Zero Carbon® Home

Scientifically Rigorous, Financially Sound, Independent Advice
For Saving Money by Cutting Carbon

Created by David Green, author of the book *Zero Carbon Home* and the webinar *Zero Carbon, Zero Bills*

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Benefits to You:

You can save $12,507 per year by cutting your energy use 60% and your carbon emissions 100%

- For all homeowners, draft sealing by MassSave is free and insulation is 75% off up to $2,000. This is enough for most homes.
- For most homeowners, a new heating/AC system (heat pump) is free or 80% off, with no increase in bills.
- For most homeowners, solar panels are about 40% off and cut your electric bill by 50% with an ROI of 10-15% after tax.
- For most homeowners, a new heat-pump hot-water tank is either free or 60% off, and will cut your bills.

Purpose and Approach:

The purpose of this report is to help you to save money by cutting the carbon emissions from your home. We analyze how you use energy at home, both for heating and electricity. Using basic rules about how energy works in buildings, we calculate how much less energy your home would use and how much less carbon dioxide your home would emit, by making ten possible changes to your home. Then, we bring in some money sense, using standard investment analysis to calculate the total cash benefit to you (calculated as net-present value, or NPV, expressed in dollars, like $10,000), the return on investment (internal rate of return, or IRR, expressed as a %, like 10% per year) and payback period (how many years it takes for your savings to cover the initial cost, like six years). This report uses average heating fuel and electricity use per square foot for houses in MA (from government sources) combined with the living area of your house (from publicly-available sources) to estimate the energy use in your house from only the address and the type of fuel you use for heating. This approach has limitations because your energy use may be different from average. For most detached homes in MA it will give you a good overview. This report should not be used if you heat with heat pumps, have solar panels, charge an electric vehicle at home or if your home is an apartment, row house, double-decker or triple-decker. Also, you must heat with either natural gas, heating oil or propane today (you cannot use more than one), and you must use either Eversource or National Grid as your electric utility. If your house does not meet these criteria, or you want a more accurate version using your home's actual energy use, please email me at:

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I used my background in science (I have a BA in physics from Oxford) and finance (I have an MBA from Harvard) to reduce our home's energy bills and carbon emissions to zero. By investing in heat pumps, insulation, triple-pane windows, and solar panels (which I call the Fab Four), we not only achieved net zero carbon emissions but also earned a 15% return on our investments after taxes. I shared our success in a book called "Zero Carbon® Home", which I later turned into a webinar called "Zero Carbon®, Zero Bills". Thousands of people have seen it. Both get great reviews. You can find the webinar slides and a recording of the webinar for free on my website, www.greenzerocarbonhome.com. An electronic copy of the book, also for free, is included with this report. The website also has written answers to over 300 questions from homeowners like you. This report is best understood alongside the website and book, but it's designed to be helpful on its own. This approach has been used on about 35 homes in MA and NY. I have never failed to cut homeowner's carbon emissions and bills substantially and sometimes to zero. These homes have ranged in size from 1,500 square foot slab-on-grade ranches, to 14,000sf mansions and from 1810 colonial farmhouses to brand new construction. This report includes the expected benefits of the 2022 Inflation Reduction Act. Some States have not yet issued the rules for making claims and hence the exact benefits are not yet known.

Here are the results and recommendations for your home.

Results Summary:

There is potential to significantly cut both your energy bills (for heating and electricity) and cut your carbon emissions as well.

Table 1.

Summary Results (if all recommendations are implemented)		
Estimated cut in energy	34,139 kWh/year	60%
Estimated cut in bills	$12,507 per year	100%
Estimated cut in CO2	24 tons CO2/yr	100%

In these tables, green means a good result, red means bad.

Here are the specific recommendations, in rough descending order of priority:

Insulation:

Adding insulation to the attic and ceiling of the basement often has the highest return on investment (or "bank for the buck").

Table 2.

Insulation FINANCIAL estimates:

Investment	Savings per year	Cash benefit (after-tax NPV)	Return on investment (after-tax IRR)	Payback period (years)
$5,901	$5,307	$114,881	918%	1

Does insulation make financial sense? yes

Insulation costs exclude installation, i.e., the homeowner installs it themselves
Insulation costs exclude MassSave 75% subsidy on up to $2,000 including installation

If the software deems the number to be incalculable it is usually because the savings each year exceed the investment.
In other words, insulation is an extremely good investment earning a return of over 100% per year.
The costs for insultion are based on prices for fiberglass batts at Home Depot and the floor, attic and wall areas of your home.

