Methodology for residential heating estimates

Vermont's regional planning commissions have been tasked with developing reasonable estimates for local consumption across the transportation, heating, and electric energy sectors. While these estimates use best available data, they should not be considered a unit-by-unit audit of energy use. Rather, they serve as a starting point for better understanding our region's current energy use patterns, the cost drivers, and what we need to do to achieve long-range energy goals. All energy data in our estimates are expressed in *British Thermal Units* (BTUs) and millions of BTUs (MMBTUs) in order to allow for comparison between different energy types.

On average, residences in New England use somewhere about 45,000 to 80,000 BTUs of heat energy per square foot annually, averaging statewide at about 110 MMBTUs per residence per year for space and water heating. (Dept. of Public Service, 2016) The bulk of this expense can be attributed to space heating. In colder climates like New England, space heating accounts for about 60% of residential energy consumption, and water heating, about 15%. (EIA, 2013)

Here are the steps we used to develop estimates at the municipal and county levels for the Northeast Kingdom.

1: Determine total square footage of housing by tenure.

NVDA used Census Bureau data from the American Community Survey 5-Year Estimates 2011-2015 (ACS), as well as the American Housing Survey, New England Division (AHS) to determine the total square footage of housing stock for *owner-occupied* and *renter-occupied* units. (On average, renter occupied units tend to be smaller than owner-occupied units.) Total square footage of housing stock was determined using the average number of persons per household, multiplied by the median square footage per person, multiplied by the number of households.

Datum	**Avg. # persons per household, owner occupied**	**X**	**Median square feet per person**	**X**	**Total households, owner-occupied**	**=**	**Total square feet**
Source	ACS		AHS		ACS		
Example (Caledonia County)	2.54	X	772	X	9,047	=	17,740,081

2. Determine heating source as a percentage of all square footage.

We then applied primary heating fuels as a percentage of all housing units to determine total square footage the fuel was being used to heat.

House heating fuel is categorized on the ACS questionnaire as follows in the box below:

Utility Gas: This category includes gas piped underground from a central system to serve the neighborhood. The only utility in Vermont that delivers gas in this manner (i.e. natural gas) is Vermont Gas, and its service area is well outside of our region. A small number of ACS respondents indicated that they heated with "utility gas." It is most likely that they confused this source with bottled, tank or LP gas. We therefore made adjustments to account for this error.

Bottled, Tank, or LP Gas- This category includes liquid propane gas stored in bottles or tanks that are refilled or exchanged when empty. This is the second largest source of heat for renter-occupied homes, and third for owner-occupied.

Electricity -This category includes electricity that is generally supplied by means of above or underground electric power lines. Census data does not distinguish between types of electric heat (e.g. resistance vs. heat pumps).

Fuel Oil, Kerosene, etc. -This category includes fuel oil, kerosene, gasoline, alcohol, and other combustible liquids. This category (oil) is the leading source of heat in the region.

Coal or coke -This category includes coal or coke that is usually distributed by truck. Some households in our region use anthracite in stove, furnaces, and boilers.

Wood -This category includes purchased wood, wood cut by household members on their property or elsewhere, driftwood, sawmill or construction scraps, or the like. Wood is the second largest source of heat in the region for owner-occupied homes.

Solar Energy -This category includes heat provided by sunlight that is collected, stored, and actively distributed to most of the rooms.

Other Fuel -This category includes all other fuels not specified elsewhere. This category very likely consists of non-fossil fuel sources.

No Fuel used - This category includes units that do not use any fuel or that do not have heating equipment.

For example:

- Of the 9,047 owner-occupied homes in Caledonia County, 4,623 of those units are primarily heated with fuel oil, accounting for 51.1% of all owner-occupied units.

- 51.1%% of all owner-occupied square footage in Caledonia County is 9,065,148 sq. ft.

3. Account for the age of the housing stock.

Our estimate accounted for the age of the housing stock. This is because our region has a significant number of pre-1940 housing units. While usage for residential structures could be as low as 45,000 Btu per square foot, usage can be much higher for older homes. Our region's pre-1940 housing structures tend to be "leaky" and poorly insulated with heat energy intensities closer to, if not greater than, 80,000 Btus per square foot. (Dept. of Public Service, 2016)

For example:

- Of the 9,047 owner-occupied units in Caledonia County, 2,730 units were built prior to 1940, accounting for 30.2% of all owner-occupied housing stock.
- Of the 9,065,148 sq. ft. of owner-occupied housing heated with fuel oil, 30.2% of that square footage (2,735,476 sq. ft.) will require 80,000 Btus per square foot. The remainder of the total square footage (6,329,672 sq. ft.) will require 45,000 Btu per square foot.

4. Convert to units of fuel and determine cost.

Finally we converted total BTUs into standard measurements of the respective fuel types using the conversion chart below and determined the total cost using the Vermont Fuel Price Report of November 2016. (Cost per "short ton" of anthracite coal came from Black Rock Coal in Montpelier.) Please note that ACS data does not account for wood pellet use, which is fairly prevalent in this region. If your municipality wishes to account for pellet use, we have provided conversion and cost information.

Fuel	Standard Unit	BTUs	Cost per unit
Utility gas	Cubic foot	1,025	$1.41
Bottled tank or LP gas (propane)	Gallon	91,333	$2.54
Electricity	Kilowatt hour	3,412	$0.15
Fuel oil, kerosene, etc.	Gallon (oil)	139,000	$2,23
Coal or coke	Short ton	19,590,000	$370.00
Wood	Cord	20,000,000	$227.00
Wood pellets	Ton	16,400,000	$275.00

5. Determine energy use for seasonal units.

While the Northeast Kingdom has a fairly high number of vacation homes, there is no corresponding ACS data on heating sources. The Department of Public Service guidelines suggest that on average, seasonal homes account for about 5% of the thermal energy used in a year-round home. (For example, a seasonal camp may not have a central heating system, but it still may use propane to heat the water, and have a woodstove or fireplace for unseasonably cool nights.)

The percentage may be higher for communities with seasonal populations who use their properties throughout the winter. For estimation purposes, we assigned 5% to seasonal units in all communities except for Burke and Jay, which were assigned 10%. Here is the formula for calculating MMBTUs for seasonal units:

Number of seasonal units (ACS)	X	Average MMBTUs per Owner-Occupied Unit	X	5% (or 10%)	=	Total MMBTUs Seasonal

Caveats:

- ACS data is not a hard count. Rather, it is based on random sampling over a multi-year period. Nevertheless, it is the best data available on residential heating. From this data we can confirm that fuel oil and wood are the most prevalent heating sources for residential units in the Northeast Kingdom, although wood is less likely to be used in renter-occupied units.
- Our estimates only account for occupied units. Seasonal populations, particularly summer populations, will most likely contribute a minimal increase to total energy consumption. The exception to this rule may be ski resort communities, which will require space heating. Nevertheless, condominiums and multiunit structures associated with ski resorts are more likely to be newer structures and thus more energy efficient. Moreover, multiunit structures will use less energy than single family homes. (EIA, 2013)
- ACS data identify only one primary source of heating. In reality many residences use two or more resources.

Sources*:

US Census Bureau:

American Community Survey Five Year Estimates, 2011-2015, Selected Housing Characteristics (Table DP4); Tenure by House Heating Fuel (Table

B25117); Tenure by Year Structure Built (Table B25036) http://factfinder.census.gov

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U.S. Energy Information Administration:

(2013, July 18) Apartment in Buildings with Five Units or More Use Less Energy Than Other Home Types http://www.eia.gov/todayinenergy/detail.php?id=11731#

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*All sources accessed December 2016