tech primer

Air to Water Heat Pumps (AWHPs)

Highly efficient domestic hot water production that reduces emissions and energy costs.

tech overview

applicable building types
hotels, hospitals and all multifamily

implementation
anytime, at equipment replacement

fast facts
- reduces GHG emissions
- integrates with existing DHW distribution system
- reduces utility costs
- reduces maintenance costs

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costs & benefits*

GHG Savings

Tenant Experience Improvements

Utility Savings

Capital Costs

Maintenance Requirements

*ratings are based on system end use, see back cover for details.

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getting to know AWHP systems

Air to water heat pumps (AWHPs) are a deep energy retrofit option to electrify a building's domestic hot water system. By either replacing or supplementing a traditional gas, oil, or steam system, AWHPs can significantly reduce carbon emissions and save energy.

how do AWHP systems work?

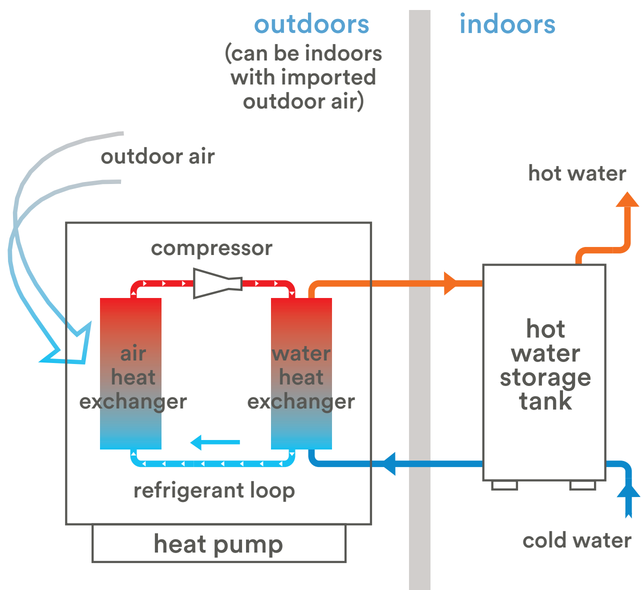
All multifamily buildings must supply domestic hot water (DHW) for faucets, showers, and baths. Most large buildings have a centralized DHW system supplied by either on-site boilers or the district steam grid. These DHW systems are a significant source of carbon emissions and operating expenses, particularly in multifamily buildings, hotels, and dorms.

Air to water heat pumps (AWHPs) provide an alternative to traditional DHW production. Rather than burning fossil fuels, AWHPs run on electricity and use a highly efficient heat exchange process that is effective even at low outdoor air temperatures.

As illustrated in Figure 1, AWHPs are modular units that generate hot water by transferring heat from air to water via refrigerant. AWHPs can integrate with a building's existing infrastructure and either replace or supplement a traditional DHW system. Although AWHPs do not produce hot water as rapidly as traditional boilers or steam systems, they save energy and greatly reduce greenhouse gas emissions.

AWHPs that use a carbon dioxide (CO2) based refrigerant are recommended. CO2 refrigerant is more efficient and has a significantly smaller global warming impact compared to conventional refrigerants, and because the refrigerant is contained within the heat pump unit, little risk of refrigerant leaks exist. AWHPs that use conventional refrigerant can still be specified but need to be designed to minimize the risk of leakage.

Fig 1. In AWHPs, heat from outdoor air is drawn into the air heat exchanger and absorbed by a refrigerant. As the refrigerant passes through the compressor, its pressure and temperature rise. The refrigerant then passes through the water heat exchanger to heat the domestic supply water, which is pumped to the storage tank for distribution.



Assess
Always consult a qualified service provider before undertaking any building upgrades.

Coordinate Upgrades for Maximum Savings
Installing onsite renewables, like solar photovoltaics (PVs), can significantly increase energy and carbon savings associated with converting to an electric-powered AWHP system for DHW.

Solar PVs generate clean, renewable electricity that mitigates the high cost of buying from the utility grid for the operation of electric systems like AWHPs. See our Solar PV Tech Primer to learn more.

Training and Maintenance
Trained staff are fundamental to maintaining AWHP systems. Knowledgeable staff can identify and address maintenance items independently or know when to engage qualified contractors.

