ENERGY ACTION NETWORK

90% BY 2050

Pathways to Clean Energy

Analysis demonstrating how Vermont can transition to a clean energy economy by replacing fossil fuels with renewables and increasing efficiency.

In 2011 the State of Vermont revised its Comprehensive Energy Plan (CEP) and established a bold goal: to meet 90% of Vermont's 2050 energy needs from renewable sources and increased efficiency. This goal includes energy used in all three sectors – *transportation, thermal and electric* – by residential, commercial and industrial users. While the CEP goal establishes the target for 2050, it does not define the path by which we will make that transition. Energy Action Network embraces that challenge.

With support from the High Meadows Fund, EAN devised a series of decade milestones that could illustrate a snapshot of where we might be in 2020, 2030, 2040, en route to 90% renewables in 2050. ***This analysis is not meant to be a "roadmap," but rather to identify the known technology pathways, key policy drivers and most important questions for policy makers to consider.*** To access the complete EAN analysis, please contact EAN.

Key Pathways to Reach 90% by 2050

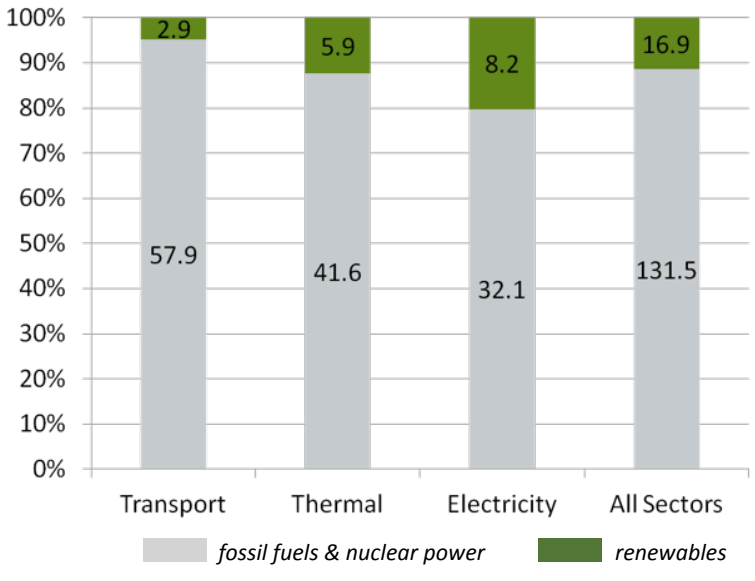
While efficiency is our most cost-effective pathway, to achieve the goals of the CEP we will need to invest in efficiency and new renewable energy resources simultaneously.

These technology pathways have the greatest capacity to transform Vermont's energy economy.

TRANSPORTATION	THERMAL	ELECTRICITY
Electric Vehicles	Building Efficiency	Solar Power
CAFE Standards	Heat Pumps	Wind Power
Biofuels	Biomass and Biofuels	Hydro Quebec

Vermont's 2010 Energy Baseline

TBTUs (trillion British Thermal Units)



