



Watt Buster Final Report

AEA Metering Project #AEA 10-012

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Executive Summary

Thirty-two commercial customers and 96 residential customers participated in the Watt Buster research project between February and October 2010. The project was conducted to determine whether building energy monitors – or in the case of commercial customers, an energy assessment – would result in energy efficiency improvements.

Residential Component

Test participants in the residential component installed and used the Tendril home system, which provides close to real-time feedback on household electrical consumption. The Tendril system includes a counter-top display unit and a web portal, allowing participants both at-a-glance information and more detailed data on the portal. The Tendril system was in place between three and four months, depending on when participants installed it.

The project included three participant surveys: baseline, mid-project and closing. The surveys elicited valuable information about participants' energy behaviors and perceptions. The relationship between a BEM and changes in electric consumption was derived from the following: comparison of the test group's actual consumption in the test period to the same months the previous year; comparison of actual test period consumption of test group subsets to control groups; and changes perceived by the test group.

The residential component also compared the weaknesses and merits of the Tendril home system with EnergyHub and OpenPeak, two other residential BEM systems, and surveyed users of appliance power meters Kill A Watt and Watt's Up?

The aggregated consumption data did not reveal significant reductions in electric consumption among test participants. However, several subsets of the test group did reduce their household electric consumption significantly: participants who thought they had already done as much as they could to make their household energy efficient, in fact found more ways to reduce their consumption. Households with electric heat (a very small percentage of the total group) reduced their electric consumption far more than any other subset. A likely explanation is that milder weather had a more significant impact on those with electric heat. Based on decade built, homes built in the 1980s were the only subset to show reduced electric consumption from the previous year.

Key findings of the residential component include the following:

- Customers found the BEMs helpful, but it is not clear they would pay for it themselves
- Building energy monitors increase knowledge and interest in energy efficiency
- Certain types of information, about appliances in particular, would help customers be more energy efficient
- Perceptions of comfort and convenience are significant barriers to energy efficiency improvements
- Time-of-day pricing may be the key to gaining consumer attention and behavior changes
- BEM technology is still evolving

Commercial Component

The commercial portion of the BEM study consisted of BuildingAdvice energy assessments of 32 commercial buildings: 21 from Chugach's service area and 11 from Municipal Light & Power's (MLP) service area. The commercial energy assessments modeled a building's total energy use, based on one week of monitoring data and background building data, and generated a report with recommendations for energy savings. The project team then met with each participant to review the report's findings and recommendations. Participants then answered a brief survey about any plans to implement the recommendations, as well as their perceptions about the project.

The commercial survey was complemented by a telephone survey of 121 of Chugach Electric's largest commercial customers.

Key findings of the commercial component include the following:

- Commercial customers are taking steps to become more energy efficient. The most common steps are energy efficient lighting, increasing employee awareness, and streamlined operations and scheduling.
- Commercial customers' decisions about energy efficiency improvements are driven by the potential for energy savings and cost.
- There is a disconnect between perceived and actual electric consumption. Commercial customers believe their energy consumption has increased over the past three years (by a mean increase of 9.5%). In fact, consumption has declined just over 3% per year. This disconnect between perceived and actual consumption should be an important element in future education efforts.
- Commercial customers are clearly driven by financial considerations: return on investment, capital outlay required, and impacts to their bottom line.
- Many of the easiest and least expensive measures are not obvious to owners and property managers. Chugach could help commercial customers make significant improvements by helping identify the low-hanging fruit of simple, low and no-cost changes.

1. Background

Chugach Electric conducted a research project, called Watt Buster, on the impacts of residential and commercial building energy monitors (BEMs) on energy efficiency and conservation. This project was funded in part by a matching grant up to \$75,000 from the Alaska Energy Authority under AEA Metering Project #AEA10-012.

The BEM research project had two distinct goals:

- To identify whether, and under what conditions, the deployment of BEMs is most effective for reducing energy usage
- To identify the best equipment available and which features are most helpful to consumers and utilities.

The project included both residential and commercial components. The original project scope also included rural customers. Chugach made numerous attempts to engage rural partners. The prospective partners were unresponsive. These efforts were described in previous reports to AEA, which concurred that this portion of the project could be dropped.

For the commercial component, energy assessments were conducted at 32 commercial sites. The commercial energy assessments modeled a building's total energy use, based on one week of monitoring data and background building data, and generated a report with recommendations for energy savings. Commercial participants were surveyed to determine whether they planned to implement any of the recommendations.

2. Residential Component

The residential component of Watt Buster project included three pieces:

- Effectiveness of BEMs, using the Tendril Home system
- Comparison/assessment of BEMs, using Tendril, OpenPeak, and EnergyHub BEMs
- Use of power meters, using Kill A Watt and Watt's Up? meters

Note: Chugach Electric intended to achieve both goals with a study in which test subjects used one of three BEMs: Tendril, OpenPeak, or EnergyHub. However, only Tendril was available in the time frame needed so the plan was amended to conduct the evaluation and comparison later in the year.

2.1. Effectiveness of Building Energy Monitors

To evaluate the effectiveness of BEMs in residential buildings, Chugach used the Tendril Home system, which test participants installed and used from March through June, 2010.

2.1.1. Methodology

The following sections describe the Tendril system and the methodology Chugach used for this portion of the research project.

2.1.1.1. *Devices Used*

The Tendril Home system consists of three devices and access to a Web portal:

- **Translate**—The Translate device receives data from the customer's electric meter and communicates the data to the other two devices: the Transport and Insight. The Translate, which must be located close to but not directly in line with the electric meter, receives data at a frequency of anywhere from every few seconds to every 10 minutes. It transmits the data to the Web portal every 15 minutes.
- **Transport**—The Transport receives data from the Translate and communicates with the Internet. It is plugged into the customer's router or modem.
- **Insight**—The Insight is a counter-top device that displays data from the Translate. It provides information on energy consumption, including projected billing amount and cost per hour, which was provided by Chugach. It also displays short messages from Chugach Electric.
- **Vantage Web Portal**—The Vantage Web Portal provides current and historical data about the customer's energy consumption and other information in a website. Chugach provided Tendril with one year of historical data for each participant, which enabled the participants to monitor and compare current energy usage with historical consumption.

