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Key Data Sources and Assumptions for the Progress Timeline
Energy Action Network Community Energy Dashboard

The Progress Timeline on the Energy Action Network (EAN) Community Energy Dashboard is a powerful tool intended to help Vermont communities have a better understanding of energy at the local level: where they are now, where they need to go to help Vermont reach its goal of 90% by 2050, and what it might take to get there.

The interactive Timeline that underpins the Community Progress graphics was developed in partnership with the Vermont Efficiency Investment Corporation (VEIC) and the EAN, using the best available official data sources and a range of best-practice assumptions for data that is not currently available on a town-by-town basis.

It is important to understand that the projections to meeting 90% of any given community's energy needs through efficiency and renewables by 2050 are not intended to be a precise roadmap, but rather a *directional* indication of what it will take for each community to reach that goal, based on how much energy they currently use.

This document is a summary of the methodologies used to estimate energy use and projected energy goals by community. What follows is a detailed description of:

- Data Sources
- Community Categories
- Assumptions and Methodologies used to determine:
  - Energy use in each of the three energy sectors: Electric, Heat, and Transportation
  - 2014 Baseline Year
  - Energy projections towards a 2020 energy milestone year and a 90% by 2050 goal
- Guidelines on Customizing Data

Data Sources

Dashboard data are drawn from the best available official data sources. These include:

- **Efficiency Vermont** – receives electric use data from the Vermont electric utilities and summarizes annual electric use by zip code and town
- **US Energy information Agency (EIA)** – tracks state-level energy use across sectors and fuel types
- **Vermont Agency of Transportation (VTRANS)** – publishes VMT (Vehicle Miles Traveled) and average fuel economies found in Vermont.
- **US Census** – Population estimates by town
- **Vermont's 2016 Comprehensive Energy Plan** – Vermont energy data and scenario alternatives

- **VEIC's Solar Market Pathways Long-range Energy Alternatives Planning model (LEAP)** – VEIC utilized LEAP software to build statewide long-term energy projections across a range of scenarios through 2050 consistent with the State's 90% by 2050 goals. The modeling work[1], which has undergone thorough stakeholder review, pulls from a variety of statewide and national sources such as the VT Total Energy Study (TES), the Comprehensive Energy Plan (CEP) and EAN's Pathways Analysis.

Because the EAN Dashboard estimates town level usage based on a variety of best available data sources, it is important to understand that this data set should not be used as a definitive measurement of energy use. The modeling efforts are meant to educate citizens and motivate participation in programs and actions that align with the goals outlined in the Vermont's Comprehensive Energy Plan.

The spreadsheets used to calculate the Timeline include a detailed account of data sources, assumptions and formulas used to derive the values. The data contained in this spreadsheet will be updated in an annual "true up" as official data become available. In addition, each town has the opportunity to further customize its data if it has more accurate community-level information than what is available through state-level data (see below for "Energy Committee Guidelines for Customizing Metrics"). For further information, please contact EAN (Dashboard@eanvt.org).

Community Categories

Community Boundaries and Sector Definitions

For each community, the assumed boundary is the town or city physical boundary. This sets the number of households and the population based on the most recent US Census data. The sectors where energy is measured are as follows:

- **Electric** – Electrical energy supply to households and businesses within the defined boundary
- **Thermal** – Thermal energy to provide heat to households and businesses within the defined boundary
- **Transportation** – Residential, commercial and industrial vehicles located within the defined boundary and the energy needed to meet the demand of yearly travel requirements

Methodology for Determining Community Categories

Because precise community level data is not available for the heat and transportation sectors, the Dashboard categorizes Vermont's towns into **five community types** (see Table 1), based on population density data from the US Census (population per square mile) [2] for these categories of data. The only exception to the population density metric is the category of "Resort Towns", which on average exhibit very different energy consumption patterns than other towns of comparable density.

The Dashboard then utilizes best-practice assumptions to determine average heat and transportation energy use across these town types. The categories are used in accordance with research that demonstrates that there are very different energy use patterns in urban and rural settings. For example,

1[3] VEIC Solar Market Pathways (https://portal.veic.org/sunshot/SitePages/Home.aspx)
2[3] UVM Vermont Legislative Research Shop (http://www.uvm.edu/~vlrs/doc/pop_density.htm)

on average, it takes more transportation energy use for a person in a rural setting to get groceries, go to work, go to school, and so on, than it does for a person in an urban setting.

