Technologies For Your Clean Energy Home

This guide provides an in-depth overview of technologies available to transition your home to clean energy.
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Want to transition your home to clean energy, but unsure of where to start? This guide provides an in-depth overview of technologies available to decarbonize your home with a description of each technology and when to use it, the costs and incentives available, an overview of the installation process, and how to get the most from your system.
Air-source heat pumps are efficient heating and cooling systems that can keep your home at a comfortable temperature all year round.

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Air-Source Heat Pumps are heating and cooling systems that move heat into a home in the winter and draw heat out of the home in the summer. Instead of burning fossil fuels, they operate on the same principle as your refrigerator: using a refrigerant cycle, powered by electricity, to move heat and to keep your home at a comfortable temperature year round. They are much more efficient than electric resistance (electric baseboard) heating and also provide highly efficient air conditioning.

Air-source heat pump systems feature an outdoor unit (containing a compressor, reversing valve, heat exchanger and expansion device) connected to one or more indoor units by small refrigerant piping. The refrigerant is a substance with properties that enable it to easily absorb and release heat.
In the winter, very cold, low-pressure refrigerant absorbs heat from the outside air at the outdoor unit’s heat exchanger (1). (Yes, even sub-zero outdoor air has heat in it!) The refrigerant then flows to the air-source heat pump’s compressor (2), which mechanically pressurizes the refrigerant, causing it to heat up. The reversing valve (3) directs the hot refrigerant to flow to an indoor heat-exchanger where the refrigerant transfers its heat to the indoor air (4). No longer hot, the refrigerant then passes through an expansion device (5), which makes it very cold. Because it is now colder than the outdoor temperature, the refrigerant can again absorb heat from the outdoor air to begin the cycle again (1).
In the summer months, the process is reversed. The refrigerant passes through the expansion device, which makes it very cold (1). The cold refrigerant absorbs heat from air inside the home at the indoor heat exchanger (2), cooling down the interior. Once outside, the warmed refrigerant goes through the compressor (3), which pressurizes and heats it up further. This time, the reversing valve (4) directs the hot refrigerant to the outdoor heat exchanger. Because the refrigerant is now hotter than the outside temperature, it gives up its heat to the outdoor air (5), much the way a conventional air-conditioning system works.

In cold climates, like Massachusetts’, high efficiency, cold-climate air-source heat pumps can provide 100% of a home’s heating and cooling needs. Two common myths are that air-source heat pumps cannot heat when temperatures are below freezing and that they cannot heat homes without a backup heating source. In fact, cold-climate air-source heat pumps provide heating below freezing temperatures and do not require a backup in well-insulated homes. Not all heat pumps available for sale in Massachusetts are specifically designed to perform well on the coldest winter days. This guide focuses on the installation of cold-climate air-source heat pumps. To find air-source heat pumps that are certified as cold climate heat pumps, look at NEEP’s Cold Climate Air Source Heat Pump List.
AIR-SOURCE HEAT PUMPS (ASHP)

The Technology

AIR-SOURCE HEAT PUMPS ARE VERSATILE

Air-Source Heat Pumps use three types of systems to distribute heating and cooling:

- **Ducted**
- **Ductless** (single-zone or multi-zone)
- **Combination of ducted and ductless system**

There are two main system types of air-source heat pumps: ducted or ductless.

- **Ducted** systems have an outdoor unit (similar to a central air conditioner), which is connected to an indoor air-handling unit that connects to the home’s ductwork. Ducted systems can work well for homes that already have ducts or where the homeowner is planning to install ducts. A version of ducted systems known as “compact-ducted” uses much smaller air handlers that usually serve two to four rooms.

- **Ductless** systems (including “mini-splits”) have an outdoor unit which is connected to one or more indoor units (or “heads”) by small copper refrigerant pipes. Each head typically serves one room or area of a house. Ductless heads can be mounted on a wall, mounted to the floor, or embedded in the ceiling. Ductless systems are a great option for houses that have no existing ductwork.

Homes can be outfitted with a combination of ducted and ductless systems for a custom configuration that meets a home’s needs. This approach can be especially useful when building an addition; if the original part of a home already has ductwork, and the ductwork can’t easily be extended to the addition, homeowners can choose to install a ductless system in the addition, and also consider a ducted system for the rest of the home.
Air-to-water heat pumps work similarly to other air-source heat pumps except that they use water, instead of air, in the distribution system. This means that instead of blowing hot air in the winter to provide heat, air-to-water heat pumps heat up water in a radiator or in baseboard heating that provides heating to a home.

Air-to-water heat pumps can require fewer interior refrigerant piping connections but, because the hot water is delivered at a lower temperature than with a boiler, they can require upgrades of existing radiators and baseboards.

Unlike typical air-source heat pumps, air-to-water heat pumps have the potential to heat domestic hot water, and they can provide cooling if they are connected to a cooling system that can use chilled water, like a hydronic fan coil.

Air-to-water heat pumps are not widely available in the United States at this time, but there is growing interest in the technology.

For more information visit: energystar.gov
Do you want to reduce your home’s greenhouse gas emissions?

ASHPs run on electricity instead of burning fossil fuels to heat and cool your home, reducing your home’s greenhouse gas emissions.

Do you currently heat your home with oil, propane, or electric resistance?

With today’s energy prices, heating your home with ASHPs instead of oil, propane, or electric resistance will lower your heating operating expenses.

Do you want to add air conditioning to your home?

ASHPs are a great option for adding air conditioning while upgrading your old, inefficient heating system at the same time! For homes without existing ductwork for central air-conditioning, ductless heat pumps can provide heating and cooling to the entire home without the expense and disruption of installing ductwork. As a bonus, you get a new heating system too!

Do you want to replace your current central air conditioning system?

ASHPs can upgrade your old, inefficient central air-conditioning system. For homes with existing ductwork, a ducted ASHP may be able to use your existing ducts, although you should talk to an installer about whether your existing ductwork needs any upgrades to accommodate a heat pump. The additional cost of installing a heat pump (instead of just an air conditioning unit) may be covered by incentives and will provide your home with a new heating system.

Do you currently have a hot air heating system (i.e., furnace) that is old or inefficient?

Ductwork for hot air systems can be paired with a central air-source heat pump, although you should talk to an installer about whether your existing ductwork needs any upgrades to accommodate a heat pump.

Are there parts of your home that are not adequately heated or cooled by your existing system?

ASHPs are a flexible solution that can be designed to ensure comfortable conditions in your entire home or parts of your home that were never comfortable before. For example, the flexibility in design allows for homes with ducts to reuse the ducts if desired, while also adding a ductless unit or two for problem areas. Ductless ASHPs can provide zonal control from each indoor unit, so you can keep different parts of your home at different temperatures based on your preferences. For homes with radiators, ductless units can provide heating and cooling without the need to install ductwork, although a mini-duct solution may be a good way to heat and cool some adjacent smaller rooms like upstairs bedrooms. Talk to your installer about your goals for your home, and they should be able to design a system to help meet those goals.

Do you have an open concept house?

Homes with larger open spaces and fewer individual rooms can reduce the number of indoor units needed to heat and cool the entire home, bringing down the cost of an ASHP installation.

Do you have photovoltaic solar panels on your roof?

ASHPs run on electricity. If you already have PV panels on your roof that are generating more electricity than your home is currently consuming, then you can use the electricity from your existing solar panels to run your heat pump, decreasing or even eliminating your heating and cooling operating expenses.

Is your house weatherized (i.e., well-insulated and air-sealed)?

Weatherized homes require less energy to heat and maintain more even temperatures throughout the home, which will allow ASHPs to heat or cool your entire home with less capacity and fewer indoor heads, reducing the cost of installing ASHPs in your home and lowering the operating cost.

If you answer yes to ANY of the following questions, then ASHPs may be a good fit for your home.
AIR-SOURCE HEAT PUMPS (ASHP)

Case Studies

Mattapan resident Nia has cut her average electric bill in half since replacing her electric baseboards and window air-conditioners with air-source heat pumps: “Wow, it blew my mind. Normally the bill is anywhere from $400 to $500, and it was more like $200, I was like, ‘Let me look at that again!’”

Peter from Berlin, MA installed air-source heat pumps for his family’s home: “I reviewed different options for an alternative heating source instead of my current electric heat. It would have been extremely costly to add a fossil fuel system with furnace, plumbing, and ductwork. The heat pumps provide whisper-quiet cooling in the summer and heating in the winter. I’m easily saving hundreds of dollars every year compared to my electric heat. My return-on-investment will be short, my house will be comfortable, and my carbon footprint is reduced. Easily one of the best things I’ve done for my home.”

With increasing concerns about climate change, moving away from a fossil fuel-based heating system was an important decision for James in Hyde Park, Boston. Once his natural gas boiler needed replacement, James installed an air-source heat pump system for his home. Now James heats his entire 120-year-old Victorian home with an air-source heat pump system. According to James, he wants to do his part to reduce climate change and fossil fuel usage.
Benefits of Cold-Climate ASHPs

COST
• Lowest up-front installation cost of any low-carbon heating or cooling solution.
• Cost-competitive to operate compared to oil, propane, or electric resistance heat

FLEXIBILITY & FUNCTION
• Provides both heating and cooling in a single, efficient system
• Can be ductless or ducted, depending on what works better for your home
• Ductless indoor units can be floor-, ceiling-, or wall-mounted
• Operates efficiently in cold-climate regions, like Massachusetts
• Cold-climate air-source heat pumps can be the sole source of heating and cooling in a well-insulated home
• Adaptable for many situations. Air-source heat pumps can:
  - Fully replace your existing heating system
  - Integrate with your existing system
  - Supplement your existing system

COMFORT
• Easy to configure for zone-by-zone temperature control
• Provides air conditioning without sacrificing the use of the window
• Indoor units are much quieter than window air conditioners
• Outdoor units are typically much quieter than a traditional central air conditioning (AC) outdoor unit

GREENHOUSE GAS EMISSIONS
• Lower greenhouse gas impact than fossil fuels with today’s standard electric grid mix – and the grid is getting greener over time
• Potential for zero greenhouse gas impacts when paired with solar PV or 100% renewable electricity
The cost to install an air-source heat pump in your home will depend on the specific characteristics of the building, how much of your home’s heating and cooling you want to cover with your heat pump system, the kind of system and the features you choose, and your installer. Before incentives, a single-head ductless heat pump costs around $5,000, including installation. Whole-home replacement systems will start at $15,000 and can range up to $25,000 or more, depending on the home.

