Small Commercial HVAC Pilot Program

Market Progress Evaluation Report, No. 1

prepared by

Energy Market Innovations, Inc.

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MARKET PROGRESS EVALUATION REPORT

OF THE

SMALL COMMERCIAL HVAC PILOT PROGRAM

- FINAL -

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EXECUTIVE SUMMARY

This report documents the experiences of a research, development, and implementation effort involving a multi-year Small Commercial Heating Ventilating and Air Conditioning (HVAC) Pilot program undertaken by the Northwest Energy Efficiency Alliance (Alliance).

The initial impetus for this project was an unsolicited proposal submitted to the Alliance by Portland Energy Conservation, Inc. (PECI) in the fall of 2001 titled "Growing the Market for Energy-Efficiency Tune-Ups for Packaged Air Conditioning Units." The goal of the proposed project was to create a market for energy-efficiency tune-up services for packaged rooftop units (RTUs) in smaller commercial buildings. In October of 2001, in response to PECI's proposal, the Alliance funded a Small HVAC pilot effort under the Efficient Solutions component of its Commercial Sector Initiative (CSI, formerly Commercial Buildings Initiative (CBI)). The pilot targeted 5-15 ton RTUs on commercial buildings,

Pilot Project Design

The Small Commercial HVAC O&M Service program that was originally approved by the Alliance Board was planned to include two phases: (1) a market test and (2) a full program implementation. It soon became clear that the market test would require a technical development phase since no existing program covered all the elements that the Alliance was interested in addressing. While the Board officially funded a Phase I in October of 2001 and a planned Phase II in November of 2002, the actual pilot development may be best understood in the context of three project steps:

- **Initial Program Research and Development (R&D***)* – Technical and market research to determine what components to include in the service protocol and how to effectively introduce the service to the market.

- **Phase I Market Test** – Work with select service contractors in a few discrete markets, test the service protocol (recommended in the initial R&D phase) on actual buildings. Based on field experience, revise the technical protocol and devise a strategic market approach for a broader market test.

- **Phase II Market Test** – Revise program design and implement in a broader but still restricted number of markets. Train service providers in order to market and conduct tune-ups to their existing customers. PECI to provide thorough support services as necessary to participating contractors.

A summary of program activity is as follows in Table ES-1

Table ES-1: Summary of Market Test Activity

No. of Service Providers	No. of Customers Contacted	No. of Customers Sold	No. of Total Units Sold
20	107	48	122

The implementation of this pilot initiative, and the resulting development of the Air Care Plus service, represents a significant effort to address opportunities for energy and demand savings from improved maintenance practices. Unfortunately, the service as developed proved to be quite costly and unreliable in delivering predictable energy savings. The Alliance Board decided not to continue funding this effort and is not currently investing resources in this area. Nevertheless, despite the failure of this program to develop a market-based service, the opportunity for energy savings has not disappeared. Moreover, a number of important lessons were learned through this investment, a summary of which is provided below.

Technical Evaluation

In order to assess the feasibility of a larger-scale program, an extensive technical monitoring and verification effort was undertaken to provide a robust estimate of energy and demand savings for each of the program components (refrigerant charge, economizer, and scheduling) and to determine if the savings estimates calculated by the PECI model were valid. Stellar Processes, Inc. was hired in April 2003 to conduct this evaluation and was given a November 2003 deadline for results (to meet a Board renewal funding vote). In its request for proposals for this task the Alliance identified several important challenges resulting, in part, from the market-based program design:

- There would be no time for extensive pre-retrofit monitoring;
- Savings needed to be estimated against a baseline;
- Savings would vary by season and climate;
- Estimates must have sufficient statistical precision to inform program decisions;
- Savings must include peak demand as well as energy.

Savings estimates are compared by measure category in Table ES-2 and Figure ES-1. Note that the number of cases shown is always far less than the total number of units monitored. This reflects the fact that service providers were not required to implement all parts of the protocol on each unit. In cases where service was not needed or the technician decided not to pursue a measure no savings were available. In both the table and the figure:

- "Opportunistic Repairs" refers to finding breakdowns that would not otherwise have been noticed during routine servicing and are not part of the ACP protocol.
- "Equipment Change" is a broad category that includes physical changes expected to improve the compressor operation such as cleaning the coil, increasing the fan speed and adjusting the refrigerant charge.
- "Savings Not Implemented" are repair measures that were identified during the service visit but, for one reason or another, were not completed. One reason for failure to implement is the technician needing approval from the customer to proceed with the repair.

As can be seen in Table ES-2, the evaluation estimates usually increased the savings estimates. This is evident by the average gas and electrical savings estimates from the M&V work being 10 percent and 13 percent more than the estimate originally developed. Furthermore, the measures under the "Savings Not Implemented" column show that program savings could have almost

doubled, in large part due to the "Thermostat Program and Schedule" measure. Thus, there is reason to believe that a premium O&M service program has the potential to provide a reasonable amount of savings if a program were to be implemented beyond the pilot stage where these measures could be enforced.

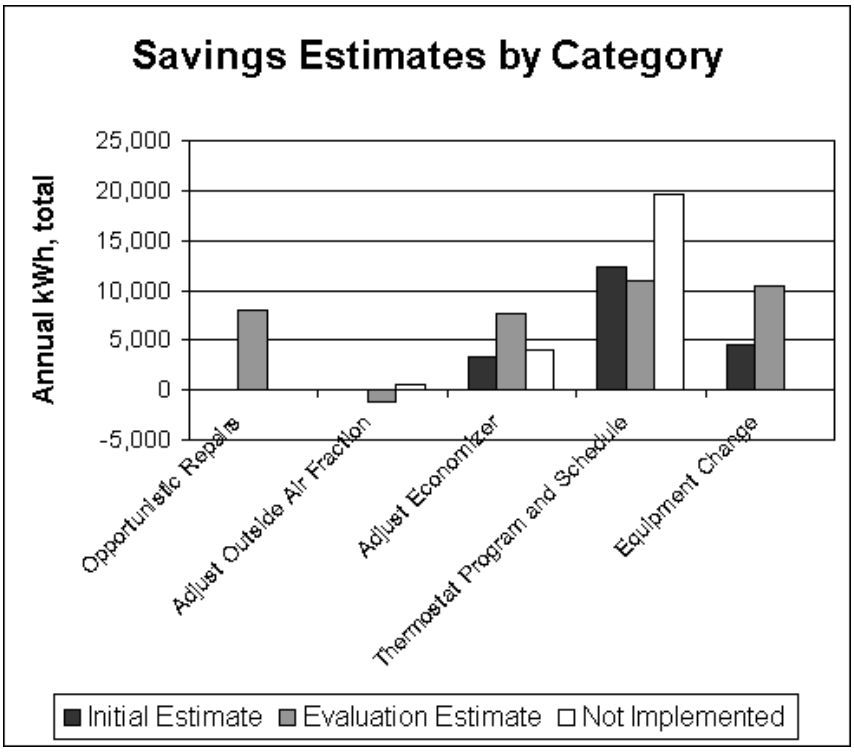
Equally important, however, is that the PECI and Stellar Processes estimates on which categories produce the savings vary dramatically in some instances. Equipment Change, which was expected to be a source of savings, provided less than anticipated savings in some cases and more savings in other cases. Overall, equipment savings estimates by PECI were less than half of the M&V estimates. OSA adjustment is a minor source of savings. Opportunistic Repairs, although variable and unpredictable, can provide large opportunities but also can be a dangerous source of negative savings if implemented improperly.

Table ES-2: Annual Energy Savings by Measure Category

Repair Category	No. of Cases	PECI Savings Estimate	Evaluation Savings Estimate	Savings Not Implemented
Opportunistic Repairs	2	0	7,956	
Adjust Outside Air Fraction	3	0	-1,169	470
Adjust Economizer	13	3,315	7,661	4,035
Thermostat Program and Schedule	14	12,410	10,991	19,656
Equipment Change	11	4,587	10,446	N/A*
Total		**20,312**	**35,885**	**24,161**

** PECI did not estimate savings for these equipment changes that were done. This, however, does not translate to a zero number.*

Figure ES-1: Savings Estimates by Category



Market Evaluation

The evaluation of the program also included an on-going market evaluation. At the conclusion of the Phase II market test in the fall of 2004, evaluators conducted the second of two rounds of in-depth interviews with service providers to explore the following:

- General impressions of ACP
- Working with Palm Pilot and service protocol
- Integrating ACP into their business
- Selling the ACP service
- Training and Support Services
- Keys to Success

Although the level of enthusiasm for AirCare Plus was lower than in the first round of interviews, even after months of participation with the pilot, the overall levels were still relatively high.

Tabulated interview results showed that:

- Four service providers classified as non-participants (PECI had no contact with them after the trainings)

- Nine service providers did not contact any customers
- Fifteen service providers had five or fewer customer contacts
- Ten service providers had no sales
- Eighteen service providers had five or fewer sales
- Two service providers constitute 40 percent of sales, five constitute 80 percent
- Sales (by one service provider) made without utility rebates

These results raised a fundamental and critically important question: *If service providers were enthusiastic about AirCare Plus and had been adequately trained, why were they not more active and more successful in selling the service?* Most service providers spoke favorably of the AirCare Plus model, the training, and the support services they had received, and indicated it would be beneficial to their business. However, at the end of the pilot period, most had still not put forth a significant level of effort in selling the service to existing customers.

As reported by participants during in-depth interviews, AirCare Plus, in its present form and given the level of training and experience of service provider technicians, took an unreasonable amount of time to complete. The following quotes summarize comments made by service providers when asked what they felt were the greatest barriers for AirCare Plus to be a valuable asset to their business:

- "The service takes too long."
- "Energy savings are not compelling enough."
- "Convincing customers it is worth the money."
- "We would have to make it more of a priority."
- "There is no demand and it is not profitable."

Each of these quotes provides significant insight into the business perspectives of these service providers. If service providers believe the service takes to long, they will be disinclined to sell it. If energy savings are not compelling enough (or are at least unproven), they will be disinclined to put forth effort to sell the service to their clients. If convincing customers that AirCare Plus is worth the money is problematic, then the service will be a difficult sell, particularly in a recessive economy. If service providers have not made AirCare Plus a priority, then program managers would have to modify aspects of AirCare Plus that would motivate them to be more proactive or aggressive. If there is no market demand and the service is not profitable, then how can anyone (the Alliance, participating utilities, service providers) stimulate demand and what level of financial incentives will be required to make the service profitable for service providers? In summary, at the end of Phase II there remained many significant obstacles and questions to the implementation of a successful Small HVAC program.

Summary of Findings

Significant findings from this effort, including both technical and market-related results, are provided below

Technical Results

Important technical findings include the following:

- **Significant opportunities for energy savings in existing RTUs definitely exist** – The pilot implementation confirmed the magnitude of the opportunity for energy savings.

- **Time required to deliver ACP service was longer than anticipated** – The development of the protocol proved quite challenging and took more time to refine than anticipated. Moreover, the resulting protocol proved to take longer to complete in the field than most service providers considered acceptable..

- **Savings are unreliable** – While the metering results from sites with participating RTUs document reductions in energy use, the observed savings are not all directly attributable to the ACP protocol. Savings came from a wide variety of changes made to the units.

- **The installation and set-up of programmable thermostats may yield significant savings** – Based upon the facilities addressed, it appears that the installation of programmable thermostats, and the set-up of existing thermostats, may yield significant savings as a focused program opportunity.

Market Results

Important market-related findings include the following:

- **The proposed service poses potential conflicts with the existing service industry infrastructure** – One issue identified during the pilot was the challenge of introducing a new service when, in some cases, customers have assumed that such work was already being undertaken as part of already-existing maintenance contracts.

- **Service providers were enthusiastic about the concept of ACP, but did not actively market the service** – Service providers are definitely interested, at a conceptual level, in having a premium service to differentiate their services and increase revenue. Yet, during the pilot market, test, very few actively marketed the service.

- **Customers are not willing to pay the cost currently required to cover the time required for ACP service delivery** – The market cost of the service is approximately $300-$500, a cost which is not acceptable in a market where maintenance needs are perceived as being minimal.

- **The best opportunity for this service may lie as a utility-sponsored program** – With utility rebates or other mechanisms to offset the cost of the service to the customer, both contractors and customers are more likely to be interested in this service.

1. INTRODUCTION

This report documents the Northwest Energy Efficiency Alliance's (Alliance) experiences developing and implementing a multi-year Small Commercial Heating Ventilating and Air Conditioning (HVAC) Pilot program. In this section, we provide an overview of the program and the rationale for its development, followed by an overview of the target market and an outline of the pilot program implementation timeline.

1.1 Project Background and Rationale

The initial impetus for this project was an unsolicited proposal submitted to the Alliance by Portland Energy Conservation, Inc. (PECI) in the fall of 2001 titled "Growing the Market for Energy-Efficiency Tune-Ups for Packaged Air Conditioning Units." The unsolicited proposal outlined the following goals and value proposition for funding the development of a refined service protocol for HVAC roof top units (RTUs).

The goal of the project is to create a market for energy-efficiency tune-up services for packaged rooftop units (RTUs) in smaller commercial buildings. Packaged HVAC systems are by far the most common type of heating and cooling equipment serving the commercial sector. Recent research indicated that there are a number of opportunities to improve the efficiency of these systems. The efficiency opportunities can be broken into three main areas, (1) refrigeration components, (2) air distribution system, and (3) controls. New diagnostic tools have been developed that could be used by the existing network of service contractors to diagnose and repair problems in each of these three components. In addition to energy savings, significant non-energy benefits are associated with applying these diagnostic tools and repairing/optimizing system operation. These benefits include improved indoor air quality, higher levels of comfort, and reduced emergency replacements of RTUs.

In commercial buildings, HVAC systems are the number one source of complaints to building owners/property managers. Because these systems are rarely serviced adequately, emergency repairs are common, often leading to disruptions and potential loss of customers, especially in retail environments. Currently, the majority of these systems are serviced through annual contracts that consist of superficial maintenance and provide minimal profit to the service providers. The program theory assumes that companies that hold these maintenance contracts have a stake in developing a higher level of service that could increase their connection to the customers and improve their profit margins. Some of these contractors are also equipment vendors and would benefit from a sales environment that was not predicated on emergency replacements.

In October 2001, in response to PECI's proposal, the Alliance funded a Small HVAC pilot effort under the Efficient Solutions component of its Commercial Sector Initiative (CSI, formerly Commercial Buildings Initiative (CBI)). The pilot targeted 5-15 ton RTUs on commercial buildings, with the following goals:

- Define an enhanced operation and maintenance (O&M) service option for existing small rooftop HVAC equipment
- Develop appropriate marketing strategies consistent with CSI
- Develop a framework to document and analyze the benefits in real world examples
- Test the market acceptance of the service in a limited market test

As initially envisioned by PECI and the Alliance, existing HVAC service providers would market the premium service developed under this program as a supplement to their standard service contract. An analogy used during the Alliance's internal project approval process was the 30,000-mile comprehensive service check for automobiles that supplements the standard and more frequent 3,000-mile oil change service. The market transformation theory underlying this program hypothesizes that, once proven, the additional revenue stream available from this service would provide a significant incentive for service contractors to market and sell the service. Because the market for this service approach is new and relies on new technology, the market barriers include the typical hurdles faced by a new product on the market such as lack of awareness, lack of product definition and differentiation, lack of experience (including proven performance), and lack of adequately trained providers.

1.2 Market Assessment Overview

As a preliminary task in the development of this program, an initial market assessment was prepared by PECI in early 2002. As characterized in this assessment, the small commercial HVAC market is a complex mix of manufacturers, designers (engineers and architects), distributors, installation contractors, and operators. The commercial applications vary significantly by size and complexity of building. In addition, both sides of the industry (manufacturing and installation/service) are undergoing consolidation with a few big companies buying out the smaller independents. These larger companies go after business in the larger building projects leaving small commercial to the local independents.

HVAC systems cut across all aspects of new and existing construction and can involve design, commissioning, retrofit and remodeling, equipment repair, and training for operators and maintenance staff. In new commercial buildings, the system is generically described by the architect and left to the engineer to develop detailed design specifications. These specifications are then used by an installation contractor (typically a firm specializing in HVAC) who is responsible for procuring and installing the components. The installers then complete a simplified check for operation and leave it to the building operations personnel to fine tune, operate and maintain the units. The installation contractors are also available for repairs and servicing as needed. Another component is the system controls, which are usually linked to an Energy Management System (EMS). Often a separate installer and supplier is involved with the controls.

Energy consumption is related to original equipment sizing and selection as well as whole system design and the specific location and building type. Interactive effects from lighting loads, scheduling and occupancy also affect energy use. The market is slowly moving on its own toward miniaturizing and improving efficiency. Controls are becoming more advanced and accurate, and remote monitoring and management is becoming more common. Technology

trends of note include better air-to-air heat exchangers, dual source heat pumps, and smaller decentralized units for multi-zoning. Key drivers in retrofits are indoor air quality, health, occupant comfort and flexibility, environmental regulations (CFC replacement), and the need to upgrade older buildings. Building owners and managers can exert strong influence in decisions about energy efficiency but often they do not participate in the process, leaving the decision to the engineers.

