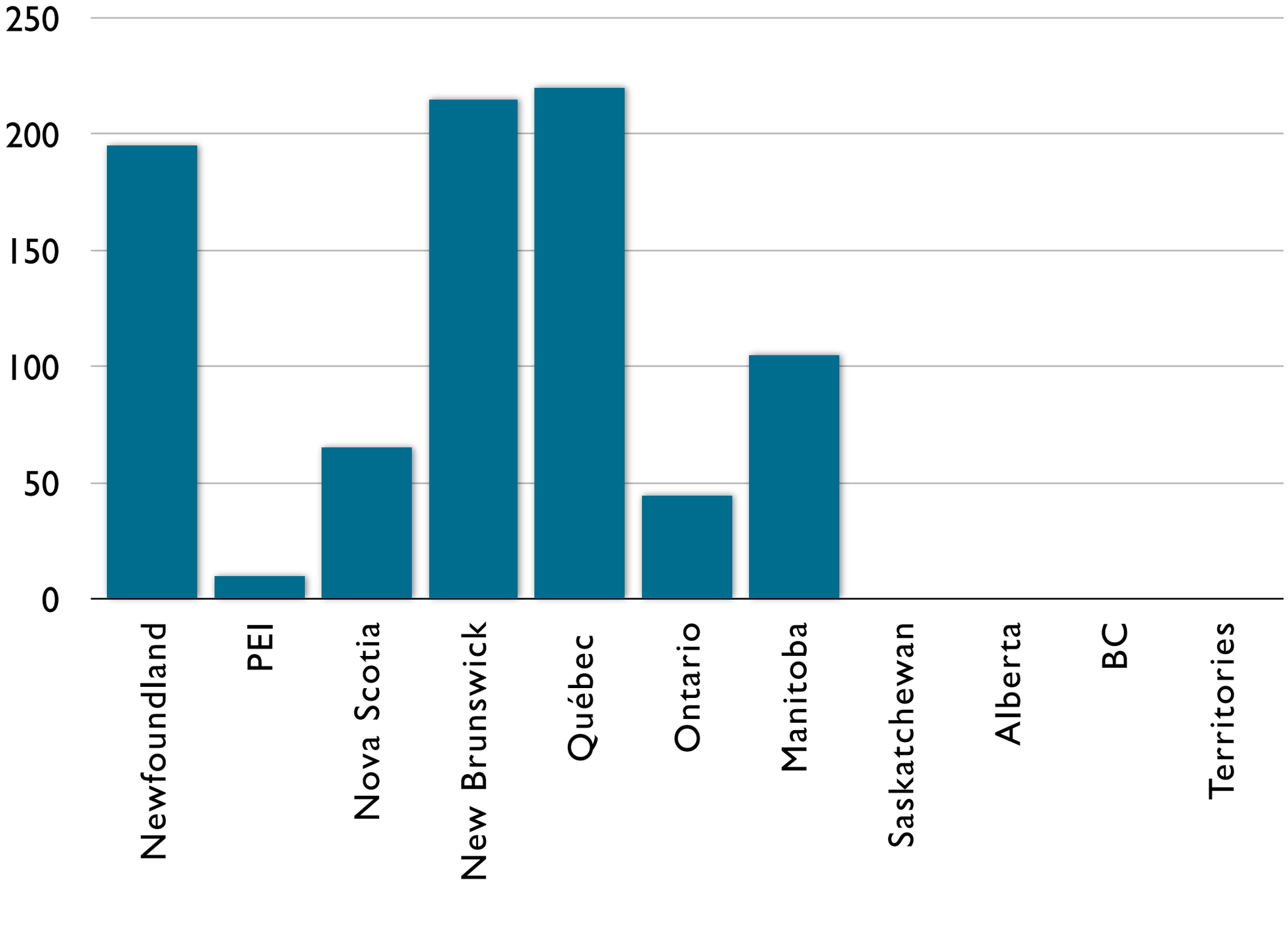

