



Building America Case Study

Low-Load Space-Conditioning Needs Assessment

Northeast and Mid-Atlantic

PROJECT INFORMATION

Construction: New

Type: Multifamily apartments, attached single-family dwellings

Consortium for Advanced Residential Buildings, carb-swa.com

Building Component: Space conditioning

Size: 209 ft²–2,895 ft²

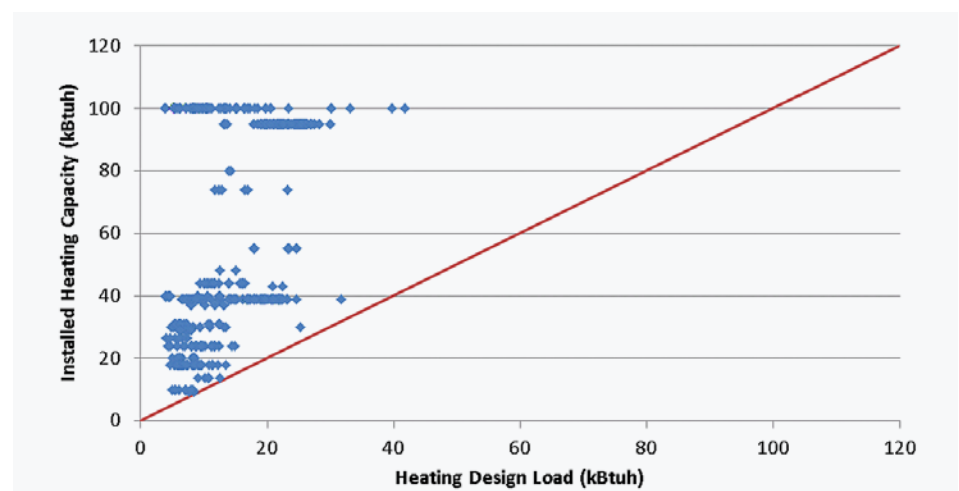
Climate Zones: Cold, mixed-humid

DATABASE ATTRIBUTES

- Dwelling unit characteristics: Location, floor level, position, square footage, volume, total and exposed enclosure area, window-to-wall ratio, construction type, unguarded blower door results, etc.
- Design heating and cooling load from REM/Rate™
- Installed heating, cooling, and whole-house ventilation equipment make, model, efficiency, and capacity.

Low-load options in the heating, ventilating, and air-conditioning (HVAC) market are limited, so many new-construction housing units are being fitted with oversized equipment that results in penalties in system efficiency, comfort, and cost. To bridge the gap between currently available HVAC equipment and the rising demand for low-load HVAC equipment in the marketplace, HVAC equipment manufacturers need to be fully aware of the needs of the multifamily building and attached single-family home markets. Over the past decade, Steven Winter Associates, Inc. has provided certification and consulting services for hundreds of housing projects and has accrued a large pool of data that describe multifamily and attached single-family home characteristics. The U.S. Department of Energy’s research team Consortium for Advanced Residential Buildings (CARB) compiled and analyzed these data to outline the characteristics of low-load dwellings, such as the heating and cooling design loads.

Design loads from 941 dwellings across the Northeast and Mid-Atlantic were analyzed. Within this data set, CARB found that only 1% of the dwellings had right-sized (within 25% of design load) heating equipment and 6% had right-sized cooling equipment.



Comparing heating design load versus equipment capacity

Low-Load HVAC Specification

Air handling unit with electronically commutated motor fan

- Airflow rate: up to 450 CFM at 0.5 in. external static pressure
- Power consumption: 20–100 Watts
- 1-in. minimum efficiency reporting value, 8 filter minimum.

Heating performance

Heat pump:

- $\geq 12,000$ Btu/h at 0°F (at maximum capacity operation) with variable capacity with modulation down to 3,000 Btu/h
- Coefficient of performance at 5°F >2 (at maximum capacity operation).

Furnace:

- 4,000–20,000 Btu/h (variable capacity)
- Sealed combustion
- 94+% annual fuel utilization efficiency.

