

(4) Closing the Gap: Getting Full Performance from Residential Central Air Conditioners

This two-year project includes the development of next-generation central air-conditioning performance ratings, development and demonstration of a central air conditioner for hot/humid climates, and HVAC contractor training.

Total project cost: \$1,534,716

Funding request: \$683,179

Project Lead: New York State Energy Research and Development Authority

Project Participants: Florida Solar Energy Center; Advanced Energy; Energy Center of Wisconsin, American Council for an Energy-Efficient Economy; CDH Energy; Wisconsin Energy Conservation Corporation, Lawrence Berkeley National Laboratory

Patents

None

Publications/Presentations

In Quarters 2 and 3, Wisconsin Energy Conservation Corporation prepared and released a draft write-up summarizing field test data on the operating characteristics of central air conditioners in Wisconsin and Minnesota.

Progress in Past Quarter and Current Status

Task 1 Improve central air conditioner performance ratings

Task 1.1 Review present standards and method of testing

Task 1.2 Field performance data review

Task 1.3 Develop population weighted temperature bin-hour distributions

Task 1.4 Preliminary proposed rating procedures

Task 1.5 Simulate benefits of alternative metrics for diverse climates

Task 1.6 Analysis and recommendations

(Status—ongoing) The Center had no activity in this area during the reporting period.

FSEC Contribution: Task 1 will be primarily completed by other project partners. However, UCF/FSEC met with CDH Energy and ACEEE personnel (NYDERSA subcontractors) during the ASHRAE Winter Meeting in February 2005 to discuss the analysis methodology for Task 1.3. In the coming months, UCF/FSEC will provide additional assistance with developing the analysis plan and reviewing the results for Tasks 1.3 and 1.5, and will review various task deliverables as required.

Task 2 Robust Feature Set for Residential Air Conditioners

Task 2.1 Develop trial specification sets

Task 2.2 Draft specification

Task 2.3 Consensus-building workshop

Task 2.4 Coordinate with manufacturers

(Status—ongoing) Task 2 will be primarily completed by other project partners (NYSERDA and its subcontractors). The Center had no activity in this area during the reporting period.

FSEC Contribution: Task 2 will be primarily completed by other project partners (NYSERDA and its subcontractors). So far, UCF/FSEC has assisted on Task 2.1 with developing trial specification sets and assisting with development of the analysis methodology. Simulations will be completed in the coming months by NYSEERDA (subcontractor CDH Energy) and UCF/FSEC will review and comment on the results. UCF/FSEC will also review the full draft specification developed by NYSEERDA (subcontractor ACEEE) for Task 2.2.

Task 3 Field Performance Data and Innovation

Task 3.1 Ratings and Field Performance

Task 3.2 Benefits of proper sizing

Task 3.3 Research using 2-stage systems

(Status—ongoing) The Center continued recruiting and field monitoring under Tasks 3.1, 3.2 and 3.3 during the reporting period. Testing and installation of monitoring equipment was performed for the remaining sites under Task 3.1, bringing the total number of tested and monitored sites to 50. Monitoring of two sites continued under Task 3.2, with swap-out of larger systems occurring in early August for one site, and early September for the other. Monitoring of 5 sites (of 20 total) continued under Task 3.3 (including three sites that were also monitored last year).

FSEC Contribution: The goal of Task 3.2 is to show the benefits of proper air conditioner sizing to contractors, customers and utilities. Field tests are being conducted in 8 case study homes (4 homes in Florida tested by UCF/FSEC and 4 homes in Wisconsin tested by ECW).

As a result of post-retrofit monitoring difficulties last summer due to the Florida hurricanes, additional post-retrofit monitoring was conducted at the Merritt Island and Lakeland project homes this summer. The air conditioner at each home was tested prior to the additional monitoring to ensure that the systems were still performing properly, then monitoring was conducted for approximately 2 months. A temperature and relative humidity logger was also sent to the North Port homeowner to obtain some additional indoor conditions data for that site with its new AC system.

Earlier results showed higher airflows per ton of AC for the new, properly sized AC systems compared with the original oversized systems in all four project homes. Efforts were made during system installation to reduce air flows even further, but the minimum fan setting still yielded higher-than-desired air flow rates. Two of the four homeowners also reported noticeably lower air velocities from the supply registers. So this summer a test was conducted in the Lakeland home to determine if restricting the supply ducts at the registers would reduce the overall airflow rate while also increasing air velocity from the registers. The test yielded a somewhat lower overall airflow rate and noticeably higher air velocities entering the living space with the supply register restrictions in place.

Homeowners who agreed to participate in the project were given the choice of keeping the new, properly sized equipment or having their original equipment reinstalled at the end of the project. The Jacksonville and Merritt Island homeowners had previously decided to keep the properly sized systems, while the Lakeland and North Port homeowners were undecided but leaning toward having their original systems reinstalled. This quarter the Lakeland homeowner decided to have the original system reinstalled (due to the properly sized system's lower supply register air velocities and higher relative humidity levels in the house) but the North Port owner is now leaning toward keeping the properly sized system pending analysis of the indoor temperature and RH data collected this summer.

Initial data analysis from last summer's monitoring, including preliminary plots of indoor conditions, power use and supply air temperatures, has previously been completed and reported. Additional data analysis has been initiated using this summer's post-retrofit data from the Merritt Island and Lakeland homes.

