

# Belmont CO<sub>2</sub> emissions, 2014-2021

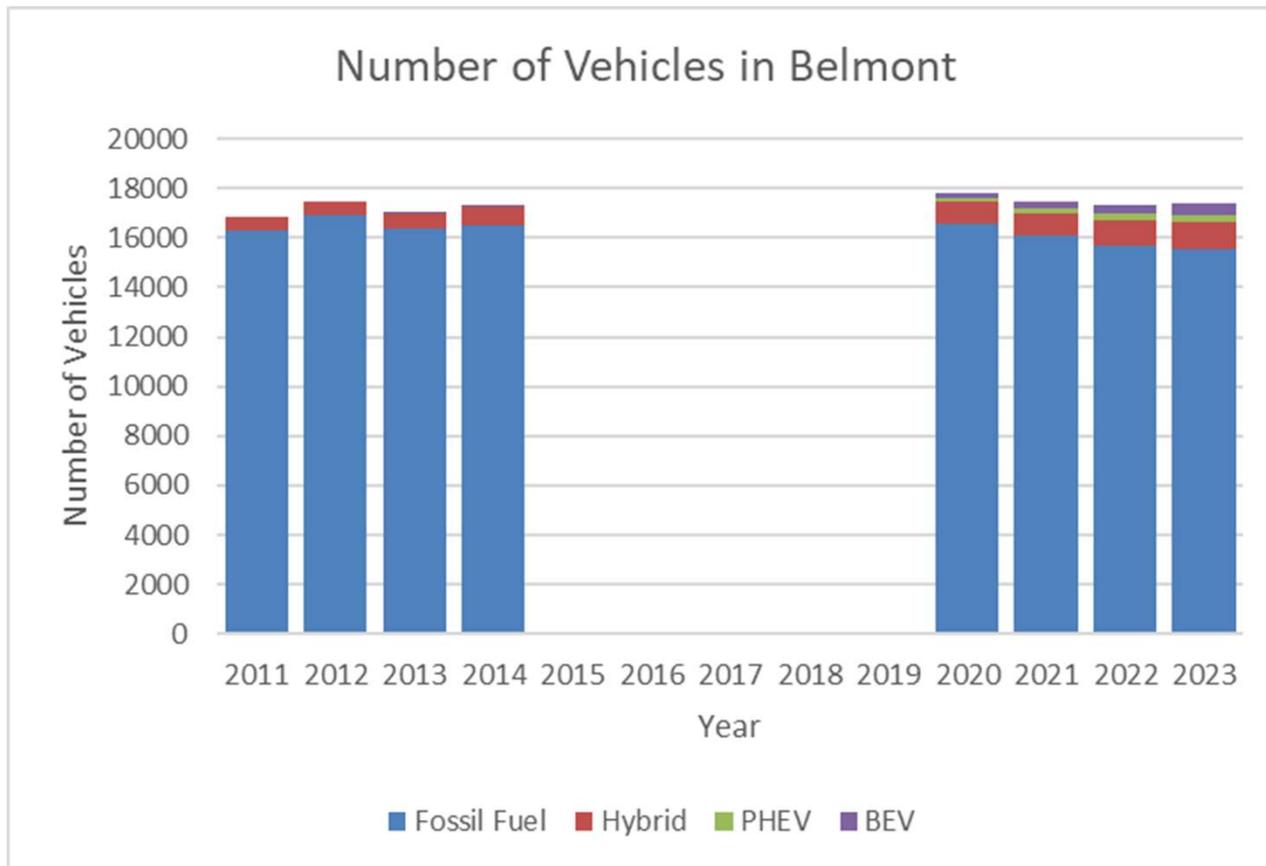
James Booth  
Belmont Energy Committee  
July 9, 2023

Updated CO<sub>2</sub> emissions analysis, for period from 2014 (year used in last Belmont GHG inventory update) to 2021 (most recent year for which data is mostly available)

Considered four main sources of CO<sub>2</sub> emissions in Belmont:

- Vehicles (gasoline)
- Natural gas
- Fuel Oil
- Electricity

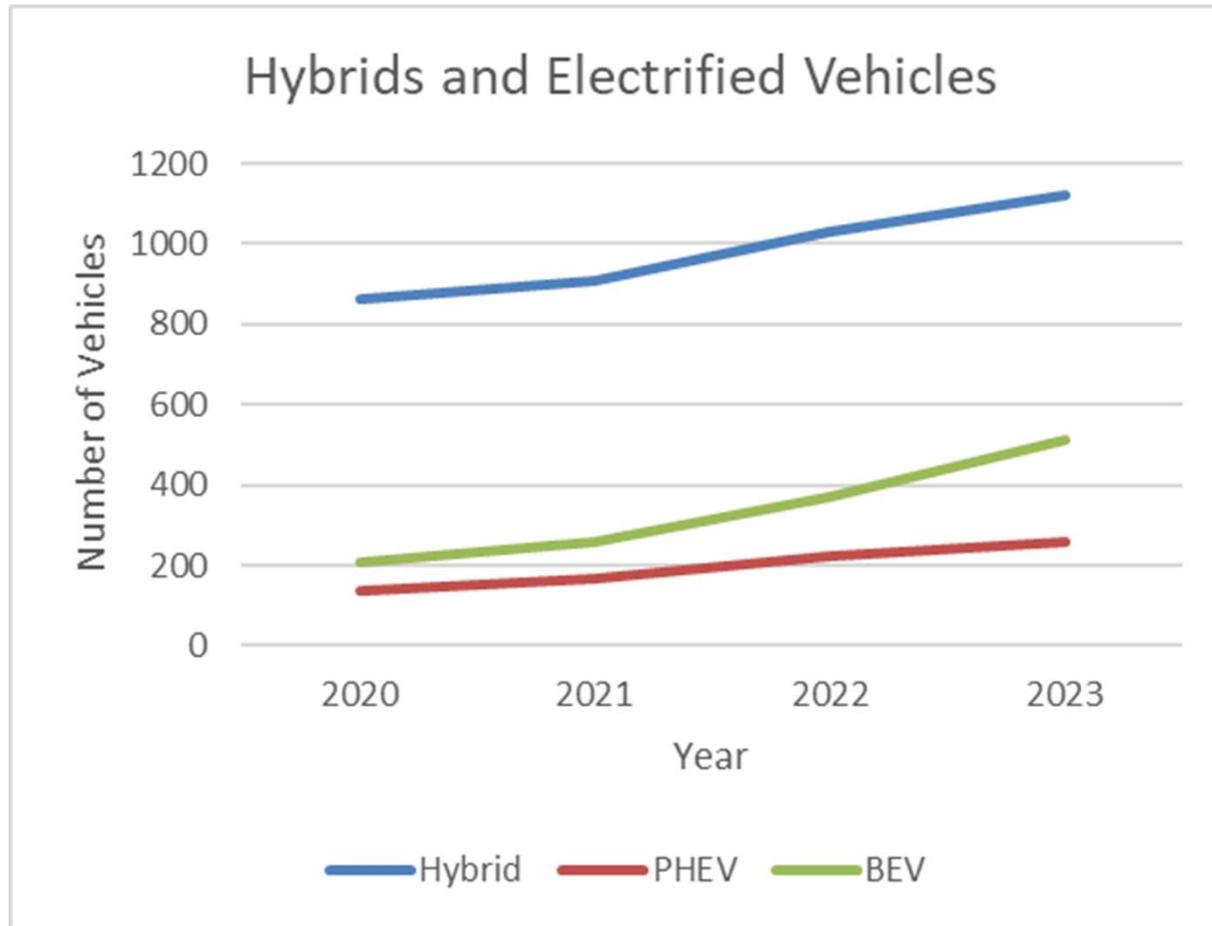
# Vehicles



PHEV: Plug-in Hybrid Electric Vehicle  
BEV: Battery Electric Vehicle

Source: Massachusetts Vehicle Census (MAPC, 2011-2014; MassDOT, 2020-2023)

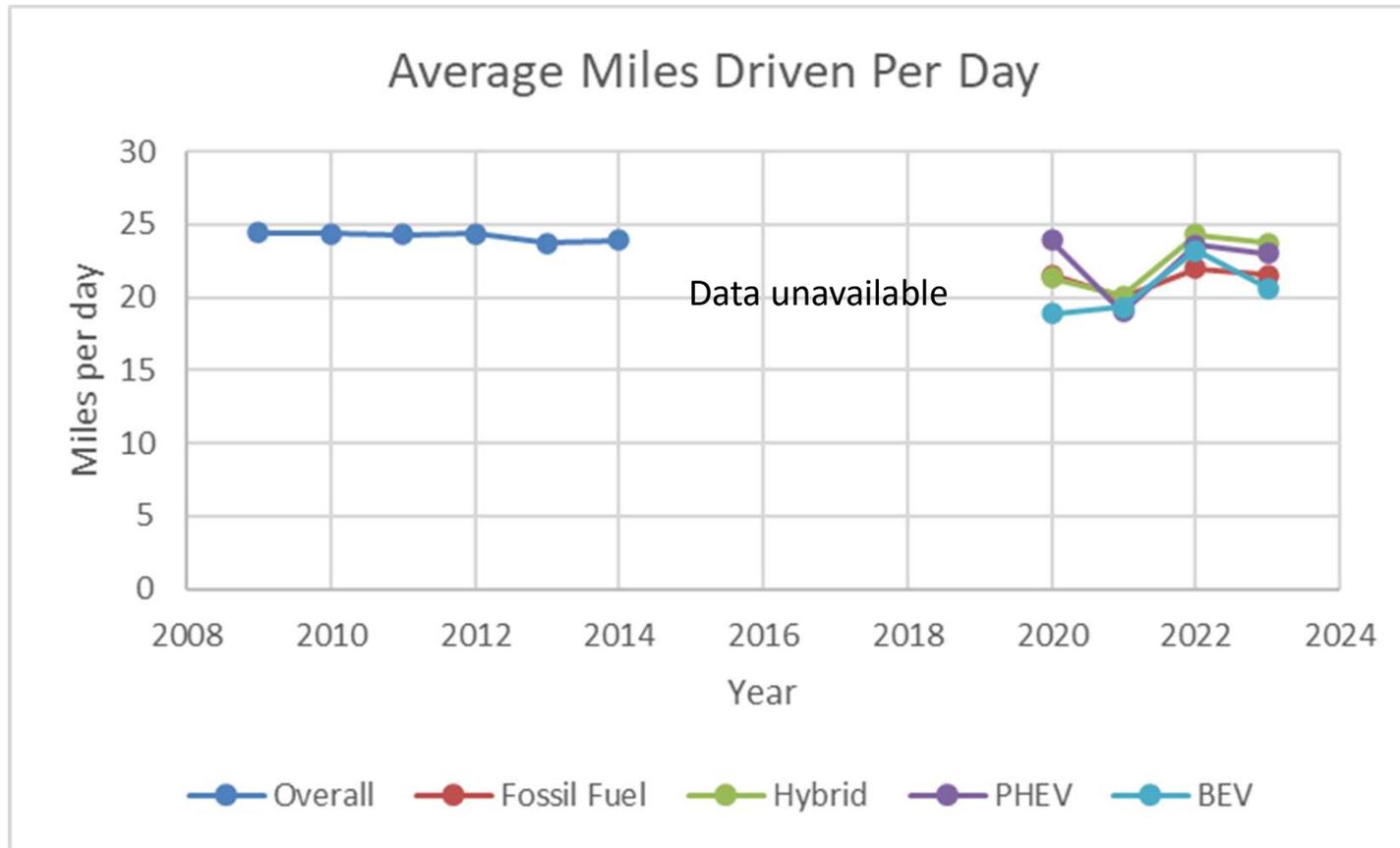
# Vehicles



("Hybrid" refers to conventional hybrid (no plug))