1.3 Program Timeline

The Small Commercial HVAC O&M Service program originally approved by the Alliance Board planned for two phases, (1) a market test and (2) a full program implementation. It soon became clear that the market test would require a technical development phase as no existing program covered all the elements the Alliance was interested in addressing. While the Board officially funded a Phase I in October of 2001 and a planned Phase II in November of 2002, the actual pilot development may be best understood in the context of three project steps:

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The overall goal for all these pilot phases was to create a full-scale program that could address small roof-top systems across the region. The Alliance Board and staff were aware (via experiences from other utility initiatives across the country) that this market had proven to be difficult to serve in terms of achieving either cost-effective savings or significant participation by service providers and their customers. A significant research objective for the Alliance was to determine whether or not a comprehensive small HVAC program could be successful as a market transformation program rather than a resource acquisition program. While there was clear rationale for the potential of such a program and there was a logical roadmap defined to develop a full-scale program, there was uncertainty at the outset as to whether or not a program would prove viable in the marketplace.

2. PROGRAM RESEARCH AND DEVELOPMENT

This section provides a summary of the preliminary research and developments (R&D) efforts that PECI conducted to define the HVAC service protocol. These R&D efforts, conducted between December 2001 and June 2002, included two primary points of focus:

- **Technical program development –** including the specification and testing of a very specific set of diagnostic and maintenance steps for the program; and
- **Marketing strategy development** – including research, strategy development, and creative design to support the marketing of the ultimate program.

2.1 Technical Program Development

The objectives of the technical program included a review of the experiences of other programs that have addressed maintenance issues for RTUs and the development of a set of recommended technical specifications that would serve as the basis for a maintenance protocol. These steps are described in more detail below.

RTU Program Review

PECI conducted a thorough review of small commercial programs including those run by the California Energy Commission (CEC), San Diego Gas & Electric (SDG&E), Eugene Water & Electric Board (EWEB), Avista, Puget Sound Energy and Clark Public Utilities. A number of the technical components included in the Small HVAC program were modifications of components included in a pilot project of EWEB. In discussions with participants of these programs, the following recurring themes emerged:

- **Importance of relationships between service contractors and customers –** A successful program must build on the existing relationships between service contractors and their customers. It is possible to get the jobs done "quick and dirty" with large incentives, but this erodes the potential for future market transformation.
- **Incentives must be targeted effectively –** Incentives to contractors are necessary, but must target actual system repairs and not just the identification of problems. Incentives of $75 were less attractive while incentives of $150 were well received.
- **High level of service is important –** Contractors must be encouraged to provide the highest level of service.
- **Contractor field training is important –** Field training for contractors is essential to ensure quality control and boost the level of consistent service.
- **Contractor marketing training is important –** In addition to technical field training, contractors can benefit from marketing training. In an industry where the traditional marketing strategy has been to offer competitive prices, offering a premium service for a

higher price is a major change of course. Service providers will need help in promoting the benefits of the service to an uneducated customer base.

- **Importance of finding the appropriate tools and protocols –** The program must give contractors the tools to present a credible product, and demonstrate the value of their services. Technical protocols are complex, and no program to date has worked out a comprehensive tool or service. The CheckMe! tool developed by Proctor Engineering addresses charge and airflow diagnosis and repair, but no protocols were found for economizers or advanced diagnostics.

The program review, supplemented by a review of the technical literature, also served to identify the most prevalent problems resulting in wasted energy:

- Economizer operation problems (mechanical and control)
- Dirty condenser and evaporator coils
- Incorrect refrigerant charge
- Low airflow across evaporator
- Duct leakage
- Poorly programmed thermostats

Technical Design Recommendations

One goal of the service was to create an offering that could be integrated with service providers' current maintenance programs. They would continue to perform their quarterly or semi-annual maintenance on the customer's RTU, and then perform the "30,000 mile tune-up" once every two to three years. Every component of the HVAC system would be diagnosed and fixed in one service call, preferably in the spring or fall when the heating and cooling seasons, respectively, are at their lowest and contractors are looking for a way to increase their workload. The service was intended not only to save customers energy, but also to ensure that their units were running optimally to improve indoor air quality and comfort.

- Tool and protocol recommendations for Phase I were based upon findings from the RTU program review, as well as a review of available diagnostic tools and protocols. These included:
    - CheckMe!
    - ACRx Handtool
    - Performance Assessment Tool
    - TrueFlow flow meters

Also, the available economizer protocols were reviewed:

- EWEB program economizer protocol
- PG&E's RTU Economizer Procedure
- Puget Sound Energy Packaged RTU Protocol
- Draft protocol for California T24 performance verification code addition

- PG&E's Commissioning Test Protocol Library general commissioning procedure for economizers
- PECI's Model Commissioning Plan and Guide Specifications, sponsored by the Oregon Office of Energy and the United States Department of Energy, 1998

For PECI, the primary selection criteria used to make the final recommendations for the pilot protocol included:

- Time required to use the tools
- Cost
- Ease of use
- Delivery of non-energy benefits
- Quality control
- Previous success in the market

Based on the above R&D activities, the recommended program components that were to be developed and tested in Phase I included the following:

- Refrigerant charge: CheckMe!
- Airflow: TrueFlow flow meter
- Economizer Protocol: to be developed via field tests
- Coil Cleaning: Protocol already established. Recommend when appropriate.
- Programmable Thermostats: to be developed via field tests

2.2 Marketing Strategy Development

PECI's literature review and informal discussions with service providers indicated a good deal of interest on the part of service providers in having an opportunity to "up-sell" to a premium service such as that provided by the program. However, very little work appeared to have been undertaken to define exactly how that up-sell would be made to the decision makers in the market place. The task of defining a marketing strategy therefore included:

- Identifying and segmenting the service providers currently holding contracts in the region.
- Interviewing a sample of these providers and their clients to establish desirable characteristics of an enhanced service and appropriate marketing mechanisms including advertising, possible incentive structures, pricing structures, reporting format, etc.
- Developing a preliminary marketing plan.
- Coordinating with the overall CSI marketing effort.

To accomplish this task three activities were undertaken: service provider interviews, decision-maker interviews, and focus groups. These were done in some or all of five target markets that were selected to provide dispersion across varying climate characteristics, market-type (rural, urban, etc.) and because they had significant amounts of small commercial buildings. The markets chosen were:

- Tacoma, WA
- Tri-Cities, WA (Richland/Kennewick/Pasco)
- Boise, ID
- Missoula, MT
- Billings, MT

Service Provider Interviews

PECI conducted a total of 24 service provider interviews (shown in Table 2-1) to determine if these businesses would have enough interest to move forward with the pilot program, to solicit specific information to guide program design, and to identify potential participants in the field demonstration portion of the pilot project. Information collected included:

- Company size, target customer sector and sources of revenue;
- Marketplace strategies for networking with colleagues, gaining industry information and getting new customers
- Extent and the quality of current service offerings and hourly billing rate
- Strengths, weaknesses, and opportunities from the service providers' perspective.

Table 2-1: Service Provider Interview Summary

Market	Interviews Completed
Tacoma, WA	8
Boise, ID	6
Tri-Cities, WA	6
Missoula, MT	4
Total	**24**

Significant findings from these interviews included:

- The service will require some form of financial incentive in the beginning.
- There is a significant need to educate the building owner on the benefits of such a service.
- The service might be best sold as a new service versus an up-sell of their existing service contract.
- Service providers are looking for any opportunity to bolster the currently weak relationship with some building owners.
- Service providers obtain most of their industry information from manufacturers and distributors.
- Service providers often offer a manufacturer's licensed service. For example, a service provider might call himself or herself a Trane Comfort Specialist.
- All firms offer service, but few focus exclusively on service.
- Regulations on refrigerant use and handling are considerations.
- Service providers were guardedly interested in the service offering. The majority of those interviewed were either interested outright or interested depending on the cost of the

service. The cost of the service was the deciding factor for most service providers who were on the fence.

Based upon the market data collected, it was concluded that the program concept was feasible and that service providers had sufficient interest to justify proceeding with the Phase 1 implementation.

Decision-Maker Interviews

To complement and supplement the market information gained in the service provider interviews, EMI was charged with conducting interviews with property owners, property managers and tenants. This series of interviews had two specific objectives:

- To develop an understanding of who is responsible for decisions regarding HVAC system repair, service and replacement and what factors or considerations influence their decision-making.
- To obtain a more detailed understanding of attitudes and awareness regarding HVAC system maintenance (i.e., overall interest in energy efficiency, perceived importance of HVAC system to their business, nature of existing service relationships, attitudes toward HVAC maintenance, and willingness to invest in HVAC maintenance).

In total, 59 telephone interviews were conducted in March 2002 in Bend, Oregon, a community judged to reflect the general target market for the program. The results of this research are summarized in Appendix A. Key findings and recommendations include:

- The local market conditions are important to identify market leaders and understand advantageous relationships unique to the market.
- The contractors will need assistance in targeting customers for the enhanced service.
- Property managers should be targeted since they influence multiple properties and smaller businesses.
- The existing contractor-customer relationship should be leveraged. The service needs to be marketed as "their" service rather than from an outside entity (i.e., utility).
- Franchise and corporate customers should be a prime target because they control many locations/RTUs and can help establish the viability of the service to the broader market.

As part of this research process, interview subjects in Bend were asked a series of questions in order to help refine the initial marketing strategy. Significant findings include:

- Most have a regular service contractor.
- Almost all respondents had an in-house program or routine for performing maintenance.
- The most important benefits from an enhanced service would be extended equipment life and reliability. Improved comfort and air quality were somewhat less important.
- Payback will be a key factor to emphasize.
- They are less likely to purchase an enhanced service from a provider they are not currently working with.

Focus Groups

Based on the previous market research tasks, a focus group research process was defined and two decision-maker focus groups were held in Portland and Spokane on May 14 and 15, 2002, respectively, with a total of 19 attendees. Attendees were selected from a list of 100 businesses per city, which were identified through an online search at the local chambers of commerce. Northwest Research Group solicited and screened participants. A $100 cash incentive was offered, and screening criteria required that participants manage a small commercial property, be the decision-maker regarding HVAC maintenance for that property, and manage a majority of rooftop unit systems.

The primary objectives of the focus groups were to understand how small commercial property managers currently maintain their HVAC systems, identify priorities regarding selection of a service provider, and understand the influence of a utility recommendation on the selection of a service provider. Additional objectives aimed to obtain feedback on promotional materials, sales strategies, and the program name. Several service names were tested, including AirCare Plus, which was later selected based on feedback from these focus groups. The promotional materials tested featured various marketing messages, including the 30,000 mile tune-up analogy, and benefits of optimizing performance and energy savings.

Results from the focus groups confirmed the existence of strong barriers, but also indicated sufficient interest among the decision-makers to continue moving forward under a business venture approach. The most significant finding was that the service technician is the most critical link to a successful market introduction. Other findings include:

- The importance of naming the source of research and the certifying agency to lend credibility to promotional materials.
- Important themes of promotional materials are system reliability, dependability, efficiency, economy of operation, tenant comfort, and reduced down time.
- An opportunity to make a stronger connection between the HVAC service and its name by making the name communicate more about what the service is.
- The importance of communicating clearly how the maintenance program works, and the importance of differentiating the product from the maintenance programs used now.

3. PHASE I PROGRAM & RESULTS

Based on results from the R&D phase, PECI began Phase I, which consisted of developing the technical protocols and performing field tests. PECI, working closely with a few selected contractors, first went through the protocols on 10 buildings to ensure that they worked under real rooftop conditions. At the same time, PECI trained the contractors to be proficient in the service. Based on these test runs the protocol was refined and was deemed ready for use. Once the protocols were defined, PECI developed an energy savings methodology to confirm the benefit of the protocols. Finally, the research into other RTU maintenance programs raised many issues that needed to be addressed to offer a successful service for HVAC contractors. Market research was conducted to gain insights in how to best approach these. Phase I activities, described below, were conducted from March 2002 through February 2003.

3.1 Overview and Goals

The goals of the Phase I implementation were two-fold:

- **Develop and validate energy savings estimates** – Develop a simple energy savings estimation methodology that can be applied across the region that would be acknowledged under utility commission standards for utility programs. Key activities under this effort included:
  - Evaluate existing tools including those used in California, EZSim, and Visual DOE for applicability to the components and problems addressed in the technical protocol. The evaluation should look at ease of use by field personnel, accuracy, and sensitivity to key parameters.
  - Develop methodology using selected tools modified as necessary.
  - Validate the methodology against results from market field test.

- **Refine and test a workable protocol** – Test the refined technical protocol and the preliminary marketing plan in 30 buildings around the region and gain experience with each of the regional service provider markets across four states. Key activities under this task included:
  - Identify service providers in each of the four states.
  - Train the service providers in the technical protocols.
  - Assist contractors in marketing to end-customers.
  - Coordinate with utilities and others as appropriate.
  - Implement the service on 30 buildings.
  - Measure energy savings impacts using methodology.

The five pilot locations were the same four used for research in the R&D phase (Tacoma and Tri-Cities, Washington; Boise, Idaho; and Missoula, Montana) plus Billings, Montana, selected to represent the Eastern part of Montana.

3.2 Technical Protocol Development

The technical protocol development focused on the following two key areas:

- Refrigerant charge optimization
- Economizer operation optimization

Refrigerant Charge

The CheckMe! service, developed by Proctor Engineering Group for residential air conditioners and adapted for the small commercial market approximately five years ago, was used in the Phase I test. Its streamlined protocols and sound technical features appeared to make CheckMe! a good fit for this phase of the program. The CheckMe! service allows service technicians to optimize refrigerant charge by utilizing the superheat or sub-cooling method to check charge. The initial results are called into a central CheckMe! office which makes recommendations. After recommendations are implemented, the final results are phoned in to verify completion. Customers are sent a certificate documenting initial and final results after test is performed. CheckMe! offers built-in quality control and on-demand technical support.

Economizer Operation

One of the objectives of the Phase I pilot was to develop protocols specific to enhancing the operating efficiency of economizers. Typical protocols generally do not give specific instructions on how to force the RTU into various operating modes during functional tests and give few instructions on how to fix problems that are encountered. The areas investigated included:

- Damper and actuator mechanical operation
- Control settings
- Control operation
- Percent outside air at minimum and maximum position

The work completed by Ecotope, EWEB and others to achieve an economizer protocol provided PECI with important background information and manufacturer's checkout instructions. This information was used to develop the subsequent procedural outline and used as a guide to help PECI develop the specific instructions needed to form a full protocol. Three economizer manufacturers predominate in the market. The Honeywell W7459A, Trane Voyager and the Carrier Durablade account for an estimated 95 percent of the units PECI would encounter in the field. PECI strove to develop procedures that would apply to the units encountered in the field tests made by these three manufacturers. After testing units on five buildings, it became clear that the protocol needed additional research and technical development. The development transitioned to the field tests.

Prior to further field tests, a *paper* protocol was developed for the most popular economizer among packaged rooftops units – the Honeywell W7459A. In this protocol a procedural outline was developed that works for all economizers. This procedure is outlined as follows:

- Check economizer full closed position functionality
- Check economizer minimum position functionality
- Check economizer full open position functionality
- Check changeover functionality
- Check outside air damper and return air damper positions and synchronization
- Check low supply air temperature functionality
- Check accuracy of air temperature sensors that could not be verified previously

Specific recommendations on how to implement these steps for the Honeywell W7459A were included within this economizer protocol. However, these specific instructions did not apply to the Trane or the Carrier economizer. Thus, PECI spent more time on the rooftop with technicians developing specific instructions for the Trane and Carrier economizers and also refining the Honeywell protocol.

3.3 Energy Savings Methodology Development

To facilitate the estimation of energy savings by technicians, an Excel spreadsheet was developed by PECI to calculate both cooling and heating energy savings. The calculations required only the minimal following inputs from the user, and included:

- Location (climate)
- Classification of cooling load
- Size of floor space being served
- Capacity of RTU
- Pre and post determination of economizer changeover strategy
- Pre and post determination of minimum and maximum economizer flow as a percentage of total supply air flow
- Recorded energy efficiency increase as a result of an adjustment to the vapor compression cycle

In the development of this spreadsheet, DOE-2E prototype models with various lighting power densities were developed for each building type with many of the prototype values based on the "Guidelines for Energy Simulation of Commercial Buildings" document produced by the Bonneville Power Administration (BPA). The output for each simulation included the following:

- Cooling and heating energy usage index
- Percent savings associated with a perfectly optimized economizer
- Savings ratio of each economizer control strategy compared to a perfectly optimized economizer.

Savings associated with refrigerant charge and airflow adjustments were estimated using a combination of CheckMe! procedures and existing cooling energy usage.

The primary schedule modification energy conservation measure evaluated was to implement an occupied or unoccupied operating schedule. Energy savings associated with duct leakage will be limited to ductwork located on the roof.

An initial plan was to validate the energy savings methodology using existing data from the EWEB pilot but these data proved to be insufficient for this purpose. Additional efforts undertaken by Ecotope, Inc. also failed to validate the savings estimates from the spreadsheet. While these efforts did not indicate that the spreadsheet was wrong it did not have the robustness that outside validation would have supplied.

3.4 Phase I Lessons Learned

Phase I field work elicited many important discoveries about needs for delivering the service to the market. The following issues were identified for further development in Phase II:

Refrigerant Tool

During fieldwork, it became evident that CheckMe! was not the right tool for this program. Several issues, including set-up and implementation time, accuracy of data collection, and flexibility were all factors in the decision to replace the CheckMe! protocol with the Honeywell Service Assistant™. The Service Assistant takes less time to implement, provides instantaneous diagnoses, and provided more accurate energy savings results. The Service Assistant had the added benefit of being able to program the interfacing PDA with diagnostic protocols, eliminating the need for a paper protocol, and offering a much better method for data collection and quality control on all components. PECI's unique relationship with Field Diagnostics Services, makers of the Service Assistant, made this integration possible.

