The American Council for an Energy-Efficient Economy

Emerging Technologies Report

In-Home Energy Use Displays

July, 2007

Summary

Definition	A device, involving a sensor and a monitor, that communicates with a house's electric meter and displays real-time and cumulative energy use to inhabitants				
Basecase	A single-family house with typical electricity usage patterns				
New Measure	The same single-family house with a basic wireless energy use monitor (like the Energy Detective) that is used by residents	Percent Savings by App.	2020 Savings TBtu (Source)	2020 Cost of Saved Energy	Success Rating (1-5)
		5%	170	$0.02 / kWh	3

Background and Description

This report evaluates the energy savings associated with in-home energy use displays, which provide real-time feedback to occupants on whole-house electricity consumption. These devices involve three basic components: a sensor that collects energy use data from the meter or circuit panel, a wall or desk-mounted display, and a means of communication between the two. After collecting demand data from the meter, the devices can display both instantaneous power usage and cumulative energy usage over selected time periods; in some cases, the device can also provide projected energy use and cost estimates and even show other home diagnostic data such as temperature, humidity, and estimated greenhouse gas emissions.

Models currently available on the market measure power use either with a current transducer that clips onto the main wire, an optical device that attaches to the meter and counts meter revolutions, or a sensor/transmitter installed behind the meter. The sensor type strongly affects installation cost and flexibility. The most successful models use a current transducer that is connected to the display by wireless or powerline transmission, allowing for greater mobility and simpler installation. Graphic user interfaces used in the display component vary in sophistication, but some of the most widely used models look like a digital clock with a limited range of navigation options.

In-home energy use displays have demonstrated potential for a variety of state and utility program applications including energy conservation, load shedding, dynamic pricing support, increased customer satisfaction, low-income assistance, and evaluation of low- or zero-energy home projects. Although ACEEE considers these devices an emerging energy-saving technology, savings potential of these devices is far more dependant on user behavior and the persistence of user response than most other technologies we screen.

Data Summary

Basecase: A single-family house with typical electricity usage patterns
New Measure: The same single-family house with a basic wireless model (like the Energy Detective) that is used by residents

Application and Status			
Market Sector(s)	**Application(s)**	**End Use(s)**	**Fuel Type(s)**
Residential	New Construction Retrofit	All Electric	Electricity
Market Segment	**National/Regional**	**Region(s)**	**State(s)**
None	National		
Current Status	**Date of Commercialization**	***Notes***	
Commercialized	2004	Most energy use feedback displays sold in the U.S. today have been introduced within the past 5 years. The Salt River Project prepay program is 15 years old.	
Market Players/Manufacturers	**Life**		
See Table 1	11	Based on the life of a programmable thermostat. Note that effective life is dependant upon user behavior (persistence) rather than the life of the technology.	

Basecase Information			***Notes (Source)***
Efficiency	N/A		
Electric Use	12,263	kWh/yr	Weighted average annual electricity use of U.S. households excluding >4-unit multifamily buildings (EIA 2003)
Summer Peak Demand	—	kW	
Winter Peak Demand	—	kW	
Gas/Fuel Use	0	MMBtu/yr	
New Measure Information			***Notes (Source)***
Efficiency	N/A		
Electric Use	11,037	kWh/yr	
Summer Peak Demand	—	kW	
Winter Peak Demand	—-	kW	
Gas/Fuel Use	0	MMBtu/yr	
Savings Information			***Notes (Source)***
Electric Savings	1226	kWh/yr	
Summer Peak Demand Savings	—	kW	Data unavailable
Winter Peak Demand Savings	—	kW	Data unavailable
Gas/Fuel Savings	0	MMBtu/yr	
Percent Savings	5	%	
Feasible Applications (%)	18	%	Assumes 10% market penetration in 2020 in all residential existing and new construction excluding multi-family buildings above 4 units
Industrial Savings Potential (>25%)	No		
2020 Savings Potential	**16,340**	**GWH**	
2020 Savings Potential (Source)	**170**	**TBtu**	
Cost of Saved Energy	**$0.02**	**$/Kwh**	
Cost Information			***Notes (Source)***
Incremental Cost	$240	2006 $	Mode price plus one hour installation labor
Other Costs / (Savings)	0	$/yr	