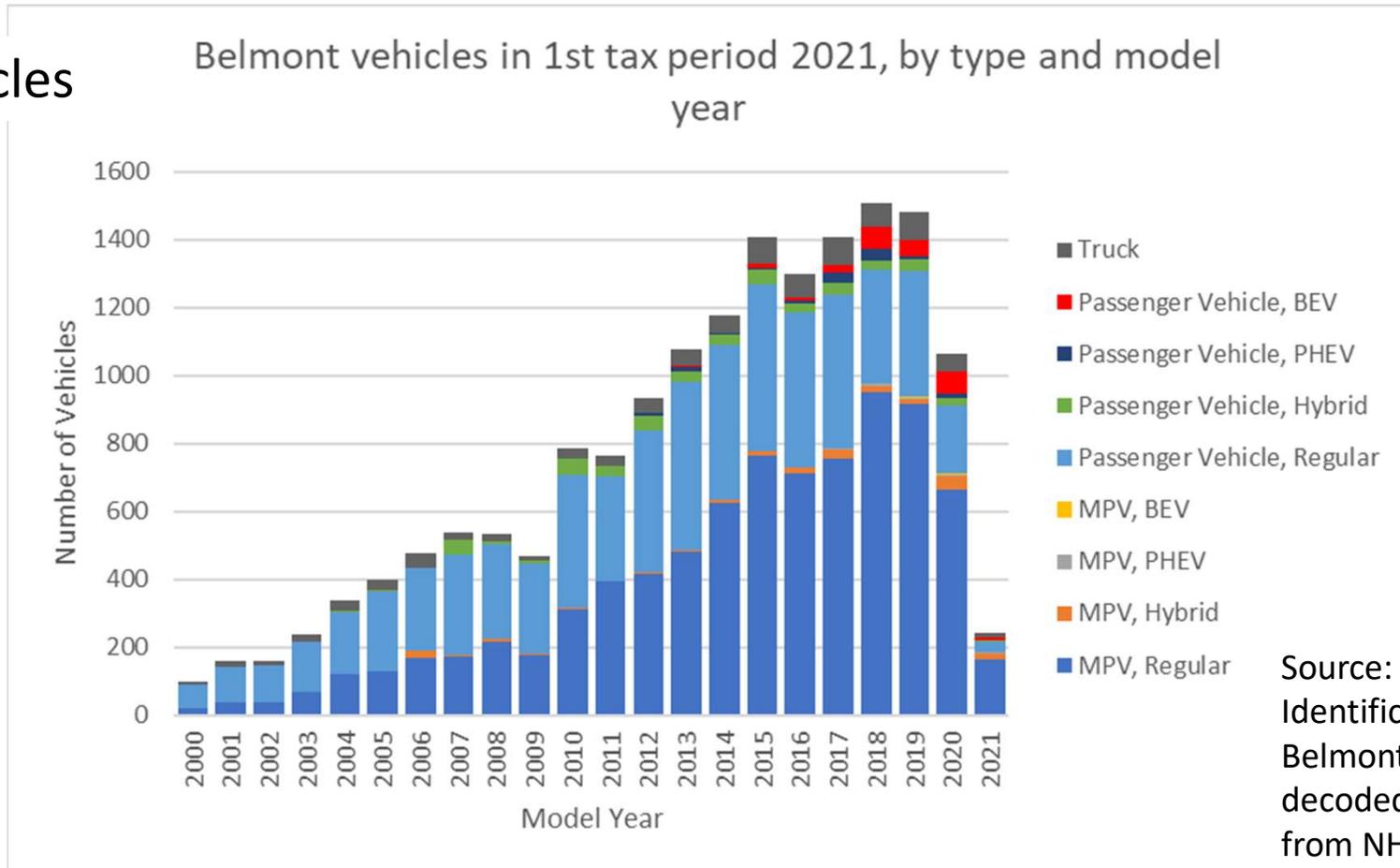
Source: Massachusetts Vehicle Census (MassDOT)

# Vehicles



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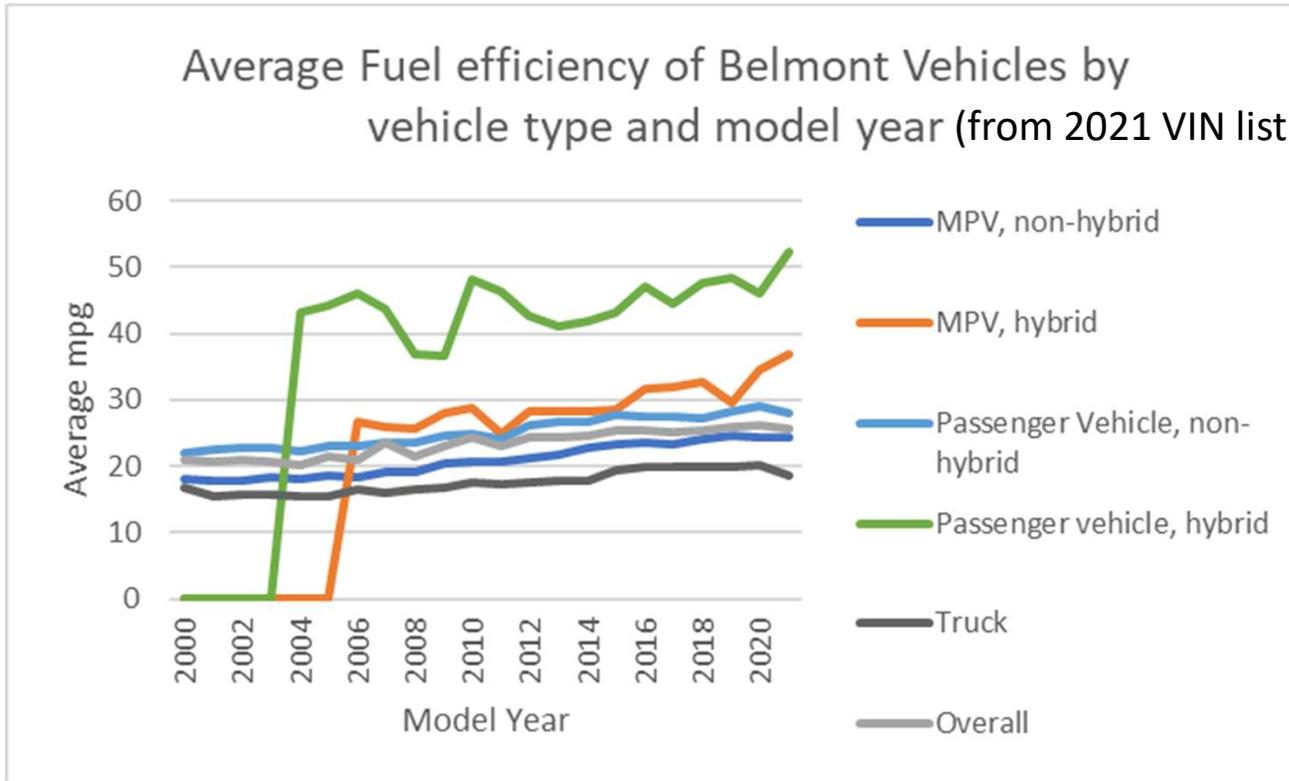
# Vehicles



