Energy Information Services and DSM: Merging Lanes on the Information Superhighway

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Over the past three years, there has been a surge of trials and applications of new telecommunications systems that seek to enable electric utilities to deliver expanded Energy Information Services (EIS) to retail customers. This paper analyzes these trends and illustrates their relevance, similarities, and differences in relation to the traditional DSM paradigm. We begin with a discussion of electric industry restructuring to establish the importance of the context in which EIS are developing. We then present the features, key drivers, and market trends of several energy information technologies and services. Specific information systems analyzed will include automated meter reading (AMR), AMR with time-of-use rates, AMR with real-time pricing and direct load control, and full-service home automation systems linked by two-way communications networks with the utility. We also present a methodology and a case study of a market assessment process that leverages past DSM experience to evaluate the relative benefits different EIS options.

Finally, we discuss the strategic importance of improved customer information and communication networks as the electric industry moves toward restructuring. Although these new areas have recently been the domain of operations staff, we argue that it is critical for DSM and marketing department staff to become involved in them as communication technologies are fast becoming the foundation on which the next generation of customer-focused market strategies will be developed.

ELECTRIC INDUSTRY RESTRUCTURING: BACKGROUND

The electric utility industry is in the midst of an important debate on the form and function of regulatory restructuring. No matter what its final shape turns out to be, industry restructuring is already having a profound influence on the two areas of focus of this paper: new energy information services (EIS) and the traditional DSM program paradigm. A number of forces have combined over the past few years to spur the current push for restructuring, including:

- the belief on the part of promoters that deregulation of other industries (e.g., telecommunications, trucking, airlines, and natural gas) has led to increased economic efficiency and improved customer choices;
- the desire of large industrial customers to obtain rate reductions; particularly in states like California where electricity costs are above national averages;
- frustration with the complexity of the regulatory process itself and its reliance on average-cost pricing; and
- the belief on the part of some utilities that restructuring is inevitable and that those who adopt first will benefit most in the long run.

Despite the momentum of the forces advocating for industry restructuring, several issues could result in a slowing or even reversal of the anticipated regulatory changes (though the latter is increasingly unlikely). If regulators and the courts decide that 100 percent of utilities' stranded assets must be paid off at an accelerated rate by ratepayers, there will be little, if any, rate savings available for many years. Along the way, it is not unlikely that rates will decrease for large users while increasing for residential and small commercial customers. Consumer groups are now geared up for this battle over the distribution of fixed costs. Another key issue that may slow the process is that some state regulators and commentators have proposed that FERC regulate key aspects of the wholesale, and potentially retail, power markets, thereby shifting oversight from the state to national level. On the other hand, such a shift from state-based to national rule-making could also accelerate the process as the debate and inevitable compromises that come with it become focused in one forum. Without direction at the national level, industry restructuring will evolve piecemeal into a confusing patchwork of state-based markets in which the rules of the game vary widely.

Despite these obstacles, however, a consensus seems to have emerged that ‘‘the genie is out of the bottle’’ with regard to some form of industry restructuring that will result in significant increases in both wholesale and retail competition. We believe that although it is impossible to predict the exact outcome and timing of the current restructuring debate, virtually everyone in the electric utility business must adjust to the reality that some form of change will eventually occur.

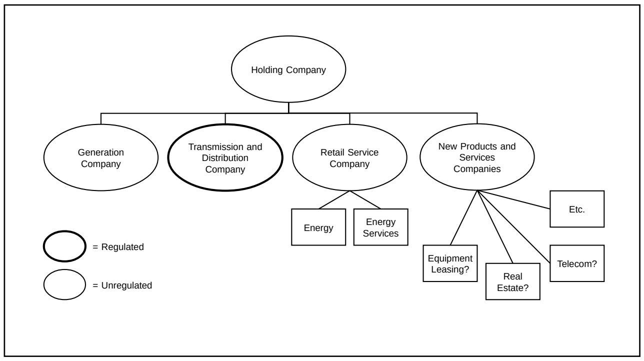
ELECTRIC INDUSTRY RESTRUCTURING: IMPLICATIONS

One key implication of increased competition concerns the timing and degree of restructuring. New business ventures often succeed or fail in relation to the ability of their champions to anticipate and time market changes. Act too soon and one may have developed a great product or service, but have no market in which to sell it. Wait too long, and one is likely to find that the market has passed one by.

