Draw Back the Curtains: What a Residential Economizer Pilot Study Revealed about Home Cooling Behaviors

Anna Kim, Research Into Action, Portland, OR
Marjorie McRae, Research Into Action, Portland, OR
Todd Greenwell, Idaho Power, Boise, ID
Brad Acker, University of Idaho, Integrated Design Lab, Boise, ID
Mark Rehley, NEEA, Portland, OR

ABSTRACT

In the summer of 2011, Idaho Power conducted a pilot study of economizers – a cooling technology – among a small sample of its residential customers. The utility installed residential economizer equipment from two different manufacturers in pilot participants' homes to estimate potential energy savings. A market study of this pilot, which accompanied a monitoring and impact study, contributed to Idaho Power's assessment of whether the pilot results supported the development of a residential economizer incentive program and identified what the utility should consider in designing and deploying such a program. Evaluation staff interviewed installers and participants about their experiences with the equipment installation, use, and performance. Idaho Power used the evaluation results to inform an additional study about the technology's suitability and likely energy savings and to determine the feasibility of offering a residential economizer incentive program.

We discovered that participants had diverse reasons for choosing to participate in the pilot project, and had varying expectations for, and experiences with, the technology. The study reached three unanticipated conclusions: 1) Even though estimating economizer savings was the pilot's principle objective, and not the assessment of possible program designs, the ability to estimate savings were affected by program design considerations, specifically communication among the utility, contractors, and customers. 2) The utility's customers used at least three different strategies to cool their homes, which may affect energy savings. 3) Pilot study evaluations can produce valuable information beyond the study's main objectives that contribute to a deeper understanding of the technology and market.

Introduction

Idaho Power and the University of Idaho, Integrated Design Lab (UI-IDL) conducted two pilot studies of residential economizers installed in a small sample of the utility's residential customers' homes in 2011 and 2012. Idaho Power and the manufacturers of the residential economizers are unaware of other residential economizers commercially available or tested in field studies. Thus, the models tested in the pilot represent first-generation residential economizers.

The main purpose of each study was to estimate any energy savings attributable to these economizers. For both Idaho Power and UI-IDL, the 2011 study was their first experience developing and implementing a pilot study of an efficiency technology.[1] The market study conducted for the 2011 study is the subject of this paper.

[1] Idaho Power has published its impact findings separately through UI-IDL (see Acker, Duarte, and Van Den Wymelenberg, 2012a and 2012b). As we discuss, the pilot enrolled fewer participants than Idaho Power sought, the residential economizers – which were first generation – had technical issues that compromised their performance during the pilot, delays resulted in the installation of units during – rather than in advance of – the 2011 cooling season, some units were

In 2011, Idaho Power contracted with Research Into Action through the Northwest Energy Efficiency Alliance (NEEA) to conduct a market study of the 2011 Residential Economizer pilot study. The purposes of this paper are to describe some of the findings from our evaluation and illustrate how Idaho Power and UI-IDL applied this research to the subsequent 2012 pilot study. We will demonstrate how market studies of pilots can produce valuable and sometimes unexpected findings.

Background

In 2011, Idaho Power wanted to explore the potential energy-saving benefits of economizers in residences within their service territory. An economizer is a ventilation system that draws outside air into the home's HVAC ducts under the appropriate weather conditions, thereby reducing the usage of the air conditioner. Economizers are common in commercial facilities. Idaho Power invited a random sample of its customers to participate in a pilot study and to allow a residential HVAC contractor (selected by, and under contract to, Idaho Power) install economizers in their homes. The participants paid a portion of the installed equipment cost.

The project sought to determine how much an economizer would reduce the homes' cooling energy use. Summer evenings are cool in most of Idaho Power's service territory; because economizers draw cool outside air into a home, staff also thought economizers had the potential to reduce the need for air conditioning by precooling the home prior to the heat of the day.