Protocol Methodology

The paper protocol, designed to encompass the three most prevalent economizers, Honeywell, Trane and Carrier, was quite cumbersome and proved to be unmanageable on the rooftop (particularly with the Northwest's climate) and difficult to capture all relevant data. The inclusion of the additional economizer manufacturers in the protocol only increased the complexity. PECI sought out a versatile, practical solution and negotiated with Field Diagnostics, a software design firm with considerable experience in diagnostic systems, to transfer the entire paper protocol into the software they developed for a Palm Digital Assistant (PDA) device. The result was a customized PDA that interfaces with the Service Assistant and contains software that can guide the technician through diagnostic routines, and then synchronize the data with a remote server for later analysis.

Technicians on the roof, rather than cycle through pages and pages of paper, would use a PDA that included "jump menus" that related to the specific economizer and/or weather conditions. The "jump logic" enabled service technicians to work more efficiently and with less room for human error. The PDA also included diagnostic and troubleshooting tools that allowed the service technicians to more easily diagnose what control component had failed. Given the complexity of the troubleshooting books for the Trane, Carrier and Honeywell products, PECI

found that the participating service technicians like the step-by-step instructions built into the PDA interface and were able to follow it precisely.

3.5 Phase I Evaluation

Energy Market Innovations, Inc. (EMI) served as the "real-time evaluator" in Phase I, beginning in early 2002. Real-time evaluation focuses on completing market research and evaluation tasks on very short time-frames and providing feedback to program planners and implementers so that information and analysis can be used to make program modifications while the program is still in the early stages of implementation. This approach is extremely valuable in pilot projects such as the Small HVAC program where there is uncertainty about fundamental issues such as technical protocols and market acceptance.

The evaluation team completed a variety of tasks throughout the development process. These included:

- Market research to support development of the marketing plan
- Conducting field observations of technical training and RTU service
- Interviewing program participants
- Providing input to the strategic development of the program

At the conclusion of Phase I in the fall of 2002, the evaluation team prepared an assessment of project achievements relative to eight progress indicators identified within the initial scope of work (SOW) between PECI and the Alliance. A summary of this assessment is provided below.

Progress Indicator No 1: A well-defined, cost-effective service distinct from standard practice is developed.

Assessment: Considerable effort was expended to develop a workable protocol. Observations made by EMI staff included:

- The protocol continues to be refined and this process is likely to continue for some time given that no combined/integrated protocol existed previously. After the development work is completed PECI will need to integrate the four field protocol elements into a single streamlined (shortest time of service possible) protocol for contractors. Additional field testing of the integrated protocol now must be done. Specifically within the protocols several issues exist.
    - Field tests demonstrated that considerable time is required to implement the service (ranging from three to six hours per unit).
    - There remain significant issues with the use of CheckMe!, including the time to run through this process and the validity of the results. There are ongoing discussions weighing the merit of this aspect of the protocol and a need to test alternative refrigerant charge test tools especially Honeywell's ACRX.
    - Need to work with The Energy Conservatory to create a commercial-sized version of the flow plates for air flow measurement.

  - Existing economizer protocols were found to be ineffective, and differences exist between manufacturers
- The emphasis placed upon protocol development diverted focus from the development of a marketing strategy.
- Original data available was insufficient to validate savings estimation methodology to meet regional technical forum (RTF) needs. A possible solution was to use metered California PIER data.

Progress Indicator No. 2: A marketing strategy exists to deliver the service through the service contractors.

Assessment: Because the development and testing of the service protocol took more time and resources than initially anticipated, there was little emphasis on the research and development of a comprehensive marketing strategy for this project. EMIs observations include:

- A marketing strategy has yet to be developed, in part, because the program has not been specifically defined.
- The initial intent to deliver the service through service contractors is now in question. Because of anticipated high costs of delivering the service in accordance with the protocol being developed, utilities may be expected to play a more active role in the marketing and delivery of program services.
- Additional work is required to fully explore:
  - The potential role of utilities as sponsors/partners
  - The business models of service providers to understand how to best market and deliver the new service
  - The specific needs and interests of business owners/consumers in order to be able to develop appropriate marketing strategies

Progress Indicator No 3: Completion of at least 30 full demonstration projects across the four states.

Assessment: The initial intent of the pilot was to conduct a market test in at least 30 buildings. These full demonstration projects were to have tested the technical protocol *and* the market strategies. While additional field tests are being conducted in order to further refine the protocol, a full demonstration market test is not being undertaken, as the marketing strategy has not yet been integrated. Because this element is not likely to be completed during the Phase I project, it is critical that the Phase II project refine the precise business model and carefully test and evaluate all aspects of this strategy within the context of a market test.

Progress Indicator No. 4: A refined and validated energy savings methodology exists.

Assessment: A refined energy savings calculation methodology has been developed; however, attempts to validate the methodology were undertaken, and the results were determined to be insufficient to rely upon. PECI is therefore proceeding to re-scope the validation of the methodology and this work will be concluded over the next few months. This is clearly a key

issue for both the Alliance and HVAC contractors. All program participants and service providers need to be convinced that the savings are significant and credible to warrant the cost of the service and/or repairs identified during the course of delivering the service.

Progress Indicator No. 5: Demonstrated energy savings in a majority of the demonstration projects.

Assessment: Technical issues have been identified and successfully addressed in the majority of projects. As noted above, the resulting energy savings are still being calculated. Initial calculations indicate inconsistent kWh savings per unit serviced. Because energy savings are not expected to provide compelling payback periods, it is not envisioned that service contractors will be able to sell this program based on energy efficiency benefits alone.

Progress Indicator No 6: Demonstrated fit with existing service provider's services.

Assessment: The pilot has demonstrated the technical merit of the service and proven that service technicians can be effectively trained to deliver the service. The pilot has yet to demonstrate how it fits into the market with regard to existing service provider's services. While service providers are interested in the program concept, they have not been given specific information about the service protocol, training, marketing support or the (potential) role of utilities. It cannot be concluded that service providers are supportive of this program until they have adequate information to consider the value of a new service within their existing business model. At this stage, it is clear that service providers will need both technical, sales and marketing training in order to successfully promote and deliver the service.

Progress Indicator No. 7: Cost sharing by utilities and/or customers.

Assessment: Given the limited amount of market research (phone interviews and focus groups), it is difficult to determine the willingness of customers to pay for an enhanced service. Because there is no current market demand for this service, the economy is in recession, the energy savings estimates are not likely to provide compelling payback periods to owners, and the actual costs of the service protocol are expected to be reasonably high, it is unlikely the market will bear the full cost of the program. There is reportedly a significant level of interest, from utilities, in the enhanced O&M service concept. Research is being undertaken to determine, more specifically, the needs and interests of regional utilities in the service and to assess:

- Their willingness to pay for some or all of the costs of the service; and
- How to best integrate this new program into their service menu.

Progress Indicator No. 8: A coordinated effort within the CSI marketing campaign.

Assessment: This has yet to be developed. Until the specific scope of the service is defined, it is premature to coordinate a marketing effort with CSI.

3.6 Program Status at End of Phase I

The original goals of the pilot were to define an enhanced O&M service, develop necessary tools or protocols, and test the market acceptance for this service in a limited market test. These goals were not all met due to technical complexities encountered during the protocol development, as well as a need to refine the diagnostic tools. As a result, the Alliance agreed to postpone the marketing field test until Phase II, and PECI re-directed its resources almost completely to addressing the short-term challenges related to the protocol development and conceptual design of the pilot. These changes were necessary and appropriate given the demands of the pilot development and the Alliance's adaptive management strategy but delayed the acquisition of important market information.

The contractual goal between PECI and the Alliance was to complete the service on five buildings in the five different locations (the number of RTUs per building was not determined.) PECI intended to be able to train a service technician to complete an RTU service in less than four hours. PECI trained multiple technicians who worked together learning the protocol and completing the service. Table 3-1, below, provides a summary of Phase I Pilot activity.

Table 3-1: Summary of Phase I Pilot Activity

Location	Buildings Completed	Total RTUs Tested*	Techs Trained
Tacoma	5	12	2
Boise	5	11	2
Tri-Cities	5	7	1
Missoula	5	9	3
Billings	5	8	2
Total	**25**	**47**	**10**

** The total number of units includes the training days*

There were significant challenges encountered during these initial tune-ups. In almost all cases, technicians worked together rather than individually to complete and RTU service. The learning curve associated with learning and refining the protocol proved too steep to enable anyone to consistently complete the service in less than four hours. Other factors that diminished productivity was the lack of certainty of what kind of equipment the technicians would encounter on the roof and, in many cases, finding RTUs that were not in good working order.

In addition to the logistical challenges faced by the implementation team, the evaluation work identified several higher-level obstacles that challenged the long-term viability of the program. These are discussed below and became research questions for Phase II.

- **As a result of widespread neglect of Small HVAC units, numerous problems are identified** – Most RTUs are not adequately serviced after installation and the majority of existing RTUs have problems affecting efficiency. This means that service providers, in completing the diagnostic process of the enhanced service, will identify a significant number of units that require repair work beyond the intended scope of the technical protocol. This will present ongoing service issues for technicians and will be costly for business owners.

- **There is no current market demand for an enhanced O&M service** – Initial estimates suggest the new service may cost as much as $250 per unit. Business owners do not currently see a need or benefit to spending additional money for a service contract up-sell. Participating HVAC contractors reported that customers have an "out of sight, out of mind" perspective and are not likely to want to pay for these repairs when they do not perceive that problems exist. Developing market demand for this service will require an extensive, focused educational effort to educate consumers about the value and benefits of higher levels of HVAC service. Further, this educational effort will depend on service providers and service technicians to educate their clients in order to sell the service. This will dictate the need for an effective sales training component for the new service.

- **Service providers expressed concerns about the marketability of the service**– Service providers expressed skepticism about their ability to actually sell the enhanced service. While service providers were supportive of the concept and saw market opportunities, they were not given specific program design information to adequately determine if they could integrate it into their business model and do so profitably. Even basic decisions such as whether the service included a refrigerant charge component were not finalized.

  Further, service providers expressed reluctance to (1) draw attention to what their existing service contracts do not provide, and/or (2) champion a service to their customers that will inevitably identify costly repairs. In the market research interviews, contractors recommended that the new service be positioned as a new distinct service from what they currently offer. They also noted that owners need to see the benefits of doing more than they now do with regard to service of their RTUs. Contractors also said that documentation of benefits should come from a credible source, and that some form of incentive may be necessary, at least at first.

- **The level of interest and understanding among regional utilities is unknown** – Given the anticipated high cost of the service, the service will likely need a utility rebate or cost sharing. Research with utilities needs to be undertaken to ascertain the feasibility and/or interest of this approach. It is possible that some utility interests may differ or conflict with those of service providers. This is a key area that needs to be better understood in order to determine the best program design and implementation models.

- **Claims of energy savings estimates (kWh) are not well documented –** Until this situation is rectified neither service providers nor utilities know if savings are significant enough to warrant the service cost.

- **Which implementation approach will be most appropriate –** There is insufficient program information and market experience to decide whether the program will be best implemented by utilities, service providers trained and supported to create market demand, or a hybrid version such as a utility-sponsored program marketed and implemented by a network of service providers. Because Phase I did not include a market test, there is also a lack of knowledge about how the program should be marketed to end-users.

4. PHASE II PROGRAM & RESULTS

4.1 Overview

Phase II was conducted between February 2003 and February 2004. At the beginning of Phase II, a revised technical protocol had been determined but had never been implemented by service providers under typical field conditions (i.e., without the hands-on assistance of PECI staff), and the marketing strategy and support materials were in the early stages of development. While the technical protocol continued to be adapted and refined, the focus of Phase II was on a market test to determine if service providers could sell and provide the AirCare Plus service (as it was by then called) to real customers.

Market Test

As shown in Table 4-1, the market test expanded the locations involved in Phase I and included varying levels of utility incentives and involvement. Utilities were contacted in the spring of 2003 to gauge interest in the ACP program and solicit participation in the form of incentives, training, equipment purchase, or nominal support via website blurbs or use of logos. The target was to recruit two service providers within each market and complete service tune-ups on a total of up to 250 buildings. The timeframe for completion of all Phase II services was spring through fall 2003, with an expected drop off during the summer season (due to service providers being busy with emergency repairs). To avoid legal issues concerning unfair competition during the market test, service providers were restricted to selling AirCare Plus (ACP) to their existing customers and not allowed to use the service as a means of recruiting new business.

In an effort to define the appropriate regional program delivery model, different levels of utility involvement were explored. The three following scenarios were tested, with each scenario applied in at least two markets:

- **No utility involvement or support**
- **Utility endorsed but without financial incentives –** This option included the potential for utility to cost-share with training and equipment expenses, co-branding, and use of account reps to assist in promotion.
- **Utility incentives and promotion –** This option included the payment of direct incentives to the customers or contractor.

During Phase II implementation, PECI took responsibility for processing rebates for two participating utilities, collecting supporting documentation and generating checks. Several utilities actively participated in assisting contractors with marketing efforts. Table 4-1 shows the cities, contractors, utilities and utility involvement in Phase II.

Table 4-1: Phase II Target Markets, Utilities and Contractors

Market	Contractor	Utility	Utility Involvement
Puget Sound, WA	Air Systems Engineering	Tacoma Power	Sales support
	Olympic Mechanical	Snohomish County PUD	$100 rebate, sales support
	McKinstry Company	Seattle City Light	$100 rebate, sales support
Spokane, WA	Aliant Energy Services	Avista Utilities	Sales support
	Lake City Heating & Cooling	Avista Utilities	Sales support
Tri-Cities, WA	Coffey Refrigeration	City of Richland; Benton County PUD; Franklin County PUD	Sales support
	Morrison Construction	City of Richland; Benton County PUD; Franklin County PUD	Sales support
Vancouver, WA / Portland, OR	Accurate Heating	Energy Trust of Oregon; Clark County PUD	ETO – none; Clark County - $100 rebate
	Entek Corporation	Energy Trust of Oregon; Clark County PUD	ETO – none; Clark County - $100 rebate
	Town & Country Heating	Energy Trust of Oregon; Clark County PUD	ETO – none; Clark County - $100 rebate
Bend, OR	Mountain View Heating	Central Electric Cooperative	None
	Quality Heating	Central Electric Cooperative	None
Ashland/Medford, OR	Southern Oregon Heating	City of Ashland	75% of service cost, up to $175 rebate
	Valley Heating	City of Ashland	75% of service cost, up to $175 rebate
Boise, ID	Ridgeway Industrial	Idaho Power	$100 rebate, sales support
	Western Heating & AC	Idaho Power	$100 rebate, sales support
Twin Falls, ID	Terry's Heating & Cooling	Idaho Power	$100 rebate, sales support
Missoula, MT	Grizzly Mechanical	Northwestern Energy	$100 rebate, sales support
Billings, MT	Alpine Plumbing & Heating	Northwestern Energy	$100 rebate, sales support
	PerfecTemp	Northwestern Energy	$100 rebate, sales support

Evaluation Activities

In addition to the implementation activities, two separate evaluation activities were funded for Phase II. One was a continuation of the real-time process evaluator from Phase I. Results of the process evaluation are presented in Section 6 of this report. The second evaluation activity was

monitoring and verification (M&V) with the goal of validating the savings estimates from the model that PECI had developed. A related goal of this effort was to provide utilities with a level of confidence in the savings estimates that would allow the results to be accepted in regulatory proceedings around the region and by the Regional Technical Forum. Results of the M&V evaluation are presented in Section 7 of this report.

4.2 Phase II Goals

The implementation goals of the Phase II market test were to:

- Revise an enhanced O&M service option for existing small rooftop HVAC equipment.
- Gather experience and market intelligence to refine and launch a full-scale program.
- Prepare for full-scale program launch.
- Develop appropriate marketing strategies.
- Develop a framework to document and analyze the benefits of the service.
- Test several program delivery scenarios.
- Test the business proposition for service contractors offering a premium service every three years.
- Test the market acceptance of the service in a limited offering in 20 markets.

Table 4-2 gives a detailed description of the implementation activities for Phase II.

Table 4-2: Program Components

Component	Description
Recruitment	▪ Continued working with the providers of Phase I. ▪ Worked with the local utility to identify additional contractors.
Enrollment	▪ Once identified, contractors signed an agreement stating their dedication to trying to sell at least 10 jobs to offset the investment in training and equipment the program will make.
Equipment	▪ The necessary equipment (tools) was either partially subsidized by the program and utility or provided entirely at no cost.
Technical Training	▪ The techs received both classroom and in-field training. Time varies by level of experience of the tech. Contractor time in-kind.
Tech Qualification	▪ After the technical training there was a qualification period where a program engineer supervised and provided additional on-site training (on 2 units).
Sales Training	▪ Sales training emphasized the value proposition contractors will use to help sell the service. ▪ Sales training was tailored to the type of contractor company (i.e., small shop versus having a sales manager). ▪ Marketing collateral included a customer brochure to help sell the benefits and a calculation tool to estimate energy savings for potential customers.
Program Support (technical & sales)	▪ Support was available on-demand during business hours to help troubleshoot problems encountered during the service.
Savings Estimates	▪ A spreadsheet tool was provided to the contractors to generate savings estimates and a service summary on completion.
Quality Control	▪ Random inspections and customer follow up were undertaken. ▪ A mechanism was developed to remove or disqualify non-performing contractors as necessary.
Marketing	▪ Concepts and materials were pre-tested via owner focus groups. ▪ Limited marketing to end-users was achieved through coordination with local utilities. ▪ The end-user marketing strategy was developed to help the contractors sell the service to their customers. ▪ A web page was developed to provide information, give credibility, and list qualified contractors.
Incentives	▪ Work was undertaken with utilities to quickly develop and offer incentives on a limited basis.

