Energy Star Billing: Innovative Billing Options for the Residential Sector

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Current demand-side management (DSM) programs aim mainly at promoting retrofits of energy-efficient technologies. So far, little attention has been paid to increasing the consumer's ability to evaluate their own energy use relative to others. Do consumers understand their energy consumption? What information do they need to change their energy consuming behavior? The University of Delaware is attempting to answer these and other such questions through research associated with an innovative, voluntary US Environmental Protection Agency (US EPA) initiative known as Energy Star Billing (ESB). EPA and its utility partners are working to stimulate efficiency improvements in existing homes by providing homeowners with an energy consumption comparison. Partner utilities incorporate a billing statement that compares each individual customer's energy consumption with other residential customers in a designated comparison group (e.g., same size house, same block, or neighborhood). It is anticipated that the least-efficient homeowners will be motivated to seek energy improvements to avoid being the ''worst'' homes in their comparison group. The achievements of the most energy-efficient homes will serve as an example of attainable performance levels for other residential users. Also, options for comparisons through time (e.g. this year compared to last year) allow customers to evaluate the consumption impacts of installed efficiency measures. An improved, service-oriented bill may also offer competitive advantages in a deregulated utility environment. The ESB program is a market-driven approach that offers technical and evaluation assistance to electric and gas utilities who wish to participate.

INTRODUCTION

The US Environmental Protection Agency (US EPA) is promoting residential energy efficiency because of its significant potential energy savings and air emissions reduction.[1] The Agency's Energy Star Programs are market-based efforts that work with various organizations to prevent pollution (US EPA 1995). The Energy Star Billing Program, the subject of this paper, aims to stimulate efficiency improvements in existing homes by providing homeowners with relative energy consumption information.

Energy Star Billing is establishing guidelines for comprehensible energy ratings for consumers. The energy ratings can be printed monthly on the utility bill, or mailed less frequently as a separate report (e.g. quarterly or annually). A utility could choose one or several of the rating options for simultaneous implementation, and could use one for the monthly bill and another in a periodic summary report. In either case, the ratings would provide a relative consumption level per house, optionally with control factors such as house size, neighborhood, weather and/or appliance mix.

Recent proposals to restructure the electric power sector challenge the energy efficiency community to re-evaluate the goal of customer efficiency programs, and to identify interventions which will most effectively meet the requirements and needs of customers, regulators and company stockholders (Hadley & Hirst 1995). The Energy Star Billing Program intends to help utilities effect low-cost, long-term market transformation in US households. Evaluation of the program will help the US EPA, utilities and researchers to verify the energy and market transformation impacts of information and energy feedback programs.

This paper describes utility bill enhancements implemented to date, discusses the advantages, costs and benefits of introducing a comparative element on the utility bill, and describes the Energy Star Billing Program in detail. Results

from upcoming applications of this billing program will be available in a year and will be presented in future papers.

ENERGY INFORMATION FEEDBACK: THE FUTURE FOR RESIDENTIAL ENERGY EFFICIENCY?

Harrigan et al. identify residential demand-side management programs as ''hardware-focused'' or ''customer-focused'' (Harrigan et al. 1995, 9). To date, most residential demand-side management programs have been hardware-focused. The utility decides which actions are appropriate for their customers to take, and then provides incentives for customers to install targeted technologies. Customer-focused efficiency programs have not been widely implemented. These programs aim to enhance the decision-making capability of energy consumers so that they can take the appropriate action for their own household. Customer-focused programs do not directly change the house or appliances. They change the customer's decision-making, which may then lead to hardware investments and behavior changes. Although customer-focused approaches have not been commonly implemented, existing experience with customer-focused programs indicate that they bring value in increasing energy savings, augmenting the customer's perception of the service provided, and transforming the market (Harrigan et al. 1995).

