

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

Progress in Past Quarter and Current Status:

This progress report is prepared by the recipient agency, NYSERDA, and includes activities by all linked partners. Progress under each sub task is delineated by the linked partner responsible for performance.

Project Management

NYSERDA.ACEEE. The Project Advisory Committee is nearly completed. Please find attached a spreadsheet with names of the 12 members who have accepted, and four others from whom we are waiting for a response.

Members of the STAC Advisory Committee.

Person	Affiliation	Community	Status
National Institutions, Research			
Brian Dougherty	NIST	Standards	
Greg Rosenquist	LBNL	Standards	Pending (1)
Keith Rice	ORNL	Simulation	
Academics, Research			
Steve Kavanaugh	U.A.	Research	
Charlie Culp	TAMU	Research	
David Tree	Purdue Herrick Lab	Research	
Field Research			
Robert Mowris	Robt. Mowris Assoc.	Field Research	
John Proctor	Proctor Eng.	Field Research	
Mark Modera	Carrier AeroSeal	Field Research	
HVAC Industry			
Wayne Reedy	Carrier	Manufacturer	
Jim Mullen	Lennox	Manufacturer	
John Judge	York	Manufacturer	Pending (2)
Roy Crawford	Trane	Manufacturer	
Jason LeRoy	Trane	Manufacturer	
Government, Allies			
Chris Scruton	CEC	Policy	
Bill Pennington	CEC		Pending (1)
Utilities			
Pradeep Vitta	Southern Co.	Utility	
Lance Eberling	PGE	Utility	
Carlos Haiad	SCE	Utility	Pending (1)
Training, Technology Transfer			
Glenn Hourahan	ACCA	Trade Assoc.	
Pat Murphy	NATE	Training	

Notes:

- (1) Multiple Efforts to reach him have not yet succeeded
- (2) Proposes to nominate a residential representative of his firm.

The Technical Director (ACEEE) received and reviewed a draft document, *Field Operating Characteristics of Central Air Conditioners*, by Wayne DeForest of Wisconsin Focus on Energy. This work was prepared as part of Wisconsin's Match effort, and did not involve federal funds.

Task 1 Improve central air conditioner performance ratings

NYSERDA.CEC. This Task is co-funded by the California Energy Commission. The contracts among its funding group for this project (CIEE), ACEEE, and LBNL (recipients) were only completed during this Quarter: ACEEE received authorization to spend in early January. This has delayed work on Task 1, our first task.

Task 1.1 Review present standards and method of testing

No activity.

Task 1.2 Field performance data review

No activity.

Task 1.3 Develop population weighted temperature bin-hour distributions

NYSERDA.ACEEE.CDH We began work with CDH Energy to develop population-weighted temperature bin-hour distribution that would provide an SEER calculation that is representative of national demographics. Reviewed data sources for population and demographic data, AC sales data, and raw weather data.

Task 1.4 Preliminary proposed rating procedures

No activity.

Task 1.5 Simulate benefits of alternative metrics for diverse climates

No activity.

Task 1.6 Analysis and recommendations

ECW. During the reporting period, WECC completed a draft write-up summarizing field test data on the operating characteristics of central air conditioners in Wisconsin and Minnesota (Task 1.2). These data were transferred to the Task 1 task leader (ACEEE).

Task 2 Robust Feature Set for Residential Air Conditioners

No activity.

Task 2.1 Develop trial specification sets

NYSERDA.ACEEE.CDH. Working with Hugh Henderson (CDH Energy) and Don Shirey (FSEC), we have largely completed the *Technical Features* (Attachment 2), that is, the set of parameters to be varied in the simulations to determine the benefits of the robust design. This work has led to some modifications we wish to make in the proposal's Robust specification proposal:

1. *Performance*: Rather than use the ENERGY STAR Draft Specification (which is in flux), we propose to compare the Robust unit with a baseline SEER 13 model. That is, we will include the same performance specifications in the Robust and baseline units (SEER 13, etc), so we can isolate the performance improvements due to "robustness" from those due to rated efficiency upgrades.
2. *Degradation Sources*: We have explicit adaptation in the face of a slow refrigerant leak to the requirements.
3. *Condenser Blockage*.
4. *Air Filter Blockage*.
5. *Cabinet Air Leakage*.