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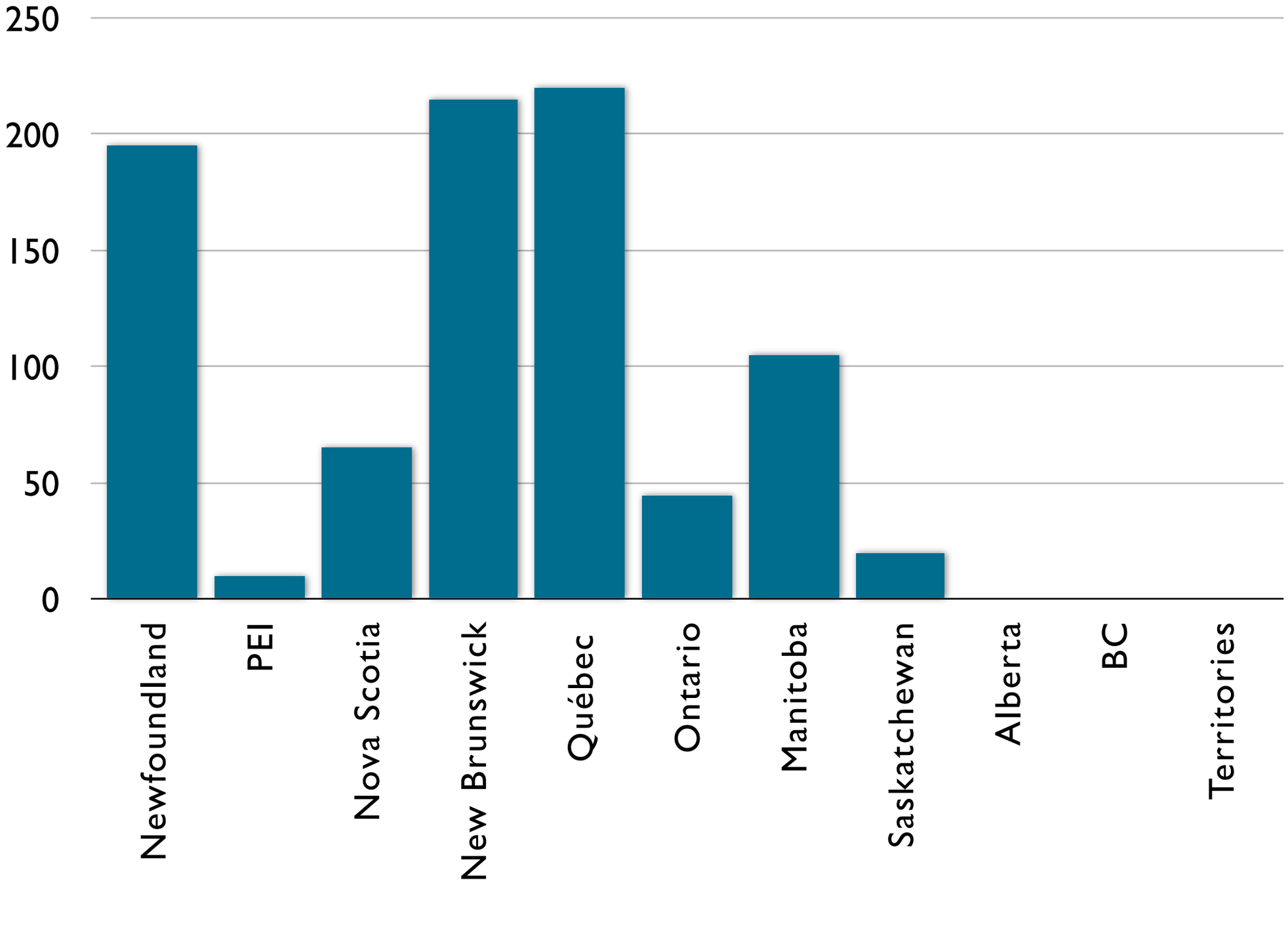