Consumer energy analysis

Research to better understand the complex consumer energy analysis environment has supported the development and implementation of the Energy Star Billing Program. According to recent research, residential customers are already attempting to gather data and analyze their energy use. One study interviewed consumers about how they read and comprehend utility bills. It found that 41 percent of interviewees examined non-financial information on the utility bill, 70 percent discussed their bills with other people, and 39 percent computed their total annual costs for electricity. The same study concluded that residential consumers' analytical capabilities are constrained by the form in which they receive energy information, sometimes leading to ineffective conservation actions (Kempton & Layne 1994). Also, if the information on the utility bill does not capture the consumer's attention, or make sense to him or her, the data conveyed in the utility bill will not have an impact (Constanzo et al. 1986). If energy feedback information is clear and accessible to consumers, they are likely to be motivated to improve comfort, and reduce cost (Harrigan et al. 1995).

OVERVIEW OF UTILITY BILLING PROGRAMS

The utility bill is an appropriate tool through which to provide customers with feedback on their energy consumption. Customers already use the information provided by utilities to analyze their energy use. Utilities generally enjoy a good reputation among their customers on matters of service and technical advice. This perceived quality and trust on technical matters appears to translate well into energy information services, thereby increasing the value of utility-provided information (Kempton 1995). Critical, however, to the success of customer-focused efficiency programs is the design of the information provided to consumers. It is easy to fall into the trap of creating bill information that makes sense to an analyst, but not to the average utility customer.

Comparative consumption information

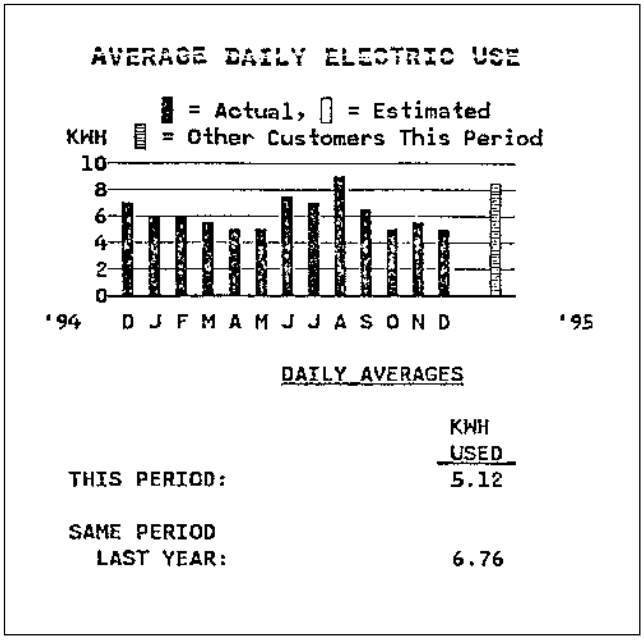
Energy-efficiency behaviors can be encouraged by clarifying the connection between action and consequence through feedback. Several features are important to include in a feedback program in order to fortify the link between a consumer's action and the consequence of the action. Energy feedback should be given in a prompt time span, so that the consumer can recognize the relationship between behavior or response, and outcome. It should be presented in specific, understandable, and significant units, and the feedback should relate to a comprehensible standard or comparison group (Midden et al. 1983).

Bill enhancements can provide two types of comparisons. Self-comparisons contrast past and present data for an individual customer. Other-customer comparisons show the customer's consumption compared with an average or range for groups of other customers, such as those with similar houses, those who live nearby, or simply all other residential customers in a utility's service territory.

Recently, some utilities have begun to include comparative data on their bills. These bills use both self-comparison and other-customer comparisons to convey information about consumption. Some utilities print a table that compares a customer's consumption this month with the same month of the previous year. Others print a bar graph of a household's monthly consumption over the past year and then compare it with the current month's average consumption, in kilowatt hours (kWh), for all residential customers, as shown in Figure 1. Both of these methods allow the consumer to note anomalous bills and perhaps account for them through weather patterns.

