CASE STUDY

Variable Refrigerant Flow (VRF)

Concord Park

Until recently, the number one complaint heard at Concord Park, the senior community next to the West Concord train station, concerned room temperatures. What some of the approximately 100 residents found too warm, others found too cold. But in 2019 Concord Park solved the problem, by getting rid of its 18-year-old gas boilers and conventional AC units. It replaced them with cold-climate air source heat pumps.

Behind the facility, 12 heat pump condensers can extract hundreds of tons of heat every hour, even from frigid winter air.

Photo Above: Drone view of Concord Park after its $20 million expansion, renovation and conversion to heat pump heating and cooling.

Specifically, with *variable refrigerant flow* (VRF) cold-climate air source heat pumps.

Homeowners considering heat pumps are often reluctant to dispense entirely with fossil fuel heating systems. But Matt Lane, Vice President of Real Estate Development at Volunteers of America of Massachusetts, which owns and runs Concord Park, said he and his colleagues were on board with the decision.

"What convinced us was the reliability of today's heat pumps, plus the availability of variable refrigerant flow," he said.

All heat pumps use a chemical refrigerant to pipe heat from place to place. During the cooling season, the refrigerant carries excess heat from inside outside. During the heating season, outdoor condensers extract heat from the outside air, and the refrigerant carries it inside. A VRF system does more. By continually varying the volume of refrigerant in its conduits, it can deliver precisely the desired amount of heating or cooling to many different interior spaces.

This makes VRF ideal for multi-unit living facilities. But Concord Park opted for something more efficient still: a VRF system with heat recovery. Such systems scavenge waste heat from spaces being cooled and deliver it to locations that need heating.

In practical terms, this means that

- while one person's living quarters are being heated, another's, even right next door, can be cooled.
- a south-facing room that receives lots of sunlight can share its excess warmth with a north-facing room that receives little sunlight.
- a hot kitchen can be cooled while nearby common areas receive exactly the amount of heat each requires.

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The Project at a Glance

Components: The system consists of 12 Mitsubishi PURY-P VRF condenser units capable of extracting 220 tons of heat every hour from the outdoor air when the outdoor temperature is 8 degrees. A 13,209-foot piping network leads from the condensers to 201 indoor units, both ductless heads and ducted air handlers. Indoor units for one industrial-sized kitchen have yet to be installed. Ultimately, the system will heat and cool 65,319 square feet of space.

Installed: **2019**

Cost of the new heat pump system:
$4.72 million

Commercial Rebate Received from Mass Save:
$485,625

A worker installs insulated ducts at Concord Park. Insulation is key to a successful heat pump system.

By making use of waste heat, VRF systems with heat recovery are up to 30 percent more efficient than conventional heat pump systems. They are also about 20 percent more expensive. More important than cost or efficiency, however, if you are a Concord Park resident, is whether the system will keep you warm in the depth of a New England winter.

Would the system continue to function down to minus 13 degrees, as the warranty promised? When the temperature plunged to minus 12 in February 2023, Concord Park's system proved its resilience, maintaining comfort without resorting to backup generators. "There were no issues," Lane says.

Credit for which must also go to weatherization. Prior to the Concord Park expansion and renovation, Lane says, an infrared analysis was conducted to identify areas with missing or compromised insulation in the walls and roof. Correcting these deficiencies maximized thermal performance, while reducing heating and air conditioning costs. Moreover, new energy efficient windows were installed throughout the three-story, 65,319-square-foot structure.

Where possible, South Coast Construction, the company hired to convert Concord Park's HVAC, also attempted to use the most efficient indoor heat pump components available, that is, the ductless units known as "heads." Some of these were wall-mounted, others, called "ceiling cassettes," were embedded in the ceilings. With a minimum of heat loss, both kinds extract excess heat when cooling and deliver heat from the outdoor condensers when heating. One of them has the capacity to heat or cool a large common room or long hallway. They dehumidify, too.

Not all of Concord Park's refrigerant piping connects to ductless heads, however. Some leads to air handlers concealed in utility rooms and above ceiling panels. From there, ducts branch out to locations that cannot accommodate ductless units—angled ceilings on the third floor, for example—and also to locations requiring extra ventilation. In addition to providing heating, cooling, dehumidification and fresh air, the ducts have been laid out in a way that prevents cross-contamination of residents' quarters in the event of a disease outbreak.

Ryan Nealley, who served as project manager and mechanical lead engineer, believes heat pumps have a place in businesses and homes well beyond Concord Park. "Massachusetts has a good climate for the current capabilities of heat pumps," he says.