The program of insulation that we suggest is as follows:

Add	6	inches of blown-in cellulose, dense-packed cellulose or fiberglass to the attic
Add	10	inches of fiberglass to the ceiling of the basement
Add	0	inches of blown-in cellulose to walls
Add	0	inches of ISO board to the floor of the basement
Add	0	inches ISO board to the walls of the basement

If you get MassSave to do the insulation and draft-sealing work for you, then insulating a typical house will cost you only a few hundred dollars. MassSave pays for the installation cost as well as the insulation cost, at 75% of the total cost up to $2,000. Most homeowners use MassSave and, since they pay for most of the insulation and installation, most homeowners will earn even higher returns on investment, and shorter payback periods than even these numbers. Some parts of the Inflation Reduction Act can also be used for insulation. You can investigate the MassSave program at their website:

https://www.masssave.com

While insulating the house, consider these additional improvements which are easy to do at the same time:

- Insulate the ducts in the basement
- Insulate the hot-water pipes in the basement
- Seal the drafts. MassSave does basic work, otherwise call a pro

In addition to the Massachusetts state subsidies, the Inflation Reduction Act contains a rebate (at the point of sale) of up to $1,600 for weatherization which includes insulation and draft sealing. This is limited by income, see below for how to calculate if you are eligible. In addition, there is a tax credit (which you deduct on your next tax return and is not limited by income) for $1,200. You can use both programs if you are eligible. The tax credit can be taken each year. Although it is a Federal Act, it is administered by each State separately. The total amount is limited to $4.5bn, which I expect will go quickly, so act now! Several States have refused to participate in the program.

Adding insulation has the highest return on investment of any investment I have ever made - it sure beats my 401(k)! And that is without any subsidies. With or without the subsidies, it is the fastest, cheapest and easiest way to cut bills by cutting carbon emissions. Fiberglass is cheap and highly effective. It is available at almost any hardware or DIY store. You can install it yourself, you do not need a contractor. See the book or my website for details, including on how to handle fiberglass safely.

Heat Pumps for heating the hot water for the sinks and showers:

Heat-pump hot-water tanks (HPHWT's) sometimes called heat-pump water heaters or just hybrid water heaters (they are called hybrids because they almost always contain back-up electric resistance heating elements as well as the heat pump) are widely available, can be installed by any plumber and, especially with the new subsidies in the IRA, are very good value for money for almost everyone. They can save you hundreds of dollars a year on heating your hot water and pay for themselves in a few years.

Because a HPHWT uses electricity it is important to know what you are paying for electricity. In MA, electricity from solar panels is almost always cheaper than utility electricity. See Table 4 in the solar panel section below. In the information below, I talk about something called the "levelized cost of electricity" or LCOE from solar panels. This is just a way to figure out how much each kilowatt-hour from solar panels actually costs. We calculate it by taking the total cost of the solar panels (after any subsidies) and dividing it by the amount of electricity the panels are guaranteed to produce over the warranty period, which is typically 25 years. The LCOE helps us compare the cost of solar electricity to what your utility company charges. The LCOE for electricity from rooftop solar panels is often less than half the price you'd pay the utility company for electricity.

Table 3.

Heat-Pump Hot-Water (HPHWT) Tank FINANCIAL estimates	Investment including installation (after MA rebate, IRA credit and Heat Loan)	Savings on heating fuel, minus extra electricity, per year	Cash benefit (after tax-NPV)	Return on investment (after-tax IRR)	Payback period (years)	Does a HPHWT make financial sense?
50-gallon HPHWT with your UTILITY electricity price	$1,623	$222	$2,284	10%	10	yes
50 gallon HPHWT at LCOE of ROOFTOP SOLAR	$1,623	$464	$7,519	24%	5	yes

A HPHWT makes financial sense, even at utility electricity rates and makes more sense at solar rates.
A HPHWT will dehumidify the basement which will reduce dampness issues.
Electricity use per year by HPHWT is 1,083 kWh per year.
Powering the HPHWT from solar panels needs an additional 3 panels added to the solar array specified below.

The investment for a HPHWT assumes the purchase of a Rheem 50-gallon HPHWT (priced from Home Depot) for $1,998 plus $2,000 to install it. It includes the $750 MassSave rebate, the IRA Part A tax credit of $974 (30% of the total amount after the MassSave rebate) and the $650 benefit of using the 0%-interest Heat Loan. $1,998+$2,000-$750-$974-$650 = $1,623. A 50-gallon tank is suitable for a house with four or fewer occupants. If you have more occupants, you may want a larger tank. These calculations assume you use the IRA Part A tax credit not the (more generous) IRA Part B Rebate which is income dependent.

