Save Money with Clean Heat

How to cut carbon emissions from MA houses to net zero by 2050

- Saves average homeowner $2,500 a year
- No tax increases

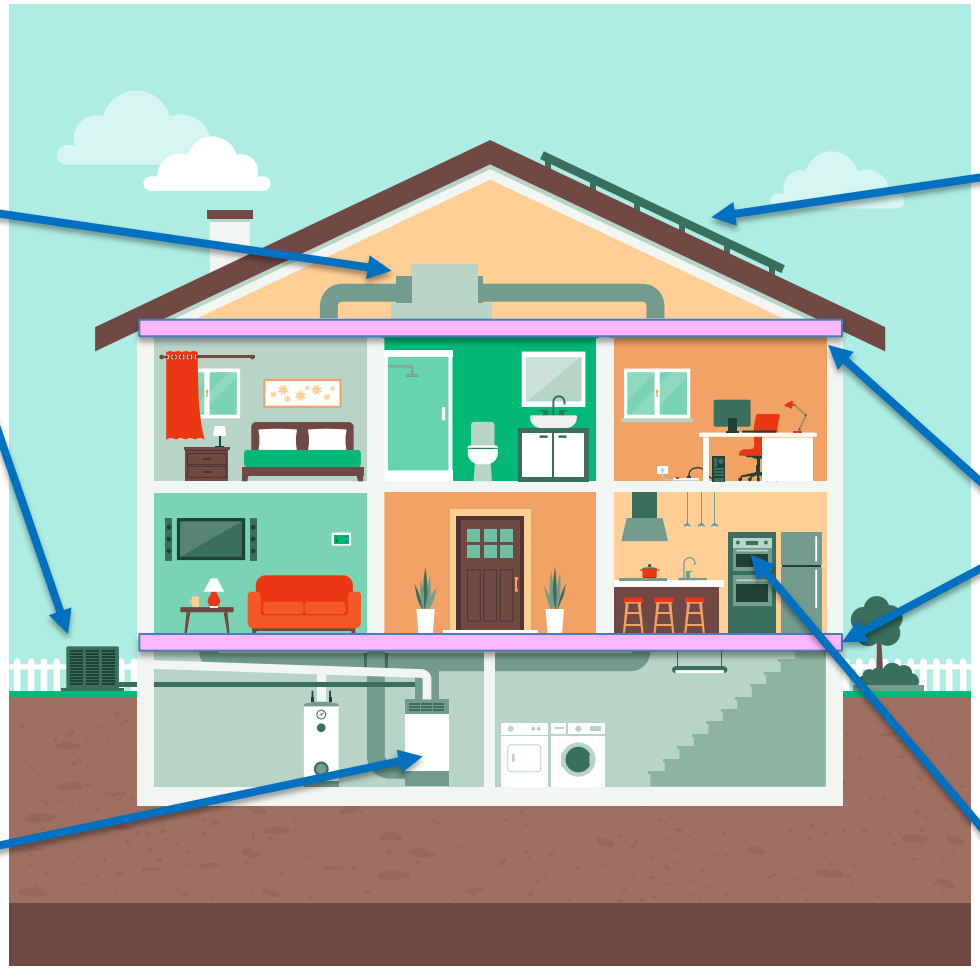
By adding insulation, heat pumps (to replace AC units keeping the furnace as a back up) and solar panels, most of which is paid for by the IRA or MA law, leaving the gas network in place, just using it very little.

This is a draft for discussion and for gathering your ideas, feedback and criticism. It is intended to supplement the Future of Clean Heat bill and Clean Heat Standard

Save Money with Clean Heat

How homes get to net zero carbon and save $2,500 a year

Heat pump provides heat at 3x the efficiency of furnace. Also provides AC efficiently



Existing furnace remains, but is only used as back up

Solar panels (or CSS) produce enough electricity to power heat pump and all other needs at 25% of the cost of utility electricity

Thick insulation in attic and ceiling of basement reduce energy use 20-30%

Existing stove remains, if gas

An average house needs a 13kW array to reach net zero on its heat-pump heating, all other electricity needs and to charge an EV. This fits on the average roof.