Source: List of Vehicle Identification Numbers from Belmont Town Assessor, decoded using online tool from NHTSA

- “MPV” = Multipurpose Vehicle (SUVs and Wagons); “Passenger Vehicle” = cars
- 92% of vehicles are non-hybrid, fossil-fuel driven (“regular”)
- Recent model year vehicles are predominantly MPVs
- Vehicles with model year older than 2000 not shown

# Vehicles



Trend of increasing fuel efficiency in more recent model years

Not including electrified vehicles (PHEV and BEV)

Sources: List of Vehicle Identification Numbers (VINs) from Belmont Town Assessors and fuel efficiency data for different vehicles from fueleconomy.gov (USDOE/EPA)

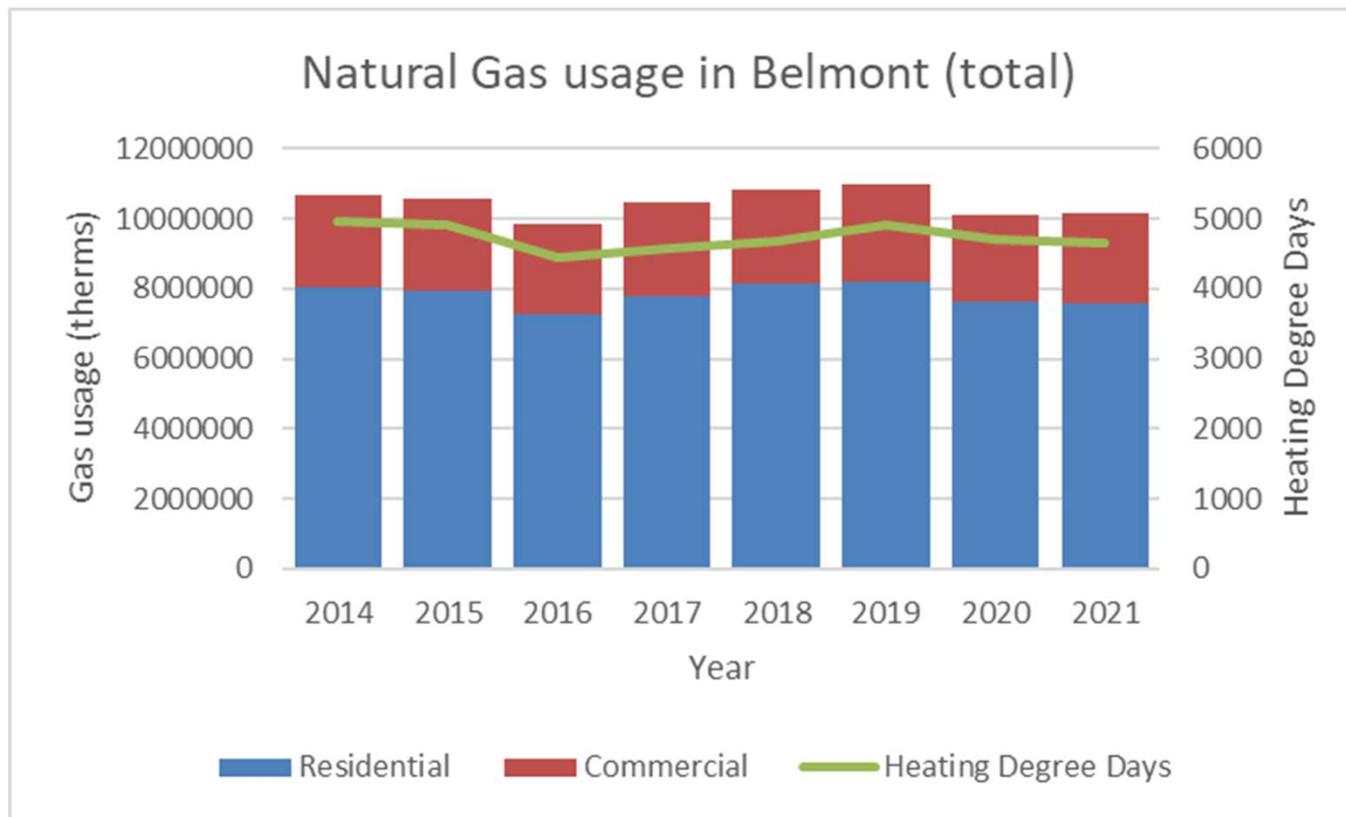
## Vehicles

Overall fuel consumption:			
	2014	2021	change
# of non-electrified vehicles	17241	17012	-1%
avg. miles/day	23.9	22.2	-7%
avg. mpg	22.2	24.3	-9%
gallons	6774640	5672767	-16%

} Massachusetts Vehicle Census (MAVC)

← 2021 calculated from fuel efficiency data of 2021 fleet, 2014 from MAVC data. Change expressed as change in fuel consumption (gallons per mile)

## Heating fuels



Total natural gas usage (including space and water heating)