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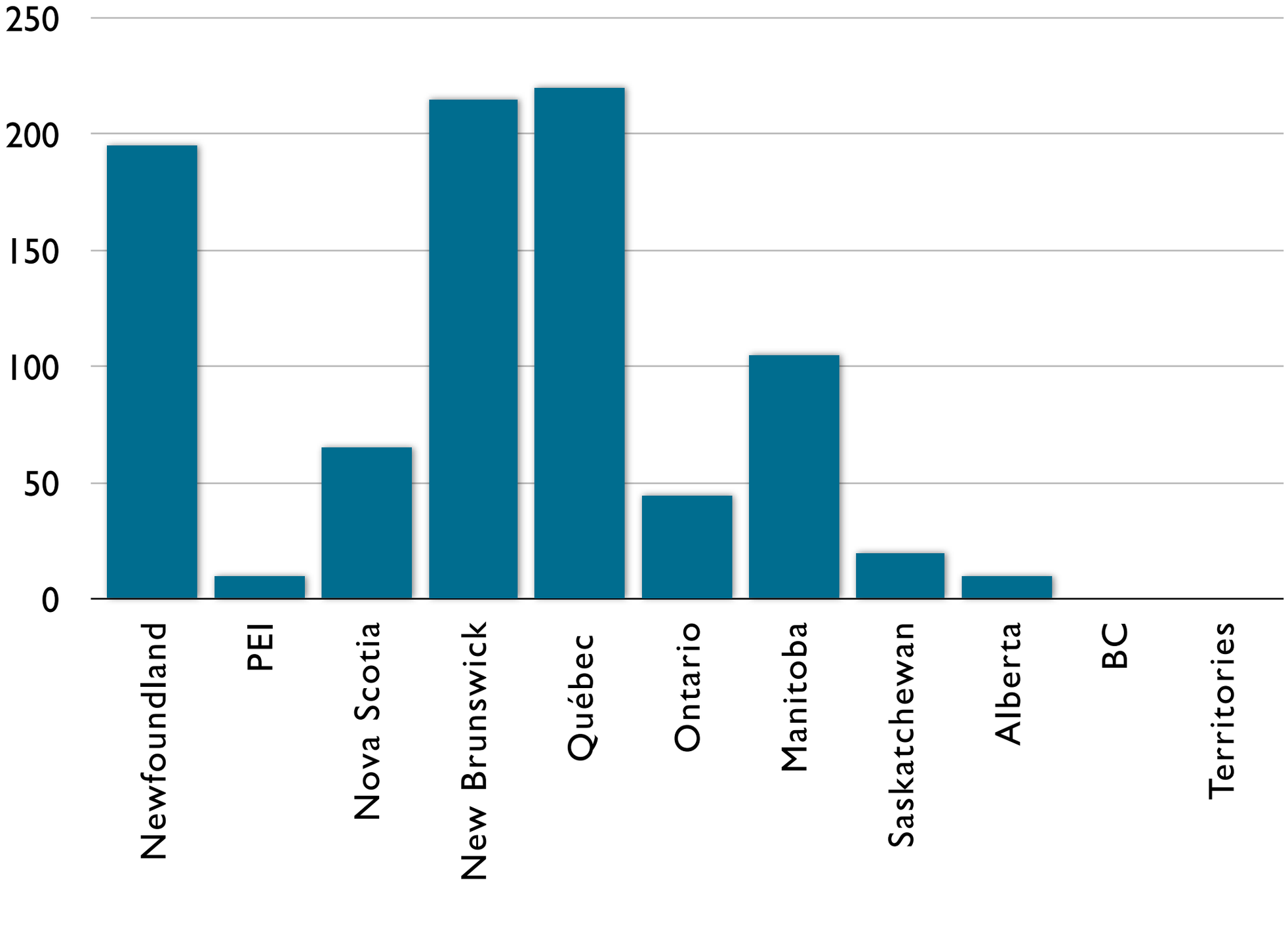

