Developing VRF System Credits for the Florida Energy Code

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Rationale & Need for Proposed Work:

The commonly used code compliance software does not have modeling capabilities for VRF systems, and the 2014 Florida Building Code – Energy Conservation does not have an alternative procedure or provision for assessing credits for VRF systems code compliance. Thus, Florida homes' residential code compliance calculations cannot claim credits for installing VRF systems.

However, VRF system modeling capabilities exist in the Department of Energy's whole building energy modeling tool, such as EnergyPlus. Therefore, relative performance and operation strategy benefits of VRF systems can be investigated against conventional HVAC systems in residential homes using this tool to provide quantitative guidance for code compliance calculations.

The relative energy saving potential of VRF HVAC systems compared to conventional HVAC systems can be estimated using computer simulations. Such computer-based simulation studies may provide energy savings data that will help the Florida Building Commission develop the Florida Energy Code for residential VRF system credits calculation.

Background:

Variable refrigerant flow (VRF) HVAC systems have certain energy savings features that make them attractive compared to conventional residential HVAC systems such as split AC or heat pump (HP) systems, especially those with ductworks installed in attics. The VRF's energy saving features applicable to residential buildings include:

- Reduced fan electric energy
- No or low duct losses (leakage and conduction)
- Individual zone thermostat control

VRF HVAC systems are not modeled in commonly used code compliance software. Also, the 2014 Florida Energy Code does not have the provision or provide alternative VRF system credits for residential code compliance. Thus, homeowners and builders cannot claim credits for installing an "energy cost-effective" VRF system.

VRF systems may provide annual cooling and heating energy savings compared to some conventional central-packaged AC with furnace or packaged HP systems. VRF system fan

electric energy use is significantly lower (4 - 5 times less) than ducted AC and HP system due to smaller external static pressure seen from the VRF fan. The most common VRF system designs do not involve any ductworks; hence, any losses (conduction and leakage) associated with the duct work can be minimized or eliminated completely. Duct leakage in Florida homes can increase the cooling and heating energy use by 33% (Cummings et al., 1991). Hence, VRF systems, which do not have duct work, can save cooling and heating energy compared to conventional HVAC systems with duct work installed in the attics.

The individual thermal zone or terminal unit control capability of a VRF system provides an opportunity for a potential energy savings strategy using thermostat setback and setup scheduling of individual zones during days and nights. For instance, turning off the living zone thermostat completely or applying thermostat resetting during the night over an extended period may save a significant fraction of the annual cooling and heating energy use. A conventional residential-packaged AC with furnace and packaged HP system design does not have the flexibility to control individual zones.

Scope of Work:

Task 1: Identify Climate Zones and Cities

Identify three to four major cities in the state of Florida where the VRF system is going to be investigated. It is envisioned that the VRF system will be investigated in the following cities: Miami, FL (1A), Tampa, FL (2A), Gainesville, FL (2A), and Tallahassee, FL (2A).

Task 2: Prototype Homes Design

Two different size homes (2000 and 4000 ft^2) will be identified for this project; a typical size home and a large size home. This effort requires the creation of a computer model of prototype homes with VRF systems and conventional HVAC systems that are typical in Florida for the two climate zones and cities. The HVAC systems proposed for this investigation are:

- Split AC with gas furnace
- Split heat pump with electric supplemental heater
- VRF heat pump or heat recovery system

One of the key advantages of VRF systems are that they are ductless. Since all software has to account for duct gains and losses, the ducts of the comparison case will be modeled inside so at to capture the other features of the VRF. The prototype homes with VRF HVAC systems will be modeled with a constant set point and with thermostat setbacks for the bedrooms and the living room. The parametric run combinations result in 4 test cases for each prototype house in each city resulting in 32 simulation runs. The home envelope and internal gains will be based on the 2014 Florida Building Code requirements. Representative manufacturer data will be used to represent the fan power calculation of VRF system, split AC and heat pump systems.

Task 3: Computer Simulations

In this task, the various home configuration and characteristics of HVAC systems will be investigated using computer simulation. The inputs and assumption are critically scrutinized until the simulation results are reasonable. This will be completed for each test case combination based on climate zone or city, HVAC type, and home size.

Then the annual cooling and heating energy savings potential of each test case combination of the VRF system and conventional HVAC system is determined from the simulation results. The annual cooling and heating energy difference between the conventional and the VRF HVAC system design establishes the annual energy savings due to the VRF system. The results will be categorized by home size, climate zone, and HVAC type.

Task 4: VRF System Credits for Residential Code

Develop a schema for estimating the VRF system credits for residential Florida code calculation based on home size, Florida cities, HVAC system type, and VRF system thermostat setting strategy.

Task 5: Write Final Report

Write a final report containing the analysis, home description, HVAC system description, assumptions, estimated annual energy savings, and scheme for the VRF HVAC system credits calculations.

Budget:

Approximately $24,000

Deliverables:

FSEC will deliver a final report describing the purpose, method, and findings of the investigation and annual energy savings potential of the VRF system compared to the conventional AC with furnace or packaged HP system based on home size, Florida cities, and ductwork location.

The outcome of this report is to provide the annual energy savings potential of VRF systems in Florida. It is anticipated that the report provides data that could be used by the Florida Building Commission to establish basis for the VRF system installation credits calculation for residential code.

References:

Cummings, J., Tooley, J., Moyer, N. (1991). *Investigation of Air Distribution System Leakage and Its Impacts in Central Florida Homes*. Prepared for the Governor's Energy Office. FSEC-CR-397-91.

Florida Building Code – Energy Conservation, 5th edition. (2014).