Usage is largely flat; fluctuates year-to-year in parallel with total heating degree days (a measure of heating load)

Sources: [masssavedata.com](https://masssavedata.com) (data provided by National Grid), [weatherdatadepot.com](https://weatherdatadepot.com)

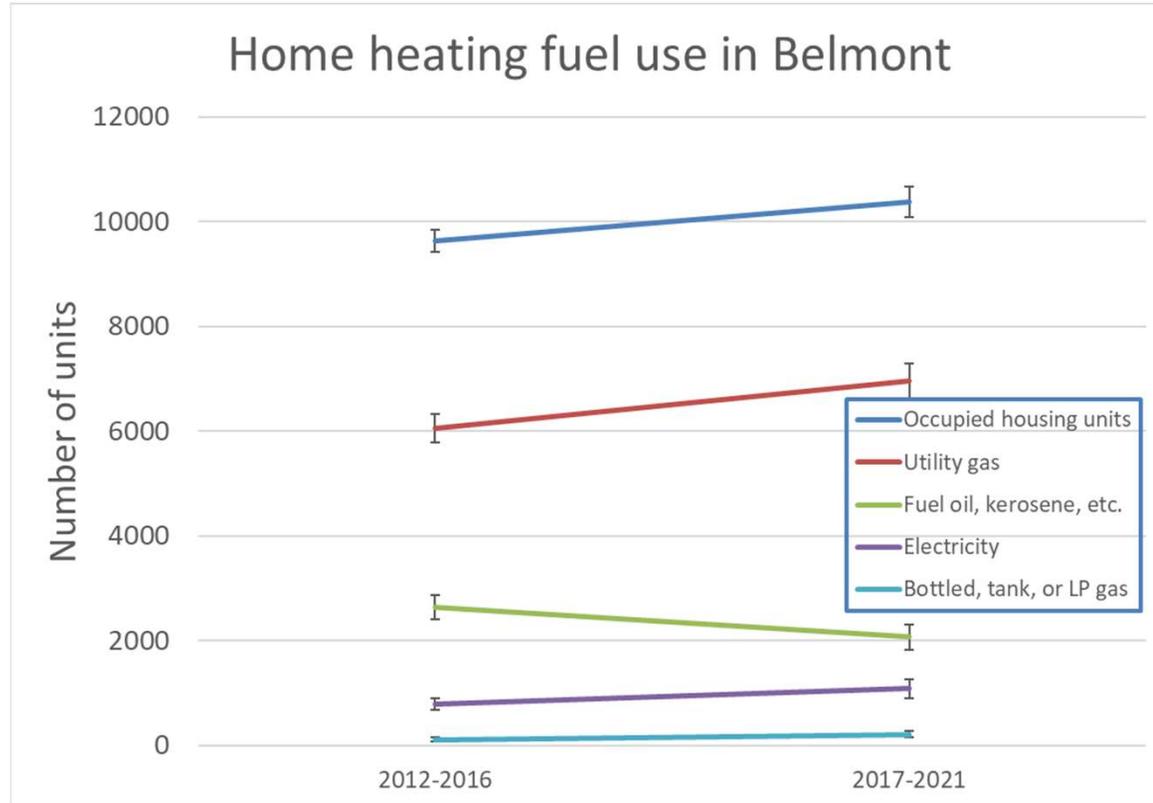
## Heating fuels

### Fuel Oil

Fuel oil usage is more difficult to assess due to the multiplicity of vendors.

Approach: estimate number of households using oil for heat in Belmont from census data

## Heating fuels



5-year estimates derive from census data collection over the entire period

Error bars show margin of error (90% confidence interval)

Source: American Community Survey, 5-year estimates (US Census)

