MULTIFAMILY RESIDENTIAL HVAC SYSTEMS

Which is the best fit for your next project?

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The construction of a multifamily residential development requires many decisions to be made throughout the design process. While some selections are a developer's preference (i.e., how many buildings? how many floors per building? how many units per floor?), others will be dictated by state and local code requirements.

HVAC systems are a key decision that impacts many other components of the design and, therefore, should be made early in the process. Below we break down today's most efficient systems in construction and give you the pros and cons to make an educated decision on what's best for your project.

Mechanical Systems can be divided into two major categories: *Decentralized Systems* and *Centralized Systems*.

Decentralized systems are a common choice for low and mid-rise residential buildings, especially when cost is a factor. These systems can provide each unit's heating and cooling equipment at an affordable budget. Typically consisting of an air handler in the units and a remote condensing unit with compressor, it offers location flexibility with the ability to be installed in the unit and vented "through wall" or located on a balcony, on grade, or a flat roof if the building design allows it. Due to the air handler and condenser typically being separate units, they are often referred to as split systems or "splits."

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Compressors generate noise, and that must be considered when deciding on their location. As a rule, they should be no more than 100ft from the air handler.

Decentralized systems tend to be simpler and initially cost significantly less to install than centralized systems. With a shorter life span, long-term maintenance and replacement costs should be considered in the overall analysis. That being said, most low

and mid-rise residential buildings will opt for some form of this system due to the economic value, flexibility, and individual unit control and metering capabilities.

Decentralized Systems consist of three options, all of which are variations of a similar set-up (identified in cost from lowest to highest):

- **Self-Contained Packaged Heating & Air Conditioning System Unit (PTAC Unit)**
- **Fan Coil Unit with Integral Heat Pump System**
- **Gas-Fired Furnace with Fan Coil Unit**

The most common of these systems is the **Self-Contained Packaged Heating & Air Conditioning** through wall system, aptly known as a PTAC unit or Packaged Terminal Air Conditioner unit. It is fully self-contained, with all cooling and heating equipment, including the compressor, tightly compact in one. The system requires mounting on an outside wall with an exterior louver for air supply, and with exhaust air discharged through the louver, no flue pipe is needed. The trade-off is that the occupant will most likely have an aversion to the unit, with the compressor noise being in close proximity to the living space. These systems are typically less expensive to install initially and are more appropriate for low to mid-rise buildings (six floors or less). The maintenance of these systems is relatively simple, but because there is a system for every unit, service calls can be frequent, leading to higher costs. PTAC units also tend to have a shorter expected life span of 10 to 15 years of usable runtime with proper servicing.

The **Fan Coil Unit with Integral Heat Pump System** is one of the most economical decentralized HVAC systems. The fan coil unit uses an integral pump to circulate heated water from the facility's domestic hot water supply, providing heat and hot water for the unit. Heat is distributed by the fan, which blows air over the hot water coil.

The cooling is accomplished with a Direct Expansion Coil (DX) in the unit coupled to a remote condensing unit as either roof or grade mounted. Further savings may be found if the condenser can be "through wall-mounted" in the unit. One potential drawback of this system is that it can reduce the life span of the water heaters because it often work harder to keep up with the on-demand heating.

The **Gas-Fired Furnace with Fan Coil Unit** and remote condenser is very similar to the **Fan Coil Unit with Integral Heat Pump System**, with the difference being that it uses a gas-fired furnace within the fan coil to heat the air distributed throughout the unit.

The unit will require a flue pipe vented to the outside to exhaust products of combustion. Cooling is provided with a Direct Expansion Coil (DX) in the unit coupled to a remote condensing unit. All decentralized options are individually controlled within units, so tenants have complete control of any changeover from heating to cooling. With the benefit of an individually metered unit (gas-fired or electric) residents can regulate to their own comfort level and carry responsibility for all utility payments.

Centralized systems feed the heating and cooling for the entire building from one centrally located mechanical area or energy center. They are primarily used in mid to high-rise buildings (over five floors). These systems are more expensive to install and are usually more sophisticated to operate and maintain. A significant drawback of centralized systems is that usage cannot be read locally; however, individual meters at each unit can resolve this issue whether utilizing gas-fired equipment or operating by electricity.

There are four options for Centralized Systems appropriate for weather found in New England (identified in cost from lowest to highest):

- **Vertical Stacked Water Source Heat Pump System**
- **Two-Pipe Vertical Stacked Fan Coil System**
- **Variable Refrigerant Flow (VRF) System**
- **Four-Pipe Vertical Stacked Fan Coil System**

The **Vertical Stacked Water Source Heat Pump System** is one of the most popular centralized systems for residential HVAC due to its flexibility for simultaneous heating and cooling as well as a lower initial cost alternative to the four-pipe system. In this vertically stacked two-pipe system, condenser water, held at a temperature between 60° and 90°, is continuously looped through the building via pipe risers to stacked heat pumps in the units. The configuration is similar to the two-pipe fan coil system, but instead of a chiller, the system utilizes individual compressors at each unit for cooling. A remote cooling tower rejects system

heat from the condenser water loop. The boiler component is the same, and there are still valves required for spring and fall seasonal changeovers. Operationally, compressors located in the individual unit heat pumps either withdraw heat from (heating mode) or reject heat to (cooling mode) the condenser water loop. Therefore, if most building occupants are not calling for the same thing, simultaneous cooling and heating can occur. Individual compressors allow more utility costs to be the responsibility of the residents than with other centralized systems.

