

WCEC's HVAC Behavioral Initiative... Because People Matter in HVAC Performance

Has it ever occurred to you that air conditioners would work much better if it weren't for the people involved? Always twiddling with the thermostat, or installing things incorrectly. Never choosing the right technology for the application or maintaining things as needed. If this thought has occurred to you, then you have an appreciation for WCEC's HVAC Behavioral Research Initiative (HBRI), which believes that people behave the way they do for a reason, and understanding that reason is key. WCEC has assembled a team of behavioral scientists to address some of these issues (see box). This innovative team is beginning to look at the ways that human factors influence the performance of AC systems in the field. By understanding these factors, we can both design better systems and buildings, and find ways to influence performance-defining behaviors. The HBRI team is working with other WCEC researchers to ensure that technologies developed and demonstrated are aligned with the goals and aspirations of users and providers, as manifest in their behavior. The team is also undertaking several discrete research projects to shed light on human behavior and how it can be influenced.

- CEC's PIER program has long understood the importance of human behaviors on energy consumption. Seed funding from PIER has allowed the WCEC HBRI team to identify some of the questions that can be addressed in the Initiative, including:
 - How do homeowners and small commercial maintenance staff typically maintain their systems?
 - What are the advantages to service contracts (such as building trust, and providing the opportunity to upsell more efficient equipment over the years), and what factors go into a homeowner's decision to purchase or not purchase a service contract?
 - What happens when a unit is run to failure? Is it replaced with a suitable efficient unit, or with whatever's on the truck? How do contractors view the opportunity to upsell a more efficient unit when a unit fails? Do they have time to make this case? How much does having a history with the customer help in promoting a different choice of replacement unit?
 - Why do HVAC contractors pull or fail to pull a permit and comply with Title 24?
 - What would a building owner do if their thermostat announced a faulty condition for their AC, and what information needs to be provided to a building owner to cause them to do something?
 - How is Fault Detection and Diagnostics perceived by potential customers? Do customers believe that they have "faults" that need to be detected? What do facility managers do with alarm data when it's received? How can it be received in a different way to ensure that it is acted upon appropriately?
- With funding from the California IOUs (via the Davis Energy Group), the HBRI team participated in development of the [HVAC Maintenance Energy Efficiency Study](#). Quality Maintenance programs in the past have had uneven success, and part of the reason for that

is the wide range of uncertainties involved in this measure and the programs that deliver it. This study identified the need to better understand the behavior of homeowners, tenants, small business owners and managers, contractors and technicians to understand Quality Maintenance services. This work was also documented in an [ASHRAE Conference Paper](#) and will be presented at the ASHRAE Conference in San Antonio in June, 2012.

- Southern California Edison is interested in influencing their residential customers by encouraging them to undertake Quality Maintenance. See the box for a complete description of the project designed to help SCE understand how to best influence these residential behaviors.
- The HBRI team is also investigating behaviors related to Quality Maintenance with small commercial decision-makers, also with funding from SCE. Four focus groups were held in SCE territory, including 32 small business owners or managers. They were asked a series of questions about the importance of AC in their business and the role that they perceive maintenance plays in AC performance. We found that very few have professional maintenance contracts, and that their interest in AC performance was driven by its impact on the bottom line. This study will be available in the fall.
- SCE is also interested in influencing residential customers' energy performance by providing them with feedback on their energy use. The HBRI team has been conducting a study with three parts to find out how much providing real-time feedback influences behavior:
 - Obtaining In-Home Energy Displays to evaluate and categorize their functionality. This task has discovered that the market for IHEDs is changing daily, and that the functionality of IHEDs varies quite substantially.
 - There are several key pieces of functionality that can be generalized and this functionality is the basis of the next step in the research. A survey is being conducted to show a "generic" energy feedback display to participants, and gauge their understanding of the information and their expected response to feedback, including real time energy use, energy used by peers, and diagnostic feedback. This study will be complete this fall.
 - The UC Davis campus houses a "Net-Zero Energy Community" which provides tenants with feedback on their energy consumption. By surveying this population before and after receiving this feedback, the HBRI team is gauging their attitudes and intentions towards energy use, and attempting to find a correlation with energy use. This study will be complete late fall.
- The California Utilities' interest in Quality Maintenance includes an interest in the behavior of contractors, in addition to homeowners and small business owners. Contractors, and the technicians they hire, have a great deal of impact on the performance of existing AC units, as well as an impact on the decision to replace a unit that is performing poorly with a more efficient unit. Understanding their attitudes and drivers can shed light on both Quality

Maintenance programs and the overall performance of AC units in the field. With funding from the California IOUs and CPUC (via Energy Market Innovations), the HBRI team is conducting an observational study of residential field technicians, wherein contractors are contacted and invited to come to a study house to provide a tune-up. The technician's work is observed prior to being informed that the observation is part of a study (and they are given the opportunity to opt out of the research if they do not wish to participate). This field observation is ongoing now, but preliminary findings suggest that technicians seldom do a complete quality maintenance job, and so far only one technician has detected the fault that was known to be in the system. This work will be published this fall.