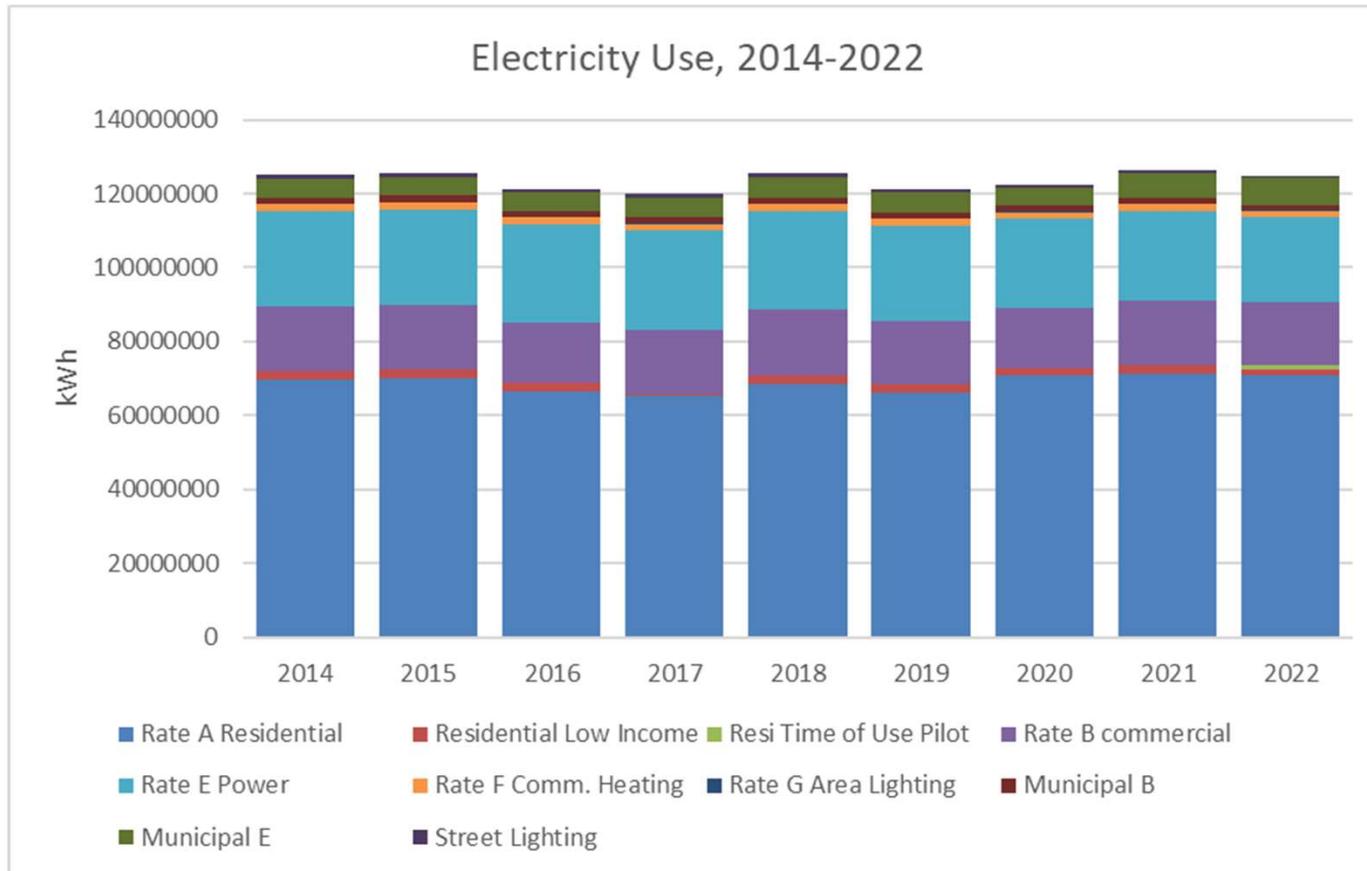
## Heating fuels

Estimated oil usage:	2014	2021	Change
housing units	2639	1835	
gallons per unit	673	673	
total gallons fuel oil	1776047	1235224	-30%

Estimate total number of households heated by oil as:

- 2639 in 2014 (based on 5-year ACS estimate for 2012-2016 (2014 is midpoint year))
- 1835 in 2021 (estimating 2019 usage based on 2017-2021 and extrapolating trend forward)
- assume average 673 gallons of fuel oil use/year/household (based on distribution of housing types in Belmont (MAPC GHG inventory tool))

# Electricity



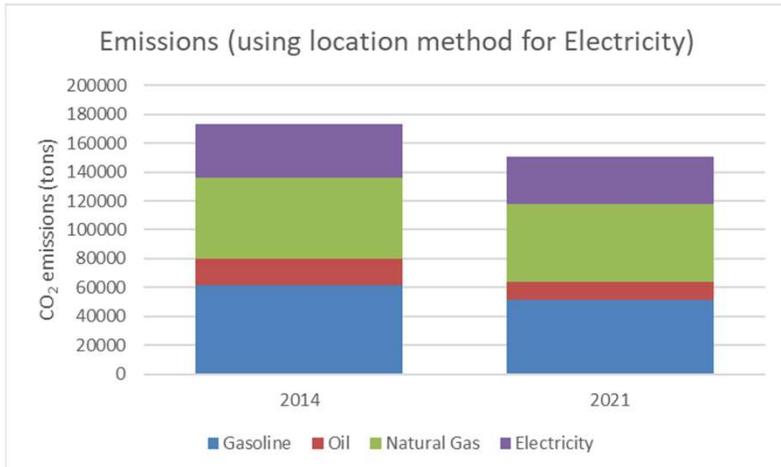
Source: Belmont Light annual DPU reports

How much of total electricity use may result from newly electrified transportation and heating?

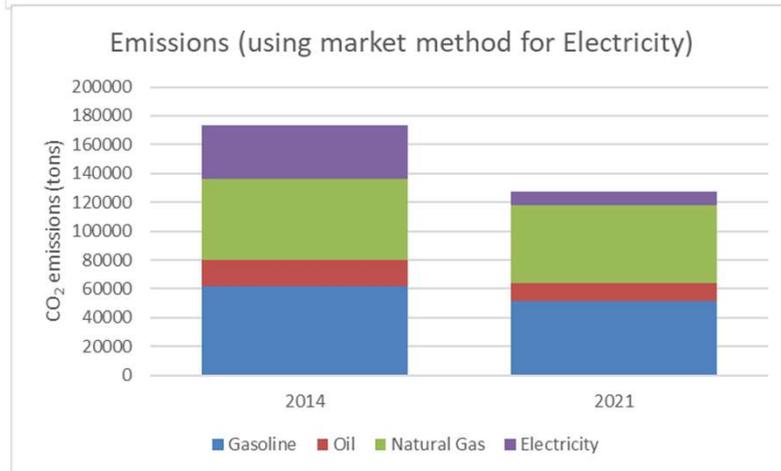
Some estimates for 2022:

	<b>% of Belmont Light 2022 total</b>	<b>Assumptions</b>
<b>BEVs</b>	0.6%	based on number of vehicles and miles driven; assume all charging occurs in Belmont, 4 mile/kWh efficiency
<b>PHEVs</b>	< 0.4%	0.4% if driven entirely in electric mode
<b>Heat Pumps</b>	< 2%	increase by ~300 of # of units heated with electricity between census periods; assume all of this heating is with heat pumps, using 8500 kWh for heating season (from average for my 2300 sq ft house)

# Overall CO<sub>2</sub> Emissions



← Using ISO-NE grid average emissions factors (kg CO<sub>2</sub>e/MWh)



← Using Belmont Light non-emitting purchases (including RECs)

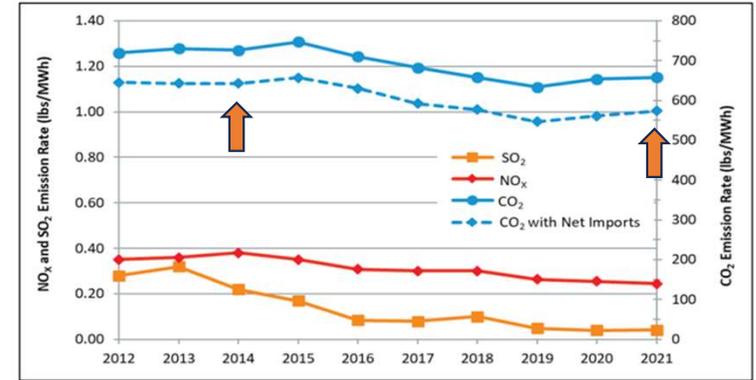


Figure 5-4: ISO New England annual average emission rates, 2012 to 2021 (lbs/MWh).

