

tech primer

Mini-Split Systems

Highly efficient heat pumps for decentralized, electric heating and cooling in multifamily buildings.

tech overview

applicable building types
all multifamily; hotels

when to implement
at equipment replacement

fast facts

- reduces GHG emissions
- improves comfort
- provides temperature and zoning control
- provides both heating and cooling
- offers design flexibility

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.



getting to know mini-split systems

Mini-split systems are an efficient, all-electric heating and cooling technology. Mini-splits can save energy and reduce greenhouse gas emissions while greatly enhancing resident comfort.

how do mini-split systems work?

Mini-split systems are an electric air-source heat pump (ASHP) technology that can be used to heat and cool spaces. Because ASHPs transfer heat rather than generate it, they are highly efficient.

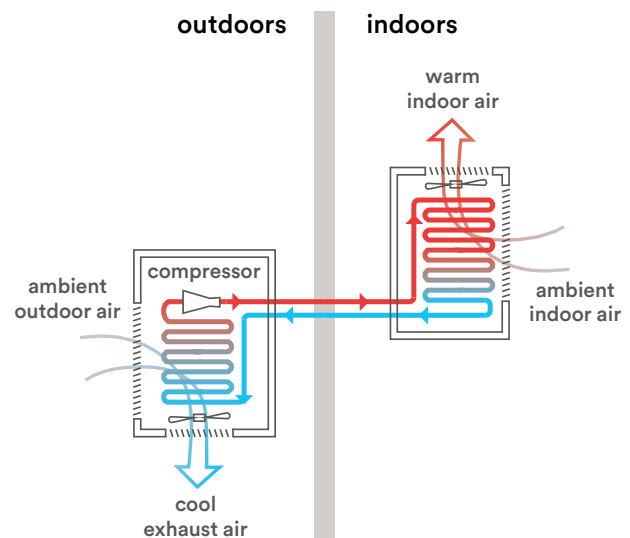
Commonly used to provide air conditioning by transferring heat from the air inside to the air outside, ASHPs can also function in reverse to provide effective heating in cold climates. Mini-splits are a type of decentralized ASHP suitable for many building types. This tech primer focuses on their use in multifamily buildings. See the *Variable Refrigerant Flow (VRF) Tech Primer* to learn more about other ASHP options.

Mini-split systems consist of two compact, ductless, components: an outdoor unit and an indoor unit, connected via refrigerant lines (see Fig. 1). This refrigerant piping requires minimal exterior wall penetrations compared to through-wall or packaged terminal ACs, reducing gaps where heat can be lost or gained through the building envelope.

Outdoor units have variable speed drives that modulate fan speed to the optimal rate, rather than simply running "on" or "off." This feature reduces energy consumption and delivers greater consistency and control of interior temperature.

Mini-split systems can be programmed with smart controls that respond to indoor and outdoor temperatures. Tenants can also adjust room temperature to their personal comfort levels using thermostatic controls on indoor units.

Fig 1. In heating mode, mini-splits transfer heat from outside to inside via refrigerant lines. Heat from air drawn through the outdoor unit is transferred to a refrigerant, which is pumped through a compressor to the indoor unit. Heat from the refrigerant is then transferred to ambient indoor air to produce warm air. In cooling mode, mini-splits operate in reverse, moving heat from inside to outside.



Assess

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

Coordinate to Maximize Savings

Implementing mini-split upgrades in conjunction with building envelope improvements (insulation, air-sealing, etc.) or other high-performance measures will reduce a building's heat loss and infiltration.

With an improved building envelope, it may be possible to install lower capacity mini-split equipment, thereby reducing capital costs.

Plan Ahead for Success

Consider implementing a mini-split system when your existing heating and cooling systems have reached the end of their useful lives, or when the building is being renovated.

