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## **How Do You Put “Smart” into the Smart Grid?**

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## A New Era in Power Generation and Consumption

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Just as the advent of the Internet represented a new dawn in personal connectivity and communication, the smart grid infrastructure, including smart metering and demand response mechanisms, is replete with potential benefits for the utilities industry.

Consider just a few: improved power grid reliability, efficiency and safety; reduced carbon dioxide emissions; and two-way communication with consumers who can benefit from better pricing options.

For utilities executives, however, the challenge is finding the best way to use the huge volumes of smart grid data that soon will be at their disposal.

This paper offers views on the most effective ways to integrate, store, manage and analyze advanced metering infrastructure (AMI) and smart metering data. It also explains how to make sure the information that utilities use to make decisions is not only consistent, accurate and timely, but also contributes to operational intelligence and fosters predictive capabilities.

In addition, this paper describes the issues and concerns related to managing large volumes of meter data with proven data management techniques, providing data security and audit trails, building interactive data delivery portals and unlocking the information that resides within data through quality analytics.

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## Changing the Way Utilities Operate

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The utility sector is facing the prospect of significant change in the way that it does business due to new requirements on production and new consumer interaction with energy production and consumption.

Electricity production will change as jurisdictions around the world require utilities to build and deploy more renewable generation facilities: They will need to work well with fleet portfolio production structures. In addition, jurisdictions are mandating that the utility business operates differently, through emissions regulation or the liberalization (deregulation) that is opening previously closed markets.

Consumers will use power differently as well, deploying software and hardware products that allow them more control over their consumption, like time-of-use pricing or even feeding the grid with surplus generation from rooftop solar panels.

But possibly the most exciting trend is the prospect for AMI, and its related benefits.

AMI is the process of establishing a metering infrastructure that enables automated meter reading (AMR). Traditionally, utilities used people or “sneaker networks” to capture the monthly electricity consumption of their customers by reading meters located on customers’ properties.

Now, regulators are requiring utilities to implement AMR to reduce the inefficiencies and inaccuracies of manual meter readings. Other utilities are seeing the value of AMR, supported by AMI, as a potential cost-reduction option and are moving toward implementing it without the push of regulators.

Either way, if a utility is not already planning an AMR implementation, it likely will in the foreseeable future. Utilities will spend billions of dollars over the next decade implementing AMR and AMI. It will touch every customer and modify the way utilities interact with their customers.

But utilities will be concerned about the costs of AMI implementation, especially in view of difficult worldwide economic conditions. They’ll also be concerned about the ability of their own staff to handle loads of data coming from millions of new devices spread across their service area, surprising unprepared utilities with their speed and quantity. The pace of change in those new devices – and the data they provide – will require planning, flexibility and agility on the part of the utility enterprise.

Finally, the changing utility business will not stop at AMR and AMI. Utilities will grapple with even more change that will come from the eventual implementation of the Smart Grid, defined by the US Department of Energy as the use of “digital technology to improve reliability, security and efficiency of the electric system: from large generation, through the delivery systems to electricity consumers and a growing number of distributed-generation and storage resources.”<sup>1</sup> The Smart Grid will produce more granular data, creating more requirements for systems that have to respond to and handle data.

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<sup>1</sup> “Smart Grid: Enabler of the New Energy Economy,” Electricity Advisory Committee, December 2008, p. 12.

## Operational Intelligence: The Benefits of AMI and Smart Grid Implementation

Long before utilities finalize their visions for a smart grid, AMR systems will eliminate manual data entry errors, reduce inaccurate bills, lessen the need to access premises and reduce the number of meter-reading personnel. AMR systems are viewed as means to assist cash-strapped utility companies.

AMR will also enable utility companies to bill using a time-of-use rate structure, charging customers based on the true cost of service when energy is consumed. The expectation is that time-of-use rates will lead to a reduction of at least 5-10 percent in demand, on average, per customer, in less than two years, translating into millions of dollars in reduced energy demand per state or province.

The AMI systems that will manage AMR systems are designed to reduce operational costs and meet the new regulations that make demand response and outage management features necessary. Utility companies expect to save at least as much as the cost of the whole AMI system over the lifetime of the system. Operational intelligence enables these companies to leverage the vast information collected from AMI systems so they can understand consumption patterns and the costs tied to them. This data fuels earnings by taking risk, customer, financial and operational intelligence to the customer level. Utility companies can then target customers, networks and interventions in order to maximize efficiency and overall profitability.