4.3 Program Activities

AirCare Plus Technical Service Protocol

As mentioned above, the development of the technical protocol, a comprehensive diagnostic routine, continued during Phase II. Based on feedback from focus groups described later in this report, the service that delivered the protocol was called AirCare Plus (ACP). The protocol addressed thermostats, airflow, refrigerant charge, and economizers, the details of which are discussed in detail below.

Thermostats

- Identify as programmable or non-programmable. If non-programmable, an upgrade to programmable is recommended if the owner and/or tenant does not reproduce programmable functionality through manual intervention.
- Record program schedule and any overrides, and adjust if necessary.
- Record set-points, and adjust if necessary.
- Determine if it is a one-stage or two-stage thermostat. Recommend upgrade to two-stage thermostat for RTUs generally greater than five tons and having economizers.

Airflow

- Measure flow rates:
  - Supply flow
  - Minimum outside flow
  - Economizer flow
- Compare supply flow to target of 350 CFM/ton. Increase if necessary.
- Record minimum outside flow and convert to a percentage of supply airflow; adjust if necessary.
- Record economizer flow and convert to a percentage of supply flow.

Refrigerant Charge

- Record charge using Honeywell Service Assistant™ (replaced CheckMe! as described below).
- Make adjustments according to diagnosis.

Economizer

- Record changeover strategy.
- Measure and record as-found minimum outside air flow before the technician changes the as-found condition.
- Confirm economizer fail closed function works.
- Perform a functional test to verify the economizer changeover function is working and check the accuracy of the outside air sensor.
- Assess outside air and return air damper positions relative to each other to determine the need for linkage adjustments.
- Confirm the packaged control's ability to stage economizer and compressors on one at a time; adjust if necessary.
- Determine if economizer is integrated or non-integrated.
- Functional test to check the supply air low limit temperature function and verify the accuracy of the supply air sensor.
- Directly check sensors that appear to have failed or could not be determined accurate.
- Record final changeover set-point.

Tools & Technology

A primary feature of the AirCare Plus pilot is the use of innovative tools and technology to provide a level of service previously unattainable for service providers. After research and field trials, participating service providers were provided a suite of tools (with value of approximately

$5,000) that could be used for both the AirCare Plus service and routine maintenance. These tools are described below:

Personal Digital Assistant (PDA) – The Palm m500

After Phase I, it became clear that a paper-based protocol was inappropriate for the rooftop, especially in the Pacific Northwest's climate. Working with Field Diagnostics Services (makers of the Honeywell Service Assistant™), PECI developed software to allow the technician to collect and store all data collected from the protocol on a PDA device that interfaces with the Service Assistant. The Palm guides the technician through the service, allowing the selection of various inspections, requiring input of critical data and saving the data as the service is completed. The digital approach ensures all data is collected, procedures are followed, and offers flexibility that a paper protocol cannot provide.

The Palm software provides different responses and requires different inputs depending on what information it receives. The service path that the technician follows using the digital protocol may take one of many different approaches depending on what the technician finds during the service. Field Diagnostics developed AirCare Manager to help the technician select the various inspections, create new jobs and sites, and save data to later be downloaded to Field Diagnostic's server through a modem. Palms have been on the market for several years, but are still unfamiliar to many people, particularly service technicians conducting routine fieldwork. PECI recognized the learning curve for using this type of technology, and endeavored to make the inspections, synchronization process, and data collection as simple as possible.

Honeywell Service Assistant™

The Honeywell Service Assistant™ was used for the refrigerant portion of the service, replacing the CheckMe! tool as described in Section 4. It combines a digital manifold where the measurement interface and diagnostic software reside, the sensor arrays, and the PDA user interface. The tool connects to the PDA containing the software via a serial cable, which then displays the data and diagnosis. Measurements are saved on the PDA and later uploaded to a secure server. The Service Assistant was chosen for its customizability of the Honeywell software for the service, the ability to develop a fully digital protocol which does not rely on paper work on the rooftop, accuracy of data, reliability, and because of existing PECI-Field Diagnostics relationships. The Service Assistant's strong point is its ability to increase the technician's understanding of the vapor compression cycle ensuring proper adjustments are made during service.

TrueFlow™ Flow Plates

TrueFlow™ Plates allow a technician to measure the supply airflow rate with an accuracy of +/- seven percent. The acrylic flow plates fit into the air filter rack on the RTU. Using the flow plates allows the technicians to measure the airflow directly and accurately. Previously, technicians had to rely on general calculations that assumed accurate temperature measurements. By providing many sizes of spacers, the flow plates can replicate many different filter sizes. This is important as the flow plates are installed in place of the filters when measuring supply airflow and in the outside air hood.

Flow Hood Adapter

Measuring economizer airflow was challenging with the flow plates because economizer hoods come in many different styles, shapes and sizes. Some economizers have two separate intake hoods and others have non-standard dimensions. Duct tape and cardboard additions were the original solution to enable the flow plates to measure economizer flow, but it was cumbersome and often a waste of technician's time. Development of the flow hood adapter was the natural solution to this problem. PECI developed and beta-tested these. Airtight pieces of material attach to the sides of one or multiple flow plates with Velcro® and are wrapped around the economizer hood. Magnets provide an airtight seal between the flow hood and the economizer hood. With a little diligence during installation of the flow hood, a good seal can be constructed which does not allow air to bypass the flow plates. The resulting airflow measurement is as accurate as the duct tape method and takes less time.

4.4 Marketing Strategy Development

Once the technical protocols were developed, the challenge was to introduce the ACP service into a highly competitive and price-sensitive market. In order for an enhanced service like ACP to succeed, it must be profitable for service providers. This means that they must be able to sell the service to the customer for a price that the customer is willing to pay and that covers the cost of the technician's time. Because the ACP service takes considerably longer to complete than routine RTU maintenance, this was a significant potential market obstacle. The goal, then, was to create a service that provided contractors with an edge over their competitors, particularly the ability to offer a higher level of service that would have a short payback through energy savings or a combination of energy savings and utility rebates.

Four activities were conducted to help develop the marketing strategy. In large part, these repeated the activities conducted in Phase I; however, the work done on the program in the interim allowed this round of research to be much more specific and therefore resulted in results directly applicable to the program implementation. The four activities were:

- Extensive interviews with service providers
- Focus groups with RTU owners and property managers
- Utility discussions to determine types and levels of support they could provide
- Creation of a website

Service Provider Interviews

In February 2003, a series of interviews were conducted to help guide program design by gauging service provider's reaction to the use of the new tools and technologies that had been developed, identify any potential barriers, and solicit information regarding how they market their services. A secondary goal of these interviews was to identify potential participants in the Phase II field demonstrations. A total of 26 service provider managers, as shown in Table 4-3, were interviewed throughout the ten target markets.

Table 4-3: Service Provider Interviews Summary

Market	No. of Completed Interview
Portland/Vancouver, WA	7
Spokane, WA	4
Tri-Cities, WA*	1
Tacoma, WA*	1
Ashland/Medford, OR	2
Bend, OR	5
Idaho Falls, ID	4
Boise, ID*	1
Missoula, MT*	1
Total	**26**

** Phase I Market*

The interviews were conducted informally to obtain qualitative information and general feedback on the program. The results were not meant to be statistically valid. The interview guide was designed to obtain information in the following areas:

- General company information
- Reaction to the new technology and tools used in AirCare Plus
- Program benefits and barriers
- Business strategies profile (e.g., commonalities in marketing methods, types of customers, etc.)

Results indicated significant interest in the program in the new markets, and that the new technology would not be a barrier for the program. The following key findings were made:

- Nearly all of the service providers are interested in working with the technology and see few problems integrating AirCare Plus service into their existing business model.
- Service providers see the benefit of the service and that it will give them a competitive edge.
- Utility endorsement is universally seen as a great benefit to selling the service.
- Typical service provider marketing efforts for RTU service do not extend much beyond building relationships or the occasional direct mailing.
- Many providers have found that preventative maintenance is a tough sell. This was typically identified as the biggest barrier to integrating the program into their business model.

Focus Groups

PECI created draft marketing materials and messages and then convened four focus groups to gauge reactions and get feedback from decision makers to assess the effectiveness and appeal of the promotional materials and program messages. Specific research objectives for the focus groups included:

- Gaining a better understanding how small commercial property managers currently maintain their HVAC systems, and which service providers are used to conduct routine maintenance.
- Learning how much influence a recommendation from a service provider would have in the decision to purchase AirCare Plus.
- Gauging reactions to brochure covers and headlines as well as the content and layout.
- Gauging reactions to product name and effectiveness.
- Gaining a better understanding of current spending on HVAC system maintenance and expectations associated with savings that commercial property managers could expect from a new HVAC system service program.

Two groups were held in Seattle, Washington and two groups in Portland, Oregon, each with mixed audiences of commercial property managers and small business owners/managers. The following key findings were made:

- Nearly all participants viewed the service summary piece showing the information they would receive as a valuable tool and it was recommended that it be larger and more apparent in the promotional pieces.
- Most participants indicated that the tagline and bullet points on the brochure intrigued them and would prompt them to actually read the rest of it.
- Nearly all participants stated that annual AirCare Plus service seemed most logical as many variables will affect the performance of HVAC systems throughout the year, such as weather, quarterly preventative maintenance adjustments, changes in service tech personnel, etc.

Web Site

An AirCare Plus web site (www.aircare-plus.com) was developed to communicate the service and benefits to participating customers. The website contained:

- Information on savings
- Program features and benefits
- General questions and answers
- List of participating contractors.

This website was not made public, and is still parked for future use.

4.5 Preparations for Implementation

Service Provider Recruitment

Potential service providers were identified through PECI interviews and recommendations from utilities. The following criteria were used in screening potential participants:

- **Regional equity** – The goal was to have two service providers in each of 10 markets, for a total of 20 service providers

- **Company size** – Aimed to recruit medium-sized companies, between 15-25 employees

- **Percentage of Commercial Contracts** – Aimed to ensure 50 percent of service providers HVAC service contracts were with commercial customers

- **Interest Level** – Service providers were sought that showed interest in an enhanced service offering

- **Market Leader** – When possible, service providers were preferred to be market leaders.

Prospective service providers were sent a recruitment package, including a summary explaining the service and the program, samples of marketing materials, and a program application. A total of 20 signed up for the program. Table 4-1 shows participating service providers and the markets they serve.

Marketing Materials

Based on feedback from the focus groups, PECI worked with a graphic designer to develop and produce the following marketing materials and communication pieces which were provided to the service providers:

- AirCare Plus logo
- Brochures with a customizable area for contractor or utility logos
- Letterhead, font, envelopes, and mailing labels
- Sales tool kit with letter templates and savings worksheets
- Service summaries, which provide unit details and descriptions of diagnosis and fixes performed, as well as energy savings
- Descriptions of utility support of the program (if applicable)
- FAQ – Contractor frequently asked questions and answers

Training Curriculum – Sales & Technical

PECI developed curriculum to train both service technicians and service providers' sales staffs. All 20 participating service providers attended the comprehensive two-day trainings. These included reviews of economizer fundamentals to help technicians understand how to troubleshoot problems and determine how to best optimize economizer operation. Similarly, a review of the vapor compression cycle was necessary given the surprisingly limited exposure that most technicians have to refrigerant work. Analysis of the cooling cycle is usually done only upon a major failure in the refrigerant circuit. The balance of training time covered the use of the tools, service protocol and program issues. Each contractor was also given a Quick Guide, outlining the service and major steps of the inspections for reference while performing the service. Table 4-4 shows the full curriculum.

Table 4-4: Training Curriculum

Technical Training
Day 1:
Program Overview
Monitoring
Palm Orientation
Flow Plate Orientation
Adv. Refrigeration Diagnostics
Refrigerant Charge Inspection
Day 2:
Economizer Fundamentals
AirCare Manager
Building Inspection
Thermostat Inspection
Unit Inspection
Airflow Inspection
Economizer Inspection

Sales Training
Marketing Materials
Savings Worksheets
Incentives & Processing
Monitoring & Verification

Optional Web Service Training

Contractors were given unique usernames and passwords to access their data on the remote server. This enabled them to ensure that data was transmitted successfully and have a running record of service for their customers. Training was optional, and five contractors attended a one-hour session on the basics of accessing data. The following topics were covered:

- Data organization and types
- How to sort data for viewing
- Configuring company characteristics

Energy Savings Methodology Refinement

The energy savings spreadsheet developed using DOE-2 models in Phase I was refined in Phase II to work with the Palm software. The final energy model lacked the ability to predict energy savings based on changes to the operating schedule and temperature set-point changes, both of which are routinely done during service. The Honeywell Savings Estimator software, a commercially available modeling program with a Windows interface, provided this analysis. Service data collected and downloaded to the AirCare Plus website was manually entered into these two modeling tools. This raw data was imbedded into a spreadsheet that includes a user interface making it practical for all users. The output of these tools was recorded on the Service Summaries for each service.

Implementation Process for Field Tests

A specific process was developed for conducting the field tests, and is outlined below:

- Service providers targeted interested customers for the service, filled out a Sales Log to track their progress, and sent it to PECI;

- PECI coordinated with the M&V contractor (discussed below), when appropriate, to install monitoring equipment;
- PECI engineer was scheduled to attend the servicing if it was the first since the service provider training;
- Service was performed, and data downloaded to the website upon completion;
- Data was analyzed by PECI using the Savings Spreadsheet and a draft Service Summary was created and sent to the service provider;
- Service provider reviewed the Service Summary, and PECI produced the final version for delivery to the customer;
- Data was entered into a database for further tracking;
- Savings were entered into a Savings Analysis spreadsheet to calculate averages and total savings;
- Service provider sent in incentive form to receive utility incentive where applicable;

4.6 Field Test Results

After the service providers were selected, trained and equipped with the tools needed for AirCare Plus, they were free to market the AirCare Plus service to their clients. In this sense, the Phase II market test was supposed to simulate what efforts service providers would make on their own to sell the service. Although the majority of service providers indicated that they were enthusiastic about the potential of AirCare Plus and they would market the program aggressively, the overall sales results were not overly encouraging. Of the original target of selling and servicing units in 250 buildings only 54 buildings were completed. In these buildings, the service was sold for 126 units although the field tests were finally conducted on only 79 units. All of these sales were made by just ten of the twenty service providers meaning that ten service providers completed no sales or services at all.

Table 4-5 summarizes the buildings sold, units sold and units serviced by service provider. The number of units serviced can be smaller than the number sold when the customer agreed to purchase the service but it was never completed. This occurred in several instances as the result of both service provider and customer issues.

Table 4-5: Total Number of Buildings and Units

Service Provider	Buildings Sold	Units Sold	Units Serviced
Air Systems Engineering	0	0	0
Olympic Mechanical	8	21	11
McKinstry Company	3	7	5
Lake City Heating	0	0	0
Aliant Energy Services	4	7	6
Morrison Construction	0	0	0
Coffey Refrigeration	0	0	0
Accurate Heating	4	15	11
Entek Corporation	3	5	5
Town & Country	0	0	0
Quality Heating	4	5	3
Mountain View Heating	0	0	0
Southern Oregon Heating	3	12	2
Valley Heating	0	0	0
Western Heating	0	0	0
Ridgeway Industrial	7	25	23
Terry's Heating	2	6	6
Grizzly Mechanical	16	23	7
PerfecTemp	0	0	0
Alpine Plumbing	0	0	0
TOTAL	**54**	**126**	**79**

Another clear outcome from the market test was that utility rebates were extremely important in selling the AirCare Plus service. As shown in Table 4-6, 91% of the 126 units sold included utility rebates.

Table 4-6: Sales vs. Rebate Availability

	WITH Rebates	WITHOUT rebates	Totals
Buildings/Sales	43	11	**54**
Units sold	102	24	**126**
Units serviced	68	11	**79**

The annual estimated savings for each unit, based on PECI's savings model, were 998 kWh and 181 therms. These results are discussed in more detail in Section 7.

5. PHASE II EVALUATION

The evaluation of Phase I revealed significant market obstacles both with the protocol and in the market that needed to be addressed in order for the Small HVAC Pilot program goals to be realized. In the program redesign for the Phase II Expanded Market Test, PECI was thorough in its efforts to develop and promote a technical protocol and program model that HVAC contractors could introduce in the marketplace in a way that would be attractive to their business and their customers. As the summary of Phase II reveals, PECI was aggressive in addressing the market issues that were identified in Phase I. This was reflected in the maturing of the following program components:

- Revised service protocol
- Technical training
- Sales training
- Service provider support services

Despite these extensive efforts during the Phase II Expanded Market Test, it is clear that the market actors did not demonstrate a willingness to drive this new HVAC service in the market. This section highlights a number of examples that reflect reluctance on the part of HVAC contractors to introduce AirCare Plus into the market.

5.1 Phase II Evaluation Activities

The EMI evaluation tracked and documented the Phase II program accomplishments by closely monitoring all aspects of implementation. The evaluation tasks included:

- Two sets of in-depth interviews with service provider managers
- Observation of technical trainings
- Observations of sales training
- Ongoing dialogue with key program personnel
- Analysis of program participation data

The first interviews with service providers were conducted immediately following their technical and sales training that PECI provided. These interviews were designed to determine if service providers were adequately prepared to perform the technical aspects of AirCare Plus and, as importantly, to sell the service to their customers.

