

Canadian Energy History

How Stored Energy Built a Northern Nation

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Canadians for a Sustainable Society,

Book: The Renewable Energy Transition, Realities for Canada and the World

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Time to get Serious

and use real social and biophysical economic metrics



Pre-Contact Population Density

Inuit - 1 person/700 sq km

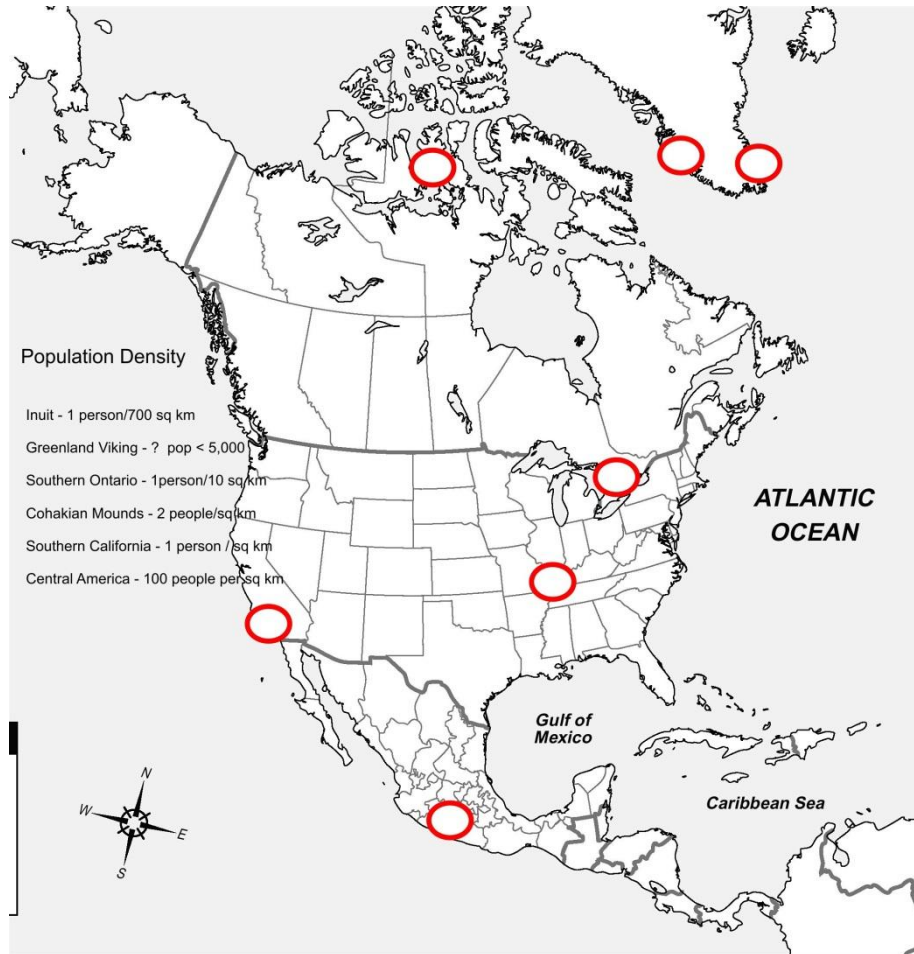
Greenland Viking - pop < 5,000

Southern Ontario – 1 person/10 sq km

Cohakian Mounds - 2 people/sq km

Southern California 1 person / sq km

Central America - 100 people per sq km



Population density (net energy proxy) utterly dependent on climate and resources at hand.

Most of Canada “empty” for a reason.

Process of Development

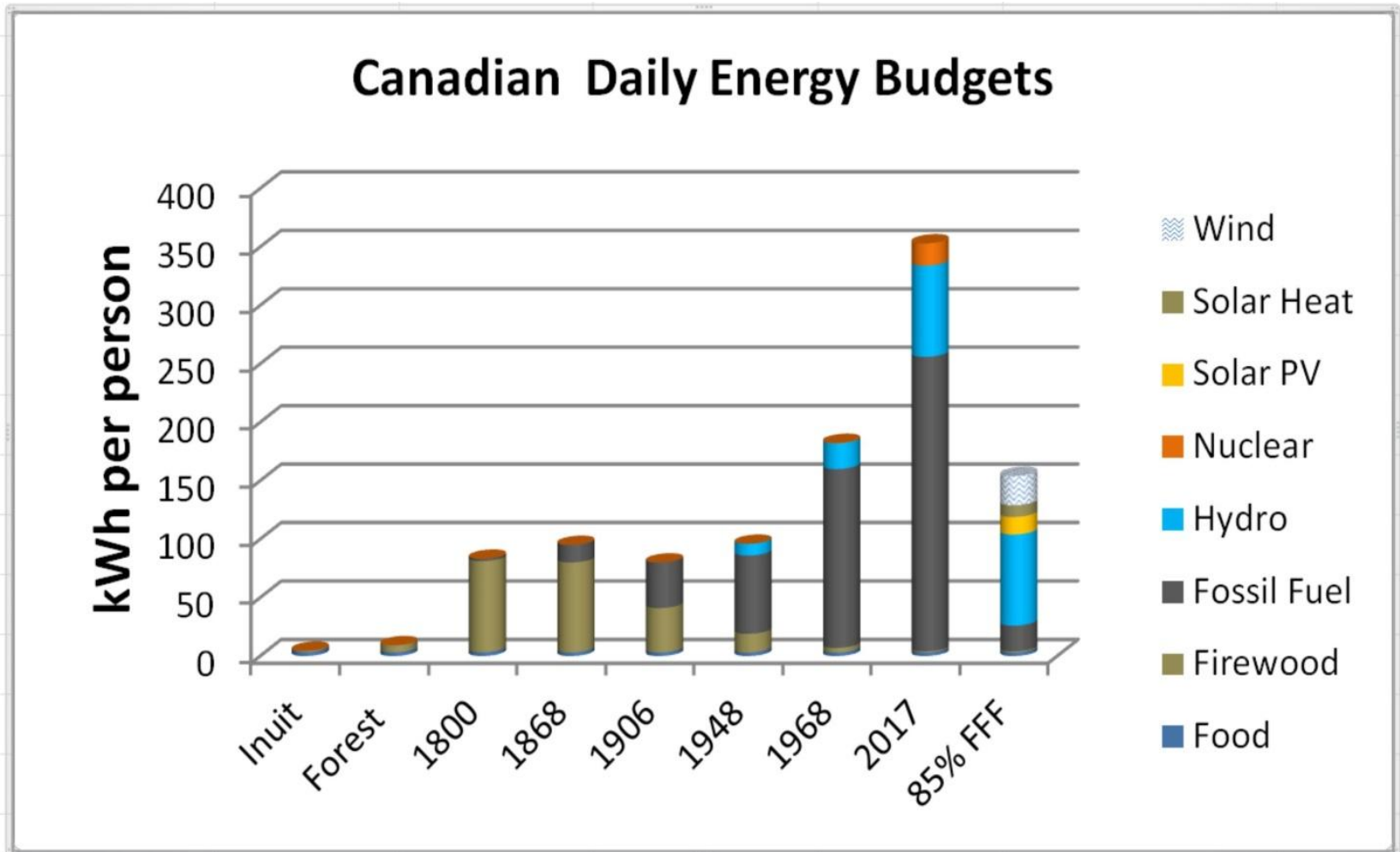
Steel axes and saws >>> Firewood >>> Heating >>> Settle best farmland