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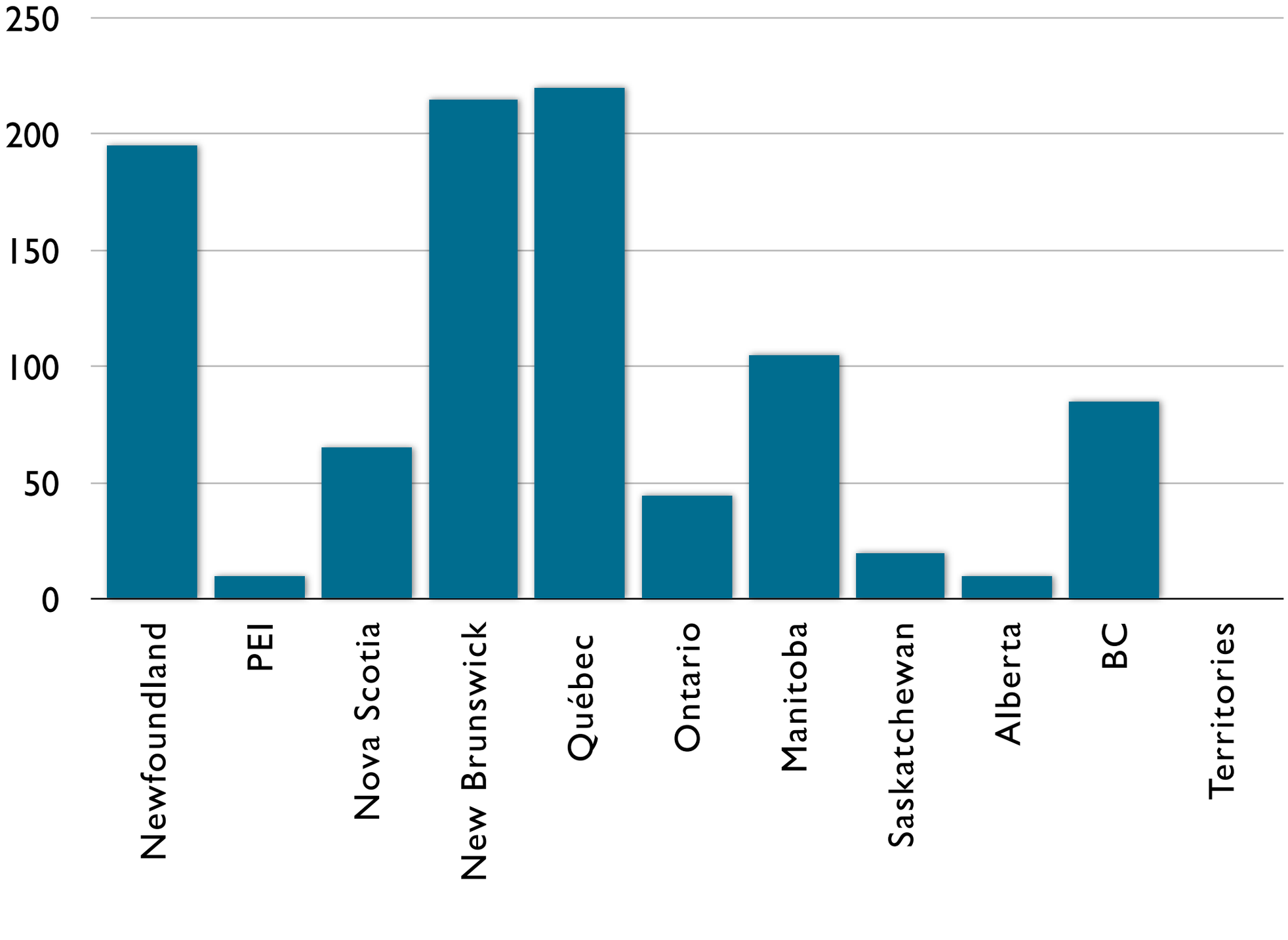

