

Addison County estimated annual CO₂ production for 2017

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This document displays estimates of annual local CO₂ production, summarizes the methods used, and presents four strategies for reducing CO₂ production substantially. This document includes CO₂ produced in heating homes, residential use of electricity, operating and heating commercial and industrial establishments, and transportation. It is an extension (for which they are not responsible) of the Addison County Energy Plan produced by the Addison County Regional Planning Council.

The main finding of this analysis is that **no one energy-using activity dominates our CO₂ production, although uses for transportation are prominent**: home heating accounts for an estimated 27.8% of CO₂ production, commercial/industrial heating and operations account for 15.8%, other uses of electricity account for 10.1% (mostly in the commercial sector), and transportation accounts for 46.4%. Since no one activity dominates, efforts to reduce CO₂ production to or near zero must address multiple sectors.

CO₂ production per residential electric customer has drifted down from 1.31 tons in 2012 to 1.27 tons in 2017. Commercial/industrial CO₂ production attributable to electricity use rose slowly 2012-2017; average production per customer has been stable. Natural gas distribution began in 2017. Since piped natural gas largely replaced other fossil fuels such as fuel oil and propane, for which we don't yet have direct consumption data, we can't say yet what the impact of the availability of natural gas has been on CO₂ production.

CO₂ production using these methods is estimated at 12.7 tons per person per year for Addison County, which is not inconsistent with the national 2014 value of 16.5 tons per capita per year.

Because the focus is on local energy use that we have direct control over, this analysis does not include the CO₂ costs to manufacture and ship goods that are manufactured elsewhere but consumed locally, nor the CO₂ cost of long-distance travel by County residents. It does include the CO₂ cost of producing goods locally that are consumed or used elsewhere. It also does not include production of other greenhouse gasses, such as methane from agriculture or waste disposal.

Solar photovoltaic energy systems on individual homes and buildings are accounted for in this analysis by reductions in sales of electricity by Green Mountain Power (GMP) to those customers, which shows up in County totals. If these rooftop systems were not in place, GMP would be selling more electricity in our community. These rooftop systems make it easier for GMP to decarbonize the electricity supply, but do not do so directly.

By contrast, the electricity production of large solar and wind arrays whose purpose is to sell energy to the utility company is accounted for in the **carbon intensity** of the electricity that Green Mountain Power distributes in its entire service area. For 2015-2016, GMP released 400 pounds of CO₂ per megawatt-hour of electricity distributed. Solar, wind and hydroelectric installations that sell power to GMP lower this figure, which by 2019 was at 210 pounds per megawatt-hour. The pooled New England carbon intensity is around 680 pounds of CO₂ per MWh.

Summary sheet for Addison Co CO₂ production

Home heating

Fuel type for home heating	Tons of CO ₂ , annual	% of all CO ₂
Natural gas	1,402	0.3
Propane	28,970	6.1
Electricity	3,131	0.7
Fuel oil	74,904	15.9
Coal	87	0.0
Wood	21,495	4.6
Solar heat	0	0.0
other	1,000	0.2
Total home heating	130,988	27.8
Commercial establishments, thermal	74,494	15.8
Addison Co electricity consumption 2017		
Commercial and industrial	25,933	5.5
Residential except heating	21,943	4.6
Electricity Total	47,876	10.1
Transportation		
Privately owned vehicles (gasoline)	157,043	33.2
Diesel fuel consumption	46,367	9.8
Gasoline from commercial vehicles	15,704	3.3
Transportation total	219,114	46.4
Grand total	472,472	100.0

Background on Addison County

Addison County has a mixed economy, with agricultural, commercial, industrial and home energy uses all being important. The commercial/industrial uses of energy are concentrated in the urban centers of Vergennes, Bristol and Middlebury, while energy use in the surrounding towns is primarily residential and agricultural. Middlebury is the location of Middlebury College, Porter Hospital and associated medical enterprises, two large retirement communities, a nursing home, county-level government offices, and two secondary schools. Middlebury College is treated as commercial/industrial, even though it includes dormitories housing approximately 2000 students, and so are parts of the retirement facilities. Bristol and Vergennes each also have important industrial as well as commercial enterprises. The county's numerous industrial enterprises include ones that extract and crush rock and gravel, mill lumber and build wood products, and make cheese, apple cider, beer, roasted coffee, and whiskey. The agricultural economy is dominated by forest products and dairies, but also includes orchards, market gardens and animals raised for meat. Larger dairy and other farms are also treated as commercial/industrial customers.

Strategies to get close to zero fossil fuel use

Statutory Vermont goal:

"It is the goal of the State to reduce greenhouse gas emissions... from the 1990 baseline by: 25% by 2012; 50% by 2028; and if practicable by using reasonable efforts 75% by 2050."

Vermont's 2016 Comprehensive Energy Plan calls for us to:

- Reduce total energy consumption per capita by 15% by 2025, and by more than one third by 2050.
- Meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050.
- Achieve three end-use sector goals for 2025: 10% renewable transportation, 30% renewable buildings, and 67% renewable electric power.

The strategy to get to these goals must have four parts:

1. **Electrify everything** possible — including building heat (43.1% of estimated Addison Co. CO₂ production) and vehicles (46.7%).
2. **Decarbonize** all electricity.
3. **Reduce energy consumption** so as to make steps 1 and 2 easier and achieve immediate reductions in CO₂.
4. Use other **renewable fuels** such as biogas or renewable natural gas when we can't electrify.