- California's Title 24 building code is a model for other states. However, its scope and complexity make it difficult to comply with, and it is estimated that contractors only take out permits in about 5-10% of the HVAC replacement jobs that require a permit, so Title 24 is not invoked in the vast majority of cases. The California IOUs have funded the [Western HVAC Performance Alliance](#) to investigate some of these types of barriers to energy efficiency. The HBRI team conducted a survey of contractors to find out how they assess the risk of being caught when not taking out a permit. The findings of the survey were that contractors for the most part do not believe that there is a credible threat that they will be caught if they do not take out a permit: 81% of contractors believe that they would definitely or probably not be caught. They also believe the consequences of being caught without a permit are not substantial: 86% felt that the consequences would be a small fine, requirement to go back and take out a permit, or other such slap on the wrist. The reasons why one would take this risk are primarily financial: half of respondents felt that they would either lose a bid to someone who was not including the expense of taking out a permit, or would be forced to lower their own bid to be competitive. This work is documented in a [paper](#) and presentation for the [ACEEE Summer Study on Energy Efficiency in Buildings](#).

HBRI Research Team

1. Kristin Heinemeier, PhD, PE: Principal Investigator (WCEC Principal Engineer, with an emphasis on HVAC maintenance and operation)
2. Claudia Barriga, PhD. Team Lead (WCEC Staff Behavioral Research Associate, with an emphasis on social-psychology and communication)
3. Laura Flynn (WCEC Graduate Student, with an emphasis on community development and its impact on homeowners)
4. Chloe Villareal (WCEC Undergraduate Student, with an emphasis on sociology)
5. Tai Stillwater (Institute for Transportation Studies Engineer, with an emphasis on the efficacy of feedback technologies)

6. Dina Biscotti (Energy Efficiency Center Sociologist, with an emphasis on the impact of social networks on behavior)

Attitudes towards Air Conditioner Maintenance: When AC is not cool enough

The California Long Term Energy Efficiency Strategic Plan calls for Quality Maintenance of HVAC systems to become the norm by the year 2020, envisioning that by that time, users will understand and value the benefits of maintaining Air Conditioners regularly. Quality Maintenance of residential and small commercial air conditioners is expected to reduce energy use by up to 30%, while providing a series of other non-energy benefits, such as improved indoor air quality, increased equipment life, reliable performance, and safety.

That said, users' motivation to procure professional maintenance for their Air Conditioners is low. A recent survey on attitudes towards AC maintenance services, conducted by the HVAC Behavioral Research Initiative team at the WCEC, gathered data from a representative random sample of 270 Southern California Edison residential customers. Respondents evaluated, among other things, the importance and relevance to them of AC maintenance benefits, the characteristics that they value in professional AC services, and the influence that monetary incentives from utility programs would have in their decision to procure a maintenance service agreement for their AC system.

Some preliminary results: HVAC Maintenance

53% of respondents said they regularly maintain their ACs but only 12% say they have professional maintenance agreements. The discrepancy is an indication that most people probably think of AC maintenance as a "do it yourself" kind of thing. Indeed, when asked what you need to do regularly to keep the AC working well, the most common answers provided were "changing filters" and "keeping the equipment clean". 61% of users said they would not hire professional maintenance unless it was urgent: an indication that professional maintenance would only follow repairs and that preventative maintenance is not really on the radar. In fact, 43% of those surveyed claimed they would require rebates of at least 50% from utilities or other programs, to consider doing preventative maintenance through an HVAC contractor.

Users' intentions to procure professional maintenance through service agreements increased significantly after respondents read some information on the benefits of regularly maintained equipment. Still, the majority of respondents persisted in saying they were not likely to procure such services in any circumstance.

What about those 12% that have professional maintenance agreements? According to our analyses, those respondents cared significantly more than others about the way in which maintenance improves energy efficiency, air quality and the reliable performance of their AC (See Figure 1, below, for ratings of the importance of all maintenance benefits across owners and non-owners of service agreements). It is possible that having service agreements has been

the way in which users, in connection with expert technicians, have learned more about energy and environmental benefits of maintenance, and have witnessed the reliable performance of their equipment.

A separate study being conducted on HVAC technicians in the field will shed more light on the way in which technicians and customers interact, and the ways in which this relationship helps increase the public's understanding and value of HVAC maintenance.

Where does the AC stand?

In everyday conversations, and in some early interviews with HVAC contractors, we often heard that a path towards spreading AC professional maintenance would be to follow the model of car maintenance. "Everybody knows that you need oil changes and check-ups at a certain number of miles". On the other hand, attitudes towards the AC are quite different from attitudes towards cars: cars are highly visible and often a big part of the owners' identity. Air Conditioners seem to be something people would rather not think about.