Coal >>> Rail Transport >>> Industry, Prairie & Northern Communities

Oil >>> Ground and Air transport >>> anywhere anytime capability

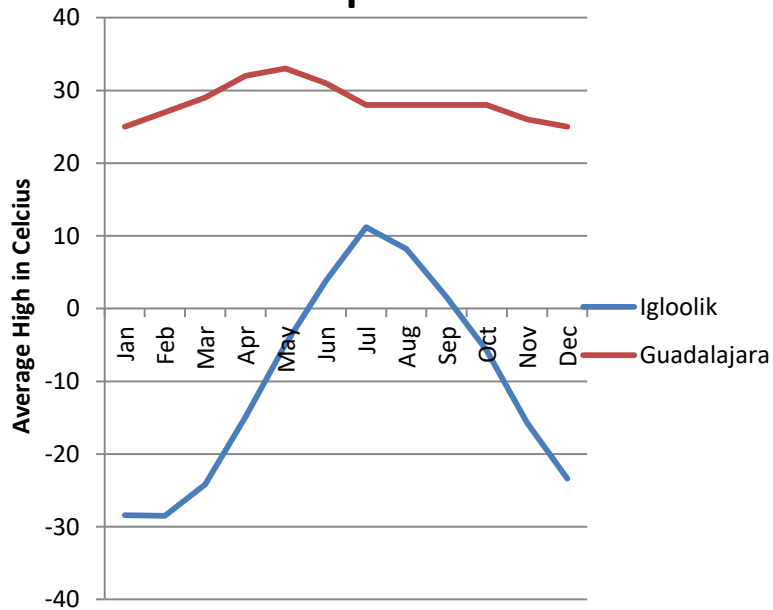
Electricity >>> Sophisticated industrial capacity, residential and farm comfort
anywhere in Canada

