

(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

None.

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

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 as requested with reviewing the results for Tasks 1.3 and 1.5, and will review various task deliverables as needed.

Task 2 Robust Feature Set for Residential Air Conditioners

Task 2.1 Develop trial specification sets

Task 2.2 Draft specification

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 NYSERDA (subcontractor CDH Energy) and

UCF/FSEC will review and comment on the results. UCF/FSEC will also review the full draft specification developed by NYSERSA (subcontractor ACEEE) for Task 2.2.

Task 3 Field Performance Data and Innovation

Task 3.2 Benefits of proper sizing

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

For the Florida portion of this task, additional post-retrofit monitoring conducted at the Merritt Island and Lakeland project homes during Summer 2005 is now complete and the monitoring equipment was removed from these homes during this reporting period. A temperature and RH logger had also been sent to the North Port homeowner to obtain some additional indoor temperature/humidity data during Summer 2005 for that new system. These data have now been retrieved and analyzed.

The Jacksonville and Merritt Island homeowners had previously decided to keep their new properly-sized AC systems. The Lakeland homeowner had previously had the original AC system re-installed. The North Port homeowner had been leaning toward keeping the properly-sized system pending her families' experience with the system and analysis of the indoor temperature and RH data collected in Summer 2005. After discussing the monitored indoor conditions from the summer, the homeowner has now decided to keep the new, properly-sized system.

Data Analysis

Analysis of the Summer 2004 monitored data, including preliminary plots of indoor conditions, power use and supply air temperatures, has previously been reported. Additional data analysis is now being completed using Summer 2005 post-retrofit data from the Merritt Island and Lakeland homes.

For the Merritt Island home, a preliminary three-day comparison of Summer 2005 data with pre-retrofit data was made this quarter. Results show lower average RH levels for the new, properly-sized system (consistent with Summer 2004 results) and also somewhat higher air handler power use for the new system (consistent with Summer 2004 AC power use results). Condenser power use data are not available for this site for Summer 2005 due to a sensor malfunction.

For the Lakeland home, a similar preliminary two-day comparison of Summer 2005 data with pre-retrofit data was made this quarter. Results show higher average RH levels for the new, properly-sized system (consistent with Summer 2004 results although the RH levels were somewhat lower than the Summer 2004 post-retrofit RH levels). The higher RH levels are largely due to the higher air flow rate (cfm/ton) across the cooling coil for the new properly-sized system despite reducing the supply air fan speed to its minimum setting. Results also show lower AC power use for the new system in Summer 2005 (which differs from Summer 2004 results which showed higher AC power use).

Summer 2005 monitored indoor conditions at the North Port home indicate that relative humidity levels for the new smaller AC system are averaging around 3% higher than those seen with the original larger system.

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

A literature review and market survey was initiated during that last reporting period 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 also collected and reviewed. Additional information was collected and reviewed during the present reporting period, including the most recent reports for the hot-dry climate air conditioner being developed in California.

During the previous reporting period, UCF/FSEC and NYSERDA subcontractor CDH Energy began identifying 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 was completed in November 2005, with input from NYSERDA subcontractor ACEEE, and was distributed to the project advisory committee for review. Feedback was requested by early December 2005, and comments were received from several committee members. Simulation efforts were initiated during the current reporting period and are scheduled for completion by March 2006.

The modeling plan included the definition of two residential buildings to be used for the analysis: a standard home (using the 2005 RESNET Standards, Section 303.4) and a high-efficiency home with higher wall and ceiling insulation levels, improved windows, high-efficiency equipment (e.g., indoor lighting, refrigerator and dishwasher), and forced air distribution system improvements. The annual cooling and heating loads for the high-efficiency home will be approximately 30% to 40% lower than those for the standard home. These defined building characteristics are also being used by CDH Energy for the simulations being performed as part of Task 2.

During the current reporting period, UCF/FSEC personnel also completed the development of a high-efficiency 27" condenser fan unit for the hot-humid climate AC unit. The unit includes an annular discharge air diffuser and a high-efficiency brushless DC motor. The unit consumes only .034 Watts per cfm of airflow (29 cfm/W), a 40% reduction compared to a standard fan and exhaust air assembly. This condenser fan unit design is also being tested and evaluated by the team that is developing the hot-dry climate AC unit in California.

Task 5 Information Dissemination and HVAC Contractor Training

The half-day course “Residential HVAC As If Energy and Comfort Mattered” was offered and held a total of 5 times this quarter in conjunction with another FSEC half-day training course for contractors. The courses were held in five Florida cities: Sarasota, Orlando, Jacksonville, Panama City and Jupiter. There were a total of 109 attendees, including contractors, utility employees, other industry personnel and the general public:

Sarasota -- October 12 th :	8 attendees
Orlando -- October 13 th :	26 attendees
Jacksonville -- October 18 th :	22 attendees
Panama City -- October 20 th :	40 attendees
Jupiter -- December 6 th :	13 attendees

In December 2005, the Class 1 Energy Gauge Rater Training workshop was held that trains and certifies Energy Raters to do house and duct airtightness testing in the state of Florida. A total of 9 people attended the workshop. Of those, 6 students passed the combined written and performance tests.

For the third time, during the Rater Training workshop, the RESNET National Rater Core Test was administered by the Energy Gauge Office as another part of the Rater certification process in the State of Florida. The RESNET National Core Test must be taken by all currently-certified Class 1 Raters before the January 1, 2008 deadline. Three of the nine students passed the Core test. The students will be allowed to come back and re-take any tests they have not passed.

Plans for Next Quarter

- Review Task 1.5 and Task 2.1 simulation results (provided by NYSERDA subcontractor CDH Energy) as required.
- Task 3.2: Additional, more in-depth data analysis (combining 2004 and 2005 monitored data where available) is now underway and should be completed by the end of the next quarter.
- Task 4: Continue development and field testing of the improved supply fan control strategy. Complete computer simulations of candidate system configurations and initiate a cost/benefit analysis of the various options.
- Task 5: The Class 1 Energy Gauge Rater Training workshop (that trains and certifies Energy Raters to do house and duct airtightness testing in the state of Florida) is scheduled to be held in March 2006. The RESNET National Rater Core Test will again be included as part of this workshop. Development of the 2006 schedule for offering the half-day course “Residential HVAC As If Energy and Comfort Mattered” will also be completed this quarter.