Information and Telecommunication Technologies: The Next Generation of Residential DSM and Beyond

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Many electric utilities are conducting pilot programs that offer a broad array of energy information and other services to residential customers utilizing advanced information and telecommunications technologies. We summarize current market trends based on a survey of 21 utility projects, which includes discussion of the types of services offered and the characteristics and costs of several competing communications systems (e.g., wireless radio, hybrid fiber-coax cable, and telephone). Projects that utilize wireless radio communications systems are the farthest along in terms of large-scale system deployment but typically offer only energy-related services. Cable-based projects offer a broader array of energy and non-energy services, but projects are still in the pilot or proof-of-concept stage. Currently, installed costs per household are substantially lower for wireless radio projects than cable-based projects, although cable-based projects offer increased functionality and upside revenue potential from non-energy services. We also report results from a focus group and a series of customer interviews that explored customers' perceptions of and interest in a set of fourteen proposed services. Most respondents indicated an interest in specific energy information services (e.g., appliance energy consumption breakdown, neighborhood comparison of energy use, historic monthly consumption). However most wanted the services only if they were free or were only willing to pay a nominal amount; thus bundling of these services as part of a comprehensive package will be needed. Customer-controlled load management and time-of-use pricing were the two energy-related services viewed most favorably by customer respondents.

INTRODUCTION

The combination of increasing competitive pressures and the specter of industry restructuring, rapid innovation in information and communication technologies, and increasing utility involvement on the customer side of the meter over the last decade have spurred many electric utilities to offer residential customers a broad array of energy information and non-energy services in experimental program offerings (EPRI 1994). In this paper, we summarize results from a research project (Goldman et al. 1996) that reviewed these pilot programs and included an exploratory market research effort involving focus group and individual customer interviews. The overall goals of the project were to provide an independent assessment of the benefits, costs, and risks of providing energy information services through various communications delivery systems (e.g., hybrid fiber-coax cable, wireless radio frequency, telephone), to examine the impact of advanced information and communications technologies on utility delivery of customer energy services, and to assess customers' perceptions of and interest in various proposed EIS.

Utilities have relied on communications technologies to support load management programs since the 1970s (e.g., powerline carrier and radio frequency systems to remotely control on-off duty cycles of home appliances). However, communications were typically one-way, from the utility to the customer, and required relatively little telecommunications system capability. In many cases, the pilot programs discussed in this study represent a significant departure from the way in which utilities have traditionally offered load management and/or energy information services to residential customers. For example, utilities have often regarded load management and innovative rates as mutually exclusive in their program designs, were wary of customer override options that jeopardized program effectiveness, and have been constrained in their communications technology and metering choices either by demand-side management (DSM) rules that required stand-alone cost-effectiveness tests or industry design and implementation practices that isolated DSM from the mainstream utility business (Hanser et al. 1993). By contrast, in some of these pilots, utilities are bundling load management, pricing, and energy information service options together and are focusing on customer-controlled load management rather than direct load control. Moreover, in designing services and applications and/or in selecting among information and communications systems, some utilities are quite consciously pursuing multiple strategic objectives (e.g., reduce costs and improve operational efficiency, retain customers through enhanced billing and metering services or reduced customer bills, and generate additional revenues from non-energy services) which they

believe will position them to succeed in the emerging competitive environment. We believe that these pilot projects foreshadow the future direction of residential customer energy services and certain types of utility DSM programs (i.e., load management).

DESCRIPTION OF UTILITY-SPONSORED TELECOMMUNICATIONS PROJECTS

We identified about 40 projects initially based on a literature review of the trade press, conference proceedings, and recent publications (Chartwell 1995; Andersen Consulting 1995) and interviews with 11 telecommunications equipment and software vendors. Projects were eliminated either because they were outside of the study's scope or because utility representatives were unwilling to provide the minimum information requested in our survey.[1] We conducted telephone interviews with utility staff involved in 21 projects between August-October 1995.[2] With two exceptions (Glasgow Electric Board and Wright-Hennepin Cooperative), utilities in our sample are investor-owned and cumulatively account for about 15% of U.S. residential electricity sales. A number of these utilities (e.g., Boston Edison, Pacific Gas & Electric, Baltimore Gas & Electric, and Public Service Electric & Gas) are currently implementing relatively large residential DSM programs. However, previous experience with large-scale residential DSM programs does not appear to be a decisive factor in explaining utility interest in these types of DSM-telecommunications projects.

Table 1 provides background information on each project including the primary communications mode (e.g., hybrid fiber-coax cable, telephone, fixed or mobile wireless radio frequency), the key strategic partners of the electric utility, the project's status and stage of development (e.g., proof-of-concept, pilot, market roll-out), and the number of participating households.

