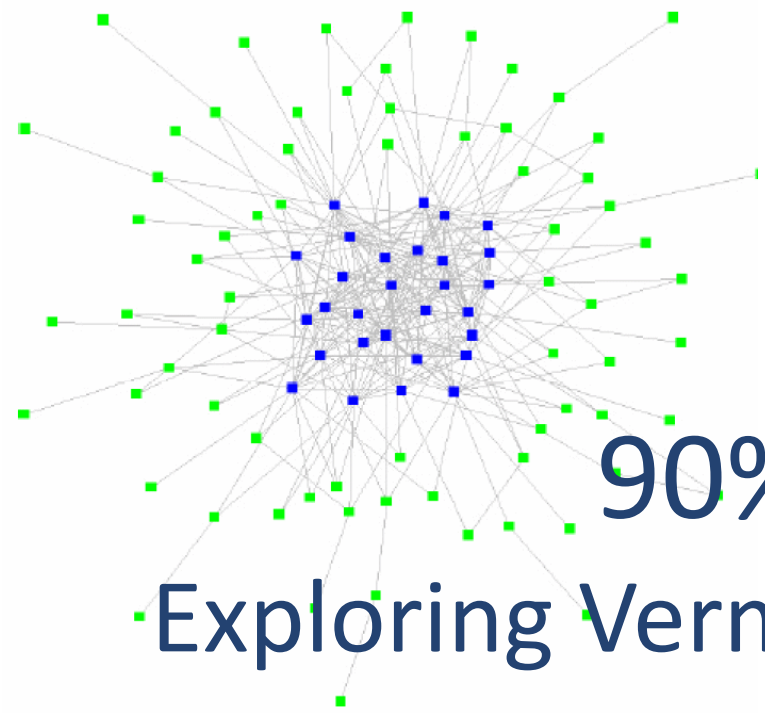


90% by 2050

Exploring Vermont's Energy Options

Leigh Seddon, Chair

Energy Action Network

Energy Action Network

Formation & Purpose

- Collaborative effort to transform Vermont's energy system
  - Create System Map – 2009
  - Identify Leverage Points – 2010
  - Build Network Capacity – 2011
  - Launch Projects – 2012

Members

- A network of collaborating businesses, organizations, individuals, and government.