At a minimum, it is clear that utilities and other energy service providers will be willing to invest significant resources in retaining large customers through intensive customer service and relationship building activities. With regard to smaller commercial and residential customers, however, the appropriate level of effort to provide both existing and new services is unclear. If retail competition moves forward quickly, many utilities will seek value-added services that differentiate themselves from their competitors on a market segment by market segment basis. Other utilities will choose to compete on a low-price, low-service basis. If restructuring goes slowly, however, and focuses only on wholesale competition, then there will be probably two types of responses from utilities: that of choosing to minimize service expenditures for small customers, treating them as indefinitely captured; and that of choosing to build loyalty and satisfaction by expanding services to these segments in anticipation of future competition or to ward off such competition. Finally, if the restructuring process leads to no concrete changes in the near term and appears to lose steam or reverse itself, it is likely that most utilities will seek to minimize their costs and service options for the smaller customers.

In the face of the uncertainty discussed above, many utilities are trying to move ahead of the debate to position themselves for competition before it arrives. As part of this effort, these utilities are in the process of changing their own internal ownership and organizational structures, separating generation, transmission, distribution, and retail marketing, and adding new businesses. One model of organizational restructuring is shown in Figure 1. According to this model, only the transmission and distribution of electricity are likely to be regulated in a radically restructured industry. These organizational changes, to the extent they materialize, will significantly affect the packaging and delivery of energy services.

Figure 1. *Example of Utility Organizational Structure under Retail Competition*



Most of the energy services that have been delivered via mandated or negotiated DSM programs may move from utilities' regulated to unregulated businesses. This is because the function of such programs will need to change in response to retail competition. Energy services will be tailored to the specific needs and costs of serving each market segment. In addition, efficiency services, which help customers reduce their bills, will typically be one component of multi-service packages that include other features such as electronic billing and equipment leasing (to name two obvious examples). It may become extremely difficult to differentiate or prorate the portion of delivery costs associated with only the DSM component of such services. As a result, DSM-related services could find their new homes on the unregulated side of the business (in the so-called ''Retail-Co's'' or ''Marketing Affiliates''). It is interesting to note, however, that this has not occurred yet in the gas area. In addition, current plans in several states call for a ''wires'' charge for energy-efficiency and other social programs during the competitive transition period. Whether this approach, a purely market-based strategy, or some combination of the two will eventuate in an era of direct access remains to be seen.

ENERGY INFORMATION SERVICES

So far we have touched briefly on the emerging role of energy information services (EIS) in a restructured electricity industry. But just what are these services and how are they related to or different from traditional DSM activities? Simply stated, EIS are information-based services that improve the distribution and consumption of energy resources for end users and energy service providers. By definition, EIS are information-based services that are enabled by information systems and technology (IS&T). Examples of EIS include:

- automated equipment control and sub-metering;
- time-of-use/real-time pricing;

- on-line meter reading (by which meters are read electronically on close to a real-time basis) and related ancillary services (for example, remote connect and disconnect of customers' power and automatic outage detection and customer notification);

- distribution automation (real-time data retrieval and communication with substations, capacitors, and other distribution assets);

- electronic bill payment;

- bill aggregation (for customers with multiple facilities and meters);

- comparative rate analyses (to match customers to their best rate option);

- end-use information (measurement or estimation of appliance/equipment usage);

- consumption bench-marking (information to help customers assess their consumption relative to customers with similar characteristics and relative to their efficiency potentials);

- customer-specific savings recommendations; and

- customer-specific marketing (e.g., appliance leasing, contractor referrals).

Partly in response to the limitations of traditional direct load control (DLC) approaches to managing customer demand, a number of new systems being developed by utilities and non-utilities alike seek to package many of the features listed above into ''smart'' in-home networks of appliances. This is an area in which no clear terminology as yet has solidified. In this paper, we refer to these systems as utility-linked home automation (ULHA) systems. Several companies are actively developing and testing such systems (see below). Some of the features being packaged in such systems include appliance control and sub-metering, real-time pricing, AMR and outage detection, distribution automation, and video communication.

If many of these services look suspiciously like traditional DSM activities, that is because they are in some cases virtually the same. The key defining point of differentiation is that EIS are delivered through information technology networks. Another important difference is that most of the discussion in the industry about EIS is predicated on the assumption that EIS are market-based, whereas DSM traditionally has been regulatory-based. There are fuzzy boundaries between the two terms currently because EIS is a relatively new concept. Like many new industry phrases, definitions are initially vague as they express abstract concepts that must ultimately move toward concrete descriptions of specific items that are agreed upon through gradual consensus.