Hybrid Fiber-Coax Cable Network Projects

Eight projects utilize hybrid fiber-coax cable networks to establish the communication link between the electric utility and customers; projects are typically in the pilot or proof-of-concept stage and are limited in scope to a few hundred customers. Several projects that utilize First Pacific Network (FPN) products have substantial field experience. In 1989, Glasgow Electric Board was a beta test site for FPN's first generation product (FPN 1000), which features non-energy services (cable TV to over 3,000 subscribers and telephone and LAN services to several hundred customers). Currently, Glasgow Electric Board is involved in a pilot project that focuses on the customer's willingness to heat water off-peak in response to a favorable tariff offered by Tennessee Valley Authority (2.7 ¢/kWh after midnight for water heating). As of December 1995, Central & South West's Customer Choice and Control has completed installations in over 600 homes in Laredo, Texas. This project focuses on energy management, testing customer's interest in and ability to shift load, given their control over scheduling and usage of major appliances. Participants can control use of their air conditioner, water heater, and clothes dryer in response to pre-specified time-of-use rates that range between 5.5. and 50 ¢/kWh.

Compared to its initial pronouncements, Entergy has substantially downsized its highly-publicized Customer-Controlled Load Management pilot to about 40-50 homes in the Chenal Valley of Arkansas. Entergy is offering a broad set of energy and non-energy services including customer-controlled load management of up to four major appliances (e.g., HVAC, hot water, and two additional appliances), automated meter reading, 22 cable TV stations, and long-distance telephone service. Entergy had originally cooperated with FPN, but now plans to continue the program testing a new time-of-use tariff through January 1997, but does not expect a roll-out after the pilot. Southern Development Investment Group (SDIG), an unregulated subsidiary of the Southern Company, is testing an extensive set of energy and non-energy services (e.g., home security, cable TV, video on demand) in a new, all-electric apartment complex in Georgia Power's service territory. Dominion, the developer of the complex, has aggregated the load under a master metering contract with Georgia Power.

Several other cable-based projects are being developed jointly by electric utilities, software companies, and telephone or cable TV service providers. Examples include the Energy Information Services trial in which TCI, Microsoft, and Pacific Gas & Electric are taking leading roles. In New Jersey, Lucent Technologies and Public Service Electric & Gas completed a ten-home proof-of concept in 1995 and are currently involved in a 1,000-customer technical trial of their Integrated Broadband Utility Solution project.

Among the eight projects, there is substantial diversity in the types of customers and residential market segments targeted by utilities. For example, the larger pilots (Public Service Electric & Gas and Central & South West) are consciously seeking a broad demographic mix among residential customers. Several pilots target wealthy owners of single-family houses (e.g., Entergy, Hydro Quebec) or upscale tenants in multi-family complexes (Southern Company) because there may be greater interest in and ability to pay for non-energy services (e.g., home security, video on demand). Customers that live in all-electric homes are often targeted, especially residences with electric heating and air-condition-

Table 1. *Overview of Utility-Customer Telecommunications Projects*

Communications System	Utility	Key Partners	Project Name	Status	Number of Households
Cable	Central & South West	FPN	Customer Choice & Control	Pilot	600
	Entergy	FPN formerly	Customer-Controlled Load Management	Pilot	50
	Glasgow Electric Board	CableBus	TVA Water Heater Project	Pilot	100
	Hydro Quebec	Domosys	Universal Bidirectional Integration	Pilot (P)	440
	Pacific Gas & Electric	TCI, Microsoft	Energy Information Services	Pilot	100
	Public Service Electric & Gas	Lucent Technologies	Integrated Broadband Utility Solution	Pilot	1,000
	Southern Dev. Inv. Group	FPN	Dominion Project	Pilot	303
	Virginia Power	Cox, Nortel	Cable-Based Energy Management System	Pilot	<48
Telephone	American Electric Power	ICS	TranstexT	Pilot (C)	460
	Gulf Power	ICS	Advanced Energy Management System	Pilot	240
	Wisconsin Energy	Ameritech	Energy Oasys	Concept	15
	Wright-Hennepin Cooperative	ITI	Meter Minder	Roll-out	5,000
Fixed Wireless	Baltimore Gas & Electric	IRIS	IRIS Fixed Network	Pilot	100
Radio	Boston Edison	Metricom	UtiliNet Automatic On/Off	Pilot (C)	15,000
	Kansas City Power & Light	CellNet	CellNet Pilot	Pilot	5,000
	PacifiCorp	Metricom	UtiliNet	Pilot	100
	Pacific Gas & Electric	CellNet	CellNet	Pilot (C)	1,700
	TECO Energy Mgmt Services	IBM formerly	TEMS	Pilot	150
Mobile Wireless	Baltimore Gas & Electric	Itron	Itron AMR	Roll-out	<500,000
Radio	Boston Edison	Itron	Itron AMR	Roll-out	40,000
	Public Service of Colorado	Itron	Itron AMR	Roll-out	300,000

Note: C = Completed, P = Planned under Status

ing, because there may be greater opportunities either to shift or reduce electricity demand. In some cases, the utility's choice of location for its pilot is heavily influenced by its desire to make use of an existing hybrid fiber/coax cable network (e.g., Virginia Power).

Telephone-Based Projects

Projects sponsored by four utilities employ telephone communications between utility and home and powerline carrier within the home. The most novel is the Energy Oasys project, co-developed by Wisconsin Energy Corp. and Ameritech, which combines wireless paging to the customer with telephone from the customer. A large suite of energy and non-energy services is envisioned after the proof-of-concept testing is completed. Like the FPN products, Energy Oasys participants use a plug-in device to receive energy information and control appliances in response to time-of-use rates.

