# Smart Grid Vision Meets Distribution Utility Reality

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**Notices**

## Introduction

The term smart grid is a hyperbole that seemingly implies a future vision when the grid runs itself absent human intervention. While this is clearly not the case, there is a hard reality emerging: the smart grid concept in many ways suggests that utility companies, executives, regulators, and elected officials at all levels of government will indeed face a brutal "pass/fail" future with regard to electric service -- a driving force of USA's world leading economy.

Regardless of whether this is a few or many years away, there is an undeniable and growing industry realization that we need a smart grid to complement traditional investments in generation while addressing supply, demand, efficiency, and environmental impact as mutually critical components of utility industry and national energy strategy.

The distribution utility industry is now in the early stages of deploying many computer-driven automation, modeling, and distribution operation paradigms embodied in smart grid concepts. Very recently, NARUC provided critical support for advanced metering infrastructure (AMI), an enabling foundation for the smart grid, at the February 2007 meeting. Momentum for the smart grid is increasing and, despite the recalcitrance of some, it is clearly not a passing fad.

At the heart of all of this unusually rapid movement for utility industry is the growing conclusion among many leading utility executives that, over time, the practical and cost-effective deployment of smart grid strategies will separate longer-term winners and losers. Simply stated, utility leaders are starting to see the smart grid as smart money.

The smart grid vision for the market has evolved in recent years through the work of various consortiums and early adopter efforts at utilities. But the smart grid movement is, by necessity and by function of the utility industry, more of an evolution than a revolution. The essence of the smart grid lies in digital control of the power delivery network and two-way communication with customers and market participants. This intelligent infrastructure will allow for a multitude of energy services, markets, integrated distributed energy resources, and control programs. The smart grid is the essential backbone of the utility of the future.

For utility executives, the implementation of a project of such scale and complexity can be daunting. Fortunately, there are cost-effective and incremental steps that can have a large impact on achieving the benefits of the smart grid and put a company on a path for long-term success.

## Distribution Business Case for the Smart Grid: The Big Picture

Distribution utilities are under significant pressure to meet new electric energy needs. Despite this, investment in smart distribution systems has historically been low as companies struggle with tightened capital budgets and other critical priorities. By some estimates, distribution information and communications systems are installed at less than 75 percent of North American electricity substations and distribution automation penetration at the system feeder level is estimated at only 15-20 percent.[1] Combine this with the fact that nearly 90% of all power outages and disturbances originate in the distribution network, and it's no surprise that the industry is now making a strong case that a fundamental investment in an intelligent distribution technology roadmap should be at or near the top of a utility's priority list.

There is no one-size-fits-all consulting "recipe card" for utilities to develop such a roadmap or program. Each utility must take stock of its current efforts, strategy, infrastructure, and regulatory circumstances while tailoring a smart-grid technology road map to meet particular circumstances. However, recent industry reports can provide valuable insight.

For example, an October 2006 study by The Energy Policy Initiative Center in San Diego outlines a scenario of smart grid implementation on the San Diego electric grid. This study shows that an initial $490M investment would generate $1.4B in utility system benefits and nearly $1.4 B in societal benefits over 20 years.[2] It is evident that these types of smart grid investments will pay handsome dividends to utilities, shareholders, customers and society at large. The smart grid also serves an important role in facilitating energy efficiency programs and distributed/renewable energy integration: both key trends that will help ensure improved environmental outcomes in the future. Smart grid studies are underway now in other parts of the country as regulators, government, and utilities collectively embrace both the challenges and opportunities.

[1] The Grid at the Hub of Utility Asset Management: The Importance of Building on Engineering Knowledge and Developing a Distribution Strategy and Technology Roadmap, Ethan L. Cohen, Senior Director, UtiliPoint, 12/2006

[2] Energy Policy Initiatives Center report, San Diego Smart Grid Study, 10/06

## Integrated, Real-time, Self-healing Electricity Delivery of the Future

Smart distribution technologies are central to achieving the benefits of the smart grid and to meeting the needs of the 21$^{st}$ century. The economic losses to the U.S. economy as a result of power disturbances and anomalies are high, but so is the opportunity for improvement as a bulk of cost savings achieved through intelligent automation goes straight to the electric utility's bottom line. Breaking the implementation process down into incremental phases will help utilities create a road map that system planners can use to build a phased approach.

The following are key product elements and practices that can be implemented in a phased plan that delivers incremental benefits in the security, quality, reliability, and availability (SQRA) of a utility's distribution systems. (Reference article below: *Quantifying the Impact of the Smart Grid: 'SQRA'*). Utilities should give important consideration to the evaluation and deployment of standards-based, model-driven, system automation platforms.