Each test member also received an antenna for the Transport; Ethernet and power cables; and a card with the test customer's user name, password, and the Web address for the Vantage Web Portal. The combination of the Translate, Transport, and Insight form a Home Area Network.

Set Point Thermostats. Tendril's product line includes a Set Point thermostat, which ties into the Home Area Network and can be controlled remotely. Chugach purchased approximately 20 of these "smart" thermostats and offered them to the test group. However, the Tendril thermostats require a compatible heating system, which not all prospective users had. Chugach installed Tendril thermostats in nine homes, and the response was quite positive. Users reported they liked the remote control and being able to monitor their heat consumption on the Tendril system. Testers were encouraged to keep the thermostats after the project ended.

Volt. Tendril also offers the Volt, a device that measures electrical consumption of household appliances and displays the data in the Home Area Network. Chugach Electric did not purchase the Volt.

2.1.1.2. *Recruitment and Selection Process*

On January 22, 2010, Chugach sent an email to the 5,844 residential members for whom it had email addresses. The email explained the Watt Buster research project, the initial requirements, and included a link to the application form on the *SmartPowerAK* website (www.smartpowerak.com). In addition, Chugach announced the project in the February issue of Chugach's member newsletter, the *Outlet*, and in a print advertisement in the Anchorage Daily News in early March. (Refer to Appendix A for copies of these materials.)

In order to participate in the study, members were required to meet the following criteria:

- Have and use a home computer and the Internet
- Have an open port on their router, or be willing to purchase a router
- Be willing to use the monitor as directed and participate in surveys
- Reside in the home for the duration of the project
- Have been a Chugach residential customer for at least three years

In response, 324 residential members volunteered to participate in the project. Prospective volunteers were asked to provide information about their home size, building type, heat source, and number of persons in the household. Chugach sorted applicants by home size, building type, and fuel source, and then selected 96 participants at random from within those groups in numbers to reflect a cross-section of the entire residential membership. Table 1 lists the number of participants within each classification, based on the self-reported information in the application.

Note: When analyzing data (refer to 2.1.2 Results), Chugach used CAMA data from the Municipality of Anchorage, which may differ slightly from the self-reported information.

Table 1: Classification of Residential Participants

Heat Source		Home Type		Home Size (Square Feet)	
Electric	5	Mobile	3	≤ 1,000	6
Gas	89	Duplex	7	1,001 – 1,799	22
		Condo	5	1,800 – 2,499	32
		Single Family	81	≥ 2,500	32

Because the test group consisted of self-selected volunteers, they did not necessarily represent the average Chugach residential customer. Even so, this research project generated valuable information about the strengths and limitations of BEMs, as well as motivations and attitudes of customers with an interest in energy efficiency.

2.1.1.3. Distribution and Training

Chugach personnel, including several customer service representatives who were direct contacts for participants during the project, received on-site training from Tendril on February 9 and 10.

After participants were selected, Chugach reviewed each participant's meter. Most of the test participants had older meters, which required replacement for the Tendril system to function. Chugach replaced all needed meters before participants were allowed to pick up devices, which caused some delay in the project start.

Selected participants were instructed via email on February 19 to pick up their devices from Chugach between February 22 and March 5. When test participants picked up their equipment, a lead service representative met with them to review the equipment, installation, and registration.

The pick-up, installation, and registration process took longer than Chugach anticipated. The initial group of test participants picked up their equipment between February 22 and March 16. Despite enthusiasm for the project, test participants had to be reminded, usually by email, to pick up their devices, install, and register them. Test participants who were particularly slow to respond received direct phone calls. Volunteers who decided not participate or failed to pick up the Tendril equipment by mid-March were replaced by other volunteers, who picked up their equipment between March 26 and March 30.

Originally, Chugach planned to conduct training sessions for the test participants. However, upon consultation with Tendril and based on Chugach staff's own training, Chugach determined that formal training sessions with the test participants would not be necessary. Directions provided by Tendril were clear, and both Tendril and Chugach provided support and assistance on request.

Chugach established a dedicated email address (WattBuster@chugachelectric.com) and phone number for Watt Buster questions. Key Chugach staff stayed in contact with participants to answer questions and monitor connections. In addition, supporting materials—Frequently Asked Questions, a Tendril User Guide, an explanation of the Home Area Network—were posted on Chugach's *SmartPowerAK* website.

Note: Refer to Appendix B for copies of these materials.

Most volunteers had few problems installing and using the Tendril devices. Problems encountered were primarily from data input errors (such as an incorrect address), signal pick-up problems, or faulty Translate devices. Most of the problems were rectified quickly. Several participants failed to follow through and never really participated in the project. The majority of complaints and problems were addressed as they emerged by Chugach personnel. In a few instances, participants contacted Tendril directly. Chugach personnel also referred problems to Tendril when necessary.

2.1.1.4. Energy Efficiency Education

Throughout the test period, education on energy efficiency was provided on *SmartPowerAK*, Chugach's energy efficiency website. In addition, Chugach posted a series of weekly messages through Tendril, which were displayed on the Insight and the Vantage Web Portal.

Additional energy efficiency education was sent to all Chugach residential customers in a special mailing and in articles in the *Outlet*, Chugach's member newsletter.

Note: Refer to Appendix B for copies of these educational materials.

2.1.1.5. Participant Surveys

During the Tendril portion of the project, three surveys were conducted: a baseline survey, a mid-project survey, and a closing survey. All three surveys were circulated in draft among the Chugach team to ensure thorough review and comment. When finalized, the survey was entered into SurveyMonkey (www.surveymonkey.com), an online survey tool. Chugach then emailed each test participant a unique link to the survey, and participants completed the survey online.

The intent of the baseline survey was to gather as much early information as possible, regarding test participants' habits, expectations and motivations, as well as some additional household characteristics. It was drawn in part from one conducted by Cape Light Compact in Massachusetts. Test participants were asked to take the survey after they had installed the Tendril system in order to get an immediate assessment of the installation process. The first baseline survey was received March 5; the final response was submitted April 14, 2010. The response rate was 94%.

