



VRF Case Study

Finch Cambridge Housing Complex

GENERAL INFORMATION

Building Owner: Homeowner's Rehab, Inc. (HRI) – A local non-profit affordable housing developer in Cambridge

Location: 671-675 Concord Ave
Cambridge, MA 02138

Year Built: 2018 – 2020

Square Footage: 125,000 Gross Square Feet

Building Characteristics: A passive house certified, affordable, 98-unit apartment building.

PROJECT OVERVIEW

Cambridge, Massachusetts is located in Greater Boston and sits across the Charles River from Boston. Although it is best known for being home to two distinguished universities – Harvard University and the Massachusetts Institute of Technology (MIT) – this city is also known for its long list of wonderful attractions, its technology-based enterprises and its charming neighborhoods. With all of these amenities, living in Cambridge comes at a high cost, as affirmed by the relentless increase in rent since the mid-1990s. To help address the city's current need for affordable housing and to play a part in combatting the current climate crisis, Homeowner's Rehab, Inc. (HRI) developed Finch Cambridge.

Finch Cambridge is a new six-story mid-rise apartment community comprised of 98 rental units

of 1-3 bedroom apartments. It is located in the Cambridge Highlands neighborhood, directly across from the Fresh Pond Reservation and conveniently close to grocery stores, restaurants, shopping centers, fitness establishments, and the Alewife MBTA station.

Designed to meet the PHIUS+ 2015 Passive Building Standard¹, the world's most energy efficient building standard at the time of building design, this airtight building has a layer of continuous exterior insulation that, in effect, creates a blanket around the entire building. Finch Cambridge's two main energy recovery ventilators (ERVs) provide a balanced flow of air into and out of the building and help to manage humidity. Its large triple-glazed windows offer beautiful views of the Fresh Pond Reservation while succeeding to lock out all air flow when closed and helping to maintain the building's interior temperature by taking advantage of the sun's heat in the winter and deflecting it in the summer. The 106-kilowatt array rooftop solar panels are projected to offset 116,160 kilowatt-hours per year,



¹Passive House Institute US, PHIUS+ 2015: Passive Building Standard -- North America, <https://www.phius.org/phius-2015-new-passive-building-standard-summary>

which represents about 20 percent of total electricity required to operate the building. The most exciting characteristic for heat pump enthusiasts is the use of variable refrigerant flow (VRF) systems for its minimal heating and cooling requirements.

In designing Finch Cambridge, one of Icon Architecture's goals was to give the building's heating and cooling systems very little to do.

"With airtightness and thermal continuity and control, the building envelope is doing the bulk of the work that we typically rely on our systems to do, maintaining interior temperature regardless of what's happening outside the building"
- Michelle Apigian, Lead Architect

With that consideration, heating and air conditioning for Finch Cambridge is provided by VRF and air source heat pump (ASHP) systems that provide simultaneous heating and cooling. These systems consist of rooftop outdoor condensing units coupled with indoor heat pump units. An indoor heat pump unit is located in each unit space with a dedicated remote thermostat/temperature sensor. The systems are connected through a network of refrigerant pipes, and are overseen/controlled by a centralized packaged controller by the manufacturer of the VRF system, Mitsubishi. The indoor equipment consists of various S-Series R-410A Mitsubishi heat pumps, while the outdoor heat pump condensing units are Mitsubishi R2-Series R410A Systems, with one S-Series R410A outdoor unit. Similarly, the branch controllers are all various models



of Mitsubishi R2-Series R410A outdoor BC controllers (see the tables below for specific information on the installed outdoor and indoor units). Energy cost estimates for these systems were based on Energy Information Administration (EIA) data from October 2017 – a commercial natural gas price of 10.10 dollars per thousand cubic feet and a residential sector electricity price (for Massachusetts) of 19.35 cents per kilowatt-hour.

The building's passive house certification will make it considerably cheaper to heat and cool than a typical building – it is projected to be 70 percent more energy efficient than the 2016 national average for multifamily buildings². Residents will have control of the temperature inside of their individual apartments with the option for simultaneous heating and cooling for different apartments. As the building utilizes very efficient energy recovery ventilators serving each unit and living space, the indoor air quality is expected to be very high. Since residents started to occupy the building in August, 2020, feedback has been overwhelmingly positive. In general, there is expected to be an ongoing high level of resident satisfaction within the walls of this passive house building – occupants are envisioned to enjoy a very quiet building with state-of-the-art controls that will lead to consistent comfort and fewer maintenance issues.

²Energy Efficiency in Multifamily Rental Homes: An Analysis of Residential Energy Consumption Data, <https://www.nmhc.org/content-assets/bd412df7b54b4ebc8f4c85c4344990c5/obrinisky-and-walter-energy-efficiency-in-multifamily.pdf>

The VRF Units:

Indoor Units: 149 Mitsubishi S-Series R-410A indoor heat pump units

# of Units	Cooling Capacity (BTU/H)	Heating Capacity (MBH)	Type
91	12,000	13.5 @ 47°F; 8.1 @ 5°F	Concealed Vertical Ducted
26	18,000	20 @ 47°F; 12 @ 5°F	Concealed Vertical Ducted
11	6,000	6.7 @ 47°F; 4.0 @ 5°F	Wall Mounted Cassette
1	8,000	9.0 @ 47°F; 5.4 @ 5°F	Wall Mounted Cassette
1	12,000	13.5 @ 47°F; 8.1 @ 5°F	Wall Mounted Cassette
8	15,000	17 @ 47°F; 10.2 @ 5°F	Wall Mounted Cassette
3	8,000	9.0 @ 47°F; 5.4 @ 5°F	4-Way Ceiling Recessed Cassette
1	12,000	13.5 @ 47°F; 8.1 @ 5°F	4-Way Ceiling Recessed Cassette
1	15,000	17 @ 47°F; 10.2 @ 5°F	4-Way Ceiling Recessed Cassette
2	18,000	20 @ 47°F; 12 @ 5°F	4-Way Ceiling Recessed Cassette
3	6,000	6.7 @ 47°F; 4.0 @ 5°F	Floor Mounted
1	18,000	20 @ 47°F; 12 @ 5°F	Horizontal Concealed Ducted

Outdoor Units: 13 units including Mitsubishi R2-Series R-410A outdoor heat pump condensing units and one Mitsubishi S-Series R410A outdoor heat pump condensing unit.

# of Units	Cooling Capacity (BTU/H)	Heating Capacity (MBH)
1	144,000	160 @ 47°F; 96 @ 5°F
9	120,000	135 @ 47°F; 81 @ 5°F
1	72,000	80 @ 47°F; 48 @ 5°F
1	96,000	108 @ 47°F; 64.8 @ 5°F
1	36,000	42 @ 47°F; 25.2 @ 5°F

Branch Controllers: Mitsubishi R2-Series R410A outdoor BC controllers (various models installed).

Rebates Used: The project received a \$147,000 grant from Massachusetts Clean Energy Center Passive House Design Challenge to help make the building more energy efficient. In addition, the project received MassSave Passive House rebates.