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tech overview

applicable building types
all multifamily, hotels
implementation
at equipment replacement
fast facts
- reduces GHG emissions
- improves comfort
- provides temperature and zoning control
- reduces maintenance costs
- provides both heating and cooling
- offers design flexibility

tech primer

Mini-Split Systems

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

cost & 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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Building Performance Exchange

A program of Built Environment Plus

Getting to know mini-split systems

Mini-split systems are an efficient heating and cooling technology that saves energy and reduces greenhouse gas emissions while greatly improving resident comfort. Mini-split systems offer multifamily buildings a path to electrification.[1]

How do mini-split systems work?

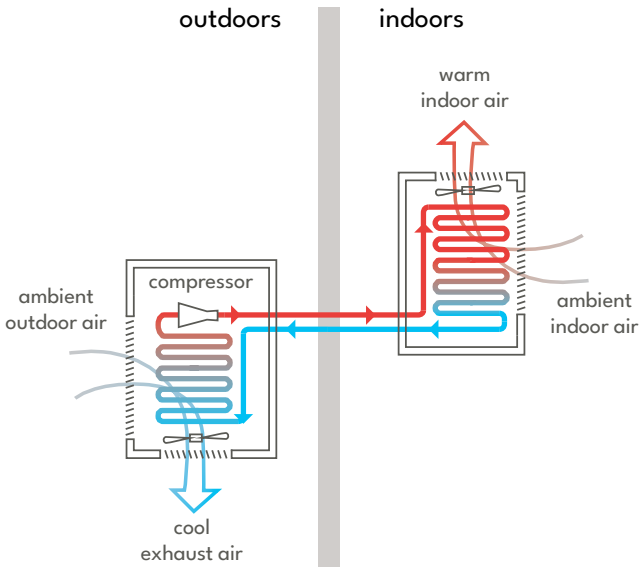
Mini-split systems are an air-source heat pump (ASHP) technology that can be used to heat and cool spaces. ASHPs are high-efficiency electric appliances that add or remove heat from an indoor space as needed. Because they transfer heat rather than generate it, ASHPs are extremely efficient.

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 climates as cold as NYC. Mini-splits are a type of decentralized ASHP suitable for many building types. This tech primer focuses on the use of mini-splits in multifamily buildings. See our Variable Refrigerant Flow (VRF) Tech Primer to learn about other ASHP options.

Mini-split systems consist of two compact, ductless, components: one outdoor unit connected to one indoor unit via refrigerant lines (see Fig 1). This refrigerant piping requires minimal exterior wall penetrations compared to through-wall or packaged terminal ACs, reducing porosity that allows for heat loss or gain through the building envelope.

Outdoor units have variable speed drives that allow them to operate at the optimal rate, instead of simply at "on" or "off" functions. This 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.

[1]Electrification is a strategy to transition from powering building systems with fossil-fuels to electricity. Electrification is an important step towards a low-carbon future for NYC.

Coordinate Upgrades for Maximum 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 equipment replacement.

Retrofit solutions

There are multiple steps to retrofitting a building with a mini-split system:

A **Plan –** 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.

Photo: Carrier Corp

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

B **Determine Unit Locations –** 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 can be ducted to serve multiple rooms.

- Consideration should be given to the placement of indoor units to avoid creating hot or cold spots in the room and to ensure spaces near windows are not too cold.
- Forced air systems move air in a way that can make the room feel colder than the thermostat reads, so the placement and operation of the indoor units should not direct high-speed air onto a spot where occupants will linger, making that spot feel drafty.

C **Install –** 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 a top priority.
- 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 on 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 types of 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
Decentralized mini-split systems have simpler refrigerant piping runs than centralized VRF systems, allowing for easy and flexible implementation. However, the distributed nature of mini-split outdoor units could have an undesired visual impact on a building and make maintenance more difficult.

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

Costs and 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

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

Take Action

This document is one of more than a dozen High Performance Technology Primers prepared by the Building Performance Partnership (BPP) to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings.

For more information, contact Built Environment Plus.

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The Building Performance Partnership (BPP), created by Building Energy Exchange (BE-Ex) and the Institute for Market Transformation (IMT), supports the creation and operation of local high-performance building hubs that accelerate measurable, equitable, and sustainable action to improve the health, comfort, and performance of buildings. With support from both BE-Ex and IMT, partner hubs serve their respective regions with customized resources that cater to the needs of their communities while benefiting from the existing resources and expertise of our network.

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*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, **dark blue** 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.