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Key benefits of SMCH

- MA cuts CO2 emissions from homes to net zero by 2050[1]
- By replacing AC units (not furnaces) with heat pumps, and adding solar panels and insulation, the avg. home saves $2,500 per year[2]
  - This cost saving translates to about a $50,000 increase in house price[9]
  - Even including the financing costs with Mass. Community Climate Bank loans (i.e., no cash down for the homeowner) adding both heat pumps and solar panels cut costs by $111/month for the average home in MA[3]
  - Low-income households (mainly tenants) on discounted electricity can save money by heating with a heat pump even without adding solar panels
- No one must remove their gas furnace (leaving cheap heat even in bitterly-cold winters) or gas stove (making allies of cooks)
- Most of the cost of insulation[4], heat pumps[5] and solar panels[6] is covered by the IRA, MassSave, SMART and net metering
- Low or zero interest-rate loans provided by MassSave Heat Loan and MA Community Climate Bank means no cash up front[3]
- No new taxes required
- Need “Clean Heat Concierges” to guide people

1 etc. see numbered appendices for supporting data and analysis

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Key Elements of SMCH

MassSave

- Triple **scale** to 75,000 homes p.a.
- Triple **scope** to include solar and heat pumps
- Add in IRA incentives allows tripling on current MA budget
- Shift cost from electricity to fossil fuels to incentivize heat pumps (and EVs)
- Need concierges to help people through it all
- Low (or zero) interest rate financing means no cash upfront
- MassSave to be run by new public authority (to avoid conflicts and IRA denial)

IRA

- Add IRA subsidies to MassSave ones
- Cap at current MassSave subsidy
- Limit total subsidy by income according to IRA rules
- Allows MassSave to triple on current budget

All 2m MA homes get to net zero by 2050 and save $2,500 per year on average

Heating

- Require all new AC units to be heat pumps
  - With IRA and MassSave subsidies heat pumps are cheaper than new AC units.
  - Current AC units will need to be replaced by 2050 anyway. 60% of homes have window AC, 20% central
- Keep current furnace (as back up) and gas stove

Electricity

- Solar, solar, solar
- New time-of-use tariff
- Smart metering to apply discounts to heat pump and EV usage, not entire bill
- Existing low-income discounts (up to 50%) already make heat pumps cheaper than natural gas

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Additional Elements of SMCH

Electricity:

- Simplify and expedite the grid interconnection process for rooftop solar
- Expand community-sourced solar (CSS) to allow tenants, homeowners with tiles or shingles, and those with shady roofs to benefit from cheap, clean solar
- Allow neighborhood associations, towns, schools, MLPs, big box stores and utilities to add CSS
- Require a time-of-use electric tariff for night-time EV charging / laundry
  - This reduces the strain on the grid and reduces the use of expensive peaker plants
- Increase R3 discount for heat pumps/electric heating (Unitil just increased the winter-time discount to 6c from the 0.6c currently offered by Eversource), add new discounted rate for EVs
- Use smart metering to apply discounted rates only to heat pump or EV usage, not entire bill
- Allow rolling 20 mins curtailment during peak demand, in return for 20-30% discount (already in TX and CA)

Utilities:

- Require utilities to plan for phase down of gas / phase up of electricity:
  - no stranded assets. DPU to order "repair" vs. "replacement" of pipes; right to “heat” not right to “gas”; must consult with communities