ENABLING INFORMATION NETWORKS

If EIS are services provided through information networks, what is the role and importance of such networks in defining and shaping these services? Better yet, it is important to understand the networks themselves. The ''Information Superhighway'' is obviously the most captivating and common term used to describe an emerging meta-communication network in the U.S. and throughout the world. In the context of delivering EIS, however, this term is unnecessarily vague and overloaded with implied hyperbole. More specific information networks that are either already in use, or are in the process of being developed specifically for energy applications, include the following (for data applications, narrow-band is typically defined as <56 Kbps, while wide-band is defined as >1.5 Mbps):

- traditional telephony, i.e., twisted-pair (narrow-band);

- power line carrier (narrow-band);

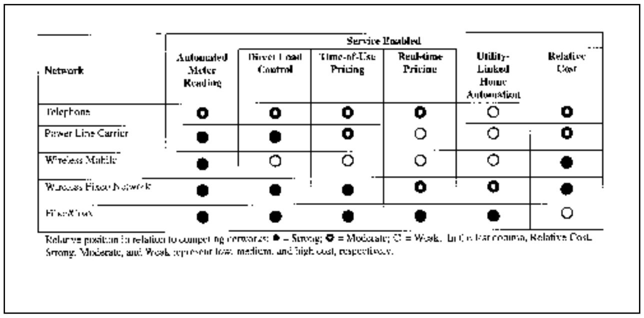
- wireless mobile radio (narrow-band);

- wireless fixed radio (narrow-band and wide-band); and

- two-way cable, fiber, or combined fiber/coax (wide-band).

In Figure 2, we present a matrix that indicates the relative strengths and weaknesses of each of these types of systems with regard to the provision of some specific energy information services.

Figure 2. Comparison of Services Enabled by Competing Information Networks



	Service Enabled					
Network	Automated Meter Reading	Direct Load Control	Time-of-Use Pricing	Real-time Pricing	Utility-Linked Home Automation	Relative Cost
Telephone	◉	◉	◉	◉	○	◉
Power Line Carrier	●	●	◉	○	○	◉
Wireless Mobile	●	○	○	○	○	●
Wireless Fixed Network	●	●	●	◉	◉	●
Fiber/Coax	●	●	●	●	●	○

Relative position in relation to competing networks: ● = Strong; ◉ = Moderate; ○ = Weak. In the last column, Relative Cost, Strong, Moderate, and Weak represent low, medium, and high cost, respectively.

KEY DRIVERS AND TRENDS

Consideration of EIS is being spurred by the fact that these systems have the potential to meet several objectives that have taken center stage with utility management. Most utilities are looking to make significant changes in the way they do business by:

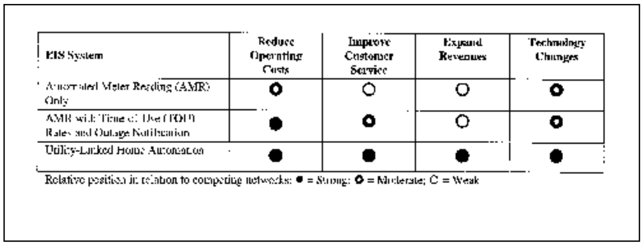
- cutting costs,
- improving service, and
- expanding revenues.

To reduce operating costs, utilities are now investing seriously in AMR and DA systems. These systems, along with expanded features, also will enable improvements in customer service via elimination of estimated reads and scheduling for new service, improved billing convenience (e.g., electronic bill payment), aggregation of accounts for large commercial and industrial customers, and the provision of expanded rate options and cost saving opportunities. EIS also have the capability of expanding revenues by leveraging the information networks necessary for creating new products and services. Finally, advances in information systems and technologies, such as improved reliability of AMR features, increased system options, reduced hardware costs, and expanded functionality, are also spurring new investments in these systems. An example of the relationship between these key industry forces and three alternative levels of energy information service for the residential sector is provided in Figure 3.

GROWTH IN DEPLOYMENT OF AMR

Over the course of the past year, fixed radio-based AMR systems have moved from the realm of utility pilot programs into the world of full-scale system-wide deployment for the first time. (Fixed radio networks typically are comprised of transceivers located on each meter that exchange data and messages with poletop units that then pass the information up the network to a central computer. Although this section focuses on fixed radio systems, it is important to note that other AMR systems based on power line carrier and twisted pair networks are also growing and advancing rapidly.) Previously, large-scale utility investments in AMR had been based, for the most part, on mobile radio systems that provided a low-cost means of reading meters by using a drive-by van to receive low-power signals from transmitters retrofitted onto utilities' existing meters. This approach, although relatively inexpensive, has limitations with regard to further expansion of system functionality. As a result, the industry is now taking dramatic steps towards using fixed-radio networks as a means of providing both the traditional AMR benefits (i.e., reduced manual meter reading costs) and new, potentially revenue enhancing, services. Some recent examples of large fixed network deployments include:

Figure 3. *Relative Importance of Key Industry Drivers for Selected EIS Systems*



EIS System	Reduce Operating Costs	Improve Customer Service	Expand Revenues	Technology Changes
Automated Meter Reading (AMR) Only	◉	○	○	◉
AMR with Time of Use (TOU) Rates and Outage Notification	●	◉	○	◉
Utility-Linked Home Automation	●	●	●	●

Relative position in relation to competing networks: ● = Strong; ◉ = Moderate; ○ = Weak

- Kansas City Power and Light (apx. 400,000 units);
- Union Electric (apx. 500,000 units);
- Duquense Light (apx. 580,000 units); and
- Western Resources (apx. 250,000 units).

Overall AMR installations are projected to grow from roughly four million units in the U.S. at the end of 1994, to twelve million units by 1998. Currently, almost 200 utilities have installed some type of AMR system (the vast majority of which are still trials). In addition, two California utilities are currently evaluating vendor bids for several million units.

GROWTH IN TRIALS OF UTILITY-LINKED HOME AUTOMATION

Although fixed radio and other AMR systems provide utilities and energy service providers with capabilities that go well beyond the services offered historically in the retail electricity business, a number of companies have been investing in a new generation of communication systems that will provide comprehensive two-way communication links between service providers and their customers. These systems are focusing on linking utilities' wide-area networks with local networks located within customers' own homes. There are probably more than a dozen major pilots of such systems now being conducted in the U.S. and Canada, examples of which include:

- Pacific Gas & Electric (''Energy Channel,'' with TCI and Microsoft);
- Southern California Edison (''Advanced Energy Management System-AEMS'');

- Hydro Quebec (UBI Consortium);
- Public Service Electric & Gas (AT&T Broadband Solution);
- Central & SouthWest (‘‘Customer Choice & Control™’’);
- Tampa Electric (‘‘Shu-box’’); and
- Wisconsin Electric and Ameritech (‘‘Energy Oasis’’).

Some of the objectives and proposed features of these systems that are available from public sources are shown in Table 1.

CASE STUDY OF EIS ASSESSMENT

In this section, we provide a case study of an assessment of the relative costs and benefits of three competing EIS systems under several possible future scenarios. The purpose of this section is to illustrate a process for comparing systems based on estimates of electricity capacity and energy benefits, as well as bill savings to customers. Note that this analysis is not meant to present a complete business assessment of these systems but, rather, is simply a first pass at what is arguably the most important component of overall system benefits. From the diagram presented in Figure 4, we can see that there are many parameters that must be estimated to conduct a comprehensive financial analysis of the relative benefits and costs of EIS systems. Most EIS assessments to date have been performed for AMR systems and have focused only on the direct cost savings attributable to elimination of manual meter reading. This is partly because such assessments have been conducted by utility operations departments within the context of the traditional regulated utility structure. The analysis in this case study, on the other hand, focuses on estimating the marginal cost savings engendered by the changes in customer usage patterns attributable to different types of EIS systems. The next step in this process will be to integrate both the operations and demand-side perspectives, as well as the more difficult to estimate benefits such as reduced energy theft and improved customer loyalty.

The three levels of EIS that we compared were:

- one-way AMR with Time-of-Use (TOU) pricing,
- two-way AMR with TOU pricing and direct load control (DLC); and
- utility-linked home automation (ULHA).

The purpose of choosing these three levels of EIS was to compare systems across a wide range of functionality and costs. Most one-way AMR systems have the optional capability to provide TOU billing, albeit at a higher cost than systems that lack the TOU feature. The second level of EIS analyzed consists of AMR systems that feature TOU pricing and direct load control (DLC). This option would enable potentially greater shifts in consumption from on-peak to other periods with consequent savings to both utilities and participating customers. The third alternative consists of a comprehensive ULHA system that includes all of the features of the first two systems plus ‘‘smart’’ in-home networks of appliances that have been programmed to respond to dispatched changes in utility prices.

In terms of evaluating the benefits of load shape changes resulting from each system, several parameters needed to be considered, including:

- costs of future peak capacity and energy (avoided generation costs),
- TOU and real-time prices,
- customer response to TOU and real-time prices (magnitude of customer load shape change),
- customer appliance holdings and levels of use, and
- EIS system costs.