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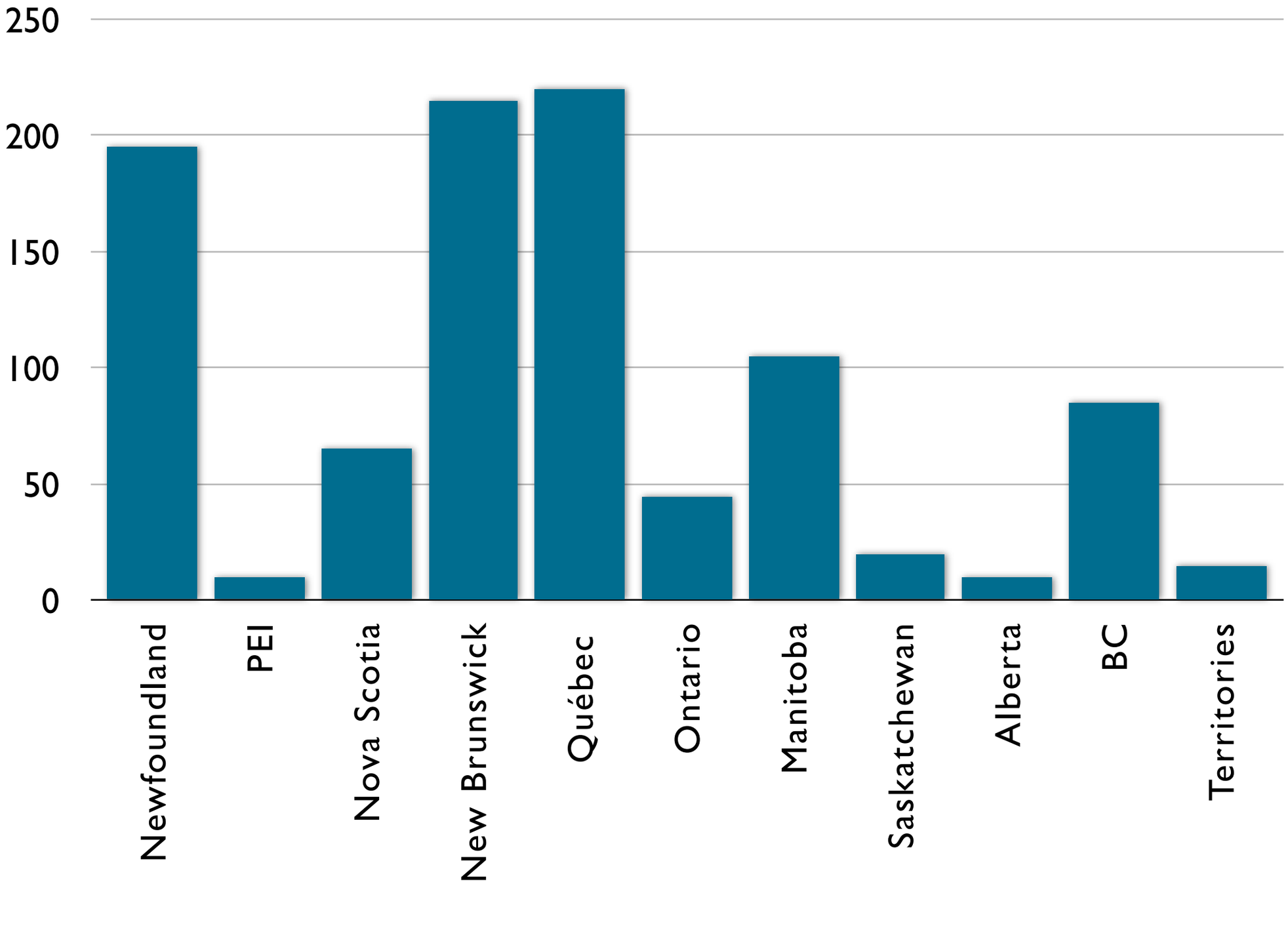


But Wait!