Table 1: Community Types

Category	Example	Density (pop/sq mile)
Large City	Burlington, Rutland, Bellows Falls	> 2,000
Small City	Montpelier, S Burlington, Proctor, Middlebury	> 200 but ≤ 2,000
Town	Waterbury, Springfield, Thetford	≥ 40 but ≤ 200
Resort Town	Stowe, Waitsfield	From list of VT ski areas
Rural Community	Moretown, Danville, Duxbury	< 40
Source: US Census and UVM Vermont Legislative Research Shop		

This typological methodology was used to develop the Progress Timeline, including:

- **A 2014 baseline year** for each of the five community types for heat and transportation (Note: if 2014 data was unavailable, data from the most recent year was used instead.)
- **Annual updates** starting in 2015 (with the most recent utility information)
- **A first "milestone"** of 20% renewables by 2020
- **The ultimate goal** of meeting 90% of Vermont's energy needs through efficiency and renewables by 2050.

Dashboard Assumptions – 2014 Baseline

Electricity data for Vermont communities was obtained from electric utilities via annual reporting to Efficiency Vermont. Utilities track energy use for planning and billing purposes; therefore, the electric utility data provides a primary source of data. Developing the corresponding town level data for ***thermal*** and ***transportation*** requires taking primary data at the state level and allocating energy use to the town level using assumptions together with the typological methodology described above. This was not a simple exercise. Vermont relies on unregulated fuels in most of the state for heating, and the whole state for transportation. Some Vermont communities have utility level natural gas data but this was not incorporated into the current dashboard. Some of the referenced statewide studies include the VEIC Solar Market Pathways Project, the VT Total Energy Study (TES) and Vermont's 2016 Comprehensive Energy Plan (CEP).

Electrical

- **Residential, Commercial and Industrial Assumptions**

The amount of electricity used in the residential, commercial and industrial market segments within each community boundary was determined using utility reported 2014 town electricity use data.

- **Renewable Assumptions**

There are two sources of renewable electricity tracked in the Dashboard: net-metered and utility scale. Information related to the sale of RECs (Renewable Energy Credits) is not included at this time. As the information on RECs becomes more widely available under new legislation to be put into effect in 2017 (Act 56), the Dashboard will reflect these changes.

Net-metered renewable electricity is defined as an installation that is less than 500kW and can be classified as commercial (e.g., municipal, farm, institution) or residential depending on the type of customer listed on the Certificate of Public Good (CPG) issued by the Public Service Board. The sources and assumptions for net-metered renewable electricity come from these CPGs and the Vermont Department of Public Service (DPS). This data contains net-metering capacity data by town for the following energy types: hydropower, methane digesters, wind, solar photovoltaics, and landfill methane.

The dashboard uses the following capacity factors (CF) to estimate net-metered electricity production (kWh):

- Roof-Mounted Solar PV. Formula = Capacity (kW) x 24 x 365 x .12
- Ground - Mounted Solar PV: Fixed Array. Formula = Capacity(kW) x 24 x 365 x .137
- Ground - Mounted Solar PV: Pole. Formula = Capacity (kW) x 24 x 365 x .137
- Small-wind turbine. Formula = Capacity (kW) x 24 x 365 x .274
- Farm methane. Formula = Capacity (kW) x 24 x 365 x .6 (The Public Service Board set CF based on performance of 7 plants studied in VT)
- Hydropower. Formula = Capacity (kW) x 24 x 365 x .55
- Landfill methane. Formula = Capacity (kW) x 24 x 365 x .75 (WEC owns the biggest operation in the state at Coventry (8MW) and it has a 75% CF in 2013).

Utility scale renewable electricity is an installation over 500kW and is managed and owned by an electric utility. In order to estimate the percent of utility scale renewable electricity, a data set titled "Net Energy and Peak Load by Source" was obtained from ISO NE from the following website: http://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/net-ener-peak-load. This dataset was incorporated into the Dashboard and used to delineate the ISO NE renewable and non-renewable energy supply mix. The sources of energy from New Brunswick, New York and Hydro: Pump Storage were excluded from the renewable energy percentage in 2014 due to unknown renewable energy ratios within these sources.

Thermal

Heat use varies widely by type of home/building, age of home/building (and therefore relative efficiency), and occupation rates of homes. Consequently, on average, we find that rural homes, which are often older and leakier, use more energy to heat than city homes, which often include multifamily homes and newer construction. In resort towns, there are often many homes that are not occupied for large parts of the year and impact the total heat use. The assumptions below were drawn from state-level and national research on heat energy usage across town types.