The objective of the mid-project survey was to take the pulse of how the project was going and to flag any major changes that might affect the results, such as number of household residents and any extended vacancies. The link for this second survey was emailed May 14. The final response was received June 18, 2010, with a total response rate of 78%.

The closing survey was designed to capture test participants' perceptions of the project: whether their behaviors and attitudes had changed as a result of it and their views about the path toward increased energy efficiency. The closing survey, conducted between July 1 and August 4, had a 90% response rate.

Note: Refer to Appendix C for copies of these surveys.

2.1.1.6. Control Groups

To evaluate whether the BEM affected energy use during the test period, Chugach created two control groups. Each control group was selected to reflect the typical Chugach residential customer with the following specific attributes: year home was built, land use description, residential style, heat fuel, heat type, total number of rooms, number of bedrooms, number of bathrooms and square feet of living area. Two control groups were selected to reflect the two different heat types: forced air and hot water baseboard heat. Overall, Chugach customers are split about evenly between the two heat types.

The control groups were compared to subsets of the test group, selected to match the attributes. The “Hot Water” control group (refer to Table 2) consisted of 1,097 residential customers who matched attributes of 21 participants, who comprise the Hot Water Test Group.

Table 2: Hot Water Group Characteristics

Attribute	Hot Water Control Group	Hot Water Test Group
Number in Group	1,097	21
Land use	Single family home	Single family home
House type	Bi-level/two-story/split-level	Bi-level/two-story/split-level
Average year built	1974	1973
Total # rooms	8	8
Bedrooms	4	4
Bathrooms	2.5	2.5
Living area	2,348 sq ft	2,284 sq ft
Heat type	Hot Water	Hot Water
Heat fuel	Natural Gas	Natural Gas

The “Forced Air” Control Group consisted of 811 residential customers who matched attributes of 23 participants (refer to Table 3).

Table 3: Forced Air Group Characteristics

Attribute	Forced Air Control Group	Forced Air Test Group
Number in Group	811	23
Land use	Single family home	Single family home
House type	Bi-level/two-story/split-level	Bi-level/two-story/split-level
Average year built	1990	1992
Total # rooms	8	8
Bedrooms	4	4
Bathrooms	2.5	2.5
Living area	2,399 sq ft	2,450 sq ft
Heat type	Forced Air	Forced Air
Heat fuel	Natural Gas	Natural Gas

2.1.2. Results

The following section describes the results of this portion of the research project.

2.1.2.1. Change in Consumption

Chugach evaluated the change in consumption

- During the test period between control and test groups
- From 2009 to 2010 for the test groups

Note: For these evaluations, subsets of the participants were used to compare with the control groups, as described above. Potentially significant variables such as weather and energy price were not ascertained for purposes of this evaluation.

Test Group vs. Control Group. As shown in Table 4, during the months of January and February 2010, before the project began, the Hot Water Test Group was using 13% more electricity than the corresponding Control Group. Once the project had begun, the Test Group reversed this as they decreased consumption to 4% less than the Control Group.

Table 4: Hot Water Group—Test vs. Control

		Test Group (avg. usage)	Control Group (avg. usage)	Usage Difference (Test vs. Control)	Percent Difference
Pre-Tendrill Deployment	January 2010	1,100	983	+117	+11.9%
	February 2010	1,056	921	+135	+14.6%
	Average	1,078	952	+126	+13.2%
During Tendril Deployment	March 2010	872	838	+34	+4.1%
	April 2010	757	782	-25	-3.2%
	May 2010	678	724	-46	-6.3%
	June 2010	578	678	-100	-14.7%
	Average	721	755	-34	-4.5%

As shown in Table 5, the Forced Air Test Group was using 2% less than the corresponding Control Group in January and February. Once the project had begun, the test group widened the margin as their consumption dropped to 4% less than the control group.

Table 5: Forced Air Group—Test vs. Control

		Test Group (avg. usage)	Control Group (avg. usage)	Usage Difference (Test vs. Control)	Percent Difference
Pre-Tendrill Deployment	January 2010	1,069	1,100	-31	-2.8%
	February 2010	989	1,014	-24	-2.4%
	Average	1,029	1,057	-28	-2.6%
During Tendril Deployment	March 2010	863	924	-61	-6.6%
	April 2010	777	833	-56	-6.7%
	May 2010	711	773	-62	-8.1%
	June 2010	721	673	+48	+7.1%
	Average	768	801	-33	-4.1%

Test Group vs. Previous Year. When the Test Group's 2010 usage during the test period was compared with their usage during the same period in 2009,

- The Hot Water Test Group consumed 1.9% **more** in 2010
- The Forced Air Test Group consumed 2.5% **less** in 2010

For the entire participant group, there was no change in consumption from 2009 to 2010 during the March-June test period.

Important: The data was adjusted to account for changes in the number of billing days. Additionally, both of these statistics fall into the error margin from a practical standpoint. Contributing factors not taken into consideration, but having significant impact, include price elasticity, occupant ages, number of household occupants, and weather. Further analysis would be required to determine why the test group's consumption increased over the previous year. One possible explanation is that gas prices, and hence, electricity, were high in 2009. Consumers tend to increase and decrease electric consumption based on price. It may be that the test group consumed more in 2010 in response to the lower prices.

2.1.2.2. Significant Results for Different Groups or Classes of Subjects

Note: The results in this section are for the entire participant group.

Chugach also compared the following variables against change in usage between March – June 2009 and March – June 2010:

- Home size
- Age of home
- Heat Type
- Heat Fuel
- Energy Efficiency Efforts Prior to Study

Home Size. The biggest drops in consumption were in homes of 3000+ sq ft (2.5%) and in homes 1501-2000 sq ft (2%).

Table 6: Consumption Change by Home Size

Home Size	% Change (2010 vs. 2009)
Up to 1,500 sq ft	+1.3%
1,501 – 2,000 sq ft	-2.0%
2,001 – 2,500 sq ft	+3.2%
2,501 – 3,000 sq ft	-1.3%
3,001+ sq ft	-2.5%

Age of Home. Homes built in the 1980s were the only group that used less electricity. Homes built in all other decades increased consumption in 2010, with the oldest homes having the largest increases.