Task 2.2 Draft specification

Task 2.3 Consensus building workshop

No activity.

Task 2.4 Coordinate with manufacturers

No activity.

Task 3 Field Performance Data and Innovation

Task 3.1 Comparison of ratings with field performance

Task 3.2 Benefits of proper sizing

AE. Advanced Energy and the Hatteras Group continued to gather contact information (name, address, and telephone number) for targeted demographics within Phoenix in preparation of the April 5 focus groups. To better understand the market in Phoenix, the team scheduled meetings or had conversations with local builders, the HVAC contractor, Arizona Public Service (APS), and organizations that have knowledge of the market or similar previous surveys.

The Hatteras Group recruited up to 14 participants for each of the two focus groups (one conventional homeowner group and one Environments For Living (EFL) and Energy Star "program" group) and secured a facility in which to hold the sessions. Hatteras created a moderators guide for use during the focus groups that aimed to understand how homeowners talk about their house and to generally understand what satisfaction homeowners relate to their HVAC systems. To probe the issue of HVAC customer satisfaction we intend to use issues such as energy, comfort, and health in homeowners of conventional versus program (EFL and Energy Star) homes, to determine if these are features homeowners relate to satisfaction of HVAC systems.

FSEC: As reported previously, all Florida A/C change out work was completed in 2004. However the change outs and post-change out monitoring were significantly affected by hurricanes Charley, Frances and Jeanne. In addition, the last A/C change out (North Port home) was not completed until very late in the cooling season (October 8, 2004). As a result, only limited pre/post change out comparisons are possible at this point.

It was also previously reported that all four homeowners agreed to approximately one month of additional monitoring during the summer of 2005. However the Jacksonville test home was sold during this reporting period, and while the new owner has indicated interest in allowing the additional monitoring, details and an agreement still need to be finalized.

Data Analysis

Some initial data analysis has now been completed for all of the study homes. Due to the limited amount of post-change out data available, preliminary comparisons were made using just two-day pre- and post-change out periods.

Preliminary plots of indoor conditions, power use and supply air temperatures were previously prepared and reported for the Merritt Island and Lakeland Florida project homes. During this quarter, preliminary plots for the Jacksonville home were developed. Since the North Port home was the last to have its AC unit changed out, very limited pre- and post-change out comparisons can be made and most of the analysis for this home will be performed using Summer 2005 post-change out data.

Jacksonville Home

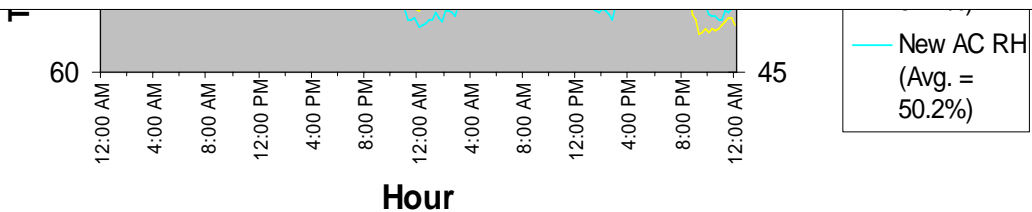
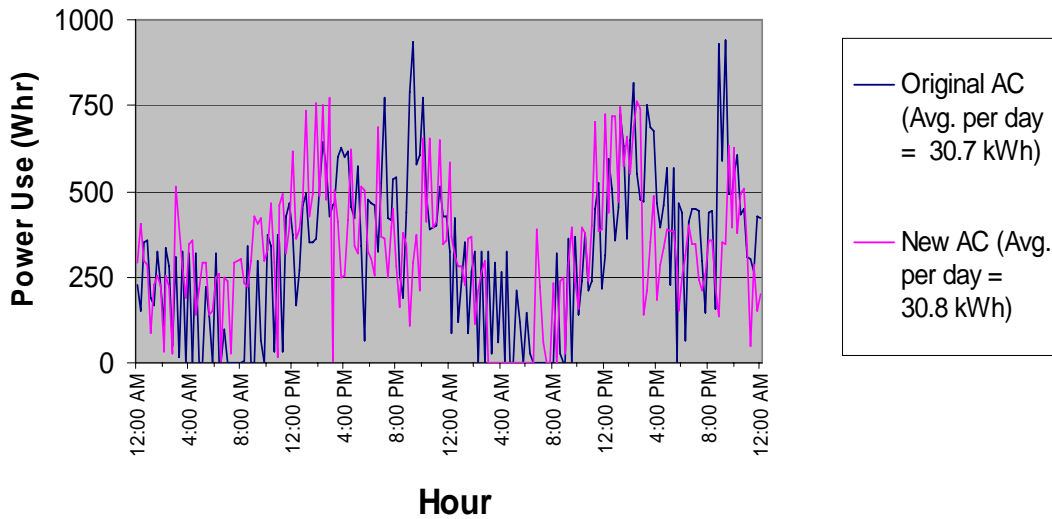
Pre- and post-change out comparison dates and National Climate Data Center conditions data for the Jacksonville comparison are provided below.