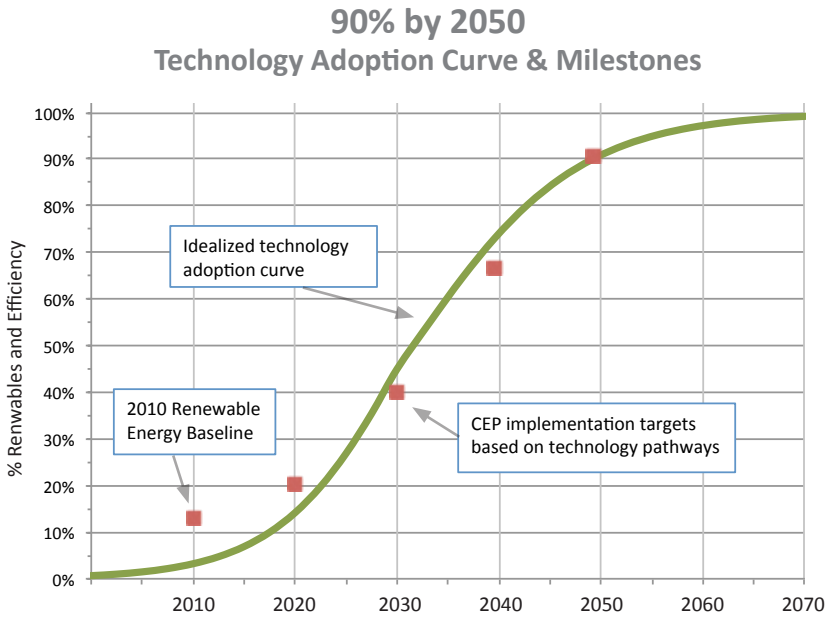
Measuring Our Current Energy Use

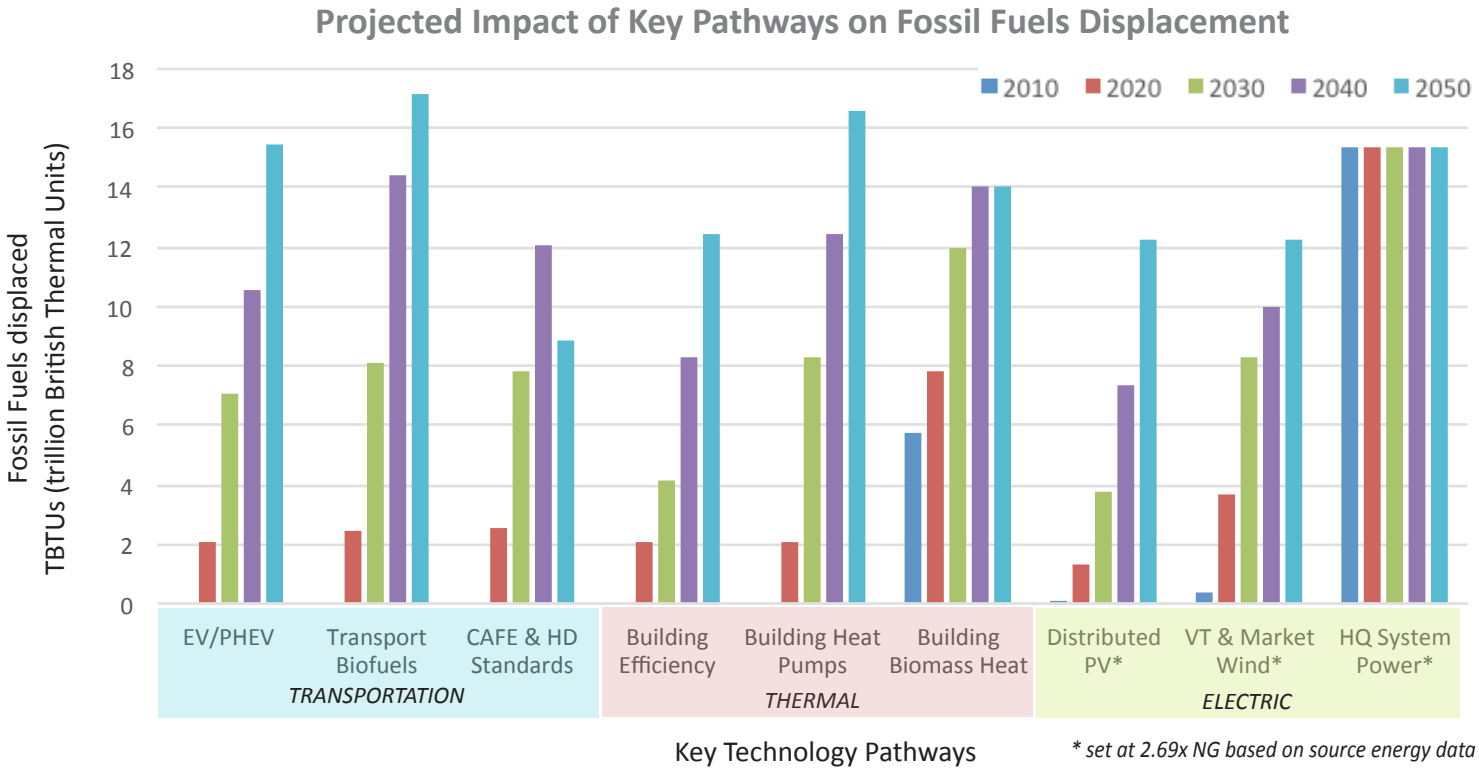
This graph shows Vermont's 2010 energy needs by sector and the relative amounts provided by renewables vs fossil fuels and nuclear power. Transportation uses the most overall energy and is the least supported by renewables. Vermont's electric sector consumes the least total energy and is now up to about 25% renewable (in 2013).