Belmont Light Power Purchase Policy: 83% non-emitting in 2021 (assuming remainder is generated by gas with emissions factor of 970 lbs CO<sub>2</sub>e/MWh (EIA, US average)). Used ISO-NE average emission factor for 2014.

## Summary of comparison of 2014 and 2021 CO<sub>2</sub> emissions:

### Fuel Oil:

- Estimated emissions dropped ~30% due to shift of households away from heating with oil
- Commercial fuel oil use unknown

### Natural Gas:

- Drop in emissions of 5%, but this is within range of annual variation and 2021 had a warmer winter
- Little change despite apparent ~15% increase in number of households heated with gas from census data
  - Better weatherization? Partially offsetting gas use with heat pumps?

### Gasoline:

- number of fossil-fuel-powered vehicles stayed approximately constant
  - electrified vehicles only ~2% of total vehicles in 2021; increasing since
- 7% decline in miles traveled and 9% drop in fuel consumption per mile -> emissions dropped 16%

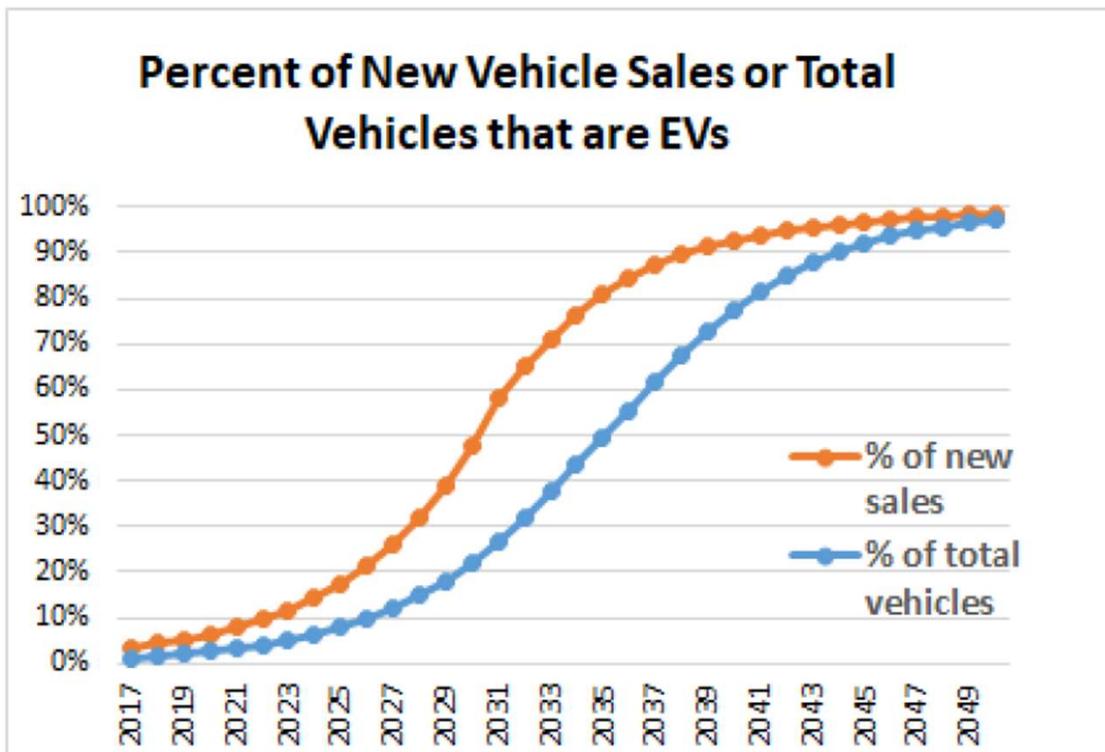
### Electricity:

- Overall usage in kWh stayed flat
- Drop of 12% in emissions due to reduced carbon intensity of New England grid (if using location-based accounting for emissions from electricity use), OR
- Drop of 75% in emissions due to Belmont Light clean energy purchases (if using market-based accounting for emissions from electricity use)