The second set of interviews was conducted in October and November, at the conclusion of the Phase II market test. These interviews provided evaluators with an opportunity to solicit summary feedback from service providers and determine their overall perspective about AirCare Plus, the quality of program support, and the potential the new service might have in the marketplace.

5.2 Service Provider Feedback on Training and Program Expectations

The first series of interviews provided the following information.

Service Technicians Rating of Technical Training

Service technicians were asked to evaluate the quality of the technical training following completion of the training. Two questions and responses are provided as follows:

Table 5-1: Overall quality of technical training (n=19)

Score	1	2	3	4	5	Average
No. of responses	-	1	2	8	8	4.21

Table 5-2: Adequate training to perform service? (n=17)

	No. of Responses
Yes	16
No	1
Total	**17**

The responses to these questions indicated a high level of satisfaction with the training process and that service technicians were confident in their ability to implement the AirCare Plus protocol.

Sales Staff Rating of Sales Training

One of the most important aspects of ACP was the ability and willingness of service providers to sell the program. Therefore, we were interested in having service providers provide feedback on the effectiveness of the sales training. PECI provided sales training to a total of 44 staff members of the 19 participating firms. Following the trainings, participants were asked to rate (on a scale of one to five with one being "very unsatisfactory" and five being "very satisfactory") the course materials, the course presentation and the overall quality the sales training. The following table summarizes the responses.

Table 5-3: Rating of Sales Training (n=14)

On a scale of 1-5, rate the following:	Average
Course materials	4.1
Quality of presentation	4.28
Overall rating of sales training	4

These numbers reflect that the sales training was widely perceived as satisfactory.
While most respondents provided a high overall rating for the sales training, almost all respondents indicated that it was too early to tell how effective the training was because they had

yet to adequately test the marketing materials with their clients. The following comments represent commonly held perspectives of service providers:

- "The sales literature and materials are okay. Of course, it all comes down to the presentation I make to the clients. I'm not sure if the tools are adequate because I haven't used them."
- "The training was good. The actual selling of the service is the challenge, but we were given enough information to do it."

Service providers were then asked if they felt the training adequately prepared them and their staff to sell the AirCare Plus service to their customers. The responses are as follows:

Table 5-4: Adequate training to sell AirCare Plus?

Responses	No. of Responses
Yes	9
No	3
Undecided	2
Total	**14**

Level of Enthusiasm for AirCare Plus

After they had received training sessions, service providers were asked to rate their level of enthusiasm for the AirCare Plus service. The following table reflects their feedback.

Table 5-5: Level of Enthusiasm for AirCare Plus Service

Rating	No. of Responses
1	1
2	1
3	3
4	5
5	4
Total	**14**
Average	**3.75**

Based on these responses, it was concluded that service providers had been properly trained to both sell and conduct the service and that they were enthusiastic about the AirCare Plus program.

Service Providers Level of Effort in Selling AirCare Plus

Once trainings had been completed and service providers were let loose into the market, PECI provided technical and administrative support on an as-needed basis. Trainings were completed by June 2003. Following the trainings, formal and informal tracking of service providers by both the evaluation team and by PECI revealed that sales activity was slow and that only a few service providers were making much of an effort to sell the service. In response, evaluators asked

service providers to rate their level of effort in selling the service. The following table reflects the feedback they provided.

Table 5-6: Level of effort in selling ACP

Rating	No. of Responses
0 – 1	6
2	5
3	2
4	1
5	0
Total	**14**
Average	**1.6**

These numbers reflect that the majority of participating service providers had not yet put forth significant effort in selling AirCare Plus.

Reasons for Initial Low Sales Effort

Since the majority had indicated AirCare Plus would be good for both their customers and their business, and since all reported that they had been adequately trained to sell and perform the service, a key evaluation questions that arose during the service provider interviews was "Why are service providers not putting forth more effort to sell AirCare Plus?" Part of the answer involved timing. Interviews with service providers revealed that the implementation of the AirCare Plus pilot was poorly timed. The summer months represent most HVAC contractors' busiest and most challenging time of year. Moreover, the summer of 2003 was unusually hot and compounded the demands on existing service provider resources. As a result, service providers were simply unable or unwilling to commit time and energy to sell a new service. When interviewed in July, almost every contractor expressed frustration that they had not been able to put forth more of an effort to sell AirCare Plus. Yet they expected that after the summer heat subsided and their workload returned to normal, that they would be willing and eager to sell AirCare Plus.

5.3 Contractor Feedback at Conclusion of Pilot

At the conclusion of the Phase II market test in the fall of 2004, evaluators conducted a final round of in-depth interviews with service providers. An interview guide was designed and interviews conducted with service providers that explored the following topics:

- General impressions of ACP
- Working with Palm Pilot and service protocol
- Integrating ACP into their business
- Selling the ACP service
- Training and Support Services
- Keys to Success

Enthusiasm for AirCare Plus

Table 5-7 highlights contractors' responses when asked to rate their current level of enthusiasm for AirCare Plus (on a scale from one to five, with one being "not at all enthusiastic" and five being "very enthusiastic"). November responses were contrasted with those provided in July.

Table 5-7: service providers Current Level of Enthusiasm for AirCare Plus

	Overall SPs	Active SPs
Jul 2003	3.75	
Oct / Nov 2003	3.25	3.42

It is significant to note that, while there was a lower level of enthusiasm for AirCare Plus after months of participation with the pilot, the overall levels were still relatively high.

Summary of Market Test Activity

Table 5-8 reflects the summary of the number of customers contacted by service providers, the number of AirCare Plus sales, and the total number of units sold. These totals represent numbers of units sold and serviced far below the goals set forth at program inception.

Table 5-8: Summary of Market Test Activity

No. of Service Providers	No. of Customers Contacted	No. of Customers Sold	No. of Total Units Sold
20	107	48	122

Analysis of these numbers revealed that:

- Four service providers classified as non-participants (PECI had no contact with them after the trainings)
- Nine service providers did not contact any customers
- Fifteen service providers had five or fewer customer contacts
- Ten service providers had no sales
- Eighteen service providers had five or fewer sales
- Two service providers constitute 40 percent of sales, five constitute 80 percent
- Sales (by one service provider) made without utility rebates

These results raised a fundamental and critically important question: If service providers were enthusiastic about AirCare Plus and had been adequately trained, why were they not more active and more successful in selling the service?

Modest Change in Level of Effort to AirCare Plus

Service providers were again asked to rate their level of effort in selling the service. Table 5-9 contrasts the responses provided in August and in November.

Table 5-9: Service providers Level of Effort in Selling AirCare Plus

August 2003	November 2003
1.6	1.9

This is one of the more significant data points we were provided. Most service providers spoke favorably of the AirCare Plus model, the training, and the support services they had received, and indicated it would be beneficial to their business. However, at the end of the pilot period, most had still not put forth a significant level of effort in selling the service to existing customers.

Is AirCare Plus a Viable Profitable Service for Service Providers?

At pilot inception, it was understood that the AirCare Plus service protocol would need to be able to be completed consistently in less than three hours for service providers to consider it a service they could profitably integrate into their business. This time requirement is critical to the pricing of the service as well as the overall viability of service providers building a business model around this service. Table 5-10 reflects the service providers responses to the question of how long the AirCare Plus service took to complete.

Table 5-10: Average Time to Complete the Service (in hours)

Average	Min	Max
3.3	2.5	4+

After determining the minimum, maximum and average amount of time taken to complete the service, contractors were asked if they consider this amount of time to be reasonable in terms of completing the service. Responses are reflected in Table 5-11.

Table 5-11: Reasonable amount of time to complete service

	Active SPs
Yes	3
No	8
Total	**11**

This was another key finding. If service providers do not think the service can be completed in a reasonable timeframe, they will certainly be less inclined to devote significant resources to the sale and service of AirCare Plus. Discussions with service providers probed aspects of the protocol that they felt might be too time consuming or particularly problematic. The majority of service providers reported that the protocol needed to be comprehensive in order to be effective and there was little criticism of the service design. Simply put, AirCare Plus, in its present form and given the level of training and experience of service provider technicians, took an unreasonable amount of time to complete.

Integrating AirCare Plus into Business: Obstacles and Opportunities

Having been provided with feedback concerning the service providers' experience with AirCare Plus, we asked a series of questions that sought to determine what they felt were the significant obstacles and opportunities of AirCare Plus, both in terms of integrating the service into their business model and in terms of developing a market for the service. We received an enormous amount of feedback from service providers. The following quotes summarize comments made by service providers when asked what they felt were the greatest barriers for AirCare Plus to be a valuable asset to their business:

- "The service takes too long."
- "Energy savings are not compelling enough."
- "Convincing customers it is worth the money."
- "We would have to make it more of a priority."
- "There is no demand and it is not profitable."

Each of these quotes provides significant insight into the mind-set of service providers as business people. If service providers believe the service takes too long, they will be disinclined to sell it. If energy savings are not compelling enough (or at least unproven), they will be disinclined to put forth effort to sell the service to their clients. If convincing customers that AirCare Plus is worth the money is problematic, then the service is a difficult sell, particularly in a recessive economy. If service providers have not made AirCare Plus a priority, then program managers would have to modify aspects of AirCare Plus that would motivate them to be more proactive or aggressive. If there is no market demand and the service is not profitable, then how can anyone (the Alliance, participating utilities, service providers) stimulate demand and what level of financial incentives will be required to make the service profitable for service providers? In summary, at the end of Phase II there remained many significant obstacles and questions to the implementation of a successful Small HVAC market transformation program.

6. MONITORING AND VERIFICATION OF PHASE II

6.1 Introduction

The goal of the monitoring and verification task was to provide a robust estimate of energy and demand savings for each of the program components (refrigerant charge, economizer, and scheduling) and to determine if the savings estimates calculated by the PECI model were valid. Stellar Processes was hired in April 2003 to conduct this evaluation and was given a November 2003 deadline for results (to meet a Board renewal funding vote). In its request for proposals for this task the Alliance identified several important challenges:

- There is no time for extensive pre-retrofit monitoring;
- Savings need to be estimated against a baseline;
- Savings vary by season and climate;
- Estimates must have sufficient statistical precision to inform program decisions;
- Savings include peak demand as well as energy.

These challenges influenced the evaluation approach. First, high variability is to be expected in the observations of savings. The target market varies widely in building types, occupancy, baseline consumption and opportunity for treatment. Using multivariate statistics, it is tempting to monitor only the energy used by a treatment group and a control group and then to apply a pooled regression to measure the effectiveness of the various treatments. However, such a statistical approach would have difficulty providing a robust estimate of savings because perfectly matching treatment and control groups could never be found given the number of variables that need to be matched. The savings estimate would therefore have a wide range of confidence limits around any result.

Further difficulties in implementing a statistical study are that it would need an extended period to estimate savings during other seasons of the year and it would require a control group for comparison. The extended period was not possible since results were due within a short time frame. In addition, since participants could not be known in advance, it was not possible to determine the relevant characteristics of the control group and recruit for it. Finally, since savings estimates need to be validated for all seasons, monitoring would have needed to cover an extended period. For all these reasons, a statistical study would not have been feasible.

6.2 M&V Approach

Instead of a statistical approach, Stellar Processes therefore proposed a case history approach in which a smaller number of sites are studied in detail and the participants are treated as representative examples. This approach was based on short-term monitoring, the results of which could be extended to annual savings using engineering methods. Using this approach, the savings attributable to the measures are apparent as a change in thermal output energy relative to the electrical input energy (e.g., as change in a Coefficient of Performance (COP)). From an engineering perspective, successful measures are evident in the energy and output characteristics

of the air handling unit (AHU). These characteristics can be specifically quantified in short-term monitoring.

The next step is then to estimate the impact of changed parameters on an annual basis. The measured performance interacts with occupancy, climate and other site characteristics over time. The appropriate solution is to apply a calibrated energy simulation model which allows energy savings during the monitoring period to be varied over the rest of the year according to the weather-adjusted, historical consumption (from utility bills) of the building. With this approach, one can also quantify multiple measures applied to the same AHU, rather than being restricted to only the overall effect. The results can then be applied to differing site conditions (e.g., different buildings, operating hours, equipment loads, climate, etc.) by varying these parameters in the model. This verification methodology is documented in the International Performance Monitoring and Verification Protocol (IPMVP) developed by USDOE.[1] A similar protocol is specified by ASHRAE for savings verification.[2] IPMVP protocol is the required verification methodology specified in most government programs.

6.3 Coordination and Site Selection

The case study approach required close coordination between the service providers, PECI, and Stellar Processes. Pre-metering had to be done after the sale had been made but before the technician had completed the ACP service. Service providers informed PECI when they made a sale and PECI transferred that information to Stellar. Stellar then contacted the service provider to get details on the site and have them arrange permission from the building manager to go on the roof several times to install the monitoring equipment, check it before and after the service, and remove it.

This system worked extremely well. The only serious problem was that none of the service providers sold the ACP service in the early spring when the market test started. In part, this was due to unseasonably warm weather in the spring of 2003 so that most service providers were more occupied than normal with emergency service calls. Sales were minimal during the hot summer season as well when service providers were again responding to emergency calls. Faced with the November deadline, Stellar was forced to use all of the early participants as monitoring cases. Later in the fall, service providers succeeded in making more sales but not in time for the evaluation team to install monitoring equipment. Thus, the sampling was based on "first come, first serve" and was not intended to represent a scientific selection by categories or climates. Table 6-1 provides a list of all 37 units that were monitored.

[1] USDOE, *International Performance Measurement & Verification Protocols (IPMVP)*, 2002.
[2] ASHRAE, Guideline 14-2002: Measurement of Energy and Demand Savings, 2002.

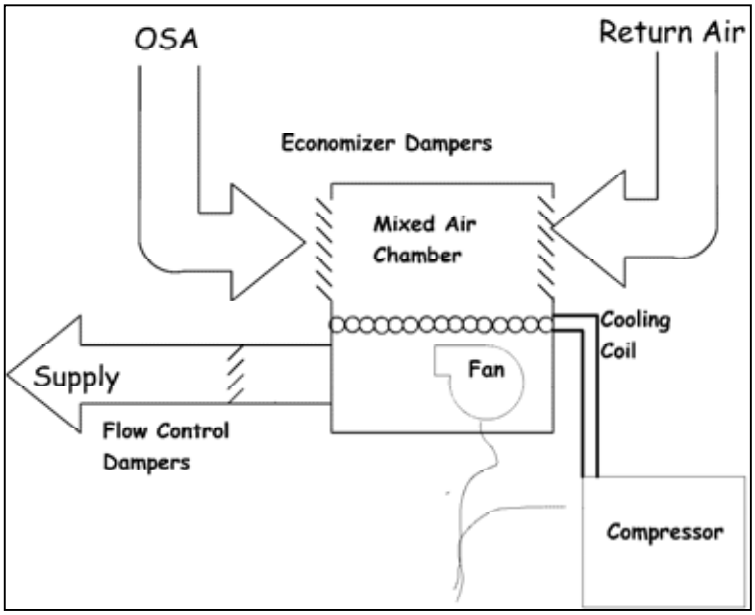
Table 6-1: Units Monitored

City	Business Type	No . AHUs Monitored	No. Economizers Monitored
Vancouver, WA	Office	7	7
Vancouver, WA	Restaurant	4	4
Vancouver, WA	Office/ Warehouse	3	2
Vancouver, WA	Restaurant	2	2
Vancouver, WA	Restaurant	2	2
Lynnwood, WA	Office	2	0
Edmonds, WA	Retail/ Office	2	0
Lynnwood, WA	Retail	2	
Twin Falls, ID	Office/ Medical Clinic	2	0
Twin Falls, ID	Retail	4	0
Prineville, OR	Industrial	2	1
Boise, ID	Office/ Medical Clinic	2	2
Boise, ID	Office	1	1
Boise, ID	Office	2	2

6.4 Technical Background for Economizers

Figure 6-1 shows a generic example of the type of air handler treated in the program. When air conditioning is required, the cooling coil chills the air before it is delivered back into the building as "supply" air. Of course, the building typically needs some fresh air for ventilation, so there is a minimum amount of outside air (OSA) added. However, during the heating season, the outside air is too cold and would require extra space heating. So the majority of the air is recycled from the building interior as "return" air.

Figure 6-1: Air Handler Schematic and Monitoring Plan



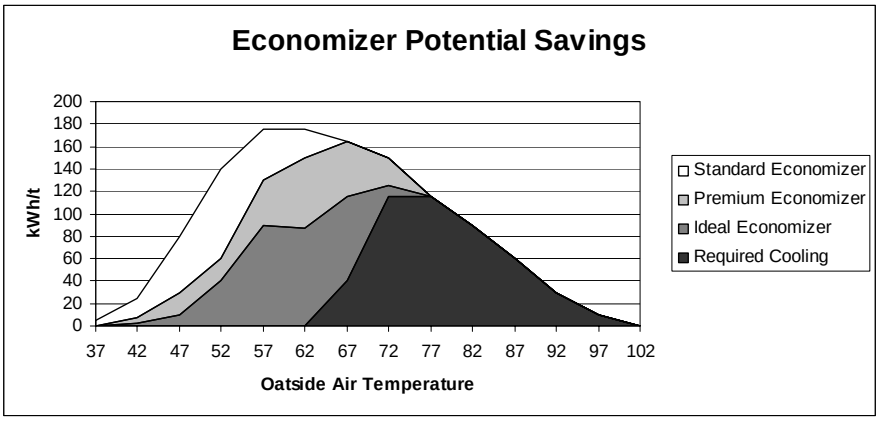
During cold weather, the building could be asking for air conditioning (due to solar gains and internal loads) even though there is cool air outside. Obviously, one could save energy by bringing in more cool air rather than operating the cooling system. The economizer is a device that recognizes when the outside air is cool enough to warrant this and then increases the amount of it coming into the building. Adding an economizer to an RTU, however, introduces practical difficulties. First, there are now mechanical parts, the control dampers that must move in unison, so there are opportunities for mechanical failure. Second, the economizer requires control logic in order to make the decisions about when to open and when to close OSA. As we shall see, it is difficult to implement a control logic that works consistently and well.