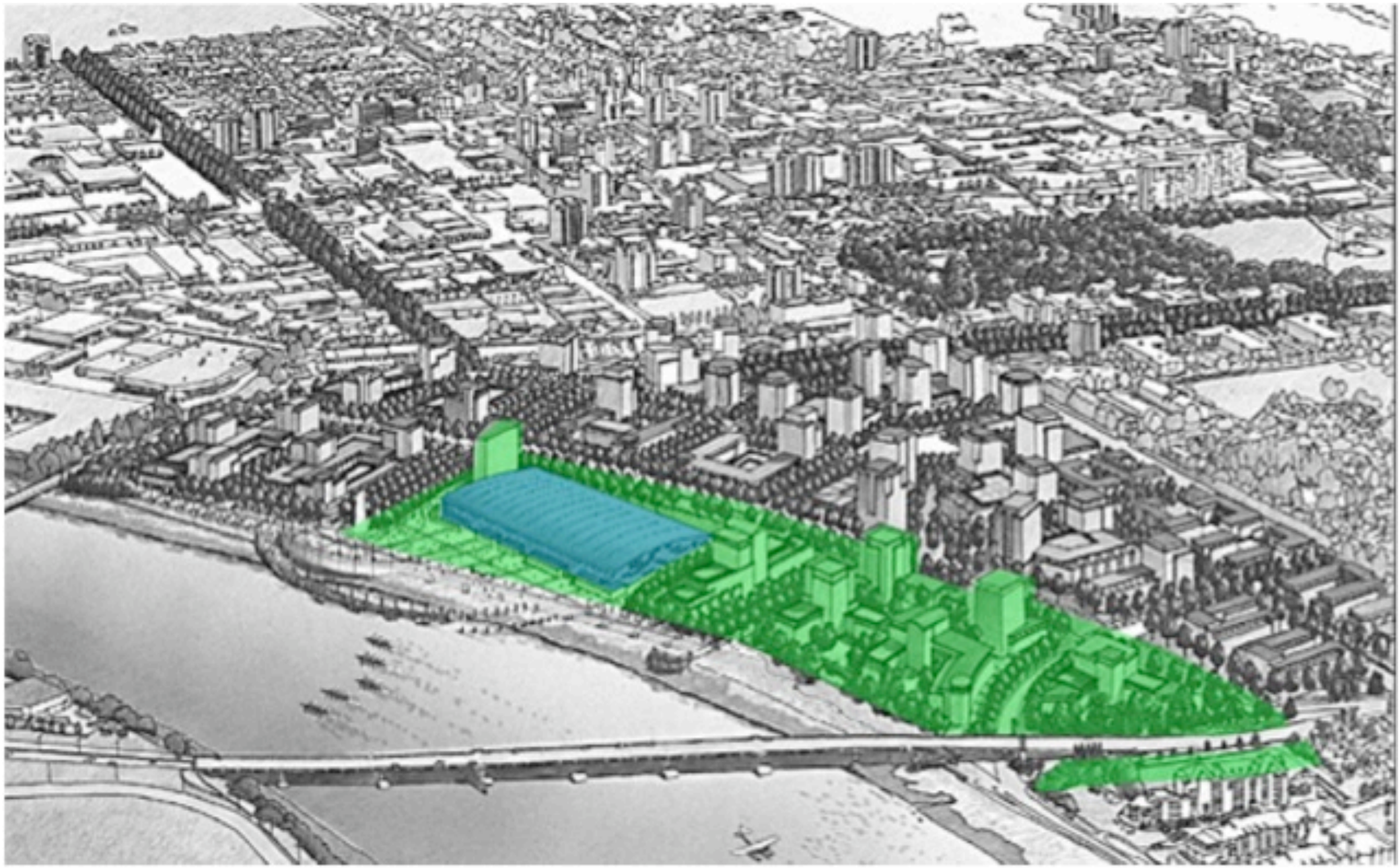
Synergy

- GSHP's higher capital costs are due to the ground loop.
- What if we could harvest heat from more accessible sources?
- What if this heat was actually a waste stream?

