

Building America Efficient Solutions for New and Existing Homes

Impacts of “Right Sizing” of Fixed Capacity (SEER 13) and Variable Capacity (SEER 22 and 21) Heat Pumps with Attic and Indoor Ductwork

Cocoa, Florida



PROJECT INFORMATION

Project Name: Draft Report: Cooling and Heating Season Impacts of “Right Sizing” of Fixed Capacity (SEER 13) and Variable Capacity (SEER 22 and 21) Heat Pumps with Attic and Indoor Ductwork

Location: Cocoa, FL

Building America Partnership for Improved Residential Construction
www.ba-pirc.org

Building Component: HVAC

Application: New and/or retrofit; Single and/or multi-family

Years Tested: 2010-2013

Applicable Climate Zone(s): IECC climate zones 1-4

PERFORMANCE DATA

Net Cost of Energy-Efficiency Measure (SEER 21 vs. SEER 13): \$3,500

Projected Energy Savings: 3,800 kWh/y

Projected Energy Cost Savings: \$440/y

A new generation of central, ducted variable-capacity heat pump systems has come on the market, promising very high cooling and heating efficiency. They are controlled differently than standard fixed-capacity systems. Instead of cycling on at full capacity and then cycling off when the thermostat is satisfied, they vary their cooling and heating output over a wide range (approximately 40 to 118% of nominal full capacity), thus staying “on” for 60% to 100% more hours per day compared to fixed-capacity systems. It should be noted that 2-stage systems were not evaluated in this research effort.

Experiments examined the performance of 2-ton and 3-ton fixed- and variable-capacity systems and the impacts of system oversizing. Measured results found that the 2-ton and 3-ton variable-capacity heat pumps each show a pattern of much higher cooling efficiency at low capacity. The 3-ton heat pump, for example, is 41% more efficient when operating at 42% of maximum capacity versus when operating at 84% of maximum capacity (Figure 1, pg 2). Monitored energy consumption over 24 months at a highly instrumented lab house (Figures 2 and 3, pg 2) found that oversizing a SEER 21 variable-capacity system yielded 8.0% cooling energy savings and 1.5% heating energy savings. By contrast, oversizing a fixed-capacity SEER 13 system yielded an 8.4% increase in cooling energy and a 0.7% reduction in heating energy.

Even more impressive results occurred during peak periods. Peak cooling demand declined by 15.7% and peak heating demand declined by 10.1% when the variable-capacity system was increased in size from 2 to 3 tons. By contrast, peak cooling demand increased by 1.0% and peak heating demand increased by 11.9% when the fixed-capacity system was increased in size from 2 to 3 tons.

DESCRIPTION



Figure 2. AHUs for SEER 13 (top) and SEER 22 (bottom) 2-ton heat pumps can be connected to indoor or attic ducts.



Figure 1. Temperature, humidity, and air flow instrumentation at entry to AHU monitors system operation in real time.

*Oversizing generally reduced both seasonal and peak energy consumption for the variable-capacity systems. For the fixed-capacity systems, oversizing generally increased both seasonal and peak cooling and heating energy consumption.

For more Information, refer to

Phase I Report:
<http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1927-11.pdf>

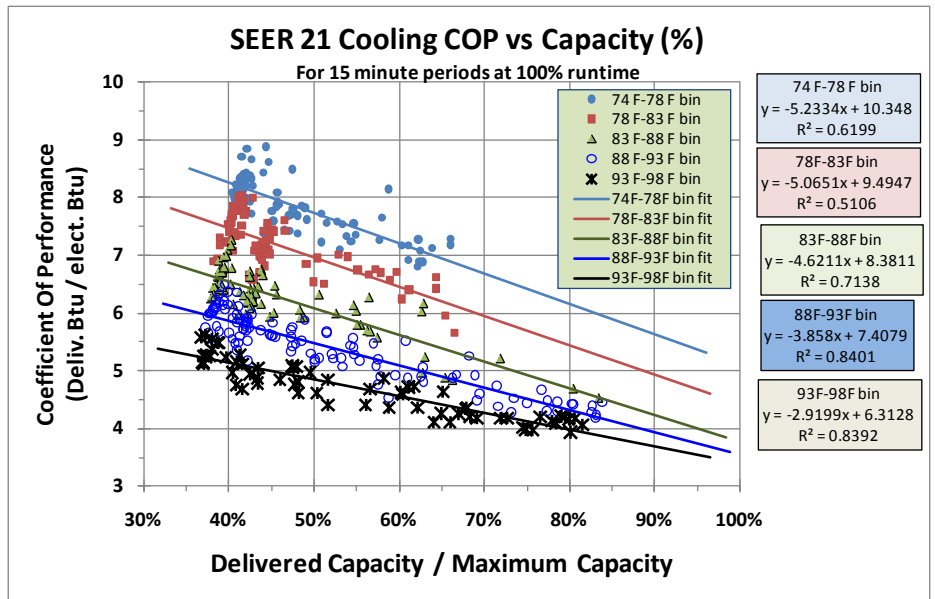


Figure 1. Measured cooling COP versus capacity fraction for a variable-capacity 3-ton SEER 21 system for various outdoor temperature bins.

Lessons Learned

- Oversizing of fixed-capacity SEER 13 heat pumps systems generally causes a significant increase in seasonal cooling and heating energy consumption and peak cooling and heating demand.
- By contrast, oversizing of variable-capacity SEER 21 heat pumps systems generally produces substantial decreases in seasonal cooling and heating energy consumption and peak cooling and heating demand.
- Oversizing of heat pumps has the additional advantage of diminishing the frequency of electric resistance back-up heating being activated, thus yielding considerable seasonal and especially peak demand heating energy reduction.
- The authors conclude, therefore, oversizing of variable-capacity heat pumps should be permitted and even encouraged since oversizing produces substantial energy and peak demand savings. Codes, standards, and programs that limit oversizing of systems should be evaluated and likely modified to encourage or at least permit significant (perhaps 50 to 100%) oversizing of variable-capacity systems.

Looking Ahead

It is a widely held belief that oversizing of fixed-capacity cooling systems prevents them from producing acceptable indoor relative humidity. The fact that a greatly oversized 3-ton SEER 13 system produced indoor relative humidity that was below 50% most of the time and lower than that produced by a 2-ton SEER 13 system argues that additional study of the parameters impacting relative humidity control should be performed.