- **Ductless**: Larger homes and homes with more rooms or zones will have higher costs. Conversely, small homes or homes that are very well insulated can use smaller heat pump systems and will see lower costs.

- **Ducted or centralized**: Costs increase depending on the size of the home and the degree of ductwork modification required. Ductwork modifications can increase the project costs significantly. Conversely, homes that already have ductwork that is suitable for heat pumps offer some of the most cost-effective whole-home heat pump opportunities.

Homes that have less than 200-amp electrical service will likely incur additional costs for upgrading the electrical service to accommodate an air-source heat pump system.

As you consider the upfront cost, keep in mind that operating costs (i.e., your monthly energy bills) for air-source heat pumps tend to be substantially lower than typical costs for oil, propane, or electric baseboard heating systems. Well-sealed and insulated homes will have even lower heating costs, and installation costs in these homes will be lower because smaller equipment will be adequate to provide the heating. By installing air-source heat pumps, you will also be adding a very efficient cooling system.

The cost to install a brand-new heat pump shouldn’t be evaluated only on the dollar savings for heating and cooling your home; increasing comfort, greenhouse gas savings, and other benefits should also be considered. Other factors can reduce costs and encourage you to install air-source heat pumps:

- If your existing heating system is more than 10 years old, consider replacing it with a heat pump before it fails. The true cost to install the heat pump is the difference between the full cost of installing the air-source heat pump and what you would have spent on a new boiler or furnace.

- If you’re considering installing or replacing an air conditioner, providing heating as well as cooling will only add incrementally to the cost and may be offset by incentives.
AIR-SOURCE HEAT PUMPS (ASHP)

Incentives & Financing

INCENTIVES
Incentives are available to homeowners in Massachusetts wishing to upgrade their heating and cooling system to an air-source heat pump. Incentives depend on the kind of system installed (centralized or ductless), the size of the system, and the kind of fuel the system is displacing. Depending on your electric provider, you may be eligible for different incentive programs.

• **Mass Save® Electric Heating and Cooling Rebate:**
  If you are located in Mass Save® territory, you may be eligible for $1,250 per ton of heating capacity if you currently have oil, propane, or electric resistance heat. Typical whole-home systems range from 3-5 tons of capacity, and systems must include integrated controls. Customers that currently heat with natural gas are eligible for $250 per ton of capacity.

• **MassCEC Rebate:**
  Customers replacing their entire natural gas heating system with an air-source heat pump system are eligible for $2,500-$5,000 depending on income level. To be eligible for MassCEC rebates, homeowners’ electrical service provider must be Eversource, National Grid, Unitil, or one of the municipal electricity providers that contribute to the Renewable Energy Trust. [Click here](#) for a list of participating municipal electricity providers.

• If you are served by a municipal electric company, visit your electric provider’s webpage to see if they offer incentives for cold-climate air-source heat pumps.

• **Massachusetts Alternative Energy Certificates (AECs):**
  AECs (worth anywhere from $3-12 each) are provided to homeowners installing air source heat pumps depending on the square footage of the home, the level of home insulation/efficiency, and whether the existing fossil fuel heating system was removed. Homeowners apply for AEC credits after their air-source heat pump system is installed. A 2,000 square foot whole-home system could receive around 100 AECs, worth approximately $300-$1,200. See the [Department of Energy Resources (DOER)](http://www.mass.gov) website for more information on AECs.

FINANCING

• **Mass Save®**
  If you are located in Mass Save® territory, then eligible air-source heat pumps can be financed through a [Mass Save® HEAT Loan](#). These loans offer up to $25,000 at 0% interest over terms of up to 7 years. If unsure whether you are eligible for Mass Save® incentives, check on the [Mass Save® website](http://www.masssave.com).

• If you are not eligible for Mass Save® incentives, check with your local municipal electricity provider to see if they have any financing options available for clean energy systems.

*Please note that the value of an AEC is subject to market conditions and that the value listed here may be different than the current market price.*
Taking steps to air-seal and insulate your home will ensure that it is ready for your new air-source heat pump system and will help reduce overall energy consumption. A tighter, more insulated home will not only save you money on operating costs and reduce your carbon emissions throughout the year, it may also allow you to buy smaller, less expensive equipment in the first place.

There are a few ways to increase your home’s efficiency and reduce its heating and cooling load.

- **Air sealing:** Ensuring there are as few gaps as possible for indoor air to escape and outdoor air to get in. Air leakage can represent up to 40% of space-conditioning costs in a leaky building. Weatherization professionals will focus on sealing leaks hidden in the attic, garage, or between floors. Air sealing often involves re-sealing windows, replacing broken or jammed vents, and replacing the rubber seals around door frames. Experienced professionals will know the common culprits of air leakage to target, but a professional assessment of hidden leaks using a blower door to pressure-test the house is the best way to find leaks in your house.

- **Insulation:** Adding insulation slows heat transfer through the building envelope (i.e., walls, roof, floors); heat transfer is the leading cause of heat loss in the winter. Working with a professional contractor to improve roof, wall, and floor insulation can considerably lower heat transfer, improving your home’s efficiency. Many insulation contractors are trained to air-seal before insulating, when it’s much easier to do.

- **Ductwork Upgrades:** If your home utilizes a centralized heating or cooling unit with ducts outside of the conditioned space of the home (i.e., in an attic, basement, garage, or crawlspace), sealing and insulating the ducts can significantly improve the overall efficiency of your system by ensuring that more of the heated or cooled air gets delivered to where it is needed.

*Mass Save® or your gas or electricity provider may provide a no-cost assessment to identify efficiency opportunities for your home and incentives to help pay for the upfront cost of insulating and air-sealing.*
1. Confirm that air-source heat pumps are the right fit for your home and your home clean energy priorities.

2. Understand the costs and plan how you will finance the project. Check out the Cost and Incentives & Financing section to understand the typical costs to install air-source heat pumps.

3. Contact installers. MassCEC recommends contacting at least three installers to learn more about installing air-source heat pumps in your home. Installers may also give multiple quotes for different installation or unit configurations so you can understand all your options. Visit our Find An Installer Near You page for a list of installers. Referrals from family, friends, or neighbors are another great way to find installers.

4. Prepare your home. If necessary, take preliminary measures to get your home ready for a new heating system, such as upgrading your electrical service (if necessary) or completing any weatherization work recommended in your home energy assessment, such as sealing air leaks, or installing insulation. If you are planning to improve the weatherization of your home, make sure your installer is aware so that they take the reduced heating and cooling needs of your home into account when designing your air-source heat pump option(s).

5. Install air-source heat pumps. Talk to your installer about how long installation will take. Air-source heat pump installations typically take between 3 days and 2 weeks, depending on home size and system complexity.
Determine whether your home has adequate electrical service for an ASHP and make an upgrade if necessary.

How many amps of electrical service does your home have? If your home has less than 200 amp electrical service, talk to an ASHP installer about whether you may need to upgrade your electrical service to accommodate an ASHP system. Check out this site for instructions on how to determine the amperage of your home’s electric service. This Old House also has a helpful video that shows what an electrician will do to upgrade your electric meter and panel. Upgrading your home’s electrical service is a good investment if you might install an electric vehicle charger or other new electrical appliances in the future. This upgrade typically takes one day to complete, and usually costs around $2,000 to $3,000, which may include fees and permitting from your local permitting agency. Upgrading your home’s electrical service requires a licensed electrician who will coordinate with your electric utility and your local permitting agency.

Think about where you would like to place the outdoor and indoor units.

OUTDOOR UNIT PLACEMENT:

- **Size and Location:** Each ASHP outdoor unit takes up a few square feet of space. Exact sizing depends on the capacity of the heat pump and how many outdoor units you install. Outdoor units for central or multi-head heat pumps typically have a footprint that is twice as large as conventional air-conditioning-only units; they are sometimes slimmer, but taller, than air-conditioning only units. Single-zone outdoor units take up less space, but you may need more of them to heat your whole home. Think about any landscaping changes that may need to occur to facilitate unit placement. It’s good to avoid proximity to walkways or other areas where meltwater from the unit might freeze and create a slippery path. The top of the outdoor unit may reach up to 6 feet above the ground once it is mounted off the ground to keep it from being buried in the snow. Choose an outdoor area where the unit will not block a window or door.

- **Air Flow:** ASHPs run most efficiently when the outdoor units have access to unobstructed air flow. For this reason, ASHPs cannot be placed in front of each other. If you are considering landscaping around the outdoor units to reduce their visibility, make sure sufficient space is left around the unit for air to circulate.

- **Roof Drip Line:** Avoid installing the outdoor unit directly under any drip line from the roof or other overhang that would subject it to falling snowmelt, ice, or rain runoff. If this is unavoidable, plan to install a drip cap or shield above the unit.