American Electric Power (AEP) and Gulf Power (a subsidiary of Southern Company) are using TranstexT products in their pilots. In fact, both holding companies are investors in Integrated Communications Systems (ICS), developer of the TranstexT product line. An interesting aspect of the AEP project is their ability to monitor the performance of 460 participating residences in three distinct geographic areas (and operating subsidiaries) from a single computer in the holding company's headquarters in Columbus, Ohio. AEP plans to roll-out the project to 25,000 homes across six states by the end of 1998. Gulf Power's project, called Advanced Energy Management System targeted large electricity-intensive single-family homes in Gulf Breeze, Florida and was

completed in 1994. Gulf Power equipped 240 homes with a smart thermostat and meter for time-of-use rates, and a control group of 200 homes with meters only. Gulf Power is not convinced that telephone is the appropriate technology to communicate TOU prices and plans to test fixed wireless radios to broadcast price information.

Wright Hennepin Cooperative Electric Association offers a telephone-based home security system, known as Meter Minder, with automated meter reading and power outage reporting, discounted cellular phones and long-distance telephone service, and an appliance warranty program. The utility has achieved relatively high market penetration as 3,000 of its 29,000 members have installed the Meter Minder; customers pay a $17.50 monthly fee for the home security add-on.

Wireless Radio Network Projects

Projects sponsored by seven utilities involve wireless radio communications in a **fixed** network. These projects typically involve the use of poletop collectors or repeaters that pass signals from transmitters located in residential electric meters to the utility's meter reading and billing operations. A number of vendors have developed products using this technology including CellNet, Metricom, IBM, and IRIS. With one exception (TECO Energy), these projects offer only energy-related services.

Most projects are still in the pilot stages, although several utilities have signed contracts for system-wide roll-out. For example, Kansas City Power & Light and Union Electric have signed long-term contracts with CellNet, who will deploy an extensive wireless radio network in each utility's service territory that will ultimately provide over one million urban customers with various service options. CellNet basically offers a turnkey approach: utilities sign a long-term performance contract with the company for installation, operation, and maintenance of the system, paying a fee of about $1.00 per meter per month for the basic service of a daily meter read. Utilities can use the data provided to offer customers innovative rate programs and other enhanced services (e.g., tamper detection, outage alarm, load profile). PacifiCorp and Boston Edison are deploying fixed network radio systems developed by Metricom; in these projects, the utility owns and operates the system outright. Baltimore Gas & Electric and TECO are testing load control options under time-of-use pricing while PacifiCorp is testing time-of-use pricing by providing customers with energy information through an in-home display unit.

We surveyed three utilities (Baltimore Gas & Electric, Boston Edison, Public Service of Colorado) that are currently involved in large scale system roll-outs of **mobile** wireless radio projects to several hundred thousand customers. Automated meter reading is typically performed either by computer-equipped vans that drive by slowly to collect meter readings. These communications devices permit ''virtual'' two-way communications in that the device accompanying the meter reader remotely ''interrogates'' the transmitter attached to the electric meter, triggering its response to be captured and stored by the meter reader's device and uploaded to the utility's billing computers at night.

KEY FINDINGS

We organize our discussion of key findings under the following topics: customer energy services offered by utilities, market trends, and technological risks and market uncertainties.

Customer Energy Services

- Utilities involved in hybrid fiber-coax cable projects offer a broad array of energy and non- energy services. Non-energy services include home security, telephone service, medical alert, cable television, video-on-demand, and internet access. However, based on our survey, we found that, in most cases, only a more limited array of services is currently being offered (see Table 2).

- In contrast, wireless radio projects currently offer only energy information services. Mobile radio projects focus on energy-related services that provide operational savings to the utility (e.g., AMR, remote connect/disconnect, outage detection), while fixed network radio projects have also utilized in-home display devices to facilitate load control, TOU pricing, and energy information services.

- Every utility in our sample offered automated meter reading (see Table 2). The benefits of AMR include improved billing reliability and customer service (e.g., fewer errors than manual reads) and reduced losses from tampering and theft. On a stand-alone basis, AMR may be cost-justified only in certain niche markets (e.g., dangerous or difficult-to-read meters). However, the information collected by an AMR service (e.g., hourly data stored for 40 days of usage) provides increased functionality to the utility which can be used to create new energy information services and products.

Market Trends

In Table 3, we group our sample of projects into six general categories that are defined by communications mode and the utility's approach to complete the so-called ''last mile'' connection to the customer's residence (e.g., build/own vs. lease from other telecommunications providers or vendors).