Table 7: Consumption Change by Year of Construction

Year of Construction	% Change (2010 vs. 2009)
1950s/1960s	+5.1%
1970s	+2.5%
1980s	-5.1%
1990s	+0.7%
2000s	+0.8%

Heat Type. Regardless of heat type, the test homes consumed slightly more in 2010 than in 2009.

Table 8: Consumption Change by Heat Type

Heat Type	% Change (2010 vs. 2009)
Forced Air	+0.4%
Hot Water	+0.3%

Heat Fuel. Test households that heat with natural gas, comprising the vast majority of the total test group, increased their consumption 0.3% in 2010. Households heated with electricity consumed 25.1% less in 2010 than in the same period the previous year.

Table 9: Consumption Change by Heat Fuel

Heat Fuel	% Change (2010 vs. 2009)
Natural Gas	+0.3%
Electric	-25.1%

Energy Efficiency Efforts Prior to Test. In the initial application, the following was posed as a yes or no question: "I have already done just about everything I can to make my home energy efficient." This question was included on the assumption that households who answered "yes" were unlikely to realize

additional efficiencies. However, test participants who answered “yes” reduced their consumption 6.5%, compared to 1.7% increased consumption among those who had not done all they could.

Table 10: Consumption Change by Previous Energy Efficiency Efforts

Previous Energy Efficiency Efforts	% Change (2010 vs. 2009)
No	+1.7%
Yes	-6.5%

2.1.2.3. Participant Feedback from Surveys

Through the three surveys during the study, the following key information was learned:

- Test participants were already engaging in energy efficient practices before the project began. Most participants had already replaced at least some of their incandescent bulbs with CFLs and usually or always turn off lights in unoccupied rooms. About three-quarters already ran their washer, dryer, and dishwasher only with a full load.
- In the closing survey, test participants were asked what, if any, changes they had made as a result of participating in the project. Almost two-thirds of the respondents (63.2%) reported changes in their household energy use. Table 11 lists changes cited, in descending order of frequency. Yet at least 85% of them had been engaging in energy efficient practices before the project began. Did participation motivate them into stepping up their efforts even more? Or might there be some overlap of past efforts and recent efforts?

Table 11: Reported Changes in Energy Efficiency Practices

Change	Percent
Turn off lights in unoccupied rooms	79.3%
Completely turn off or unplug electronic devices not in use	65.5%
Run dishwasher, washing machine and dryer only when full	56.9%
Turn down thermostat in winter, when leave house	41.4%
“Other”	27.6%
Installed a programmable thermostat	24.1%
Turn down temperature of hot water heater	22.4%

- As a result of the project, participants became more knowledgeable about and interested in household energy use and energy efficiency.
- Participants plan to purchase energy efficiency appliances in the future.
- Over the course of the test period, participants’ responses on several issues remained constant: information that would help households be more efficient; barriers to becoming more efficient; and what others would pay for a BEM.
- Participants believe the following types of information would help customers become more energy efficient:
 - Which appliances and equipment are least efficient
 - Habit changes that wouldn’t impact their lifestyle
 - Information about the most energy-efficient product models

- Participants considered the cost of new appliances and (in a distant second) the desire for comfort at home as barriers to energy efficiency.
- Consumers are willing to make some behavior changes, especially changes that do not inconvenience them or impact their comfort level.

Note: Refer to Appendix C for copies of the complete survey results.

2.1.3. Conclusions

Based on the results of this project, it is not completely clear whether BEMs result in reduced energy consumption. Although test participants reported they did adopt more energy efficient practices, the hard data is not conclusive.

As described in section 2.1.2.2 (Significant Results for Different Groups or Classes of Subjects), Chugach compared 2009 and 2010 usage based on several characteristics of the buildings. Based on this data, BEMs may be most effective for those individuals

- **With electric heat.** Test participants with electric heat consumed 25.1% less energy during the test period compared to the same months the year before. They account for a very small percentage of the total participants, so the impact of those savings was diluted in the aggregate. A possible explanation is that households heated with electricity would be affected disproportionately by mild temperatures.
- **Who are interested in energy efficiency.** One of the unexpected findings was that test participants who had already taken steps to be more energy efficient in fact reduced their consumption significantly more than others.
- **With homes built in the 1980s.** Homes built in the 1980s were the only energy savers; their consumption dropped 5.1%. Test homes built in all other decades increased energy consumption in the 2010 test period.

The size of home may also impact the effectiveness of BEMs, but these results were mixed, with the largest homes (3,000 square feet or more) reducing the most, followed by homes of 1,501 to 2,000 square feet). However, there was essentially no difference in energy savings based on heating type, whether forced air or hot water.

Perceptions of inconvenience and quality of life impacts are probably significant barriers to energy efficiency among the general population. This conclusion is based on the significant rating of these as barriers among our highly motivated Watt Buster participants. If this is an issue for them, it is likely a bigger issue for the general public.

In addition, greater efforts should be devoted to effective information and education about the energy use of specific appliances and household behaviors. Also, a table of low-medium-high energy consumption for households with multiple variables could provide customers a context for how they compare to similar households.

Time-of-day pricing would likely be a significant incentive for energy efficiency. In addition, although participants found the BEMs useful, under the status quo—with no time-of-day pricing—customers are probably unwilling to pay the actual costs of BEMs.

2.2. Comparison/Assessment of Building Energy Monitors

The original plan included a single project that assessed the effectiveness of BEMs and to identify the most effective BEM features. However, when Chugach learned that the EnergyHub and OpenPeak BEMs would not be available for the four-month research period, the project team concluded that the only practical approach would be to recruit a smaller group of volunteers for the comparison and assessment component of the project.

2.2.1. Methodology

On June 22, Chugach sent an email to all 96 Watt Buster participants, explaining the comparison component and asking for volunteers (refer to Appendix A for a copy of this email). The only requirement was that continuing volunteers had to have completed all three of the Watt Buster surveys. Chugach accepted the first 10 participants who responded.

When the Tendril testing ended June 30, the 10 continuing test participants picked up the OpenPeak system and were asked to use it for one month. Their actual usage ranged from 3 weeks to more than two months. Most of the participants kept it for two months or more. During this period, one volunteer became frustrated and opted out of the remainder of the project. The plan was for the volunteers to return the OpenPeak after one month and install the EnergyHub. However, testing by Chugach revealed numerous problems with EnergyHub, which delayed delivery to the volunteers.