Richmond Oval

source: http://cache.daylife.com/imageserve/09jH0tXfonfW4/610x.jpg

A Perfect Ten

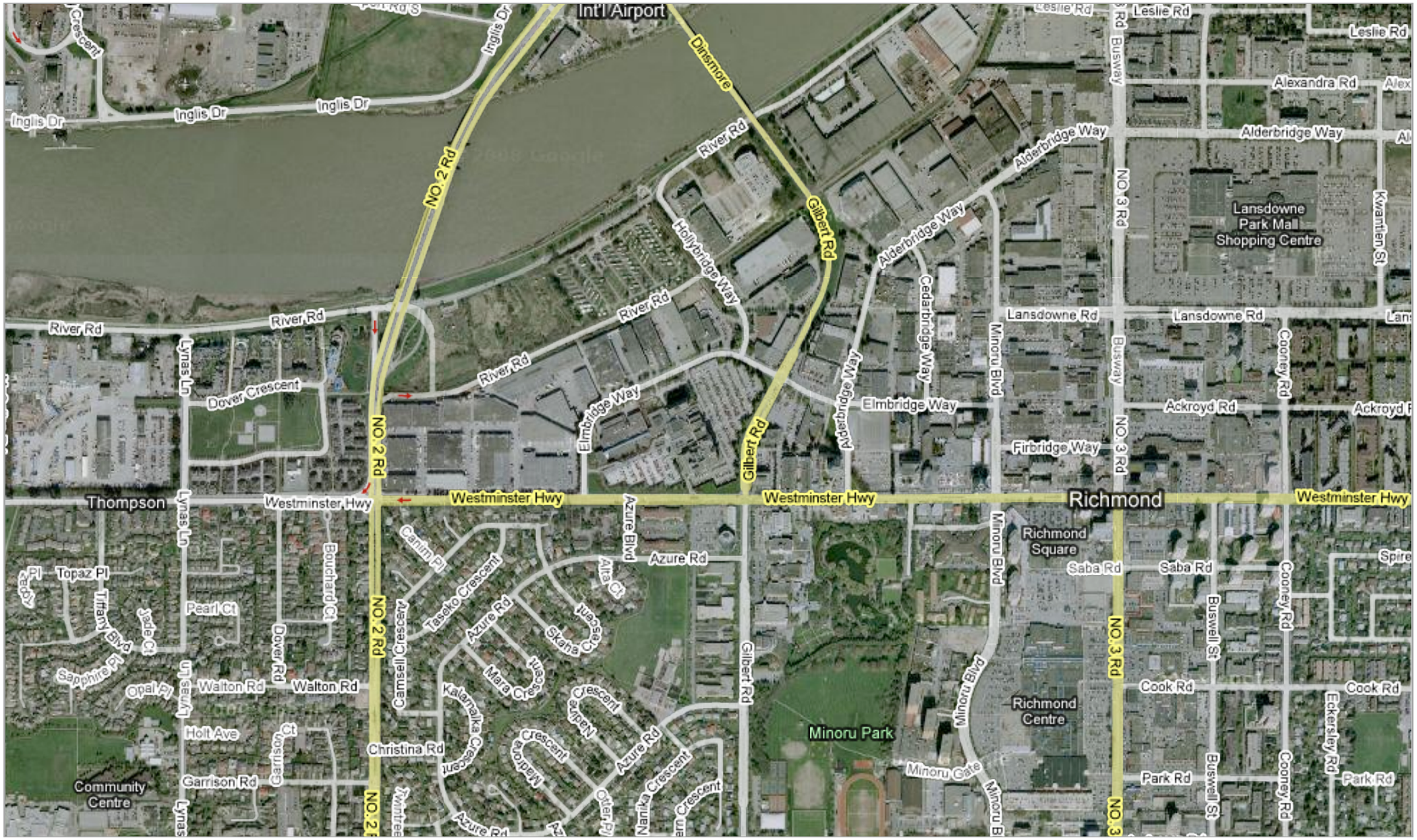


Nanaimo Aquatic Centre

source: http://easylivinglandscaping.com/images/NanaimoAquaticCentre.jpg

The Whole Picture

Google Maps



Synergistic systems

- The full value of GSHP is realised when we couple such systems to the vast supply of low-grade heat available in most urban environments. For example:
  - Sewer pipelines
  - Cooling towers
  - Refrigeration units ...
- *When coupled to waste heat sources, GSHP can deliver usable heat at 400% efficiency, with far lower installation costs because the need for bore-holes can be dramatically reduced.*