The economizers studied consist of a control box, dampers, and an outside vent. These components are installed into an existing forced-air cooling system, along with an intake vent placed on the roof or side wall. A flexible duct connects the vent to the home's existing ducts. When the system calls for cooling, the vent opens, and the air handler draws outside air into the ducts and circulates it throughout the home; the air conditioner's compressor remains off, saving energy. The vent opens only when the outside air temperature drops to a predetermined level; the air conditioner then only runs when the outside air is warmer than that temperature.

This pilot study involved two different brands of commercially available residential economizers, which we refer to as Model 1 and Model 2. Each model was installed by a specific installation company, which we identify as Contractor 1 (installed Model 1) and Contractor 2 (installed Model 2).

For the 2011 pilot, Idaho Power sent letters to its customers soliciting pilot participants and hoped to receive 200 replies from interested customers. Of those interested customers, it hoped to identify 50 homes suitable for pilot participation. Instead, it received requests to participate from 52 residential customers and it qualified and installed systems in just 19 applicants' homes. Its contractors installed some of the economizers in July and August 2011, which was later than anticipated due to pilot project set-up delays. (Having learned from these experiences, the utility reports that its set-up processes for the 2012 pilot ran more smoothly and contractors completed installations before the cooling season.) Once the 2011 installations were complete, UI-IDL returned to the sites to install data loggers to measure energy usage, and returned at the end of the cooling season to remove the data loggers and download usage data.

For the market study of the 2011 pilot study, the evaluators interviewed three contacts that represented the contracting companies (two contacts at one company) in October 2011. In November 2011, we interviewed 17 of the 19 pilot study participants (8 Model 1 and 9 Model 2). The small number of participants limited which statistical methods we could use and, thus, our ability to detect patterns and to predict and apply findings to overall population of potential economizer owners.

---

not fully functioning until after the conclusion of the 2011 cooling season, and other challenges.

The timing of the installations and interviews also affected our findings. Since installations were delayed, some participants did not use the newly installed economizers for an entire cooling season; in some cases, units were not fully functional until after the end of the cooling season in September.

This paper describes our findings from the participant and installer interviews. We have organized the information per the steps in the participation process: enrollment, installation, instructions, communication, and performance. We discuss what Idaho Power learned from our process research and how Idaho Power used our initial conclusions and recommendations to guide improvements to the subsequent 2012 pilot study.

Initial Findings

Enrollment

Idaho Power's enrollment strategy was straightforward: they sent invitational letters to a random sample of their customers in 2011 and 2012. Additionally, Idaho Power also invited 2011 pilot participants to participate again in 2012. The invitations for both years were identical. They offered participants:

"A $1,100 economizer system for $250" with the potential for: *"Reduction in summer cooling costs; Increased home comfort; [and] Better air quality"*

In 2011, the majority of interviewed participants (14 of 17) said they had not known anything about economizers before they were contacted to join the study. Two participants said they had learned about economizers through the internet, and one said he had heard of them at work. It is somewhat unusual for such a low percentage of participants to be familiar with a technology before agreeing to participate; people who self-select to participate in pilots tend to be particularly interested in new technologies and often have some background on the topic.

We asked the 17 participants why they had decided to enter the pilot study. This was an open-ended question, and participants could describe multiple reasons. The majority (11) said they had signed up because they wanted to save money on their energy bills. Additionally, three participants noted that the economizer price was a factor in their decision. Four participants liked the opportunity to contribute to Idaho Power's research, in addition to other reasons for participating. Four participants reported they already were cooling their homes naturally, by opening their windows at night; thus, they expected to be comfortable with the economizer.

