Establishing the Scope for The
Business Case Structure to Evaluate Advanced Metering

What factors should be considered when determining whether to invest in an advanced metering system? How can a business case be structured to properly assess the costs, benefits and potential risks?

This paper provides the Energy Commission's initial thoughts on how the business case for advanced metering should be structured to provide the joint agencies with sufficient information to analyze the pros and cons of different deployment strategies. The purpose of this paper is to solicit comments on both the scope and types of analysis the utilities should be required to provide in the Phase 2 proceeding.

The scope of evaluation proposed in this paper goes substantially beyond the analysis historically common to the traditional utility business case. A traditional utility business cases usually focuses on the costs and benefits of meter reading and directly related communication, data preparation and a subset of accounting and billing applications. Evaluations tend to overlook the broad applications that real-time data flows and access to information can have on most other utility applications. More substantially, the traditional business case evaluation for advanced metering often ignores two very critical high-value areas: (1) the opportunities that advanced metering provides to address the risks and uncertainties associated with system operation and system reliability and (2) impacts on customers and customer services. Table 1 identifies the major differences in the business case scope recommended by the Energy Commission.

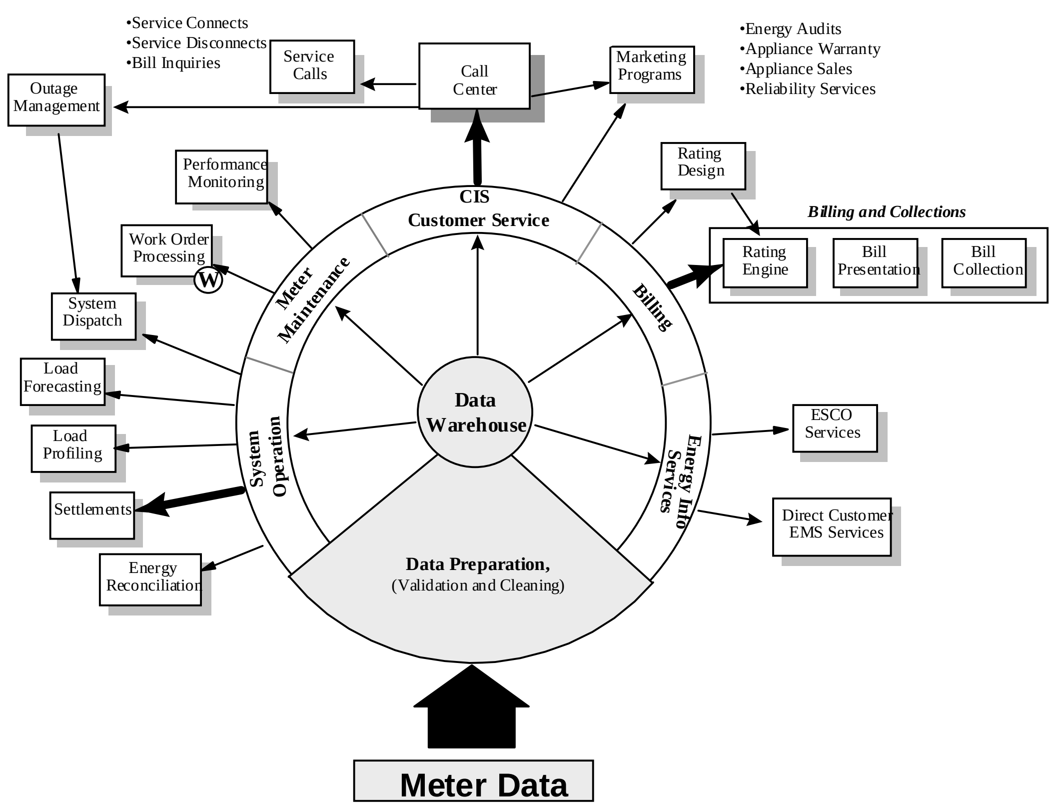
Table 1. Contrasting the Traditional and Proposed Utility Business Case for Advanced Metering

	Traditional Business Case	Proposed Business Case
Methodology	Net present value of costs and benefits	Net present value of costs and benefits
Assumptions	Utility owns all equipment and process.	Contrast utility ownership with financed or outsourced options.
	Contrast base case with full implementation	Contrast base case with targeted and full implementation
	Maintain the fixed revenue requirement.	Identify impacts with and without the revenue maintenance requirement.
	Metering assumed independent of other systems and applications.	Metering considered part of an integrated suite of utility applications.
	Customer impacts not considered.	Customer impacts considered.
	Risk and uncertainty not considered.	Risk and uncertainty regarding price and system delivery constraints considered.
	New customer service and revenue opportunities not considered.	New customer service and revenue opportunities considered.