Investment in an integrated platform that allows a utility to expand its efforts over time, while leveraging installed infrastructure today, is a key consideration in smart grid strategy:

### Advanced Metering Infrastructure

There is no smart grid without widely deployed, intelligent metering systems and meter data management. AMI systems that support two-way communications with customers while supporting secure, encrypted, and reliable system wide communication for distribution automation represent an enabling foundation for the smart grid. Increasingly, utilities will engage customers through two-way energy/information portals and through other automated means. This could, in the future, create a fully functioning marketplace with C&I accounts and residential customers with automated computer agents tied to home automation systems responding to price signals.[3]

### Distribution and Outage Management

The focus of achieving cost savings and improved customer service lies in distribution management systems (DMS) that provide real-time response to adverse or unstable conditions. In a smart grid, software programs must provide self-healing functionality in order to instantly detect and react to power disturbances with minimal customer impact.

[3] Electricity Sector Framework for the Future, EPRI, 2003

The smart grid DMS system must provide a seamless graphical view with real-time performance, integrating all relevant network information from various sources in a dynamic system topology model. The interface will provide new and innovative techniques to the presentation of data and information based on system connectivity. Over time, the first generation of trouble-call type OMS systems now deployed at the majority of utilities will give way to smart grid DMS/OMS platforms that are tightly linked to advanced metering infrastructure (AMI). Through the consolidation of both real-time OMS and DMS functionality, telemetry, and integrated security, smart distribution systems will be poised as a true self-healing network.

## Distribution and Substation Automation

Transmission systems have enjoyed virtually complete supervisory control of transmission network switching since the early 1980s. In contrast, distribution systems are far behind. Automated switching not only enables the operator to make necessary topology changes to the network, but also it reduces demand on field crews, who otherwise must manually accomplish the switching actions.

The smart grid will require functionality such as control center supervision, area-wide solutions and visualization with centralized modeling. Implementations should leverage installed infrastructure and deploy a model-based, scalable approach to automation, providing a more practical and cost-effective solution that ensures that current hardware isolated and disconnected restorative grid technology gives way to true reactive, software-driven intelligence with central or distributed control.

## Simulation and Optimization

Through advanced simulation and optimization schemes, the utility of the future will reap cost savings and operational performance benefits not previously achievable. The ability to analyze automation and budget scenarios will drive smart grid planning and performance even further.

Routine and emergency response performance are indicators of a utility’s ability to react effectively to power disturbances on the system and optimize operations. Planning and training for either routine or emergency situations is accomplished using a transient simulator where real-time conditions are accurately presented. Smart grid operations will make effective use of simulators to improve operational performance and prepare utilities for the possibility of emergencies and disasters.

In the smart grid, distributed resources will further optimize the network with advantages such as increased security, fuel diversification and greater reliability. Modeling will be an important issue for utilities as they plan for increased distributed resources and employ practices such as transitioning control from a centralized to decentralized operation. Modeling market interfaces within an increasingly geodesic network framework could also follow in the future.

## Enterprise Business Intelligence

Overlaying these intelligent distribution system technologies is the enterprise business intelligence derived from system data and analytics. This key piece of smart grid operations provides the high-level presentation and ability for interpretation of grid data and decision support through real-time dashboards and historical analysis. Data is transformed into actionable information and a bridge is built between IT and operations.

Increasingly sophisticated modeling and artificial intelligence-based software will help create knowledge and efficiency from data. This process requires an intuitive data model throughout all operations to build knowledge on a common information blueprint and industry standard information object models (e.g., common information model, WG-14, open applications group).

As the smart grid is deployed, the largest potential economic variable is in data maintenance. The Gartner Group reports, "***A typical enterprise will devote 35-40% of its programming budget to develop and maintain, extract and update programs whose purpose is solely to transfer information between different databases and legacy systems***." The importance of platform integration and open architecture comes into play here as there are large financial benefits to efficiently leveraging available enterprise information with real-time smart grid operational data through data sharing between legacy systems. Sharing this information through secure web portals will also be essential.

## Summary and Conclusion

Intelligent distribution systems are an inevitable reality for utilities as they replace aging infrastructure, deal with capacity constraints, and strive to meet the demands of increasingly environmentally conscious and sophisticated end-use customers. While capital flow into the energy sector is improving, it is time for distribution companies to strike an optimal balance between cost, quality and service in pursuit of the smart grid.

The smart grid will be automated to support self-healing technologies and to respond to disturbances in the transmission system to prevent outages. Sensitive and specialized loads will be provided with improved power quality. New operating challenges will be confronted as distributed generators transform the network into micro-grid operations while preserving our environment. These efforts deserve regulatory and legislative support from all levels of government.

Utilities must employ a 'no regrets,' business driven approach to investment in smart grid systems, tailored to their individual needs and to the needs of their communities, if they are to succeed and provide exemplary customer service. Long term smart grid planning and implementation can be simplified through the creation of a smart grid technology road map and through the current inventory and modeling of a utility's existing system and development of its unique simulation. The business case must also take into account the cost effectiveness, operational improvements and return on investment of specific initiatives and must consider community-wide benefits. Regardless of the approach each utility chooses, a proactive incremental implementation of smart distribution systems can have a dramatic impact on system reliability and customer satisfaction.