In addition to this tax credit under the Inflation Reduction Act (IRA) Part B there is a rebate of up to $1,750 for a low-income family and $875 for a moderate- income family. See the section at the end of this report on how to determine your eligibility. If you qualify, a new heat-pump hot-water tank could be free or almost free, even if you can't benefit from the tax credit because you do not owe enough in taxes to use it up. These subsidies are so generous they make getting a new heat-pump hot-water tank an obvious decision for almost everyone. The IRA Part A tax credit can be taken each year and is available for both heat pumps for heating the air in the house as well as for heat-pump hot-water tanks, but the combined maximum tax credit is $2,000 per year. So a savvy homeowner might add a heat-pump hot-water tank this year and a heat pump for heating the air next year. This would enable even high-income households to get a new heat-pump hot-water tank for little money this year and still get $2,000 off a heat pump for heating the air in the house the following year.

Solar Panels:

In the past decade, solar panels have gotten much better at generating electricity and their cost has dropped significantly. Now, they're powerful enough that a well-insulated home, with triple-pane windows and efficiently heated using electric-powered heat pumps, can produce all the energy it needs from solar panels on the roof, which is what we do on our house. The direction the roof faces (east, west, or south) matters little, and the roof can be either flat or sloped. The only challenge is if the roof has a lot of interruptions like dormer windows, chimneys, or hips. Even roofs in part shade (like my garage) can produce cheap electricity. The amount of shade on your roof is taken into account in the calculations below.

Solar panels qualify for the Federal 30% tax credit (on the cost including installation) and often generous State subsidies. This often makes it much cheaper to generate your electricity from solar panels than buying it from your electric utility. Thanks to net-metering laws in most states, your utility company gives you credit for contributing extra solar electricity to the grid. This credit builds up in the summer and is used during the winter. If you build up enough credits in the summer and heat with electricly-powered heat pumps, then you can heat your house year round without burning any fossil fuel. This is what we do today.

Solar panels are an investment, but they can bring in great returns, making them really worthwhile. If you don't have the cash upfront, you can often get a low-rate loan or lease them for no money down. Leasing is a bit like leasing a car, it's not as good a deal as paying cash, but it gets you solar power without a big initial cost. For more details, check out my website at www.greenzerocarbonhome.com. Some leasing companies use very high interest rates and commissions, and can be poor value.

Table 4.

Solar Panel FINANCIAL estimates WITHOUT battery		Solar Panel FINANCIAL estimates WITH battery	
28 kW array generates approx 24,645 kWh/year		28 kW array generates ap 24,645 kWh/year	
Gross installed cost, array only	$85,012	Gross installed cost, array plus battery	$100,012
Net cost after 30% FTC and $1,000 STC, array only	$58,508	Net cost after 30% FTC and $1,000 STC, array plus battery	$69,008
NPV SMART, array only, after tax	$0	NPV SMART (array + batt adder), CS, and CPEC subsidies after tax	$3,998
Net cost after FTC, STC, NPV SMART (array only) after tax	$58,508	Net cost after FTC, STC, NPV SMART (array + batt adder), CS after tax	$65,010
Cash benefit (after-tax NPV array cash flows (without battery))	$67,732	Cash benefit (after-tax NPV array cash flows (with battery))	$61,409
Current electric bill	$7,314	Current electric bill	$7,314
Discount rate	3.0%	Discount rate	3.0%
Return on investment (after-tax IRR)	11%	Return on investment (after-tax IRR)	10%

	Payback period, years	9		Payback period, years	10
	Cost per kWh (LCOE) over 25 years (after subsidies)	$0.103		Cost per kWh (LCOE) over 25 years (after subsidies)	$0.115
	Current price of electricity	$0.327		Current price of electricity	$0.327
Cut in elec bill $5,002	Cut in current cost of electricity	68%	Cut in elec bill $4,745	Cut in current cost of electricity	65%
	Do solar panels make financial sense?	yes		Do solar panels and a battery make financial sense?	yes

These cost estimates do not include installing a new roof. Solar panels extend the life of the roof by providing shade.
If your roof is likely to need replacing within the next ten years or so, replacing it before you add solar may be a good idea.
Prices for solar panels are based on recent quotes for high-quality panels in MA at $3.07 per Watt, installed, before subsidies.
These financial estimates estimate the amount of sun on the roof of your house, this is an inherently uncertain number.
FTC refers to the federal tax credit of 30% of the total cost. STC refers to the State Tax Credit which is $1,000 in MA.
SMART refers to the MA solar subsidy program. CS refers to Connected Solutions which is a utility program that pays to utilize your battery and CPEC refers to the Clean Peak Energy Certificates program. Both CS and CPEC are extremely complicated and are assumed to be zero, so if you get them, the numbers will only improve. These numbers include MA net metering.
If your roof cannot fit solar panels the next best option (in MA) is often to use a community-source provider like NexAmp which gives you 100% solar electricity made in MA at 12.5% off the utility rate. We use this on a house that cannot do solar.