Participants returned their OpenPeak devices between August 7 and September 17. The EnergyHub systems were picked up between September 9 and September 20, Chugach had asked participants to use the EnergyHub for at least one week and to return it by September 24. Perhaps because of the delay, only three of the remaining nine volunteers actually installed the EnergyHub.

Chugach then posted a comparison survey of the three BEM systems on SurveyMonkey and sent links to the nine remaining participants on September 24. All nine participants completed the survey.

Note: Refer to Appendix C for a copy of the survey.

2.2.2. Devices Used

OpenPeak's OpenFrame 7E consists of a base unit, an Ethernet cable, power adapter, and cleaning cloth. The unit can be used with either wireless or Ethernet. Once programmed, the OpenPeak device receives kwh consumption information from the consumer's electric meter. Applications, such as YouTube, games and Google Map, may be added to the base unit. OpenPeak had intended to solidify an agreement with Google so that consumers could use Google Power Meter to track their power consumption online. However, the agreement was not in place for Chugach testers to use.

Note: Refer to Appendix B for instructions Chugach prepared to complement the OpenPeak Quick Start Guide.

The EnergyHub System consists of a dashboard display, a power strip, three sockets, a power cord, a user manual, and an installation checklist. The EnergyHub, like the Tendril, requires a wireless connection. The power strip and sockets permit the consumer to monitor and track energy consumption of specific appliances. (Tendril offers an add-on for appliance monitoring—Volt—which Chugach did not purchase.) EnergyHub also promised the Google Power Meter option, but it did not materialize during the project time frame.

2.2.3. Results

Through the survey, the following key information was learned:

- For many, EnergyHub was too complicated. Testers who were not intimidated liked it very much, in particular the appliance monitoring feature. It was rated the most difficult to use.
- Tendril had several strengths over the others, such the ability to compare current and past weeks and months, the ability to compare with other households, and the availability of a Web portal. It rated the easiest to use and provided the most valuable information.
- The OpenPeak was simple to use, with a pleasing design, but it didn't offer as many energy efficiency features as the other two. It was rated easiest to install.

Table 12 summarizes what the respondents liked and disliked about the different systems.

Table 12: BEM Comparisons

Device	Positives	Negatives
OpenPeak	• Simple to connect and view • Clock feature • Looks contemporary • Usage graph, smaller time increments	• Not as detailed in usage • No thermostat control • No ability to monitor individual appliances • No web browser • No remote access
Tendril	• Thermostat • Excellent wireless connectivity • Good base display • Able to compare week to week • Liked hourly reading • Simplicity and small footprint • Usage graph • Liked the brief energy efficiency messages • Output clear and understandable	• Didn't like having three devices • Son kept unplugging the transmitter • Information compounded and not easy to analyze • No information about specific appliances • Looks old school • Hard to see and read compared to others • Want usage broken into smaller time increments • Difficult to hook up and equipment was bad, had to be replaced • Required the monitor to be near the receiver
EnergyHub	• Ability to monitor individual appliances (mentioned repeatedly) • More user friendly • Easy to operate • Gives good information • Monitor is nice, communicates with SmartMeter	• Overwhelming, too complicated • Wireless connection spotty at best • System would drop out for no reason • Took a long time to install and couldn't reach the appliances I was most interested in (water heater) • Look and style • A hassle; too many parts

Note: Refer to Appendix C for a copy of the complete survey results.

2.2.4. Conclusions

The technology of building energy monitors is still very much in flux. All three companies fell short on some of their promises or over-stated the functions and capabilities of their systems. Chugach believes the EnergyHub system has the most potential for value, to both customer and the utility, but its usefulness also makes it more complex for the customer.

2.3. Use of Appliance Power Meters

Chugach supplemented the BEM research project by gathering information about the use of appliance power meters, which is described in this section.

2.3.1. Methodology

In October 2009, Chugach began offering consumer power meters on loan to customers. Two different meters are available: the Kill A Watt and the Watts Up?. Both models allow the consumer to measure power consumption of household appliances and determine the cost of power consumed. The appliance is plugged into the meter, which is then plugged into an outlet. The consumer inputs the electric rate, selects a cost projection period (e.g., hour, day, week, month, year), and selects a power measurement. The Chugach customer may keep the appliance meter for up to two weeks. Customers borrowing the device receive a briefing on how to use it and a copy of the operating manual.

In April, Chugach publicized the availability of these meters in emails and in the *Outlet*. Beginning in April, borrowers were asked to complete a brief survey when they returned the device. A Chugach customer service representative called borrowers who neglected to return the survey. Between April 1 and September 30, 114 Chugach members borrowed an appliance meter; 84 of them completed the survey, in whole or in part.

Note: Refer to Appendix C for a copy of the survey.

2.3.2. Results

Through the survey, the following key information was gleaned:

- Two-thirds of the respondents borrowed the Kill A Watt device.
- The most frequently cited reasons for borrowing the meter included
 - Lower their electric bill (73.1%)
 - Desire to reduce energy use (67.9%)
 - Curiosity (65.4%).
- Nearly 80% found the meter easy to use.
- Close to two-thirds (63.1%) had not made any changes based on what they learned, but about the same amount (62.3%) did plan to make changes.

Note: Refer to Appendix C for a copy of the complete survey results.

2.3.3. Conclusions

These are useful tools that help customers become more aware of how various appliances use energy. Although using the meter did not usually result in immediate changes, they appear to motivate customers to plan energy efficiency changes in the future. Chugach should continue to loan out these power meters but needs to remind customers periodically that they are available. Interest in them spiked after an article appeared in the *Outlet*, but dropped again.