Energy Consumption History

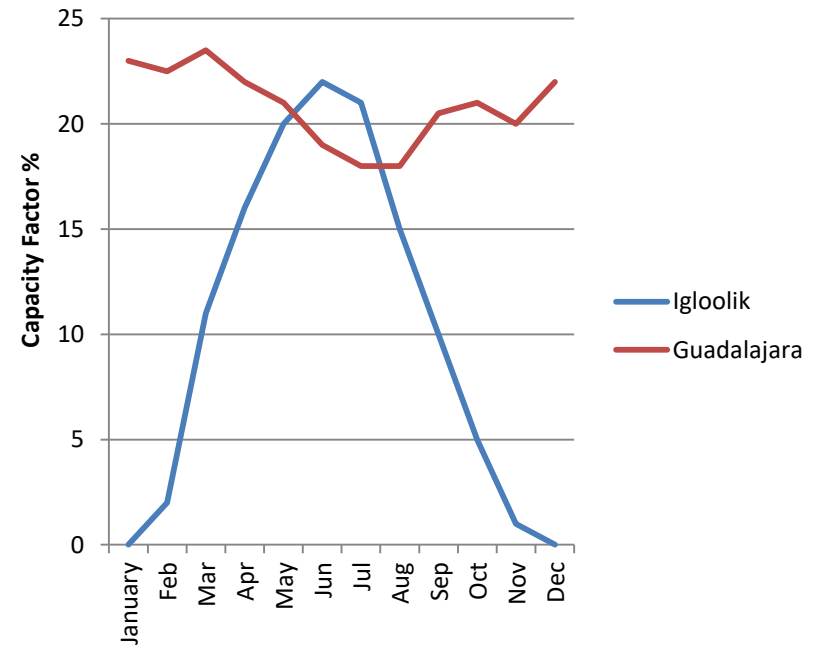


Solar Capacity vs Energy Demand for Northern Regions

Monthly Average High Temperature

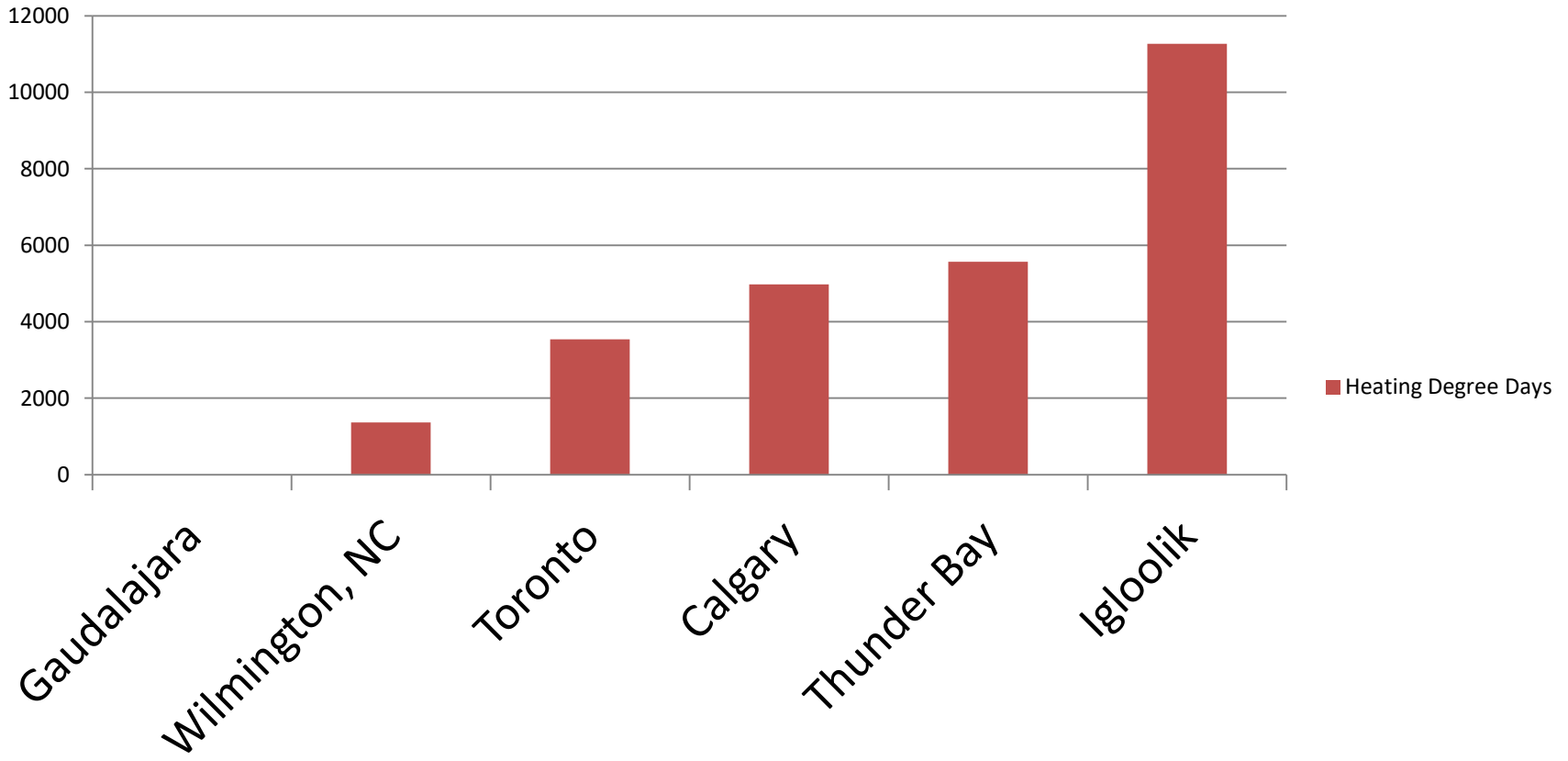


Solar Capacity Factor

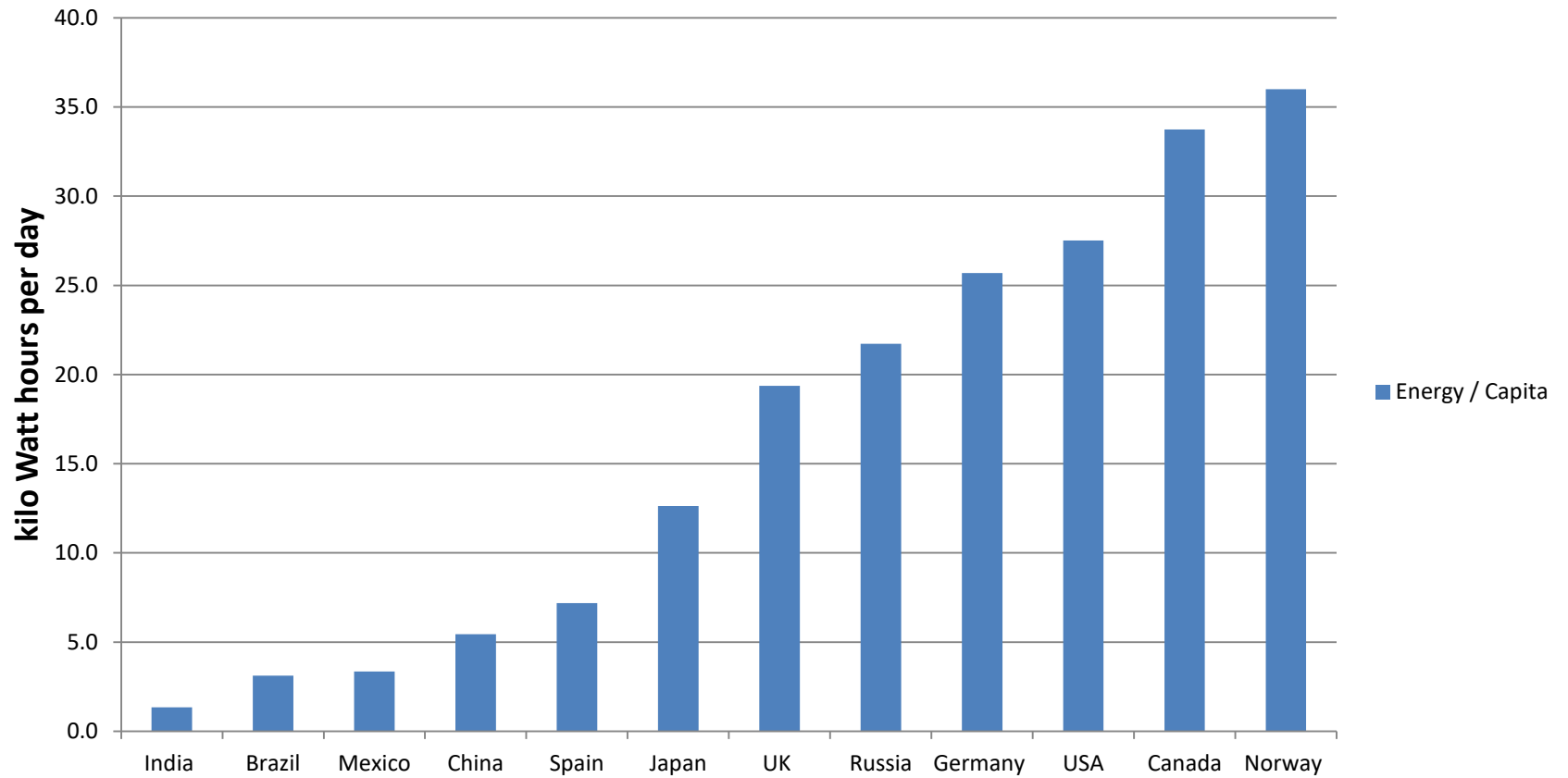


Degree Days by Latitude

Heating Degree Days

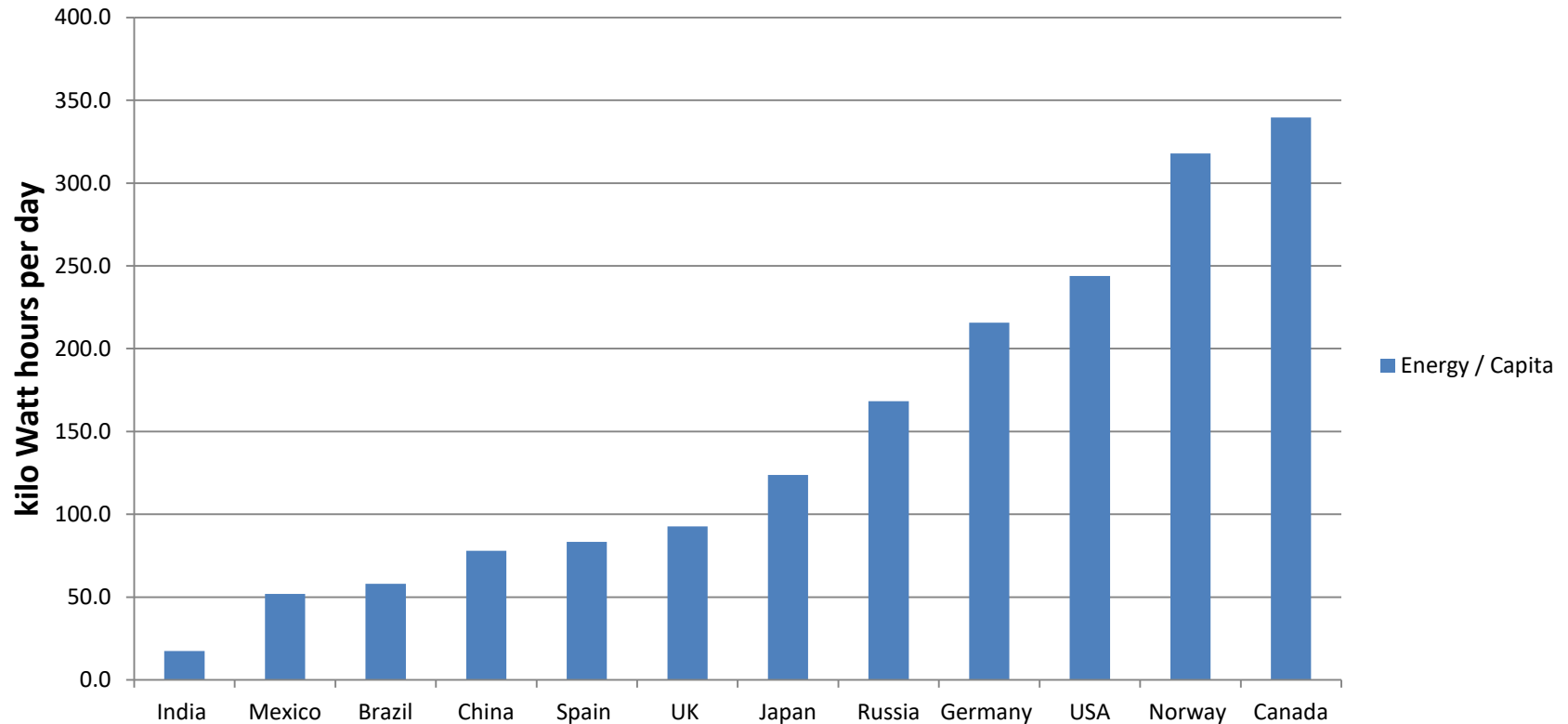


Residential Daily Energy Budget



Need for Unified Energy Measure to represent daily per capita energy budget

Total Daily Energy Consumption kWhrs / Capita / Day



The Small Problem of Seasonal Storage