Category	Example	Average Heating
Large City	Burlington, Rutland, Bellows Falls	77% of average
Small City	Montpelier, S Burlington, Proctor	98% of average
Town	Morrisville, Springfield, Fair Haven	110% of average
Resort Town	Stowe, Waitsfield	120% of average
Rural Community	Moretown, Danville, Peacham	140% of average

- **Residential Assumptions**

- Number of households per community drawn from Efficiency Vermont (2014) and census data (2010).
- State average heat use per household was calculated using LEAP output values, the number of households in the state and TES values for fuel consumption by fuel type.[3]
- State average heating varies based on town type
- Percent for communities is based on type of housing stock, which includes: mix of average home size, % multifamily, average age of home, and % occupied.
- Used state mix of heating fuels to calculate heat by type from VEIC's Solar Market Pathways LEAP output: 39% heating oil, 17% propane, 29% wood, 1% electric resistance, 14% natural gas.

- **Commercial & Industrial Assumptions**
  - Number of C&I establishments in a community is calculated by scaling state total number of C&I establishments by a percentage of a town's electrical energy use for C&I compared to the state total (community C&I electric energy use/state total energy use * C&I establishments in the state)
  - Utilized VEIC's Solar Market Pathways LEAP model output to generate the total statewide C&I thermal energy consumption and scaled for each town based on number of C&I establishments (derived above) in the state.

- **Renewable Assumptions**

The Dashboard assumes that thermal renewable energy consists of wood, wood waste and wood chips. For the residential sector, these sources account for 29% of the thermal load. The commercial renewable thermal value comes from assumptions within the VEIC Solar Market Patheways LEAP model and account for 10% of the thermal load.

Transportation

Transportation energy use also varies widely across the rural/urban spectrum. On average, those who live in more rural areas will need to drive more vehicle miles (for groceries, work, school, supplies, etc) than those who live in more urban areas. The assumptions below were drawn from state-level and national research on transportation energy use across town types.

Category	Example	Average Car Miles Traveled
Large City	Burlington, Rutland, Bellows Falls	90% of average
Small City	Montpelier, S Burlington, Proctor	95% of average
Town	Morrisville, Springfield, Fair Haven	110% of average
Resort Town	Stowe, Waitsfield	120% of average
Rural Community	Moretown, Danville, Peacham	150% of average
Note: Based on Vermont Transportation Study and assumptions listed above.		

- **Residential Assumptions**

[3] Reference file: MMBtuperhousehold4thattemptwcookingandappliances.xlsx

- Determined number of vehicles based on VT state average of .9 cars per person, and applied to the number of people for each town. [4]
- Assumed mix of car fuel type uses VEIC's LEAP Model outputs: gasoline (84.3%), ethanol (11.7%), diesel (3.9%), electric (0.1%)

- **Commercial & Industrial Assumptions**
  - Utilized VEIC's Solar Market Pathways LEAP model output to generate the total statewide C&I transportation energy consumption and scaled for each town based on number of C&I establishments (number derived using method discussed above) in the state.

- **Renewable Assumptions**
  - The Dashboard assumes that transportation renewable energy consists of biofuels and a portion of the electric vehicles energy use supplied by renewable electricity (determined by the electric supply mix).

2020 Milestone and 2050 Projections

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. The 2016 CEP continues to support this goal and identifies specific targets and milestones en route to 2050. These include energy used in all sectors – transportation, thermal and electric – by residential, commercial and industrial users.

The Dashboard contains a first milestone for the year 2020 to provide a snapshot of where towns need to be in the coming years if we are to reach 90% by 2050. Two key factors are fundamental to this transition: 1) significant improvements in efficiency across all energy sectors; and 2) increasing electrification of
both the thermal and transportation sectors to displace fossil fuels.

This analysis is not meant to be a "roadmap," but rather a means to identify known technology pathways, key policy drivers and important questions for policy makers to consider in choosing one technology pathway over another and the pace at which we want the transformation to occur.

EAN is collaborating with VEIC, Regional Planning Commissions (RPCs) and the Vermont Department of Public Service on a statewide energy model that can be used by towns and regions to build long-range energy plans that are consistent with the state's 90% by 2050 goals. Using the Long-range Energy Alternatives Planning tools (LEAP – see box), EAN is supporting VEIC's efforts to pilot the development of energy scenarios and milestones for three of Vermont's eleven RPCs in 2015 and 2016.