Conclusions

- Ground-source heat-pumps can reduce energy use for space conditioning and hot water provision by more than 50%.
- The higher capital costs of such systems is easily paid off *-- pay-back periods of less than 10 years.*
- In a setting where electricity is used for heating and cooling, the cost of GSHP is far less than the cost of electric power system expansion *-- a net savings in both cost and energy.*
- Establishing community networks, reduces capital costs by a further 40% *-- making it possible to mandate use of technology in cities.*

RESOURCES
FOR THE FUTURE

Offsetters Climate Neutral Society

GREENERG TECHNOLOGIES

Thank you !

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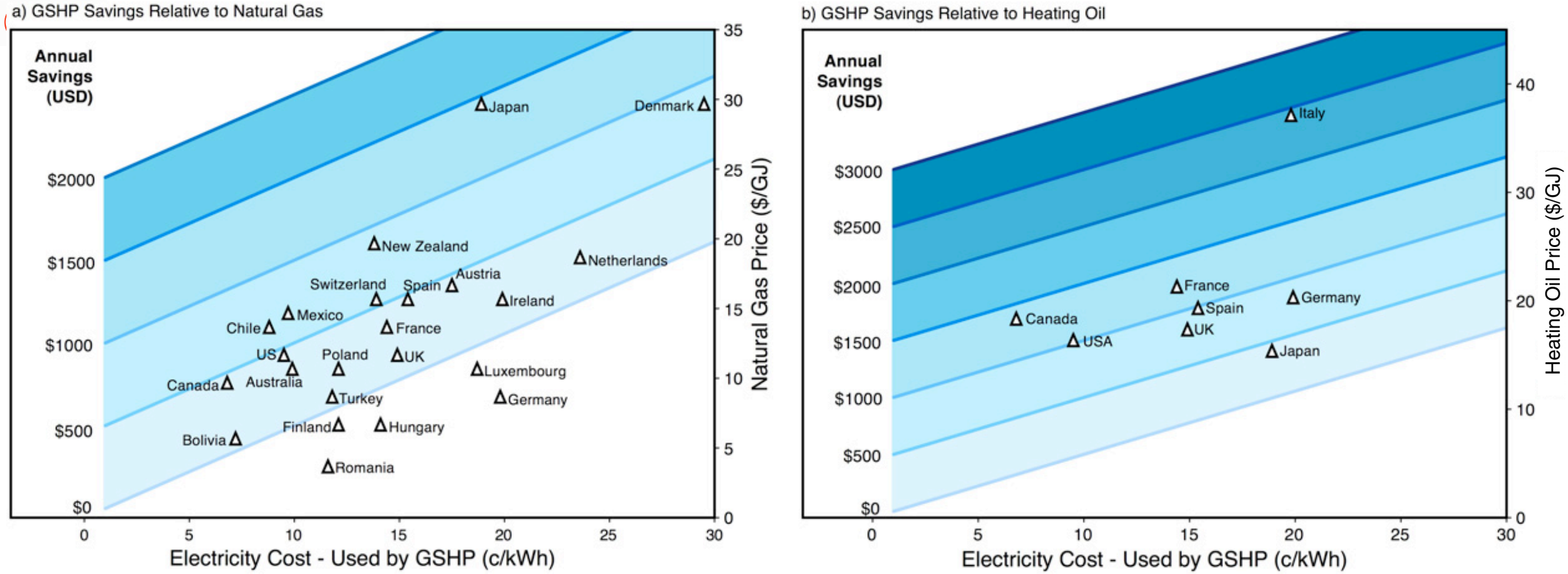
Economics



The economics of GSHP depends on the cost and choice of heating fuels vs. electricity. The incremental system costs is usually 8 to 12 thousand dollars. Compared to gas heating (panel a) savings in Japan would lead to a pay-back period of 4 years. The system pays for itself in even less time when compared to heating-oil. Finally, if air conditioning is included, the incremental cost of the system is more in the 6-8 thousand dollar range with even shorter pay-back periods.