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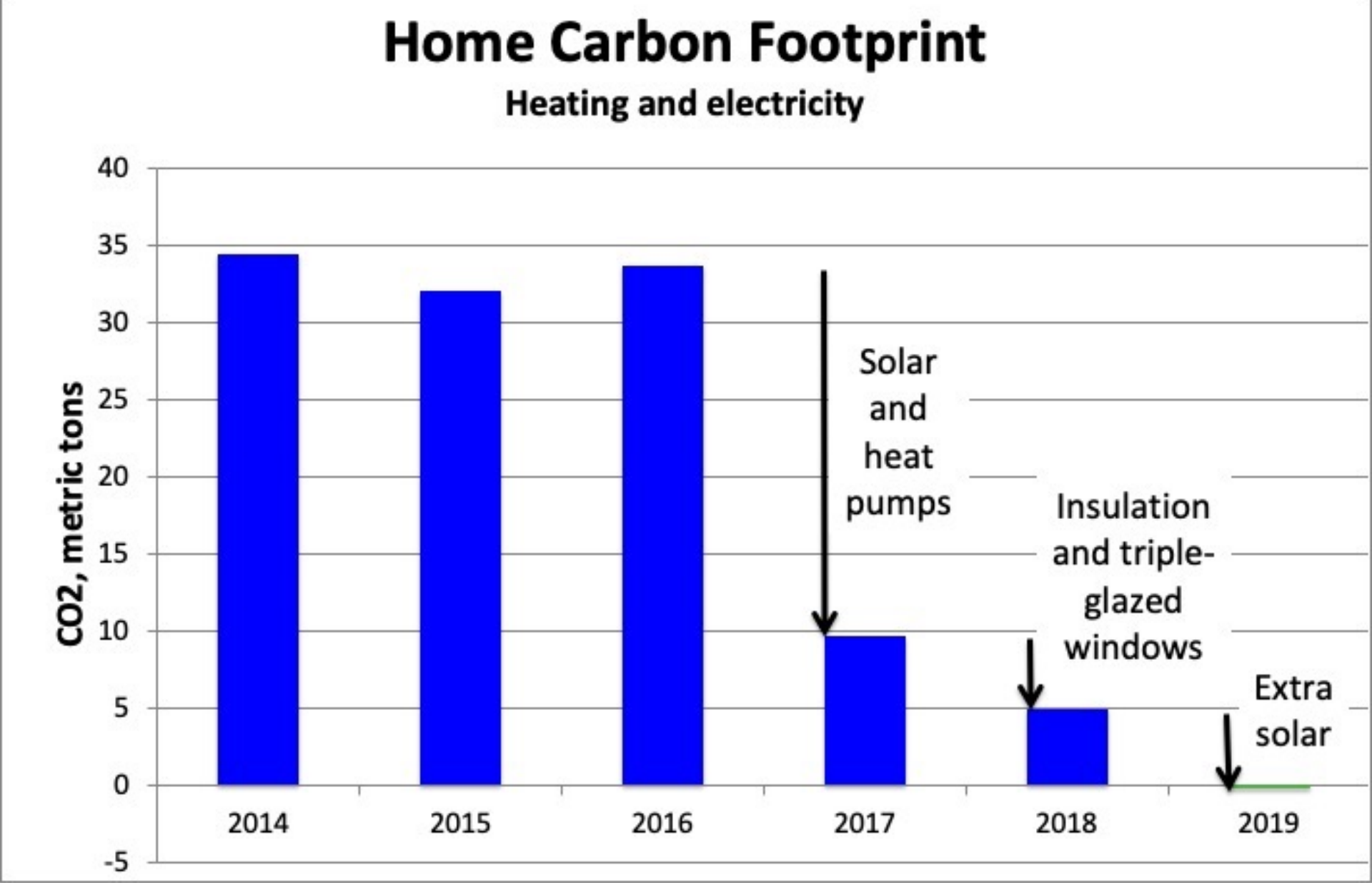