- Storage and Investment by Latitude

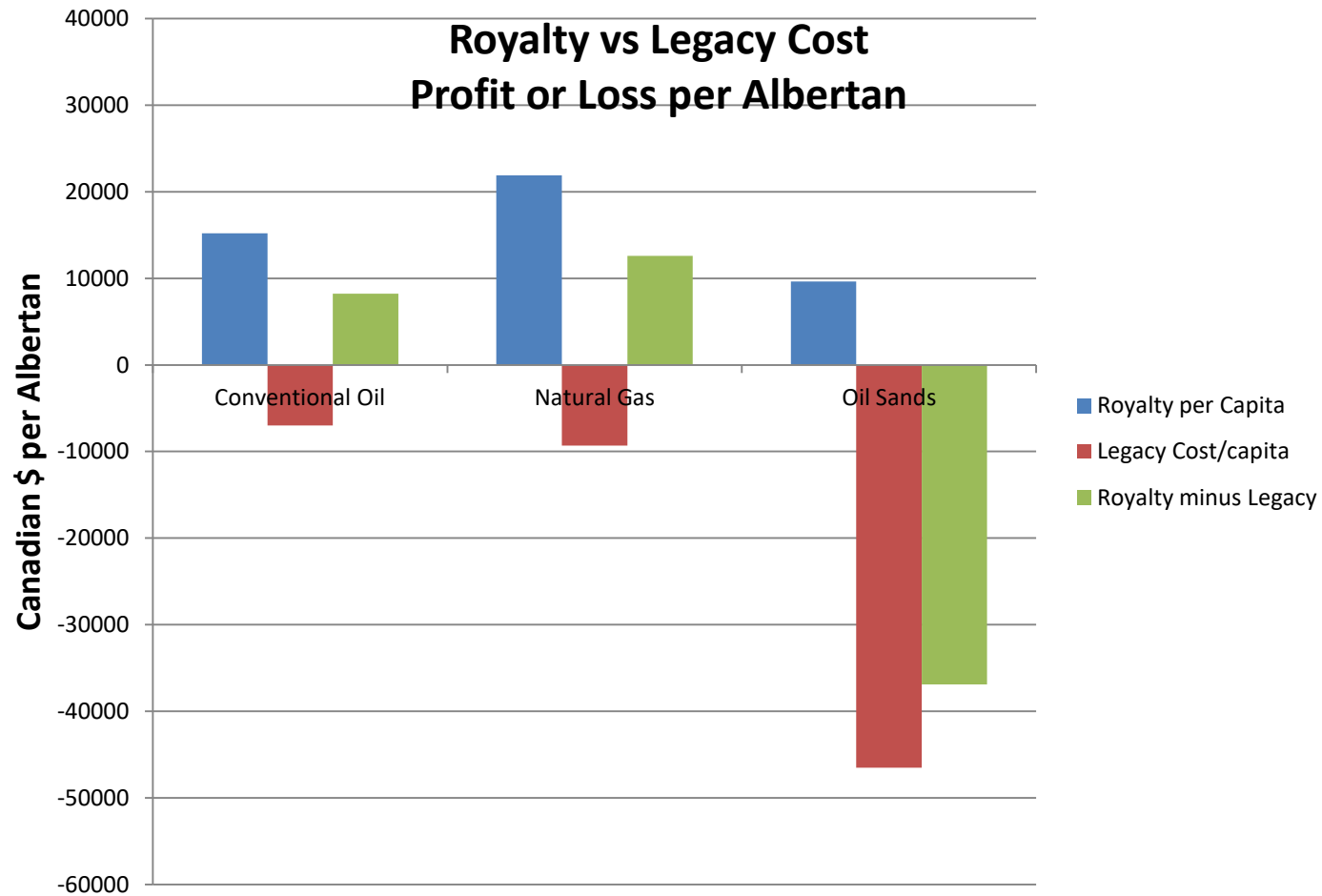
	Annual Budget kWh	Storage Required Days	Storage Required Annual kWh	Size of Array Required kilo Watts	Storage	Array	Total
Igloolik	14600	120	4800	63.4	\$ 4,080,000	\$ 126,736	\$ 4,206,736
Calgary	10950	90	2700	27.2	\$ 2,295,000	\$ 54,315	\$ 2,349,315
Victoria	7300	60	1200	17.3	\$ 1,020,000	\$ 34,564	\$ 1,054,564
St. John's	10950	90	2700	28.5	\$ 2,295,000	\$ 57,031	\$ 2,352,031
Wilmington	4380	4	48	3.2	\$ 40,800	\$ 6,337	\$ 47,137
Guadalajara	1825	0.5	2.5	0.7	\$ 2,125	\$ 1,302	\$ 3,427