Appropriate times to consider upgrading to a mini-split system include when the boiler needs to be replaced, the distribution piping is leaking, or a cooling tower has failed.

how to upgrade to mini-split systems

Due to the high costs of replacing heating and cooling systems, the best time to consider this upgrade is during a major renovation or at the time of heating and cooling equipment replacement.

retrofit solutions

Consider the following when retrofitting a building with mini-split systems:

- A Determine Unit Locations:** When planning for a mini-split system, consideration should be given to how refrigerant lines will run through the exterior walls, where outdoor units will be located, and where indoor units will be installed.
- Outdoor units can be placed under windows where through-wall or packaged terminal ACs may exist, or placed on brackets and mounted on an exterior wall or balcony.
 - Indoor units can serve one room or be ducted to serve multiple rooms.
 - Forced air systems move air in such a way that a room can feel colder than the thermostat reads, so indoor units should be placed to avoid directing high-speed air onto a spot where occupants will linger and feel drafts.



Photo: Carrier Corp

Mini-split indoor units come in a variety of wall, ceiling, & floor mounted styles.

- B Install Equipment:** Installation should be carried out by qualified contractors with significant experience. Poor installation can result in refrigerant leaks and an underperforming system.
- Refrigerant lines must run from the outdoor unit to each indoor unit. The refrigerant can be a highly potent greenhouse gas so preventing leaks through careful installation is crucial.
 - Condensate formed at the indoor unit needs to be removed by either installing interior plumbing lines to drain the condensate or misting the condensate into the fan of the outdoor unit.
 - Condensate formed at the outdoor unit needs to drain safely away without causing ice to accumulate on the unit or walkways.



Photo: Green Star Energy Solutions, LLC

Exterior view of outdoor unit installed under window.

Efficiency Guidelines

Preliminary data has shown that the most efficient installations of mini-split systems tend to be where one outdoor unit is paired with one indoor unit.

It may not be possible or cost effective to install one outdoor unit for every indoor unit, but limiting the number of indoor units connected to each outdoor unit will maximize efficiency.

Electrical Requirements

Mini-split systems require a 208/230V electrical service which may be available in buildings with Packaged Terminal ACs or electric resistance heaters, but may not be available in buildings with other heating systems.

The need for a new or upgraded electrical service should be determined early in the retrofit timeline, as it may impact the project feasibility and budget.

Mini-Split vs VRF Systems

Decentralized mini-split systems have simpler refrigerant piping runs than centralized VRF systems, enabling easy and flexible implementation. However, mini-splits require many terminal units, which could have an undesired visual impact on a building's facade and increase maintenance complexity.

Mini-split systems are best for buildings where the outdoor units can be installed in inconspicuous, but accessible locations.

costs & benefits of mini-split systems*

Greenhouse Gas (GHG) Savings



Converting a multifamily building to a mini-split system can greatly reduce heating and cooling related GHG emissions, depending on the existing heating and cooling system.

Tenant Experience Improvements



Mini-split systems greatly improve tenant satisfaction by delivering quiet, uniform heating and cooling that can be precisely adjusted to personal comfort preferences.

Utility Savings



Although mini-split systems consume significantly less energy than systems that use natural gas, fuel oil, or district steam, utility costs for operating a mini-split system can be high due to the current cost of electricity. Future changes in utility costs should be considered when evaluating project feasibility.

Capital Costs



The capital costs for a mini-split system conversion are high. Installing an indoor unit in each space provides the greatest level of temperature control but raises costs by increasing the number of indoor units, amount of refrigerant piping, and electrical work. Using one unit to serve two adjacent rooms can save money but reduces the level of control. The project cost could also be impacted if the building's electrical service needs upgrading.

Maintenance Requirements



When properly installed, mini-split systems require a moderate level of maintenance. Indoor units include air filters, which need to be periodically cleaned or replaced. Outdoor units require annual cleaning and power-washing. Refrigerant leak testing should be completed as refrigerant piping is installed, after the installation is completed, and repeated before and after the first heating season. The system must be closely monitored for leaks within one year of installation. Mini-split systems are technologically complex, and if problems occur, they will need to be addressed by qualified contractors.

**The Costs & Benefits rating system is based on a qualitative 1 to 4 scale where 1 (lowest) is lowest and 4 (highest) 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.*

Note: Existing system assumed to be gas-fired steam boiler, steam radiators, & window ACs.

take action

This document is one of more than a dozen High Performance Technology Primers prepared by Building Energy Exchange and its partners to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings. Access the complete Tech Primer library: be-exstl.org/building-blocks

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