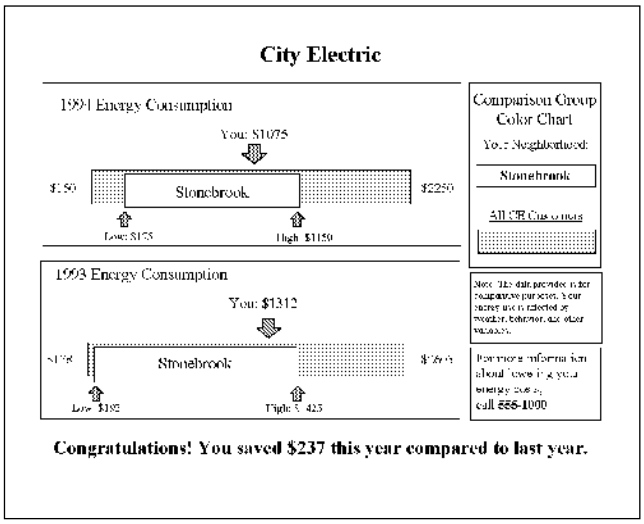
Based on limited research conducted to date, we believe that new graphical displays developed for the Energy Star Billing

Figure 1. *Utility Bill Comparing Average Monthly Consumption for all Residential Customers*



Program may provide customers with more meaningful, comprehensible feedback on consumption than those now in use. For example, an Energy Star bill might represent electricity consumption for a comparison group, a neighborhood, for example, as a range of dollar values along a bar. The household's consumption is indicated by printing a pointer on the bar, like the comparative charts now required on many new US appliances, as shown in Figure 2. Since customers tend to compare their bills with that of their neighbors', this design provides them with a recognizable

Figure 2. *Sample Energy Star Billing Annual Report, Neighborhood Comparison Group*



comparison group with which to measure their consumption. Energy Star bills can also include messages that reinforce customer behavior based on the information collected by the utility, as shown in Figure 2.

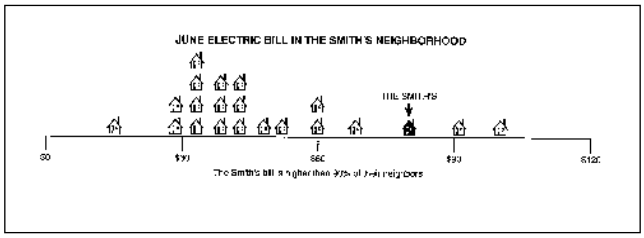
Or, the utility might print residential sector consumption distribution with households clustered along an axis depicting consumption from zero to the highest consumption figure in the comparison group. The household receiving the bill is highlighted, so that the customer can immediately identify where they appear in the range and in the utility's distribution, as shown in Figure 3. This display would allow customers to determine whether they are a high, average or low consumer both in terms of consumption and utility customer distribution. For example, the customer's bill in Figure 3 might appear close to average on a simple bar, but is clearly high when shown on the distribution curve. In both cases, the customer is likely to see the effect of hardware installations by noting how they compare to their neighbors over time. This rating may serve as a reminder of success or potential for improvement.

Energy information feedback programs: The track record

Well-designed billing programs serve utilities by stimulating energy conservation through customer-initiated improvements, and by improving customer service. Benefits to customers may include more comprehensible energy information, potential to reduce consumption and, therefore, electricity costs, and increased value for services already rendered. Despite the small number of controlled experiments, empirical evidence about the impact of feedback programs on consumer behavior reinforce the potential value of customer-focused billing programs.

Motivating energy efficiency behavior. Feedback on energy consumption provided on the utility bill seems to stimulate energy conservation. This is because it allows consumers to examine their relative consumption and explore the impacts of a behavior or hardware change by implementing the measure and observing its impact on their consumption over time. The actions motivated by this infor-

Figure 3. *Pilot Energy Star Billing Display Currently Being Tested, Utility Distribution Comparison Group*



mation may vary depending on the type of feedback provided to the consumer. Information can be provided on an annual, quarterly or monthly basis. Annual reports may educate the consumer on their energy consumption relative to other household expenditures; monthly information provides a more timely comparison, and highlights anomalous consumption patterns.