The area of the Northwest region west of the Cascades has a moderate climate in which studies have suggested that potential energy savings from economizers is quite high[3]. Figure 6-2 shows the results of one local study in which the total cooling load is represented by the entire area under the highest curve. The black area of the figure represents situations where mechanical cooling will always be required. The white, light grey, and dark grey areas show situations where an economizer could substitute outside air for mechanical cooling. Economizers are currently thought to function poorly, only providing the savings represented by the white area. However, with some improvements, a premium economizer could provide the additional savings in the light gray area – effectively doubling the amount of savings. Since the improvement could be

[3] Reid Hart, Presentation on "Premium Economizers" June 17, 2003 Portland Oregon CEE Program Meeting, Eugene Water & Electric Board.

accomplished at low cost, these potential savings appear to be a cost-effective conservation target. However, this sort of study is based on an engineering analysis assuming that economizers will work as expected. As we shall see, that assumption may not be warranted.

Figure 6-2: Potential Economizer Savings



6.5 Methodology

The pre- and post-performance data collected from the monitored units and the buildings where they were located were intended to provide a complete description of the unit operation including:

- **Building occupancy** – Identify the building occupancy cycle, unit operating cycle, and interior set temperature. These basic data are collected to normalize for any occupancy or usage changes that may not be associated with the treatment.

- **Economizer operation** – Identify the operation of the economizer at all times during fan operation and compare to the operation of a hypothetically perfect economizer.

- **Compressor operation** – Identify the efficiency of the primary cooling loop at all times during compressor operation before and after the treatment.

The monitoring procedure comprised four separate steps:

- Site Description
- One-time Measurements
- Install Monitoring Equipment
- Analyze Recorded Data

Site Description

Collect the building size and general physical description for use in developing the calibrated simulation model.

One-time Measurements

Measure true power, power factor and the corresponding operational power levels for all fan and compressor operating levels. This information is used to identify each level of fan and compressor operation so that energy consumption can be binned into operational categories.

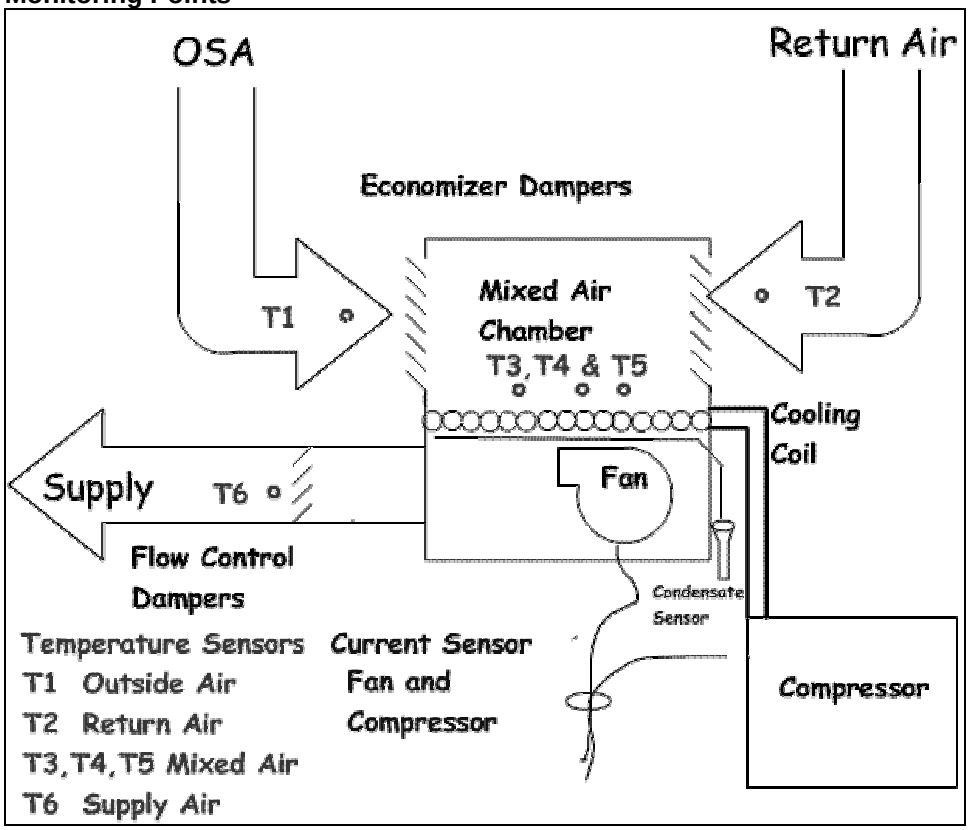
Measure total airflow through the unit under different conditions so that there is an accurate estimate of airflow under typical operating conditions.

Install Monitoring Equipment

The datalogger collects temperature and power measurements at the points shown in Figure 6-3 under both pre- and post-retrofit conditions[4]. For analysis, data are reviewed at the hourly level although the datalogger samples much more frequently. In order to preserve the dynamic information, the datalogger bins measurements into categories and reports hourly computations. For example, the temperature in an air duct is not meaningful unless the system is running. So the datalogger only collects temperature data when the unit is running and then apportions those data into whether the unit is heating, cooling or ventilating. As a result, the datalogger is able to report summary statistics, such as the COP of the unit, based on only the instances when it is actually operating. Note that the physical operation of the economizer was not directly monitored. By comparing the temperatures of the various airflows certain reasonable assumptions could be made about economizer position and operation. However, physical verification would be needed to determine the actual economizer operation.

[4] These measurements are used to represent airflow and damper positions for the economizer. The actual movement of the dampers was not measured.

Figure 6-3: Monitoring Points



Analyze Recorded Data

In actual operation, much of the computed efficiency information was derived after data retrieval in order to preserve memory within the datalogger. Computations include calculation of the OSA fraction during economizing periods, comparison of the economizer to a hypothetical perfect economizer, checking the frequency of compressor cycle operation, and derivation of the compressor COP curve before and after the treatment.

It is important to note here that the supply and mixed air temperatures are dry bulb temperatures. Therefore, the COP measured from temperatures is better described as the "effective sensible COP." In fact, a unit operating in the Northwest can be expected to remove water vapor from the air passing through the evaporator coil. In buildings with high humidity, the difference between the full and sensible output can be significant, in the range of 10-30 percent. Logged data included a measurement of the amount of condensed water in order to capture the latent energy recovered by the air handler.

6.6 Examples of Field Observations

Figure 6-4. Example of Monitored COP Performance

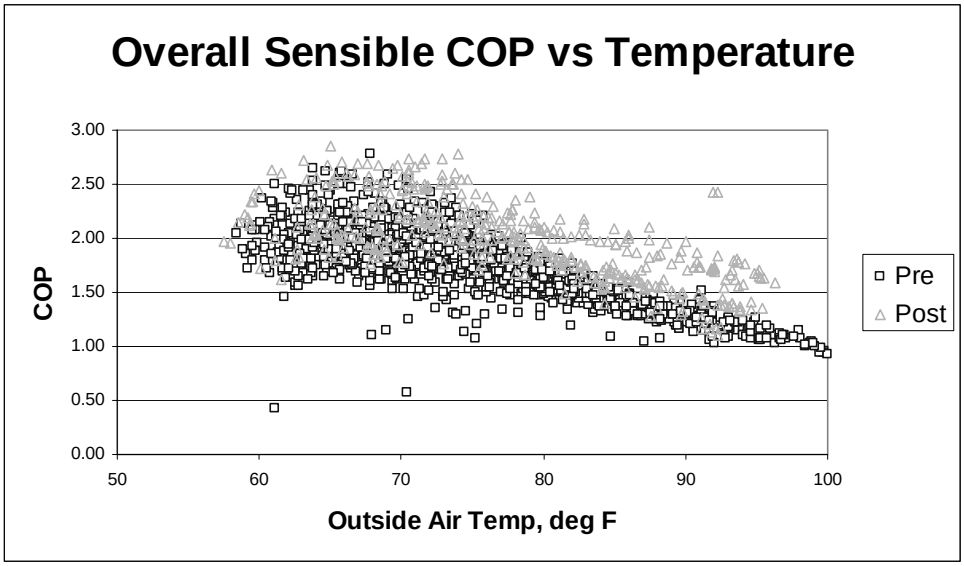


Figure 6-4 shows an example of monitored COP or the ratio of thermal output energy to the electrical input energy. This example shows an effective repair of the unit as seen in the higher COP after the service visit.

Figure 6-5: Example of Economizer Operation

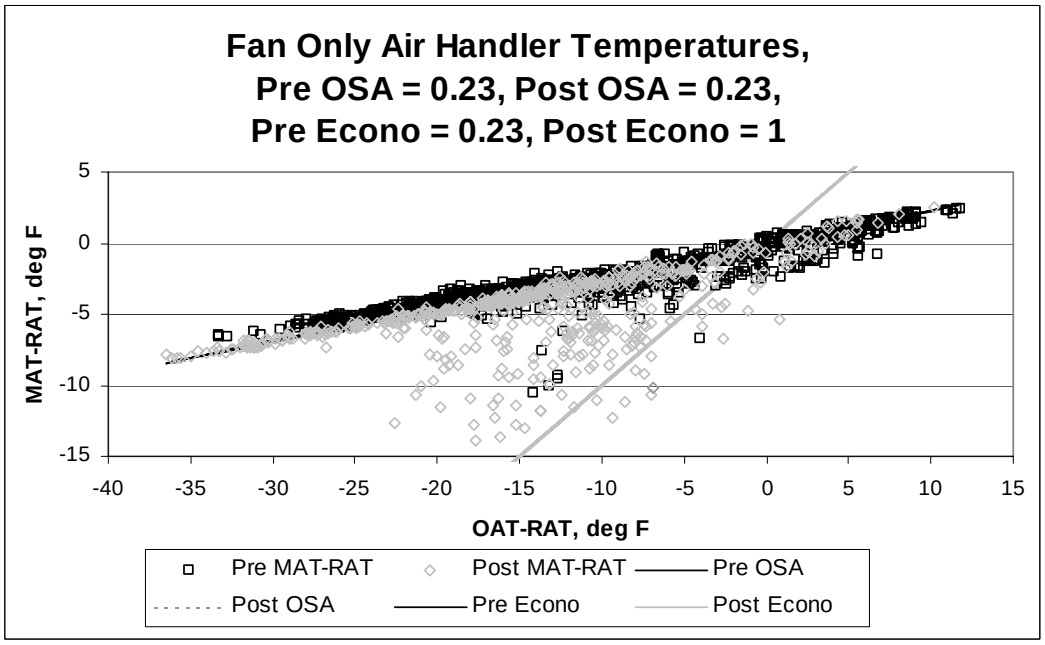


Figure 6-5 shows an example of an effective economizer repair. Figure 6-5 is a graphical representation of the fraction of outside air. This is the most reliable way to estimate the energy impact of outside air introduced thorough an economizer during actual operation; not merely during a forced test. In this presentation, the points show the temperature differences between the air streams. The slope of these points reveals the amount of outside air. Before the service call, the unit operated with 23 percent OSA at all times. After the service visit, the unit sometimes opens to as much as 100 percent OSA but only under cool conditions.

Figure 6-6: Example of Operations Profile

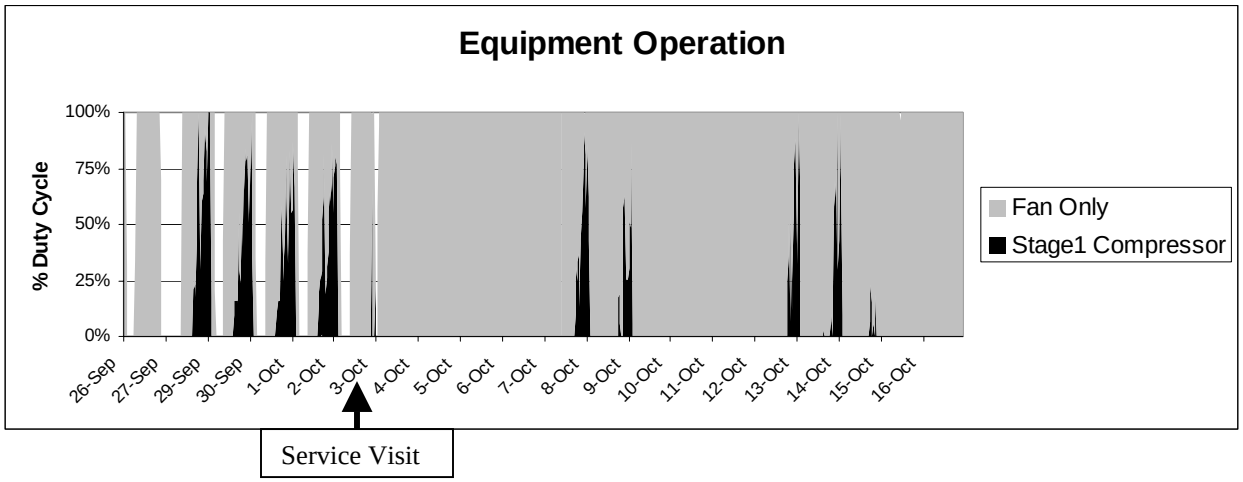


Figure 6-6 shows an example of a less effective service change. Before the service, the unit was off at night but after the service, the fan runs constantly. Continuous fan operation causes a

significant increase in energy consumption, more than countering the reduced compressor use. Further research would be required to determine why this situation occurred.

6.7 Verification Savings Results

The savings verification method computes an annual savings based on measured changes for the AHU as annualized through a calibrated simulation model. For each case, monthly consumption records from utility bills were matched to simulated values using the EZSim tool[5]. The calibrated tool was then used to estimate annual heating and cooling savings from the various conservation measures.

Previous work employed various monitoring methods[6] to refine the program targets and diagnostic algorithms, and to develop an initial methodology for estimating annual savings attributable to the repairs.[7] For example, PECI developed a table of predicted savings for various economizer "tweaks" based on DOE2 modeling simulations. This methodology relies on referencing the actual economizer operation to that of an ideal "perfect" economizer. Part of the M&V evaluation involved assessing these algorithms to see if reasonable savings estimates could be quantified.

At first glance, there appears to be reasonable agreement between the initial savings estimated by PECI and the evaluation savings estimated from the monitored verification. Results are shown in Table 6-2. However, the agreement is deceptive since, in many cases, the verification assigned savings to different measures than those estimated by the implementation team.

Table 6-2: Quantitative Savings Results

Initial Estimate (PECI) Average per AHU	Evaluation Estimate (Stellar) Average per AHU
998 kWh	1096 kWh
181 therms	204 therms

Furthermore, the M&V estimates do not include two sites that were treated as outliers. The stories behind both cases are instructive. In one case, a technician found that a wiring short caused the air conditioner to operate all the time, even during heating. His repair rectified the situation resulting in large savings. While the ACP protocol did not target this problem directly, during the economizer portion of the service, a wiring short will be discovered. However, during this service the technician identified and remedied this problem that had been undiscovered during previous maintenance before the actual service on this unit began.

In the second outlier, a non-functioning air conditioner was restored to service on a building that had two units, leading to a 50 percent increase in energy use. Stellar Processes determined through analysis of monitored data that either one of the units could have handled the whole building under most conditions and it would have been more efficient to operate one unit fully

[5] For detailed information on the EZSim tool see www.ezsim.com
[6] Ecotope, "Enhanced Operations & Maintenance Procedures for Small Packaged Rooftop HVAC Systems Protocol Development, Field Review, and Measure Assessment", 2002
[7] PECI, "Interim Report To Northwest Energy Efficiency Alliance On Energy Savings Methodology," 2002.

loaded than two units half-loaded. By calling for service, the tenants had shown they were unwilling to accept the slightly higher space temperatures provided by a single unit. The owner, however, may have chosen to leave the second unit disabled if they were presented with information on the limited number of hours that tenants would be affected and the electrical energy savings benefit. If a control system could be installed that would start the second unit on an as-needed basis only, this would have been the best solution. This case produced large negative savings but the service technician was simply doing his job, which was identifying and correcting mechanical problems. However, the technician did not look at the case from a whole-building, retro-commissioning perspective, which would have identified a more effective procedure. While such a perspective is clearly outside of a technician's scope and skill set, it points out the value that could be gained from adding training to the ACP program to help technicians recognize situations that do not fit under the protocols. Once recognized, the building manager could be informed of the situation and told they need to consult with an engineer or other qualified provider. They could be referred to another program, such as Betterbricks.com.

