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

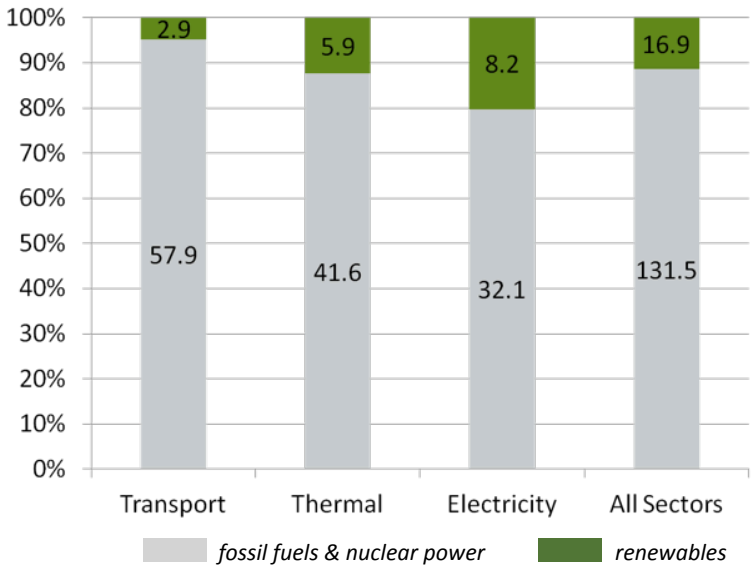
While efficiency is our most cost-effective pathway, to achieve the goals of the CEP we will need to invest in efficiency and new renewable energy resources simultaneously.

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 Pump	Wind Power
Biofuels	Biomass and Biofuels	Hydro Quebec

Vermont's 2010 Energy Baseline

TBTUs (trillion British Thermal Units)