Our survey compared attitudes towards AC with attitudes towards other technologies, and found that although people highly value the service provided by AC, they think of it as a low-maintenance, low-tech, ugly, boring, and somewhat dispensable technology. In contrast, cars are perceived as exciting, beautiful and necessary, which may explain the higher percentage of people who are willing to pay for car maintenance, check-ups, and regular service providers like AAA. The differences in symbolic meanings between the two indicate that the car model may be flawed as a path towards HVAC maintenance. Efforts to increase quality maintenance services may have to follow other paths. A preliminary analysis of our results suggests that a focus on AC relations to health and cleanliness may be useful, since respondents seemed to be well aware that AC systems had systemic effects on air quality. The fact that most people considered AC as one of the most wasteful technologies could also be used as an opportunity. Maintenance services may need to be pitched as something that prevents waste and health risks, rather than a preventative service to avoid failure.

Where to begin?

It is possible that the most influential communicators about HVAC maintenance are already in contact with users: technicians who show up to do repairs when equipment breaks, or to install new equipment when residents move. A study on the way in which technicians address maintenance with customers is presently being conducted by the WCEC. This research, that will observe techs in the field, will be able to detect whether technicians are presently acting in a way that leads towards change in attitudes towards maintenance (basically, teaching people that there is more to AC maintenance than the "do it yourself" things), or perpetuating a low-level approach to caring for equipment.

A more extended report of the survey results, which will include a thorough analysis of the ways in which people's values and beliefs influence their AC maintenance choices, is currently being prepared by our team. We hope to tell you more about it soon!

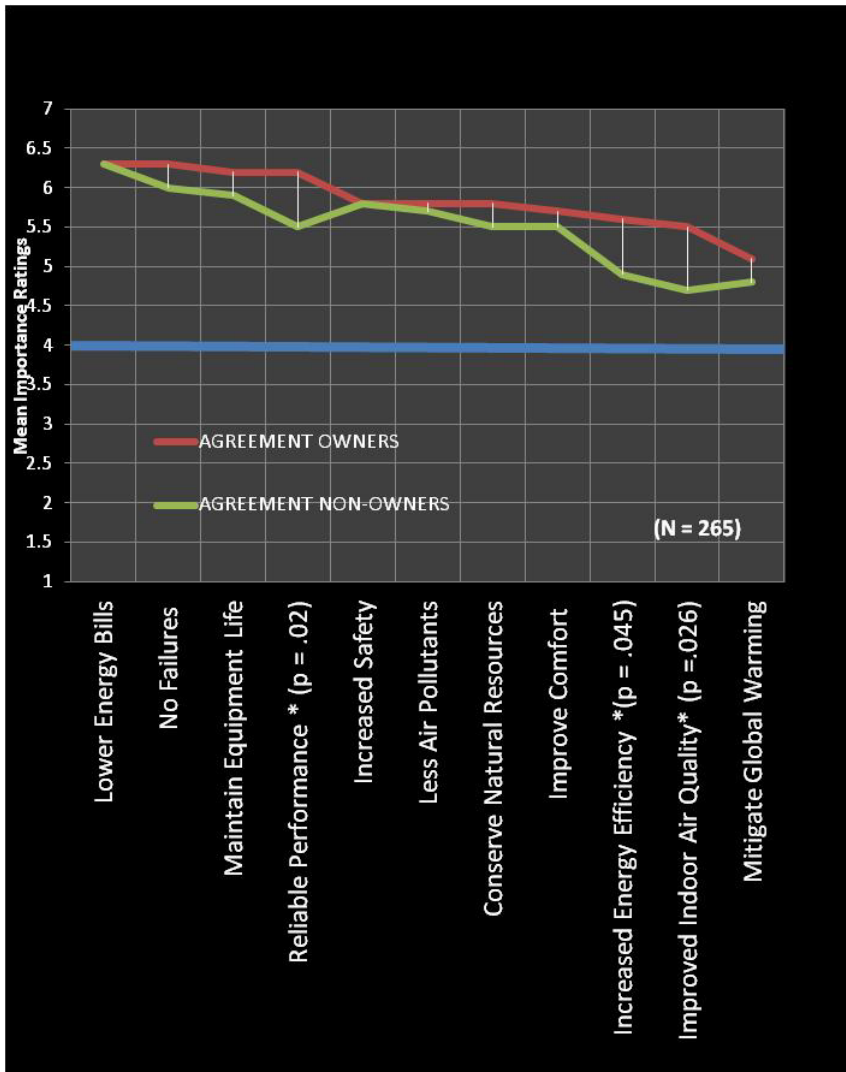


Figure 1. Mean ratings for the importance of maintenance benefits, for owners and non-owners of HVAC maintenance agreements