EROI - Energy Return on Energy Invested

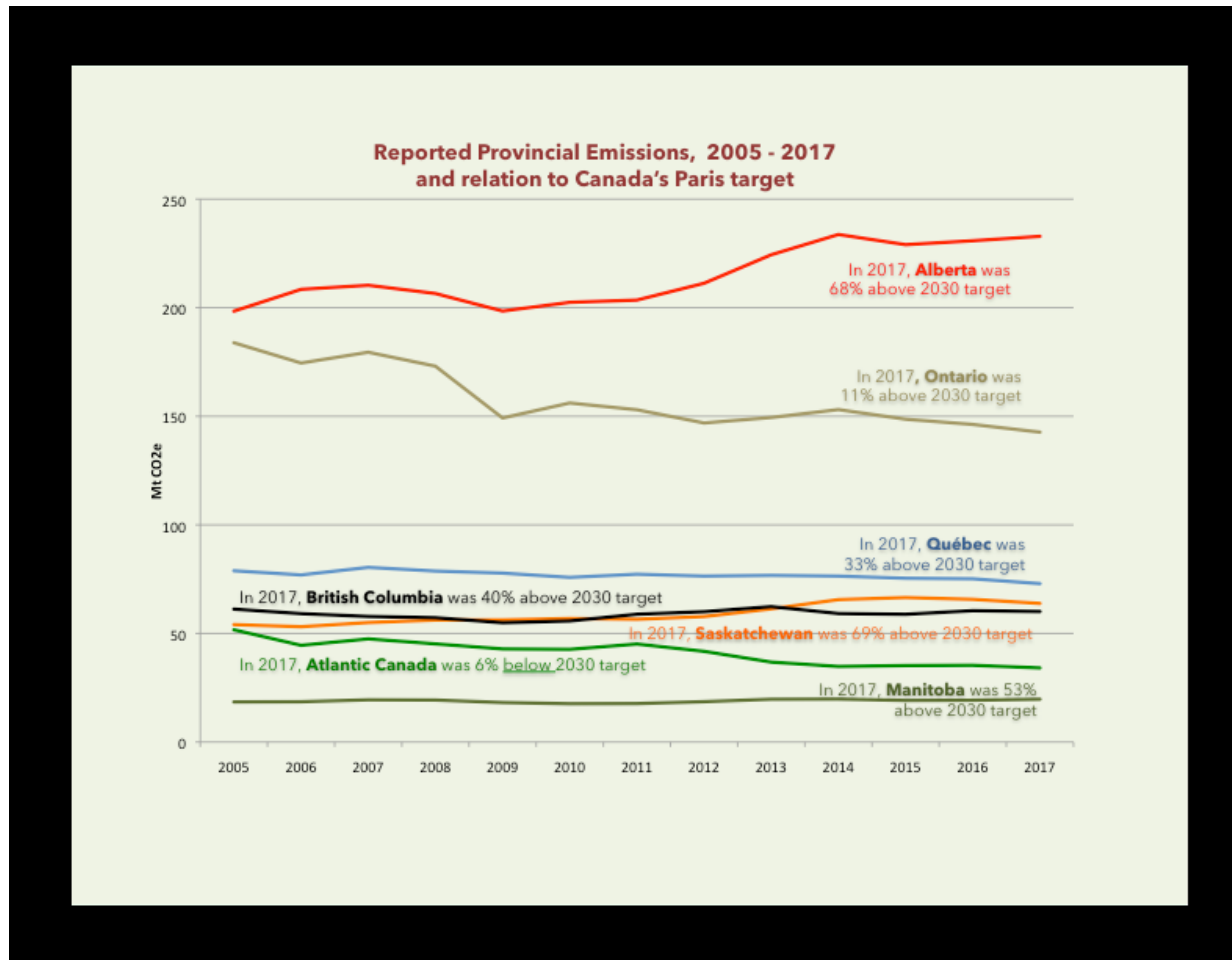
E-ROY

- Available net energy is the core national determinant of real wealth creation.
- EROI of oil in the glory days of Texas and Saudi gushers maybe reached 100:1
- EROI of current world oil industry ~17:1
- Oil Sands ~ 4:1, not including remediation
- Solar ~ 8:1**
- Wind ~ 15:1
- EROI of at least 8:1 needed for semi-sophisticated society.
- Charles Hall: “Energy and the Wealth of Nations”