Because there is a great deal of uncertainty in most of the parameters that must be estimated to compare present value costs and benefits of EIS systems, our analysis was conducted for several possible scenarios. For the purpose of our scenario analyses, we chose the three parameters that we believe are the most uncertain:

- costs of future peak capacity and energy,
- customer load shape response, and
- EIS system costs.

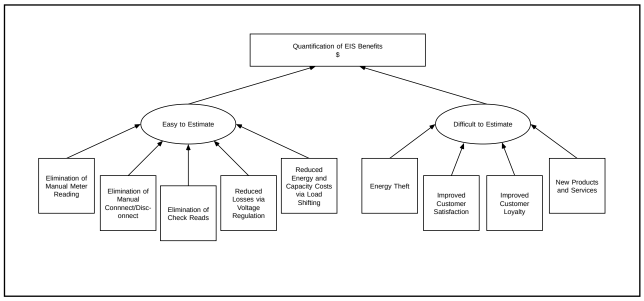
Avoided Costs

The avoided cost savings (in capacity and fuel) that might be obtained from shifts and reductions in customers’ patterns of use enabled by EIS technologies are by no means certain. Several critical aspects of uncertainty in avoided cost savings must be addressed to provide a realistic range of likely futures. Traditional uncertainty in avoided capacity cost forecasts is attributable to uncertainties in economic growth, changes in the intensity and patterns of energy use, and

Table 1. *Summary of Selected Utility-Linked Home Automation Pilots*

Service/Project	Firms-Elements	Objective	Features	Location-Homes -
PG&E Energy Channel	● PG&E—Energy application software ● TCI—Set-top box and transport ● Microsoft—Operating system	Develop and demonstrate feasibility of delivering high-end EIS Test customer acceptance and interest	● Two-way communication ● In-home appliance monitoring (with limited control) ● AMR ● Dispatchable pricing ● Electronic bill payment	*Location:* Walnut Creek and Sunnyvale *Homes:* Phase II—100 Phase III—1,000
SCE Advanced Energy Management System (AEMS)	● Cox Cable ● Unity Systems ● Davis Energy Group ● WEXL	● Test and assess technology and customer acceptance ● Develop system to receive data via cable, wireless, or phone ● Test new rate concepts	● Appliance level usage information ● Electronic billing ● AMR and outage detection *Future Enhancements*: Appliance control, rate dispatch, and other energy communication services	*Location:* Palm Springs, Orange County, Rialto *Homes:* 50 planned for initial pilot
Hydro-Quebec UBI Consortium	● National Bank of Canada ● Groupe Videotron ● Loto-Quebec ● Canada Post Corporation ● Videoway Communications	● Develop a system for home energy management, and business, shopping, and entertainment services ● Determine whether costs can be borne by service providers	● Appliance control and submetering ● Two-way terminal ● Remote control ● Smartcard ● PIN pad and magnetic card reader	*Location:* Phase I in Saguenay region *Homes:* Phase I—600 Phase II—33,000
PSE&G/AT&T	● AT&T ● Intellon (CEBus) ● Andersen Consulting ● General Electric Meter ● American Meter ● Honeywell	To develop and test a system for delivering enhanced energy services	● AMR ● Outage and tampering detection ● Real-time load management ● Customer-controlled load management ● Bill analysis options	*Location:* New Jersey *Homes:* Phase I—10 Phase II—1,000 Phase III—10,000
Tampa Electric	● Was IBM but relationship broken off ● Destineer is providing wireless PCS system for WAN	To develop and test a system for delivering enhanced energy services	● Appliance monitoring and control ● AMR ● Outage notification ● Interface for voice, video, and data	*Location:* Tampa *Homes:* Goal is 130
Wisconsin Electric—Energy Oasis	Ameritech Johnson Controls	To develop and test a system for delivering enhanced energy services	● Smart meter for in-home LAN and utility WAN ● Appliance load control and metering ● Lonworks protocols ● Two in-home displays ● Pilot will use PCS for WAN	*Location:* Wisconsin *Homes:* Phase I—15 Phase II—150 Phase III—20,000
Central & SouthWest-PowerView	First Pacific Networks Raytheon	To develop and deploy a system for delivering enhanced energy services	● Appliance monitoring and control ● AMR and DA ● Smart appliances ● Interface for voice, video, and data	*Location:* Laredo, TX *Homes:* Up to 2,500

Figure 4. *Elements of Comprehensive EIS Benefit Quantification*



future costs of new generating plants. Industry restructuring adds another element of uncertainty to these projections.