Table 1. "**Why did you decide to enter the pilot program?**"

Reason*	Number (n=17)
Save Money	11
Participate in Pilot Study	4
Already Cooling Air at Night	4
Rebate	3
Curiosity	2
Comfort	1
Help the Environment	1
Help Idaho Power	1

House Fan Substitute	1

*Multiple responses allowed

To better understand participants' cooling needs and expectations, we explored how they typically cool their home. Three general patterns emerged, which we characterize as follows:

- Constant Setter: Thermostat is kept at a constant temperature at all times.
- Time Zoner: Temperature is adjusted to specific settings based on a daily or weekly schedule, usually with the assistance of a programmable thermostat, but sometimes manually. Time Zoners do not open their windows at night.
- Night Cooler: Manually opens windows at night, cooling the home and simulating the effect of an economizer; this group does not run an air conditioner when the windows are open.

Table 2. Cooling Type

Identified Type	Number (n=17)
Constant Setter	7
Time Zoner	7
Night Cooler	3

It is important to note that these are not segments, and a segmentation study was not performed. Instead, these are categories based on observations within a small sample.

This consideration of how participants interact with their cooling system reveals useful insights into their reasons for participating in the pilot studies. Constant Setters and Time Zoners were more likely to mention saving money as a reason for participating. The Night Cooler participants wanted to see if the economizer would replace the need to open windows. They said they were not motivated to participate in order to save money, but rather wanted to see if it would be more convenient for them not to have to open their windows at night, and if their home would be more secure with the windows closed at night.

Four of the participants – Constant Setters – said that their air-conditioning units had trouble maintaining the set temperature or cooling the house after having been turned off for a period of time. As a result, the occupants reported leaving the unit on all day to try to keep their home cool. They said they did not necessarily want their home to maintain a set temperature all day, but felt they had no option in order to keep their home relatively comfortable.

When Idaho Power reviewed the logger data from 2011, it analyzed energy savings for only some of the homes. In particular, the pilot study did not use data from three homes in its energy savings analysis because the data logs showed that the occupants had not used their air conditioner compressors before the economizer was installed. This brought the sample down to 14 units. (Idaho Power ensured all participants in the 2012 pilot used their air conditioner compressors prior to economizer installation.)

Installation

Both of the installation contractors reported that their companies had installed commercial economizers prior to the pilot study, but had had little experience installing residential economizers. Despite this lack of direct experience, both installation contractors reported that the installation of residential economizers was fairly straightforward. They explained that the economizer just had to be wired, connected to the input and output ducts, and the sensors had to be placed. One contractor explained that training and certification in air flow design was required. The other contractor said installers needed to be able to read a schematic; know how to properly size ductwork; and have experience with existing HVAC systems, duct

fabrication, and low-voltage control. Additionally, as a requirement for factory authorization to install Model 1, Contractor 1 had to have a certain number of NATE (North American Technician Excellence, Inc.) certified installers on staff. Both contractors said that all of their installers were qualified to install residential economizers and they believed that most installers in the area had the required skills.

While the installations were straightforward in theory, the contractors said they learned a lot by completing the installations during the pilot study. For one, they were able to familiarize themselves with the new residential economizer models. In addition, they said they learned about how the models interact with existing technology; the retrofits that were required for installation; and interactions between HVAC systems and housing characteristics, which determined if, and how, ductwork should be installed.

All installers reported that the installations took longer than they had expected, and often much longer than the four hours estimated by the manufacturers. Factors affecting installations included housing characteristics, age of existing equipment, and access to the installation site. On average, Contractor 1 took up to 16 hours to install each unit of Model 1, and Contractor 2 took eight hours to install each unit of Model 2. It is not clear what caused this disparity between installations of the two units. Acting on these 2011 findings, Idaho Power identified homes for which it would likely be very difficult and expensive to install an economizer, and excluded them from the 2012 study.

Nearly all of the pilot participants had to ask the contractor to make a return visit (callback) after installation. The type of callbacks depended on the model. Model 1 had callbacks related to the operation of the actuator, which is a type of motor. These errors were identified and resolved, but often required multiple callbacks before all of the problems were identified. Contractor 1 noted that participants became impatient because of the multiple callbacks, but that they seemed happy once the issues were resolved.