Putting Advanced Metering Into Perspective – Isolated Function or Integrated System?

Interval metered customer demand and aggregated usage data is a common denominator and foundation for most electric utility back office, customer service, and system operating functions. Billing, outage management, high bill resolution, forecasting, real-time dispatch, rate design and many other utility functions depend upon some form of metered interval data. To be most effective, metering systems must be integrated into and designed from the outset to support many other utility functions (Figure 1).

Figure 1. Meter Data Applications Within a Traditional Utility



Traditionally, metering systems are viewed as the vehicle for collecting energy usage data to support a monthly billing function. Often referred to as the 'utility cash register', that perspective creates a focus on meter reading to support revenue requirements, that in turn ignores the impact that metered data has on every other aspect of utility operations. Treating metering and billing as a separate system, isolated from other utility operations, creates duplication of data and multiple systems with overlapping functionality, delayed access to information and overlapping unnecessary costs.

Two attributes determine how metered data is used to support the functions identified in Figure 1: (1) the time interval over which customer usage is measured and (2) how long it takes to access (time frame) and retrieve measurement results.

For example, traditional billing, based on tiered rates, uses aggregated kWh retrieved over monthly billing cycles. Automated meter reading systems (AMR), that rely on meter readers using hand-held recorders or drive-by vans with short-distance remote reading capabilities, can easily support conventional billing requirements. However, outage management, dynamic tariffs and many customer energy management functions, at the other extreme, often require usage interval data and data retrieval cycles measured in minutes, not the monthly cycle associated with traditional billing statements. Advanced metering infrastructure (AMI) with remote communication capability is necessary to support all of these functions. The important question is how to quantify the additional benefits and costs associated with AMI systems that are not necessarily billing related but provide much more fundamental functions such as preserving system reliability and improving customer service.

Meters used with AMR and AMI systems record the same usage information, sometimes over equivalent recording periods (e.g. once every 15 minutes). However, there are three significant differences that differentiate the eventual capabilities of AMR and AMI systems:

1. AMI systems retain and make the detailed interval data available for other uses: AMR systems aggregate the detailed interval data into a either single 'running total' for the facility or into defined 'billing buckets' to support a particular rate.
2. AMI systems provide remote communication to support frequent (daily or on-demand) access to metered data: AMR provides limited communication that requires either on-site or near-site capability to access metered data.
3. AMI systems can support customer access to usage data independent of the billing process while AMR systems do not provide this capability.

What is important to note is that AMI systems can be designed to support all utility functions, while conventional standard watt-hour meters and AMR systems cannot.

Table 2 identifies some of the high-value utility and customer applications and services that can be supported with an advanced metering AMI infrastructure. Implementing the AMI infrastructure creates benefits on its own, independent of the underlying tariff structure.

Table 2. Comparing the Functional Capability of Various Metering Options

Application / Function	Standard Watt Hour Meter	Automated Meter Reading (drive-by)	Advanced Metering Infrastructure with Communications
Utility Functions.			
a. Automated Meter Reading	**NO**	**LIMITED**	**YES**
b. Outage Detection	**NO**	**NO**	**YES**
c. Theft Detection	**NO**	**LIMITED**	**YES**
d. Load Survey	**NO**	**LIMITED**	**YES**
e. Customer Energy Profiles –for EE / DR Targeting	**NO**	**NO**	**YES**
Customer Functions			
a. Customer Rate Choice	**NO**	**NO**	**YES**
b. Customized Billing Date	**NO**	**NO**	**YES**
c. Energy Information	**NO**	**NO**	**YES**
d. Dynamic Tariffs	**NO**	**NO**	**YES**
d. Enhanced Billing	**NO**	**NO**	**YES**

The Meter as the "Utility Cash Register" – Related Example

Experience with telecommunications, financial, transportation, and many other industries indicate that the cost savings and operational impacts attributed to AMI are probably only first order effects that reflect just the most immediate and most easily attainable benefits. Experience with other industries and within the electric utility industry, consistently shows that AMI-type technology applications can trigger a series of first, second, and third order effects which increase efficiency, demand for new products and services, and the formation of entirely new business ventures (Figure 2).

Electronic supermarket cash registers and bar codes provide a good example. Prior to the advent of bar coding, product codes and pricing information were not standardized. They had to be entered separately to support each function related to the product manufacturing, distribution and sales process. Bar codes were originally developed to make checkout easier - this is equivalent to the current meter read done to support monthly billing.