Table 2. *Services Offered in Utility Telecommunications Projects*

Communications System	Utility	Automated Meter Reading	Outage Detection	Remote On/Off	Load Control	TOUM Pricing	Energy Information	Non-Energy Services[a]
Cable	Central & South West	x	P		x	x	x	
	Entergy	x			x	P	x	C, T
	Glasgow Electric Board	P				x		H, C, I, O
	Hydro Quebec	P			P	P	P	C, V, I, O
	Pacific Gas & Electric	x			P	x	x	H, O
	Public Service Electric & Gas	x	x	x	x	x	x	H, M, O
	Southern Dev. Invest. Group	P	P			P	P	H, M, C, V, I, O
	Virginia Power	x	x		x	P	P	C, V, T, I
Telephone	American Electric Power	x				x	x	
	Gulf Power	x	P			x		
	Wisconsin Energy	x	x	x	x	x	x	H, M, O
	Wright-Hennepin Cooperative	x	x				x	H, T, O
Fixed Wireless Radio	Baltimore Gas & Electric	x	x		P	P		
	Boston Edison	x		x				
	Kansas City Power & Light	x	x			P		
	PacifiCorp	x				x	x	
	Pacific Gas & Electric	x						
	TECO Energy	x			x	x	x	H, M, I, O
Mobile Wireless Radio	Baltimore Gas & Electric	x		x				
	Boston Edison	x		x				
	Public Service of Colorado	x	P			P		M,O

Notes: X = energy service is currently offered; P = planning to offer service in future

[a]Non-energy services are currently offered in only Entergy, Glasgow, and Wright Hennepin pilots; other utilities are planning to offer these services in future; H = Home Security, M = Medical Alert, C = Cable TV, V = Video on Demand, T = Telephone Services, I = Internet Access, O = Other

Based on information provided by utility contacts, we also present cost ranges for projects in each category, the utility's cost target or goal, and estimates of either peak demand savings or customer bill reductions. Other benefits from these projects may include savings in operating costs and improved productivity (e.g., fewer meter readers), increased revenues from non-energy services, and increased customer satisfaction leading to customer retention or growth. However, we were unable to evaluate project costs and benefits with any rigor because: (1) few utility contacts provided data quantifying these other benefits, although some contacts included anecdotal information on productivity impacts or customer satisfaction, (2) costs and savings estimates are self-reported and provided without documentation with one exception (e.g., Gulf Power), and (3) reporting costs for R&D projects that involve small sample sizes is inherently difficult; costs are often not reported in a consistent fashion.[3] Thus, reported costs should be regarded as order of magnitude estimates for the ''last mile'' connection, while cost targets are indicative of utility goals for large-scale pilots or system roll-out. We offer the following insights:

- Utility and product vendors believe that early, successful entry, defined as significant market share, will create a sustainable competitive advantage in this emerging business area. For example, if wireless radio systems are deployed first in system roll-outs and capture most of the potential energy-related benefits (e.g., operations-

Table 3. *Market Features of Utility Telecommunications Projects (Costs and savings in dollars per residence)*

Strategy	Utility	Key Partners/ Vendors	Installed Cost (Current)[a]	Installed Cost (Target)[b]	Peak Demand and/or Energy Savings
Cable, Utility-Owned	Central & South West	FPN	1,000–3,000	1,000	Avg. bill savings of 7–10%; 2 kW peak demand reduction
	Entergy	FPN formerly			
	Southern Dev. Invest. Group	FPN			
	Glasgow Electric Board	CableBus	240[c]	NA	$14/mo
Cable, Leased	Hydro Quebec	Domosys	2,000–3,000	300–500	$60–80/yr
	Pacific Gas & Electric	TCI, Microsoft			
	Public Service Electric & Gas	Lucent Technologies			
	Virginia Power	Cox, Nortel			
Telephone, Leased	American Electric Power	ICS	1,000–1,500	750	$175/yr
	Gulf Power	ICS			2–4 kW peak demand reduction
	Wisconsin Energy	Ameritech			
	Wright-Hennepin Cooperative	ITI	240[d]		
Fixed Wireless, Utility-Owned	Baltimore Gas & Electric	IRIS	240–1,000	NA	
	Boston Edison	Metricom			
	PacifiCorp	Metricom			
	TECO Energy Mgmt Services	IBM			
Fixed Wireless, Leased	Kansas City Power & Light	CellNet	180–240	NA	
	Pacific Gas & Electric	CellNet			
Mobile Wireless, Utility-Owned	Baltimore Gas & Electric	Itron	100–200	NA	
	Boston Edison	Itron			
	Public Service of Colorado	Itron			

Note: first pacific Networks (FPN), Integrated Communications Systems (ICS), Interactive Technologies Inc. (ITI); NA = Not Available

a,b Cost ranges for pilot projects in each group; excludes costs of installing backbone network

c Cost estimates are for incremental costs of pilot (i.e., CableBus switch, AMR meter, and water heating wiring); and do not reflect total cost of linking Glasgow's cable network to the residence

d Costs are lower because Wright Hennepin project does not include in-home display unit and cost of CPU is excluded from installation cost.

related savings, energy information services, time-of-use pricing), will they successfully foreclose competing communications systems (e.g., hybrid fiber-coax cable) whose large-scale deployment depends on utility system benefits and revenues derived from multiple, non-energy applications?