Model 2 callbacks related to malfunctioning units. Contractor and Idaho Power staff concluded the humidity sensor programming caused the malfunction. The humidity controller initially was programmed with a limited humidity range that was not appropriate for the local climate. The units could not be reprogrammed manually, so replacement controllers were ordered. The replacements did not arrive in time for the 2011 cooling season. The sensors were replaced for the 2012 pilot study. Contractor 2 commented that their clients were very patient regarding the humidity controllers. This contractor thought that as a result of the equipment problems, the energy usage data for 2011 would be affected and more reliable results on economizer performance would be available in 2012.

Additionally, there were some changes in sensor placement. Four participants (across both models) believed that the temperature and humidity sensors were placed in the wrong location because they thought they had a straightforward understanding of placement rules. Placement, however, is more complicated and the ideal location required the consideration of more factors than the side of the house and the height of the sensor.

These complications in completing installs and addressing callbacks had an impact on the effectiveness of impact findings for the 2011 pilot study. At the same time, the experience led to very valuable information about the installation of residential economizers. . Installations went more quickly, efficiently, and smoothly in 2012.

Instruction

The contractors were instructed to explain to the participants how to use the units. Installers from both contractors reported that they gave basic instructions on how to operate the units and how to program different temperature settings. Contractor 2 said their installers told participants that they would need a programmable thermostat to get the most benefit from the economizer.

Participants' impressions about instructions and informational materials differed from contractors' self-reports. The surveyed contractor representatives were not present for all of the installations, so their accounts were not all first-hand, which may explain some of the discrepancy. For example, participants'

responses to verbal instruction were mixed, but they often described their interactions with the installers as "brief," while contractors described the instruction as more thorough.

Participants commented on the quality of written materials and verbal instruction. Four of the Model 2 participants reported that they were told the units would function automatically and should not be touched during the pilot study. Other participants said they were given these instructions and ignored them so they could experiment with the equipment.

The manufacturers provided manuals for the models. The Model 1 manual was designed for the homeowner, while the Model 2 manual was designed for the installer. Only 12 participants said they received an instruction manual. They perceived distinct differences in the quality of manuals. All seven participants who received a manual for Model 1 felt it was at least "somewhat helpful." One participant described the Model 1 manual as "better than average." In contrast, all five participants who received a manual for Model 2 felt that the manual was not helpful. One participant described the manual as "written for an installer," and others said there was too little information and that much of it was not useful to them. Two of the participants who received manuals for Model 2 were instructed not to make adjustments and one of them did not read the manual for that reason.

Table 3. "How helpful were the materials?"

Helpfulness	Model 1	Model 2	All (n=12)
Very Helpful	2		2
Somewhat Helpful	5		5
Somewhat Unhelpful		3	3
Very Unhelpful		1	1
Did Not Read Manual		1	1

The inconsistency in these instructions, combined with the differences in how the participants described using their cooling equipment and the differences in the equipment models, made it more difficult for UI-IDL to accurately estimate energy savings. In some cases, the instructions participants received changed how they would have used the devices were they not trying to be cooperative study participants, obfuscating potential impacts.

In 2012, Idaho Power addressed many of these problems with a letter that UI-IDL's technician distributed to the homeowner when the data logger was installed. This document described who was involved in the study, the study's goals, how participants should interact with the equipment, and whom to contact with questions. It also instructed participants to inform UI-IDL if they did not receive a manual. During the installation, the technician reviewed the letter with the participant. By providing consistent instructions and going over them in person with the participants, the 2012 study reduced some of the variables that might have influenced energy use.

Communication

Almost all of the participants reported they sought to contact someone regarding their economizer post-installation. Although participants had been instructed to contact Idaho Power, many forgot this instruction or misplaced the contact information. Consequently, some participants contacted the contractors or the UI-IDL technician, which delayed or precluded appropriate responses. Participants voiced several complaints indicating that their attempts to communicate issues did not result in action.