Goal

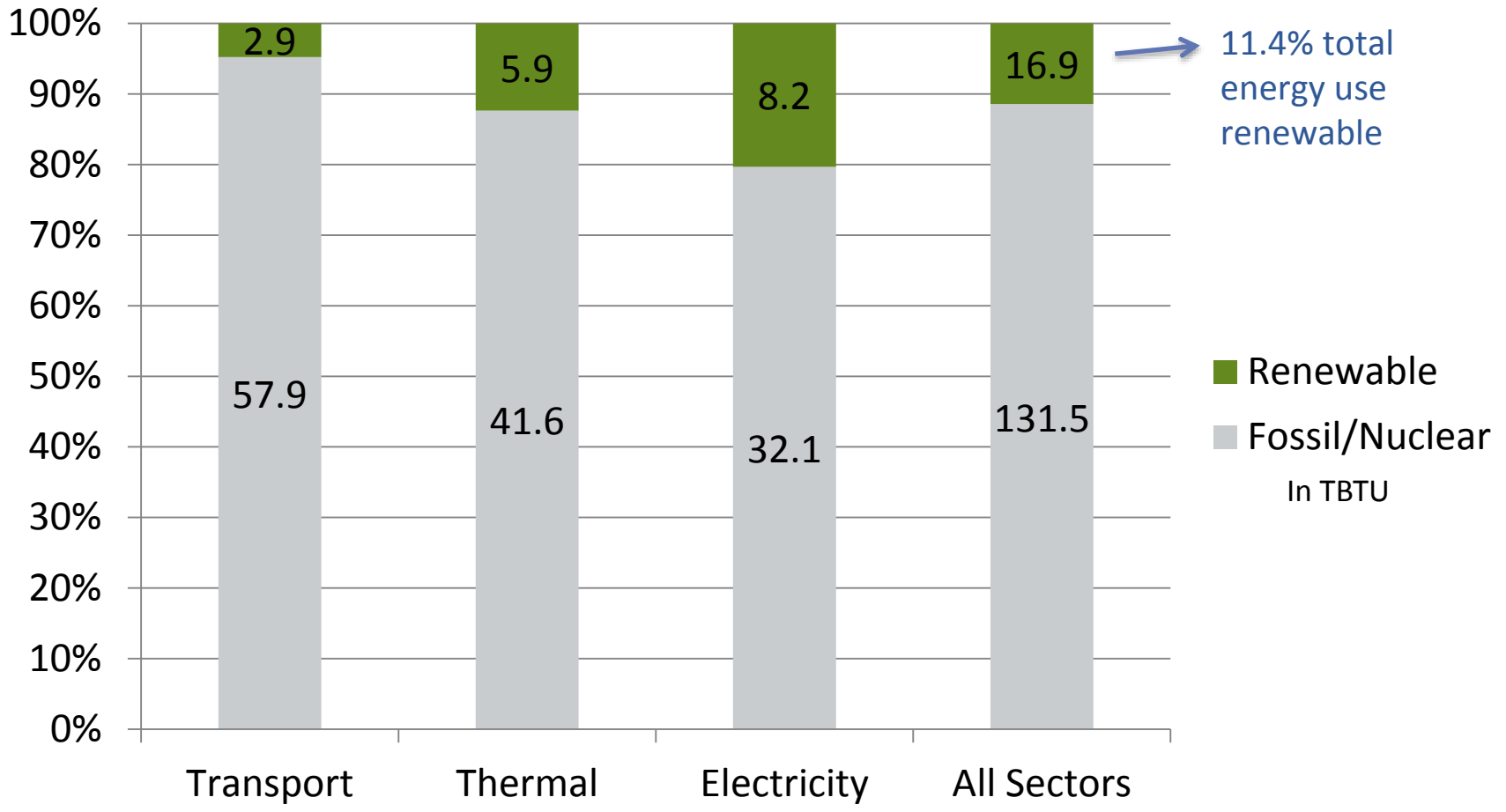
- To create a secure, reliable, and affordable energy future for Vermont based on investments in energy efficiency and renewable energy sources.

2050 Energy Pathways Analysis

Goals:

- Explore options for future energy use in Vermont in an informed and consistent manner
- Identify key barriers and opportunities inherent in the Vermont's Comprehensive Energy Plan (CEP)
- Serve as a framework for discussion about policy, technology, and economic choices
- Support and stimulate discussion of CEP recommendations and implementation

VT Energy Baseline 2010



Source Energy Analysis

Why Is It Important?

New England NG generation operates at 38% efficiency factor not including T&D losses

Table B-1 Source Energy Factors by Fuel Type for Generating Electricity (kWh of source energy per kWh of generated electricity)

Energy Group	National	Eastern	Western	ERCOT	Alaska	Hawaii
Bituminous Coal	2.996	2.993	3.035			5.696
Subbituminous Coal	3.089	3.084	3.126	3.059	3.937	2.863
Lignite Coal	3.262	3.252		3.272		
Natural Gas	2.627	2.629	2.631	2.620	3.405	3.198
Petroleum Fuels	3.117	3.094	3.404	4.022	3.311	3.049
Other Fossil Fuel	2.465	2.377	2.859	2.140		2.856
Nuclear	3.075	3.075	3.083	3.060		
Hydro	1.000	1.000	1.000	1.000	1.000	1.000
Renewable Fuels	4.459	4.527	3.947	6.419	2.868	5.157
Geothermal	6.160		6.160			6.160
Wind	1.000	1.000	1.000	1.000		1.000
Solar (PV)	1.000		1.000			

Source: Deru & Torcellini, *Source Energy and Emission Factors for Energy Use in Buildings,* NREL Technical Report NREL TP-550-38617, Revised June 2007