Task 4 Develop New Climate-Sensitive Air Conditioner Designs

Task 4.1 System Configuration: identification, simulation and cost-benefit analysis

Task 4.2 Prototype System: design, construction, laboratory and field testing

FSEC Contribution: UCF/FSEC personnel continued efforts to design an improved supply air fan control for the hot-humid climate air conditioner being developed as part of this project. During the previous reporting period, a fan control methodology was established and a home was located for testing. This quarter's efforts centered on identifying and acquiring the necessary instrumentation and equipment to implement the control strategy. HVAC equipment was selected and installation begun. Once the equipment selection was made, efforts concentrated on identifying and acquiring the proper devices to interface industry standard ECM motors with the datalogging and control equipment. The operating characteristics of these motors were also investigated and characterized.

A literature review and market survey were initiated to collect information regarding recent advances in high-efficiency residential air conditioning equipment and equipment with improved dehumidification performance. This included a thorough review of all published reports related to the high-efficiency residential air conditioner being developed in California for hot-dry climates. Manufacturer's product information, technical reports, and presentation materials were collected and reviewed. Additional information will be collected and reviewed during the next reporting period. We will also begin coordinating our efforts with New York-based ColdPoint Corporation who is developing an air conditioner optimized for northern climates through an on-going NYSERDA project.

During this reporting period, UCF/FSEC and NYSERDA subcontractor CDH Energy identified candidate system configurations for the hot-humid climate air conditioner. We also began developing a plan for computer modeling of these systems to determine their effectiveness and potentials for efficiency and dehumidification performance. The modeling plan will be completed and simulations initiated during the next reporting period.

Progress continued in preparing an existing UCF/FSEC laboratory facility for testing of the prototype unit being developed under this task. Key humidity measurement instruments were returned to the manufacturer for re-calibration. The need for additional humidity generation equipment was identified, and the necessary equipment will be selected and procured during the next reporting period.

Task 5 Information Dissemination and HVAC Contractor Training

(Status—not started) The Center had no activity in this reporting period. The Center’s portion of this task is scheduled to be completed later in the project.

FSCE Contribution: The training classes associated with this project have been included in a printed brochure that summarizes FSEC’s residential courses for 2005. The brochure was initially mailed to 2300 Central Florida contractors in March 2005. A second mailing occurred in July 2005.

Another brochure was developed and mailed to 2300 HVAC contractors in Florida for the course “Residential HVAC As If Energy and Comfort Mattered.” The course will follow another FSEC ½ day training course for contractors. Costs for the mailing and printing are being split. The courses are being held in Jacksonville, Panama City, Sarasota, Orlando, and Jupiter. Pre-registration in Jacksonville is very light, but other cities are good.

Registration for all of FSEC’s continuing education courses for 2005 is available on-line at http://www.fsec.ucf.edu/ed/contin_ed/courses.htm.

In August, FSEC held “Diagnosing Moisture Problems” at the Metro-Orlando Home Builder’s Association. Twenty-two people attended.

In September, the Class 1 energy rating workshop was held that trains and certifies energy raters with diagnostic tools. There were two international students, one from Venezuela and one from Puerto Rico, who attended this training.

For only the second time, the RESNET National Rater Core Test was administered by the Energy Gauge Office as another part of the certification process in the State of Florida. The RESNET National Core Test must be taken by all current certified Class 1 raters nationally before the January 1, 2008 deadline.

The first day of rater training consisted of lectures and labs. The lectures included the relationship between diagnostic testing and real life situations, building pressures and building pressure measurement as well as introduction to the blower door. There were two labs, one demonstrating pressures and another mainly to learn procedure and measurements using the blower door. Homework was given.

The second day of training consisted of duct lecture and lab as well as the Florida Class 1 written exam. A field trip to a home previously audited was also required to complete a Class 1 rating.

The third day of training began with the students doing a complete Class 1 rating on the Building America manufactured house lab. Each student, working alone, was responsible for a complete rating, including the scaled house sketch, field measurements and performance testing using the blower door and

duct blaster. They were also required to input the field data into the Energy Gauge software in order to produce a HERS score. After they completed that task they were taken to the Brevard Community College Learning Lab for the RESNET National Core Test which consisted of 50 questions and a two hour window to complete it. The final task was the Florida Performance test administered by the rater trainers.

All tests administered required a passing score of 80% or greater. The September training had 8 students. Of the 8 students, there were 5 students passing all 4 tests, with 1 of the 5 passing the RESNET National Core Test. There was one existing rater who also took the RESNET Core Test and passed. The students will be allowed to come back and re-take any tests they have not passed.

Plans for Next Quarter

Seasonal shut-down of monitoring activities will occur in Quarter 6. Monitoring equipment will be removed from all sites in Tasks 3.1 and 3.3. Additional data from next cooling season is needed for the two sites involved in Task 3.2. Compilation and analysis of the data will commence in Quarter 6.

FSEC Contribution:

- Provide further assistance to NYSERDA (subcontractor CDH Energy) in developing the analysis methodology for Task 1.3 and Task 1.5 as required.
- Review Task 2.1 simulation results (provided by NYSERDA subcontractor CDH Energy) as required.
- Largely complete the analysis of field data collected as part of Task 3.2, and start the final report for UCF/FSEC's portion of this task.
- Task 4: Continue development and field testing of the improved fan control strategy. Complete literature review and computer modeling plan. Continue preparing laboratory facilities for testing the prototype unit being developed under this project task.
- Task 5: Hold the ½ day HVAC course in four or five cities (depending on attendance).