Savings estimates are compared by measure category in Table 6-3 and Figure 6-7. Note that the number of cases in Table 6-3 is always far less than the total number of units monitored. This reflects the fact that service providers were not required to implement all parts of the protocol on each unit. In cases where service was not needed or the technician decided not to pursue a measure no savings were available. In both the table and the figure:

- "Opportunistic Repairs" refers to finding breakdowns that would not otherwise have been noticed during routine servicing and are not part of the ACP protocol.
- "Equipment Change" is a broad category that includes physical changes expected to improve the compressor operation such as cleaning the coil, increasing the fan speed and adjusting the refrigerant charge.
- "Savings Not Implemented" are repair measures that were identified during the service visit but, for one reason or another, were not completed. One reason for failure to implement is the technician needed approval from the customer to proceed with the repair.

As can be seen in Table 6-3, the evaluation estimates usually increased the savings estimates. This is evident by the average gas and electrical savings estimates from the M&V work being 10 percent and 13 percent more than the estimate from the program implementer PECI as shown in Table 6-2 above. Furthermore, the measures under the "Savings Not Implemented" column show that program savings could have almost doubled, in large part due to the "Thermostat Program and Schedule" measure. Thus, there is reason to believe that a premium O&M service program has the potential to provide a reasonable amount of savings if a program were to be implemented beyond the pilot stage where these measures could be enforced.

Equally important, however, is that the PECI and Stellar Processes estimates on which categories produce the savings vary dramatically in some instances. Equipment Change, which was expected to be a source of savings, provided less than anticipated savings in some cases and more savings in other cases. Overall, equipment savings estimates by PECI were less than half of the M&V estimates. OSA adjustment is a minor source of savings. Opportunistic Repairs,

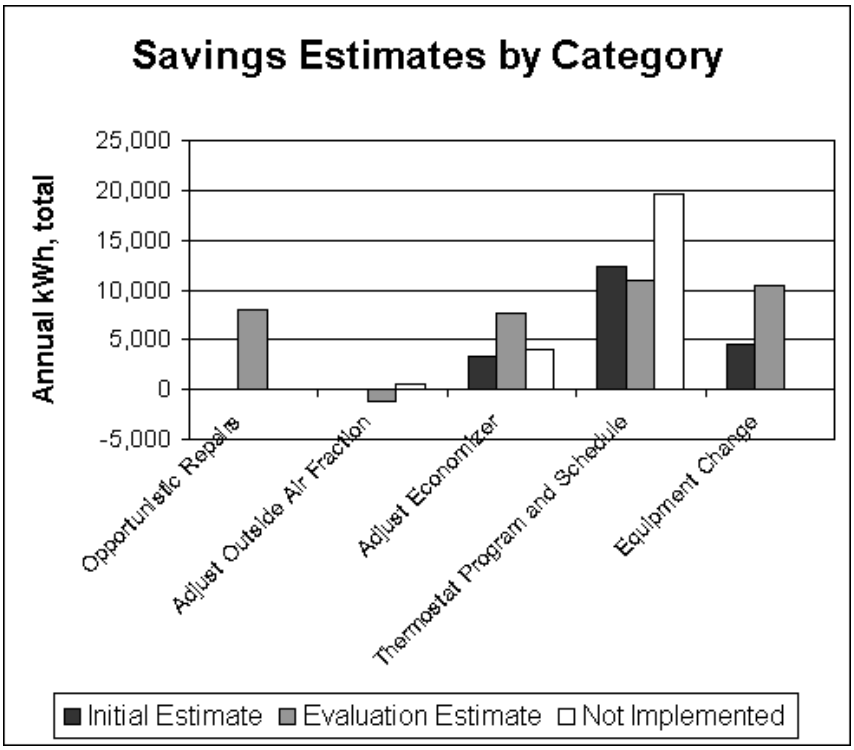
although variable and unpredictable, can provide large opportunities but also can be a dangerous source of negative savings if implemented improperly.

Table 6-3: Savings by Measure Category

Repair Category	No. of Cases	PECI Savings Estimate	Evaluation Savings Estimate	Savings Not Implemented
Opportunistic Repairs	2	0	7,956	
Adjust Outside Air Fraction	3	0	-1,169	470
Adjust Economizer	13	3,315	7,661	4,035
Thermostat Program and Schedule	14	12,410	10,991	19,656
Equipment Change	11	4,587	10,446	NA*
Total		**20,312**	**35,885**	**24,161**

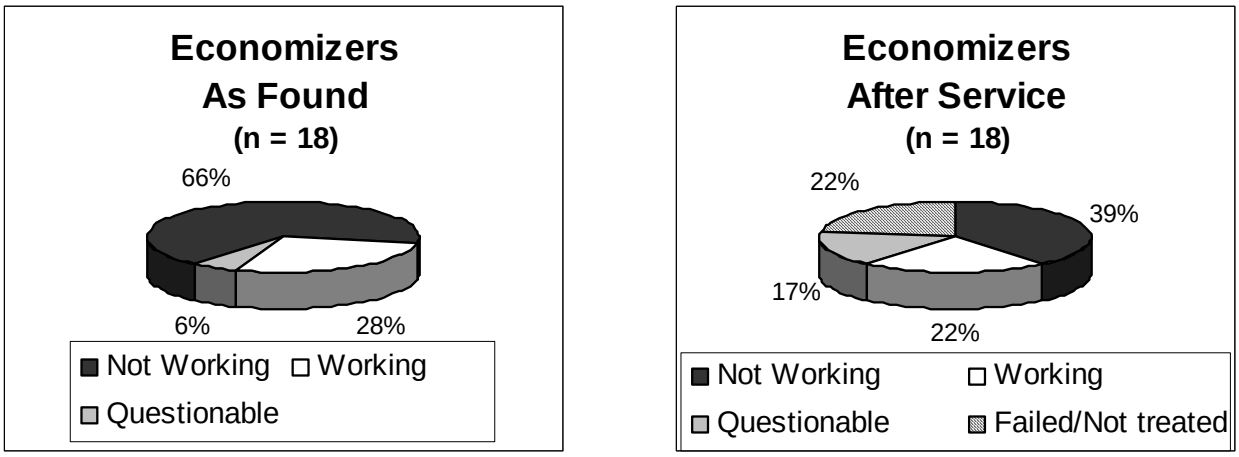
** PECI did not estimate savings for these equipment changes that were done. This, however, does not translate to a zero number.*

Figure 6-7: Savings Estimates by Category



6.8 Economizers Are Difficult to Restore

Figure 6-8: Economizers Not Restored



The left side of Figure 6-8 shows that economizers fell into three categories prior to servicing – working, not working and questionable. Working units are self-explanatory. Those in the questionable category were working partially or on rare occasions but failing to operate at other times when they should have given the monitored outside air temperature.

The economizers in the not working category were not operating during the monitoring period for several reasons, not all of which are completely clear from the limited monitoring data. In some cases there was a clear mechanical or electrical failure. In others there may have been a controller logic problem. One hypothesis regarding controllers is a widespread failure due to a large temperature deadband built into the control logic (and documented in the manufacturer's literature) which in practice is excessively large leading to economizers not working under conditions where buildings would clearly benefit from outside air. All of the economizers monitored were manufactured by the same company and in fact, the control system was made up of the same components. Since most of the monitoring occurred during summer months when temperatures were not low enough to fall below the deadband it is possible that in some of the units this accounts for why they were not working. This is partially supported in the fact that economizers in Idaho, where the fall season nighttime temperatures were lower, performed well. However, there were other cases where it appeared that, even taking the deadband into account, the units were not economizing when they should have been. In at least a few of these cases technicians did not note that there were any problems with the economizer. Given both the limited monitoring data and the wide range of ways in which units can fail further research is recommended to determine all the possible causes including the deadband, other design or mechanical/electrical issues or the protocol itself.

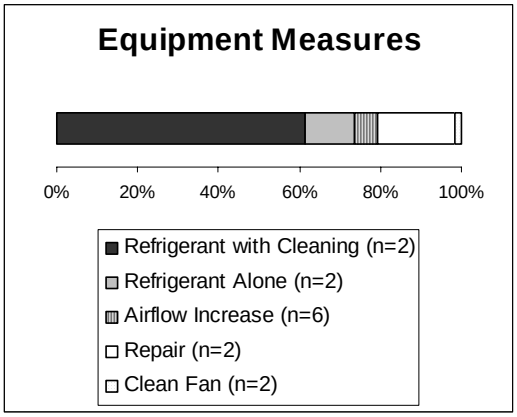
The additional category of failed/not tread on the right side of Figure 6-8 reflects a situation where the technician identified a unit as operating incorrectly but did not attempt to correct the situation. While the protocol correctly allowed the technician to identify the problem this reflects

a significant process problem in the program design since there was not a follow-through mechanism to assure implementation.

Equipment Change Measures

The distribution of savings in this category is shown in Figure 6-9. Savings from only refrigerant charge adjustment were quite low. Charge adjustments are time consuming by nature and the service technician's time was not adequately paid for to implement this measure. There were approximately 15 recommendations for vapor compression adjustments that were not implemented by the service technician. As a result, there are only a very few cases of charge adjustment to examine. In two cases, refrigerant adjustment was combined with coil cleaning so that the impact could not be separated.

Figure 6-9: Equipment Measure Savings



The success of other cleaning examples suggests that cleaning alone can account for most of the observed impact. In only one of those cases was there a significant improvement due to charge adjustment. In that case, the compressor performance prior to service was clearly inadequate. The lack of refrigerant savings is disappointing because it was a major focus of the training effort and remains a major program effort in other states.

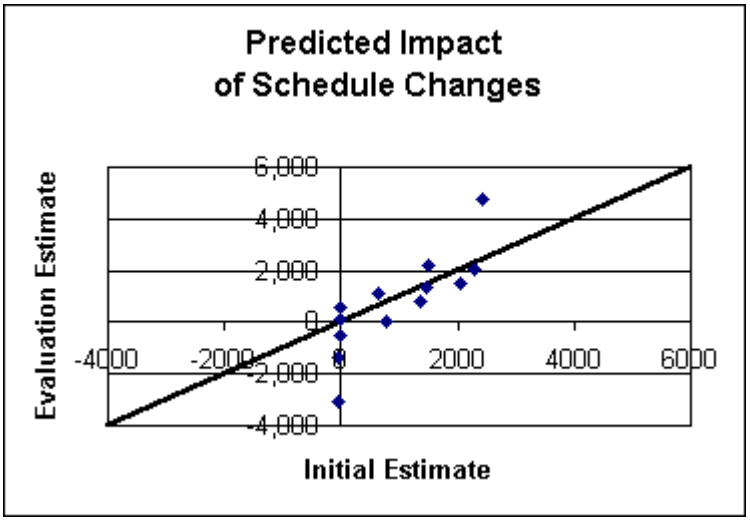
Airflow adjustments are well understood and can be implemented by the service providers but do not appear to provide substantial savings. There is little improvement of COP and there is an increase in energy and demand due to the higher fan speed. At one site, there were significant savings merely from cleaning the fan blades.

Scheduling and Programming

Scheduling provided one of the best opportunities to enhance savings but technicians frequently failed to implement schedule changes. This is the result of an implementation barrier because the technician often felt that he was not empowered to change customer's choices. Furthermore, to schedule operations requires some understanding of how the customer uses the facility. Frequently, the technician did not seek out this knowledge nor were they forced to obtain this knowledge during this pilot test. The result is that this category has much potential for low-cost savings opportunities although the persistence of scheduling adjustments is not known.

The methods for predicting the savings from scheduling changes could be improved. Figure 6-10 shows the evaluation savings plotted against the initial savings estimates by the service team. If these estimates match, one expects to see the points aligned on the 45-degree line. Where higher savings are expected, the two estimates have such agreement (with one high outlier). But for low and negative savings agreement was much less consistent. The most important cause for negative savings was the technician's oversight in failing to eliminate continuous fan operation. The site protocols included an upgrade recommendation for programmable thermostats when appropriate. However, this recommendation was not usually implemented during this pilot study and as such continuous fan operation was witnessed frequently. Continuous fan operation could possibly result from other issues such as improper control wiring of the unit or improper programming of a programmable thermostat. Both of these issues are either directly or indirectly targeted during the service of the unit.

Figure 6-10. Predicted Savings for Scheduling Changes



6.9 Conclusions

Total program savings estimates were similar for both PECI and Stellar Processes. However, the savings from individual measures often varied from the predicted savings. While the number of cases is insufficient to draw generalized conclusions, some important issues related to the implementation of the ACP protocol were identified during the M&V activities and analysis:

- Opportunistic repairs can provide large savings but neither the frequency of occurrence nor the amount of savings can be predicted.
- The failure to recognize whole-building operations can result in loss of opportunities or even in negative savings. This indicates a need for retro commissioning. While , this is beyond a technician's role the program could train technicians to recognize situations where re-commissioning would be beneficial and then provide a recommendation and referrals to the building manager.

- Economizer operations are still not fully understood and need some further study. Monitoring the economizers did prove many were not operating during the monitoring periods, even after site repairs. The reasons why repairs were ineffective require further study.
- There are insufficient cases to draw conclusions on refrigerant adjustment because contractors were reluctant to modify refrigerant charge or did not follow the service protocols. Both of these issues are a result of the contractor's time not being adequately covered to perform this work. Only one case demonstrated large savings from an adjustment. A few other cases showed no significant savings, but the correct protocols were generally not followed in these instances.
- Scheduling savings are sufficiently understood but were not always implemented. Contractors do not feel authorized to implement changes in the programmable thermostat scheduling or setback programming.
- While site protocols included a check for excessive fan operation, contractors were not required to upgrade non-programmable thermostats to programmable ones which would have eliminated the most common potential cause of this situation. The lack of an upgrade requirement resulted in continuing energy use that could be easily eliminated.

7. SUMMARY

The implementation of this pilot initiative, and the resulting development of the Air Care Plus service, represents a significant effort to address opportunities for significant energy and demand savings from improved maintenance practices. Unfortunately, the service as developed proved to be quite costly and unreliable in delivering predictable energy savings. The Alliance Board decided not to continue funding this effort and is not currently investing resources in this area. Nevertheless, despite the failure of this program to develop a market-based service, the opportunity for energy savings has not disappeared. Moreover, a number of important lessons were learned through this investment, a summary of which is provided below.

7.1 Technical Results

Important technical findings include the following:

- **Significant opportunities for energy savings in existing RTUs definitely exist** – The pilot implementation confirmed the magnitude of the opportunity for energy savings. Indeed, one of the confounding issues experienced during the pilot was the unanticipated magnitude of work required to optimize the RTUs that were serviced.

- **Time requirements to deliver ACP service were longer than anticipated** – The development of the protocol proved quite challenging and took more time to refine than anticipated. Moreover, the resulting protocol proved to take longer to complete in the field than most service providers considered acceptable.

- **Savings are un-reliable** – While the metering results from sites with participating RTUs document reductions in energy use, the observed savings are not all directly attributable to the ACP protocol. Savings came from a wide variety of changes made to the units.

- **The installation and set-up of programmable thermostats may yield significant savings** – Based upon the facilities addressed, it appears that the installation of programmable thermostats, and the set-up of existing thermostats, may yield significant savings as a focused program opportunity.

7.2 Market Results

Important market-related findings include the following:

- **The proposed service poses potential conflicts with existing maintenance infrastructure** – One issue identified during the pilot was the challenge of introducing a new service when, in some cases, customers have assumed that such work was already being undertaken as part of already-existing maintenance contracts.

- **Service providers were enthusiastic about the concept of ACP, but did not actively market the service** – Service providers are definitely interested, at a conceptual level, in having a premium service to differentiate their services and increase revenue. Yet, during the pilot market, test, very few actively marketed the service.

- **Customers are not willing to pay the cost currently required to cover the time required for ACP service delivery** – The market cost of the service is approximately $300-$500, a cost which is not acceptable in a market where maintenance needs are perceived as being minimal.

- **The best opportunity for this service may lie as a utility-sponsored program** – With utility rebates or other mechanisms to offset the cost of the service to the customer, both contractors and customers are more likely to be interested in this service.

APPENDIX A:

SMALL HVAC DECISION-MAKER MARKET RESEARCH

Small HVAC Decision-maker Market Research

***Draft* Report**

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April 15, 2002

CONTENTS

1. OVERVIEW AND METHODOLOGY

In support of the Northwest Energy Efficiency Alliance's Small HVAC Pilot Program, *energy* Market Innovations, Inc. (*e*MI) conducted targeted market research to aid in understanding the demographic characteristics and decision-making processes of small commercial building owners / managers. The overall goal of this research was to better understand how decision-makers are likely to be involved for each building type, and to collect additional information that will aid in the development of appropriate and effective marketing strategies and promotional materials for the program.

1.1 Objectives

Because the time and resources available for this research were quite limited and it was not feasible to conduct a region-wide study that would provide statistically accurate information, we designed a quick, comprehensive and qualitative approach to apply in Bend, Oregon (a community which was determined to adequately reflect/represent the general target market.) Our surveys and collection of data within this single city enabled us to characterize many of the building and business types (and the many combinations that exist) that the small HVAC Pilot program intends to serve.

The specific objectives of this project fall into two broad categories. The first was to develop some understanding of who is responsible for decisions regarding HVAC system repair, service and replacement and what factors or considerations influence their decision-making. The second was to obtain a more detailed understanding of attitudes and awareness regarding HVAC system maintenance (i.e. overall interest in energy efficiency, perceived importance of HVAC system to their business, nature of existing service relationships, attitudes toward HVAC maintenance, and willingness to invest in HVAC maintenance.) Thorough analysis of our work has revealed some clear and sensible recommendations for the development of a marketing plan that will help the Small HVAC Program realize its ambitious goals.