Source Energy Analysis - Fuels

Fuel Oil has about a 16% adder for refining and delivery

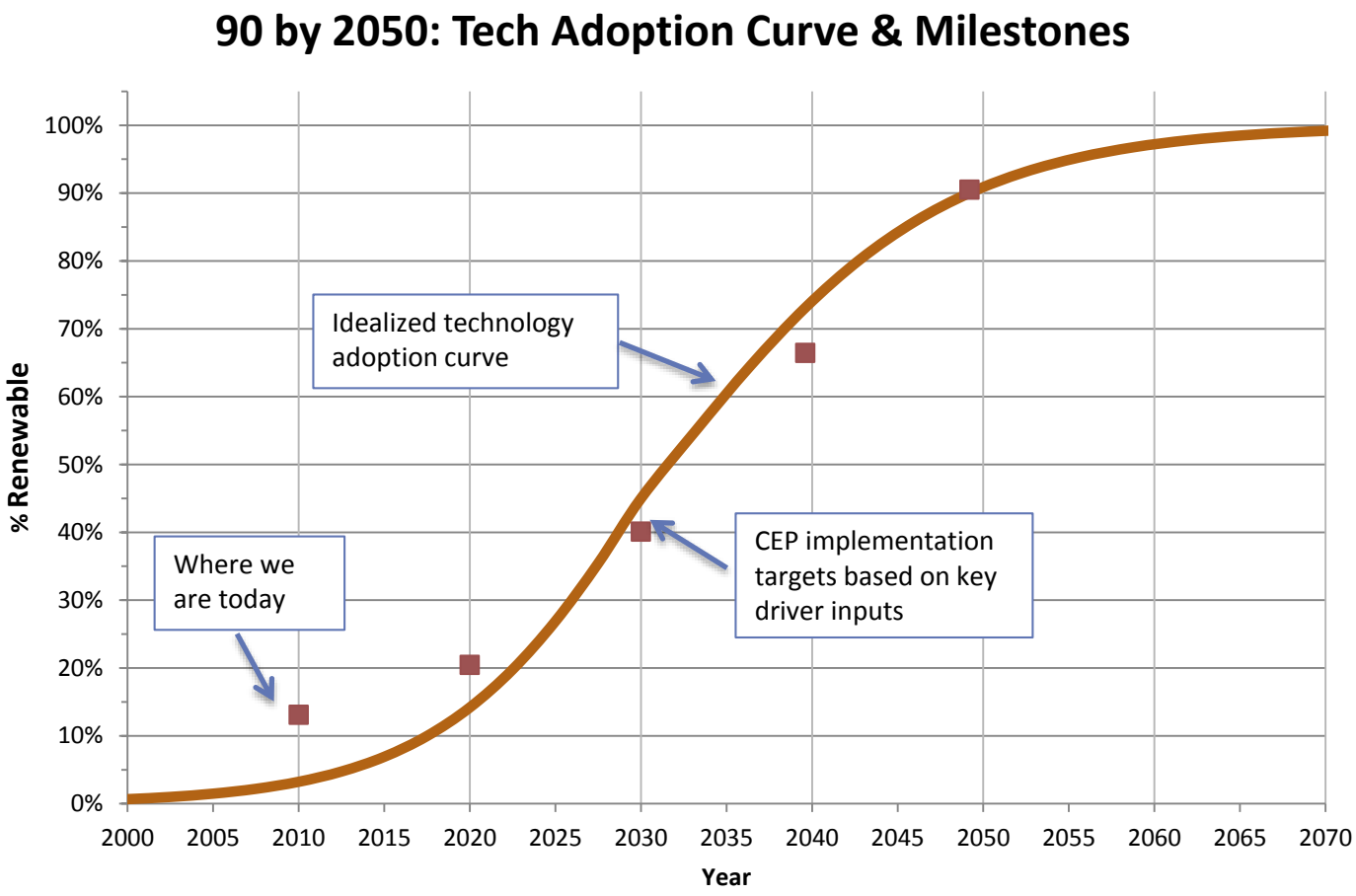
Table 5 Source Energy Factors for Fuel Delivered to Buildings