- **Condo or Homeowner Association:** If you are part of a condo association or homeowners association, find out whether you need to obtain permission to place units outdoors.

- **Noise and vibrations:** Outdoor units are typically much quieter than an old air conditioner, so many homeowners are comfortable with having these outdoor units near a yard or patio. You may want to talk to your installer about the potential for noise or vibrations if you choose to mount the outdoor units directly on the wall of your home. Many homeowners find this to be a great option. If you are sensitive to noise or vibrations, you may want to avoid having the outdoor unit mounted outside a sensitive space like a bedroom. Alternatively, you could ask your installer about vibration dampening brackets or opt for a ground-mounted stand instead of wall-mounted brackets.

- **Accessibility:** Make sure that the outdoor unit is accessible for maintenance, ideally with a nearby electrical outlet for any maintenance equipment.
**DUCTLESS INDOOR UNIT PLACEMENT OPTIONS:**

**Wall Mounted**

Wall-mounted units are typically about three feet wide and two feet tall. Ideally, they should be installed at least 6 inches below the ceiling to allow for air circulation. Installing these units on an exterior wall simplifies the connection to the outdoor unit and to the drain for the condensate water that results from dehumidification in the summer. Consider the rooms in which you would like to place the units and where on the wall they would be installed.

**Ceiling Mounted**

These indoor units are popular with homeowners who who want to conserve wall space. Because heat rises, ceiling mounted units are most efficient in rooms with ceiling heights of 8 feet or less. Homes use a refrigerant line, instead of ductwork, to provide heating and cooling with ductless ceiling mounted units.

**Floor Mounted**

These units work efficiently when they have access to unobstructed air flow, similar to traditional radiators. Floor units are around two feet tall, between two and three feet wide, and 8 inches deep. If considering floor units, make sure you have an unobstructed floor space. Floor units can be a great option for heating, as heat rises naturally. If you are removing your old, cast-iron radiators as part of your project, you could install these floor-mounted units where the old radiators used to be.

**Air Vents**

Air vents connect to an indoor air-handling unit that connects to ductwork in your home. Some ducted heat pumps can be installed in conjunction with a new or existing furnace to provide heating and cooling for most of the year before switching to the furnace during the coldest parts of the winter. Other ducted heat pumps operate as the home's only source of heating and cooling with an in-unit electric resistance back-up heat source.

**DUCTED INDOOR UNIT PLACEMENT OPTIONS:**

**Wall Mounted**

Wall-mounted units are typically about three feet wide and two feet tall. Ideally, they should be installed at least 6 inches below the ceiling to allow for air circulation. Installing these units on an exterior wall simplifies the connection to the outdoor unit and to the drain for the condensate water that results from dehumidification in the summer. Consider the rooms in which you would like to place the units and where on the wall they would be installed.

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Questions to Ask Your Installer

During your conversation with installers, consider asking the following questions:

**CONFIGURATION**
Did you perform a heat load calculation to determine the sizing of the system?

Many installers size systems using general rules and their experience. If you are installing an air-source heat pump to serve as your primary or only source of heat, it is important that the system be well designed: a heat load calculation for your specific home is an important tool in selecting the right equipment.

Where will you mount the outdoor unit(s) and how? Will exterior piping be visible? If so, what type of covering will you use?

Make sure you understand and are comfortable with the location of the outdoor units. If there will be exterior piping on your house, installers have different options to cover it up so that it looks like a downspout.
QUESTIONS TO ASK YOUR INSTALLER (CONT.)

What type of indoor units do you recommend, where will they be located, and why?
Make sure you understand where the indoor units will be placed and whether this matches your goals for your heat pump project and how you use the space.

How will the controls and thermostat be set up?
Ask your installer to explain the thermostat and controls for your system. This is especially important if your installer is putting in integrated controls that operate your heat pump system and a backup heating source together. Additionally, many wall-mounted ductless units have the thermostat in the heat pump indoor unit; a separate thermostat installed at chest height would more accurately sense the temperature in the living space.

COST
What is the installation price and what incentives may be available? Who will apply for these incentives?
Make sure that you understand upfront who will apply for any incentives that you are pursuing and when you need to apply (before vs. after installation).
Aside from annual electricity costs, what other annual costs can I expect (such as regular maintenance or parts)?

MassCEC suggests that you have your heat pumps inspected and cleaned every one to two years. Ask if your contractor performs routine maintenance or if they have someone that they recommend.

TIMING

How far in advance can we plan the installation and how long does the installation take?

Be sure to communicate if you have particular time constraints and get a sense when your installer will be available to do the installation. Summer is the busiest time of the year for air-source heat pump installers and many installers have some delays during the summer season.

What should I do to prepare for the installation?

Make sure you understand from your installer if there is anything you need to do to prepare to have them working in your home.
QUALITY ASSURANCE

Do you provide a warranty for the systems you install? What are the different warranty options?

Make sure you understand what is covered by any warranty offered by your contractor (i.e., equipment, labor, or both).

Have you participated in manufacturer training for the systems you would install, and can you provide references from previous customers?

As with any home improvement project, it is important to ensure that your installer has the right training and a good track record with past customers.

Will you hire subcontractors to complete portions of the project? If so, what will they do?
What are the names of these companies and how long have you worked with them?

Many air-source heat pump installers sub-contract the electrical work. Some will even allow the homeowner to select their own electrician.
Will you provide training for me on how to properly operate and maintain the system (i.e., thermostat settings, cleaning air filters)?

Air-source heat pumps are relatively simple to operate, but there are a few differences compared to other heating systems, and your installer should be a good educational resource.
AIR-SOURCE HEAT PUMPS (ASHP)

Getting the Most From Your New System

OPERATION
• Air-source heat pumps work most efficiently when you keep your thermostat at a comfortable temperature consistently, even overnight and when you are at work or away for a day or two. Unlike fossil fuel heating, temperature setbacks are not recommended.

• Continue to use your heat pump in very cold weather. If you feel like your house is not getting enough heat, turn up the temperature on your thermostat and consider setting the air flow at the highest setting. Properly sized and installed cold-climate air-source heat pumps can heat homes when the outdoor temperature is well below zero.

• If you are using your existing heating system as a backup, use it only when needed. If you do not have integrated controls that automatically coordinate the operation of the two heating systems, turn the thermostat for your existing system down a few degrees lower than the usual setting to ensure that your air-source heat pumps are your primary heating source. If you feel that your heat pumps are not providing enough heat on very cold days, turn up the backup heat slightly.

• For more information, see NEEP’s guide on Getting The Most Out of Your Heat Pump

HOMEOWNER MAINTENANCE
• To keep your units operating efficiently, clean or replace indoor air filters every 1-6 months, depending on how dirty they are. Check out Insource Renewables’ video on how to clean your air filters. The primary filters can be washed in the sink or cleaned with a vacuum cleaner; some optional filters, like deodorization filters, may need replacing over time.

• Keep leaves, debris, snow, and ice away from the outdoor units.

• Trim back any plants or bushes that are encroaching on the heat pump.

• Make sure the airflow is unrestricted around both the outdoor and indoor units.

PROFESSIONAL MAINTENANCE
• Schedule a maintenance check with your air-source heat pump installer every 1-2 years (or at the installer’s recommended interval) to make sure that everything is running smoothly.

• Check on your system at least once per season to make sure there is no obvious damage, like mold, ice buildup, or indicator lights turned on. If there is damage to your heat pump, schedule a maintenance check with an installer to make sure your air-source heat pump is working properly.

• If doing home renovations after installing an air-source heat pump, be extra careful to make sure that equipment and refrigerant lines are not disturbed, which could cause a leak.
Ground-source heat pumps run on electricity and use the constant temperature of the ground to provide heating and cooling for your home.

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Ground-Source Heat Pumps are heating and cooling systems that transfer heat between the earth and your home. Ground-source heat pumps operate similarly to a refrigerator, but on a much larger scale. A refrigerator moves heat out of the refrigerator or freezer to an outside coil, which is warm to the touch due to the heat it has extracted. The GSHP uses a more sophisticated version of the same technology to pump heat from the ground into the house during heating, and from the house into the ground when cooling.

Ground-source heat pumps do not burn fossil fuels; they use electricity to run a compressor. Because they take advantage of the stable, underground temperature of the earth (about 50 degrees Fahrenheit in Massachusetts), ground-source heat pumps are the most efficient heating and cooling system available. They are much more efficient than electric resistance (electric baseboard), oil, propane, or natural gas heating. They also provide highly efficient air conditioning.

Most ground-source heat pump systems feature an underground loop of piping that circulates an anti-freeze fluid (a mixture of water and non-toxic propylene glycol or ethanol) between the ground and a central heat pump unit. The central heat pump is usually located in the basement or mechanical closet of a house. It includes a refrigerant loop with a compressor, reversing valve, expansion valve, and two heat exchangers. One heat exchanger transfers heat between the outdoor fluid and the refrigerant. The second heat exchanger transfers heat between the refrigerant and the indoor distribution system, which brings the heating and cooling to all the rooms. The indoor distribution system may consist of ducts for forced air, hydronic baseboards, or radiant floors. In addition to heating and cooling, some ground-source heat pumps can also provide domestic hot water.
In the winter, anti-freeze fluid pumped through the ground loop absorbs low-grade heat from the ground (1). At the ground loop/refrigerant heat exchanger, the anti-freeze fluid transfers its heat to an indoor refrigerant loop, without any mixing of the two substances (2). The warmed refrigerant flows to the compressor where it is pressurized, causing it to heat up further (3). The reversing valve (4) directs the hot refrigerant to the refrigerant/indoor distribution heat exchanger, where the heat is transferred to the air- or water-based distribution system that spreads the heating throughout the house (5). The refrigerant next passes through an expansion device (6), which makes it very cold. Because it is now colder than the temperature of the anti-freeze fluid in the ground loop, the refrigerant can again absorb heat from the ground loop to begin the cycle again (2).

