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MAKING SMART GRID A REALITY

A White Paper by

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OVERVIEW

In 2007, *Cisco Systems* launched I-Prize—a worldwide contest to identify innovations that could spawn a new billion-dollar business. The response was overwhelming. Over 1,200 ideas were submitted from around the world, with first place going to a proposal to create a sensor-enabled electricity grid. Since that announcement, firms including Cisco, General Electric, ABB, Siemens, Oracle, and Microsoft have aggressively positioned themselves to be major players in this emerging market. In addition, the world's largest and most powerful countries have jumped on the bandwagon: China is making enormous investments in energy technology; Australia is mandating installation of digital meters; the European Union is pushing for more rapid adoption of renewable sources into the grid; and the United States is granting billions of dollars to electric utilities to accelerate their “smart” efforts. Across the globe, power delivery providers are initiating Smart Grid programs, supported by their rate and business cases and confident in their ability to achieve reasonable returns.

Yet at a fundamental level, there is still confusion in the market about exactly what benefits a smart grid will provide. As for how to plot a course from today's “dumb” grid to tomorrow's smart one, there is even less clarity.

At a recent energy summit held in Paris, experts from leading consulting firms gathered to address such questions as “What is a smart grid?” and “How do I get started in deploying one?” Bringing together perspectives from North America, Europe, and the Pacific Rim, these leaders represented a collective 150+ years of industry experience across more than a dozen utilities worldwide. The following conclusions regarding smart grid technology were formulated as a result of their discussion.

The Definition of Smart Grid Varies Widely

What is a Smart Grid? While a common definition is emerging, its application varies widely from one power company to the next. For many utilities, the scope of what they include in their Smart Grid-related initiatives ranges from modest infrastructure upgrades to a broad “smart energy” program incorporating increased use of renewable sources, upgrades to customer support, and development of new energy products and services. All of these components are important and can be grouped in any combination of projects that a company chooses. But, to gain clarity around purpose, objectives, funding, and expected outcomes, it is imperative to arrive at your own definition of the essential elements of a smart grid. Referring to Smart Grid as an “energy internet” is a good starting point as it incorporates the three layers required to make the grid intelligent—the existing **power distribution layer**, a **communication layer** to provide real-time intelligence on the operation of that network, and an **application layer** in which new value-added products and services can be developed and extended to customers beyond the simple kilowatts and BTUs they receive today. With few exceptions, an intelligent power grid must contain the following:

Essential Elements of a Smart Grid

- Smart meters—digital monitoring devices that allow bi-directional communication—at each commercial, industrial, and residential premise
- Communication devices placed throughout the distribution network to collect, aggregate, and transmit information from the smart meters
- Software applications that process baseline meter data and add value to it for use by operators and end customers

Building a Smart Grid is a Transformational Effort

As a company clarifies its own definition of a smart grid, it must also address the question of “How do I build one?” There are some early and proven approaches that any Smart Grid program should take into account in order to lower the risk of failure and improve the return that your company will receive from this investment.

Establish a Solid Foundation

Know Your Customer – While much of the activity related to Smart Grid today involves deployment of the physical components of the communications infrastructure, its future potential lies in its ability to serve consumers of energy in new and improved ways. The term *ratepayer* will increasingly be replaced by *customer*, and consequently a new view of customers will emerge beyond the traditional industrial/commercial/residential paradigm that exists today. Understanding individual

customer needs will be critical to developing personalized energy services. While many utilities currently do not have the IT systems to process such information, they can look to other industries for lessons on customer segmentation, churn analysis, and multi-channel service. Developing an up-front but flexible customer service strategy, a high-level model of customer data, and a channel approach for servicing customers can provide direction and correction throughout a company's Smart Grid implementation; these deliverables should be developed at the onset of your program.

Customer Service Tips

- Establish a clear customer service strategy as you initiate any new Smart Grid program.
- Develop a comprehensive data model to capture all of your customer information.
- Define a service approach that reaches customers across multiple channels.

Focus on People – Regardless of the scope of a Smart Grid initiative and whether it's evolutionary or revolutionary in nature, it will impact one or more employee communities within your company. You may achieve a whole new level of technological sophistication in your power delivery infrastructure, but the success of implementing an intelligent grid will still depend heavily on the willingness of employees to change their behavior in ways that optimize adoption and leverage of that technology. In order

to properly prepare for this change, you should conduct an impact analysis to identify all stakeholders, build awareness of coming changes, train for desired new behaviors, and develop incentives and rewards that reinforce the change. It's important to avoid becoming so enamored with the technology resources that you under-invest in managing the change experienced by your human resources.

Change Management Tips

- Conduct a thorough stakeholder analysis and define a clear strategy for driving adoption.
- Don't just focus on external communications; plan for detailed communications inside the entire organization as well.
- Develop robust training programs and incentives to increase awareness and educate employees on the impact of the program.

Prepare to Continuously Improve – Many of the impacts to a power company's operations resulting from Smart Grid are yet to be defined (Internet experts were not predicting social networking in 1995). Therefore it's critical that companies adopt a framework for analyzing and improving business processes on an ongoing basis. Replacing analog meters with smart ones, a process that on the surface may seem simple, becomes increasingly complex as the new meters connect to communication devices, aggregate data, and interface with legacy billing systems. Issues of quality and scalability increase with the scope of the effort—to roll out 2 million meters over a 3-year period means that 3,000 smart meters must come online each workday.