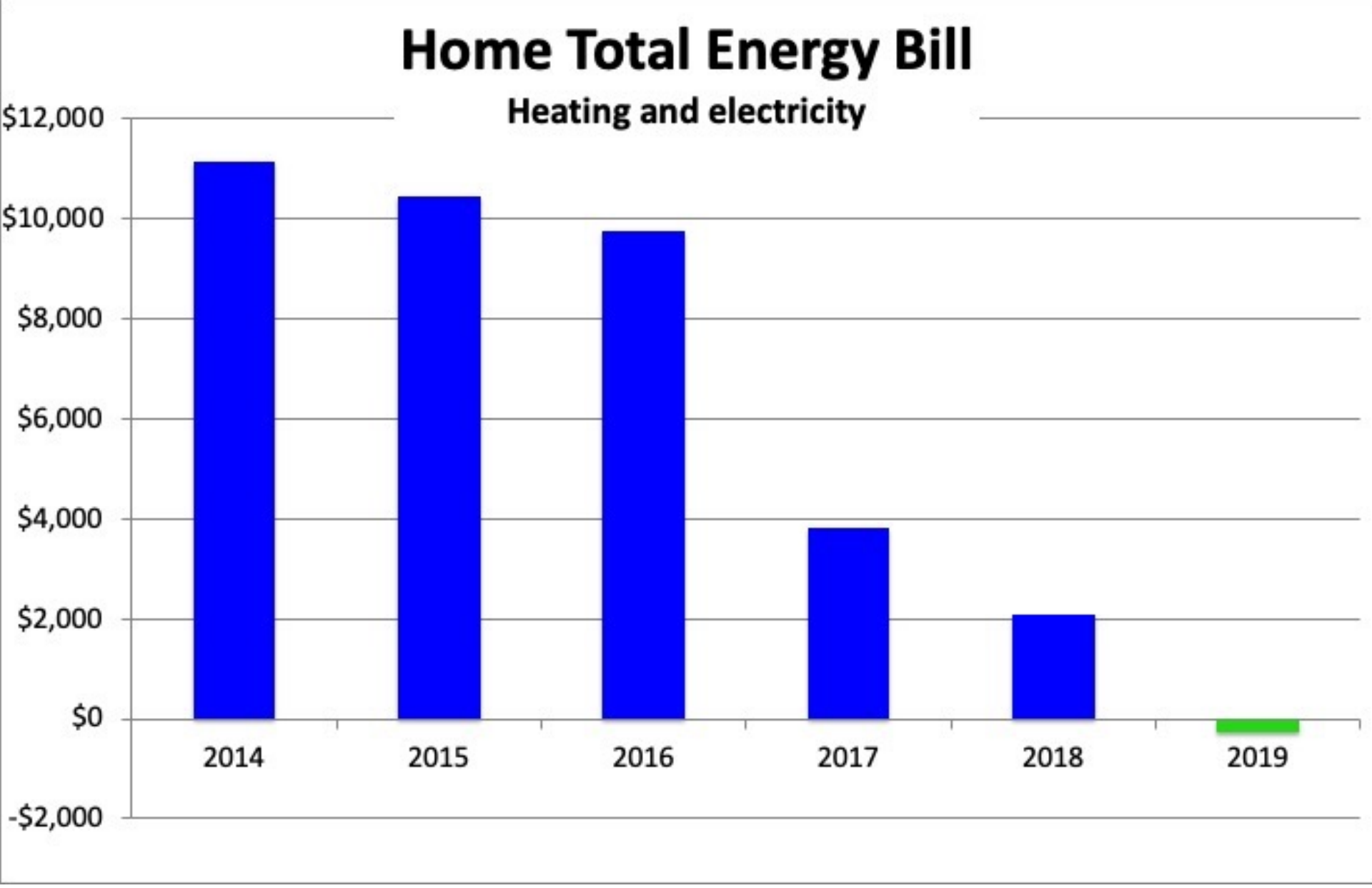
Appendix 1 :
Case Study showing net zero energy and net zero bills are possible.