Charging an electric vehicle (EV) from solar panels requires approximately 3kW to be added to this array which is about 8 extra panels. An EV with Vehicle to House (V2H) charging is usually cheaper than a home battery, see my website: https://www.greenzerocarbonhome.com/ for more details. My new Ford F150 Lightning does this very well!

Windows:

After your attic and basement, your windows are likely the next-biggest leakers of warmth and money from your home. Upgrading your windows is a key step in reducing your energy use, cutting down on energy bills, and lowering carbon emissions. Triple-glazed windows, also known as triple-pane windows, have three layers of glass with two air gaps between the three panes. It's the air that does the insulating, not the glass itself. A modern triple-glazed window only lets about 15% of the heat (and money) escape compared to an old-style single-pane window. These advanced windows, with low-E coatings and argon filling, are the unsung heroes of the zero-carbon revolution.

But, let's be real, replacing windows is pricey and usually won't pay for itself with the savings on energy bills, at least not for many years. So, the best time to go for triple-glazed windows is when you already need to replace your windows for other reasons, like if they're leaking or damaged. That is what we did. Our 1970's-era single and double-pane windows were broken, leaking and misted up between the panes. At that point, the extra cost for a triple-glazed window over a new double-glazed one is small, maybe just 5% more, because most of the cost is in the installation and the type of wood you choose for the frame.

If your windows don't need a full replacement, you might want to consider "fit from the inside" window inserts, sometimes called interior storm windows. These are way cheaper (from $75-$200 for a 10 square foot window) than getting all new windows, and you can install them yourself with no tools needed - you just push the window insert into the window frame from the inside. Besides giving your windows an extra layer of insulation, they also block drafts. This is especially handy for sash windows, which are known for being very drafty. For more details, check out the book, website and webinar at www.greenzerocarbonhome.com.

Table 5.

Triple-Glazed Windows (TGW) FINANCIAL estimates	Investment	Savings on heating, per year	Cash benefit (after-tax NPV)	Return on investment (after-tax IRR)	Payback period (years)	Do TGW make financial sense?
Adding triple-glazed windows at full cost inc. installation	$74,407	$814	($53,747)	-6%	25	no
Adding TGW at exta cost vs double-glazed windows (DGW)	$7,155	$814	$11,547	15%	8	yes
Adding Innerglass "fit-from-the-inside" window inserts	$12,878	$638	$2,007	4%	16	no

Replacing your windows does not make financial sense now.
Replacing any broken or leaking windows with TGW makes better financial sense than replacing them with DGW.
Adding window inserts does not make financial sense on your home, though the case is better if your windows are drafty.
The investment is based on recent price quotes for windows (per square foot) multiplied by your estimated window area.
The investment does not include any MA or IRA subsidies. Part C of the IRA subsidies (see below) can be used for windows.

Heat Pumps for heating the air in the house:

Heat pumps don't burn fossil fuels to generate heat, instead, they shift heat from one place to another. This process, which is explained in the book and webinar, is much more efficient than making heat, and heat pumps can be about three times more efficient than making heat by burning fossil fuels. That's why heat pumps are a significant step forward in improving energy efficiency. Heat pumps can be either geothermal heat pumps (where the heat is sourced from ground water) or air-sourced

heat pumps that source the heat from the outside air. Geothermal heat pumps are very expensive and disruptive (you need to drill wells in your back yard) and are not considered here. All the heat pumps I describe here are air-sourced heat pumps.

Getting heat pumps right in a net-zero plan can be tricky. They're pricey, and the return on investment varies a lot based on the fuel you currently use for heating, your electricity costs and the subsidies. This report takes account of both the average price of heating fuel and average electricity prices in MA, and State and Federal subsidies. It looks at the total cost of getting a new heat pump and also the extra cost compared to replacing an AC unit. This is often because it's best to install heat pumps when your AC units need replacing, not when your furnace or boiler fails. Most homes in Massachusetts need back-up heat on super-cold winter days when the outdoor temperature is below about 20°F. This heat can be supplied by fossil-fuel or by using fan heaters. We do this on a few days each year. If your AC units are on the fritz, it's a good time to switch to heat pumps because the extra cost compared to a new AC unit is usually small. This makes the payback time shorter and the return on investment better.