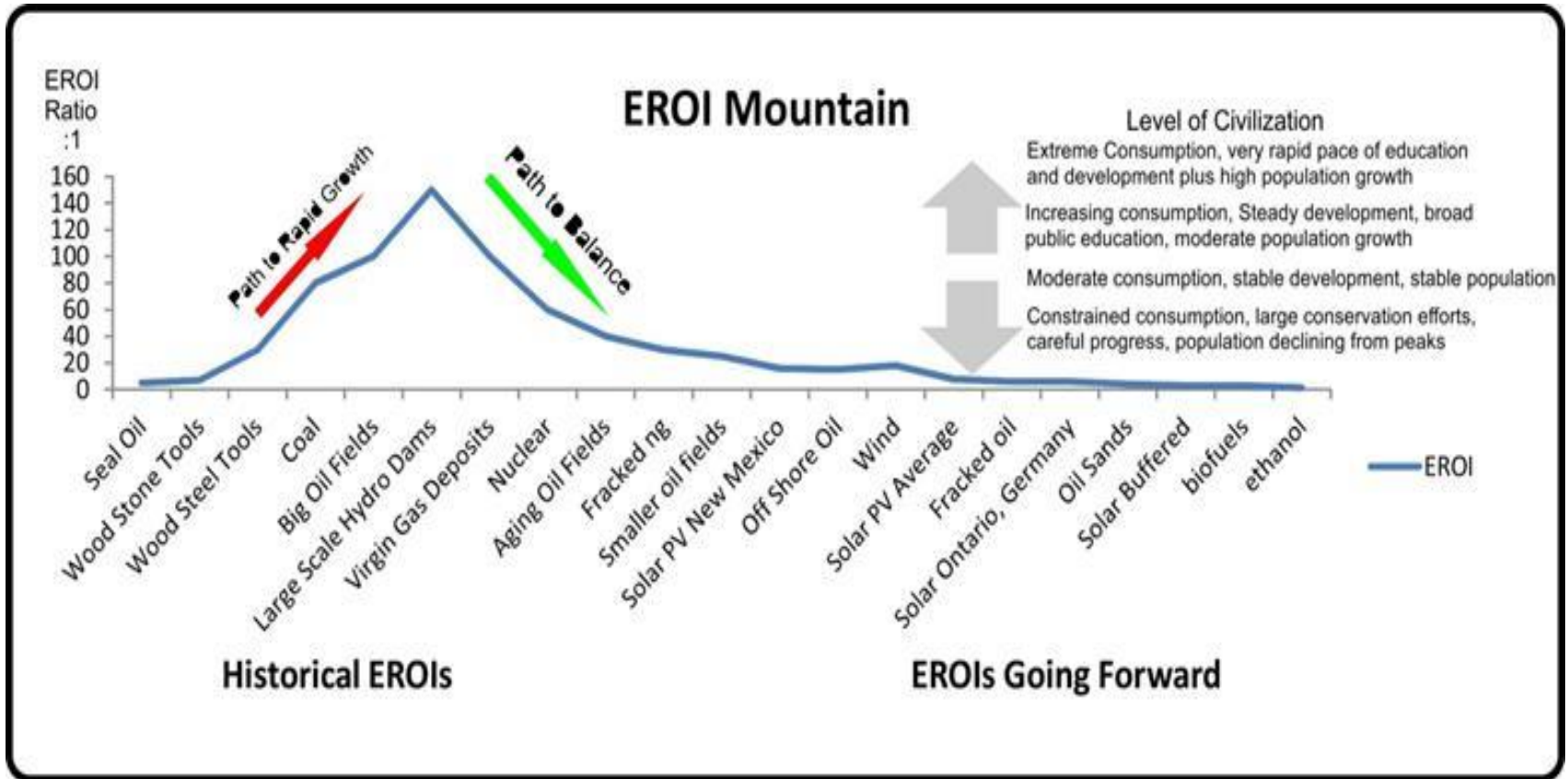
Are we making money yet?



Financial problems and political problems in dealing with one industry economies. Resilient societies have a broad economic base.



EROI Mountain



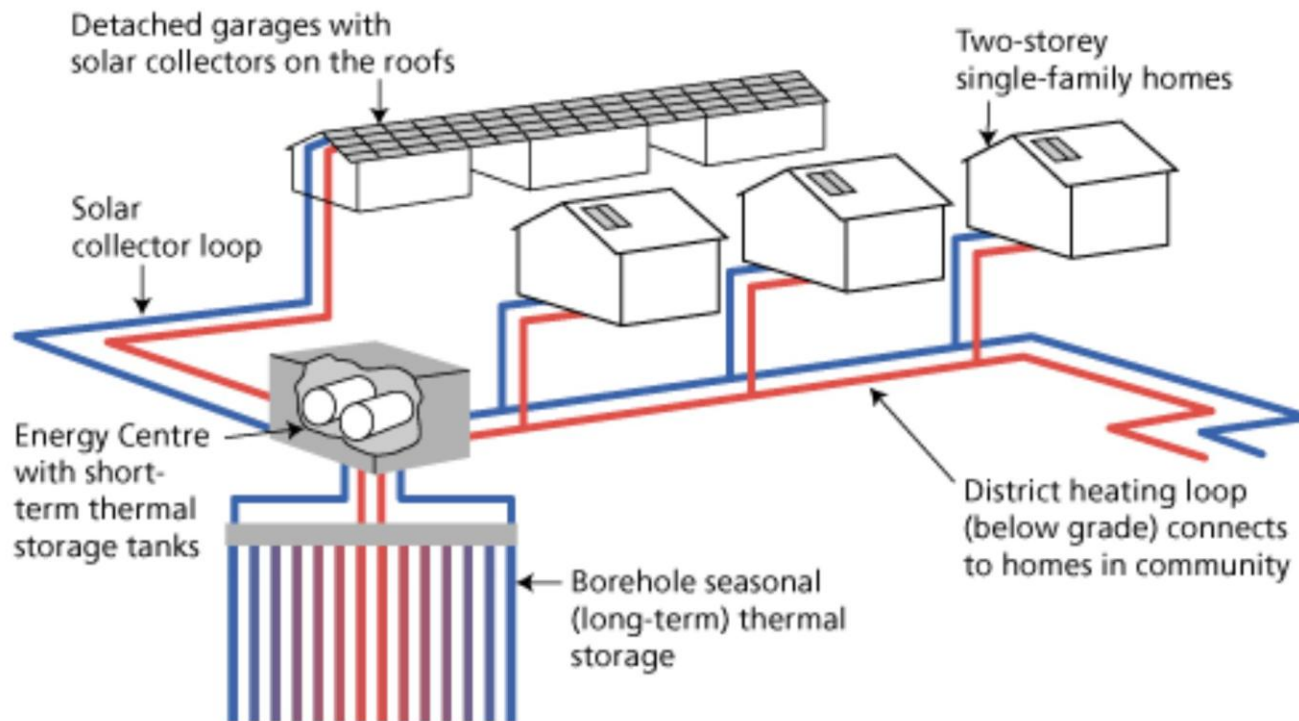
COP to the Rescue?

Can coefficient of performance of electrical heating systems offset the decline in EROI?

