THE POWER TO KNOW®

How Does Forecasting Enhance Smart Grid Benefits?

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Executive Summary

Every industry – including the energy and utilities sector – is still reeling from the impact of a global recession. But unlike any other industry, utilities are under intense pressure, both environmental and regulatory, to:

- Curb greenhouse gas emissions.
- Decrease the volatility of energy prices.
- Increase efficiency through grid optimization.
- Increase the supply of renewable and distributed power generation and storage.
- Provide advanced consumer services.
- Implement an advanced metering infrastructure to monitor energy consumption and instruct consumers on how to spend less.

Deploying the technologies to address these challenges, and ultimately transforming utilities from the inside out, requires insight and foresight. While utilities have successfully used forecasting in the past, this new set of challenges will require even greater attention to the data sets and data models that feed those forecasts.

This white paper examines the new challenges affecting forecasters, as well as the opportunities for harnessing smart grid data to maximize the value of forecasting.

New Utilities Industry Challenges

The longstanding challenge is to supply resources at the lowest resource cost. Now, utilities also must comply with new rules and expectations for their operations. These new challenges are different. They require utilities to plan for future uncertainty in:

- **Fuel price volatility**. The volatility in gas prices after hurricanes in 2007 and 2008 drove some retail energy companies into bankruptcy. Severe shortages of generating-fuel sources, even coal and water, followed by oversupply, are the norm. Budgeting for fuel is sometimes like consulting a crystal ball.
- **Carbon tax possibilities**. Many legislative initiatives under consideration include carbon taxes of varying rates and implementation schedules. These taxes will greatly affect already volatile fuel prices if they are enacted.
- **Energy efficiency program mandates**. State and provincial legislatures or utility commissions aren't waiting for federal guidelines. They are demanding that utilities look at alternatives for building new generation, especially improving current grid and generation efficiencies. This affects loads and load shape.
- **Regulators' demands**. Regulators are going to expect utilities to answer questions about the effectiveness of programs intended to reduce load. They are going to ask utilities to go back and determine whether goals were met for energy efficiency. In the case of regulated utilities, the answers will have an impact on the ability to recover costs.
- **Economic uncertainty of recession**. As global and local economies struggle to emerge from the worst recession in a generation, utilities are tasked with implementing infrastructure and operational changes to meet these challenges. Their efforts are made more complex because of uncertainty caused by revenue instability.
- **New user profiles**. In the past, utilities viewed meters, not people, as their customers. But demand response programs, smart appliances, plug-in hybrid electric vehicles and home area networks are changing that view. Utilities now understand that the behavior of all the different users of air conditioners, televisions, water heaters, hybrid electric vehicles and other appliances contributes to the loads of households throughout the day. As a result, utilities will be required to understand demographics and user profiles. For example, utilities must grapple with the possibility that an increasing percentage of their customers' vehicles will be plug-ins and will need to consider the implications that will have for demand.

Key Forecasting Capabilities in the Smart Grid Era: Data Segregation

A large East Coast utility has a smart grid pilot project producing hourly data. This utility has learned the importance of analyzing individual customers – whether they are large business users, small or large commercial or industrial customers, or residential customers. Pre-aggregating the load requirements attempts to predict the answer *before* any analytics are performed.

The danger in guessing is immense. If the utility has a peak load of 100 megawatts in a neighborhood, it wants to be able to identify the 90 percent of customers consuming 10 megawatts and the 10 percent of customers consuming 90 megawatts. Averaging won't work in this situation, especially if the utility wants to offer incentives to the top 10 percent to consume electricity at other times of the day.

The utility has learned, through its pilot, that it needs tools to perform segmentation before it begins analysis.

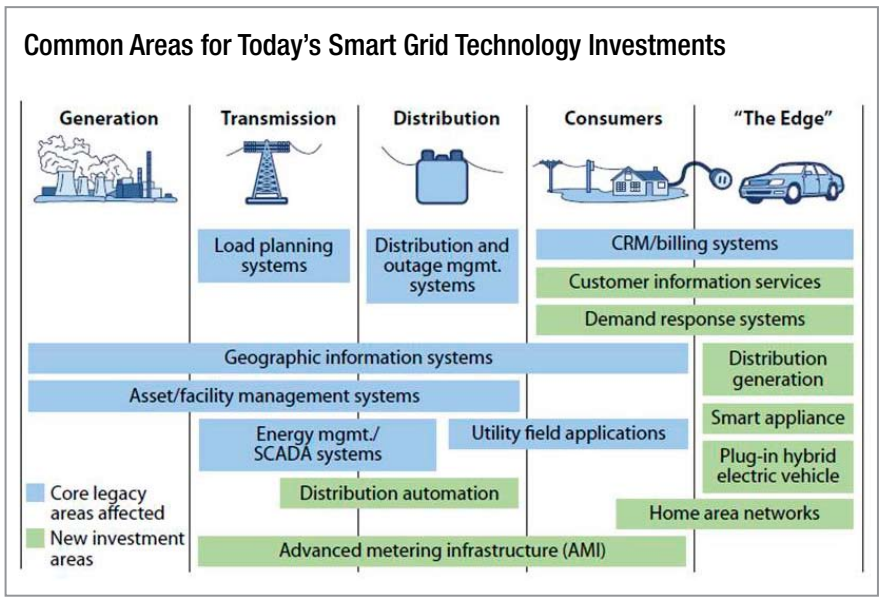


Figure 1: This traditional view of smart grid implementation shows how consumers and "the edge" are now being considered customers, not just their meters. Utilities will come to see all the different users of air conditioners, televisions, water heaters and other appliances as contributing to the loads of those households at different times of day. They will be required to understand demographics and user profiles.