Greater operational intelligence also ensures that there is sufficient capacity to meet peak demand. Depending on where growth occurs within a utility's service footprint, there might not be sufficient capacity to support expected growth. A strong operational intelligence solution can enable the utility to forecast future load growth at ZIP-code level, to enable peak hour growth to be matched to infrastructure capacity.

Operational intelligence also benefits utility companies by helping them to maximize the performance of their assets. Operational intelligence gives utilities the capability to predict and set alerts for equipment failures. It consolidates and reports on the vast amounts of data produced in field service operations so companies can measure the cost and effectiveness of those services. Proactive management of the field service organization reduces unplanned outages and optimizes field service efforts.

Operational data can also alert companies as to when regular preventative maintenance should occur to prevent unplanned repair calls and potential failed equipment situations. Such data also provides information on inventory, tools and skills required of service technicians on each call. That information helps technicians complete their work the first time out.

## Anticipated Obstacles to AMI and Smart Grid Implementation

As with any major change in the way companies do business, there are many hurdles associated with implementing AMI, especially because utilities are so large and their business so complex.

The implementation logistics alone are astounding to consider, with each utility needing to deploy millions of new devices at their customers' sites. Once all the hardware is out in the field, tested and operating, utilities will be collecting untold quantities of new data about their customers' minute-by-minute consumption of electricity.

For instance, in just the first six hours of operation, an AMI implementation will generate the same amount of data on a customer as produced in the entire year before. In just 25 days, it will generate the same amount of data as the last 100 years.

Utilities so far have been focused on hardware and communications aspects of their AMI rollouts, but now more are trying to get a grip on what they're going to do with all the data streaming in from millions of new devices. They are asking how they can turn the data into meaningful information to gain greater operational intelligence.

Other challenges exist. Security is a key obstacle to moving beyond AMI and toward the Smart Grid. Large quantities of data will stream in from more types of devices and different networks, and this data will be provided to different types of users on a variety of applications. Regulators will require utilities to understand and enhance their in-place security to make sure it's complete. And data records will need to be maintained so that when something goes wrong and the Smart Grid makes a dumb move, the utility can find out where the bad decision was made and adjust accordingly. Some analysts anticipate that utilities might want to try to find minute changes in customer behavior using data that is now three, five or even 10 years old to perform long-trend change analyses. The need for smart changes is endless.

**AMI offers ample business case justifications for implementation. AMI data will help the utility by:**

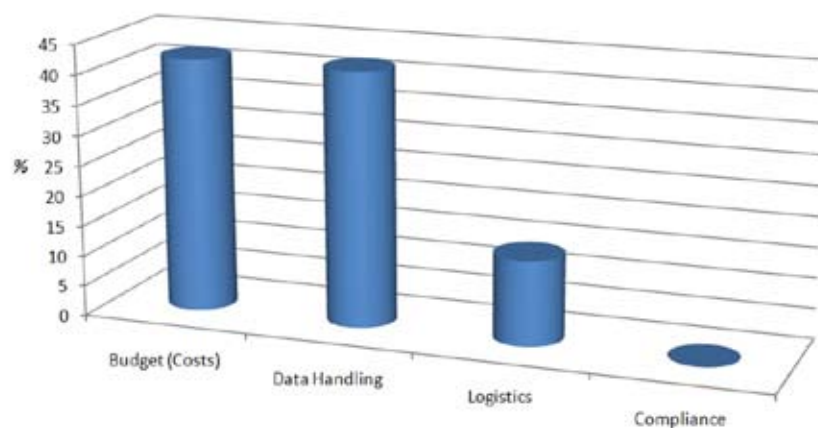
- Improving reliability.
- Increasing efficiency and measurability.
- Giving utilities the ability to design new rate structures.
- Optimizing distribution assets.
- Detecting fraud.
- Improving forecasting.
- Visualizing trends and anomalies.
- Providing the opportunity for real-time analysis of large amounts of data.

## Anticipated Concerns About AMI and Smart Grid Implementation

In addition to those challenges, utilities have expressed concerns about issues such as:

- Security, including utility personnel and end users, as well as inter-application.
- Performance.
- Reliability.
- Audit trails for changes.
- Central administration for backup and redundancy.
- Amount of data needed at any particular point in time.
- Flexibility and agility to respond to new equipment options or business circumstances.