The estimates below show costs based on utility-electricity rates and also rates from rooftop solar panels. Solar panels often produce cheaper electricity than what you get from the utility company. Check Table 4 above for an estimate of your electricity cost from solar panels on your roof. On my house, solar electricity is 70% cheaper than utility electricity.

Today, using solar panels to power heat pumps is usually even cheaper than heating with natural gas, and it produces zero carbon emissions. This is how we heat our house. These estimates assume you have done the insulation recommended in Table 2, if you have not, then these estimates, below, will under-estimate the size of the heat pump needed.

Table 6. Ducted Heat Pump System.

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)	8	8	8
Heat pumps est. list price:	$44,857	$44,857	$44,857
Est. MassSave rebate	$9,875	$9,875	$9,875
MA Heat Loan/4% CD interest*	$7,000	$7,000	$7,000
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
Total Subsidies	$26,875	$22,875	$18,875
Net price	$17,982	$21,982	$25,982
Approximate cash benefit (NPV) of a ducted heat pump at utility electricity prices:	-$15,253	-$19,253	-$23,253
Approximate cash benefit (NPV) of a ducted heat pump at LCOE from rooftop solar:	-$3,829	-$7,829	-$11,829
Approximate cash benefit (NPV) of a ducted heat pump at extra cost vs replacing AC units at utility electricity prices:	$17,595	$13,595	$9,595
Approximate cash benefit (NPV) of a ducted heat pump at extra cost vs replacing AC units at LCOE from rooftop solar:	$29,019	$25,019	$21,019

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.*

Table 7. Ductless Minisplit Heat Pump System.

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

This calculates for a DUCTLESS MINISPLIT 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)	8	8	8
Heat pumps est. list price:	$86,253	$86,253	$86,253
Est. MassSave rebate	$9,875	$9,875	$9,875
MA Heat Loan/4% CD interest*	$7,000	$7,000	$7,000
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
Total Subsidies	$26,875	$22,875	$18,875
Net price	$59,378	$63,378	$67,378
Approximate cash benefit (NPV) of a ductless heat pump at utility electricity prices:	-$57,259	-$61,259	-$65,259
Approximate cash benefit (NPV) of a ductless heat pump at LCOE from rooftop solar:	-$40,244	-$44,244	-$48,244
Approximate cash benefit (NPV) of a ductless heat pump at extra cost vs replacing AC units at utility electricity prices:	-$23,426	-$27,426	-$31,426
Approximate cash benefit (NPV) of a ductless heat pump at extra cost vs replacing AC units at LCOE from rooftop solar:	-$6,410	-$10,410	-$14,410

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.*

If your home already has ductwork, either for heating the air or for the AC, then it is usually cheaper to install a ducted heat pump system rather than a ductless system.

If the software considers the number to be incalculable it is because the results are very bad financially.
The cost of minisplit systems is highly variable based on the layout of your house and the number of indoor "heads" needed, so get quotes for your specific house. Minisplits are more cost effective in open-plan houses with lots of air circulation. Minisplits are least cost effective if your house has a traditional layout with lots of rooms closed off by doors.
If you have ductwork for AC but have radiators for heating, you can use the AC ductwork with a heat pump, just keep your fossil-fuel boiler for when the heat pumps can't heat the house on their own, or use electric fan heaters.
If you have window AC units, consider window-mounted heat pumps which heat in winter and cool in summer.
The investment are based on quotes for heat pumps (per square foot) in MA multiplied by the floor area of your house.
Heat pumps rarely save money if you use utility electricity and heat with natural gas. In this situation consider adding solar too.
If you can't add solar, you can still save money with heat pumps if you use the gas furnace only when the outdoor temperature is below about freezing. This is because heat pumps get less efficient (and more expensive to heat with) as it gets colder outside.

These estimates assume you keep your fossil fuel heating system as a back up, which is what we do.

You can save money (often several thousand dollars) by using the 7-year MassSave 0% interest Heat Loan. This is free money. You can take the money you would have spent and invest it is a CD, which today can earn you 4%. If you were to borrow $25,000 (the maximum allowed under the program) to buy the heat pumps, you would have an additional $7,000 using the MassSave loan and investing the $25,000 in a 4% CD for seven years. Some families may not have the cash available to pay for the heat pumps and so will need use the Heat Loan without then having spare cash to invest. In this case just eliminate the Heat Loan subsidy line and subtract the amount on this line from the NPV amounts shown in green or red in Tables 6 and 7.