A three year analysis of the link between billing information and household energy consumption in Norway and Finland tested the hypothesis that a more informative energy bill will generate household energy conservation measures. Researchers increased the frequency of actual meter reading and provided more extensive feedback on the bills, which cost an equivalent of US$12.84 annually and resulted in 5 percent and 10 percent average energy reductions. The cost of conserved energy equaled 1 cent/kWh (Wilhite et al. 1993, ii). The study concludes that increased energy feedback leads to changes in energy-use behavior which results in a decrease in energy consumption (Wilhite et al. 1993).

Experience with annual reports at National Fuel Gas, Madison Gas & Electric, and a study in New Jersey show how utility billing information can motivate consumers to take action (Harrigan et al. 1995). National Fuel Gas attempted to promote a home audit program through newspaper advertisements, bill stuffers, and radio ads. Despite these efforts, National Fuel Gas could not meet target numbers of audits. In contrast, the company mailed out an annual energy report to each customer with relative energy consumption information based on weather-correction and displays of self and other-customer comparisons. The mailing included a post card describing the audit program. One mailing generated a year's backlog of audit requests (Harrigan et al. 1995, 50).

Madison Gas & Electric (MG&E) provided a self-comparison annual report in which energy use was summed for the prior three years and compared with weather data. This pilot program resulted in audit requests from 15 percent of residential customers (Shea & Griedl 1989). This information indicates that comparative information can generate support and interest in related efficiency efforts. More anecdotally, some customers who received an annual weather-corrected report in a New Jersey pilot program (Kempton & Layne 1988; 1994) volunteered that if they could measure the impact of prior conservation efforts, they would be motivated to implement further measures. Although none of the three programs have been conclusively measured or quantified, the available data strongly suggest that properly-designed feedback can stimulate conservation.

Other benefits to utilities. Feedback programs can also serve to improve consumers' perception of the services provided by the utility. There is some evidence that customer service is an important benefit of consumer feedback programs. Program managers often report strong, positive customer reactions (National Fuel Gas as reported by Harrigan et al. 1995). Customer reactions to the Madison Gas and Electric annual report found that of the 50 percent of customers who responded to the survey, 85 percent were interested in continuing to receive the information, 8 percent were not. In focus groups following the pilot program, MG&E customers said that they would be willing to pay a dollar or two for the yearly report. The annual report that was pilot-tested in New Jersey found that customers used the annual weather-adjusted consumption figure to evaluate major retrofits (Kempton & Layne 1994; Layne et al. 1988). The monthly figures were used to interpret the energy impacts of household events. On average, customers said they would be willing to pay $1.59 for this type of information (Kempton and Layne 1994, 865). Customers in a more recent survey indicated they would be willing to pay $0.54 per month for comparative billing information provided on their utility bill (Egan et al. 1996).

In addition to the benefits cited above, partner utilities may gain experience in conveying useful information in an increasingly complex utility environment. Utilities looking toward the future may see paper-based systems as a way to gain early experience in how customers use energy information services, providing staff expertise and market experience to prepare for the next generation of energy information services media and technology.

Costs to utilities. Costs of ESB implementation include system start-up costs, including reprogramming, ongoing production costs, and customer service costs. Changes to monthly billing systems are somewhat idiosyncratic to the size of the utility and the type of data processing system. Utilities will have to generate data on different comparison groups, or determine house size and appliance mix for comparison groups. This service can be conducted in-house, or it may be contracted out to companies that specialize in gathering this type of information. Consultants specializing in providing information on house sizes (using square footage) charge 10–60 cents per record for gathering this data and providing it in machine-readable form.