Under the current regulatory structure, utilities manage portfolios of power plants to meet the demand requirements of their own systems. If a peak demand occurs only for a brief period of the year (for example, 100 hours in the summer), the utility may have a plant in its portfolio that operates only during that peak demand period. Because of their infrequent operation, the costs of such plants on a per kWh sold basis are very high. In a restructured industry that contains a statewide or larger regional wholesale entity, the load shape for which plants would be dispatched might be flatter than the individual utility load shapes, unless all of the utilities in the pool have highly coincident shapes. In a California-only pool, the utility shapes, in fact, would be highly coincident. In a larger pool that included the Pacific Northwest, however, the combined load shape would be flatter. As a result, the marginal cost difference between on-peak and off-peak periods also could decrease.

As a result of this uncertainty, we developed two avoided cost scenarios: a high cost scenario in which peak capacity continues to be filled by low capacity factor plants, and a low cost scenario in which minimal new capacity is needed and demand is spread more evenly over plants serving a large regional wholesale power pool.

Customer Load Response

The second key parameter in our analysis is the response of customers to the price and other load shifting options enabled by the different types of EIS systems. There are various combinations of pricing and technology options that may provide the incentive and means for customers to change their current patterns and amounts of energy usage. Uncertainty exists with regard to the amount by which customers will change their current usage patterns in response to these new services.

Perhaps the most important factor affecting the potential change in customers' usage patterns is the time-differentiation of the tariff structure. The higher the differential between on-peak and off-peak prices, the larger the shift in usage between periods. Research has shown, however, that customers' elasticities with regard to TOU prices are by no means linear. The price differential between on-peak and off-peak periods must be three- to five-fold before most customers begin to reschedule their use of key appliances (Train, 1994; Khawaja, 1995). Because the TOU tariffs themselves will be cost-based in a competitive market, the on-peak to off-peak tariff differential will be closely related to the utility's avoided costs. We have developed two customer response scenarios that correlate with the avoided cost scenarios. In the first scenario, high peak avoided costs result in large price differentials between time periods and, concomitantly, high levels of customer load shifting. Under flatter avoided costs, smaller price differentials between time periods lead to smaller shifts in customer demand patterns.

EIS System Costs

The final key driver selected for the scenario analysis is the cost of the EIS systems themselves. Because most EIS systems consist of technologies developed for the telecommunications and computer industries, it is likely that component costs will decrease in the future. Many of the companies developing ULHA systems are banking on being able to reduce costs to some ''target'' level. In addition, some companies may be understating current costs to generate interest and stimulate demand that they hope will lead to cost reductions. Uncertainty in costs exists on both sides of current system cost estimates, although there is more uncertainty on the cost reduction side. Furthermore, there is a wider range of uncertainty in the costs of the ULHA systems than in the more proven crop of AMR and DLC-only systems. As a result of the wide range of uncertainty in the ULHA systems, two EIS cost scenarios (high and low) are used in our financial analysis.

Summary of Scenarios

The individual parameter scenarios combine to produce four overall scenarios, as shown in Table 2. The first scenario is most favorable to the EIS systems because high peak avoided supply costs and significant customer demand reductions are combined with low EIS system costs. The least favorable scenario combines low avoided supply costs, small customer demand reductions, and high EIS system costs.

The specific quantitative assumptions used for each scenario are shown in Table 3. The customer response percentages represent the percentage reduction in peak kWh on a per-customer basis. Note that high percentage reductions are

Table 2. *EIS Case Study Scenario Definitions*

Scenario Number	Avoided Costs	Customer Peak Load Response	EIS System Costs
1	High	High	Low
2	High	High	High
3	Low	Low	Low
4	Low	Low	High

obtained only in the scenario with a high differential between peak and off-peak rates (as determined by on-peak/off-peak avoided cost differentials).

Other key assumptions imbedded into our calculation of avoided cost benefits include the following:

- Period over which the net present value of benefits is calculated: 20 years
- Useful life of EIS systems: 20 years
- Utility nominal discount rate: 11 percent
- Inflation rate: 3.8 percent
- In addition to the percentage reduction in peak demand from load shifting, we have estimated that there will be small energy savings from the ULHA systems as well (roughly one-third of the shift in peak demand in percentage terms).