Cooling performance

Heat pump/air conditioner:

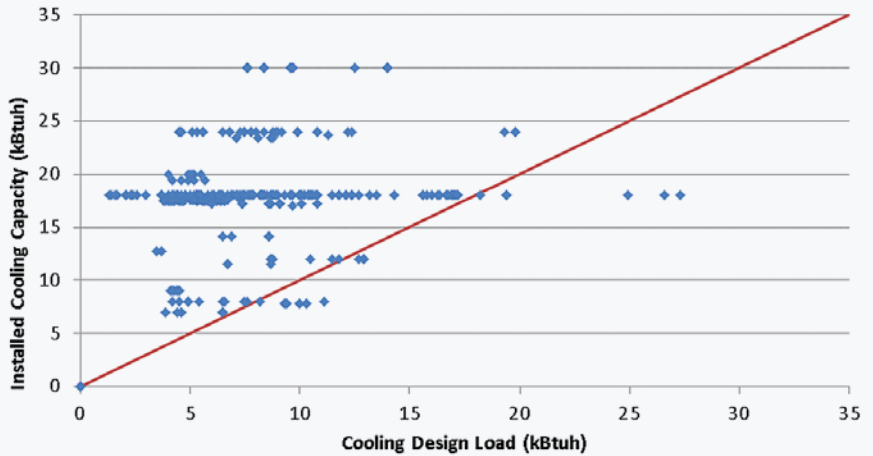
- 3,000–12,000 Btu/h at 95°F (variable capacity)
- Seasonal energy-efficiency ratio ≥ 18 , energy-efficiency ratio ≥ 13
- Sensible heat ratio: ~65% for humid climates, ~85% for dry climates
- Dry-mode operation to enhance dehumidification without overcooling.

Energy/heat recovery ventilator with electronically commutated motor fan(s)

- Airflow rate: up to 80 cfm at 0.2-in. external static pressure (variable rate that is user/contractor specified)
- Power consumption: 10–50 Watts
- Apparent sensible effectiveness: 80% minimum at 32°F
- Total recovery efficiency: 60% minimum at 95°F
- Single-wall penetration by making use of concentric or tandem ducting
- Air filtration for all airstreams.

For more information see the Building America technical report *Low-Load Space-Conditioning Needs Assessment* at buildingamerica.gov.

Image credit: All images were created by the CARB team.



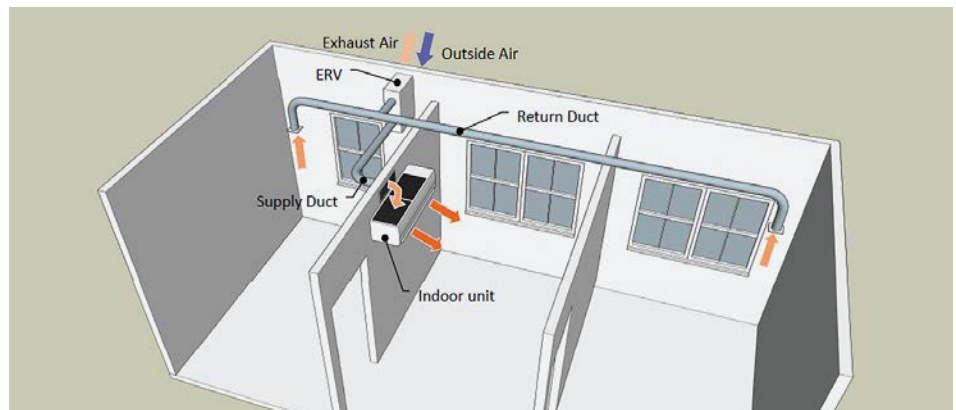
Comparing cooling design load and equipment capacity

More than 75% of the heating and cooling design loads for multifamily apartments in the data set were lower than 12 kBtu/h. For the attached single-family dwellings, more than 75% of the heating design loads were 25 kBtu/h or lower. The cooling design loads were similar to those in the multifamily dwellings. Therefore, CARB outlined a low-load HVAC specification (see sidebar) for equipment manufacturers to provide a roadmap for developing appropriate HVAC equipment for low-load dwellings.

Potential Low-Load Solution

With currently available technologies, CARB has successfully used an all-electric approach with:

- Inverter-driven air-source heat pump(s)
- Heat or energy recovery ventilator configured to also serve as an internal distribution system for point-source or minimally distributed space-conditioning system(s).



This figure shows a method to integrate whole-house ventilation with point-source space conditioning to provide better distribution throughout the living space.