Fuel	Source Energy Factor	Higher Heating Value	
Anthracite Coal	1.029	12,700 Btu/lb	29,539 kJ/kg
Bituminous Coal	1.048	12,155 Btu/lb	28,270 kJ/kg
Subbitumious Coal	1.066	8,818 Btu/lb	20,509 kJ/kg
Lignite Coal	1.102	6,465 Btu/lb	15,038 kJ/kg
Natural Gas	1.092	1,010 Btu/ft^3 *	37,631 kJ/m^3 *
Residual Fuel Oil	1.191	149,500 Btu/gal	41,666 kJ/L
Distillate Fuel Oil	1.158	138,700 Btu/gal	38,656 kJ/L
Gasoline	1.187	100,000 Btu/gal	27,870 kJ/L
LPG	1.151	91,000 Btu/gal	25,362 kJ/L
Kerosene	1.205	135,000 Btu/gal	27,870 kJ/L

* Heating value for 60°F and 14.70 psia (15.6°C and 101325 Pa).

Source: Deru & Torcellini, *Source Energy and Emission Factors for Energy Use in Buildings,* NREL Technical Report NREL TP-550-38617, Revised June 2007

Transformation S-Curve

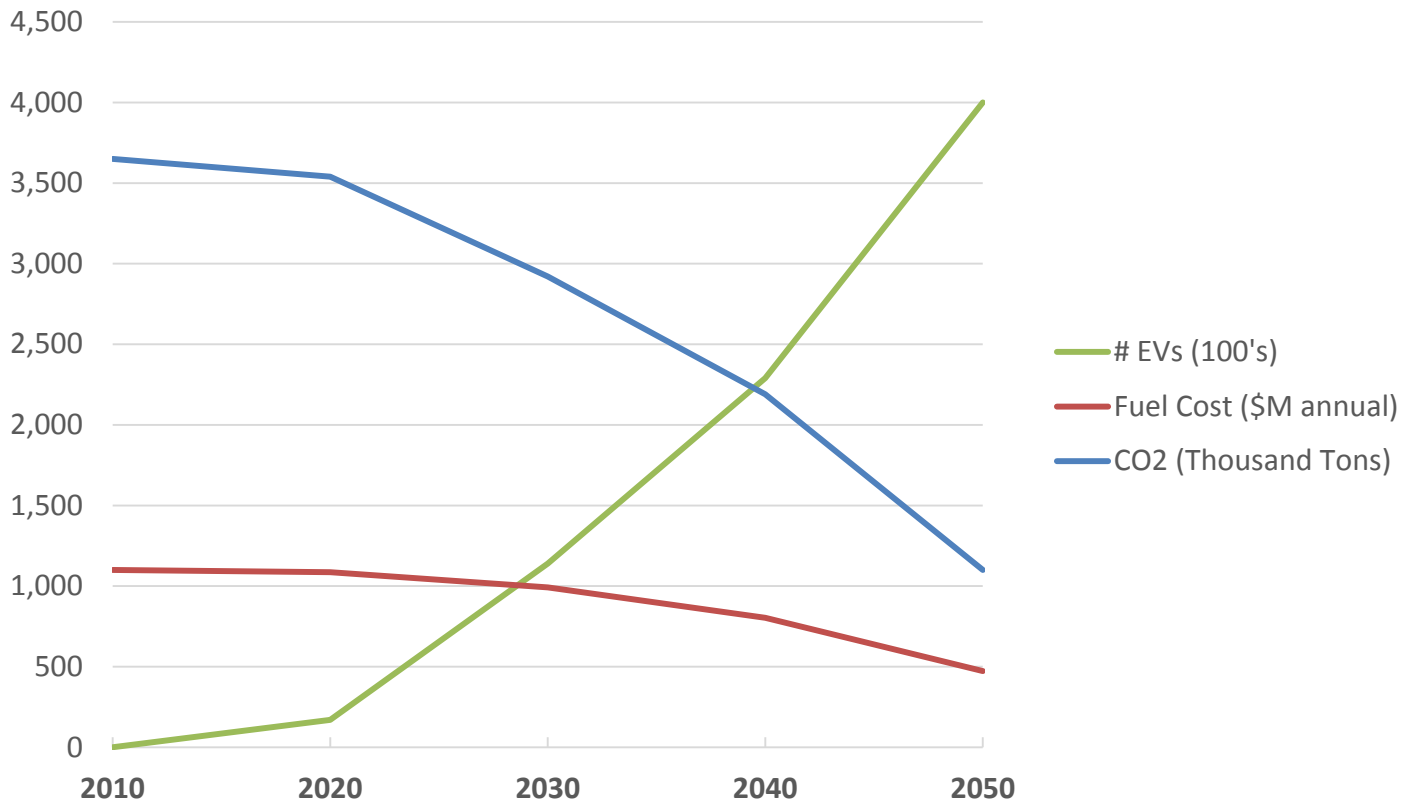


Transforming Transportation

Time to Plug In!

- **Electrification is critical path to achieving 90% goal, greater efficiency, and cost savings in sector.**