Issues related to the initial installation went primarily to the contractors. Across all issues participants reported, Model 1 participants were more likely to contact Idaho Power; none of the Model 2 participants mentioned contacting Idaho Power (Table 4).

Table 4. Whom Participants Contacted for Assistance

Contact*	Model 1	Model 2	All (n=17)
Contractor	2	6	8
University of Idaho	1	2	3
Idaho Power	4		4
Did Not Experience Problems	1	3	4

*Multiple responses allowed

Based on our interviews, it appears that 2011 participants did not have a clear line of communication, regardless of whether they had received contact information and lost it, or had never received it. In 2012, Idaho Power addressed this problem by providing contact information with the handout homeowners received when the data loggers were installed. The UI-IDL technicians reviewed the method of communication with the participants. These additional steps to ensure that participants received clear and consistent instructions resulted in reducing the confusion for participants and more efficient resolution of issues that arose in 2012. Better resolution of issues also leads to increased consistency across participants' usage data.

Regarding the communication between the contractors and Idaho Power, the contractors reported they received good support from Idaho Power. As part of the pilot study, Idaho Power requested documentation on each economizer installation, so that the utility might understand the applications and any challenges the contractors faced. Recognizing that the pilot was a structured learning period for all parties, the contractors assessed as reasonable this request for installation documentation. However, they noted that documentation of a given installation could take up to one hour, for which they were not fully compensated. These unanticipated costs were in addition to their costs to install the systems, which often exceeded their original agreement with the utility. Thus, we learned that the contractors' unreimbursed costs to participate in the pilot exceeded the expectations of all parties. One contractor reported having been prepared to "take a loss" on these installation costs because they wanted to support this study.

Performance

Participants provided their observations regarding the performance of the equipment and their experience using it. These include how well the equipment functioned, issues that were encountered, and perceived energy impacts.

As mentioned in our discussion of installation issues, Model 2 participants had problems stemming from the humidity controller, which were not resolved during the 2011 pilot, and a few of both Model 1 and Model 2 participants thought sensors were incorrectly placed (Table 5). Many Model 1 participants (5 out of 8) reported a damper error message. Contractors resolved the damper error message and sensor placement issues during return visits made soon after installation. Other issues arose later on. Five Model 2 participants reported the display blacked out during operation and would remain so until reset; the manufacturer corrected this problem before the 2012 pilot study.

Table 5. Performance Issues by Model

Issue*	Model 1	Model 2	All (n=17)
Humidity Controller		9	9
Damper Error Message	5		5
Sensor Placement	1	3	4
Blacked-out Screen		5	5
Other	2	2	4
No Issues Reported	2		2

*Multiple responses allowed

The 2011 Model 2 equipment included a pump designed to run continuously, which confused and concerned three participants, who said they did not understand why their energy-using device was on when the unit did not appear to be doing anything. Prior to the study, Idaho Power was not aware of the reaction participants may have to this feature and this information allowed them to better address participant concerns.

The vast majority of participants experienced performance issues, whether real or perceived. With this knowledge, Idaho Power was able to more effectively anticipate concerns and to reduce the number of issues that interfered with the proper use of the economizers. There was improved communication with participants in 2012, as well as removing other barriers to collecting accurate data.

Half of the Model 1 participants believed they had saved money on their energy bill, while only one of the Model 2 participants believed they noticed bill savings. Most of the participants who reported believing they noticed bill savings said those savings were lower than they had expected, although two participants – one with Model 1 and one with Model 2 —said the savings exceeded their expectations. Related to this, five Model 1 participants and one Model 2 participant said they had used less air-conditioning during the study period due to the economizer but two of these participants did not believe that they paid less for their energy.