Table 3. *Assumptions for Scenario Analyses*

	Avoided Supply Costs and Rates					Customer Response (ΔPeak kWh)				
					EIS	Single Family		Multifamily		
Scenario	Avoided Costs (Capacity followed by energy)		TOU Rate	Technologies	Cost/ Home	AC	No AC	AC	No AC	
1	High	Peak = $50/kW-Yr			Low:					
		Peak = $0.04/kWh	Peak = $0.32/kWh	AMR w. TOU (1 Way)	$70	10%	10%	10%	10%	
		Mid-Peak = $0.03/ kWh	Off-Peak = $0.08/ kWh	AMR, TOU, & DLC (2 Way)	$150	20%	15%	15%	12%	
		Off-Peak = $0.02/ kWh		Full EIS (2 Way)	$500	30%	20%	20%	15%	High
2	High	Peak = $50/kW-Yr			High:					
		Peak = $0.04/kWh	Peak = $0.32/kWh	AMR w. TOU (1 Way)	$100	10%	10%	10%	10%	
		Mid-Peak = $0.03/ kWh	Off-Peak = $0.08/ kWh	AMR, TOU, & DLC (2 Way)	$250	20%	15%	15%	12%	
		Off-Peak = $0.02/ kWh		Full EIS (2 Way)	$1,500	30%	20%	20%	15%	
3	Low	Peak = $23/kW-Yr			Low:					
		Peak = $0.03/kWh	Peak = $0.15/kWh	AMR w. TOU (1 Way)	$70	3%	3%	3%	3%	
		Mid-Peak = $0.0142/ kWh	Off-Peak = $0.10/ kWh	AMR, TOU, & DLC (2 Way)	$150	6%	5%	4%	4%	
		Off-Peak = $0.0142/ kWh		Full EIS (2 Way)	$500	10%	7%	7%	5%	Low
4	Low	Peak = $23/kW-Yr			High:					
		Peak = $0.03/kWh	Peak = $0.15/kWh	AMR w. TOU (1 Way)	$100	3%	3%	3%	3%	
		Mid-Peak = $0.0142/ kWh	Off-Peak = $0.10/ kWh	AMR, TOU, & DLC (2 Way)	$250	6%	5%	4%	4%	
		Off-Peak = $0.0142/ kWh		Full EIS (2 Way)	$1,500	10%	7%	7%	5%	

Case Study Results

Avoided supply costs were calculated for each of the two EIS system types for each of the four scenarios across several customer market segments. The net present value of these savings minus the EIS system costs are shown in Table 4.

Table 4. *Present Value of Avoided Supply Cost Savings Minus EIS System Costs*

Scenario	Avoided Supply Costs and Rates	Technologies*	System Cost/ House	NPV Savings Per Household				
					Single Family		Multi Family	
				All	AC	No AC	AC	No AC
1	High	AMR w. TOU	$70	$58	$146	$32	$83	$1
		AMR, TOU, & DLC	$150	$64	$281	$3	$80	($65)
		ULHA	$500	($77)	$353	($187)	($96)	($338)
2	High	AMR w. TOU	$100	$28	$116	$2	$53	($29)
		AMR, TOU, & DLC	$250	($36)	$181	($97)	($20)	($165)
		ULHA	$1,500	($1,077)	($647)	($1,187)	($1,096)	($1,338)
3	Low	AMR w. TOU	$70	($50)	($37)	($54)	($47)	($59)
		AMR, TOU, & DLC	$150	($116)	($84)	($124)	($119)	($136)
		ULHA	$500	($419)	($344)	($437)	($422)	($469)
4	Low	AMR w. TOU	$100	($80)	($67)	($84)	($77)	($89)
		AMR, TOU, & DLC	$250	($216)	($184)	($224)	($219)	($236)
		ULHA	$1,500	($1,419)	($1,344)	($1,437)	($1,422)	($1,469)

AMR = Automated Meter Reading; TOU = Time-of-Use Rates; DLC = Direct Load Control; ULHA = Utility-Linked Home Automation

From these results we see that none of the EIS options are cost effective from an avoided supply cost perspective in the low avoided cost scenarios. In the high avoided cost scenarios, we see that the AMR with TOU system, which is characterized by lower costs and lower-peak savings, is cost effective in all market segments except multifamily without air conditioning. The second level of EIS, which includes DLC, is generally cost effective only in the most optimistic system cost scenario and market segments with air conditioning. The ULHA system is only cost effective in one cell of the matrix: the single-family air conditioning segment under the high avoided cost and low equipment cost scenario.

The customer perspective provides another viewpoint worth considering in comparing the relative benefits and costs of EIS systems. Although it is unlikely that any of the EIS systems analyzed would be sold to customers directly at full cost (they would probably be amortized onto monthly bills instead), it is still informative to determine the relationship between customers' first-year bill savings and the ULHA system costs. These results are shown in Table 5. The ratio of on-peak to off-peak rates is too small to generate significant bill savings for customers in the low avoided costs scenarios. Under the high avoided cost and on-peak/off-peak rate differential scenarios, however, several of the systems have paybacks that are less than five years. Although paybacks of these levels are still well above most residential customers threshold for energy-related investments (typically, on the order of one to two years), they do indicate the potential for generating positive customer cash flows by amortizing the cost of the systems and charging customers to recoup these fixed costs on a monthly basis.