- 70% penetration of electric vehicles (350,000) by 2050 would raise energy efficiency of sector by over 50% and save over $500M/YR (2010$) in vehicle operating costs.
- Would require 28% additional electricity (GWH), but would have minor impact on VT peak (GW) load if battery charging was mainly at off-peak times and controlled by Smart Grid communication/control.

Effects of Electric Vehicles



Thermal Sector - Efficiency

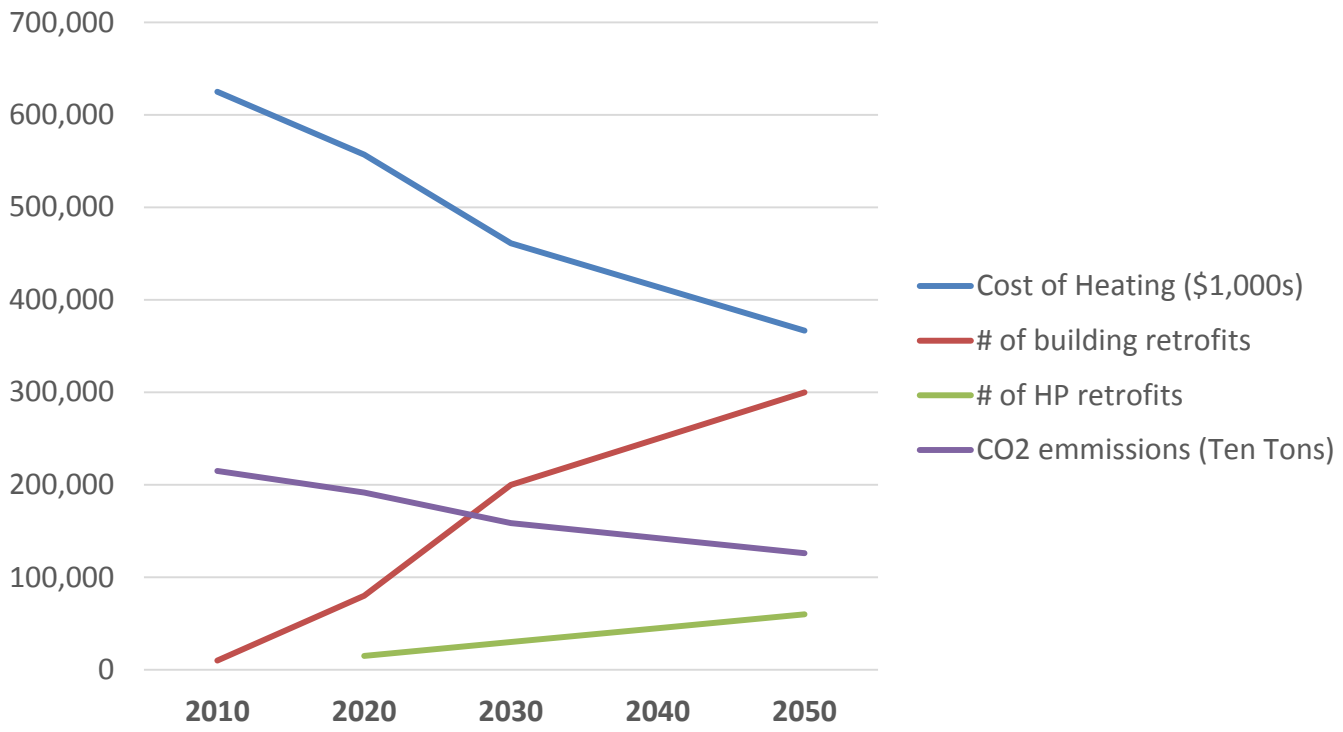
- **Efficiency investment is key to transforming thermal sector**.
- New construction can move to “near net zero” by 2020, but focus must be on existing building stock (250K homes, 50K commercial buildings).
- 30% improvement in building stock performance is possible with target of 300,000 retrofits by 2050. Current legislative target of 80,000 retrofits by 2020 is correct target but not being achieved with current programs (< 50% of annual req).
- Efficiency goal would require $6B in investment but would dramatically lower energy costs and create new jobs.