The goal of this effort is to allow all RPC's to initiate comprehensive energy planning within the framework of overall state goals. The LEAP model data also underpins EAN's Community Energy Dashboard, which will begin to enable towns across the state to better understand their energy use and plan a renewable energy future.

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[4] Vermont Agency of Transportation. August 2013. "The Vermont Transportation Energy Profile." http://vtransplanning.vermont.gov/sites/aot_policy/files/VTEPAugust%2028%202013%20FINAL.pdf

The LEAP tool and the Dashboard utilize “site energy” as opposed to “source energy” for their calculations. Site energy includes all energy used at the site itself. It does not include all the energy inputs required to deliver the energy we consume in all sectors (e.g., energy associated with extracting, processing, and delivering primary fuels, or for electricity, conversion inefficiencies at power plants and transmission and distribution losses.)

LEAP Tools for Sustainable Energy Analysis

The LEAP model is a widely used software tool for energy policy analysis. It was developed at the Stockholm Environment Institute, and has been adopted by thousands of organizations and policymakers in more than 190 nations around the world for energy planning purposes. It has been used at many different scales, ranging from cities and states to national, regional and global applications.

LEAP is designed around the concept of long-range scenario analysis of how an energy system can evolve over time. Using this tool, policy analysts can create and then evaluate alternative scenarios by comparing energy requirements, social costs and benefits, and environmental impacts. It is an integrated modeling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy in a transparent and intuitive way.

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Energy Committee Guidelines on Customizing Metrics

The bulk of the data used in the Dashboard Progress Timeline – especially for heat and transportation – is categorized into five town types. Consequently, there may be some clear discrepancies between your actual town data and the category in which your town is placed. Your Energy Committee may have access to more precise information for your specific community.

The Dashboard provides a detailed spreadsheet for each town containing all of the assumptions, data sources, and formulas used in calculating the Progress Timeline. If your Energy Committee wishes to further customize this information, the following guidelines are provided to assist in this effort.

The majority of the population and household data can be found using US Census Bureau information as a starting point. That data can be supplemented by any community information that is available publicly through state or local organizations (such as town offices, energy committees, etc.), as well as:

- Public Service Department evaluation reports characterizing the residential and commercial sectors
- EIA surveys such as Commercial Building Energy Consumption Survey (CBECS), Manufacturing Energy Consumption (MECS), Residential Energy Consumption Survey (RECS) and Transportation Energy Consumption Survey (RTECS)

Your energy committee may wish to further customize the underlying data in the following categories:

1. **Residential make up of a community.**

   Note: Pre-loaded data includes town specific number of households determined by number of electric accounts from Efficiency VT – 2014 data. Towns can obtain more recent data from Lister files or town property tax records (number of households and sq. footage), but these will not contain occupancy demographics, which can be found in census bureau data

   - Number of single family homes, average size, average age
   - Occupancy demographics – average number of people per home, household makeup
   - Number of multifamily unit or rental units: average number of units, average size of units, average age
     - Occupancy demographics – average number of people per home, household makeup
   - Number of other type homes (such as manufactured)- average size, average age
     - Occupancy demographics – average number of people per home, household makeup

2. **Commercial makeup of community**

   Note: towns can obtain information from their local chambers of commerce or their tax office listing of properties in town through assessed taxes. US Census also lists businesses by town (July 2014).

- Commercial/Organizational nonfarm business makeup of community include:
    - Type of business
    - Number of each type of business
    - Average size of building for each type
- Industrial business makeup of community include:
    - Type of business
    - Number of each type of business
    - Average size of building for each type
- Educational/Institutional makeup of community include:
    - Type of business
    - Number of each type of business
    - Average size of building for each type
- Agricultural (farm) business makeup of community include:
    - Type of farm
    - Average size of farm (by acre or herd count)
- Federal/state/local government businesses/buildings
    - Type of business
    - Number of each type of business
    - Average size of building for each type

3. **Mix of heating fuel sources for residential heating** (energy committee may have this information)
   Note: this can be difficult to obtain

4. **Mix of heating fuel source for commercial/industrial/institutional buildings** (energy committee may have this information)
   Note: this can be difficult to obtain

5. **Existing local renewable projects** and amount and type of energy they provide (See Vermont Renewable Energy Atlas found on the Community Energy Dashboard, and local information)