### Utilities' Biggest Fears In Implementing AMI

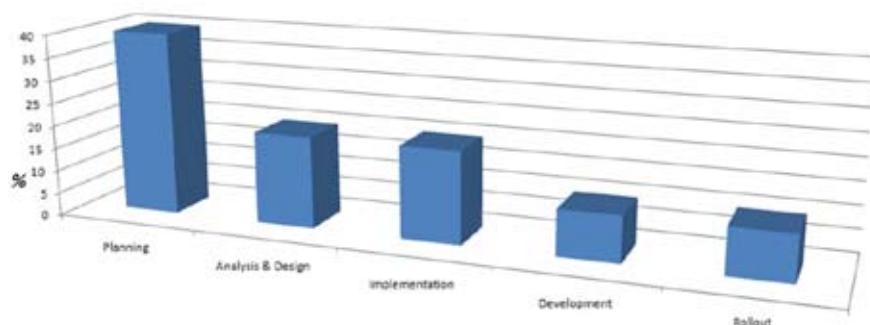


Source: SAS Webcast: Putting the Smart in the Smart Grid, Dec. 8, 2008.

Some secondary concerns involve architecture and exceptions:

- With regard to architecture, utilities are trying to determine if they should have one system of record for all their stakeholders for analysis and reporting, or whether they want to have separate data marks with subsets of the data for the individual stakeholders that are using the data for analysis.
- With regard to exceptions, utilities will need to create measures for handling the data that doesn't fit protocols. The millions of new devices coming online from new automated meters and the Smart Grid will require expert governance solutions.

### What Phase Is Your Smart Grid Project In?



Source: SAS Webcast: Putting the Smart in the Smart Grid, Dec. 8, 2008.

## Key Success Factors to AMI and Smart Grid Implementation

To achieve the benefits outlined above, a successful AMI implementation requires a data management plan that allows the utility to take the data and then warehouse, validate, clean and make it available to all the stakeholders for analysis and reporting. The system will need to be flexible and agile to incorporate smart grid evolutions.

Currently, utilities are dividing into two groups in their observable plans for handling the large quantities of data that will flood in with new AMI implementations.

The first group focuses on where it is going to put the data, i.e., which data warehouse or storage system will be used to store the data. Since the incoming data is more than most utilities have ever generated, the immense quantities of data are a real concern. This group is dealing with the here and now of AMI data.

The other group takes a completely different approach by acknowledging the need for a near-term plan to store the data, but then it goes a step further. It is focusing on the potential to apply predictive analytics to the data, to create business insights and intelligence that weren't previously possible. For instance, a utility might seek to predict how the users of the grid will respond on degree-day variances. The answers will come from statistics gleaned from the AMI-generated data.

“The “smart” in Smart Grid will come when utilities can look forward to see clearly what is coming, just as the banking and telecommunications industries have been doing for decades.”

## SAS® Solutions for AMI and the Smart Grid

SAS provides data management and analytic capabilities to assist utilities in optimizing their business performance.

**Easy conversion of utility transactional data.** SAS data integration and management technologies converts transactional meter data management and data from operational systems by managing many data sources and automating conversions into a forecast-ready format. SAS Analytics bins transactional data into the desired time intervals, such as hours, days, weeks, months, etc., and produces statistics on each interval that can add business insight.

**Utility performance monitoring.** SAS Analytics not only forecasts, but also provides a look at, historical trends. Historically, high or low demand can be brought to the attention of analysts so they can make better decisions about power availability. Similarly, historical trends can be identified, helping analysts to understand the effects of climate and economic factors. By building predictive models, analysts clearly see future demand patterns which helps make the Smart Grid more reliable.

**Unprecedented scalability.** Designed to forecast load demand on the grid by analyzing millions of metering data with unprecedented speed, SAS solutions for utilities can provide forecasts at any level of geographic or asset hierarchy, all the way down to the meter level. Forecasts can be produced for any frequency – hourly, daily, weekly, monthly, etc. – in accordance with the different planning needs within the organization. Because SAS Analytics is so scalable, forecasts can be updated as often as desired. With each update, new forecasting models and parameters are calculated so that the forecasts adapt with changes in the marketplace.

**Unsurpassed analytics for improved forecast accuracy.** All forecasting model parameter estimates are statistically optimized every time forecasts are generated for each combination. This ensures the greatest possible accuracy and allows the forecasting model to adapt as underlying demand patterns change. SAS Analytics takes the burden off of busy forecasters and planners and provides them with the information necessary to gain a competitive edge.