5,400 sf home in Dover, MA built in 1974, oil heat. 35 other homes from 1,200 sf slab-on-grade to 14,000sf mansions from brand new to 1810 colonial farmhouses have had similar results.



Both carbon emissions and bills were cut to net zero. Total investment (net of subsidies) was $75,000. Return on investment was 15% after tax.

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Zero Carbon Case Study Summary

	Total money invested (after subsidies and tax credits)	Total Money Saved	Years to pay for itself	Return on Investment (after tax)	Total carbon footprint reduction (CO2 per year)
Heat pumps	$26,250	$2,888	9.1	9%	20 Tons
Insulation	$1,000	$2,923	0.3	100%	7 Tons
Triple windows	$4,500	$974	4.6	19%	2 Tons
Solar panels	$42,791	$5,572	7.7	13%	14 Tons
Total	$74,541	$12,358	6.0	15%	43 Tons

This homeowner achieved net zero carbon, net zero bills; could have financed all of it with the Heat Loan and Mass Community Climate Bank loans; and paid off the loans with the energy-bill savings before the loans were due.

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Appendix 2: Average MA Homeowners Costs Before and After SMCH

Bills today and with SMCH for average home in MA heated with natural gas

						Current bills			Bills with heat pumps but not solar		Bills under Save Money with Clean Heat law	
	Energy use - average MA house		therms translated into kWh			**Bills - house heated with natural gas**	3	COP (efficiency of heat pump)	**Bills - house heated with heat pump on utility electricity**		**Bills - house with heat pump with solar panels**	
Heating Using EIA RECS 2020 NE average heating energy psf	594	therms	17,410	kWh		$1,151	5,803	kWh needed to run heat pump	$1,894		$464	
Electricity Using EIA RECS 2020 NE average electricity psf	7,560	kWh				$2,467	7,560	kWh other electricity	$2,467	New electricity bill with heat pump, at utility prices	$605	New electricity bill with heat pump and solar
Total all bills						**$3,618**	13,363	kWh total electricity with heat pump	**$4,361**	New total bills with heat pump	**$1,069**	New total bills with heat pump and solar

Asssumptions:				
Cost of natural gas	$1.94	per therm	from:	https://www.eia.gov/dnav/ng/NG_SUM_LSUM_A_EPG0_PRS_DMCF_M.htm
Cost of utility electricity	$0.33	c/kWh	from:	https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a
Cost of solar electricity	$0.08	c/kWh	from:	current quotes for solar panels in MA at $3.07 per Watt
Average house in MA has floor area of:	1,800	sf	from	https://www.ahs.com/home-matters/real-estate/the-2022-american-home-size-index/

$2,500 SAVING

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Appendix 3: Estimated monthly bills with and without heat pumps and solar, inc. loan costs

Impact of adding either heat pumps alone or heat pumps and solar panels to an average 1,800sf home heated by natural gas, with median family income in eastern MA (from EIA data)

	Current monthly utility bills	Monthly utility bills after adding heat pump on utility electricity	Cost per month after adding heat pump and solar panels
Heating with natural gas	$96	$0	$0
Electricity (not for heat pump)	$206	$206	$39
Electricity for heat pump	$0	$158	$50
Total utility bills	$301	$363	$89
Adding a heat pump:			
List price of heat pump		$14,310	$14,310
MassSave rebate for heat pump (under current law)		$6,500	$6,500
IRA Part A tax credit for heat pump		$2,000	$2,000
IRA Part B low income rebate for heat pump		$8,000	$8,000
IRA Part C energy efficiency rebate for heat pump (not yet available)		$0	$0
Net price of heat pump after all rebates and credits		-$2,190	-$2,190
Reduced MassSave rebate under SMCH (which leaves the net price at zero)		$4,310	$4,310
Net price, and loan amount, for heat pump after all rebates and credits under SMCH		$0	$0
Adding solar panels:			
List price of enough solar panels to offset electric bill after adding the heat pump			$26,236
Federal tax credit of 30%			$7,871
MA tax credit , max $1,000			$1,000
Net price, and loan amount, for solar panels after tax credits			$17,366
Total loan amount for heat pump and solar panels under SMCH after rebates and tax credits		$0	$17,366
Note, max loan size is $100,000			
MCCB loan amortization, first 18 months*		$0	$0
MCCB loan amortization, after first 18 months**		$0	$72
Maximum monthly loan interest (until rebates and credits are received, max 12 months)		$24	$68
Monthly loan interest after rebates and credits are received		$0	$29
Total loan service bill during the first 18 months		$24	$68
Total loan service bill after the first 18 months		$0	$101
Total bills (utlity plus loan service) during the first 18 months	$301	$387	$157
Total bills (utlity plus loan service), after the first 18 months	$301	$363	$190

* the MCCB (Massachusetts Community Climate Bank) loan is interest only for the first 18 months

** the entire amount of the MCCB loan for the heat pump is paid off with the credits and rebates within the first 18 months

$111/month saving

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Appendix 4: Est. MassSave subsidy to keep net cost of insulation the same after IRA credits