- Overall, wireless radio projects are farther along than competing communications delivery systems in terms of large-scale deployment. Recent contracts signed between utilities and various vendors for system-wide rollouts of fixed or mobile radio networks highlight this trend (e.g., Kansas City Power & Light, Union Electric). At the present time, wireless radio systems also appear to have lower installation costs per house for energy-related services than competing technologies (e.g., $180-1000/house vs. $1000-3000/house), although they have more limited functionality. Utility staff may often

have substantial in-house expertise with wireless radio systems based on their experience with direct load control programs; these projects also typically involve less complex teaming arrangements and fewer partners than cable-based projects.

- Over the last 3-4 years, a number of electric utilities have launched hybrid fiber-coax projects with significant fanfare in the trade press. A few of the utilities, such as Entergy and Central and South West, have decided to build and own their communications infrastructure between utility and customer, while most others have decided to partner and develop lease arrangements with telecommunications providers. The fiber-coax projects typically involve complex teaming arrangements: the utility, along with a telecommunications service provider, often assumes the project integrator or lead role while other companies provide various types of equipment (HVAC controls, thermostat, in-home display), software, or specialized expertise. The success of these partnering arrangements (e.g., successful integration of disparate corporate cultures, balancing of expertise) is one key factor that distinguishes projects that are moving forward to the next stage of development from pilots that appear to be floundering. These strategic alliances are critical in part because the project team leaders (e.g., utility and telecommunications provider) often hope to profit from their venture by marketing their product to other utilities. For example, CSW Communications is in contract negotiations with city of Austin to deploy a cable-based system to serve several hundred thousand customers, which builds on its Customer Choice and Control pilot in Laredo, Texas (Energy Services & Telecom 1996a). Similarly, PG&E/TCI/Microsoft recently announced that seven utilities had agreed to pay an upfront fee for use of the energy information services technology, will have access to PG&E's market research for its pilot, and will conduct their own market research trials (Energy Services & Telecom 1996b). Finally, Public Service Electric and Gas/Lucent Technologies announced that Consolidated Edison had agreed to participate in their Integrated Broadband Utility Solution.

- It is difficult to see how many utilities will be able financially to justify large-scale deployment of cable-based systems to residential customers given current installed cost levels and revenue projections that derive from existing service offerings. However, there is anecdotal evidence that installed costs per household have declined significantly in just a few years and it appears likely that some utilities will be able to reach their near-term cost targets. With respect to revenues, utilities are conducting large-scale market research trials which should help them refine and target their service offerings. Moreover, utilities and others continue to search for the ''killer application(s)'' (e.g., Internet access, video-on-demand, home security services, and medical alert) that will open up the residential market for large-scale deployment of two-way, communications-enabled services. The utilities involved in cable-based projects appear eager to get involved in the burgeoning home-based information, entertainment, and communications market. These utilities expect that residential customers will ultimately want a critical mass of compelling applications which can be provided at reasonable cost (''one-stop shopping'') and that customers will want interactive services provided over familiar and easy to use interfaces (e.g., computer or TV). These utilities are also betting that, in the long-run, they can improve the efficiency of utility operations by selecting a base communications system (i.e., two-way broadband) that can handle the greatest number of utility applications (Andersen Consulting 1995).

- We believe that several strategic drivers influence and help explain a utility's choices with respect to provision of communications-enabled services. For example, utilities pursuing wireless radio projects focus on near-term improvements in utility operations to reduce rates or provide energy information services that are cost-effective today in niche markets. In some cases, these utilities are relatively low-cost providers in their region that may believe that competitive advantage can be maintained by reducing costs in their core distribution business.[4] Similarly, a number of the utilities who are testing a broad array of energy and non-energy services in cable projects tend to be located in states where industry restructuring is proceeding relatively quickly (e.g., California) or are higher-cost providers in their region. These utilities are hoping that communications-enabled services will provide a competitive weapon to retain existing customers and/or offer important new sources of future revenue growth to offset expected revenue losses in commodity sales.

Technological Risks and Market Uncertainties

These pilot programs allow utilities to assess some of the technological risks associated with providing communications-enabled services. For example, utilities have experienced first-hand the challenges of system integration (e.g., integrating home network and customer premise equipment with the utility distribution network) and problems that arise because of the lack of standardized or competing communications protocols. Utilities must also be concerned that large-scale investments in communications systems will become obsolete quickly; a concern driven in part by the rapid pace of technical innovation in information, computing, and com-

munications technologies. This creates a potential business risk for utilities because the economics of many projects depend on long-term revenue streams. For example, in some wireless radio projects, utilities are signing contracts that involve 20 year leasing arrangements with vendors.

Ultimately, utilities hope to recoup their investment in communications systems and energy and non-energy services through savings in system operation as well as revenues derived from customers' willingness to pay for non-energy and energy information services. Most utilities report that their projects yield benefits, either in terms of operational efficiency gains, improved productivity, or energy savings. However, in many cases, it is unclear if the magnitude of these benefits exceeds project costs. Some pilot projects are supported financially by ratepayers using R&D funds, where demonstrations of cost-effectiveness are not required. Other utilities justify large-scale, system-wide deployments of wireless radio networks as part of normal utility operations; in some cases, regulators have not yet approved recovery of costs and earnings for projects or are unlikely to review the projects in any detail under incentive regulation schemes (e.g., performance-based ratemaking, rate cap or freeze).