TECHNOLOGIES FOR YOUR CLEAN ENERGY HOME: GROUND-SOURCE HEAT PUMPS
In the summer months, the process is reversed. Anti-freeze fluid from the ground loop (1) cools the refrigerant at the ground loop/refrigerant heat exchanger (2). The refrigerant then flows through the expansion valve (3), which makes it even colder. At the refrigerant/indoor distribution heat exchanger (4), this cold refrigerant absorbs heat from the air or hydronic distribution system, cooling the interior of the house. The compressor then concentrates the heat in the refrigerant (5), and the reversing valve (6) directs the hot refrigerant back to the ground loop/refrigerant heat exchanger (2), where the refrigerant easily releases the heat to the ground loop. The fluid in the ground loop is then cooled by the earth (1).

Ground-source heat pumps work very well in four-season climates like New England’s. You are not limited to the temperature of the ground and you do not need a supplemental fossil fuel system to keep your house comfortable year-round.
GROUND-SOURCE HEAT PUMP CONFIGURATIONS
The ground loops for ground-source heat pump systems can be installed in different configurations, depending on the amount of land available and whether there is a pond next to a home. The most common system type in Massachusetts is a closed-loop vertical system. The system circulates an anti-freeze mixture through pipes that extend around 500 feet into the ground within one or more boreholes that are at least 20 feet apart from each other.

The second most common type of ground-source heat pump in Massachusetts is an open loop system. This system exchanges water directly with an underground well. Ground water is returned to the well after passing through the heat pump.

Another ground-source heat pump configuration that is less common in Massachusetts due to space requirements is called a closed-loop horizontal system. Similar to the closed-loop vertical system, an anti-freeze solution is circulated through pipes that are laid out horizontally at a depth of about six or more feet underground. Horizontal loop systems require more yard space than vertical loop systems. Horizontal systems can cost less to install if the digging conditions are favorable. Closed-loop horizontal systems can be less efficient than vertical systems, due to the greater ground temperature fluctuations at shallower depths.

HOME IMPROVEMENT SCENARIONS THAT WORK WITH GROUND-SOURCE HEAT PUMPS:
• Existing home replacing heating or cooling system
• Existing home doing major renovations
• New home construction using ductwork or baseboard heaters
Ground-source heat pumps can be paired with either forced hot air or hydronic distribution systems to distribute heating or cooling throughout the home. With **forced hot air distribution**, the heat pump transfers heat to air that circulates through ductwork. With **hydronic heating distribution**, the heat pump transfers the heat to water that is circulated to baseboards or radiators. One reason ground-source heat pump systems are so efficient is that they deliver water at modest temperatures, approximately 110 to 120 degrees Fahrenheit, but this usually requires longer baseboards or larger radiators than those designed to work with traditional boilers. However, the old baseboards or radiators can often be replaced by heat-pump-compatible ones in the same locations.

Ground-source heat pump systems are compatible with zoning your house for heating and cooling. Depending on the size of a home, multiple heat pump units may be used to heat sections of a house (such as an entire floor or all of the bedrooms).

**DISTRIBUTION SYSTEMS THAT PAIR WELL WITH GROUND-SOURCE HEAT PUMPS**

- Forced-hot-air ductwork
- Baseboard radiators
Are Ground-Source Heat Pumps a Good Fit For My Home?

If you answer yes to ANY of the following questions, then GSHPs may be a good fit for your home.

☐ Do you want to reduce your home’s greenhouse gas emissions?
  GSHPs run on electricity instead of burning fossil fuels to heat and cool your home, reducing your home’s greenhouse gas emissions.

☐ Do you heat your home with oil, propane, or electric resistance?
  Ground-source heat pumps are the least expensive to operate of all the clean energy systems and the energy savings will be greatest.

☐ Do you have a enough yard space?
  You don’t need a huge yard to install a ground-source heat pump, but you will need enough room to fit a drill rig onto your property. Drill rigs are very large trucks; imagine a truck over sixteen feet long, six feet wide, and eight feet tall going into your front or back yard. Ground-source boreholes generally need to be at least 15 feet away from your home’s foundation and spaced 20 feet apart. The number of bore holes needed depends on the size and heating needs of a home. A typical 2,000 square foot home would require 2 bore holes. After drilling is complete, homeowners can landscape over the borehole area (or over the loop field, in the case of a horizontal system).

☐ Does your home have existing ductwork?
  GSHPs are easy to add to homes with existing ductwork, especially ductwork that is already sized to provide heating and cooling. Ground-source heat pumps can also use radiant floor heating or other hot water distribution if they are sized for low-temperature hot water. Other existing heating distribution systems (i.e., radiators and some hot water baseboards) may need to be retrofitted or replaced for compatibility with GSHPs. If you are installing new ductwork as part of your GSHP installation, the ductwork typically takes between 3 and 5 days to install.

☐ Do you have photovoltaic (PV) solar panels on your roof?
  GSHPs operate using electricity. If you already have PV panels on your roof, then you can use your existing solar panels to run your heat pump, decreasing or even eliminating your operating expenses. Because GSHPs are the most efficient heating and cooling option, their electricity needs can be met with fewer PV panels.

☐ Is your house weatherized (i.e., well-insulated and air-sealed)?
  Weatherized homes require less energy to heat, which will allow you to install a smaller GSHP system (less drilling!), reducing the cost of installing a GSHP system and lowering the operating cost.
Anastasia and Ezekiel Wheeler installed a ground-source heat pump system in 2019 to heat and cool their two-unit home and have been extremely pleased with the outcome. Before the installation, their 18th century home was heated by an oil burner with baseboard distribution. They have been enjoying the increased comfort from the ground-source heat pump.

“It’s definitely quieter,” Ezekiel stated, “The system circulates the air around which is nice as the air is a bit fresher, less stagnant, especially when you wake up in the morning. The house is a little drier”.

As part of the installation, the Wheelers had ductwork installed in their antique home. Although this was a challenging aspect of the project, the end result was excellent. Ezekiel calculated a break even point of 12-17 years for replacing his oil heat with a ground-source heat pump. This includes the cost of installing ductwork, which was one third of the project cost.

In addition to their heat pump, the Wheelers also installed solar PV on their roof and purchased an electric car, in their quest to become a fossil-fuel free household. Ezekiel is very motivated to reduce his impact on the planet and feels that “a sustainable future needs to be profitable, more fun and more comfortable, or there’s no chance of it getting done.” He is pleased to report “so far, so good” on all those fronts.
Achieve Renewable Energy Systems, LLC installed a ground-source heat pump system in a 2,890 square foot home in Winchester, Massachusetts. The house consists of the original home, constructed in 1937, and an addition, constructed in 2005. Prior to installing ground-source heat pumps, the house was heated by a fuel oil boiler supplying baseboards in the original home, and hydronic forced air in the addition; air-conditioning was installed only in the addition. The fuel oil use was very high with over 2,000 gallons consumed annually.

The homeowners primarily wanted to eliminate the use of fuel oil because of adverse health effects, but they were also interested in improving comfort, reducing operating costs, and reducing carbon emissions.

After conducting an energy audit that showed the house was poorly insulated and inefficient, Achieve increased insulation in the attics, walls, and basements prior to installation. The energy efficiency upgrades allowed Achieve to install a smaller system, lowering the project costs and operating expenses for the homeowners. The ground-source heat pump system consists of two heat pumps and two bore holes, each with a depth of 380 feet.

After the ground-source heat pump installation, fuel oil use was eliminated. The homeowners report a dramatic improvement in comfort, especially on cold days. This is a result of both the ground-source heat pump installation and the energy efficiency upgrades. The homeowners say that the ground-source heat pump is much quieter than their old heating system and the heating operating costs are noticeably lower. The homeowners averaged over $300 per month in energy savings during 2019.
GROUND-SOURCE HEAT PUMPS (GSHP)

Benefits of GSHPs

OPERATION
• Operating costs are typically lower than oil, propane, or electric resistance, and about the same as (or marginally higher than) natural gas heating
• Operates efficiently as a whole-building solution in cold climates, like Massachusetts

FLEXIBILITY & FUNCTION
• Provides both heating, cooling, and potentially hot water in a single, efficient system
• Most efficient heating and cooling system available
• Can use ductwork that is already installed in homes

COMFORT
• Consistent home temperature
• Compatible with zoned thermostats
• Quiet
• Safety
• No onsite fossil fuels

GREENHOUSE GAS EMISSIONS
• Lower greenhouse gas impact than fossil fuels
• Potential to have zero greenhouse gas impacts when paired with solar PV or 100% renewable electricity
GROUND-SOURCE HEAT PUMPS (GSHP)

Cost

ESTIMATED COST
The cost to install a ground-source heat pump in your home will depend on the specific characteristics of the building, the extent to which you are replacing the existing distribution system, the kind of system you choose, and your installer. Costs also depend on the drilling/trenching required and the level of modification needed to your existing heating and cooling distribution system. Generally, prices will range from $35,000 and up before the incentives are applied.