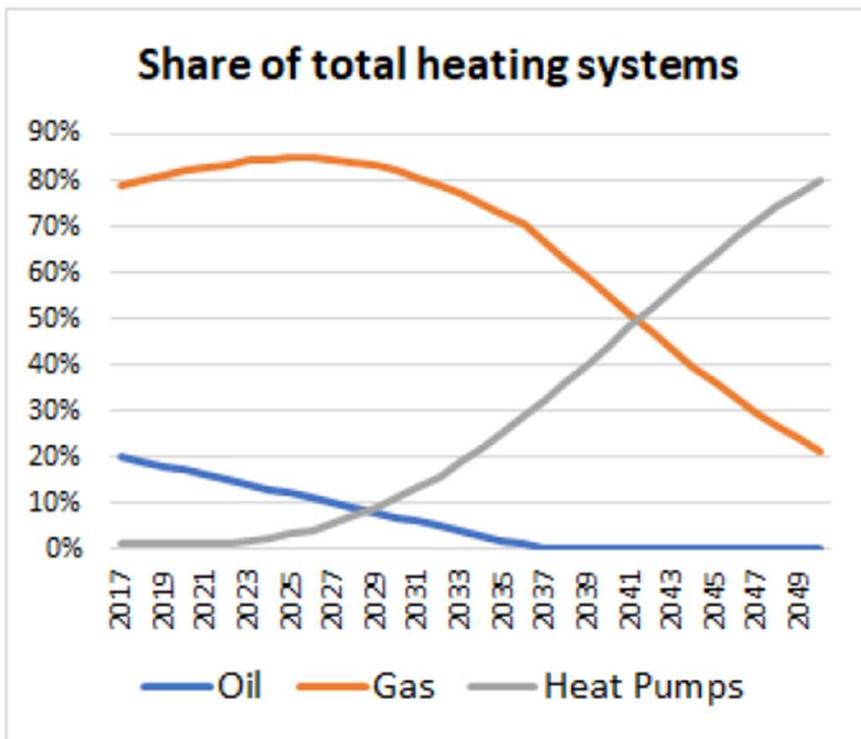
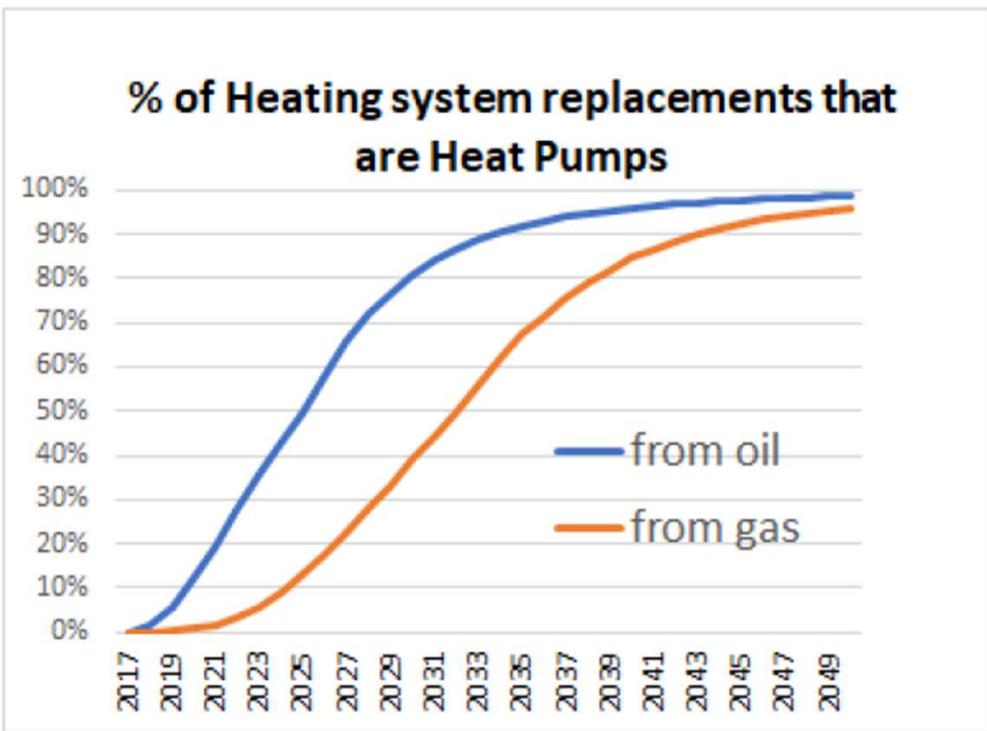
**Not included in the analysis (yet):**

- Commercial use of heating oil. Don't have data on this (could be a useful outreach/research project).
- Public transportation
- Waste (typically a small fraction of total)

Extra slides:

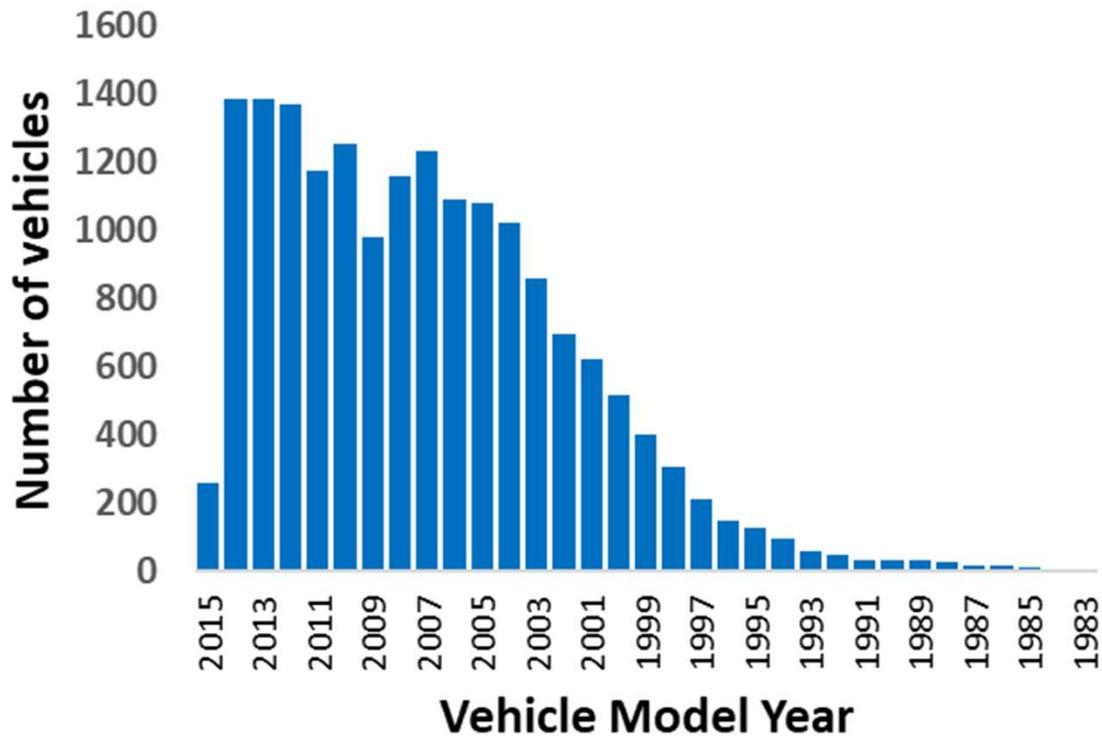


From Belmont Climate  
Roadmap: target trajectories



From Belmont Climate Roadmap: target trajectories

### Distribution of model years of vehicles (as of Q4 2014) (Belmont)



Similar distribution of ages as in 2021

Source: Massachusetts Vehicle Census (MAPC)