A review of the data logs revealed that some participants saved energy (a finding that held for both the 2011 and 2012 pilot studies). Energy usage impacts covered a wide range – from minimal to great, and both positive and negative. Negative energy savings often occurred as a result of extended fan runtimes, when fan energy more than offset any compressor energy savings. Using improved fan motor technology also played a large role in energy use. The newer, electronically commutated motors (ECM) used in newer air conditioners are more efficient than older, permanently split capacitor (PSC) motors and the efficiency difference can play a major role in energy savings.

Homeowner behavior also has the potential to influence the cost-effectiveness of the economizer. For instance, if a Constant Setter were willing to change behavior and overcool the home at night, the economizer would be more of a benefit than if a Constant Setter maintained the same temperature. Night Coolers are likely to see smaller savings than the others because they simply can open their windows by hand. While these scenarios seem plausible, Idaho Power was unable to measure energy differences between these different types of users. The sample size was not large enough to identify whether or not there were significant differences between these groups.

Reports of increased comfort differed by model. Three-fourths of Model 1 participants reported an increase in comfort with the economizer, and half of these said the change exceeded their expectations. Most Model 2 participants did not notice a change in comfort.

Five Model 1 participants and two Model 2 participants said that the economizer had improved their home's indoor air quality; they noticed this change during different times, between evening, night, and

morning hours. Idaho Power did not anticipate the potential health and comfort benefits when considering the first pilot, but after seeing these results, Idaho Power quantified air quality in 2012 by metering carbon dioxide and VOC (volatile organic compounds) levels in participants' homes. This metered data indicated the 2012 pilot economizers improved air quality, and supported participant reports that the air seemed cleaner and fresher.

Participants suggested a number of improvements to the economizer design, particularly to the controls and display. One model was designed as an in-home thermostat replacement while the other was designed to be a technical informational display. Four participants (three with Model 1, and one with Model 2) suggested a more "modern" interface, at least on par with modern programmable thermostats. Three participants (one Model 1 and two Model 2) suggested direct integration with the programmable thermostat or at least a display within the house rather than on the unit. Participants also suggested wireless connectivity (for Model 1) and posting the outside temperature on the display (for Model 2). They indicated that displaying the outside air temperature also may help homeowners understand how the economizer functions and is working. While Idaho Power does not see itself in the role of commenting on the development of technology, it is helpful to understand what potential customers may expect from an economizer.

Communication was the recurring issue across participants and installers. Some participants reported they would have preferred to know in advance of the installation where the ductwork would be located, yet contractors were unable to determine this until they were working on site. Two participants suggested involving the participant more in the installation to ensure that they have reasonable expectations regarding the device's performance. Independently, one contractor acknowledged that they could have improved communication about scheduling installations.

Participants also suggested that more instructions should be provided, such as a FAQ sheet or a guide to thermostat settings, tailored to different cooling strategies and other factors that homeowners consider. One participant also suggested that participants receive a follow-up phone call a few weeks into the cooling season, subsequent to the installation, to give homeowners the opportunity to ask questions about using the unit for cooling.

Idaho Power took steps to address these issues in 2012, particularly with improved communication channels as described above.

Lessons Learned

Despite some technical issues with these early residential economizers that were evident in the 2011 pilot, the information from the UI-IDL data loggers suggested some of the homes saved energy using the economizer, a finding supporting Idaho Power's decision to conduct a 2012 pilot. As discussed the most common technical problem, that of a malfunctioning controller, was corrected for 2012. According to Idaho Power, the 2012 study (which did not include a process component) provided additional valuable information about the technology's installation and performance, and customers' acceptance and use of the technology. Of continuing concern is why the economizer worked for some participants and not for others. This evidence suggests that widespread use of residential economizers still faces significant challenges.