The City of Azusa Power and Light data processing department estimated five programmer person-days to implement the Energy Star Billing program, including data record changes, and achieved it. It took Traer Municipal Utilities a total of 8 person days to set up the program, which included data gathering, introductory mailings, trial runs, set-up and staff training. Traer sent its first Energy Star bills in April, 1996. A data processing subcontractor for Midwestern municipal utilities estimated $11,000 for complete implementation. If bill changes require regulatory approval, costs may be considerably higher. An Eastern investor-owned utility with 300,000 customers estimated a cost of $100,000

for changes to bills if regulatory proceedings were required. If billing changes do not increase the number of pages, ongoing production costs are near zero (only ink cost). If a second page is required, costs would be approximately 1 cent/customer/month (See Table 1) (Harrigan et al. 1995).

Annual reports have slightly different cost estimates associated with their analysis, compilation and delivery. The annual report that was pilot-tested in New Jersey was estimated to have an ongoing production cost of $0.35 per customer, assuming distribution to the whole service territory rather than to selected customers (Harrigan et al. 1995, 24). If an annual report were completely outsourced, one contractor estimates the implementation cost for an annual report to 20,000 residential customers would be $30,000 to set up and $0.50 per customer to deliver on an annual basis.

Ongoing costs also include resources to respond to customer service calls, since any new billing element is likely to generate interest. Once a utility has implemented the program on an ongoing basis, it is not yet clear whether ESB would increase calls (through questions about comparisons) or reduce them (e.g. fewer high-bill complaints because the customer can see others are high this month also). ESB evaluation will answer these questions as the program proceeds.

Expected costs and benefits to consumers. Well-designed consumption comparisons can generate household energy savings. Evidence from small experiments and empirical tests indicates that consumption information results in a more aware and informed consumer (Wilhite et al. 1993). Some home buyers now request utility bills when comparing homes for purchase. ESB adds a comparative element with information that buyers want in this context. We therefore anticipate that the Energy Star rating would stimulate efficiency improvements by buyers and/or sellers in comparatively inefficient homes.

However, utility bill enhancements will add to the amount of information consumers are given to read. Poor implementation of the program could potentially lead to more complicated bills, frustrated customers, and increased customer service calls. The design of energy information enhancements is critical to successfully communicating with consumers. Recent research indicates that there are tradeoffs between customer comprehension of graphics, and the accuracy with which the display presents comparative consumption data. For example, bar graphs, like the ones showing energy consumption on appliance labels, are generally assumed to be understood by a larger share of readers than a bell curve. However, irregular distributions can result in highly inaccurate bar graph representations of the underlying data. Further research is underway to explore this issue.

STRUCTURE OF THE EPA ENERGY STAR BILLING PROGRAM

EPA and the University of Delaware are working with interested utilities to enhance their billing format with customer

Table 1. *Illustrative Cost and Savings Estimates from Comparative Feedback Methods*

Feedback Method	Capital Cost	Yearly Cost	Yearly Energy Savings	Reference
Comparative bill enhancements (a)	$0.10 to $0.60*	$0 to $0.05	n.a.	Harrigan et al.
More frequent bills and mailed info (b)	$0	$12.84	Helsinki, 5% Oslo, 10%	Wilhite & Ling
Annual weather-adjusted report (c)	$0.20 to $1.50	$0.35 to $0.50	n.a.	Layne et al.; NFG verbal, personal communication

Source: Harrigan et al. 1995, 29.
*Uncertain estimates, considered ± 50% or more; see text.
(a) Additional customer service benefit of $0.54 per customer per month.
(b) Calculated from the Norway experiment. In Finland, about one-half the savings were achieved.
(c) Additional customer service benefit of $1.59 per customer per year.

feedback information that motivates homeowners to pursue cost-effective energy-efficiency measures. The University of Delaware's Center for Energy and Environmental Policy (CEEP), through a cooperative agreement with the US EPA, is promoting the use of utility bill-based energy use feedback systems. CEEP is investigating different billing options, assisting in system implementation, providing outreach to utilities interested in innovative billing systems, and designing evaluation procedures to monitor results of utility efforts.