2.4. Recommendations for the Future

Based on the information learned through the residential component of this research project, Chugach recommends the following:

- Focus education efforts on painless habit changes. Consumers are willing to change their energy consumption behavior if those changes do not inconvenience them or impact comfort level.
- Provide clear information comparing the energy consumption of specific appliances and models.
- Provide an easy way for consumers to compare their household energy consumption with other similar households. Tendril's comparison was not adequate since there was no meaningful breakdown of household attributes, such as home size and number of household members.
- Consider proposing time-of-day pricing to encourage energy efficiency at peak times.
- Design and conduct a longer term project using just the EnergyHub. Although it is more complicated to install, it has tremendous potential value to both customers and the utility.
- Continue to loan appliance power meters to customers, reminding them periodically that they are available. The meters are useful tools that help customers become more aware of how various appliances use energy. Although using the meter did not often result in immediate changes, they appear to motivate customers to plan energy efficiency changes in the future.

3. Commercial Component

The commercial portion of the BEM study was comprised of BuildingAdvice energy assessments for 32 commercial buildings: 21 from Chugach's service area and 11 from Municipal Light & Power's (MLP) service area. Unlike the BEMs used in the residential portion of the study, which allowed occupants to monitor electric usage in near real-time over a multi-month period, the commercial energy assessments modeled a building's total energy use (based on one week of monitoring data and background building data) and generated a report with recommendations for energy savings. The project team then reviewed the report's findings and recommendations with each participant. Following the report, test participants completed a survey about changes they made or plan to make because of what they learned.

3.1. BEM Used

For the commercial component, the project team used the BuildingAdvice system (www.airadvice.com). This modeling system assesses how a building uses energy based on the following data:

- Real-time measurements of temperature, humidity, carbon dioxide, and lighting from monitors placed throughout the building
- Background data
 - Utility bills
 - Building information (e.g., construction type and usage profile)
 - HVAC system information (e.g., system type and efficiency, control systems type, schedules, and set points)
 - Weather data

Using this data, the BuildingAdvice software models how the building uses energy and generates an energy savings assessment that includes information about current use, estimated potential savings, and general recommendations on improvements.

Each of these BuildingAdvice elements is described in more detail in the following sections.

3.1.1. Monitors

A BuildingAdvice system includes 10 monitors—each approximately 6"x5"x3" in size—and a gateway. The monitors are placed throughout the building and measure ambient temperature, relative humidity, ambient light, and carbon dioxide¹ in 2-minute increments. Each monitor has a power supply and uses the ZigbeeTM wireless mesh protocol (802.15.4MHz) to communicate readings to a central Communication Gateway. This Gateway transfers the monitor readings to the AirAdvice data center using cellular (GSM) communications. In addition, to prevent data loss if wireless communication is not available, the monitoring system can also store up to one month of data.

At the beginning of the study, the project team had one BuildingAdvice system available. However, to complete all the needed monitoring within the study period, the team added a second set of monitors at the end of April. Although this second set measures the same data, it is not a BuildingAdvice system: the monitors record the data but do not transmit it to a data center. Instead, the Control Contractors representative manually downloaded the data after each deployment.

¹ Only 5 of the 10 monitors record carbon dioxide.

3.1.2. Background Data

In addition to the monitor data, the BuildingAdvice modeling software also incorporates background data about the building. For this study, the following building information was gathered for each building:

Table 13: Commercial Background Data Gathered

Category	Information
Utility billing history	• Electric usage and demand (kWh/KW and total cost) for 12 months • Fuel usage and cost for 12 months
Building information	• Building usage • Square footage (total, gross floor area for various areas) • Number of stories • Construction type • Weekly operating hours • Number of workers on main shift • Number of PCs • Offices heated (percentage) • Offices cooled (percentage)
HVAC system information	• Heating system type • Domestic hot water type • Economizer (yes/no) • Cooling system type • Humidification system (yes/no) • Demand control ventilation system (yes/no) • Dehumidification system (yes/no) • Temperature control schedule (time, heating set point, cooling set point, whether occupied)
Controls system information	• Controls type • Schedule type • Air delivery method • Air-flow modulation

In addition, the BuildingAdvice model uses weather data (for the monitoring period and for the period of the utility history provided) from the weather station nearest the building's zip code. The model also incorporates ENERGY STAR data for comparable buildings².

² Because Alaska-specific data is limited, it is assumed that these comparable buildings include many from outside Alaska.

3.1.3. Energy Savings Assessment Report

Using the monitor and background data, the BuildingAdvice software generates an assessment report for the building³. The report includes the sections described below; refer to Appendix G for copies of each report.

- **Executive Summary:** The building's calculated energy use (in kbtu/sq ft), ENERGY STAR rating, cost (in dollars/sq ft), and carbon footprint. In addition, the building is compared against other similar buildings in the ENERGY STAR database. At the bottom of the summary, the report provides estimated potential savings from raising the building's ENERGY STAR rating. All of these values are calculated using the utility billing history and the ENERGY STAR Portfolio Manager⁴.
- **How Does Your Building Use Electricity Today?:** The building's historical electricity usage (and demand, if the data was provided) compared to outside temperatures.
- **How Does Your Building Use Fuel Today?:** The building's historical gas usage compared to outside temperatures.
- **Building Comfort and Ventilation Analysis:** Summary of the ambient temperature, humidity, and carbon dioxide monitoring results.
- **Temperature:** Detailed information about the ambient temperature readings from the monitors, including the temperature spread during occupied times and the percentage of time the temperature was outside the desired range. The bottom of the page includes a graph of the readings from each meter, which helps identify changes in temperature and when those changes occurred. The page also provides temperature-related recommendations for saving energy.
- **Relative Humidity**⁵: Detailed information about the humidity readings from the monitors, as well as recommendations for improvement and a graph of the meter readings.
- **Carbon Dioxide:** Detailed information about the carbon dioxide readings from the monitors, including recommendations and a graph of readings. The carbon dioxide readings help identify how much fresh air is being brought into the building: the more fresh air, the lower the carbon dioxide. During times with cold or hot outside temperatures, using less outside air reduces energy usage because the HVAC systems are heating/cooling less air. However, during moderate temperatures, bringing in outside air can reduce the use of the HVAC systems.
- **Lighting:** Detailed information about ambient light readings from the monitors. As with the other detailed pages, the lighting page in the report includes a graph of the monitor readings and recommendations on energy savings opportunities.
- **Outdoor Conditions:** Temperature and dew point during the monitoring period.
- **Building and Monitor Placement Information, Building Description, Building Controls Information, and Building Utility Information:** List of data provided by the participant for the report as a means of validating the accurate report inputs.