It should be noted that EAN's analysis measures ***source energy*** which includes all the energy inputs required to deliver the energy we consume in all three sectors. This includes the energy associated with extracting, processing and delivering the primary fuels. For electricity, source energy also includes the conversion inefficiencies at the power plant and the transmission and distribution losses.

Adoption Curve & Milestones

To further define what the adoption curve for 90% by 2050 might look like, EAN devised a series of decade milestones to provide a snapshot of where we might be in 2020, 2030, and 2040. One valuable insight gained during this process was the importance of balancing the transition across all three energy sectors -- transportation, thermal and electricity. For example, additional renewable electricity will only have a significant impact once electricity is used to displace fossil fuels (e.g. power electric vehicles or thermal heat pumps). The rate of adoption of certain technologies, such as electric vehicles, will determine how swiftly Vermont moves toward a renewable energy future.





Collaborative Energy Scenario Modeling

LEAP allows policy analysts to create and evaluate different scenarios by comparing the associated energy requirements, social costs/benefits and environmental impacts.

EAN is currently collaborating with Vermont Energy Investment Corporation (VEIC) to build a state-wide energy model that can be used by towns and Regional Planning Commissions to build long-range energy plans that are consistent with the State's 90% by 2050 goals. Using the Long-range Energy Alternatives Planning model (LEAP), EAN will be assisting VEIC in building energy scenarios and milestones for three of Vermont's eleven Regional Planning Commissions. The goal of this pilot effort is to allow all RPCs to initiate comprehensive energy planning within the framework of overall state goals.

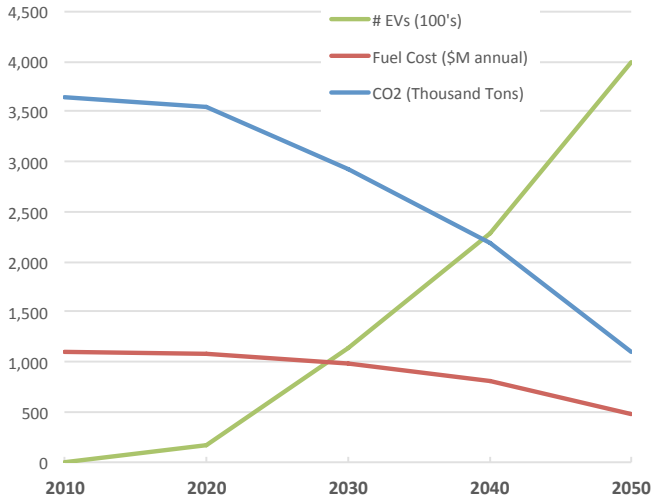
3 Examples from EAN's Analysis

1 TRANSPORTATION

Electric vehicles (EV) and plug-in hybrid electric vehicles (PHEV) offer the promise of greatly reduced energy use and operating cost per vehicle mile.

By transitioning 70% of our automobiles (light vehicle fleet) to EVs and PHEVs run on renewable fuels, Vermonters could save $500M annually at today's gasoline prices and cut vehicle greenhouse gas (GHG) emissions to less than a third of 2010 levels.

Electric Vehicle Impacts

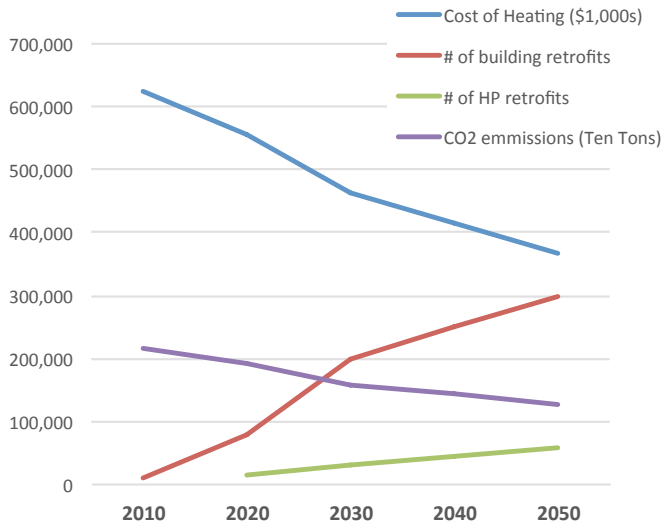


2 THERMAL

This chart (right) shows the impact of combining a statewide efficiency program that reaches 300,000 homes by 2050 (with 30% average savings) and heat pump retrofits of 60,000 buildings (20% penetration rate).