With respect to utility system benefits, CS&W reports that customers in its Customer Control and Choice pilot are reducing their energy bills by about 7-10% on average with a peak demand reduction of 2 kW per household. Gulf Power reported summer peak demand reductions of about 2.25 kW/home from TOU prices in its Advanced Energy Management System pilot. Annual bill savings for residential customers reported by several utilities ranged between $60-175 per year. The amount of savings, customer's willingness to pay a portion of the value of these savings to the utility for these services (e.g., 10-20%), and customer's payback criterion (e.g., 2-3 years) establish an upper limit on the annual contribution that could be expected from customers.[5]

Based on our survey, only a few utilities (e.g., Glasgow Electric Board, Wright-Hennepin) have achieved reasonably high market penetration rates in promoting non-energy services that generate substantial revenue streams from residential customers. Most other utility projects are either still at the technical proof-of-concept stage, pilot market research, or large-scale technical trial. Thus, significant uncertainties still exist regarding services desired by residential customers and their willingness to pay for them. This situation motivated our exploratory market research effort, which we discuss next.

CUSTOMER MARKET RESEARCH

Many utilities have conducted market research exploring customer's interest in communications-enabled energy information services, although, with one or two exceptions, results of such studies are proprietary (Frauenheim 1995). To partially address this information gap, we conducted a focus group and individual interviews with residential customers in Newark, Delaware between December 1995 and January 1996 which explored customer perception of and interest in a set of fourteen proposed energy and non-energy services (see Table 4).[6]

Our focus group included three women and four men who were selected based on a systematic random sample.[7] Several participants had home computers which they used to access on-line services. One focus group participant had previously participated in a time-of-day pricing program and made regular use of bank-by-phone services. We also conducted ten personal interviews in order to complement the focus group results, specifically to capture elements that could be clouded by group dynamics. Due to a very low response rate, six interviewees were recruited through colleagues' and friends' contacts.[8]

In order to gauge customers interest in and perceived economic value of the services, respondents were asked to fill out a short questionnaire at the end of the focus group discussion and individual interviews; results are presented Table 5. Because our sample is so small, we interpret the quantitative results as providing a consistency check on the qualitative discussion and findings and possibly as an indication of some customers' willingness to pay for various services.

- **Most respondents indicated interest in specific energy information services, although average willingness to pay was quite low; thus bundling of these services as part of a comprehensive package will be needed.**

Compared to previous studies, we developed a more extensive set of information services which included historic data on monthly consumption, neighborhood comparisons of energy use, breakdown of individual appliance and end use consumption, instantaneous consumption and time-of-day pricing, information on energy efficiency programs and products, and ''do-it-yourself'' videos. For many respondents, energy information services were perceived as having practical value and application (e.g., increase awareness of their own energy consumption and alert them to energy savings opportunities and potentials). Typically, 10-40% of the respondents did not want the proposed energy information service even if it was offered free of charge. Some people regarded the services as unnecessary either because they could access the information with greater ease using other media (e.g., paper bills) or because they would not use the information or questioned its validity.[9] Overall, most respondents wanted the service only if it was free or were

Table 4. *Summary of Proposed Energy and Non-Energy Services*

No.	Service	Description
1	Historic Monthly Consumption	Gives customers a graphical display of monthly energy usage for an entire year.
2	Neighborhood Comparison of Energy Use	Allows customers to compare their electric or gas bills with households in their neighborhood.
3	Appliance Energy Consumption Breakdown	Gives information on how much energy is consumed by each major appliance in the house.
4	Instantaneous Consumption and Time-of-Day Pricing	Provides the amount of energy being used and the price at which it is being sold, allowing the customer to decide how to reduce energy bills by shifting energy demanding activities.
5	Billing and Payment Plans	Allows customer to review and pay the bill directly via an interactive system.
6	Energy Services Agreements and Rate Options	Offers detailed descriptions of energy services, agreements, and rate options aimed to increase customers awareness of these utility offerings.
7	Energy Efficiency and Conservation Programs	Information about the energy savings programs that could be offered via the system.
8	Energy Efficiency Product Information	Up-to-date energy efficient appliance information offered as a service to customers as part of overall energy efficiency goals.
9	Entertainment Videos on Demand	Allows customers to order movies of their choice on a pay-per-view basis.
10	''Do-it-yourself'' Videos and Ordering Energy Information Booklets	Enables orders for ''Do-it-yourself'' Videos and Energy Information booklets.
11	Scheduling of Installation, Field Services and Repairs.	An interactive scheduling service that would allow customers to plan ahead and suggest preferred time for service installation or repair.
12	Specific Customer Queries	An interactive customer service center that would work almost like an electronic mail-box.
13	Load Management and Automation	Services to reduce utility peak load demand, and customer control and operation of appliances based on customized time schedule.
14	Security Services	Security services that would allow remote monitoring and control of residences through light switches or locks, when home is unoccupied.

only willing to pay a nominal amount ($0.50-$1.00 per month or $1-2 per use).