If you get both the MassSave and the IRA subsidies, plus you use the MassSave Heat Loan, then you can get a heat pump with up to $25,000 off. This makes heat pumps (particularly ducted ones) exceptionally good value for almost everyone. You can get a whole new heating and AC system for very little money. It only gets better if you need to replace an AC unit, and even better still if you power the heat pumps with solar panels on your roof or from community-source solar. These IRA subsidies, when combined with the MassSave subsidies often make replacing your AC units with heat pumps a good financial decision, regardless of your household income, and even if you are paying utility prices for electricity. The additional subsides can also take thousands of dollars off the cost of energy-efficiency upgrades to your home. Please note that our analysis of all subsides is based on our understanding, but we not giving investment, tax or legal advice.

Inflation Reduction Act (IRA) subsidies

The Inflation Reduction Act contains significant subsidies that are available to all Americans. These subsidies include a tax credit which can be claimed by all taxpayers and is not limited by income (Part A), a rebate which can only be claimed by low- and moderate- income families (Part B), and a rebate based on improvements in home energy efficiency (Part C).

Part A: Tax Credits under 25C and 25D (i.e., a reduction in the taxes you owe April 15). Available to all taxpayers.

The IRA provides tax credits which can be claimed by all U.S. taxpayers. You will not get the benefit until you file your next tax return. If the credit is not used entirely in one tax year, the excess can be carried over to future years. The tax credits are not limited based on income. Some can be taken for rental or vacation homes. The tax credits are usually for 30% of the project costs. For solar panels, batteries and geothermal heat pumps (geothermal is not covered in this report) there is no limit to the amount you can claim. For air-sourced heat pumps, which is what I describe in the heat-pump sections, this tax credit is for up to $2,000 per year and can be combined with related work such as insulation, doors, windows and work on your electrical panel for a maximum of $3,200 per year. You can claim these credits every year and there is no lifetime cap. If you are claiming the full 30%, then the total project cost would need to be over $10,000, which it usually will be. See below for examples of how this benefits you. Here is the IRS form for claiming these credits: https://www.irs.gov/pub/irs-pdf/f5695.pdf

Part B: Electrification Rebates (i.e., money off at the point of sale). Only for low- and moderate-income families.

The IRA offers up-front rebates (with income qualifications, see below) on heat pumps (both air-sourced and geothermal) for heating the air in the house of up to $8,000, on heat-pump hot-water tanks up to $1,750, on upgrading your electrical panel up to $4,000, on upgrading your wiring up to $2,500 and on insulation and draft sealing up to $1,600. These rebates are included in the heat pump calculations in tables 6 and 7 above. You can claim multiple of these credits but the total cannot exceed $14,000 per household. These IRA rebates are issued at the point of sale, you do not need to wait until you file your tax return to get the money. These rebates are limited by income. The rebate is 100% if your household income is below 80% of the area median income (AMI) and 50% if your household income is greater than 80% of the AMI. There is no rebate if your household income is greater than 150% of AMI. This program is administered by DOE not IRS. At July 2024 only New York has implemented this.

The AMI for your house is	$142,000	80% of AMI is	$113,600	150% of AMI is	$213,000

The IRA rebates will substantially reduce the cost to you and will increase the cash benefit (NPV) and return on investment (IRR).

The IRA also offers an up-front rebate (with the same income limitations) of up to $840 on an electric-induction stove. We have one and it is great - I grew up cooking on gas but I will never go back to cooking on gas or electric resistance. I never burn the food, nothing catches fire and it is very easy to clean. It also emits no asthma-inducing gases from combustion. Several standard-sized induction stoves can be found at Lowe's or Home Depot for between $899 and $1,599. This rebate makes the net cost to you to be between $59 and $759 which is less than the price of a new electric or gas stove. There is also a rebate of up to $840 on a heat-pump clothes dryer. I have not used one of these, though I hear they are good. They tend to be smaller in capacity than standard tumble dryers. There are several available at Home Depot or Lowe's for betweeen $1,300 and $1,700. This rebate makes the net cost to you to be between $460 and $860. This makes a heat-pump clothes dryer cheaper than electric-resistance clothes dryers which are priced between $500 and $2,000. Even renters qualify for these rebates. The rebates are available for portable heat pumps (that replace window AC units), portable induction cooktops and portable clothes dryers. These can all be taken with you to your next apartment. This is a great opportunity for renters to cut their carbon emissions and upgrade their appliances! The total amount of rebates is limited to and is administered by the States.

Part C. Energy-Efficiency Rebates. These are available to all and are not income capped, though they are more generous for low-income families.