³ Although one set of monitors used was not a BuildingAdvice system, the same software was used to generate the assessment report.

⁴ Additional information about Portfolio Manager is available at http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

⁵ Humidity is a component of air quality, not energy efficiency. Also, in Alaska, it is normal to see very low humidity readings.

3.2. Methodology

The following sections describe the methodology used for the commercial component.

3.2.1. Customer Recruitment

For the study, the project team needed 30 commercial customers, including both small and large commercial customers. To recruit the needed commercial customers, representatives from Chugach and MLP selected a pool of prospective commercial participants based on their knowledge of the customers. The following aspects were considered when selecting the customers:

- Building square footage (minimum of 10,000 sq. ft.)
- Industry/Building Use
- Demonstrated level of interest in energy efficiency
- Past responsiveness to the utility
- Utility service area

After identifying a potential pool, the utility representatives contacted a building representative via email, phone, or fax with information about the project. Initially, the utilities contacted potential participants one at a time, as the project was ready for a new participant. However, because this approach exacerbated scheduling challenges, in early April Chugach sent an email (refer to Appendix E for a copy) to the remaining pool of approximately 50 potential participants, telling them about the study and asking them to participate.

After this email was sent, approximately 15 customers contacted Chugach, indicating they were interested in participating in the study. To fill the remaining slots (as well as two other openings when participants opted out after the process began), the utilities identified other potential participants and contacted them directly until they found a total of 30 participants. All participants were confirmed by the end of May.

Note: Although Chugach only planned to include 30 buildings in the project, because of changes over time, the project team completed assessments on 32 buildings.

The final participant list included the following building usage/size:

Table 14: Commercial Participants

Square Footage	Building Usage						Total
	Grocery	Office	School	Retail	Warehouse	Hotel	
10,000-29,999	1	10		1		1	13
30,000-49,999		6					6
50,000-69,999		3	2				5
70,000-89,999		2					2
90,000-199,999		2			2		4
200,000+		2					2

3.2.2. Initial Assessment Meeting

After a commercial customer indicated interest in participating in the study, Chugach scheduled a meeting with the customer. The meeting was attended by the following people:

- Chugach representative
- MLP representative (if the customer was in the MLP service area)
- Control Contractors representative
- Customer representative(s) in the following roles
 - Management representative (e.g., COO)
 - Facility manager
 - Facility maintenance personnel

Note: For some customers, the roles of management representative, facility manager, and facility maintenance personnel were filled by one person; for other customers, these roles were filled by multiple people.

This initial assessment meeting typically lasted between 45 minutes and 2.5 hours, depending on the size of the building, complexity of the systems, age of the systems, and questions from the occupants. Twenty-nine of the assessment meetings were completed by mid June; the last assessment meeting was combined with the monitor deployment because of the building's location.

3.2.2.1. Confirming Study Participation

During this initial meeting at the customer's location, the utility and Control Contractors representatives explained the study and assessment process in greater detail, including the customer's responsibilities:

- Provide building and historical energy usage data
- Assist the project team in identifying locations to place monitors
- Have a representative available when monitors are deployed and picked up from the building (10 monitors in place for 1 week)
- Meet with the project team to review the report and recommendations
- Complete a brief follow-up survey

After providing this introductory information, the commercial customer could decide to not participate in the study⁶.

3.2.2.2. Gathering Background Information

If the customer committed to participating in the study, the project team gathered basic building information that the participant representatives would know without research, such as building square footage. After the preliminary information was gathered, the project team walked through the participant's building with facility representatives to record additional information about the building, such as specifications on HVAC systems.

If all of the needed information was not readily available, the project team requested that the participant research the information. In most cases, the utility representatives assisted in gathering utility usage by pulling the data from the utility's databases.

⁶ Only one customer opted to not participate after this meeting.

3.2.2.3. Identifying Monitor Locations

During the walk-through, the project team also identified the best locations to place the monitors. When identifying these locations, the project team particularly looked for the following:

- Populated areas through which people walk (e.g., reception areas)
- Areas in each of the building's four corners
- Areas about which the facility manager receives the most complaints (e.g., too hot or too cold)

In addition, the project team tried to ensure that the locations were in areas that would be used during the week the monitors were in place (e.g., verify that the person in an office was not going to be on vacation during the deployment week).

3.2.2.4. Scheduling Deployments

The project team also worked with the participant to schedule a time for the monitors to be deployed. Initially, the team allowed participants to select dates that worked best for them. However this approach was very difficult to manage because of the number of schedules to be coordinated; also, such ad-hoc scheduling did not always efficiently utilize the monitors (e.g., there were gaps between deployments). For deployments beginning at the end of April, the project team created a deployment schedule with pre-defined slots, from which the participants could select. Each week included two slots: one from Tuesday afternoon to Tuesday morning and one from Wednesday afternoon to Wednesday morning.

3.2.3. On-site Monitoring

On the scheduled deployment date, the project team brought the monitors to the location at the pre-arranged time (typically 2:00 PM). The team then placed the monitors in the pre-selected areas throughout the building. When a monitor was placed in an area, the team described to occupants the purpose of the monitors and requested that they not unplug or move the monitor. In addition, the team left documentation with each monitor to explain its purpose and request that it not be moved or unplugged.

In spite of these precautions, a few monitors were unplugged, either for short periods of time (e.g., while janitors were vacuuming the space) or for extended periods (e.g., the monitor was unplugged and left unplugged for the remainder of the week). When a monitor was unplugged, it did not record any data for that period; if the no-data period was long enough, the project team excluded results from that monitor in the report.

At the end of the monitoring week, the Control Contractors representative returned to the location and gathered all the monitors. If necessary, he downloaded the data from the previous week and reset the monitors before deploying them at the next location.

All on-site monitoring was completed by the end of July.

3.2.4. Assessment Reports

Before preparing the energy assessment report, the project team ensured all data was available and worked with the participant as needed to gather the data. Once all the data was available, Control Contractors entered the data in the BuildingAdvice software and generated the energy savings assessment.

3.2.4.1. Reviewing Reports

Before giving the report to the participant, the project team reviewed the report for anomalies, investigated any found and made adjustments as needed. For example, in some cases the project team determined that data provided by participants was incomplete or inaccurate (especially for historical usage data). In these cases, the project team worked with the participants to correct the data and reran the reports.