6. Transportation data
- Number of vehicles registered in within the boundary
- Type of vehicles
- Average commute statistics (Towns need to do their own surveys for this)
- Carpool/Carshare statistics (Check GoVermont! Information, but this will only be a percentage)
- Bus ridership statistics (Check bus transit by county)
- Bike/Walking statistics

7. Data Source Schedule
- Determine how often – or when - you will update each data entry, depending on when the information is made available by source

8. General Data Sources
City Size, *Population*, *Population Density*, *Area*: http://vermont.gov/portal/government/towns.php?town=63
Vermont 2010 Baseline Energy use by town (residential and commercial):

https://www.efficiencyvermont.com/About-Us/Energy-Efficiency-Initiatives/Town-Energy-Data
Overall energy use for state of Vermont in 2020 and 2050 – VEIC Solar Market Pathways LEAP Output
https://portal.veic.org/sunshot/_layouts/mobile/mblwiki.aspx?Url=%2Fsunshot%2FSitePages%2FHome%2Easpx

Vermont Housing Stock
Composition: http://quickfacts.census.gov/qfd/states/50/5046000.html.
Percent multifamily: http://quickfacts.census.gov/qfd/states/50000.html
Housing Square footage: http://www.census.gov/const/C25Ann/sftotalmedavgsqft.pdf
Housing Occupancy Rates: http://www.vhfa.org/about/news/blog/?p=3234

Fuel Information
Thermal Facts/fuel usage/fuel rates:
http://quickfacts.census.gov/qfd/states/50000.html
http--vermontfuel.com-5docpage_files-Vermont%20Consumption%20of%20Fossil%20Fuels.pdf
Electric Heat costs (commercial)
http://publicservice.vermont.gov/sites/psd/files/Pubs_Plans_Reports/Utility_Facts/Utility%20Facts%202013.pdf
Wood fuels costs:
http://www.biomasscenter.org/pdfs/VFFS_brochure-1.pdf
Residential Fuel costs:
http://publicservice.vermont.gov/sites/psd/files/March-2014%20Fuel%20Price%20Report.pdf

Transportation
Transportation Energy Use in Vermont:
http://ntl.bts.gov/lib/42000/42400/42431/Vermont_Transportation_Energy_Report.pdf

Customizable Field	Potential Source for Local Data
% Renewable Electricity, Residential	Local electric utility, Public Service Department
% Renewable Electricity, Commercial	Local electric utility, Public Service Department
Average MMBTU use per Household	Local fuel dealer(s)
Average Home Size (ft^2)	Assessor's Office, US Census
% Multifamily	Assessor's Office, Local Housing Trust, US Census
Age of housing stock to state average (40% before 1950)	Assessor's Office
Percent Occupied	Assessor's Office, US Census
Residential Heating, % Oil	2010 US Census (American Fact Finder) - House Heating Fuel
Residential Heating, % Propane	2010 US Census (American Fact Finder) - House Heating Fuel
Residential Heating, % Wood	2010 US Census (American Fact Finder) - House Heating Fuel
Residential Heating, % Heating Electric Resistance (ER)	2010 US Census (American Fact Finder) - House Heating Fuel
Residential Heating, % Natural Gas	2010 US Census (American Fact Finder) - House Heating Fuel
Number of Registered Cars	Department of Motor Vehicles Office
Residential Transportation, % Electric	Department of Motor Vehicles Office
Residential Transportation, % Propane	Department of Motor Vehicles Office
Residential Transportation, % Biodiesel	Department of Motor Vehicles Office
Residential Transportation, % Diesel	Department of Motor Vehicles Office
Residential Transportation, % Gasoline	Department of Motor Vehicles Office
Average mileage per vehicle per year	Department of Motor Vehicles Office
Average miles per gallon per vehicle	Department of Motor Vehicles and fueleconomy.gov
% Renewable Thermal Energy, Commercial & Industrial	EAN Dashboard Renewable Atlas
% Renewable Transportation Energy, Commercial & Industrial	EAN Dashboard Renewable Atlas
Number of establishments, Businesses	Assessor's Office; Town Clerk; Chamber of Commerce, US Census
Number of establishments, Agricultural and Mining	Assessor's Office; Town Clerk; Chamber of Commerce, US Census
Number of establishment, School/Muni	Assessor's Office; Town Clerk; Chamber of Commerce, US Census
Number of Commercial and Industrial establishments	Assessor's Office; Town Clerk; Chamber of Commerce, US Census