**Automatic selection of best model.** Based on well-documented, statistically sound procedures, SAS Analytics automatically selects the statistical models that best fit the data and generates forecasts with no need for human intervention.

**Seasonal changes.** Due to the changing needs and use of customers, the demand for power typically fluctuates over the course of a day, week, month, year, etc. SAS solutions for utilities account for these natural fluctuations in demand, or seasonality of power, when forecasting.

**Variability measures.** Confidence limits, available with every forecast, indicate the variability of the forecast. These variability measures are useful in the inventory replenishment planning process where customer service levels need to be guaranteed to a certain level.

### ■ SALT RIVER PROJECT (SRP)

When the Salt River Project was faced with the challenge of knowing when to sell excess electricity for the best price, it turned to SAS solutions for utilities. SAS helps pull together disparate data for translation into intelligence that feeds a sophisticated forecasting model that provides timely and accurate results.

“We’re talking tens of millions of dollars in what this group does, so the impact of SAS has to be in the millions.”

**Harry Sauthoff**

**Principal Financial Analyst**

### SAS® by the Numbers

Enterprises around the world use SAS foundational technology to manage high volumes of data, glean valuable enterprise intelligence, optimize performance and predict demand. In fact, SAS may be the only technology that has been tested and proven in production with massive data volumes:

- SAS has over 45,000 clients around the world.
- Hundreds of sites use SAS Intelligence Storage, which hosts data warehouses in excess of 30 terabytes.
- SAS technology can access over 200 data sources.
- SAS is database-neutral, and thus, can implement the data store on major database platforms such as Oracle, DB2 and Microsoft SQL server, as well as many others. This enables utility companies to keep their existing software investments.
- SAS set a world record on published benchmarks of 81.2 gigabytes per hour per CPU for data loading.

**Versatile and customizable output.** With SAS, you can share forecasting output across the enterprise or with select business units via a Web browser. Output can even be sent to individual sites, allowing them to make better planning decisions. Forecasting results can also be customized to seamlessly deliver to anyone who needs to view them.

**Exception reporting.** Automatically generated forecasts that fall outside of a desired performance standard can be flagged for additional attention. SAS provides a full range of in-depth analytic and forecasting capabilities to address more specific forecasting needs.

SAS solutions for the utilities industry combine award-winning software and best-practice services to transform masses of data into strategic business intelligence and perform analytic and BI processes with minimal administration.

## SAS®: Proven Success with New Data Challenges

It's a fact that all companies are coming to the AMR, AMI, and the smart grid marketplace with few direct case studies to offer as proof that they understand the new business issues that need to be taken into account in the emerging era of the Smart Grid – issues such as managing and analyzing the massive volumes of expected data and accurately predicting demand.

SAS, however, has many years of experience working for a wide range of vertical markets that have faced new data challenges, including healthcare, telecom and financial services. Interestingly, there are striking similarities between the use of SAS technology within the financial industry and the likely requirements for smart grid/AMI implementations.

For instance, several major credit card vendors use SAS technology to store and analyze all their data in real time, primarily to detect and prevent fraudulent use of cards. The amount of data is staggering when you consider that cardholders may present their credit card several times throughout the day for purchases. Such voluminous credit card transactions can be compared to a utility's continuous meter readings.

Utility meters will be doing essentially the same thing, but at set, user-defined intervals, sending information back to the utility for analysis. Utilities have the ability to determine whether their analysis is real-time, quasi-real time or historical.

SAS also offers one federated view of all the information that's available to the utility. Indeed, SAS software's most applicable strength may be its proven ability to access other business systems to pull and push data and convert that into forecasts, reports and analysis. SAS understands that utilities have many types of business systems in place that will be called upon to play a part in implementing the Smart Grid - Oracle, DB2, weather data, SCADA data or SAP.

Facing the data onslaught need not be a nervous undertaking. With SAS, experience and robust applications offer the possibilities for new, unforeseen improvements in companies' business operations.

### ■ PBS

PBS, a leading provider of electronic payment systems in Denmark, processes 2 million to 4 million transactions daily and 700 million a year. It maintains 3 billion to 5 billion historical transactions. With the amount of data growing by 30 percent a year, PBS was unhappy with its processing time. Using SAS, processing time dropped from eight hours to an hour, and querying times are now consistently fast. The solution has paid for itself in postponed mainframe purchases.

“With SAS Intelligence Storage, we can reduce response time and increase accessibility. Those are crucial to us.”

**Dainis Krastins**  
Chief Technology Officer



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