The supermarket industry initially resisted the move to electronic registers and bar codes because the value was not considered sufficient to offset the required investment – in other words, the reduction in 'checkout costs' (e.g. meter reading) was not considered sufficient to justify a move to a new technology. However, it soon became apparent that the same bar code used to support automated checkout, could also be used to automate the inventory function, which in turn found applications in purchasing, pricing, shrinkage analysis, automation of general accounting, and automatic order entry applications.

Figure 2. The Impacts of Improved Information Technology: Bar Codes and Metering

	Information Theory	Bar Code Example	A Metering Future
First Order Effects	**Substitution:** Information technology will be used as a substitute for human tasks and coordination. Communication tasks now performed by management within and between organizations can be done more economically by computers.	The lack of standardized supermarket product codes and pricing information required separate entries to support each function related to manufacture, distribution and sales. Bar codes were developed to make checkout easier. Industry resisted the move to bar codes because the value was not considered sufficient to offset the required investment.	Automated metering is used to replace meter readers and fixed-cycle meter reading and billing schedules. Meter data is then electronically distributed between distribution, energy, and other service providers to support more advanced billing and energy management options.
Second Order Effects	**Increased Demand:** Information-based systems allow the development of more customer options and more timely information. The first effect, more options spurs customer demand for product and services. The second effect, more timely information, improves management functions and reduces the volume of unfavorable events and quality problems.	Bar code applications were quickly developed to support inventory, pricing, shrinkage analysis, automation of general accounting and automatic order entry. The same bar code information facilitated point-of-sale promotions, customer purchase analysis, spot pricing, product information on demand, and targeted promotions.	Electronic metered data is used to support dynamic real-time rates, automated facility management and the development of all virtual energy service companies. Demand responsiveness becomes an integral part of utility system reliability planning and operations. Customers integrate electronic data to optimize purchasing, production, and distribution decisions.
Third Order Effects	**New Business Structures:** Information technology encourages a shift toward more coordination-intensive business structures. Availability of data allows decision making to be decentralized which reduces the need for layers of management. Automated links between organizations cause activities in one to trigger response in all others that may reside on or participate in the value chain.	Bar codes now support automated manufacturing, real-time order entry, and automated Internet shopping applications directly from customer residences. Concepts developed with bar codes were also instrumental in the development of smart cards.	Electronic metered data is integrated with financial markets and energy resources to support dynamic fuel switching and demand management. Conventional billing and financial transactions fully automated to maximize asset yield management for suppliers and customers. New companies evolve to support dynamic integration of conventional and distributed supplies.

The next development was linking specific purchases to individual customers through the use of discount cards that captured enhanced information about customer purchasing patterns. The same bar code information then facilitated the development of entirely new applications targeted at improving customer service and value. Examples include; point-of-sale promotions, customer purchase analysis (market research), real-time price updates, dynamic promotion with point-of-sale coupons, enhanced product price/health information through localized displays, and support for portable self-checkout devices. Today, the use of bar codes is being further expanded to support real-time order entry and automated shopping applications directly from customer residences.

All of these functions have value to the customer and impacts to provider operations. Current investment decisions in bar code and related systems now consider a very wide range of cost and benefit value components.

If advanced metering follows the same pattern evidenced by the implementation of electronic cash registers and bar codes, then focusing only on the original "checkout" function (meter reading) produces a sub-optimal investment decision that grossly understates the value of metering.

Establishing the Framework for Preparing the Business Case

Traditional utility cost benefit analysis embodied in the Standard Practice methodology (SPM) and other conventional business case approaches emphasize cost minimization. In doing so, these approaches implicitly establish the functionality of existing metering and information management processes as the defacto standard against which all other alternatives are judged. With this approach, new investment is judged not by the value of the future capabilities and customer needs supported but by how well the 'new system' can satisfy the 'existing system' business practices. Regulatory approaches rarely start from or assign value to functional capabilities necessary to support anticipated future customer or market needs. Consequently, metering options that provide additional and more valuable functionality at a higher initial cost, immediately become less attractive investments because there is no attempt to value the increase in functionality relative to the level of service provided in the existing metering system.

Investments in advanced metering are usually evaluated using a form of capital investment model or Standard Practice methodology. Both methodologies compute the net present value of a stream of costs and benefits over a defined time period. In both cases, the prospective investment is considered feasible only if the net present value is positive. Utilities that operate in a regulated environment may also have to consider other Pareto Optimal 'least cost' criteria where guidelines may mandate that (1) the aggregate dollar value of the benefits must exceed the investment cost and (2) the investment must also produce an outcome where no one will be worse off – a no loser outcome.