Strategy 2 is not primarily under local control — that's the function of the state's Renewable Portfolio Standard, adopted in 2015, which calls for 75% of our electricity to be from renewable sources by 2032. The RPS also calls for 10% of electricity to be from distributed generation by 2032, and for an additional 12% of electricity energy (beyond the 75%) to be from energy transformation projects (home weatherization, air source or geothermal heat pumps, high-efficiency heating systems, biomass heating systems, demand management strategies, support for electric vehicles, and infrastructure for the storage of electricity generated by renewable sources).

Possible local levers by strategy – not necessarily an exhaustive list

Strategy 1 – electrify everything

Tax fossil fuels

Subsidize purchase of electric vehicles, heat pumps

More public charging stations for electric vehicles

Subsidize electricity itself

Provide technical assistance to industrial enterprises, businesses and home owners about switching to cold-climate electric heat pumps

Discourage or forbid new natural gas hookups

Work with owners of rental complexes to switch to electric heat

Support Transportation Climate Initiative

Government entities and non-profits can lead by example – Towns, school districts, County, college, hospital – with buildings and vehicles

Strategy 2 – decarbonize the electricity

Mostly being handled at state level through Renewable Portfolio Standard

Green Mountain Power already has a low carbon intensity (208 pounds of CO₂ per megawatt-hour of electricity) and intends to get to 100% carbon-free by 2025 and 100% renewable by 2030.

Solar panels on individual houses and businesses reduce electricity use from the grid, and associated emissions, but don't decarbonize everyone else's electricity.

Solar and wind farms designed to sell power to the utility grid do help decarbonize the electricity supply.

Strategy 3 – efficiency and conservation

Help people weatherize and insulate their homes

High-level technical efficiency assistance to industry and businesses

Help or require owners of rental complexes to invest in weatherization and insulation

Work with businesses to install more efficient outdoor lights and fewer of them.

Increase residential density of our villages and cities

Make walking and cycling easier

Increase use of public transit

Strategy 4 – other renewables

Support digestion of organic wastes to generate renewable fuel and heat (*Farms, Industrial enterprises*)

Replace diesel fuel with biodiesel, or blend diesel with biodiesel

Encourage use of wood for back-up heat IF true sustainability of wood supply can be guaranteed – in conjunction with electric heat pumps

Methods

Time period

These estimates are based on available data for recent years, but not always exactly the same time period. For example, the home heating estimates and household vehicle estimates are averages from the American Community Survey (run by the US Census Bureau) for the period 2013-2017, while the electricity consumption data from Green Mountain Power are for 2017. No houses were heated with natural gas before 2017.

Home heating

Counts of homes by heating source are from households sampled by and responding to the US Census Bureau's American Community Survey (ACS). The Addison County Regional Planning Commission converted number of households to number of BTUs of energy needed to heat those houses. I then applied conversion factors for each heating source, from BTUs to pounds of CO₂: 117 per million BTU for natural gas, 139 for propane, 161 for fuel oil, 210 for coal, 120 for wood, and 0 for solar. I used a value of 120 pounds CO₂ per million BTU for households listed as having "other" fuel source. For homes heated with electricity, I converted BTUs to MWh, and then applied a carbon intensity of 400 pounds of CO₂ per MWh. The ACS data show that an estimated 59 homes in Addison County are heated directly with solar energy, and so have zero CO₂ production for heating.

Commercial energy use

The Addison Co Regional Planning Commission used a value of 0.725 billion BTUs of energy use per commercial establishment. I have followed their lead in simply multiplying the number of commercial establishments (1188, based on the US Census) by 0.725 billion BTUs to get total BTUs for operations of commercial establishments. To estimate CO₂ production by commercial establishments, I used a value of 150 pounds of CO₂ per million BTU (intermediate between the values for propane and for fuel oil). As businesses switch from propane or fuel oil to natural gas (which produces 117 pounds of CO₂ per million BTU), this average carbon intensity will come down somewhat.

Other electricity

Amounts of electricity consumed by residential and by commercial customers of GMP were supplied by Efficiency Vermont for 2017. The residential MWh total has been reduced by the number of MWh of electricity used for home heating, so as not to count electrical home heating twice. Adjusted total estimated usage by residential customers and by commercial customers was multiplied by 400 pounds of CO₂ per MWh to get estimates of CO₂ released, and converted to (short) tons by dividing by 2000.

Vehicles

Methods supplied by Addison Co Planning Commission staff were used to estimate the annual number of gallons of gasoline used in privately owned cars using: 2013-2017 ACS estimates of the total number of passenger vehicles owned by Addison County households, and the average amount of gasoline used per Vermont vehicle (derived from the average number of miles traveled per vehicle (1188) and the average fuel efficiency of passenger vehicles in Vermont at 19.5 mpg). I estimated Addison County diesel use as one-quarter of gasoline use (the statewide average), and then multiplied total gallons of diesel by 22.38 pounds of CO₂ per gallon of diesel to obtain estimated CO₂ released. Finally, I estimated gasoline use by commercial vehicles as 10% of household vehicle use.

Missing data

More robust estimates of Addison County CO₂ production could be made if we had access to the following data:

- Gasoline sold in the county, by year, including fuel sold for agricultural use
- Diesel fuel sold in the county, by year, including fuel sold for agricultural use
- Propane sold in the county, by year, by residential versus commercial customers
- Fuel oil sold in the county, by year, by residential versus commercial customers
- Number of vehicles registered in the county, by type (e.g. passenger car/SUV/light truck, heavy truck and equipment, bus), by year