Thermal Sector - Fuels

- **Biomass, Biofuels, and Heat Pumps are key technology pathways.**

- 70% of building heat is currently met by imported fuel oil, LPG & natural gas at an annual cost of over $625 M.
- 75% of thermal demand in 2050 could be met by biomass and bio-fuels if we invest now in new technology and protect VT's forest resource from low value exploitation.
- Remaining 25% could be met by heat pumps, especially in new construction.
- At today's fuel prices savings would be over $260 M a year.

Efficiency & Heat Pump Impact

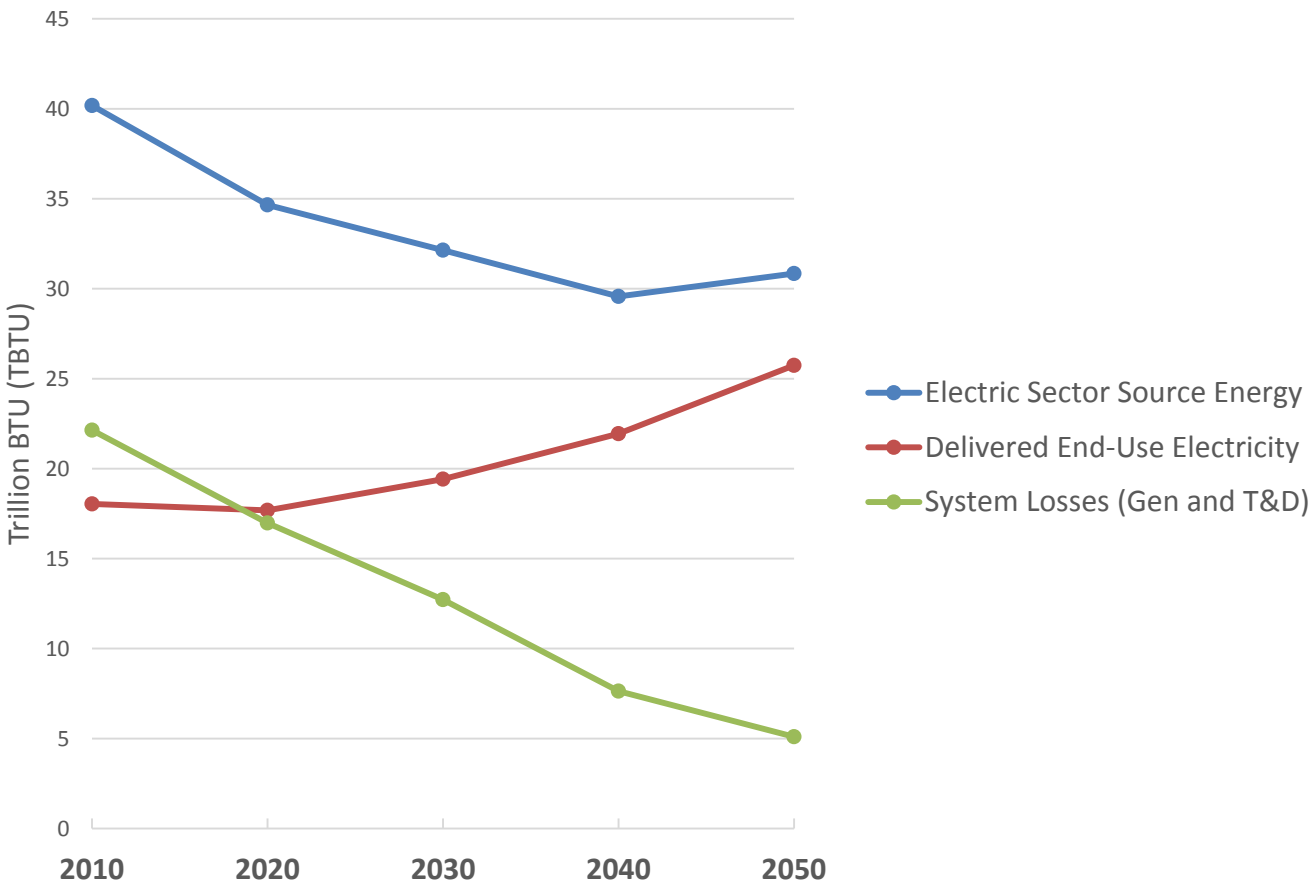


- $625 M in heating cost in 2010 for residential & commercial purchases of oil, LPG, and NG (EIA).
- Efficiency retrofits have average energy reduction of 30%. Individual building range = 20% to 50%. (VEIC)
- Heat pumps are cold climate air-source units that provide 75% of annual building load.
- ASHP save 40% of energy cost with electricity at $.146/kWh, oil at $3.99/gal and LPG at $2.99/gal (Letendre)