Enter the Smart Grid

The change that is required is irrevocably tied to the analytical use of data created by the advances of a smarter grid.

The smart grid is viewed as the enabler for utilities grappling with new economic and regulatory realities.

This new grid, with its smart metering and advanced metering infrastructure (AMI), will affect how:

- Load is determined and met.
- New technologies will affect energy sales.
- Customers will interact with the utility for their purchases of electricity.

As utilities implement the AMI and smart grid systems intended to help with some of the challenges outlined above, they will be creating torrents of data that could be harnessed for new business insights.

Utilities seeking the greatest return on investment for their new technology installations should use new business transformation technologies to maximum benefit. Advancing the tools and techniques of forecasting using information technology will be important in achieving that goal.

Meeting Smart Grid Challenges Through Forecasting

Many utilities already use forecasting to address their current challenges, but forecasting will increase in importance because of the growing complexity of challenges and the availability of more data inputs from a data-rich smart grid environment.

Forecasting is a data-intensive numeric discipline that utilities use for a wide range of planning, investment and decision-making purposes. Simply put, forecasters attempt to determine how customers will use energy and then plan utilities' operations around that possible use. Forecasters try to understand, on an hourly or monthly basis, how customers respond to prices, weather, climate change concerns and personal economic conditions. They also look at new factors, such as energy management software or electric vehicle recharging concerns.

In short, forecasters try to predict patterns of behavior using a wide range of factors. Understanding and quantifying these factors helps build forecast models. Applying customer segmentation techniques makes these models even more precise.

New Forecasting Models Must Work with Smart Grid Technologies

Most utility forecasters have been working with models they have developed over the last 15-20 years – models developed in mostly good economic times. The forecast models tended to perform well simply because there was not a lot of volatility in either the data or the variables affecting customer demand.

That relative stability is evaporating quickly because of the new challenges to the industry and the rapid expansion of smart grid projects that enable greater efficiencies at the utility and customer levels.

Today, energy efficiency programs and growing customer awareness about energy consumption are forcing forecasters to make wholesale changes to their models.

Many existing models are not performing to the standards that utilities or their regulators expect. Utilities are being forced to look at their models and reconsider how they evaluate, manage and select data in order to create models that answer regulators' questions regarding efficiency and operational questions coming from management.

New Questions for Forecasters

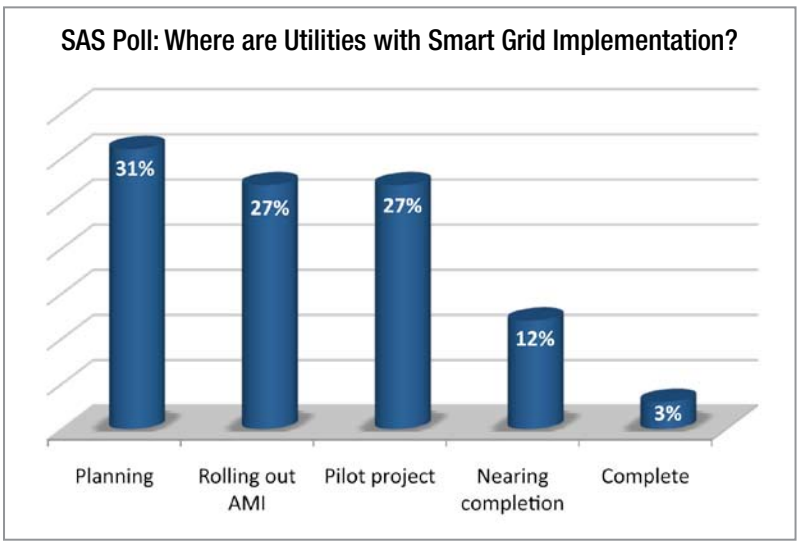
Utilities forecasters are facing new challenges related to gaining the greatest value from data inputs, including how to:

- Manage large quantities of energy usage data from new inputs from smart meters.
- Quickly build forecast models for smaller time increments, such as 15 and 30 minutes.
- Organize, summarize and analyze continually growing data sets. In the first six hours of operation, one smart meter could potentially generate the same amount of data as was produced for the entire previous year. In only 25 days, the meter could generate the same amount of data as was produced in the previous 100 years.
- Identify which indicators are having an impact on the forecast and how to quantify the impact.
- Know when customers are changing their behavior in response to economic conditions, climate change, demand response programs or government initiatives, such as smart meters.