Drake Landing - 30:1

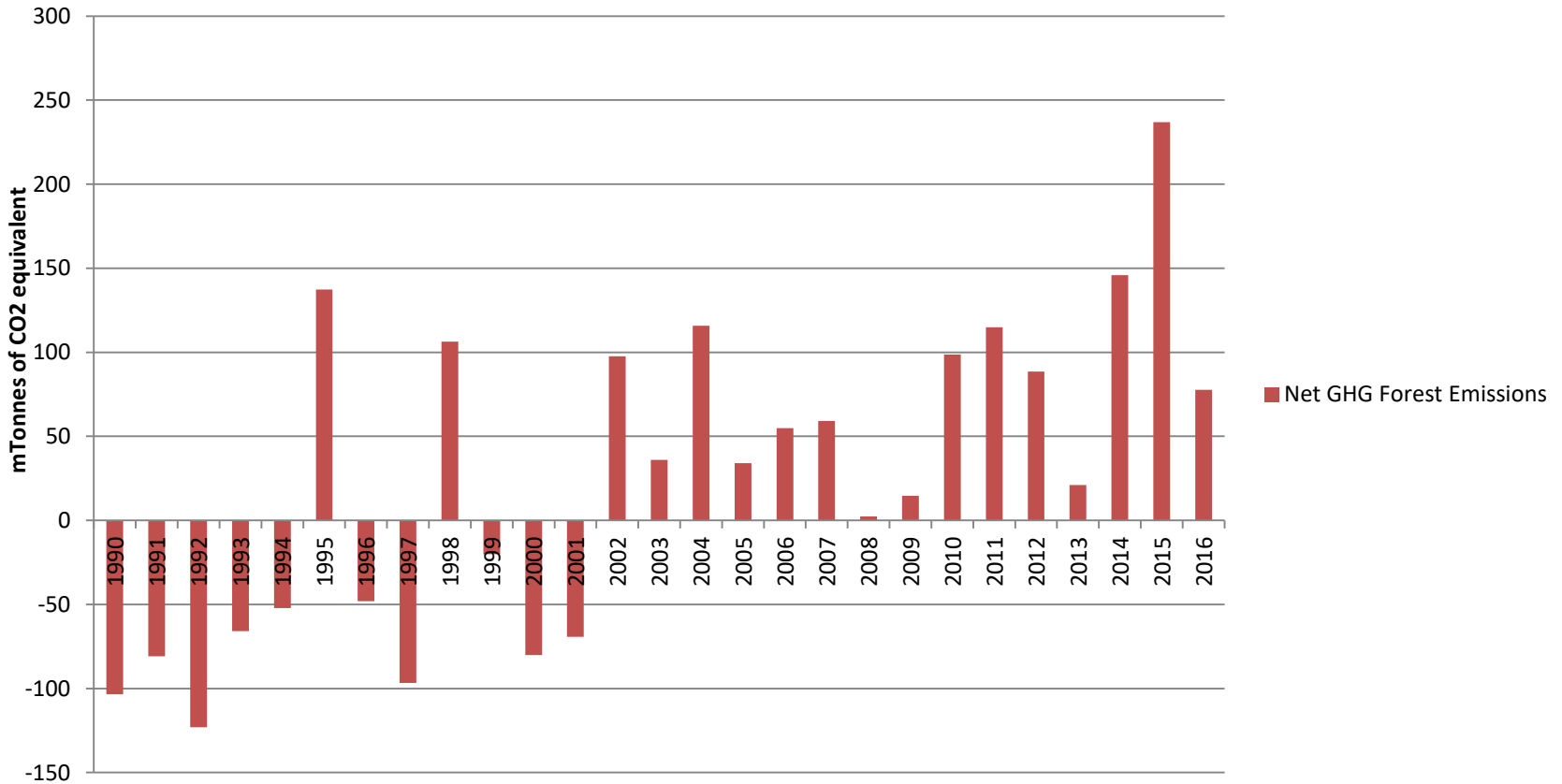
Drake Landing Geothermal Storage

Art Hunter, Sweden

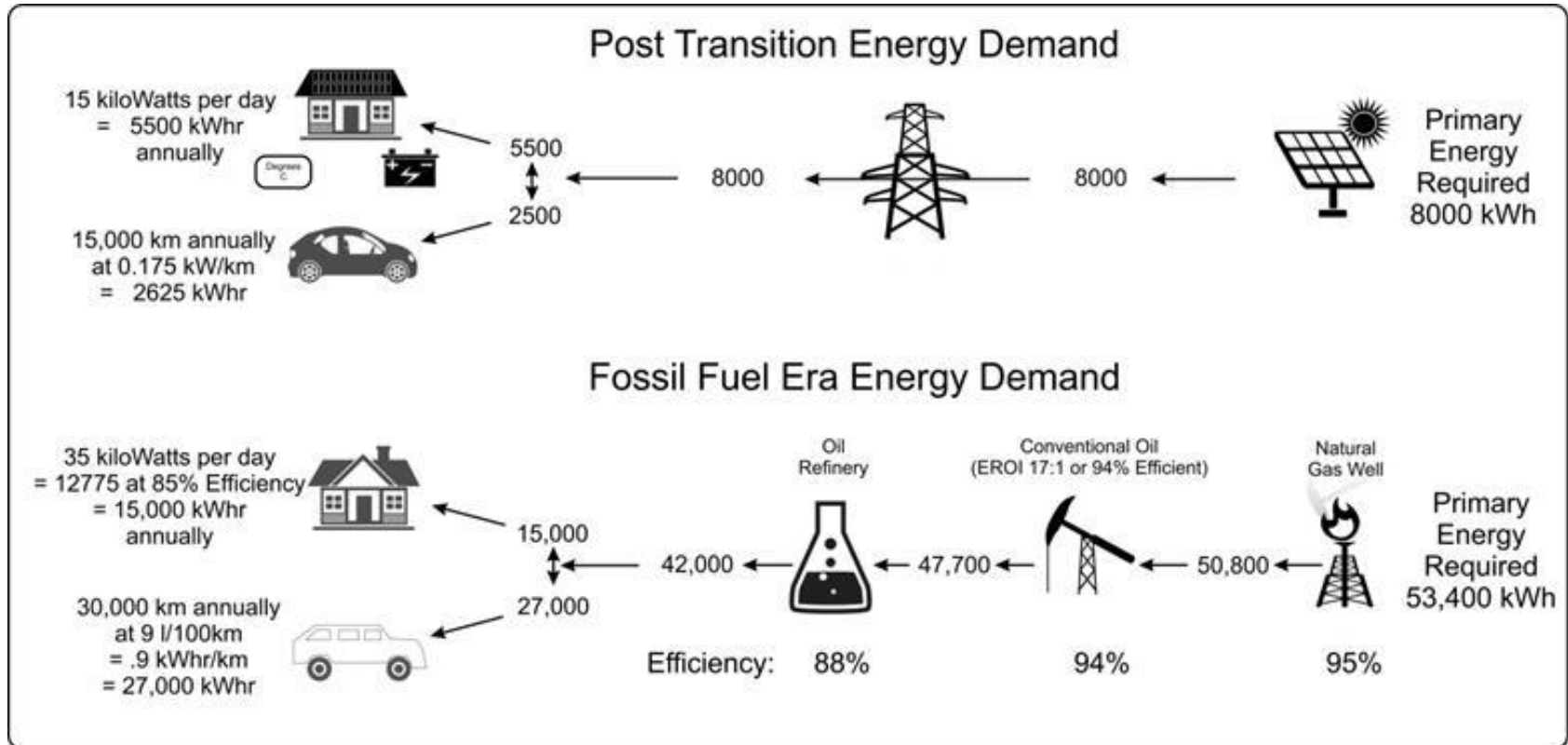


Planting Trees as Salvation?