Success Factors			
Market Barriers	**Non-Energy Benefits**	**Current Promotional Activity**	**Next Steps**
- Lack of precedent - Variables in response and persistence	- Increased consumer awareness, education and interest	- Isolated utility programs	- Research - Larger utility pilots and incentive programs - Ramp up marketing to individuals
Priority (1-5)	**Likelihood of Success (1-5)**	**Success Rationale**	
3	3	Long-term success highly dependant on success of early pilots	
Data Quality Assessment (A-D)	**Data Explanation**		
A	Majority of data is based on comprehensive review of numerous studies by third parties designed to evaluate energy savings potential.		

Current Status of Measure

About a half-dozen companies sell in-home display devices in the U.S. The device with the widest distribution is produced and distributed directly by the Salt River Project — a public power utility based in Phoenix — for its pre-payment program. The program has over 50,000 customers enrolled, with 10,000 added each year. With traditional tariff structures, large-scale deployment of these units has only occurred in Australia, New Zealand, and Canada. In Australia and New Zealand, over 11,000 in-home displays have been installed as part of a heavily subsidized utility promotion campaign that includes an aggressive marketing strategy. In Canada, 870 Blueline PowerCost Monitors were installed across a number of utility territories as a part of a 2005 pilot project that involved no strategic consumer outreach.

Over the past ten years, advances in microelectronics and computing have allowed for more affordable and sophisticated energy feedback displays, with greater interoperability between the device and personal computers or a utility's advanced metering infrastructure. These advances, coupled with high energy prices and an increased interest in peak load management, have resulted in a growing market for these products. Public encouragement of dynamic pricing structures in the Energy Policy Act of 2005 and by California energy policies have led to greater diversification of feedback products.

Table 1. Energy Feedback Displays Commercially Available in the U.S.

Product Name	Manufacturer	Sensor / Connection Type	Status	Cost w/o installation
Cent-a-Meter	Cenergies	CT / wireless	11,000+ installed in Australia and New Zealand; for sale in U.S	$150
EM-2500	Energy Monitoring Technologies	CT / hardwired	For sale in U.S.	$215
ECM-1220	Brultech	CT / hardwired	For sale in U.S.	$300
PowerCost Monitor	Blueline Innovations	Optical sensor / wireless	870 installed by Canadian utilities; for sale in U.S.	$140
SRP M-Power Meter	Salt River Project	CT / powerline	50,000+ installed in Arizona	Valued at $138, free to customers
The Energy Detective	Energy, Inc.	CT / powerline	For sale in U.S.	$140

Sources: Updated from Stein 2004, 2005; Parker et al. 2006

Savings Potential and Cost-Effectiveness

The results from roughly 20 studies on energy use feedback over the past 35 years indicate energy savings from energy use feedback devices falls somewhere between 4% and 15%. The Salt River Project claims that their prepayment customers have reduced electricity use by 12%. Results may vary significantly depending on the type of marketing, instruction, and/or goal-setting that accompanies the device. Other factors such as the presence of children or previous exposure to government conservation campaigns are also likely to affect savings. A 2004–2005 controlled pilot study by Hydro One in Canada found that, without any energy savings guidance on the part of the utility, participants achieved aggregate savings of 5% in base-load electricity that persisted over the 18-month test period. We take this to be a reasonably reliable and conservative estimate for the purposes of our analysis.

The cost of a home energy display device ranges from $125 to $400 for the device, plus up to three hours of installation by a contractor (Parker et al. 2006). Most products, however, are simple and easy to install, at $125 to $200 purchase price plus no more than $100 (one hour of fully loaded labor) installation. Available research suggests that more technologically sophisticated devices that may come at a higher cost do not necessarily correlate with improved energy savings (Allen and Janda 2006).