The **Two-Pipe Vertical Stacked Fan Coil System** is like the four-pipe system, except only two pipes deliver EITHER hot OR chilled water. Since hot and chilled water share the same piping and pumps, cooling and heating cannot be provided simultaneously. The building owner is required to change the system over every spring and fall to the appropriate heating or cooling mode. Manual or electric valves are used to isolate the cooling and heating systems. Two-pipe vertical stacked fan coil systems require mechanical rooms but on a smaller scale.

The advantage of this system is that the initial costs are significantly less than the four-pipe system. So, while the two-pipe system does not offer the same flexibility and level of comfort control, the upfront cost differential is often substantial enough to persuade the developer to choose the two-pipe system. One way to enhance the system is to install supplemental electric heating coils in the unit fan coils, allowing individual heating while the central system is in cooling mode.

The **Variable Refrigerant Flow (VRF) System** is a type of heating and cooling system for residential and/or commercial applications. To understand how VRF is unique, it's helpful to understand the basics of common HVAC systems. Most heating and cooling systems fall within two broad categories: ducted split systems or ductless, mini-split systems (like the Packaged Terminal units found in many hotel rooms).

If you live in a residential home, chances are you have a split system with a compressor unit outside and an evaporator coil in the garage or attic that uses a refrigerant to cool the air. The refrigerant is used to change the temperature of interior and exterior coils. Cold refrigerant produced by the external compressor flows through an internal coil, then cycles air over the coil cooling the air to the space.

VRF systems operate a bit differently than a split system. It relies on refrigerant alone instead of a water-based cooling system. Without chillers or coils, a VRF system is quick, responsive, and adaptive to outdoor conditions. It uses inverter compressors allowing the motor to run at variable speeds, saving energy and adjusting usage based on current heating and cooling needs.

A VRF system allows for multiple air handlers within the same system. Since it can be used without ductwork, different rooms can have a wall or ceiling-mounted indoor unit to distribute air, enabling users to make more specific heating and cooling decisions based on the space. This type of system can also be ducted with continuous outside air to increase a room's air exchange. A VRF system is preferred for clients looking to trade a higher up-front equipment cost for increased energy savings and room-to-room HVAC customization.

The **Four-Pipe Vertical Stacked Fan Coil System** carries the highest initial cost; however, it generally provides the resident with the highest degree of comfort control. Due to its major components, a boiler, chiller, cooling tower, and associated pumps, the four-pipe system requires a mechanical room in a penthouse or on the ground floor. Hot and chilled water is distributed from the mechanical room to fan coils inside the living units via two pairs of dedicated supply and return pipes (stacks); one for heating and one for cooling.

One of the most significant advantages of this system is that it allows the unit occupant to switch from heating to cooling at will. With the system running on four pipes, two self-contained systems, hot and cold water can be available in each unit simultaneously during transitional seasons. Throughout the Spring and Fall in New England, weather often fluctuates drastically, and people have varying tolerances for these temperatures. With a four-pipe system, the occupant in Unit A can run the air conditioner while the occupant in Unit B runs the heat without affecting each other's comfort level.

Understanding the benefits, drawbacks, capabilities, and limitations of each system will go a long way to making the right choice for your project. Erland has the in-house expertise to work with developers and design partners to support the selection of the appropriate HVAC system for your next multifamily residential property.

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HVAC COMPARISON MATRIX.

Decentralized Residential HVAC Systems / New England Area

Systems Options:	**Option 1:** Self-Contained Packaged Heating & Air Conditioning System (PTAC Unit)	**Option 2:** Fan Coil Unit with Integral Heat Pump System	**Option 3:** Gas-Fired Furnace with Fan Coil Unit
First Cost	Low	Lowest	Medium to Low
Operational Costs*	Average*	Lower*	Average*
Utility Metering to Units	Yes	Yes	Yes
Seasonal Change Over	By Tenant	By Tenant	By Tenant
Maintenance Cost	Average	Average	Average
Performance	Good	Good	Good
Replacement Costs	Average	Average to High	Average
Electric Utility	Required	Required	Required
Gas Utility	Required	Required	Required
Uses Domestic Hot Water Heater for Space Heating	No	Yes	No

Costs can be metered to tenant

Relative cost assumes similar usage and setpoints, and costs will vary depending on tenants' requirements

Centralized Residential HVAC Systems / New England Area

Systems Options:	**Option 1:** Vertical Stacked Water Source Heat Pump System	**Option 2:** Two-Pipe Vertical Stacked Fan Coil System	**Option 3:** Variable Refrigerant Flow (VRF) System	**Option 4:** Four-Pipe Vertical Stacked Fan Coil System
First Cost	Medium	Medium to High	Medium to High***	Highest
Operational Costs*	Average*	Average	Average to High	Lowest
Utility Metering to Units	Some	No	No	No
Seasonal Change Over	By Building Manager**	By Building Manager	Not Required	By Building Manager**
Maintenance Cost	Average	Average	Above Average	High
Performance	Good	Good	Good/Very Good	Very Good
Replacement Costs	Average	Average	Above Average	Average to Low
Electric Utility	Required	Required	Required	Required
Gas or Oil Utility	Required	Required	Not Required	Required

Some costs can be metered to tenant

****Residents have some flexibility to choose cooling or heating***

*****System can be designed for outside air integration(s) and varies depending on requirements***

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