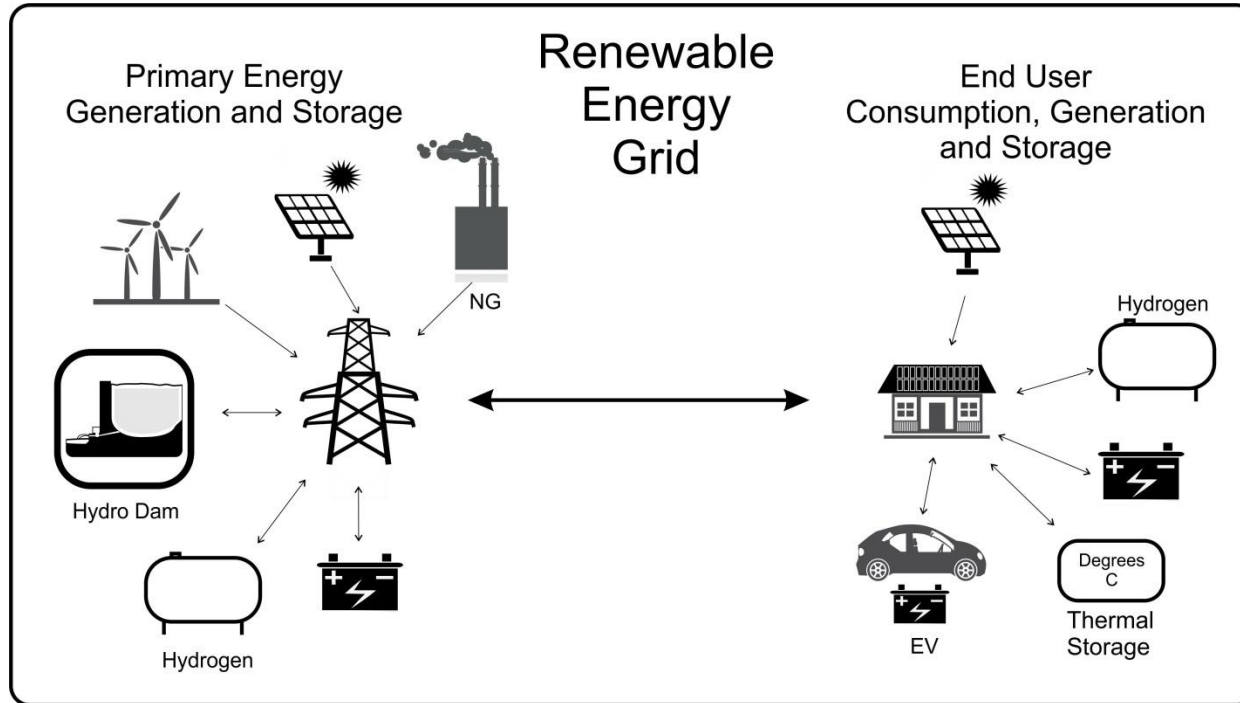
Net GHG Forest Emissions

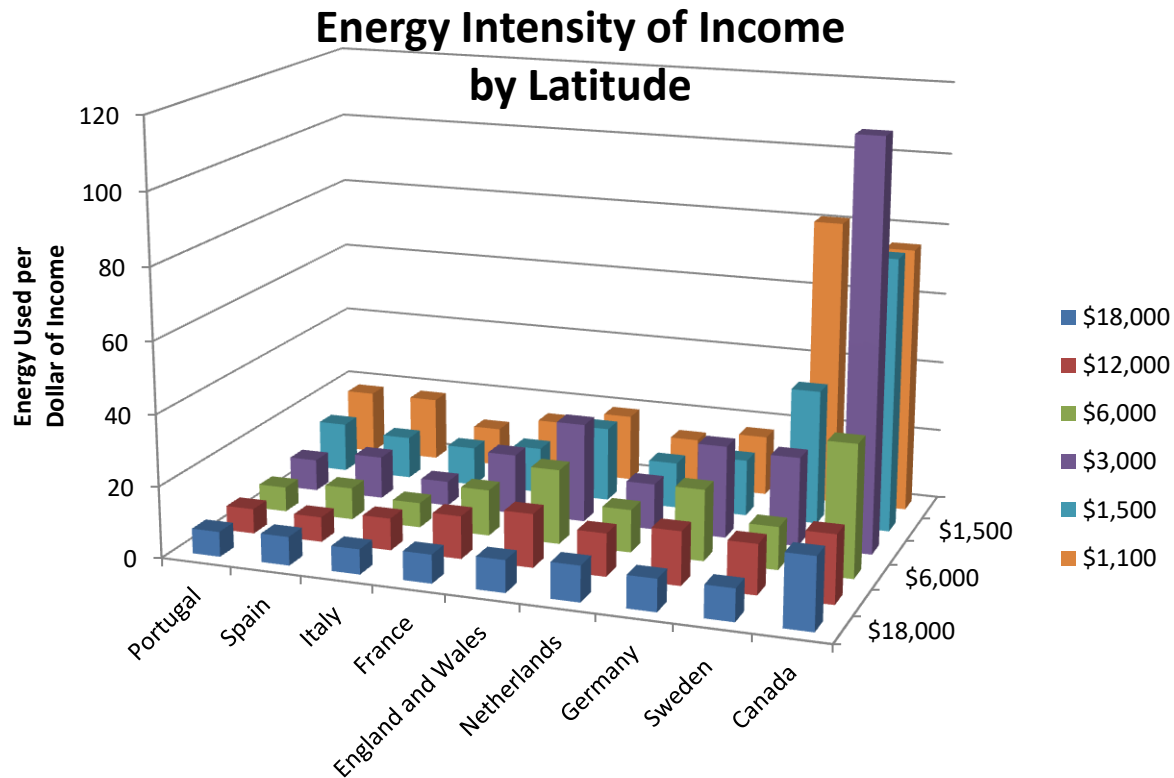


The Different Energy Levels of Fossil Fuel vs Electrical Societies



The Grid as a Living Organism





Energy Equality - Richard W. Unger, as well as energy consumption history slide
 “Energy Consumption in Canada in the 19th and 20th Centuries”

Even if technically excellent, the transition to renewables won't work if it isn't well explained and if it pushes the already poor and stressed into a more desperate situation. Witness Syria, France “Yellow Vests” and Ontario. Environmental balance also has to produce social balance.

Policy Priorities

The fastest, best ways to transition off fossil fuels

- EVs – easiest, fastest, biggest payoff, cheapest
- Get young hands and minds working on real systems with data collection and open source control programs
 - (Art Hunter's system with enhancements and external readout screens in 10ft or 20ft containers outside every high school and college in the country. PV, wind, solar hot air/water, insulation, external blinds, geothermal, heat pump, etc.)
- Energy Audit for every building using one metric (kWh). People have no idea how much energy they use outside of \$\$\$.
- Start drilling holes for geothermal storage all across Canada (drill borehole infrastructure for district heating, large complexes, maybe not work in the far north)
- Landlord/tenant coordination to encourage upgrading
- Stop making buildings which can't be retrofitted
- Workforce re-training program across country – Alberta oil workers, German coal workers

Thank You!