However, both the Standard Practice[1] and other conventional approaches have many limitations that tend to misstate both the costs and potential benefits from implementation, specifically:

- Meter system costs do not generally consider outsourcing or other less expensive alternatives to utility ownership and benefits often are defined only as customer demand and energy savings, valued according to existing rates rather than actual wholesale or effective market prices.
- Investments in advanced metering do not consider the aggregate cost for other utility hardware and information system investments necessary to provide related call center, outage management, billing and customer services that would otherwise be provided through implementation of an integrated advanced metering system. In other words, the business case focuses on the costs and benefits from only one individual component of a much larger suite of loosely connected systems.

[1] See "Briefing Paper: Problems with the Standard Practice Methodology", Report to the California Energy Commission, Levy Associates, August 2003.

- Finally, the risks and opportunity cost for 'not investing' in updated metering systems, while difficult to estimate are often ignored all together.

A capital investment model provides a reasonable and comparable approach for evaluating the metering investment decision only if the traditional 'metering system' analytical framework is modified to specifically address the three limitations identified above. Three changes to the analytical framework are required.

1. Scenario Approach: A scenario approach that includes three levels of implementation and two financing alternatives will produce the information necessary to examine the sensitivity of the business case to implementation related economies of scale and financial economies of ownership. Figure 3, depicts the six scenarios to be examined under the recommended scenario approach. Each financing and implementation option is described in Table 3.
2. Integrated Utility System Cost/Benefit Scope: Each of the scenarios must assume that metering is just one component of an integrated set of utility operating and information systems. Changes in one system, metering in particular, will create beneficial and non-beneficial impacts in other systems. Cost and benefits must account for the differing impacts that each implementation scenario will / could be expected to have on utility costs, benefits and operations.
3. Opportunity Costs and Risk: Not having the capability to quickly respond to short-term weather related outages; normal market price spikes or longer-term outage/price situations incur a cost to both the utility and customer. For example, the inability to quickly implement supplemental interruptible, curtailable and demand response rates during 2000-2001 resulted in extraordinary increases in the rates and bills for all customers and potentially unnecessary rotating outages. Like traditional loss of load probabilities, some of these situations can be anticipated and estimated using risk-based adjustments. Developing rate designs that focused customer attention on just those hours with high market prices was simply not feasible. The potential opportunity costs and risks to not making the investment in advanced metering and related systems must be identified as part of the business case assessment.

Figure 3. Recommended Scenarios for the Advanced Metering Business Case

	Financing Options	
Implementation Options	**Utility Ownership**	**Outsourcing**
1. Base Case	A_1	B_1
2. Partial Implementation	A_2	B_2
3. Full Implementation	A_3	B_3

Table 3. Scenario Parameters

Financing Options	
A. Utility Ownership	Assumes conventional utility purchase and ownership.
B. Outsourcing	Assumes that the utility purchases metering and related services on a contract, outsource basis.
Implementation Options	
1. Base Case	Assume no additional advanced metering for the next 10 years, with a continuation of the existing metering and related systems, maintenance/expansion plans and existing rates. The Base Case must identify the actual costs for maintaining the existing metering and related support systems. The Base Case must also identify or estimate the actual financial and other impacts on other hardware and utility information systems as well as other improvements necessary to address development that would have otherwise been served by the Full Implementation scenario. The Base Case should also identify any significant investments in new metering systems made during the last five years.
2. Partial Implementation	Assumes implementation (electric only) that targets customer segments with a significant opportunity to save on their bills (residential and C/I) with support for TOU, Critical Peak Pricing and two-part RTP for the largest C/I customers.
3. Full Implementation	Assumes full system implementation (gas and electric) over a five-year period with support for TOU, Critical Peak Pricing and two-part RTP for the largest C/I customers. Implementation should specify an advanced metering infrastructure (AMI) with interval metering (minimum 15 minute intervals) and remote communication capability. Useful modifications to outage detection and other operating systems that are associated with the use of the AMI system should also be specified.

The traditional business case evaluation of advanced metering compares the costs of full implementation to existing base case system costs. Additional utility investment in billing, customer information, load survey, outage management and other related operating systems are almost always excluded from base case system costs. However, the full implementation or AMI scenario often includes the costs to modify these same systems, without also accounting for the benefits that might accrue from these modifications. Under the recommended scenario approach, modifications to the base case to keep the existing system up-to-date and to provide special functionality that might otherwise have been provided with AMI will be identified.

The scenario approach will allow a comparison of the incremental difference in costs and benefits across financing and implementation scenarios. This will provide the joint agencies with the data they need to evaluate the cost effectiveness of each scenario and the impact of AMR deployment on different customer segments.