

# Selection of Clean Heating & Cooling Equipment

## for Commercial, Institutional & Industrial Facilities in Massachusetts

Clean heating and cooling, also known as renewable thermal, equipment can be used to reduce fossil fuel consumption, greenhouse gas emissions and operating costs. Established technologies include air-source heat pumps, ground-source heat pumps, solar thermal and modern wood heating.

Good applications for these technologies include:

- New construction
- Replacement of failing equipment
- Upgrades to equipment that is expensive to operate (such as electric resistance heating, older boilers or furnaces or window air conditioners), has high emissions (such as oil-fueled equipment) or is unreliable or difficult to maintain

The building envelope, equipment controls, and distribution system are also critical elements of heating and cooling systems and should be optimized and properly maintained to ensure occupant comfort and efficient operation.

This overview of selected technologies will help you determine the best options for your facility. Learn more at [ag.umass.edu/clean-energy/chc](http://ag.umass.edu/clean-energy/chc)

|               | Air-Source Heat Pump (ASHP)                                                                                                                                                                                                                                                         | Ground-Source Heat Pump (GSHP)                                                                                                                                                                                                                                                 | Solar Thermal                                                                                                                                                                                                                     | Modern Wood Heating                                                                                                                                                                                        |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description   | <ul style="list-style-type: none"> <li>• Draws heat from outside air and moves it indoors to provide heating, or draws heat from inside and moves it outside to provide cooling</li> <li>• Recent advances have improved performance in cold climates like Massachusetts</li> </ul> | <ul style="list-style-type: none"> <li>• Draws heat from the ground and moves it indoors to provide heating, or draws heat from inside and moves it to the ground to provide cooling</li> <li>• Highly efficient because of nearly constant temperature underground</li> </ul> | <ul style="list-style-type: none"> <li>• Uses flat plate, evacuated tube, or concentrating collectors to capture sun's energy and heat the water or air</li> </ul>                                                                | <ul style="list-style-type: none"> <li>• Burns wood pellets or chips in a central boiler or furnace</li> <li>• Fully automated with bulk fuel delivery and requires limited routine maintenance</li> </ul> |
| Applications  | <ul style="list-style-type: none"> <li>• Space heating &amp; cooling</li> <li>• Domestic hot water</li> </ul>                                                                                                                                                                       | <ul style="list-style-type: none"> <li>• Space heating &amp; cooling</li> <li>• Domestic hot water</li> </ul>                                                                                                                                                                  | <ul style="list-style-type: none"> <li>• Space heating</li> <li>• Domestic hot water</li> <li>• Pool heating</li> </ul>                                                                                                           | <ul style="list-style-type: none"> <li>• Space heating</li> <li>• Domestic hot water</li> <li>• District heating</li> <li>• Process heating</li> </ul>                                                     |
| Load Coverage | <ul style="list-style-type: none"> <li>• Can operate as primary or supplemental heat source depending on building and system design</li> </ul>                                                                                                                                      | <ul style="list-style-type: none"> <li>• Can operate as primary or supplemental heat source depending on building and system design</li> </ul>                                                                                                                                 | <ul style="list-style-type: none"> <li>• Typically installed with a complementary heating source</li> </ul>                                                                                                                       | <ul style="list-style-type: none"> <li>• Generally the primary heat source, sometimes with fossil fuel backup for peak periods</li> </ul>                                                                  |
| Fuel Type     | <ul style="list-style-type: none"> <li>• Electricity - but up to 3.5 times more efficient than traditional electric resistance heating</li> </ul>                                                                                                                                   | <ul style="list-style-type: none"> <li>• Electricity - but up to 5 times more efficient than traditional electric resistance heating</li> </ul>                                                                                                                                | <ul style="list-style-type: none"> <li>• Primary input is solar energy, with minimal electricity for pumping</li> <li>• Complementary heating source may use electricity, fossil fuels or another form of clean energy</li> </ul> | <ul style="list-style-type: none"> <li>• Wood pellets or chips produced according to state rules to reduce emissions and assure sustainable forest management</li> </ul>                                   |