Case Study Conclusions

The results presented in the case study vary widely across the scenarios and customer market segments analyzed. The scenarios themselves, however, are all fairly probable. This indicates that investments in EIS systems must be made and analyzed judiciously. Clearly, if restructuring leads to a reduction in the value of marginal peak capacity because of improved regional use of power plants (i.e., higher load factors), then the capacity-related value of EIS systems may be too small to significantly influence their deployment. Although utility avoided cost savings and customer bill reductions are only one of the areas of potential benefit from these systems, it is clear that the market for peak power will play a critical role in their ultimate economics.

ULHA systems have been described by some as a ‘‘Trojan horse’’ entryway for electric utilities to become two-way communications network providers. This does not appear to be a likely scenario for California given that there are not

Table 5. *Customer Simple Paybacks (First Year Bill Savings/System Costs)*

Scenario	Avoided Supply Costs and Rates	Technologies*	System Cost/ House	Customer's Simple Payback (Years)				
					Single Family		Multi Family	
				All	AC	No AC	AC	No AC
1	High	AMR w. TOU	$70	4.3	2.7	5.1	3.8	7.5
		AMR, TOU, & DLC	$150	5.6	2.9	7.4	5.4	13.3
		ULHA	$500	7.0	3.7	8.6	7.8	16.6
2	High	AMR w. TOU	$100	6.2	3.9	7.4	5.4	10.6
		AMR, TOU, & DLC	$250	9.3	4.8	12.3	9.1	22.2
		ULHA	$1,500	20.9	11.1	25.9	23.4	49.9
3	Low	AMR w. TOU	$70	40.9	25.3	49.4	35.6	71.5
		AMR, TOU, & DLC	$150	50.8	27.1	63.5	57.2	114.9
		ULHA	$500	26.2	15.1	29.8	30.3	60.4
4	Low	AMR w. TOU	$100	58.5	36.1	70.5	50.9	102.1
		AMR, TOU, & DLC	$250	84.7	45.2	105.8	95.4	191.4
		ULHA	$1,500	78.7	45.2	89.4	90.9	181.1

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* AMR = Automated Meter Reading; TOU = Time-of-Use Rates; DLC = Direct Load Control; ULHA = Utility-Linked Home Automation

enough peak supply cost savings for utilities to justify investment in a broadband infrastructure for enabling greater changes in customers' demand patterns and the fact that two broadband ‘‘pipes’’ are already in progress (from both the cable and telephone industries). Of course; results for EIS systems in other areas of the country with more definitive needs for low use peak capacity and higher per customer peak loads (e.g., electric heating) could differ significantly.

OVERALL SUMMARY AND CONCLUSIONS

Interest in energy information services will continue to increase as long as electric industry restructuring continues to move in the direction of greater retail competition. In a competitive retail environment, radically improved customer information and communications systems will be the key to retaining existing customers and winning new ones. Information is critical to understanding customer needs and wants. Increased knowledge of the services desired and valued by customers can be used to create a stronger influence on customers' choices of service providers. In an environment of full retail competition, market forces may cause traditional DSM types of services to migrate into the new emerging field of EIS.

Assessing the benefits and costs of specific EIS will be complicated by the fact that these services are likely to be packaged with non-energy related services. Nonetheless, as indicated by the case study presented in this paper, the techniques developed and experiences obtained from assessing the load shape impacts of DSM programs also can be applied to quantification of the EIS systems. At the same time, these traditional approaches must be augmented with the necessary elements of conventional business planning. The good news for the DSM community is that, to the extent to which DSM activities have been focused on providing highly valued services directly to customers, these experiences will be the foundation upon which the next generation of market-based services will be developed. In particular, although advertising will inevitably rise up as a key marketing tool in retail energy markets, energy-efficiency and bill savings from price-induced load shape changes will be vital aspects of most service providers' portfolios of value-added services.

Finally, the growing influence of the Internet and other information networks provides the promise of delivering much more efficiency-related information directly to customers, at an increasingly lower cost, than has hitherto been possible. This convergence of trends in the telecommunications and electricity industries will offer unprecedented opportunities to minimize one of the key historic barriers to both broader and higher levels of energy-efficiency, namely, customers' lack of information. To this end, we can only add, ''Carpe diem.''

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