Homes that have less than 200-amp electrical service will incur additional costs for upgrading the electrical service to accommodate a ground-source heat pump system. You will also need to repair some landscaping after the drilling or trenching is complete. Keep in mind that heating operating costs (your monthly electric bill) for ground-source heat pumps tend to be substantially lower than the cost of oil or propane and about the same as natural gas. In the summer, electricity consumption by ground-source heat pumps is substantially lower than electricity consumption by traditional air conditioning systems. Ground-source heat pumps also require little to no maintenance and can last much longer than even their air-source counterparts.

Factors other than the upfront costs, such as increased comfort, greenhouse gas savings, and other benefits, should also be considered when evaluating a ground-source heat pump system. If your existing heating system is more than 10 years old, plan to replace it before it fails. The true cost to install a ground-source heat pump system is the difference between the full cost of installing a ground-source heat pump system compared with what you would have spent on a new boiler or furnace PLUS the cost of a central air conditioning system, since the GSHP provides both heating and cooling.

INCENTIVES
Incentives are available to homeowners in Massachusetts wishing to upgrade their heating and cooling system to a ground-source heat pump. Incentives depend on the kind of system installed, the system size, and your electric provider.
INCENTIVES

• **Federal Investment Tax Credit**: 26% of the installed cost of the system may be claimed as a tax credit on your 2020 personal income tax return. This amount drops to 22% for systems installed in 2021 and is set to expire at the end of 2021. See the IRS website and/or consult your tax advisor to confirm eligibility. Note that the Internal Revenue Service refers to ground-source heat pumps as “geothermal” heat pumps.

• **Massachusetts Sales Tax Exemption**: Ground-source heat pump systems are exempt from the 6.25% Massachusetts sales tax.

• **Massachusetts Alternative Energy Certificates (AECs)**: AECs (worth approximately $3-12 each) are provided to homeowners who install qualified ground-source heat pumps, depending on the square footage of the home and the level of home efficiency. Homeowners apply for AEC credits after installation. A typical 2,000 square foot home system could receive around 300 AECs worth approximately $900-$3,600. See the Department of Energy Resources (DOER) website for more information on AECs. *Please note that the price of AEC credits is subject to market demand and that the price listed here may be different than the current market price.*

FINANCING

• **Mass Save® HEAT Loan**: If you are located in Mass Save® territory, then eligible ground-source heat pumps can be financed through the Mass Save® HEAT Loan, which offers loans of up to $25,000 at 0% interest over terms of up to 7 years. If you are unsure whether you are eligible for Mass Save® incentives, check on the [Mass Save® website](#).

• If you are not eligible for Mass Save® incentives, check with your local municipal electricity provider to see if they have any financing options available for clean energy systems.
GROUND-SOURCE HEAT PUMPS (GSHP)
Efficiency First

Taking steps to air-seal and insulate your home will ensure that it is ready for your new ground-source heat pump system and will help reduce overall energy consumption. A tighter, more insulated home will not only save you money on operating costs and reduce your carbon emissions throughout the year, it may also allow you to buy smaller, less expensive equipment in the first place.

There are a few ways to increase your home’s efficiency and reduce its heating and cooling load.

- **Air sealing:** Ensuring there are as few gaps as possible for indoor air to escape and outdoor air to get in reduces the heating and cooling load in a home. Air leakage can represent up to 40% of space-conditioning costs in a leaky building. Weatherization professionals will focus on sealing leaks hidden in the attic, garage, or between floors. Air sealing often involves re-sealing windows, replacing broken or jammed vents, and replacing the rubber seals around door frames. Experienced professionals will know the common culprits of air leakage to target, but a professional assessment of hidden leaks using a blower door to pressure-test the house is the best way to find leaks in your house.

- **Insulation:** Working with a professional contractor to improve roof and wall insulation can considerably lower heat transfer, improving your home’s efficiency. Many insulation contractors are trained to air seal before insulating, when it’s much easier to do.

- **Duct Upgrades:** If your home utilizes a centralized heating or cooling unit with ducts outside of the conditioned space of the home (i.e., in an attic, basement, garage, or crawlspace), sealing and insulating the ducts can significantly improve the overall efficiency of your system by ensuring that more of the heated or cooled air gets delivered to where it is needed.

Mass Save® or your gas or electricity provider may provide a no-cost assessment to identify efficiency opportunities for your home and incentives to help pay for the upfront cost of insulating and air-sealing.
1. Confirm that ground-source heat pumps are the best fit for your home and your home energy priorities.

2. Understand the costs and plan how you will finance the project. Check out the Cost and Incentives & Financing sections to understand the typical costs to install ground-source heat pumps.

3. Contact installers. MassCEC recommends contacting at least three installers to learn more about installing ground-source heat pumps at your property. Visit our Find an Installer Near You page for a list. Referrals from family, friends, or neighbors is another great way to find an installer.

4. Prepare your home. If necessary, take preliminary measures to get your home ready for a new heating system, such as upgrading your electrical service or completing any weatherization work recommended in your home energy assessment, like sealing air leaks or installing insulation. If you are planning to improve the weatherization of your home, make sure your installer is aware so that they take the reduced heating and cooling needs of your home into account when designing your ground-source heat pump system.

5. Install ground-source heat pumps. Talk to your installer about how long installation will take. Ground-source heat pump installations typically take between 2 to 4 weeks, depending on home size, system complexity, and schedules of the driller and installer.
GROUND-SOURCE HEAT PUMPS (GSHP)

How Can I Prepare for a Ground-Source Heat Pump Installation?

Does your home have adequate electrical service for a GSHP system?

How many amps of electrical service does your home have? If your home has less than 200 amp electrical service, talk to a GSHP installer about whether you may need to upgrade your electrical service to accommodate a GSHP system. Check out this site for instructions on how to determine the amperage of your home's electric service. This Old House also has a helpful video that shows what an electrician will do to upgrade your electric meter and panel. Upgrading your home's electrical service is a good investment if you might install an electric vehicle charger or other new electrical appliances in the future. This upgrade typically takes one day to complete, and usually cost around $2,000 to $3,000, which may include fees and permitting from your local permitting agency. This upgrade requires a licensed electrician who will coordinate with your electric utility and your local permitting agency.

Locate property plans and share them with an installer.

Many towns have codes regarding how close the GSHP wells can be to your septic system, existing drinking water wells, and the property line. If you have a plot plan or blueprints of your property, share them with your installer so they can make sure that your yard has adequate space for a drill rig or a horizontal GSHP system that complies with all local regulations and codes.

Delay new landscaping until after your GSHP is installed.

The installation of a GSHP system will disrupt your yard, whether you a drilling bore holes for a vertical loop or excavating for a horizontal loop. Grass, plantings, and walkways may be affected. The yard will need to be refinished after the holes are dug, so it is best to save major landscaping projects until after GSHP installation. Once the ground loops are installed you can landscape, pave, or place a patio directly over the drill site!

Weatherize your home!

It's important to weatherize your home before installing a GSHP system. GSHPs operate best in well-insulated and air-sealed homes with efficient windows. Get a home energy assessment and implement the recommended weatherization measures. Make sure to tell your installer about any weatherization measures that you have done or are planning, so that they can size your GSHP system appropriately.
During your conversation with installers, consider asking the following questions:

**CONFIGURATION**
Did you perform a heat load calculation to determine the sizing of the system?

Many installers size systems using general rules and their experience. If you are installing a ground-source heat pump, it is important that the system is well designed, and a heat load calculation for your specific home is an important tool in selecting the right equipment.

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**What loop type system do you recommend and why?**

Make sure you understand what type of loop system (closed or open loop and vertical or horizontal loop) your installer recommends and how much of your yard will need to be re-done after the installation is complete.

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**COST**
What is the installation price and what incentives may be available? Who will apply for these incentives?

Make sure that you understand upfront who will apply for any incentives that you are pursuing and when you need to apply for these incentives (before or after installation).
Aside from annual fuel or electricity costs, what other annual costs can I expect (such as regular maintenance or parts)?
MassCEC suggests that you have your heat pumps inspected every one to two years. Ask if your contractor performs routine maintenance or if they have someone that they recommend.

TIMING
How far in advance can we plan the installation and how long does the installation take?
Be sure to communicate if you have particular time constraints and get a sense when your installer will be available to do the installation. Summer is the busiest time of the year for ground-source heat pump installers and many installers have some delays during the summer season.

What should I do to prepare for the installation?
Make sure you understand from your installer if there is anything you need to do to prepare to have them working in your home and yard.

QUALITY ASSURANCE
Do you provide a service agreement and/or warranty for the systems you install? What are the different options?
Make sure you understand what is covered by any service agreement or warranty offered by your contractor. Some warranties cover labor, some cover the equipment, and some cover both.
QUESTIONS TO ASK YOUR INSTALLER (CONT.)

Have you participated in manufacturer training for the systems you would install, and can you provide references from previous customers?
As with any home improvement project, it is important to ensure that your installer has the right training and a good track record with past customers.

Will you hire subcontractors to complete portions of the project? If so, what will they do? What are the names of these companies and how long have you worked with them?
Many ground-source heat pumps installers sub-contract the electrical work. Some will even allow the homeowner to select their own electrician.

Will you provide training for me on how to properly operate and maintain the system (i.e., how to set the thermostat)?
Ground-source heat pumps are relatively simple to operate, but there are a few differences compared to other heating systems, and your installer should be a good educational resource.
GROUND-SOURCE HEAT PUMPS (GSHP)

Getting the Most From Your New System

OPERATION

• Ground-source heat pumps work most efficiently when you set your thermostat at a comfortable consistent temperature even when at work or away for the weekend.

PROFESSIONAL MAINTENANCE

• Schedule an annual to bi-annual maintenance check with your ground-source heat pump installer to make sure that everything is running smoothly.
Automated wood heating is a heating system that burns locally sourced, sustainable wood pellets instead of fossil fuels.