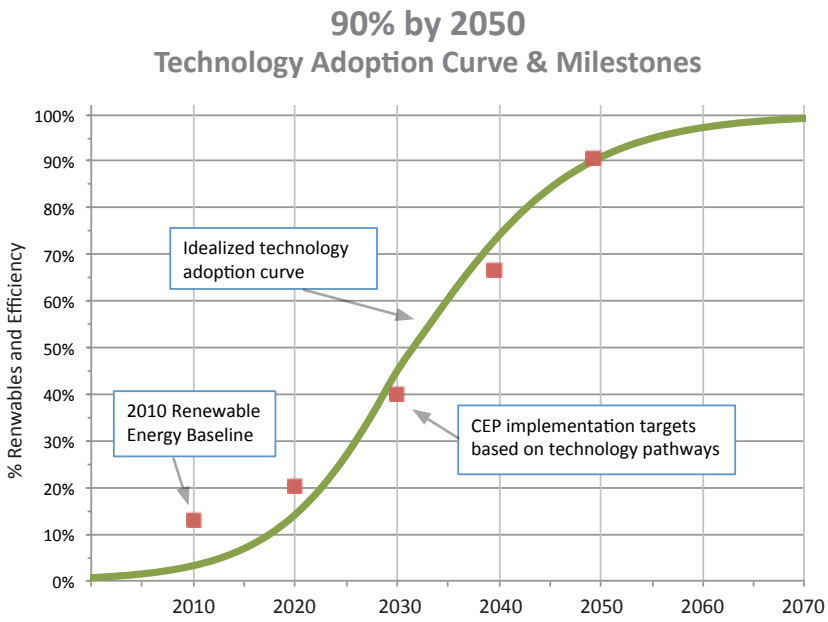
Measuring Our Current Energy Use

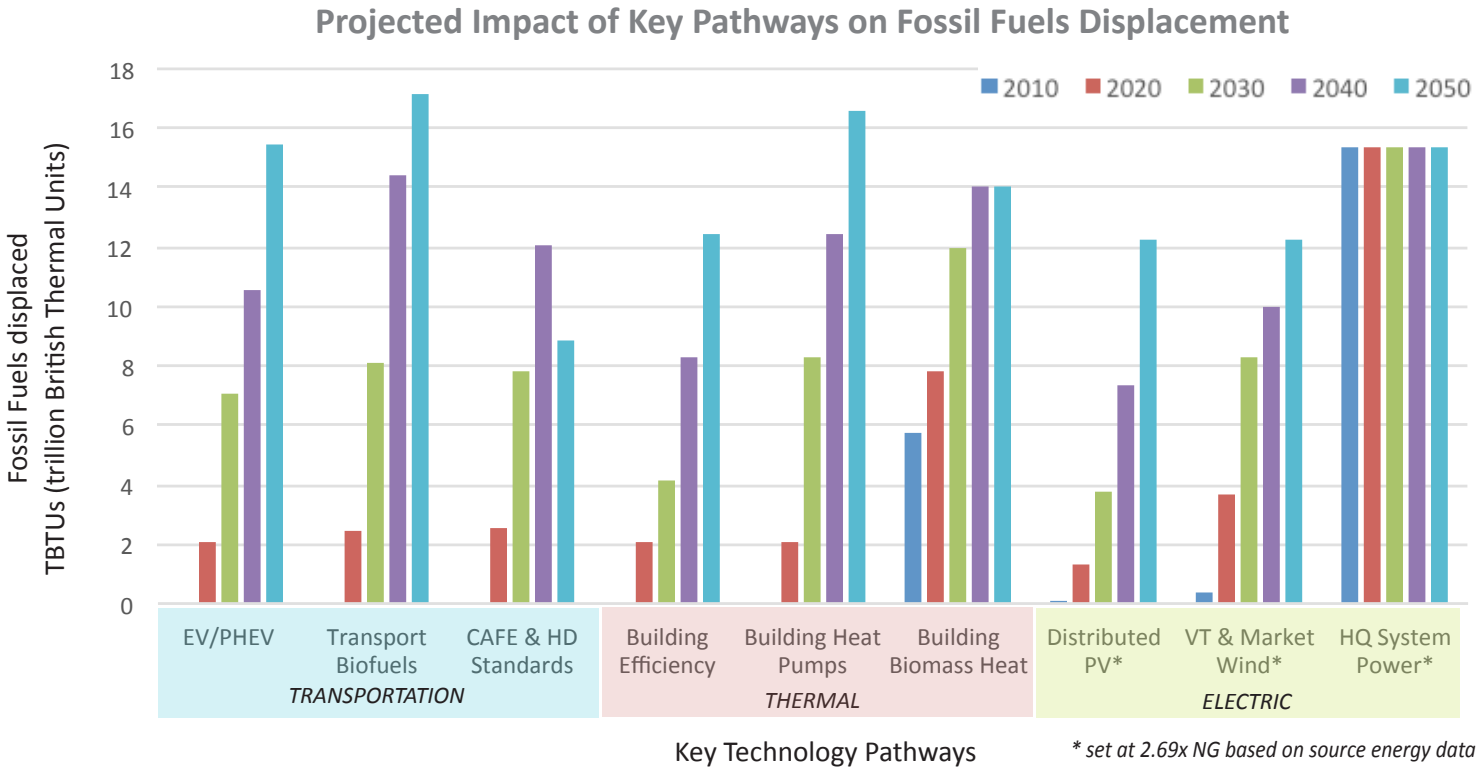
This graph shows Vermont's 2010 energy needs by sector and the relative amounts provided by renewables vs fossil fuels and nuclear power. Transportation uses the most overall energy and is the least supported by renewables. Vermont's electric sector consumes the least total energy and is now up to about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

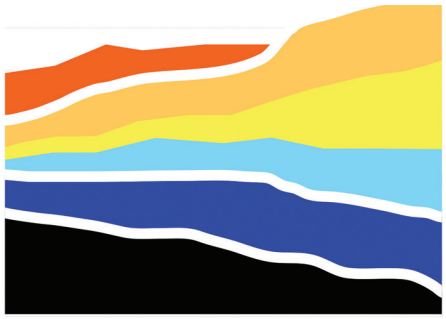
It should be noted that EAN's analysis measures ***source energy*** which includes all the energy inputs required to deliver the energy we consume in all three sectors. This includes the energy associated with extracting, processing and delivering the primary fuels. For electricity, source energy also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







Dynamic Energy Scenario Modeling

EAN's analysis was not guided by an econometric model or dynamic energy model, but relies on current research about the potential for efficiency, new electric technologies, and renewable energy resources to enter the market-place over time and displace current non-renewable fossil and nuclear fuels.

EAN is collaborating with UVM's Gund Institute for Ecological Economics and state partners to develop a dynamic energy simulation model for Vermont. This model will be completed in 2014 and will be used to test the assumptions and effects in the current EAN non-dynamic "accounting" model.