<i>Monitoring</i> Period	<i>Comparison</i> Dates	Jacksonville NCDC Data Temperatures (F)			
		Max	Min	Avg	Avg Dew Pt
Pre-Change out	8/25/2004	88	73	81	74
	8/26/2004	90	73	82	74
Post-Change out	10/2/2004	90	73	82	71
	10/3/2004	90	71	81	71

The three figures below are preliminary plots of indoor conditions, power use and supply air temperatures for the Jacksonville Florida home.

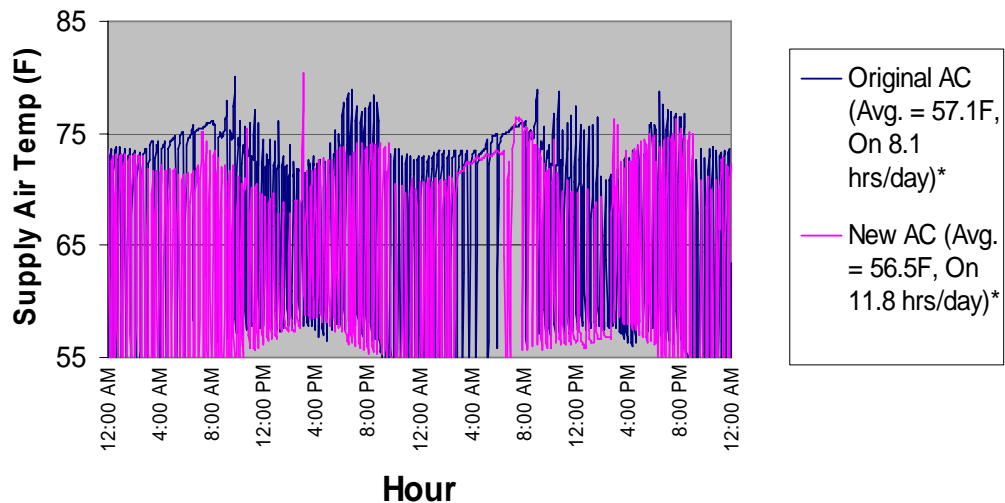
Jacksonville AC Power Use Comparison

8/25-8/26 2004 (Original) 10/2-10/3 2004 (New)



Jacksonville AC Supply Air Temp Comparison

8/25-8/26 2004 (Original) 10/2-10/3 2004 (New)



* All supply temperatures below 63F assumed as system on and used in averages and "on time" estimates.

The table below summarizes the conditions, power use and run time averages shown on the above Jacksonville home plots.