|                                                                   | Air-Source Heat Pump (ASHP)                                                                                                                                                                                                                                                                                                                                                                            | Ground-Source Heat Pump (GSHP)                                                                                                                                                                                                                                                                                               | Solar Thermal                                                                                                                                                                                                                                    | Modern Wood Heating                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Greenhouse Gas (GHG) Emissions                                    | <ul style="list-style-type: none"> <li>Emissions are dependent on source of electricity used by heat pump, will be lower if renewable sources of electricity used</li> </ul>                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>Emissions are dependent on source of electricity used by heat pump, will be lower if renewable sources of electricity used</li> </ul>                                                                                                                                                 | <ul style="list-style-type: none"> <li>No emissions from solar thermal</li> <li>Emissions may result from complementary heating source</li> </ul>                                                                                                | <ul style="list-style-type: none"> <li>GHG emissions reduced by at least 50% compared to fossil fuel emissions, per state rule</li> <li>Net emissions reduced over time with forest regrowth or as wood residues would have decayed</li> </ul>                                                       |
| Space Heating & Cooling Distribution System Options               | <ul style="list-style-type: none"> <li>Variable Refrigerant Flow (VRF) systems deliver hot and cool air through network of refrigerant pipes and can provide highly efficient simultaneous heating and cooling if needed</li> <li>Ductless systems serve individual rooms without need for ductwork</li> <li>Central systems use ductwork to distribute hot or cool air throughout building</li> </ul> | <ul style="list-style-type: none"> <li>Ducted ventilation system to distribute hot or cool air throughout building</li> <li>Hydronic distribution systems for heating and cooling are best for systems designed for lower water temperatures in heating mode (&lt;150°F), and may also provide domestic hot water</li> </ul> | <ul style="list-style-type: none"> <li>Central systems use ductwork or hydronic distribution to transport heat throughout building</li> </ul>                                                                                                    | <ul style="list-style-type: none"> <li>For boiler: hot water system with radiators, piped radiant heating or fan coil units are best for systems designed for higher water temperature (&gt;180°F)</li> <li>For furnace: hot air distributed through ductwork (limited options available)</li> </ul> |
| Additional Considerations                                         | <ul style="list-style-type: none"> <li>Lowest initial cost of clean heating and cooling technologies</li> </ul>                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>Requires trenches or wells outside facility, and certain sites may not have sufficient space or appropriate geological conditions</li> <li>Higher installation cost may be offset by long term savings</li> </ul>                                                                     | <ul style="list-style-type: none"> <li>Collectors should be mounted in location with at least 5 hours unobstructed sunlight per day, 75% shade-free annual basis</li> <li>Generally requires space in building for water storage tank</li> </ul> | <ul style="list-style-type: none"> <li>Requires space for silo or bin to store fuel, which must be accessible through pneumatic tube from delivery truck</li> <li>Installation of thermal storage tank recommended</li> </ul>                                                                        |
| State Programs & Incentives                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                      |
| Massachusetts Clean Energy Center<br>www.masscec.com              | —                                                                                                                                                                                                                                                                                                                                                                                                      | —                                                                                                                                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>Incentives up to \$100,000</li> </ul>                                                                                                                                                                     | —                                                                                                                                                                                                                                                                                                    |
| Mass SAVE®<br>www.masssave.com                                    | <ul style="list-style-type: none"> <li>Upgrade incentives up to 50% of incremental cost</li> <li>New construction and major renovation incentives</li> <li>Interest-free loans</li> <li>Upstream program with participating distributors</li> </ul>                                                                                                                                                    | <ul style="list-style-type: none"> <li>Upgrade incentives up to 50% of incremental cost</li> <li>New construction and major renovation incentives</li> <li>Interest-free loans</li> <li>Upstream program with participating distributors</li> </ul>                                                                          | <ul style="list-style-type: none"> <li>Interest-free loans</li> </ul>                                                                                                                                                                            | —                                                                                                                                                                                                                                                                                                    |
| Massachusetts Department of Energy Resources<br>www.mass.gov/doer | <p>The Alternative Energy Portfolio Standard regulation allows owners of qualified systems to earn alternative energy certificates (AECs) based on the amount of clean energy delivered by the system. AECs can be traded at a value determined by the market to provide income for the system owner and help to offset initial capital costs and any operating costs.</p>                             |                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                      |