Energy savings may go unrealized without regular maintenance of the AWHP system.

how to upgrade to an AWHP system

A high-performance AWHP retrofit includes installing heat pump units connected to indoor hot water storage tanks and optimizing the existing piping distribution system.

retrofit solutions

There are multiple steps to retrofitting a building with AWHPs:

A Plan System Layout– Conduct a review of the building's existing hot water usage to determine system size and equipment layout. In most multifamily buildings, approximately one AWHP and one storage tank is needed for every four apartments.

- Multiple heat pumps can be grouped together in one location. Clearances for heat pump units must be maintained to ensure exhaust air from one heat pump does not feed directly into another.
- The existing DHW heating plant and storage tanks can remain in place for redundancy.

Photo: Sanden

Rooftop air to water heat pumps.

B Install Heat Pump Units– AWHPs can be located outdoors or indoors, if ducting for air intake is also installed. Design of water piping to connect the heat pumps and storage tank must be considered in either case.

1. **Outdoor Installation–**

- Install units above the normal snow line in locations where they are unlikely to become covered by banked snow.
- Take measures to prevent pipes from freezing, such as insulation or heat tracing.
- Install fencing around outdoor units to prevent tampering and damage.

2. **Indoor Installation–** Heat pump units can be placed inside if ducting for outdoor air intake is also installed.

- Heat pumps cool the surrounding air and can create cold interior spaces.
- If a location in the building requires year-round cooling, the heat pumps can provide efficient cooling to that space as a byproduct of hot water production. However, if the space requires heating in winter, the heat pumps will significantly add to the heating load.

Photo: Sanden

Indoor hot water storage tanks.

C Control Condensate– Both condensate formed on the heat pump coil during summer and ice melted by the heat pump's defrost mode during winter will need to be safely drained.

- Units should be raised a minimum of 4" above the ground to allow for drainage.
- A dedicated condensate drain may be necessary to prevent water from pooling or ice from forming in areas where it could become a hazard.

D Optimize Distribution– The DHW distribution system should be optimized by installing low-flow water fixtures and repairing leaks. These cost-effective measures will decrease the required size of the new AWHP plant and storage tanks.

- Note that storage tanks contain water above 140F, so mixing valves are needed to reduce the water temperature provided to the building.

costs & benefits of AWHP systems*

Greenhouse Gas (GHG) Savings

Converting to an AWHP system can greatly reduce DHW related GHG emissions. Electricity is a cleaner source of energy compared to natural gas or fuel oil.

Tenant Experience Improvements

Tenants' everyday experience will remain largely unchanged, however installing AWHPs will provide residents with reliable and efficient domestic hot water.

Utility Savings

Heat pump systems are much more efficient than traditional hot water systems, potentially consuming less than half the amount of energy to provide the same level of heating.However, electricity is currently a significantly more expensive form of energy than natural gas, fuel oil, or district steam. Future changes in utility costs should be considered when evaluating project feasibility.

Capital Costs

AWHPs require a moderate capital investment, however incentives are available that may lower upfront costs, which are expected to drop as the market for AWHPs grows. Further due diligence is recommended for determining site specific costs, benefits, and retrofit considerations.

Maintenance Requirements

When properly installed, AWHPs require a moderate level of maintenance. The heat pump units require annual cleaning and power-washing, which can be performed by building staff.

**The Costs & Benefits rating system is based on a qualitative 1 to 4 scale where 1 () is lowest and 4 () is highest. Green correlates to savings and improvements, orange correlates to costs and requirements. Ratings are determined by industry experts and calculated relative to the system end use, not the whole building.*

Take Action

This document is one of more than a dozen High Performance Technology Primers prepared by Building Energy Exchange and the Retrofit Accelerator to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings. Access the complete library of Tech Primers here:

be-exchange.org/tech-primers

The **NYC Retrofit Accelerator's** team of Efficiency Advisors offers free, personalized advisory services to help streamline the process of making energy efficiency improvements to your building. The **High Performance Retrofit Track (HPRT)** of the **Retrofit Accelerator** can help you design and implement a 10-15 year capital plan to reduce your building's energy use by 40-60%.

HPRT participants commit to accomplishing deep energy reductions by holistically upgrading all major building systems, including the heating system, cooling system, and the building envelope.

Get in touch with the **NYC Retrofit Accelerator** today!

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The **Building Energy Exchange (BE-Ex)** is a center of excellence dedicated to reducing the effects of climate change by improving the built environment. **BE-Ex** accelerates the transition to healthy, comfortable, and energy efficient buildings by serving as a resource and trusted expert to the building industry.

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