These Energy-Efficiency Rebates can be for up to $8,000, see below for details. These Energy-Efficiency Rebates cannot be combined with the Electrification Rebates of Part B if it is for the same work, but can be combined for different projects. Hence a high-income homeowner (with income above 150% of AMI) could still receive the Part C Energy-Efficiency rebate even as they could not claim the Part B Electrification Rebate. In addition, a savvy homeowner (whose income is below 150% of AMI) could use the Part B Electrification Rebates for upgrading the electrical panel (up to $4,000), and upgrading the wiring (up to $2,500) as these do not create energy savings, and then upgrade the insulation and add heat pumps (which will create energy savings) and claim the Energy-Efficiency Rebate for those additions.

The Energy-Efficiency Rebates can be obtained one of two different ways: 1) based on modeled (i.e., projected) energy savings of greater than 20% (in which case the rebate is up to $4,000) with the rebate doubling (to up to $8,000) if the projected savings are greater than 35%; or, 2) based on actual measured energy savings of greater than 15% which generates a rebate of up to $4,000. Energy savings means the reduction in the total amount of energy used by burning heating fuel and the energy used as electricity combined.

1. Modeled Energy Savings. If the modeled energy savings are greater than 35%, then the Energy-Efficiency Rebate for Modeled Energy Savings is up to $8,000 for families with income less than 80% of AMI, and up to $4,000 for families with income above 80% AMI. See table below for your subsidy. Most households implementing most of the recommendations in this report will achieve energy savings of at least 35%. If the modeled savings are greater than 20% but less than 35%, then the rebate is for up to $4,000 if the family income is less than 80% of AMI, and is for up to $2,000 if the family income is above 80% of AMI. The projected energy savings from implementing all of the actions recommended in this report are:

Table 8. IRA Rebates under Part C - Energy Efficiency.

60% energy savings are projected by implementing the recommendations of this report.		
If your family income is less than	$113,600 then your IRA Part C Rebate is up to	$8,000
If your family income is more than	$113,600 then your IRA Part C Rebate is up to	$4,000

2. Actual Energy Savings. Projects that achieve actual energy savings of at least 15% are eligible for a rebate of up to $4,000 if the income is less than 80% of AMI and for up to $2,000 if the income is above 80% of AMI. Note that the rebate is up to $8,000 based on modeled energy savings but is limited to $4,000 based on actual energy savings.

If you intend to use the IRA rebate Part B for buying the heat pump (see table 6 or 7 above), you can only use this Part C Rebate for other projects such as such as for insulation, a heat-pump hot-water tank, windows and appliances.

You can maximize the total value of the IRA subsidies by:

- using the Part A Tax Credit for a different project each year (e.g., a heat pump this year and a heat-pump hot-water tank next year); you can claim for solar panels in the same year as the heat pumps or in a different year.
- using the Part B Electrification Rebate (if you are eligible based on your income) for a heat pump, heat-pump hot-water tank, new appliances, upgrading your electrical panel, and upgrading your wiring; and
- using the Part C Energy-Efficiency Rebate for projects that reduce energy use such as a heat pump, insulation, and window upgrades even if your income is too high to qualify for the Part B rebate. You can claim Part A and Part C for the same heat pump, but you cannot claim Part B and Part C for the same heat pump.

Please read the memo attached this email with a detailed plan to maximize your savings at each income level.

In addition to these Federal subsidies, you can also claim State-level incentives. The total subsidies are very generous and so developing a plan over the next several years that fits your home and your family's financial situation and "green" goals is the best way to save money by cutting your carbon emissions. This plan can also include getting an electric vehicle, which are also heavily subsidized under the IRA and often under State laws too. For instance, a Ford F150 Lightning Pro with a list price of $49,995 (in March 2024) is eligible for both a $7,500 tax credit from the federal government and a $7,500 rebate from the MA government making the net price $34,995. This is a great price for a great truck! The truck can also be used as a back up generator for your house during grid outages. This is what I do with my F-150 Lightning Lariat and it worked very well during a recent grid outage that lasted for a full day. The Lariat trim has a bigger battery and a bigger on-board generator (that outputs 220V at 30 amps, the Pro edition outputs 110V at 20 amps) that can run my house's emergency panel for 3 days, but most homeowners do not need a battery, or generator, this big. We have had 3-day power outages at our house. Please note that our analysis of all subsides is based on our understanding, but we not giving investment, tax or legal advice.