	Tstat Temps (F)		Interior RH (%)		AC Power Use (kWh/day)		Supply Temp (F)		Run Time (hrs/day)	
	Original	New	Original	New	Original	New	Original	New AC	Original	New
Jacksonville	75.0	73.4	51.1	50.2	30.7	30.8	57.1	56.5	8.1	11.8

This preliminary analysis indicates that the AC system retrofit at the Jacksonville home performed as expected. While AC power use was slightly higher with the smaller post-change out system, the indoor dry-bulb temperature was 1.6°F lower during the post-change out monitoring period. Also, RH was slightly lower with the smaller, post-change out system. These results are in contrast with the previously reported higher power use at the Merritt Island and Lakeland homes, and higher RH levels at the Lakeland home with the new, smaller A/C systems.

North Port Home

At this point there is no post-change out monitored data for the North Port home that can be directly compared with the pre-change out data (the two highest maximum daily temperatures during the post-change out period were only 86°F and 88°F). However, an initial comparison using just this data indicates that both power use and RH levels will be higher with the smaller post-change out AC.

Task 3.3 Research strategies for enhanced field performance

ECW. The Center continued data cleaning and preliminary analysis of data collected in 2004 under Task 3.1 and 3.3. Planning for field monitoring for the 2005 cooling season was also initiated in Quarter 3. Analysis of the 2004 data suggests some modifications to the field approach in 2005.

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. Efforts continued to design an improved supply air fan control for the hot-humid climate air conditioner being developed as part of this project, and are on schedule to validate the control performance within an A/B test procedure aimed to evaluate the mocked up control in Summer 2005. An existing facility was modified in preparation for the laboratory testing of the humid climate air conditioner prototype.

Task 5 Information Dissemination and HVAC Contractor Training

FSEC. 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. Another mailing is planned for Summer 2005. A smaller flyer will be produced that

will feature HVAC courses to be held in selected cities (Jacksonville, Panama City, Bradenton, Orlando, and Palm Beach Gardens), and mailed to target groups. That mailing will take place in late summer for the workshops being held in October 2005.

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

1. Plans for Next Quarter

Project Management

NYSERA.ACEEE. Finalize commitments for the Advisory Group

Task 1 Improve central air conditioner performance ratings

Task 1.3 Develop population weighted temperature bin-hour distributions

FSEC. Provide further assistance to NYSERDA (subcontractor CDH Energy) in developing the analysis methodology for Task 1.3 (Develop population weighted temperature bin-hour distributions)

Task 2 Robust Feature Set for Residential Air Conditioners

Task 2.1 Develop trial specification sets

FSEC. Complete the development of trial specification sets for Task 2.1

Task 3 Field Performance Data and Innovation

Task 3.1 Comparison of ratings with field performance

ECW. The Center expects to implement field monitoring of additional single-stage systems.

Task 3.2 Benefits of proper sizing

AE. The two focus groups are scheduled for April 5, 2005 in Phoenix. Representatives from Advanced Energy and the Hatteras Group will travel to Phoenix to moderate and observe the discussions. The Hatteras Group will conduct in-person meetings with local builders, the utility company, and the HVAC contractor to better understand the market and how homeowners talk about satisfaction with their homes and HVAC systems. Following the focus groups and in-person meetings, we will begin creating the survey document. The objective of the focus group is to capture the language homeowners use about their house and HVAC systems. We will apply this language and what we learn from the focus groups and in-person interviews to create the survey document that will be sent to approximately 6000 homeowners in the Phoenix area.

FSEC. Perform additional analysis on field data to verify preliminary results and continue to investigate possible reasons for the unexpected power use and RH findings. Final data analysis will be completed after additional monitoring during Summer 2005.

ECW. The Center expects to initialize testing and monitoring of sites for proper-sizing test sites

Task 3.3 **Research strategies for enhanced field performance**

ECW. The Center expects to implement field monitoring of additional two-stage systems.

Task 4 **Develop New Climate-Sensitive Air Conditioner Designs**

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

FSEC. Continue collaboration with NYSERDA subcontractor CDH Energy to define prototype configurations that they will evaluate through computer simulations

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

FSEC. Continue preparing the existing laboratory facility for upcoming tests and initiate field testing to validate the new supply air fan control for the hot-humid climate air conditioner.

Task 5 **Information Dissemination and HVAC Contractor Training**

FSEC. Prepare for second mailing of training course brochure, and start developing small flyer featuring residential HVAC courses to be held in October 2005