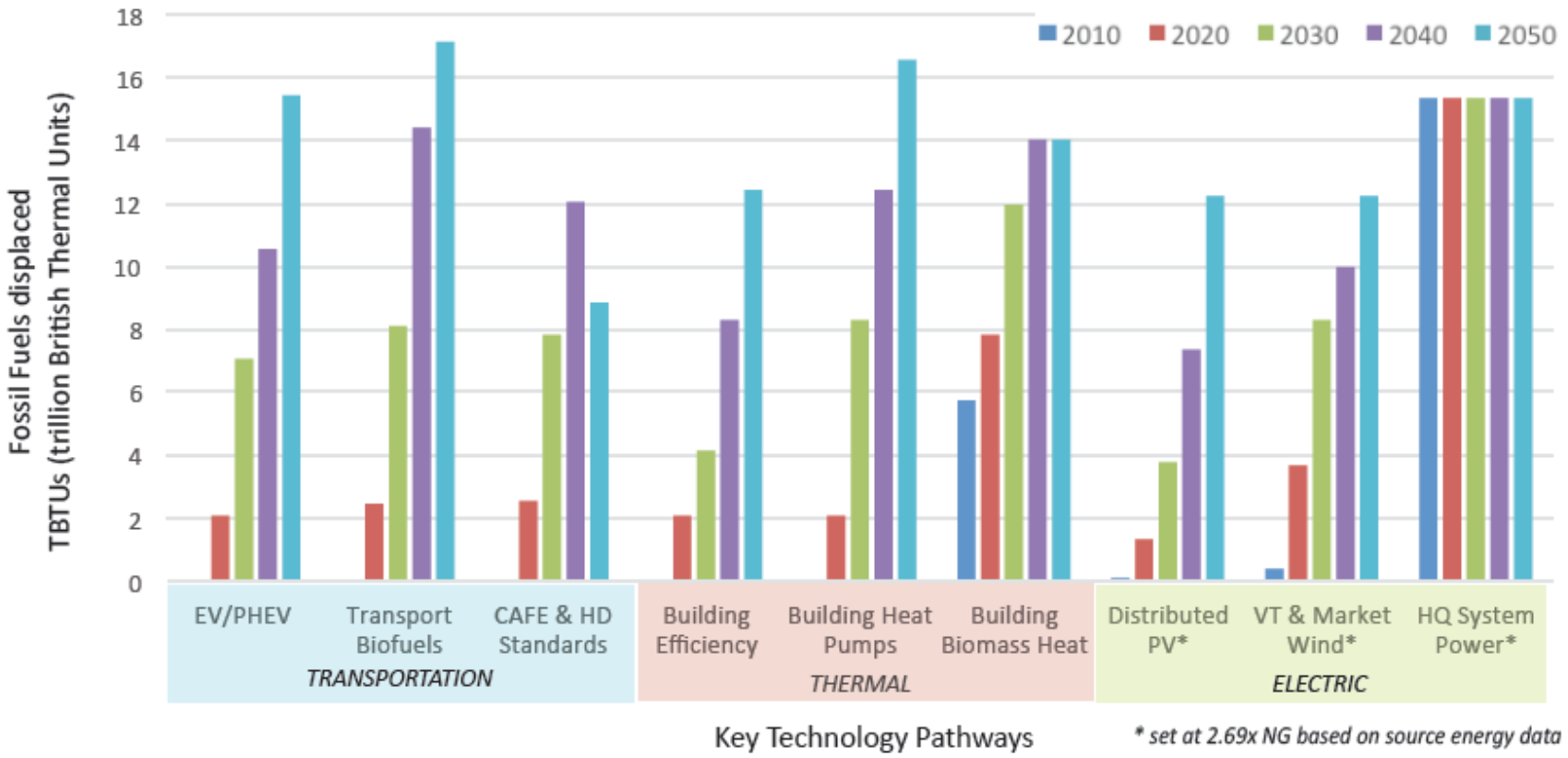
Electrical Energy

- Annual electrical *end-use* energy will grow 43% from 2010 to 2050 to power transport and thermal heat pumps.
- But total *source* electrical sector energy will actually decrease by over 20% because of increased efficiency due to RE source additions (no fuel combustion losses and less T&D losses).
- Regional and in-state wind can meet a large portion of new requirements at a competitive price, but by 2050 solar PV will actually provide more energy.
- Need for “firm” RE power is important consideration as we move to high penetration of RE generation, but Hydro Quebec is “firm renewable” power and provides over 30% currently.

Renewable Electricity Impact



Fossil Fuel Displacement by Key Pathways



The First Milestone: 20% by 2020

- Getting to 20% renewable from our current 12% is a reasonable goal for the first milestone.
- Achieving that extra 8% is a difficult but achievable target that will keep us on track to meeting 90% by 2050 goal.
- But we need to act right now to stay on target and to effect an orderly transition before energy dislocations make the task an expensive, emergency response.
- Here's what we need to do in next seven years…..

Transportation Sector Targets

Electric vehicles: increase to 5% of light vehicle fleet
Requires adding 28,000 EVs and PHEVs

Biofuels: increase by an additional 3% of liquid fuels for light vehicle fleet
Requires an additional 10 M gallons biofuels annually