Program implementation

The US EPA has set up a simple procedure for launching the Energy Star Billing Program and signing partner utilities. Utilities and EPA sign a memorandum of understanding that defines the responsibilities of each organization. The utility then implements the billing option it prefers. Utilities are encouraged to design the program so that they can test the program's energy consumption and customer service impact. EPA offers implementation assistance by evaluating billing options and providing technical recommendations. In addition, EPA provides public recognition for the utility's commitment to protecting the environment and reducing customers' utility bills. Utilities submit regular reports to EPA to track the utility's progress in achieving program goals. The success of the Energy Star Billing Program may motivate utilities to explore partnerships in other Energy Star Programs, such as Energy Star Homes for energy-efficient new homes, and Energy Star Programs for energy products such as furnaces, air conditioners, heat pumps, and thermostats.

At the launch of the program, the US EPA collaborated with the American Public Power Association (APPA) to make contact with APPA's municipal utility membership. As a result of this early effort, EPA signed memoranda of understanding with two municipal utilities, the cities of Azusa, California and Traer, Iowa. Traer began mailing Energy Star bills on March 30, 1996, and Azusa is expected to begin sending Energy Star bills by mid-1996. The University of Delaware is conducting parallel outreach activities on advanced billing systems to both investor-owned and municipal utilities.

Energy Star Billing implementation issues

Energy Star Partner utilities must decide how the program can best fit their needs. Should the information be included on the bill or sent separately? Does the utility need to develop new software to implement the program? What is the best time interval for sending comparative information? Which display options will work best for utility customers? How can utilities bundle this new service with other customer services? What additional billing enhancements might utilities include in the future, e.g. detailed disaggregated information? EPA has worked with the University of Delaware to address these issues.

We have already identified some issues that utilities must contend with in order to accurately represent comparative information to their customers. For example, a utility's customer base distribution, measured in consumption, can complicate graphical displays. Bell curves or scatterplots best display the range and distribution of utility customers' consumption, since the majority of customers tend to fall around the median of electricity consumption. Most utility distributions are positively-skewed (the mean is above the median), that is, the bulk of customers are clustered on the low-consumption end of the range, with high consumers as outliers (see Figure 3). The challenge to researchers and utilities is to accurately convey consumption data to the average consumer in a comprehensible manner. The University of Delaware plans to conduct semi-structured interviews with utility customers, and to survey a random sample of consumers to determine how they interpret various graphical displays. The survey is expected to result in more definitive information on readability and customer preferences for various display options (Egan et al. 1996).

Program evaluation

Critical to the success of the Energy Star Billing Program is accurate evaluation of the Program's impact. When partner utilities sign memoranda of understanding, they are encouraged to submit brief quarterly reports on the status of program implementation. They are also provided with a guideline for evaluating the program's impact. The utility reports the energy impacts of the program, as well as the customer, employee and corporate response. Complementary research on utility customer feedback systems by the University of Delaware will help to confirm the statistical accuracy of the energy impact assessment of these type of billing programs. The EPA and the University encourage utilities to use experimental program design with control groups and pre- and post-test evaluations.

CONCLUSION

The EPA's Energy Star Billing program takes an innovative approach to improving the energy-efficiency of the US residential sector. The program is consistent with recent energy policy trends that create incentives for industry and consumers to reduce their long term energy and environmental impact through voluntary agreements. It is different from most traditional energy-efficiency programs in that it affects the customer, not the house or appliances. It is expected to achieve small savings per house, but is inexpensive and universally applicable. Thus we expect the cost of conserved energy to be low. By improving the information flow

between utilities and their consumers we expect that the program will deliver cost-effective, lasting efficiency improvements. The program provides a strategic opportunity for utilities to prepare for an uncertain regulatory future by improving their customer-utility relationship. The program targets a long-standing, and long-overlooked opportunity to effect change in households; by improving the flow of information and motivating consumers to take action. The long-term programmatic goal is that consumers will have access to comparative information. When they can read household consumption information as they do miles-per-gallon automobile ratings, they will act to become more energy-efficient and thus reduce pollution. Moreover, utilities can be positioned to develop complementary low-cost financing programs in lieu of rebates in order to meet the consumer demand created for energy-efficient equipment and services.