Market Barriers

Because the purchase and use of a home energy-use display is strictly voluntary, the success of these devices in the market is predominantly driven by consumer awareness. Widespread adoption by individuals is unlikely without large-scale marketing via government initiatives or utility programs. There are two fundamental barriers to meeting this precondition. First, large-scale utility or government programs may require a clearer demonstration of predictability regarding user response and persistence, which is not available in all regions. Research on marketing strategies or the social dimensions of energy conservation would help support leading-edge programs.

The primary barrier to market adoption, however, is simply a lack of precedent in North America. The Salt River Project's popular prepayment program is one promising model with a strong history of success; however, because pay-as-you-go customers are self-selecting and must be diligent in monitoring their house's energy use to keep the power connected, their energy savings rate is not easily translated to the average ratepayer. Meanwhile, promotion campaigns for programmable thermostats have rarely produce reliable savings, making some utilities wary of programs that try to target behavior modification or "conservation."

Several other minor issues are unresolved regarding the potential impact of energy use monitors. There is little research evaluating the promise of the devices as a reinforcement tool for critical peak pricing or dynamic pricing structures. There is also some evidence, but no conclusive data, suggesting geographic factors play a significant role in user response and energy savings potential.

Next Steps

At $125 to $200 and increasingly simple installation, displays are becoming economical for utilities to include in conservation programs. Costs may rise if a utility program requires products with programmable rates or integration with advanced metering infrastructure.

We recommend utilities interested in harvesting a 5–10% additional energy savings through the use of these devices consider a phased program that would involve a pilot installation to test response and effective marketing strategies. If the pilot is successful, the utility or agency should consider a large-scale incentive program that subsidizes the purchasing cost of the units, accompanied by an appropriate marketing strategy.

The increased use of household equipment that involves electronic programming capability and navigation (cable/satellite television, digital video recorders, personal computers) should create an atmosphere of acceptance for these devices that may not have existed two decades ago. Manufacturers and retailers should be sensitive to new markets arising from this increased public consciousness and interest in saving energy.

Key Assumptions Used in Analysis

The 2020 savings potential estimates assume 10% penetration into individually metered households, both existing and new construction. We use a 5% savings estimate within this segment based on the findings of the Hydro One pilot project. We feel this is the most reliable and reasonably conservative estimate available.

Average Price of Electricity	$0.083/kWh
Percent New Res. Construction in 2020 (EIA 2006)	14.8%
Average Price of Natural Gas	$10.16/MMBtu
Projected 2020 End Use Electricity Consumption (EIA 2006)	0.39 quads
Real Discount Rate	4.53%
Projected 2020 End Use Gas Consumption (EIA 2006)	1.25 quads
Heat Rate	10.42 kBtu/kWh

References

Allen, D. and K. Janda. 2006. "The Effects of Household Characteristics and Energy Use Consciousness on the Effectiveness of Real-Time Energy Use Feedback: A Pilot Study." In *Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings,* 7:1. Washington, D.C.: American Council for an Energy-Efficient Economy.

[EIA] Energy Information Administration. 2003. *2001 Residential Energy Consumption Survey.* Washington D.C.: U.S. Department of Energy.

———. 2006. *The 2006 Annual Energy Outlook.* Washington, D.C.: U.S. Department of Energy.

Parker, D. et al. 2006. "How Much Energy Are We Using? Potential of Residential Energy Demand Feedback Devices." In *Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings,* 1:211. Washington, D.C.: American Council for an Energy-Efficient Economy.

Stein, Lynn F. 2004. "California Information Display Pilot Technology Assessment." Prepared for Southern California Edison. Boulder, Co.: Primen, Inc.

———. 2005. *In-Home Display Units – Tools for Conservation and Demand Response.* Customer Insights Strategic Service Report CI-SR-21-05. Knoxville, Tenn.: EPRI Solutions, Inc.