These initial results suggest several possible strategies: (1) bundle a set of energy information services as part of a more comprehensive package of communications-enabled services that could command a reasonable monthly fee; (2) offer energy information services which are easily unbundled and can be marketed on a per use basis (e.g., ''do-it-yourself'' videos, product information), and (3) conduct

Table 5. *Market research results: Customers' Interest in and Willingness-to-Pay for Energy Services*[a]

No.	Service	Does not want	Want if free	Want and will pay[b]	Pay per month[c] ($)	Pay per month[d] ($)	Pay-per-Use[d] ($)
1	Monthly consumption	2	8	5	0.16	0.62	
2	Neighborhood comparison	6	3	7	0.34	0.91	
3	Appliance energy breakdown	4	7	6	0.16	0.50	
4	Instantaneous consumption and Time-of-day pricing	1	10	4	0.13	0.50	
5	Billing and payment plans	6	7	3	0.06	0.50	
6	Energy services and rate options[e]	2	11	3	0.13	2.0	
7	Energy conservation programs	3	9	4	0.28	1.50	
8	Energy efficient product information	4	5	8	0.13	2.0	1.17
9	Entertainment videos on demand	3	3	11	3.53	8.57	3.13
10	Do-it-yourself videos and booklets	3	10	4	2.17		
11	Scheduling repairs and services	5	10	1	0.12	2.0	
12	Customer queries	4	11	2	0.12	2.0	2.0
13	Load management and automation[f]	12	3	0.63	5.0		
14	Security services	6	4	6	3.82	10.83	

[a] One interviewee was willing to pay $2 per month to have all the services available plus a $5 for Pay-per-Use of each service.
[b] One interviewee would prefer an annual maintenance fee of not more than $60 for services 1 through 8.
[c] Average over all respondents
[d] Average of those who would pay
[e] One respondent said ''I'd pay, if I know I would save more money in the long run''
[f] One respondent was willing to pay a ''one-time'' set-up fee of $15, subsequent willingness to pay depending on cost/savings ratio
Note: Number of responses may not add up to 17 since not all respondents answered the question for each service.

additional market segmentation analysis in order to determine if some energy information services can be offered profitably on a stand-alone basis to certain targeted customer groups. Our focus group discussion also provides utilities with some insights on customer concerns (e.g., privacy, technological overkill, relevancy) that must be addressed so that energy information services add value to their product offering.

- **Respondents' limited interest in energy efficiency and bill reduction is partly due to their perception that energy savings potential is low or would negatively impact their lifestyle.**

Some respondents' limited interest in energy information services arises in part because they do not consider the potential for energy savings worth pursuing.[10] The basis for this conclusion often rests on two significant discrepancies: (1) the perceived potential for energy savings vs. the actual potential, and (2) the perceived impacts on lifestyle which are thought to be significant vs. minimal lifestyle changes that are typically required to reduce bills. The willingness

to engage in behavior to save energy seems to be correlated with the knowledge about technical and behavioral potential for energy efficiency as well as the size of the economic reward relative to changes that have to be made. Thus, in order to overcome consumer information barriers, effective consumer education will be a necessary component of any large-scale utility effort to deploy energy-related services (e.g., efficiency options do not compromise lifestyle, savings potential).

- **Customer-controlled load management (CCLM) and time-of-day pricing were the two energy-related services that yielded the most favorable overall responses.**

Customers viewed these two services as particularly useful and they also had the fewest negative responses. During the focus group discussion, several participants made the connection that CCLM could work particularly well in conjunction with time-of-day pricing. This may be another indication of the benefit of service bundling: a more accurate price signal on electricity service costs may be perceived more favorably in tandem with a service that puts customers in a position to improve their home energy management and reduce bills. We believe that these service options were popular because customers clearly saw that the technology would enable them take control of and responsibility for their energy management.

- **Some customers appear willing to pay for non-energy services such as entertainment videos on demand and security services, although customer concerns about unfair competition and utilities entering new business areas may represent a barrier among some segments of the residential customer base.**

A greater number of respondents indicated some willingness to pay for security services and entertainment videos on demand which were offered by an electric utility as part of an advanced communications system. The average amounts offered by those customers willing to pay (e.g., $11 per month for security services and $3 per view for entertainment videos on demand) appear to be reasonable compared to similar services that are well-established in the market. Again, while we do not expect precise values from this small sample, security services and video do provide a calibration that our measures are close to market value, thus lending some credence to the responses for energy-related services that are not currently offered in the market.

Focus group participants and several interviewees raised major concerns regarding the appropriateness of utility entry into these new businesses or the advantages of purchasing these services from a utility vs. a firm that specialized in this business. The utilities current status as a regulated monopoly entity is both a curse and a blessing in the residential market. Some respondents indicated that they tend to trust utilities or value their technical capabilities more than other types of businesses (e.g., security firms) and thus may be receptive to utilities offering non-energy services. On the other hand, because they are often perceived as a large monopoly, utilities are vulnerable to arguments that their entry into new markets will negatively impact small businesses, that they may be unfair competitors, or that they could become too powerful. These sentiments were expressed in one form or another by some focus group participants and interviewees.