**AUTOMATED WOOD HEATING: Four Reasons to Switch**

1. **LOWER GREENHOUSE GAS EMISSIONS**
2. **SAVE ON ENERGY BILLS**
3. **BUY LOCAL**
4. **NO HASSLE**

Automated wood heating is a heating system that burns locally sourced, sustainable wood pellets instead of fossil fuels.

Clean Energy Lives Here
MASSCEC.COM/GOCLEAN
Automated Wood Heating is a heating system that burns locally sourced, sustainable wood pellets instead of fossil fuels. An automated wood heating system works just like a gas/oil boiler or furnace except that it burns wood instead of fossil fuels. Unlike traditional wood stoves or boilers, these heating systems are automated and don’t need to be manually loaded or cleaned. Automated wood heating systems can use the existing pipe or ducts in your home and require minimal homeowner interaction besides emptying a small ash bin a few times a year.

Automated wood heating systems feature a central wood boiler or furnace, usually in the basement or mechanical room of a house, a thermal storage tank (i.e., hot water tank) for homes with boilers, located next to the boiler; and a bulk pellet storage bin, usually in the basement or garage of a house, although pellet storage can also be located outdoors. In the winter, wood pellets are delivered directly to your home by a truck similar to an oil or propane fuel truck. The pellets are conveyed from the truck to your storage bin by a hose connection, typically located on the side of the house. The storage bin automatically feeds pellets into the boiler or furnace. As the pellets burn, the energy they produce is used to heat your home and domestic hot water. Thermal storage tanks store hot water, so that the boiler does not need to turn on every time the home needs heat or hot water, which increases the efficiency of the system.
EXISTING SYSTEMS THAT PAIR WELL WITH AUTOMATED WOOD HEATING SYSTEMS:

- Forced hot water baseboard or radiator
- Ductwork

HOME IMPROVEMENT SCENARIOS THAT WORK WITH AUTOMATED WOOD HEATING SYSTEMS:

- Existing home replacing heating or hot water systems
- Existing home doing major renovations
- New home construction
AUTOMATED WOOD HEATING (AWH)

Is Automated Wood Heating a Good Fit for My Home?

If you answer yes to **ANY** of the following questions, then automated wood heating may be a good fit for your home.

☐ Do you want to reduce your home’s greenhouse gas emissions?
  **AWH systems burn sustainably grown wood instead of burning fossil fuels to heat your home reducing your home’s greenhouse gas emissions.**

☐ Do you have a place to store the fuel?
  **Automated wood heating systems need sufficient space for a bulk storage bin that can hold as much as five tons of wood pellets. A small (3 ton) pellet bin typically takes up 4.5 ft. by 6 ft., while a larger pellet bin (5 ton) takes up 10 ft. by 10 ft. Bulk storage bins are typically at least 6 ft. tall. If you do not have a basement or you do not have adequate space in your basement, you can also put these storage bins in crawl spaces, an outdoor storage shed or silo, or a garage. Vacuum lines up to 80 feet will then be run to the house to transport the pellets to the boiler.**

☐ Do you have an oil or propane hot water boiler or furnace?
  **With today’s energy prices, heating your home with an AWH system instead of oil or propane will lower your heating operating expenses. Plus, AWH systems can easily be incorporated into your current heating distribution and completely replace your current method of heating.**
  **Wood pellets are a low carbon alternative to more carbon intensive fossil fuels such as oil or propane.**

☐ Are you interested in supporting the regional economy?
  **Wood pellets and chips for automated wood heating systems come from byproducts of sustainably managed Northeastern forests, keeping more of your dollars in the regional economy.**

☐ Do you also need a heating solution for your domestic hot water?
  **Automated wood heating systems can also heat your hot water. You may be surprised by how much energy is consumed producing hot water and the savings can add up over a year.**
Ted Wright recently added an automated wood heating system and solar hot water to his home in Montgomery, MA, with the help of MassCEC rebates and has been extremely happy with the result.

Ted uses his new fully automated pellet boiler to provide space heating for his home and as back-up hot water heater for his solar hot water system in the winter. During the installation, he disposed of his old oil-fired system and his old wood furnace that was highly-polluting and non-EPA certified.

Ted decided to add a solar hot water heater to minimize the consumption of pellets during the warmer season. He has found that the pellet boiler and solar hot water system work well together to heat his hot water and home comfortably.

“I wanted to install a system that would be cleaner and more efficient than our existing combination of oil-fired boiler and supplemental wood-fired boiler,” Ted stated.

He also wanted a more automated system, because he didn’t want to worry about cutting, splitting, and manually feeding the wood fired boiler in the future. Ted has found the pellet system is very easy to maintain and generates far fewer ashes than his old wood system. He also likes how it can function without any backup heat, and therefore replaced both his old wood and oil boilers.
Winchester resident Wyatt Biel installed an automated wood heating system with the help of a rebate from MassCEC and has been extremely pleased with the results.

Prior to switching to a pellet boiler, his home was heated by oil. Wyatt shared that he wishes he had made the transition to automated wood heating sooner.

“The pellet boiler has operated flawlessly since installation,” Wyatt stated. “Receiving delivery of pellets is effortless.”

He has found that the boiler has exceeded his expectations for meeting his heating needs, and he appreciates how the system moderates fuel input and energy output so adaptively. He feels that heating with wood pellet boilers is still underutilized in the U.S.
AUTOMATED WOOD HEATING (AWH)

Benefits of AWH

FLEXIBILITY & FUNCTION
• Homeowners can use existing heating distribution systems, such as ducts or radiators
• Systems can provide both space heating and domestic hot water
• Systems are fully automated; homeowners only need to set their thermostats and the boiler or furnace will regulate itself
• No chopping wood or feeding logs; homeowners only need to empty a small ash bin a few times a year

GREENHOUSE GAS EMISSIONS
• Lower greenhouse gas impact than fossil fuels by using pellets derived from sustainably harvested or scrap/waste wood

SUPPORT LOCAL ECONOMY
• Heating expenditures stay in the local economy and support the local forestry industry, thereby helping to keep forest land economically viable
INCENTIVES
There are incentives available to homeowners in Massachusetts wishing to upgrade their heating system to an automated wood heating system. Incentives depend on the kind of system installed and the cost of the system. Depending on your electric provider, you may be eligible for different incentive programs.

- **Massachusetts Alternative Energy Certificates (AECs):** AECs (worth approximately $3-12 each) are provided to homeowners who install qualified automated wood heating systems every quarter, depending on the number of tons of pellets used. Homeowners apply for AEC credits after installation. A typical 2,000 square foot home will use 4-6 tons of pellets per year, which translates to quarterly payments that could be worth $60-250 annually. See the [Department of Energy Resources (DOER) website](https://www.mass.gov) for more information on AECs.

*Please note that the price of AEC credits is subject to market demand and that the price listed here may be different than the current market price.*

FINANCING
- **Mass Save® HEAT Loan:** If you are located in Mass Save® territory, then eligible automated wood heating systems can be financed through the Mass Save® HEAT Loan, which offers loans of up to $25,000 at 0% interest over terms of up to 7 years. If unsure whether you are eligible for Mass Save® incentives, check on the [Mass Save® website](https://www.masssave.com).

If you are not eligible for Mass Save® incentives, check with your local municipal electricity provider to see if they have any financing options available for clean energy systems.

ESTIMATED COST
The cost to install an automated wood heating system in your home will depend on the specifications of the building, the extent to which you are replacing your existing system, and your installer. Costs also depend on the size of the system, size of storage bins, and modifications to the distribution system required for installation. Automated wood heating systems costs typically start around $26,000 before incentives.

If your existing heating system is more than 10 years old, consider replacing it before it fails. The true cost to install an automated wood heating system is the difference in cost between replacing your existing boiler or furnace with an in-kind replacement versus the cost of installing an automated wood heating system.

TECHNOLOGIES FOR YOUR CLEAN ENERGY HOME: AUTOMATED WOOD HEATING
Efficiency First

Taking steps to air-seal and insulate your home will ensure that it is ready for your new automated wood heat system and will help reduce overall energy consumption. A tighter, more insulated home will not only save you money on operating costs and reduce your carbon emissions throughout the year, it may also allow you to buy smaller, less expensive equipment in the first place.

There are a few ways to increase your home’s efficiency and reduce its heating and cooling load.

• **Air sealing:** Ensuring there are as few gaps as possible for indoor air to escape and outdoor air to get in reduces the heating and cooling load in a home. Air leakage can represent up to 40% of space-conditioning costs in a leaky building. Weatherization professionals will focus on sealing leaks hidden in the attic, garage, or between floors. Air sealing often involves re-sealing windows, replacing broken or jammed vents, and replacing the rubber seals around door frames. Experienced professionals will know the common culprits of air leakage to target, but a professional assessment of hidden leaks using a blower door to pressure-test the house is the best way to find leaks in your house.

• **Insulation:** Adding insulation slows heat transfer through the building envelope (i.e., walls, roof, floors); heat transfer is the leading cause of heat loss in the winter. Working with a professional contractor to improve roof, wall, and floor insulation can considerably lower heat transfer, improving your home’s efficiency. Many insulation contractors are trained to air-seal before insulating, when it’s much easier to do.

• **Duct Upgrades:** If your home utilizes a centralized heating or cooling unit with ducts outside of the conditioned space of the home (i.e., in an attic, basement, garage, or crawlspace), sealing and insulating the ducts can significantly improve the overall efficiency of your system by ensuring that more of the heated or cooled air gets delivered to where it is needed.