In summary, a proactive review of utility smart grid strategy and legislative policy is vital. The leadership landscape will reward those who move now.

## Background References:


Grid 2030, U.S. Department of Energy, July, 2003

Electricity Sector Framework for the Future, EPRI 2003

The Cost of Power Interruption, EPRI/Primen 2001

Analysis of Extremely Reliable Power Delivery Systems, EPRI CEIDS/IntelliGrid, 2001

NERC Security Guidelines for Critical Infrastructure Protection

San Diego Smart Grid Study, The Energy Policy Initiatives Center, October, 2006

The Grid at the Hub of Utility Asset Management: The Importance of Building on Engineering Knowledge and Developing a Distribution

Southeast Energy Efficiency Alliance

Strategy and Technology Roadmap, Ethan L. Cohen, Senior Director, UtiliPoint, 12/2006

Strategic Directions in the Electric Utility Industry, Sierra Energy Group for Black & Veatch Energy, 2006

Jeffery Taft, Senior IT architect, IBM, The Intelligent Power Grid, whitepaper, 2006

Gartner Group

Center for Smart Energy & Smartgrid Newsletter

Center for Energy & Climate Solutions

Modern Grid Initiative

IDC Energy Insights

Intelligrid

Barry Ambramson, Servidyne

### *Quantifying The Impact of the Smart Grid: Security, Quality, Reliability and Availability (SQRA)*

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The business drivers and overall benefits achieved through the Smart Grid are dependent on SQRA. The greatest impact on the cost of energy is not the price of electricity and gas but the cost of power SQRA. An EPRI/Primen report, *"The Cost of Power Disturbances"* published in 2001 outlines the economic impact of power system anomalies and disturbances on the U.S. economy as equal to $119B to $188B each year. This is a tremendous weight on the productivity of U.S. businesses and to the economy as a whole.

#### *Security*

Security is one of the most important issues that utilities face and encompasses both external security of critical infrastructure systems and operational security of the electric system. The complexity and sheer size of the electricity infrastructure makes it vulnerable to both natural and human events. Unfortunately, even with decades of experience in security issues, there is an urgency to understand how to protect the system from terrorist or cyber attacks, particularly to control centers. In the broadest sense, high operational security relates to high availability of the electrical system and is best served by minimizing the impact of outages on the electrical network through minimizing instability, providing more diversity in generation supply and deploying self-healing networks.

#### *Power Quality*

Increasingly, critical industrial loads are requiring uninterrupted power supplies with tighter power quality tolerances. It is estimated that 60% of an average utility's load by the year 2015 will be required by sensitive electronics such as semiconductors and automated manufacturing. Furthermore, growth in the distribution system is leading to voltage stability problems due to the changing load composition. The resulting surcharge on electricity costs due to power quality issues is estimated to be 44%, accentuating the economic costs of poor power quality.

Improved power quality is accomplished by considering the interaction between the transmission and the distribution systems. The Smart Grid will monitor this impact. Activities to ensure load compensation, voltage and system stability, load shedding and optimal use of distributed generation will all be controlled in real-time through smart Distribution Management Systems (DMS) to mitigate outages and maintain power quality.

#### *Reliability*

The most critical business issue facing the industry today, worldwide, is improving reliability. In a 2006 Black & Veach study, utility executives ranked reliability as their number 1 concern. Clearly, the key benefit is improved customer service, but just as critical is the positive financial impact for the company and for society.

Improving reliability starts with the accurate measurement of its performance. Indices measure the quality of service based on its impact on customers and the system and reflect the degree of sustained outages in both frequency and duration (SAIDI, CAIDI, SAIFI, MAIFI). Intelligent infrastructure must not only measure, but also maintain an accurate log of each outage and its eventual restoration.

Automation will be a key ingredient to achieving reliability goals. As utilities automate different parts of their system, they must focus on the overall picture, preferably through the use of software systems modeling. Hardware-based automation of independent portions of systems has had a positive impact on improving service reliability; however, the integration of different automation technologies may pose compatibility issues and the continued development and deployment of standards is essential.

#### *Availability*

The quantity of power supply and control of that supply is becoming an increasing challenge from both potential limitations of supply and the issue of congestion. The assumption that sufficient supply means sufficient availability is no longer the case as system constraints continue to mount. An intelligent system is needed to ensure availability, providing such features as adaptive islanding, fault anticipation and re-routing.

There is a close linkage between reliability and availability in that each is a measure of the time that power is flowing to an end-use process and that process is up and running. However, according to EPRI's Intelligrid, "*availability acknowledges that once a process is interrupted, time is usually required to make repairs and get things up and running again.*" There is a distinct difference between the availability of power in response to a single one-hour power interruption and one of sixty one-minute interruptions. This is an important distinction for customers with sensitive digital loads as it can make a significant impact on business productivity.

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