- **Customer reactions to energy information and other services are influenced by their perception of electric utilities, marketing experiences with providers in other recently deregulated industries, and privacy and network security concerns.**

Based on the focus group discussion, we found a direct link between customers' receptiveness to new services and their attitude towards electric utilities and experiences with telephone utilities and cable companies. For example, several focus group participants appeared to distrust their investor-owned utility. This distrust appeared to amplify their concerns regarding privacy issues for some services (e.g., services that involved the utility collecting disaggregated data on personal energy use or customers' product and equipment needs), specifically whether the utility would provide information on their usage patterns or energy services needs to other private firms. In their view, this could result in an increase in unwanted marketing pitches from other commercial product and service providers. Privacy issues and the annoyance factor associated with unwanted marketing pitches were a significant concern for several focus group participants because of their prior experiences with deregulation in the telecommunications industry and the prospect of increased competition in the electricity industry. Not surprisingly, those customers that had negative experiences with providers of telecommunications services tended to be more dubious and suspicious of new service offerings. These concerns were reinforced when the framework for discussion was a deregulated competitive environment in which utilities also offered a range of non-energy services. Several focus group participants' misgivings about a single entity providing bundling of energy and other services (e.g., telecommunications, cable network, security services) were less pronounced if the utility was a locally-controlled, publicly-owned municipal entity. If our small sample is reflective of the population of residential customers, then it is clear that utility marketing and advertising materials will have to address the image of the electric utility as well as differentiate these service offerings from customer's negative perceptions of the marketing of telecommunications services and providers.

- **Choice of communications display medium: TV, computer or 'smart box'**

Many respondents viewed the computer as a more convenient medium for display of energy information and other services than TV. However, respondents also commented that TV was universally available and therefore allowed services to be provided to all customers, not just those who owned computers. Some respondents said they prefer current information mechanisms, such as paper bills, the telephone, consumer reports, libraries and CD-ROMs. Our small sample suggests significant differences among residential customers in their attitude toward and familiarity with various media (e.g., TV vs. computer) which when combined with differing availability and usage patterns affects their receptivity to more sophisticated communications systems.

CONCLUSION

We are convinced that utility pilot programs testing communications-enabled services provide insight into an important facet of future residential DSM and customer energy services. In aggregate, these programs represent a significant phenomenon: the cumulative financial investment of utility shareholders and other equity partners may soon approach recent funding levels for ratepayer-funded DSM activities targeted at residential customers ($700-900 million/year in 1994). Thus far, the battle for competitive advantage involves both choice of communications technologies, products, and service offerings as utilities have formed strategic alliances with telecommunications providers and product vendors. Over the next several years, winners and losers will be determined increasingly by the actual field performance of those that can create an attractive, reliable, low-cost, two-way communication connection between service provider and home and can successfully target and market bundles of energy and non-energy services in various residential market niches. Given the market and regulatory uncertainties and technological risks, utilities and their partners must overcome significant hurdles before large-scale deployment of communications-enabled services in the residential sector becomes a robust and profitable business activity.

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ENDNOTES

1. We focused on projects that targeted residential customers, that offered energy information services in conjunction with other services, and that utilized two-way communications. We eliminated projects that targeted commercial/industrial customers, whose objectives were exclusively distribution automation, or that offered non-energy services exclusively.
2. It is important to note that this market is very dynamic: features of existing projects evolve rapidly, while new projects are announced frequently in the trade press.
3. Project costs reported by utilities typically include costs of communications link between utility distribution network and customer's home network (the so-called ''last mile''), customer premise equipment, program administration, and marketing expenses. The cost of the communications backbone network is typically not included; in some cases, utilities rely heavily on existing cable networks in their pilot programs. We assume that some utilities also did not include all start-up or development costs.
4. Kansas City Power & Light and Baltimore Gas & Electric may be two examples of utilities in our sample who are aggressively moving forward with large-scale projects focused on cost reduction and automation of customer service and distribution.
5. This assumes that the utility could recoup some portion of the communication system costs by offering TOU prices, direct load control, or customer-controlled load management as energy services to participating customers. Currently, utilities typically receive cost recovery from all ratepayers based on a determination that these activities provide overall net benefits to the system.
6. The local utility is not currently conducting a DSM pilot program that utilizes advanced communications systems.
7. Because of high refusal rates and Newark's particular demographic profile, our sample for both the focus group and interviews did not adequately represent minority or low-income populations.
8. We believe the poor response rate may be attributable in part to the timing of our surveys (i.e., Christmas holiday season) and the severe winter weather.
9. For example, several respondents questioned the validity of neighborhood comparisons of energy use because of the difficulty in normalizing for differences in lifestyle, demographics, and building type.
10. One focus group member stated that the savings potential was not perceived as high enough to care. Despite one participant's earlier testimonial that she had achieved significant DSM savings, this comment did not generate remarks or corrections of any kind.

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