New questions to be answered include:

- As customers throttle back their thermostats to save money and manage bills, how should utilities respond with regard to their purchases of natural gas, coal or wind power?
- What times of the day have the largest impact?
- What if the temperature varies significantly from the forecast on any given day – how will that influence customers' behavior?
- Will customers gain the confidence to increase their climate comfort even if it means paying larger bills? Or will climate change concerns cause them to grow content with less comfort in the home and office?
- What types of pricing programs (time of use, critical peak, etc.) are likely to produce the largest benefits? Which segments of the customer base are most likely to respond – and thereby influence the forecasted demand during periods of energy curtailment?

Utilities' forecasting models must now anticipate customer response and changing attitudes about energy consumption in addition to such traditional influences as economic and weather conditions. Models must also be built quickly to test new hypotheses and scenarios, and to answer what-if questions from shareholders, management and, increasingly, regulators.



Source: SAS webcast poll, "Smart Solutions for the Smart Grid: Enhancing Your Forecast Methodology for the 21st Century," March 4, 2010.

Most smart grid implementations are still in their planning and pilot phases. This gives utilities the opportunity to plan how to demonstrate the benefits of new technologies, especially as they relate to maximizing the new data sets coming from an advanced metering infrastructure. Utilities will have to do the analytics today to get the green light from regulators and senior management for implementations tomorrow.

Expect Load Forecasting Techniques to Change

Currently, forecasters and modelers spend most of their time evaluating, managing and repairing data problems and errors. Moving forward, modelers and forecasters must use their IT systems more efficiently. Future state IT forecasting solutions will need, at a minimum, to:

- Quickly process large volumes of meter data.
- Develop new models when historical forecasting models lose relevance.
- See what factors are driving energy load.
- Explain the impact of each new factor to management.
- Understand the impact of weather across the utility's entire territory.
- Understand the impact of energy efficiency and demand response programs by customer class or ZIP code.

Sensitivity Forecasting Comes to the Fore

Providing a single forecast – or even a forecast with a high and a low probability – no longer works. Now, forecasters are asked to produce peak-energy forecasts under a variety of scenarios and must be able to prepare these forecasts quickly.

For example, management executives might read a news story about a large industrial electricity user facing difficulty or even bankruptcy. The executives want to know immediately how that might affect their load forecasts and earnings. This type of what-if or scenario-based modeling requires enterprise-level forecasting tools that provide agility, flexibility, scalability and accuracy.

These sorts of developments can affect long-term forecasting for integrated resource planning and construction planning. Small changes can have a big impact on utility operations – especially if the changes are not anticipated, forecasted, correctly interpreted and then acted upon. Approaching change proactively, rather than reactively, is a key factor in how quickly those actions occur.

Looking Ahead

While existing forecasting methods have performed well in meeting the objectives of the past, new methods and IT resources will advance quickly to define the future. The speed of adoption will be rapid because of the flood of new data pouring in from the smart grid and AMI.

These new forms of forecasting techniques will include intricate combinations of:

- Nonlinear and linear forecasting.
- Time series and other types of model forms.
- Undiscovered or previously unobserved component models.
- Models that look at data origination.

Utilities may also use diverse model forms that forecast different views of the future.

Utility forecasters will have to decide which model is best. Alternatively, they might consider a combination of models, or a weighted average of the different forecast models, in order to minimize the variability in the estimates. The days of one-size-fits-all are gone for the utility forecaster.

Disaggregating Weather Factors for Better Forecasting

Utilities know that weather is a major driver of load. Consumers respond to minute-by-minute changes in temperature – whether caused by temporary cloud cover or fluctuating winds.

While large utilities have dozens of weather stations across their operating regions, they have learned that not all customers in the same territory are affected by weather in the same way. Disaggregating load data for regions located on hills, in valleys or along shorelines makes sense because those users will likely respond to weather events differently.

Utilities' forecast systems must be able to build disaggregated forecast models that look at a variety of weather factors. Temperature alone is no longer the primary forecasting option, and forecasting models must be able to determine more indicators of factors affecting load.

Chosen forecasting models must be easily understood from an input and output perspective. The forecaster should be able to answer the question: "What factors were used, which weren't and why?" Senior management and regulators will want to understand why the forecasting model performed the way it did. Black-box forecasting solutions will not likely provide the answer.

Having the right combination of forecasting tools and information technology will determine success or failure in this new era and maximize investments in smart grid infrastructure.

Additional Insights

This white paper is based on insights shared in a SAS on-demand webcast: *Smart Solutions for the Smart Grid: Enhancing Your Forecasting Methodology for the 21st Century.*

To view this free webcast, visit www.sas.com/smartgrid.

Discover how your organization can prepare for the smart grid, and capitalize on the influx of data that's coming with it, by making analytics an integral part of your system design, testing and implementation, and a foundation of your forecasting methodology.

To learn more about SAS solutions and technologies, please visit www.sas.com/industry/energy.

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