At today's fuel and electricity cost, this would save Vermonters $260 M per year when fully implemented. It would also cut GHG emissions by over 40% from current levels.

Efficiency and Heat Pump Impacts

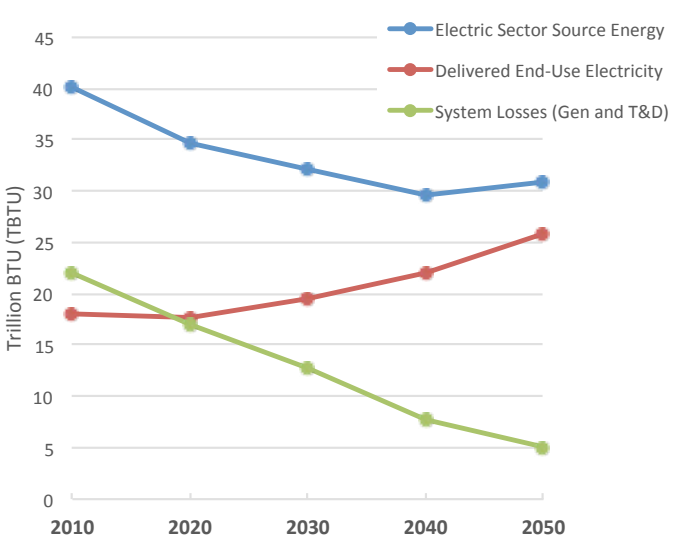


3 ELECTRIC

Transitioning our electric system to rely predominantly on renewables is the foundation of achieving 90% by 2050. Not only will it allow for electrification of transportation and a portion of our heating needs, but it is the single most important element to minimize waste in our overall energy system and reduce GHG emissions.

EAN's 90% by 2050 energy analysis shows that despite increasing our end-use electrical consumption by 43% in 2050 to power transportation and thermal sectors, the electrical sector overall source energy consumption will actually decrease by 23% because of new more efficient renewable generation that has no source losses *(see page 1).*

Renewable Electricity Impacts



Our First Milestone: 20% x 2020

For the 2020 milestone, EAN set a target goal of 20% renewable across all sectors. Given available technology, Vermont's current energy programs, and where the state should be on the transformation S-curve (see page 2), achieving 20% (roughly a doubling of our 2010 renewable %) appears achievable and cost-effective. To illustrate the actions that might allow Vermont to reach this goal, EAN has compiled a list of specific targets for each of the key technology pathways.

SECTOR	2020 EAN TARGET		2010	2014	2020
		unit	baseline	achieved	target
TRANSPORT					
Electric Vehicles	Increase EVs and PHEVs to 5% of light vehicle fleet	# of vehicles	94*	867	28,000
Biofuels	Increase consumption to 10 million gallons annually	million gallons	1.2	?	10
Efficiency	Increase Vermont fleet fuel efficiency by 5% over 2010 (saves 17 million gallons annually)	fleet MPG	21.6	?	22.7
THERMAL					
Building Efficiency	Reduce building fossil fuel use by 5% from 2010 (Act 92 goals, enacted 2008)	trillion BTUs	33.5	33.1	31.8
Biomass	Increase use of biomass heating to offset 7% of 2010 building fossil fuel use	trillion BTUs	4.5	?	6.8
Heat Pumps	Cut fossil fuel use by 5% over 2010 through cold climate heat pumps	# of retrofits	---	5,000	23,000
ELECTRIC					
Wind	300 MW capacity from in-state and regional plants	megawatts	7.4	220	300
Solar	150 MW of photovoltaic capacity	megawatts	11	87	150
Hydro	35 MW of small-scale hydro	megawatts	5.5	29	35
Methane	20 MW of farm and landfill digesters	megawatts	15.1	17	20

*Notes: This table, compiled from E.I.A. and State Reports, appears in EAN's 2014 Annual Report. Electric generation includes Net Metering, Standard Offer, and SPEED projects reported through September 2014. "?" indicate incomplete data. * 94 EVs registered in VT in 2009.*

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