Cost to insulate the average 1,800sf home in MA			
Current MassSave subsidy compared to new subsidy required to make the cost to homeowner the same after the IRA			
	Year 1	**Year 2**	**Total**
	Add 10" fiberglass to ceiling of basement	Add 12" fiberglass to attic	
Current MassSave rebate calculation:			
Cost of fiberglass batts from Home Depot	$1,120	$1,545	$2,665
Labor to install (8 hours x 2 people @ $45/hour all in)	$303	$417	$720
Total cost	$1,422	$1,962	$3,385
Current MassSave subsidy			$2,000
Net cost to homeowner			$1,385
IRA Part A tax credit calculation:			
Cost of fiberglass batts from Home Depot	$1,120	$1,545	$2,665
30% tax credit	$336	$463	$799
Net cost to homeowner	$784	$1,081	$1,865
Homeowner installs the fiberglass themselves or claims the installation cost under IRA Part B			
Current MassSave subsidy to homeowner			$2,000
New MassSave subsidy to make net cost the same with IRA Part A tax credit			$481
Cut in MassSave subsidy by adding IRA subsidy			$1,519
Cut in MassSave subsidy by adding IRA subsidy, %			76%
IRA Part B (Electrification Rebate) calculation			
Income less than $113,000 (in eastern MA)	$1,600	$1,600	$3,200
income over $113,000 but less than $213,000 (eastern MA)	$800	$800	$1,600
Net cost to homeowner after IRA Part A tax credit and IRA Part B rebate			
Income less than $113,000 (in eastern MA)	-$816	-$519	-$1,335
income over $113,000 but less than $213,000 (eastern MA)	-$16	$281	$265

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Appendix 5: Estimated cost before and after subsidies (by income level) for adding a heat pump

for an average homeowner living in an 1,800sf house in eastern MA

Ducted Heat Pump FINANCIAL estimates - including the benefit of 0% interest MA Heat Loan, IRA and MassSave subsidies

This calculates for a **DUCTED** system at a year-round COP (efficiency) of 3.0.

	Annual income under $113,600	Annual income between $113,600 and $213,000	Annual income over $213,000
Estimated heat pump size (tons)	5	5	5
Heat pumps est. list price:	$15,555	$15,555	$15,555
Est. MassSave rebate	$6,250	$6,250	$6,250
MA Heat Loan/4% CD interest*	$4,355	$4,355	$4,355
IRA Part A Tax Credit for heat pump	$2,000	$2,000	$2,000
IRA Part B Electrification Rebate for heat pump	$8,000	$4,000	$0
IRA Part C Energy Efficiency Rebate for heat pump	?	?	?
Total Subsidies	*$20,605*	*$16,605*	*$12,605*
Net price	-$5,051	-$1,051	$2,949
Approximate cash benefit (NPV) of a ducted heat pump at utility electricity prices:	$7,333	$3,333	-$667
Approximate cash benefit (NPV) of a ducted heat pump at LCOE from rooftop solar:	$25,092	$21,092	$17,092
Approximate cash benefit (NPV) of a ducted heat pump at extra cost vs replacing AC units at utility electricity prices:	$18,495	$14,495	$10,495
Approximate cash benefit (NPV) of a ducted heat pump at extra cost vs replacing AC units at LCOE from rooftop solar:	$36,254	$32,254	$28,254

Please note: a green cell indicates a good financial investment, a red cell indicates a poor one, or at least one where the non-cash benefits such as reducing asthma and carbon emissions should be considered as well as the financial benefits.

** Some families may not have the cash available to invest in a CD even after using the 0% Heat Loan and so may not be able to take advantage of the CD interest. If this is the case for you, then eliminate the savings on this line.*

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Appendix 6: Estimated cost and savings for solar panels on the average 1,800sf house in MA

This array generates enough electricity to get to net zero while heating with a heat pump.
To get to net zero on the house and charging an EV, add another 3kW to the array.
A heat-pump hot-water tank requires another 1kW, total 13kW which will fit on an average roof.