Guidance from the IRS on these IRA Part A Tax Credits and IRA Part B Rebates is available here:
https://www.irs.gov/pub/taxpros/fs-2022-40.pdf
The DOE has yet to issue guidance on making claims under the IRA Part C Home Energy-Efficiency Rebate program.
In addition, MA residents with income below approx. $94,000 are eligible for an average of $4,725 for energy efficiency, see:
https://www.mass.gov/info-details/weatherization-assistance-program-wap#who-is-eligible-

Conclusion:

In conclusion, this analysis of your home's energy use and energy bills shows that by following these suggestions, you can significantly cut your energy use, carbon emissions and bills on your home. Before you take any of the actions suggested in this report, please read the section of the book related to each recommendation because there are often important details that can help make an addition successful. The book is included as an attachment to this email. You may also find the Q&A section of the website useful. If you need further guidance please visit my website:

https://www.greenzerocarbonhome.com/

Or you can email me at:
dgreen@greenzerocarbon.com

Yours sustainably,

Zero Carbon LLC.
David Green. President.

Criteria for use of this report.

Because this report makes simplifying assumptions so that it can be created with only your address and type of heating fuel, it has limitations. It can give you a reasonable overview of what is likely to make financial sense on your house only if your house meets all of the following criteria:

- The house must be in MA
- It must be single family and detached from other houses: no apartments, row houses, double deckers or triple deckers
- You must use either Eversource or National Grid as your electric utility, and be paying Basic Rate or close to it
- You must heat with heating oil, natural gas or propane: no wood heating
- There cannot be existing solar panels
- There cannot be electric vehicles charged on the home meter
- There cannot be a heat pump used for heating today
- There must be two heated floors: no single-story houses and no heated attic or basement
- There is no cottage or garage that is heated
- There is no swimming pool that uses electricity from the meter or heating fuel
- Your attic has about 6" of fiberglass or blown-in cellulose insulation
- Your basement ceiling has no insulation
- Your house frame is made of 2 by 4 (2" by 4") studs. If your wall is about 6" deep at the door you have 2 by 4s.
- Your marginal tax rate (i.e., the amount you pay on your last dollar of income) must be between 25-35%

If you do not meet all these criteria, or you would like a report based on your actual energy use (rather than calculating it based on average energy use per square foot for houses in MA multiplied by the square footage of your house) please contact me by email at dgreen@greenzerocarbon.com. Because generating these custom reports or more-accurate reports takes my time I charge for these reports and they cost $199 each.

Important Matters:

By using this report you are accepting these terms and conditions. This report is exclusively for the private and personal use of the homeowner to whom it is addressed, it is not for use by corporations, bots, installers, manufacturers, lenders or service providers. All commercial use is prohibited. Scraping of data from this report, software or website is prohibited. This information is confidential to the addressee and is copyright Zero Carbon® LLC. This analysis assumes that your house's energy use per square foot is average for homes in MA. This may not be correct for your house. It is only for use on detached houses, it will not be correct for apartments, row houses, double deckers or triple deckers. It will not be correct if you already have: geothermal or air-sourced heat pumps, solar panels, an EV charged on your house meter, and either very little or a lot of insulation. Also, you must use either heating oil, natural gas or propane for heating and you must use National Grid or Eversource as your electric utility and be paying Basic Rate or something close to it. We use 5% IRR or a positive NPV as the criteria for what makes financial sense. These may not be right for you.

This information, including inputs, algorithms and outputs is owned by Zero Carbon® LLC and is not to be copied or distributed. You may not copy, decompile, reverse engineer, modify, or create derivative works of this software or this report. Zero Carbon® LLC has the right to use and publish the data submitted, for example in case studies, to promote the adoption of energy-efficiency measures. All such data will be anonymous. The mark Zero Carbon® is a trademark of Zero Carbon® LLC registered with the United States Patent and Trademark Office with numbers 5,730,207 and 5,944,678. Use without the written permission of Zero Carbon® LLC may be a violation of law. David Green, your coach and Zero Carbon® LLC is/are not: providing investment, tax, financial or legal advice; recommending particular manufacturers, retailers or installers; soliciting or reviewing bids from installers; installing equipment or providing services; providing any warranty or guarantee of results; or accepting any liability for loss or damages attributed to the use of these recommendations.

These estimates are only as good as the data you provided or obtained from third-party sources, garbage in = garbage out. These estimates are intended to assist you in making decisions around cutting energy use, cutting bills and cutting carbon-dioxide emissions, they are not predictions. Please see the book Zero Carbon® Home and website www.greenzerocarbonhome.com for further information. If you need help interpreting these estimates, or want a more accurate version of this report (that uses your actual energy use rather than assuming it is average per square foot multiplied by the square footage of your house), please contact me:

dgreen@greenzerocarbon.com