1.2 Survey Design and Implementation

EMI conducted secondary research and interviews beginning in late March and continuing into early April, 2002. As a first step in our research, we conducted in-depth interviews with

- HVAC service providers,
- local property management companies in Bend, and
- Bend Chamber of Commerce and local Economic Development Office.

The information gathered was extremely valuable in developing an informed understanding of the characteristics of this particular market.

Our 'quick-hit' interviews were designed to be short in length and help ascertain decision making patterns and considerations for the various business and building types. [More detailed interviews were to be conducted by PECI subsequent to our work.]
The initial target samples for this survey were defined as follows:

Channel / Building Type	Target No. Completes	Actual No. Completes
Grocery (Mom & Pop, grocery and convenience)	10	9
Small Retail (non-food, non-strip mall)	15	11
Small Office (1-2 story)	10	4
Warehouse (light industrial)	10	9
Strip Mall tenant – chain	10	10
Strip Mall tenant – independent	10	3
Restaurant – fast food (chain & independent)	10	4
Restaurant – mid-range/family	10	4
Restaurant – high end	5	5

The actual number of interviews conducted was smaller (total of 59) yet accurately reflects the overall profile of channel and building type. Our success rate in identifying these decision makers was quite high yet often required several phone calls to complete the interview process. The interview subjects were randomly selected from the phone directory and the Chamber of Commerce' Local Business directory. An Access database as been prepared to facilitate the analysis of survey responses.

1.3 Focus on Bend, Oregon

Our initial research involved discussions with representatives from the following: City of Bend, OR (city planning), Deschutes County (planning department), the Central Oregon Community College Business Development Center, the Central Oregon Economic Development Council, Central Oregon Association of Realtors, the Bend Public Library, and the Bend Chamber of Commerce.

Cumulatively, those interviewed painted the following picture of Bend and its surrounding communities:

- Bend, OR has a population of 52,000 with 'greater' Bend (which includes LaPine, Redmond, Prineville, and Sisters) having a population of 110,000.
- Bend has experienced remarkable growth over the last 10-15 years. It has had a 'strong' economy; the real estate and small business markets have consistently outperformed the rest of Oregon. Recently, the region has been experiencing an economic slowdown. The economy is strongly influenced by vacation/recreation dollars.
- Bend has an increasingly diverse economy and is experiencing predictable problems associated with growth. The medical services community is growing and diversifying.

- There are between 4300-4600 businesses in the greater Bend area. 75% of the 1500 members of the Bend Chamber of Commerce have 5 employees or less.
- A substantial percentage of business owners rent or lease space rather than own. We received different estimates ranging from 60-90% off small business owners that rent or lease space.

Our initial research also involved discussions with HVAC service providers in the Bend area. Discussions with service professionals revealed that the number of HVAC service providers has increased considerably over the last 10 years ("chasing development dollars" as one person described) so there is more competition for business and it is increasingly difficult to retain talented technicians. One established service provider who has been in business for more than 20 years noted that there were "at least 50" HVAC contractors currently working in the area. This contractor also indicated that this number is far more than the community can sustain ('"there should be 30") and that, professionally speaking, he has respect for "maybe 2 of them" for providing quality commercial or residential services.

2. SURVEY RESULTS

2.1 Overview of Responses

We spoke with 6 different property managers/leasing agents who collectively offered several insights into the 'greater Bend' small business market. These included representatives of the following firms: Coldwell Banker/Commercial, Compass Commercial Real Estate, Wm. Smith Properties. We also interviewed the property manager of a national chain of strip malls, and two private property owners who have substantial commercial real estate holdings in the area. General perceptions offered by Landlords about their tenants and energy efficiency include:

- the vast majority of tenants have no incentive or interest in 'helping the landlord.'
- small businesses complain a lot about the cost per square foot that they pay in rent.
- if there is clear gain/benefit to participating / paying for energy efficiency improvements, the property managers will do so.
- those tenants with "triple net" leases in which they pay all the energy bills will be interested in exploring energy efficiency programs, those tenants with full service gross leases will not.

There is a clear trend to have tenants be responsible for the repair and service (but not replacement) of HVAC equipment and for them to pay their utility bills. Some specific comments concerning a property managers willingness to promote a small HVAC program.

- "It is my responsibility to look out for my tenants and to help them minimize costs to any extent possible."
- "I have spent years having bad experiences wit HVAC service providers and have finally found one I like and trust. There is a problem retaining qualified HVAC technicians and I won't pay for training time."
- "This program would be an easy sell to tenants if you can clearly state the savings/benefits."
- "I would have no trouble promoting this to tenants IF AND ONLY IF I trust the product and service provider. If I don't trust the service provider, I won't go to bat for them."
- "I don't have time to go around promoting things like this to my tenants. I don't hear my tenants interested in energy efficiency."
- "Even though most of my tenants are responsible for maintenance of HVAC systems. I want my owners to pay for service contracts because tenants sometimes aren't reliable enough to follow through (on maintaining the equipment)."

2.2 Detailed Survey Results

Below are the results from the survey questionnaire. A complete copy of the questionnaire is provided as an Attachment.

Position of Respondents

Approximately 85% of those surveyed were either an owner or a manager. The remaining participants were, for the most part, in business leadership positions, which are typically associated with management of business systems and facilities.

Table 1: Position	Count	Percentage
Manager	30	51%
Owner	19	32%
Property Manager	3	5%
Director	2	3%
Accounts Payable	1	2%
Superintendent of Maintenance	1	2%
Sales Rep.	1	2%
Facility Manager	2	3%
Total Number of Responses	59	

Business Ownership Status

Table 2 summarizes the ownership status of the companies that participated in the survey. Almost 60% of the businesses are independently owned. The remaining businesses are associated with a larger company.

Table 2: Status of ownership	Count	Percentage
Affiliated with Larger Company	11	19%
Corporation	1	2%
Franchise Business	12	20%
Independently Owned	35	59%
Total Number of Responses	59	

Own / Rent Status

Table 3 summarizes the own/rent status of the survey respondents. Twenty-three, or 39%, owned the property their business occupied, and 33, 56%, rented. Of the 59 responding to this question, three managed multiple facilities, some of which the company owned and some of which the company rented.

Table 3: Own / Rent Status	Count	Percentage
Rent	33	56%
Own	23	39%
Own and Rent	3	5%
Total Number of Responses	59	

Monthly Utility Expenses, Electric and Gas

Table 4 shows the ranges of utility bills for the businesses surveyed. The top table has data for electricity bills, the bottom table has data for gas bills. It is interesting to note that in the ranges shown below, over 60% of question respondents stated that their company spent $500 or less on their electric bill in the average month. It is also interesting to note that almost 30% of the respondents spent over $1,000 a month on electricity in the average month. These results may suggest the situation facing most small-sized businesses; they typically either spend either very little, or large amounts, on electricity in the average month. Obviously, the group spending more than $1,000 a month will benefit the most from conservation programs. The distribution of the gas bill expenses also is bottom-heavy in its distribution. Over 50% spend $250 or less in the average month on gas bills. Comparing the expenses of gas and electric, it seems that a conservation program targeting consumers of electricity may have increased opportunity for return, since more customers are spending such high amounts in the month and are more attuned to these bills. Although we have not yet undertaken the requisite analysis, it is possible that the respondents who answered that their company spent over $1,000 in an average month on electricity are also those who are more interested in learning more about a new service offering geared to increased energy efficiency of their HVAC systems.

Table 4a: Electric: Monthly Range	Count	Percentage
0-250	9	29%
251-500	10	32%
501-750	1	3%
751-1000	2	6%
>1000	9	29%
Total Responses	31	

Table 4b: Gas: Monthly Range	Count	Percentage
0-250	10	56%
251-500	2	11%
501-750	3	17%
751-1000	0	0%
>1000	3	17%
Total Responses	18	

Established HVAC Contractor Relationship

Respondents were asked whether or not their company had a regular HVAC contractor. Over 70% answered that they did, in fact, have a regular HVAC contractor. This suggests that, at least in the early stages of the pilot program, service providers will have the greatest success in marketing this program to existing customers rather than attempting to solicit new customers with a new service offering.

Table 5: Established HVAC Contractor Relationship	Count	Average
Yes	42	71%
No	17	29%
Total Number of Respondents	59	

Reason for Choosing Contractor

The reasons why businesses chose their HVAC contractor are summarized in the following table. Over 15% responded that they could not remember how they had chosen their HVAC contractor, and an equal number reported that the contractor relationship was “inherited” from previous occupants. Service and price, as criteria for choosing a contractor, were identified by only 7% of the respondents as the reason they had chosen their HVAC contractor.

Table 6: Reason for choosing contractor	Count	Percentage
Don't Recall	7	17%
Inherited them/Came with the territory	7	17%
Have had provider for many years	4	10%
Recommendation	4	10%
Owner Selected	4	10%
Service and price	3	7%
Yellow Pages	2	5%
Knew owner	2	5%
Property Manager	2	5%
Corporate Recommendation	1	2%
Other	1	2%
Solicitation	1	2%
Members	1	2%
Found them through volunteer work	1	2%
Depends	1	2%
Can service all our outlets	1	2%
Total Number of Responses	42	

Prevalence of HVAC Service Contracts

Almost 60% of respondents reported having a service contract with their HVAC contractor.

Table 7: Service Contract	Count	Average
Yes	35	59%
No	24	41%
Total Number of Respondents	59	

Approximate Time of Most Recent Service

Table 8 shows when respondents indicated that their most recent HVAC service had been conducted. While almost 30% responded that they had received service within the last six months and 17% responded they had received service within the last month, over 30% reported either never having service done or couldn't remember when the last service was conducted.

Table 8: Last Service	Count	Percentage
Last Month	10	17%
Last Six Months	17	29%
Last Year	6	10%
Last 2 Years	1	2%
Don't Recall	16	27%
Never	3	5%
Various	6	10%

Total Number of Responses 59

Importance of HVAC Systems

Respondents were asked a series of questions relating to the importance of HVAC systems and their decision-making related to these systems. Respondents were asked to rate, on a scale of 1-5, the degree to which they agreed with a series of statements. Most importantly, almost 80% strongly agreed (rating of 5) that it was important that their system not break down. In other words, these systems are important to their business and it is important to them that they be able to focus on their businesses and not have to deal with unexpected repair issues. However, none of the contacts surveyed indicated that their HVAC systems were unreliable. Therefore, additional research needs to be undertaken to ascertain whether or not reliability is in fact an issue for these customers before any marketing materials are designed to focus on these potential benefits.

Another interesting finding was the number of respondents who consider it important for them to accurately plan and budget for heating and air conditioning equipment replacement. Identifying those businesses that place a high value will likely aid in identifying those businesses that are likely be willing participants with the pilot program.

Table 9: Importance of HVAC	N/A, D/K	1	2	3	4	5
It is important that our heating and air conditioning not break down.	0%	0%	0%	5%	17%	78%
The overall performance of my heating and air conditioning system is important to my business.	2%	0%	3%	24%	10%	61%
I believe it is best, from an investment perspective, to run my heating and air conditioning system until it breaks rather than investing in on-going maintenance.	29%	47%	12%	8%	0%	3%
I believe it is important to be sure my heating and air conditioning is running as efficiently as possible.	0%	0%	3%	17%	10%	69%
It is important for me to be able to accurately plan and budget for heating and air conditioning equipment replacement.	14%	0%	3%	37%	10%	36%
Higher utility costs have caused me to pay more attention to the performance of my heating and air conditioning system.	2%	5%	7%	24%	20%	42%
Total Number of Responses	59					

Importance of Preventative Maintenance

A large majority of respondents, 90%, agreed that preventative maintenance is important.

Table 10: Preventative Maintenance	Count	Average
Yes	53	90%
No	6	10%
Total Number of Respondents	59	

Important Attributes of HVAC Service Providers

Respondents were asked to rate the importance of various attributes related to HVAC service providers. Prompt, responsive service, and ability to respond to emergency situations were all rated more importantly than the requirement that services be competitively priced. This underscores the importance of trust and responsiveness as key issues in the relationships among these decision-makers and HVAC service providers.

Table 11: Importance of HVAC Service Provider	N/A, D/K	1	2	3	4	5
Prompt	0%	0%	2%	3%	8%	86%
Competitively Priced	3%	2%	2%	14%	17%	63%
Most reliable	0%	0%	0%	3%	10%	86%
Demonstrates exceptional technical ability	0%	0%	0%	3%	15%	81%
Responds quickly to emergencies	0%	0%	0%	2%	7%	92%
Provides best quality	2%	0%	0%	3%	5%	90%
Total Number of Responses	59					

3. KEY FINDINGS AND RECOMMENDATIONS

Based upon our research with business owners, business managers, property managers, franchise / corporate energy managers, and local HVAC contractors, we offer the following summary of key findings and recommendations for consideration:

3.1 Understand Local Market Conditions

Especially for the pilot implementation of the small commercial HVAC program, we recommend that the Alliance and / or PECI conduct research to understand the local markets in detail. The better everyone understands the local market conditions, the better the chance for success. Over the past 10+ years, the Bend region has seen quite a bit of economic/commercial growth and, with it, an influx of HVAC service providers. Not every region in the Pacific Northwest has market conditions similar to Bend, yet the need to understand the needs and interests of the key players (i.e. commercial business, service providers, property managers) in any market is essential. In seeking to understand the Bend market, we have identified specific property managers who are decision-makers for a large portion of the market. We have identified chains and franchises and gathered information on their relationships with corporate decision-makers.

3.2 Assist in Identifying Target Customers

If possible, we recommend building into the marketing strategy a step where the participating contractors receive some initial assistance in developing their list of target customers. Energy efficiency and HVAC performance are not high on most small business owners' list of priorities. While most decision makers are interested (on a conceptual level) in energy efficiency and interested in saving money, they did not seem willing to devote a great deal of time to this issue. They are busy with the ongoing issues of running/managing their businesses. As one contractor noted, he has a '90%' closure rate with owners, yet finding the owner and getting time with them is a formidable challenge.

3.3 Target Property Managers

As a cornerstone of the initial implementation, we recommend targeting property managers. These firms will have decision-making roles, or at least significant influence, in many properties and will be able to guide the contractors to the most attractive candidates. It may be worth the time of the Alliance to recruit property managers into the program along with the participating contractors.

A vast majority of small business owners rent and a small number of reputable property managers control a substantial percentage of the commercial rental market. Targeting these property managers, who have clear benefits from participating in the small HVAC program, both in terms of extended life of existing HVAC equipment and providing valued tenant services, will

be an effective way to reach a substantial number of the eligible businesses. Property managers represent an essential element in creating market demand for the service

3.4 Leverage Established Relationships

Initial marketing should target customers with whom service providers already have established relationships. To support these relationships, marketing materials should likely be developed in a way that the individual contractors can brand it as "their service" rather than a service coming from an outside entity (*e.g.*, the Alliance).

More than 70% of those surveyed have an existing relationship with an HVAC service provider. A majority of those surveyed expressed an interest in hearing more about a new program that would lower their utility costs and improve system performance from their service provider. Working with service providers to determine which of their clients are the most appropriate beneficiaries of the small HVAC program should be a priority.

3.5 Target Large Consumers First

Understanding that this is a new service, the financial benefits of which are not yet proven, the program should target consumers who have relatively high bills.

A majority of those surveyed spend less than $500 a month on electricity. Many, many small businesses spend less than $250 a month on electricity. Asking those who spend a few hundred dollars a month on electricity to devote resources (time and money) to save a few dollars a month will be a tough sell. Asking those who spend a few thousand dollars a month to devote resources toward this program will realize more interest and more participation.

3.6 Beware Split Incentives

Based upon the nature of leasing agreements, there is likely to be a conflict between owner and tenant interests in preventative maintenance.

Strong barriers exist between tenant and property owners, and this is reflected in the separate allocation of HVAC responsibilities. Tenants are responsible for routine maintenance and upkeep of equipment. And yet property owners are the party responsible for replacing the equipment if it actually breaks down. Property owners will most likely want to extend the life of their HVAC equipment and avoid the large costs associated with replacing HVAC equipment. Yet the tenants, who are often responsible for HVAC maintenance, don't necessarily care about avoiding equipment replacement costs. Rather, they want to save money on their utility bills and ensure that they don't have to endure the inconvenience of a breakdown.

3.7 Minimize Emphasis on Environmental Benefits

Marketing themes highlighting environmental benefits may not be wise. Any messages or materials containing this emphasis should be thoroughly tested prior to use.

This is a clear example of how understanding the local market is important. The Bend Chamber of Commerce representative with whom we spoke suggested there is polarization in the community around the issue of conservation. While this "we vs them" (businesses vs. conservationists) attitude did not reveal itself in any of our interviews, it is nevertheless an issue to which we should be extremely sensitive.

3.8 Recruit Franchise and Corporate Customers

We recommend that the Alliance consider recruiting franchises and corporate customers into the program directly. Although such recruitment takes substantial focus and effort, once they are sold on the program benefits at the higher level, these customers would provide a broad base of work for the participating contractors.

By focusing on a small number of decision makers who control a large number of properties and work with specific service providers, the program will be able to develop a 'foothold'. This approach will ensure broad geographic participation and training of service providers across all four states.

One franchise we interviewed with more than 300 regional businesses works exclusively with Trane equipment. If this is true of other franchises as well, there may be fertile relationships to develop with specific HVAC manufacturers.