Solar Panel FINANCIAL estimates WITHOUT battery		
9 kW array	generates appro› 10,170 kWh/year	
	Gross installed cost, array only	$26,236
	Net cost after 30% FTC and $1,000 STC, array only	$17,366
	NPV SMART, array only, after tax	$1,457
	Net cost after FTC, STC, NPV SMART (array only) after tax	$15,908
	Cash benefit (after-tax NPV array cash flows (without battery))	$53,804
	Current electric bill	$2,331
	Discount rate	3.0%
	Return on investment (after-tax IRR)	24%
	Payback period, years	5
	Cost per kWh (LCOE) over 25 years (after subsidies)	$0.068
	Current price of electricity	$0.326
Cut in elec bill $1,845	Cut in current cost of electricity	79%
	Do solar panels make financial sense?	yes

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Appendix 7: Estimated cost savings for an EV

compared to a gas-powered equivalent car
on utility electricity and on rooftop solar panels.

	Tesla Model 3 Long Range RWD	Toyota Camry XLE
List price (Kelly's Blue Book)	$42,480	$31,000
Cost of level 2 home charger	$2,000	
IRA tax credit	$7,500	$0
MA MOREV rebate	$3,500	$0
Net cost	$33,480	$31,000
5-year maintenance	$1,115	$1,168
Cost per mile ($4/gal, 30c/kWh)	$0.08	$0.14
Cost per year to drive 12,000 miles	$900	$1,714
Cost per mile (solar @ 8c/kWh)	$0.02	$0.14
Cost per year to drive 12,000 miles	$240	$1,714

The yellow highlight indicates the lowest cost vehicle in each category of: net cost; 5-year maintenance; and cost to drive on either utility electricity or on electricity from solar panels. When powered by roof-top solar panels, the Tesla Model 3 costs about $1,500 per year (or $125 per month) less to run than the Toyota Camry XLE.

It takes about 8 extras solar panels (3kW) to power an EV doing 12,000 miles per year.

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Appendix 8: Does the Solar Array fit on the Roof?

Does a solar array to get to net zero fit on the roof?		
	average 1,800sf house in MA	
Additional array size needed to generate all electricity used (heat pumps plus house load)	9	kilowatts
New array electricity produced per year	10,170	kWh per year
Electricity purchased from utility per year	0	kWh per year
Electricity purchased from utility per year	$0	per year
Panel size	21.0	sf
Panel power	425	W
Number of panels needed	20	panels
Array area needed	422	sf
Existing roof area (as flat roof)	851	sf
Existing roof area as half of sloped roof area	595	sf
Existing roof area as both sides of sloped roof area	1,191	sf
Array area as % of both sides of sloped roof area	35%	
Panel cost per watt before tax credits and subsidies	$3.07	per watt DC
Array cost (before tax credits and subsidies)	$26,236	Array cost (before tax credits and subsidies)

A rooftop solar-panel array that generates enough electricity to get the average home in MA to net zero using a heat pump for heating and also powering all other electricity uses (but not including charging an EV) occupies only 35% of the roof area of the house. To get to net zero on the house and one EV travelling 12,000 miles per year requires a 13kW array that would occupy approximately half the roof area.

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Appendix 9: Increased House Prices from Reductions in Utility Bills

1. A homeowner who adds solar panels will, on average, see an increase in their house price by about 4.1%. This is from a study by Zillow: https://www.zillow.com/research/solar-panels-house-sell-more-23798/ This study looked only at the presence or absence of solar panels, it did not look at the size of the solar panel array. Because a bigger array reduces the bills more than a smaller array, a bigger array will increase the house price more than a smaller array. In general (see the reference below), cutting utility bills by $1 per year leads to a $20 increase in house price. Using this rule, an array that offsets the entire electric bill (after adding a heat pump) would increase the house price about 7%.
2. In addition, large-scale academic research shows that adding heat pumps also increases house prices by between 4-7% see here: https://greenzerocarbonhome.com/heat-pumps-increase-your-house-price-4-7/
3. Together, adding heat pumps and solar panels can increase the house price between 8-14%. On the average-priced house in MA ($630,000 in 2024) this is between $50,000 and $90,000 in additional benefit to the homeowner.

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The following people and/or organizations have contributed to this draft:

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We have incorporated ideas championed by Senator Mike Barrett, Asst. Majority Leader, Chair Joint Committee on Transportation, Utilities and Energy and ideas that originated in the Future of Clean Heat bill and in the Clean Heat Standard.

The analyses supporting the main points were performed by David Green who can be contacted at davidlcgreen@gmail.com with any questions, comments, criticism or ideas.