3.2.4.2. Reporting Findings

Once the assessment report was ready, the utility representatives scheduled a review meeting with the participant. This meeting, which typically lasted from 1 to 3 hours, was attended by the project team (i.e., utility representatives and a Control Contractors representative) and participant representatives.

The project team encouraged participants to have someone with decision-making authority—such as the facility manager, CEO, or COO—attend the meeting. For smaller buildings, usually the owner and a facility representative attended. In addition, sometimes participants included external parties, such as the company managing the building control systems, the property manager, or the building's administrative manager.

During the meeting, the project team explained the report and its findings, reviewing and explaining each page with the participants. Although meeting attendees usually understood some aspects of the report (e.g., lighting), other sections—such as control systems—required additional explanation. For each area within the report, the project team also identified recommendations on areas the participants could investigate further.

While discussing the findings, the participants were oftentimes able to identify activities in their buildings that correlated with the data, such as changing out the boilers to reduce gas usage.

3.2.5. Surveys

After the assessment review meeting, the project team gave participants a follow-up survey to assess the usefulness of the report and whether they plan to implement any of the energy efficiency recommendations (refer to Appendix H for a sample of the survey).

The project team posted the survey on SurveyMonkey and initially sent emails to participants shortly after the assessment review meeting. However, because of a low response rate, the project team began also giving participants a hard-copy version of the survey at the end of the assessment review meeting and personally contacting participants to remind them to complete the survey. Although participants were very slow to complete the survey, requiring multiple follow-up contacts by the project team, all participants did complete a survey before the end of the research project.

3.2.6. Customer Education

As alluded to throughout this Methodology section, customer education in the commercial portion of the study was very individualized. Utility and Control Contractors representatives met with each participant at least twice. During these meetings, the energy assessment program was described in detail, including information about elements such as ENERGY STAR, potential energy savings, and factors affecting energy efficiency. In addition, the project team was able to discuss specifics about the participant's building and systems and answer participants' questions.

3.3. Results

The majority of facilities took advantage of the BEM project to assess where they were in energy efficiency and plan future efforts. The few buildings with high ENERGY STAR ratings used the assessment to validate measures they had already taken. The survey responses indicate participants are very responsive to recommendations for low cost, simple measures that could be taken, prior to or short of major changes in the facility.

Those who did well in ENERGY STAR ratings (75-100) were aware that with small changes they can achieve an ENERGY STAR rating. At least two locations plan to pursue changes needed to achieve ENERGY STAR designation.

The assessments met participants' expectations and they were satisfied with the results and recommendations. A strong majority (80%) of the participants plan to pursue one or more of the recommendations. Their decisions about whether to implement recommendations are driven largely by the potential energy savings and cost.

Information deemed most helpful to the participants tended around themes of

- How customers compare with others
- Where the savings potential is
- Where minimal effort will yield significant savings
- Distinctions between gas and electric use

The vast majority (29 of the 30) would recommend the assessment to others. It should be noted, however, that no reference was made to the actual cost of conducting an assessment, and it was free-of-charge to the test participants.

Note: Refer to Appendix F for a summary of key findings from each location; Appendix G includes copies of the full assessment reports, each of which includes findings and recommendations for that location. Refer to Appendix H for results from the survey.

3.3.1. Additional Research

In part to complement the commercial component, Chugach commissioned Ivan Moore Associates to conduct a phone survey of Chugach's largest commercial customers. One hundred twenty-one customers responded to the survey. It is important to note that unlike the Watt Buster research, these participants were not self-selected; they were called at random from lists provided by Chugach. Key results of this survey include the following:

- Taken as a whole, respondents believe their energy consumption has increased over the past three years (by a mean increase of 9.5%). However, consumption has actually declined 3% per year. This disconnect between perception and actual will be an important element in future education efforts.
- Commercial customers (77.9% of respondents) are taking steps to become more energy efficient. The most common steps were installing energy efficient lighting (92.6%), increasing employee awareness (85.3%), and streamlining operations and scheduling (56.8%).
- Of the respondents, 70.5% have done all they plan to do to improve energy efficiency. The 29.5% who do plan to make energy efficiency improvements are most influenced by energy prices and by improvements that would impact their bottom line.

Note: Refer to Appendix H for a copy of the survey and results.

3.4. Conclusions

Based on the results of the BuildingAdvice project and the commercial survey, the following conclusions can be drawn:

- **How decisions are influenced.** While the terms used may vary, commercial customers are clearly driven by financial considerations: return on investment, capital outlay required, and impacts to their bottom line.
- **Low-hanging fruit.** Many of the easiest and least expensive measures are not obvious to owners and property managers. Chugach could help commercial customers make significant improvements by helping identify the low-hanging fruit of simple, low, and no-cost changes. Lighting retrofits are relatively inexpensive and yield significant savings.
- **Interest in energy efficiency.** Many commercial customers are taking steps to become more energy efficient. Yet the phone survey indicates 70% have done all they plan to do. Is this an immovable roadblock—or a reflection of customers' lack of awareness? Chugach suspects it is the latter. An energy assessment, or similar process, would probably motivate customers to make additional energy efficiency improvements.
- **Comparisons with others.** Most commercial customers are aware of ENERGY STAR ratings and are generally interested in how they compare to similar facilities.

3.5. Recommendations for the Future

Based on the information learned through the commercial component of this research project, Chugach recommends the following:

- Develop an information and education program including but not limited to the following components:
 - Real-life examples of specific energy efficiency improvements and money saved
 - Publicize energy efficient role models, i.e., commercial customers who have made significant improvements
 - Examples from the research project as pointers for others
 - Develop and publicize resources available to help commercial customers become more energy efficient
- Work with Enstar to develop a coordinated approach to commercial customers
- Take maximum advantage of Chugach's ENERGY STAR partnership to help commercial customers achieve ENERGY STAR ratings
- Offer historical use profiles to reduce the disconnect between perceived and actual use (if this is already available, it could be more heavily marketed)
- Continue to monitor BEM technology and consider repeating the research project in middle schools of the Anchorage School District.