Contractors reported the 2011 installations typically required site-specific and costly adaptations, thus taking more time and resources to complete than anticipated. Thus, the residential economizer technology is not yet ready for deployment through a full-scale program, with the possible exception of a new construction program. The evaluators recommended that Idaho Power's 2012 pilot seek to better understand why installation times varied widely, what housing configurations are compatible with minimal-cost installation, and how installation processes might be streamlined and costs reduced. Acting on this recommendation, Idaho Power selected sites for the 2012 pilot that it anticipated could have comparatively simple and inexpensive installations. Despite this effort, Idaho Power reports that custom work appears necessary for most installations so that installation costs remain a concern.

We found that communication issues affected pilot outcomes. Technical and engineering staff at Idaho Power and UI-IDL designed the pilot and they focused on a real-world physical test of the equipment they did not anticipate that the communication needs of all parties needed to be addressed in detail as part of the pilot study procedures. We recommended that Idaho Power develop a standard script to explain the study's goals and expectations to residential participants and installers, and conduct additional research to identify any communication gaps and learn how they might help participants communicate their questions, problems, and concerns. Idaho Power applied these recommendations and improved communication with its customers and installers for the 2012 pilot.

Our interviews with participants suggest that they engage in different cooling behaviors – which we characterized as Constant Setters, Time Zoners, and Night Coolers – and that behavioral differences might influence the savings potentially available from economizers. We recommended that Idaho Power continue to gather information from its pilot participants to understand their cooling behaviors and explore whether behavioral differences might explain some portion of the observed variance in economizer savings. Should it appear that savings are related to behavioral differences, we recommended that Idaho Power conduct research to determine what proportion of homeowners each category describes and whether further behaviors need to be identified with respect to this technology, or if perhaps a complete segmentation study is warranted. We recommended that Idaho Power consider the feasibility of conducting targeted advertising/outreach and education to residential customers should they want to design a full scale economizer program and the implications of incenting a technology that may not benefit customers with certain cooling behavior patterns. Due to the small participant size for both 2011 and 2012, it was not feasible to gain a clear picture of the impacts of these different behaviors, but Idaho Power will consider the possibility of targeted advertising if they pursue programs in the future.

Conclusion

For decades, economizers in commercial applications have proven themselves to be an effective energy efficiency measure. Yet researchers at Idaho Power and UI-IDL, and the manufacturers and suppliers they spoke with, could not identify prior studies of economizers in residential applications, either at demonstration sites or commercially available. Idaho Power thus set out to assess the energy savings of residential economizers, testing first-generation equipment as their first experience conducting a technology pilot study.

Owing to a number of conditions affecting the first-generation equipment, its installation, and the pilot study activities (such as number of customers willing to participate and timing of installations), Idaho Power is in process of drawing conclusions about the technology's energy savings.

Our market study of the 2011 pilot study developed findings and conclusions that Idaho Power used to improve its 2012 pilot, which has the potential to influence any Idaho Power decision to develop an economizer program, and which can support the utility in any future efficiency technology pilot studies it plans to conduct going forward.

We identified the importance of communicating clearly with contractors and participants about the purpose of the pilot study and how customers are expected to use the technology, as well as the importance of establishing clear lines of communication between pilot study staff and contractors and participants to facilitate quickly and accurately answering questions and addressing concerns. Finally, we identified patterns in customers' cooling behaviors that likely impact the energy savings economizers can be expected to deliver.

Idaho Power took on a challenging project, particularly as a first experience with pilot studies, to try to quantify savings with equipment that is heavily influenced by behaviors that vary widely from household to household, and even day to day. Future examination of residential economizers should involve in-depth

discussions with participants to understand their pre- and post-economizer cooling behaviors and explore whether such behaviors affect economizer energy savings.

References

Acker, B., C. Duarte, and K. Van Den Wymelenberg. 2012. *Residential Economizer - Energy Impacts, Technical Report.* 20110311-01. Boise, Id.: Integrated Design Lab, University of Idaho.

Acker, B., C. Duarte, S. Shrief, and K. Van Den Wymelenberg. 2012. *Residential Economizer - Energy Impacts. Technical Report.* 20120307-01. Boise, Id.: University of Idaho.