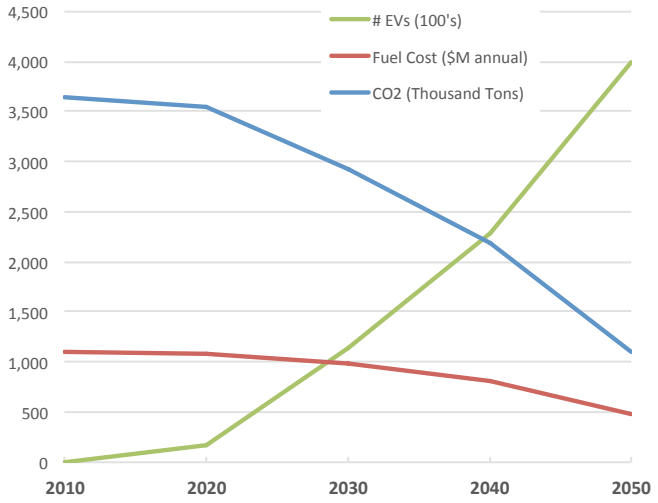
3 Examples from EAN's Analysis

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

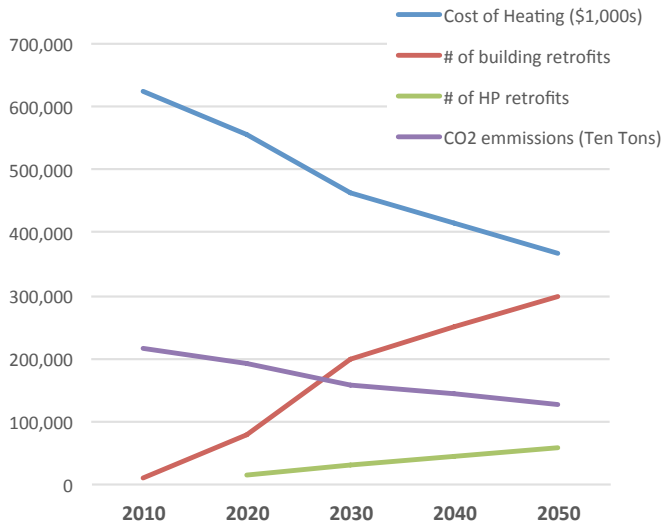


2 THERMAL

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

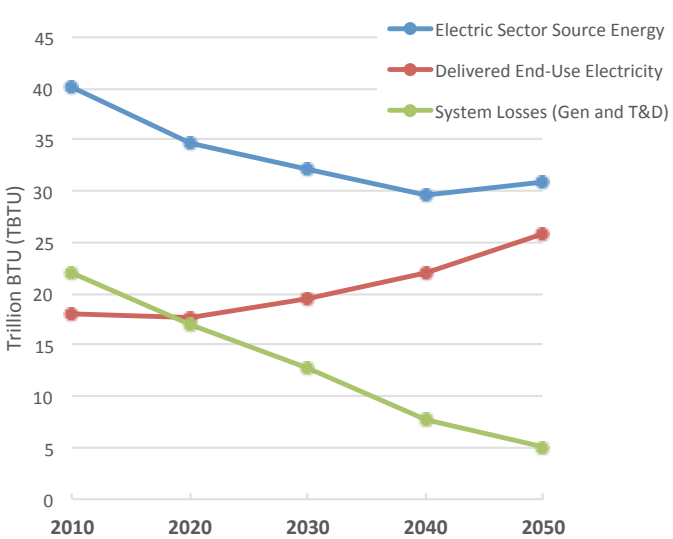


3 ELECTRIC

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.

TRANSPORTATION SECTOR TARGETS

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

Biofuels: increase by an additional 5% of liquid fuels for light vehicle fleet
Requires an additional 15 M gallons biofuels annually

Efficiency: increase vehicle fleet efficiency rating by 5%
Requires support of Corporate Average Fuel Efficiency standards & Heavy Duty 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 7% of building sector heat load
Requires installation of 20,000 new pellet stoves or boilers

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

Biomass Combined Heat & Power (CHP)
Requires building 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 50 MW regional wind capacity
Requires siting guidelines and permit process reform

ENERGY ACTION NETWORK

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