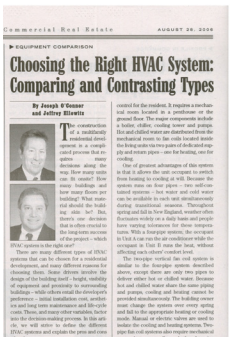
Multifamily Residential HVAC Systems: How do you Decide?

By,
Joseph O'Connor and Jeffrey Ellowitz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EQUIPMENT COMPARISON

Choosing the Right HVAC System: Comparing and Contrasting Types

By Joseph O'Connor and Jeffrey Ellowitz

The construction of a multifamily residential development is a complicated process that requires many decisions along the way. How many units can fit onsite? How many buildings and how many floors per building? What material should the building skin be? But, there's one decision that is often crucial to the long-term success of the project – which HVAC system is the right one?

There are many different types of HVAC systems that can be chosen for a residential development, and many different reasons for choosing them. Some drivers involve the design of the building itself – height, visibility of equipment, and proximity to surrounding buildings – while others entail the developer's preference – initial installation cost, aesthetics, and long term maintenance and life cycle costs. These, and many other variables, factor into the decision-making process. In this article, we will strive to define the different HVAC systems and explain the pros and cons of each.

As seen in Banker & Tradesman Magazine

Systems breakdown into two major categories- centralized and decentralized:

Centralized systems feed the heating and cooling for the entire building from one centrally located mechanical area. They are mostly used in mid to high-rise buildings, which are structures with 5-7+ floors. These systems are more expensive to install and are usually more sophisticated to operate and maintain. A major drawback of centralized systems is that usage cannot readily be individually metered; therefore, the energy costs must be included in any rental or condo fee calculation.

Decentralized systems provide separate heating and cooling equipment for each unit, are less expensive to install initially, and are more appropriate for low to mid-rise buildings – those that have 6 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 occurrences. These systems also tend to have a shorter life span than centralized systems. A great benefit of all decentralized systems is that they can be individually metered at the unit, whether gas-fired or run by electricity.

Centralized Systems

There are three centralized system choices that are appropriate for the weather conditions commonly found in New England: four-pipe vertical stacked fan coil units, two-pipe vertical stacked fan coil units, and vertical stacked water source heat pumps.

The **four-pipe vertical stacked fan coil system** carries the highest initial cost, but generally provides the highest degree of comfort control for the resident. It requires a mechanical room located in a penthouse or the ground floor. The major components include a boiler, chiller, cooling tower, and pumps. Hot and chilled water are distributed from the mechanical room to fan coils located inside the living units via two pairs of dedicated supply and return pipes – one for heating, one for cooling.

One of greatest advantages of this system is that it allows the unit occupant to switch from heating to cooling at will. Because the system runs on four pipes – two self-contained systems – hot water and cold water can be available in each unit simultaneously during transitional seasons. Throughout spring and fall in New England, weather often fluctuates widely on a daily basis 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 others' comfort level.


Kimball Woods *Burlington, Massachusetts*

A great example of a residential complex with this type of HVAC system is Kimball Woods, which is currently under construction in Burlington, Massachusetts. The 455,000 square foot development will consist of two 10-story residential towers with a total of 256 units when it's completed in the summer of 2006. The owner wanted a premium HVAC system for this flagship property, so the complex will have a four-pipe system with a state of the art DDC (Direct Digital Control) Building Management System to control the energy efficient chillers and boilers. One item that must be addressed is that the major components of this system will require a skilled maintenance staff on call to operate and maintain them.

The **two-pipe vertical fan coil system** is similar to the four-pipe system described above, except there are only two pipes to deliver EITHER hot OR chilled water. Because hot and chilled water share the same piping and pumps, cooling and heating cannot be provided simultaneously. The building owner must 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 fan coil systems also require me-

chanical rooms, but on a smaller scale than four pipe systems.

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, which will allow individual heating while the main system is in cooling mode.

The **water source heat pump system** is one of the most popular centralized systems for mid to high-rise residential HVAC because it offers some flexibility for simultaneous heating and cooling, but is a lower initial cost alternative to the four-pipe system. In this two-pipe system, condenser water, held at a temperature between 60° and 90°, is continuously looped through the building via 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 is used for system heat rejection 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, as long as most of the building occupants are not calling for the same thing, simultaneous cooling and heating can happen. Another benefit of this system is that individual compressors allow more of the utility costs to be the responsibility of the residents than with other centralized systems.

Decentralized systems

Decentralized HVAC systems are a common choice for low-rise residential buildings, especially when first cost is a factor. The systems typically consist of an air handler in the units and a remote condensing unit with compressor offering location flexibility as it can be installed in the unit and vented "through wall," or located on a balcony, on grade, or on a flat roof if the building design allows it. Because the air handler and condenser are typically separate units, these are often referred to as split systems, or "splits."