• **Programmable Thermostat:** Using a programmable thermostat allows you to automatically raise and lower your home’s temperature to accommodate your schedule. A programmable thermostat allows you to automatically turn down your heating system for the times when you’re away and turn it up for you to come back to a warm home.

Mass Save® or your gas or electricity provider may provide a no-cost assessment to identify efficiency opportunities for your home and incentives to help pay for the upfront cost of insulating and air-sealing.
1. Confirm that automated wood heating is the best fit for your home and your home clean energy priorities.

2. Understand the costs and plan how you will finance the project. Check out the Cost, Incentives, & Financing section to understand the typical costs to install an automated wood heating system.

3. Contact installers. MassCEC recommends contacting at least three installers to learn more about installing an automated wood heating system in your home. Visit our Find An Installer Near You page for installers. Referrals from family, friends, or neighbors is another great way to find an installer.

4. Prepare your home. If necessary, take preliminary measures to get your home ready for a new heating system, such as completing any weatherization work recommended in your home energy assessment like sealing air leaks or installing insulation. If you are planning to improve the weatherization of your home, make sure your installer is aware so that they take the reduced heating needs of your home into account when designing your automated wood heating system.

5. Install automated wood heating system. Talk to your installer about how long installation will take. Automated wood heating systems installations typically take between 3 days and 2 weeks, depending on home size and system complexity.
Plan for where you would store the pellet or wood chips.

Think about where you would put a pellet storage bin. While the width and depth of a bin vary on the volume of pellets it can hold, height is also important. Most storage bins will be a minimum of six feet high. Storage bins are typically put in the basement of a home, but can also be in a storage shed, crawl space, or garage. A small storage bin is 4.5 ft. by 6 ft., while a larger storage bin will be 10 ft. by 10 ft.

Pellet storage bins can also be custom built to fit a particular space, which can be a good option if the available space is irregularly shaped.

Collect your fuel bills from the last two to three years (if they’re available).

Your current fuel usage and cost is a great way to determine the savings you’ll get by switching to an AWH system.

Current fuel usage can also help installers size an AWH system for the needs of your home.

Weatherize your home!

It’s important to weatherize your home before installing an AWH system. AWH systems operate best in well-insulated and air-sealed homes with efficient windows. Get a home energy assessment and implement the recommended weatherization measures. Make sure to tell your installer about any weatherization measures that you have done or are planning, so that they can size your system appropriately.
During your conversation with installers, consider asking the following questions:

**CONFIGURATION**
**Did you perform a heat load calculation to determine the size of the system?**
Many installers size systems using general rules and their experience. If you are installing an automated wood heating system, it is important that the system is well designed, and a heat load calculation for your specific home is an important tool in selecting the right equipment.

**Where do you recommend placing the boiler, thermal storage tank, and bulk pellet storage?**
Make sure you understand and are comfortable with the location of the boiler, thermal storage tank, and bulk pellet storage. The bulk pellet storage should be located in an area that gets natural air circulation like a basement.

**COST**
**What is the installation price and what incentives may be available? Who will apply for these incentives?**
Make sure that you understand upfront who will apply for any incentives that you are pursuing and when you need to apply (before or after installation).
What is the expected price of wood pellets?
Your installer should be able to provide you with the current price of wood pellets from a supplier that serves your area. You can also reach out to other suppliers. The Department of Energy Resources surveys the market to estimate the average price of wood pellets each heating season.

Aside from annual fuel costs, what annual costs can I expect (such as regular maintenance or parts)?
MassCEC suggests that you have your automated wood heating system inspected every one to two years. Ask if your contractor performs routine maintenance or if they have another company that they recommend.

TIMING
How far in advance can we plan the installation and how long does the installation take?
Be sure to communicate if you have particular time constraints and get a sense when your installer will be available to do the installation. Summer is the busiest time of the year for automated wood heating installers and many installers have some delays during the summer season.

What should I do to prepare for the installation?
Make sure you understand from your installer if there is anything you need to do to prepare to have them working in your home.
QUALITY ASSURANCE

Do you provide a warranty for the systems you install? What are the different warranty options?

Make sure you have a sense of what is covered by any warranty offered by your contractor. Some warranties cover labor, some cover the equipment, and some cover both.

Have you participated in manufacturer training for the systems you would install, and can you provide references from previous customers?

As with any home improvement project, it is important to ensure that your installer has the right training and a good track record with past customers.

Will you hire subcontractors to complete portions of the project? If so, what will they do? What are the names of these companies and how long have you worked with them?

Some automated wood heating installers may sub-contract part of the installation work.

Will you provide training for me on how to properly operate and maintain the system (i.e., how to set the thermostat to how often to empty the ash bin)?

Automated wood heating systems are relatively simple to operate, but there are a few differences compared to other heating systems, and your installer should be a good educational resource.
OPERATION
• Most automated wood heating systems will alert you when pellets are running low in your bulk pellet storage bin. Once you receive a notification, schedule a bulk pellet delivery. During this delivery, the pellets will be run through a tube into your bulk pellet storage. Homeowners will need pellets to be delivered every 3-4 months, depending on heating needs and the size of your home.

PROFESSIONAL MAINTENANCE
• Schedule an annual maintenance check with your automated wood heating system installer to make sure that everything is running smoothly.

HOMEOWNER MAINTENANCE
• Empty the ash bin in your boiler every two to three months. During the winter months, you may need to empty your ash bin more frequently depending on the heating needs and size of your home.
SOLAR HOT WATER: Four Reasons to Switch

1. LOWER GREENHOUSE GAS EMISSIONS
2. COST COMPETITIVE
3. LESS EXPENSIVE SOLAR
4. VERSATILE

Solar hot water is a hot water system that uses energy from the sun to heat your home’s water.

Clean Energy Lives Here
MASSCEC.COM/GOCLEAN
Solar Hot Water is a hot water system that uses energy from the sun to heat your home’s water. Solar collectors, mounted on the roof or ground next to a home, absorb heat from the sun and transfer it through a fluid loop into a solar storage tank (typically located in the basement or mechanical room) that stores preheated water. This heated water is then piped throughout the home to showers, dishwashers, sinks, and washing machines. Solar hot water systems can also be used for pool heating and for space heating.

Due to Massachusetts’ location, collectors work most efficiently when they are oriented as close to due south as possible and tilted around 40 degrees to the horizon. Collectors should receive at least 5 hours of unobstructed sunlight each day and be at least 75% shade free.

Solar hot water systems are typically sized to provide up to 80% of a home’s annual domestic hot water needs. Since the sun is stronger in the summer, the solar hot water system can provide all of a home’s domestic hot water needs during that season. In the winter, when the days are shorter, a backup heat source (often an electric resistance heating element) is used to provide additional hot water to meet 100% of a home’s hot water needs.
There are two main types of solar hot water collectors. **Glazed flat plate collectors** are collectors that look similar to solar photovoltaic (electricity) collectors. They have a clear glass or plastic casing over the collector which traps heat like a greenhouse. Flat plate collectors can operate at a wide range of temperatures. **Evaporated tube collectors** are collectors with thin, copper tubes filled with fluid. This fluid is inside larger vacuum-sealed clear glass or plastic tubes. Evaporated tube collectors typically perform better during the winter than flat plate collectors, but they are not as efficient at all temperatures.

**HOME IMPROVEMENT SCENARIOS THAT WORK WITH SOLAR HOT WATER SYSTEMS:**

- Existing home replacing hot water system
- Existing home replacing heating system that also heats hot water
- Existing home doing major renovations
- New home construction

Flat Plate Collector System  Evacuated Tube Collector System
If you answer yes to ANY of the following questions, then solar hot water may be a good fit for your home.

☐ Do you want to reduce your home’s greenhouse gas emissions?

SHW systems use heat from the sun, instead of burning fossil fuels, to heat your hot water, reducing your home’s greenhouse gas emissions.

☐ Are you looking to just replace your hot water tank? Or are you planning to replace a combination boiler and need a standalone solution for domestic hot water?

A solar hot water system can replace your existing system in either case. If your existing hot water tank is causing problems, reach out to a solar hot water installer; they can install a solar-ready tank for you now and install the rest of the system later.

☐ Do you have a suitable location for solar hot water collectors on your roof or in your yard?

Solar hot water collectors are most efficient when facing due south in Massachusetts, but as long as your roof faces less than 90° east or west of true south, you may have a viable site for solar hot water. At Massachusetts’ latitude, the ideal tilt should be about a 40-degree angle to the horizon and collectors should receive at least 5 hours of unobstructed sunlight per day. Installers may be able to tilt collectors up or mount the collectors at an angle on your wall (also called an awning mount) to receive more sunlight. Systems can also be mounted on the ground.

☐ Is your existing hot water tank over 10 years old or reaching the end of its useful life? Have you had maintenance issues and are you concerned about it failing?

If your existing hot water tank is reaching the end of its useful life, reach out to a solar hot water installer today and they can install a solar-ready tank for you now and complete the rest of the system later.

Other Hot Water Options:

If solar hot water is not right for you, there are other hot water options to consider.

Heat pump water heaters, which use a highly efficient heat pump to heat your water, are an excellent option to pair with solar hot water or if solar hot water is not an option.

For more information on heat pump water heaters visit the Department of Energy’s (DOE) website.