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ENDNOTES

1. U.S. energy consumption in the residential sector costs consumers more than $100 billion annually (US Environmental Protection Agency 1995). Residential sector energy consumption is projected to increase by 20 percent over the next two decades, causing an anticipated 7 percent increase in the average household expenditure for energy (Energy Information Agency 1996). Energy use in US households already contributes to air pollution emissions: 20 percent of all US carbon dioxide emissions; 26 percent of all US sulfur dioxide emissions; and 15 percent of all US emissions of nitrogen oxides (US Environmental Protection Agency 1995). As consumption in this sector continues to grow, so will associated emissions of pollutants.

REFERENCES

Costanzo, M., D. Archer, E. Aronson, and T. Pettigrew. 1986. ‘‘Energy Conservation Behavior: The Difficult Path from Information to Action.’’ *American Psychologist* 41 (5): 521–528.

Egan, C., C. Payne, and W. Kempton. 1996 (forthcoming). ‘‘Graphical Information Displays: Problems of Accuracy versus Accessibility.’’ ACEEE 1996 Summer Study on Energy Efficiency in Buildings.

Energy Information Administration (EIA). 1996. *Annual Energy Outlook 1996.* Washington, DC: Energy Information Administration.

Hadley, S. and E. Hirst. 1995. ‘‘Utility Demand Side Management Programs, 1989 to 1998.’’ ORNL CON 405. Oak Ridge, Tenn.: Oak Ridge National Laboratory.

Harrigan, M., W. Kempton, and V. Ramakrishna. 1995. *Empowering Customer Energy Choices: A Review of Personal Interaction and Feedback in Energy Efficiency Programs* Washington, DC: The Alliance to Save Energy.

Kempton, W. 1995. ‘‘Improving Residential Customer Service through Better Utility Bills.’’ *E Source Strategic Memo* Boulder, Col.: E Source.

Kempton, W. and L. Layne. 1994. ‘‘The Consumer’s energy analysis environment.’’ *Energy Policy* 22 (10): 857–66.

Layne, L., W. Kempton, A. Behrens, R. Diamond, M. Fels, and C. Reynolds. 1988. *Design Criteria for a Consumer Energy Report: A Pilot Field Study*, PU/CEES Report 220, Princeton, N. J.: Center for Energy and Environmental Studies, Princeton University.

Midden, C., J. Meter, M. Weenig, and H. Zieverink. 1983. ‘‘Using Feedback, Reinforcement and Information to Reduce Energy Consumption in Households: A Field-Experiment.’’ *Journal of Economic Psychology* 3 (1983) : 65–86.

Shea, L., and D. Griedl. 1989. *Residential Energy Use Comparison Survey Report of Survey Results.* Madison: Madison Gas and Electric Company.

United States Environmental Protection Agency (US EPA). 1995. ‘‘Energy Star Billing Program Description.’’ Program Information, Washington, D.C.: U.S. Environmental Protection Agency.

Wilhite, H. and R. Ling. 1992. ‘‘The Effects of Better Billing Feedback on Electrical Consumption: A Preliminary Report.’’ In Proceedings of ACEEE 1992 Summer Study on Energy Efficiency in Buildings. 10:173–75.

Wilhite, H., R. Ling, A. Uutela, U. Anttila, and A. Arvola. 1993:627. *A Nordic Test of the Energy Saving Potential of New Residential Billing Techniques*. Copenhagen: The Nordic Council of Ministers.