The compressors generate noise, and that must be considered when deciding on their location. Also, as a general rule, they should not be more than 100 feet from the air handler. The decentralized systems tend to be less sophisticated and significantly less costly to install initially than centralized systems. They also tend to have a shorter life span than the centralized systems, so long term maintenance and replacement costs should be considered in the overall analysis. With that said, the majority of low rise residential buildings will use some form of these systems for their economy, flexibility, and individual unit control and metering capabilities.

There are three options for decentralized systems, all of which are variations of a similar set-up: fan coil units with integral pump; gas fired furnace with an air conditioning coil (a-coil) and remote condenser; and self-contained packaged heat and A/C through the wall.

The **fan coil unit with integral pump system** – an example of which is called "Aqua Therm," which is manufactured by First Company – is one of the most economical decentralized HVAC systems. The fan coil unit uses an integral pump to circulate heated water from the domestic hot water heater through the fan coil, thereby utilizing that domestic hot water heater to provide both hot water and heat for the unit. The heat is distributed by the fan, which blows air over the hot water coil. The cooling is accomplished with a DX (Direct Expansion) coil in the unit coupled to a remote condensing unit, which can be roof or grade mounted. Further savings may be realized if the condenser can be through wall mounted in the unit. One of the potential drawbacks of this system is that it can reduce the life span of the water heaters because they often work harder to keep up with the heating demand.

This type of system is currently being installed at Quail Run, a 138,000 square foot, nine building, wood-framed residential complex in Stoughton, Massachusetts. When finished, the complex will be equipped with a very functional and economical decentralized fan coil system with remote condensing units and dual-purpose domestic hot water heaters. This system features simplicity of control, but will have a relatively short service life. A less skilled maintenance staff than is necessary at Kimball

Quail Run Apartments *Stoughton, Massachusetts*

Woods can maintain it.

The **gas fired furnace with a-coil and remote condenser** option is very similar to the system described above, except instead of getting heat from the hot water heater, it uses a gas fired furnace within the fan coil to heat the air, which is then distributed throughout the unit. The unit requires a flue vented to the outside to exhaust products of combustion. The cooling is provided exactly the same as the system described above.

The most commonly used name for **a self-contained packaged heat and A/C through wall system** is "Magic Pak." It is fully self-contained – all the cooling and heating equipment, including the compressor, comes complete in one unit. It requires mounting on an outside wall with an exterior louver for air supply. There is no flue pipe required because exhaust air is discharged through the unit's louver. The system is very compact with all the components placed together. The trade-off is that the unit occupant is more likely to have issues with noise due to the close proximity of the compressor to the living space.

All of the decentralized options are individually controlled within the units, so the tenants have complete control of any changeover from heating to cooling. The systems are also readily individually metered. This works for both the tenant and the landlord or condominium association because the resident can control his/her own comfort level, but also has the responsibility for all the utility payments.

The breakdown of centralized and decentralized is not finite. The physical makeup of a building often predicates which HVAC category it will fall into but, once that decision is made, the possibilities get broader and the developers' preferences come into play. They must consider initial cost, maintenance, aesthetics, and much more. Understanding the benefits, drawbacks, capabilities and limitations of each system will go a long way to making the right choice for your project.

HVAC Comparison Matrixes

Centralized Residential HVAC Systems– New England Area			
Systems Options	***Option 1:*** 4 Pipe Vertical Stacked Fan Coil Units	***Option 2:*** 2 Pipe Vertical Stacked Fan Coil Units	***Option 3:*** Water Source Heat Pumps Vertical Stacked
Selection Criteria			
First Cost	highest	medium to high	medium
Operational Costs*	lowest	average	average*
Utility Metering to units	no	no	some
Seasonal Change over	by building mgr**	by building mgr	by building mgr**
Maintenance cost	high	average	average
Performance	very good	good	good
Replacement Costs	average to low	average	average
Electric Utility	required	required	required
Gas or Oil Utility	required	required	required
* Some Costs can be metered to tenant			
** Residents have some flexibility to choose cooling or heating			

Decentralized Residential HVAC Systems– New England Area			
Systems Options	***Option 1:*** Fan Coil Units with Integral Pumps Coupled to Domestic Water Heater, Remote Condenser	***Option 2:*** Gas Furnace with A-Coil and Remote Condenser	***Option 3:*** Self Contained Packaged Heat and AC Thru-Wall
Selection Criteria			
First Cost	lowest	medium to low	low
Operational Costs*	lower*	average*	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 to high	average	average
Electric Utility	required	required	required
Gas Utility	required	required	required
Uses Domestic HW heater for space heating	yes	no	no
* Costs can be metered to tenant			
Relative cost assumes similar usage and setpoints, costs will vary depending on tenants requirements			

Biographies of the Authors:

Jeffrey Ellowitz is the Manager of Erland Construction's Residential Group. He has been at this Burlington, Massachusetts-based construction management company for more than 20 years.

Joseph O'Connor is Erland's Director of Mechanical Systems and Senior Mechanical Estimator. He has more than 16 years of experience in the construction industry, as both an Estimator and Project Manager.

In preparing this article, they were assisted by Katie Fay of Erland's Marketing Department.