Heat pump water heaters use electricity to move heat from one place to another, similar to air-source heat pumps, drawing heat from an indoor space like a basement and moving it into a hot water tank. Heat pump water heaters cool the spaces they are in and do not work as efficiently in a cold space. To operate efficiently, they work best if installed in locations that stay at least 40°F year round. Spaces with excess heat, like a furnace or boiler room, are ideal locations. Additionally, heat pump water heaters require adequate air flow and it is recommended that they be located in a space that is at least 1000 cubic feet with unrestricted airflow.
Case Studies

Along with fifty-eight other residents of his community, Tom Ehbrech recently installed Solar Hot Water in his home in Arlington, MA, through HeatSmart Arlington/Winchester. He has been very pleased with the system so far.

“Financially I think it’s a winner. Partly because the lifetime warranty of the tank pays for itself, and partly because of the free energy,” Tom stated.

One thing he thinks is great about solar hot water panels is that they get a lot of energy from the sun on bright cloudy days or when the sun is not shining directly on the panels, even in the winter. Tom advises homeowners considering installing solar hot water to plan where they want the tank to go ahead of time. He also suggests that if homeowners are considering adding solar PV as well, the installations should be coordinated for efficiency.

Mary Johnson of Ashfield had her automated wood heating system installed in May 2019 and a solar hot water system completed in June 2019. “I am so very happy with them,” Mary says of her new clean energy systems. “More than I could have imagined.” Her previous antiquated oil system – installed in the 1970s – frequently broke down and proved to be inefficient even after multiple repairs each season. Similarly, the house’s oil hot water system was faulty and did not fulfill her family’s domestic hot water needs. The wood boiler and the solar hot water system are connected so that the automated wood heating system can serve as a backup for hot water. During the summer season, the wood system remains inactive since the Johnsons’ hot water needs are solely provided by the sun. The automated wood boiler provides warmth in the autumn, winter, and spring as the primary source of heating in the home. Mary is impressed with the silence and efficiency of both the solar hot water system and biomass boiler.

With her rebate awards from MassCEC, Mary’s total monthly loan payments for both brand-new systems and wood fuel turned out to be less than the cost of her previous monthly heat and hot water bills. As the Director of Green America’s Carbon Farming Innovation Network, Mary is passionate about contributing to climate change solutions, and feels relieved that her home no longer relies on fossil fuels for heating and domestic hot water. She plans to go all electric with solar panels and an electric vehicle to cover her family’s electric usage and transportation.
SOLAR HOT WATER (SHW)

Benefits of SHW

COST COMPETITIVE
- With strong state and federal incentives, solar hot water systems are not that much more expensive than typical hot water heating systems to install
- Energy from the sun is free! Operating costs are lower than heating hot water with natural gas, oil, propane, or electric resistance
- Since solar hot water systems use energy from the sun to heat your hot water, you do not need to worry about market changes to natural gas, oil, propane, or electric prices

FLEXIBILITY & FUNCTION
- Solar hot water systems can integrate with any type of backup fuel
- Robust tanks and hardware are built to last 20 years or more
- Requires less space than a solar photovoltaic (PV) system, so it can be an option for homeowners who want to go solar but do not have enough space for solar PV

GREENHOUSE GAS EMISSIONS:
- Renewable energy minimizes the greenhouse gas impact of your home’s hot water
Cost, Incentives, & Financing

**ESTIMATED COST**
The cost to install a solar hot water system in your home will depend on the specifications of your home, the extent to which you are replacing your existing hot water system, the kind of system you choose, and your installer. Costs also depend on the number of collectors and size of thermal storage tanks installed. Solar hot water systems costs typically start around $10,000 before incentives are applied or around $4,500 after incentives.

**INCENTIVES**
There are several incentives available to homeowners in Massachusetts wishing to upgrade their hot water system to solar hot water. Incentives depend on the kind of system installed and the size of the system. Depending on your electric provider, you may be eligible for different incentive programs.

- **Federal Investment Tax Credit:** For systems installed in 2020, 26% of the installed cost of the system may be claimed as a tax credit on your personal income tax return. This amount drops to 22% for systems installed in 2021 and expires after 2021. See the IRS website and/or consult your tax advisor to confirm eligibility.

- **MassCEC Clean Heating and Cooling Program:** Offers rebates up to $2,500 or $4,500, depending on income eligibility. Rebate amounts are based on the number of collectors installed and performance ratings of collectors. To be eligible for MassCEC a rebate, homeowners’ electrical service provider must be Eversource, National Grid, Unitil, or one of the municipal electricity providers that contribute to the Renewable Energy Trust. [Click here](#) for a list of participating municipal electricity providers.

- **Massachusetts Alternative Energy Certificates (AECs):** AECs (worth approximately $3-12 each) are provided to homeowners installing qualified solar hot water systems depending on the number of solar collectors installed, the performance ratings of the system, and site-specific conditions such as shading and orientation. Homeowners apply for AEC credits after their solar hot water system is installed. A two-collector system could receive approximately 100 AECs totaling $300-$1,200. See the [Department of Energy Resources (DOER) website](#) for more information on AECs.

**FINANCING**

- **Mass Save®:** If you are located in Mass Save® territory, then eligible solar hot water systems can be financed through the [Mass Save® HEAT Loan](#), which offers loans of up to $25,000 at 0% interest over terms of up to 7 years. If unsure whether you are eligible for Mass Save® incentives, check zip code eligibility on the [Mass Save® website](#).

- If you are not eligible for Mass Save® incentives, check with your local municipal electricity provider to see if they have any financing options available for clean energy systems.

*Please note that the price of AEC credits is subject to market demand and that the price listed here may be different than the current market price.*
1. Confirm that solar hot water is the best fit for your home and your home clean energy priorities.

2. Understand the costs and plan how you will finance the project. Check out the Cost, Incentives, & Financing section to understand the typical costs to install solar hot water.

3. Contact installers. MassCEC recommends contacting at least three installers to learn more about installing solar hot water in your home. Visit our Find An Installer Near You page for a list of installers. Referrals from family, friends, or neighbors is another great way to find an installer.

4. Install a solar hot water system. Talk to your installer about how long installation will take. Solar hot water installations typically take 3 days to 1 week, depending on the number of collectors installed, system complexity, and installer and plumber scheduling.
Think about where you will place your solar hot water collectors.
Collectors should receive at least five hours of unobstructed sunlight per day, so look for a location that faces as close to south as possible (up to 90 degrees east or west of true south may still be viable) and think about trees or other buildings that might shade the collector. An installer can measure the site and accurately predict a system's production.

Most residential solar hot water systems use two or three collectors. This takes up 50-100 square feet of roof space, depending on the collectors used.

For ground-mounted systems, consider the space where the collectors will be mounted. Trenching, property line set back, sewage lines, and distance to your house should all be considered when planning a ground-mounted system.

If you’re planning to install the collectors on your roof, talk to your installer about the suitability of your roof.

If planning to install the solar hot water collectors on your roof, evaluate the condition of your roof before installing a solar hot water system. If your roof is over 10 years old, talk to a solar hot water installer about whether they would recommend roof replacement prior to installation to avoid additional costs of removing and re-installing a solar hot water system at a later date. The additional weight load that solar hot water panels will put on your roof is generally not a barrier to a residential solar hot water project, however, the roof structure must comply with current building code standards. The added load for solar hot water collectors is less than 5 pounds per square foot (similar to solar photovoltaic panels). If necessary, reinforcements can be added to the roof to support the collectors.

Think about where you will locate the solar hot water tank.
Depending on your current hot water system, you will need to replace your existing hot water tank with a solar compatible tank or add a new solar tank that connects to your existing hot water tank. Solar tanks are usually about 24 inches in diameter and 6 feet high. A foot or two of space should be reserved in front of the tank for equipment that will protrude from the tank, so allow for about 3 feet by 3 feet for solar hot water components or 5 feet by 5 feet if connecting to an existing system.
During your conversation with installers, consider asking the following questions:

**CONFIGURATION**

*How many collectors are needed for my home and why?*

Make sure you understand how your installer determined the number and size of collectors needed for your home. Most installers base the number of collectors on the number of bedrooms or people living in a home.

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**Will my system include remote monitoring?**

Many solar hot water systems are installed with internet-connected monitoring. This allows the homeowners and the installers to monitor performance of the system and identify any issues early. Talk to your installer about whether this is a good option for you.

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**COST**

*What is the installation price and what incentives are be available?*

Make sure that you understand upfront who will apply for any incentives that you are pursuing and when you need to apply (before or after installation).
What annual costs can I expect (such as regular maintenance or parts)?
MassCEC suggests that you have your solar hot water system inspected every one to two years. Ask if your installer performs routine maintenance or if they have someone that they recommend.

TIMING
How far in advance can we plan the installation and how long does the installation?
Be sure to communicate if you have particular time constraints and get a sense when your installer will be available to do the installation. Summer is the busiest time of the year for solar hot water installers and many installers have some delays during the summer season.

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Make sure you understand from your installer if there is anything you need to do to prepare to have them working in your home.

QUALITY ASSURANCE
Do you provide a warranty for the systems you install? What are the different warranty options?
Make sure you have a sense of what is covered by any warranty offered by your contractor. Some warranties cover labor, some cover the equipment, and some cover both.
What relevant training, certifications, and licenses does your team have? Can you provide references from previous customers?
As with any home improvement project, it is important to ensure that your installer has the right training and a good track record with past customers.

Will you hire subcontractors to complete portions of the project? If so, what will they do? What are the names of these companies and how long have you worked with them?
Many solar hot water installers sub-contract the plumbing work.

Will you provide training for me on how to properly operate and maintain the system?
Solar hot water systems are relatively simply to operate, but there are a few differences compared to other hot water systems, and your installer should be a good educational resource.

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Talk to your installer about scheduling an annual to bi-annual maintenance check to make sure that everything is running smoothly.
Clean Energy Lives Here.  
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