Efficiency: increase vehicle fleet efficiency rating by 5%
Requires support of CAFE standards & Heavy Truck Fuel Efficiency standards by encouraging new efficient vehicle purchases

Thermal Sector Targets

Efficiency: Reduce building heat loses by 5%
Requires retrofitting 50,000 buildings with 30% average energy savings

Biomass: Increase by additional 5% of building sector heat load
Requires purchase and installation of 15,000 new pellet stoves or boilers

Solar: Provide 2% building heat & hot water through solar systems
Requires installation of 3,000 residential-scale (10 sq. m) SHW systems

Biomass Combined Heat & Power (CHP)
Requires updated biomass harvesting and use guidelines to encourage most efficient use of forest resources. Goal to build 60 MW of highest-efficiency combined heat and power plants, providing 50 MW thermal and 10 MW electric generation

Electric Sector Targets

Hydro Electric: Build or refurbish 5 MW small-scale hydro capacity
Requires active support of Agency of Natural Resources to streamline permitting

Solar Energy: Build 100 MW new PV capacity (50 “Solar Farms”)
Requires setting enhanced goals for the Standard Offer Program

Wind Power: Build 30 MW new in-state and 100 MW regional wind capacity
Requires siting guidelines and permit process reform

Questions/Comments?

Please Contact:

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or

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