Process Improvement Tips

- Institutionalize a methodology for managing smart grid processes.
- Continuously analyze, measure, and improve internal processes and procedures.

In addition to meter management, processes such as load control, work management, and customer service also will be affected greatly as the Smart Grid communication environment comes online. Having a robust method for “leaning” out new and existing processes will have a major impact on your ability to speed return on investment.

Roadmap the Technology – The technology market for Smart Grid products is very fragmented. Some of the household names in technology are already in this space while others are playing catch-up, but many of these products and services are being provided by niche players. The market has much of the same “mom-and-pop” feel of the mid-90s Internet. Creating a robust and flexible technology roadmap will help make sense of this mélange by placing the various solutions in their appropriate roles and timelines. Be prepared to commit to platforms and products that are temporary in nature; they will serve as steppingstones to future technology that is more functional and interoperable. Also, cyber-security should assume an earlier and higher priority than with many other industry applications. Finally, as with all enterprise systems, scalability and reliability are key characteristics to look for in Smart Grid solutions.

Technology Tips

- Make sure your technology roadmap is flexible enough to add on additional products and services as they become more readily available in the future.
- Develop a water-tight cyber-security strategy to help protect valuable data assets.

“Although a few utilities may be able to integrate their technology solutions vertically across the transmission, distribution, and consumer delivery stages, most will rely on an ecosystem of many different software and hardware providers to support modular pieces of their overall smart grid initiative.”

– Smart Grid Technologies Coming to a Utility Near You, Forrester Research, Inc., October 2009

Structure the Program – Because a Smart Grid initiative impacts so many parts of an organization—power delivery, human resources, IT, customer service, etc.—it is

Program Management Tips

- Secure a program management office early in the planning stages of any smart grid initiative.
- Regular, frequent status communication with a cross-functional steering committee is essential.
- Plan for risk; govern accordingly.

critical that an appropriate level of governance be put in place to keep all the moving parts and pieces organized. The application of proven techniques such as a program management office (PMO), steering committee, status reporting, change control, and quality assurance will improve communication and cooperation among various working teams associated with the initiative. Duplication of effort is common in

large, complex initiatives and appears to occur frequently in the early stages of a Smart Grid program. Striking the right balance between conformity and autonomy is important in delivering an initiative with many unknown elements; appropriate governance will help maintain that balance.

Articulate the Program's Strategy – It's imperative that each company publish, internally and externally, its own definition of Smart Grid since the term has such widely varying meaning in the current environment. You should articulate the mission of your program, list its critical activities, and define the metrics by which you will measure success. Summarize this definition in a way that all stakeholders—customers, employees, and shareholders—can have a quick summary of why you are investing in an intelligent grid. A clearly articulated Smart Grid strategy will serve the same function as a constitution by providing a baseline from which to assess all requested changes in scope to the program.

Strategy Tips

- Define and document a smart grid strategy articulation map.
- Clearly articulate and publish the mission of the program.
- Establishing success metrics is only half the battle; measuring is where the rubber meets the road.

Plan for Early Returns on Investment

In an effort to validate the business case and demonstrate to stakeholders the program's value, every Smart Grid initiative should look for early returns on investment. Deployment of the baseline elements—installation of smart meters and their associated communication network—will require a significant amount of capital, and as such, some opportunities will quickly surface to further capitalize on the new technology. These “quick hits” generally fall into two categories:

Grid Efficiency – Many utilities are focusing their initial scope on improving the quality and reliability of the distribution grid. There are opportunities to reduce labor costs, minimize asset deterioration, and lower consumption of natural resources. Quick hits include:

- Improvements to automated meter reading (AMR) by leveraging the full-time availability of an advanced metering infrastructure (AMI). For example, meter readings can be done on demand or at scheduled intervals without the need for route drivers.
- Line voltage reduction to reduce consumption of natural resources and increase the lifespan in the field of power delivery assets.
- Extension of outage notifications from beyond the substation to individual premises, thereby focusing service crews on trouble spots and decreasing loss of service.

“Goals of [a Smart Grid] program include improved energy storage, security, smart grid technology and reliability. A new Smart Grid will be more reliable, more secure, and quicker to recover from disruptions.”

– Steven Chu
U.S. Secretary of Energy
March 11, 2009

Customer Service – A Smart Grid will provide a great deal more detail about a customer’s consumption of energy while giving utilities remote access to the service connection point. Quick hits include:

- Remote order fulfillment capabilities that allow a provider to connect/disconnect service at a location without physically accessing the site.
- Pre-payment options that will improve collections by allowing customers to pay-as-they-go for energy services as they can today for cellular telephones—an especially attractive option for lower-income households.
- Energy-usage monitoring to provide customers with more detail about how and when they are consuming power throughout their day so they can adjust behaviors to better control energy costs.

“Technology is key to achieving greater energy efficiency in the future, but we must not lose sight of our near-term mission: to help our customers better monitor and manage their energy use in their homes and businesses.”

– Jim Rogers
Duke Energy CEO
2009 Annual Report

By incorporating these quick hits in the scope of your Smart Grid program, you have the opportunity to show early results on performance of the technology. This allows you to fine-tune the scope and direction of the initiative while also winning the hearts and minds of customers and operations personnel. Their championship will be important as you continue with your program into a phase that requires more significant investment of time and money in order to yield acceptable returns.

More Investment Yields Greater Returns

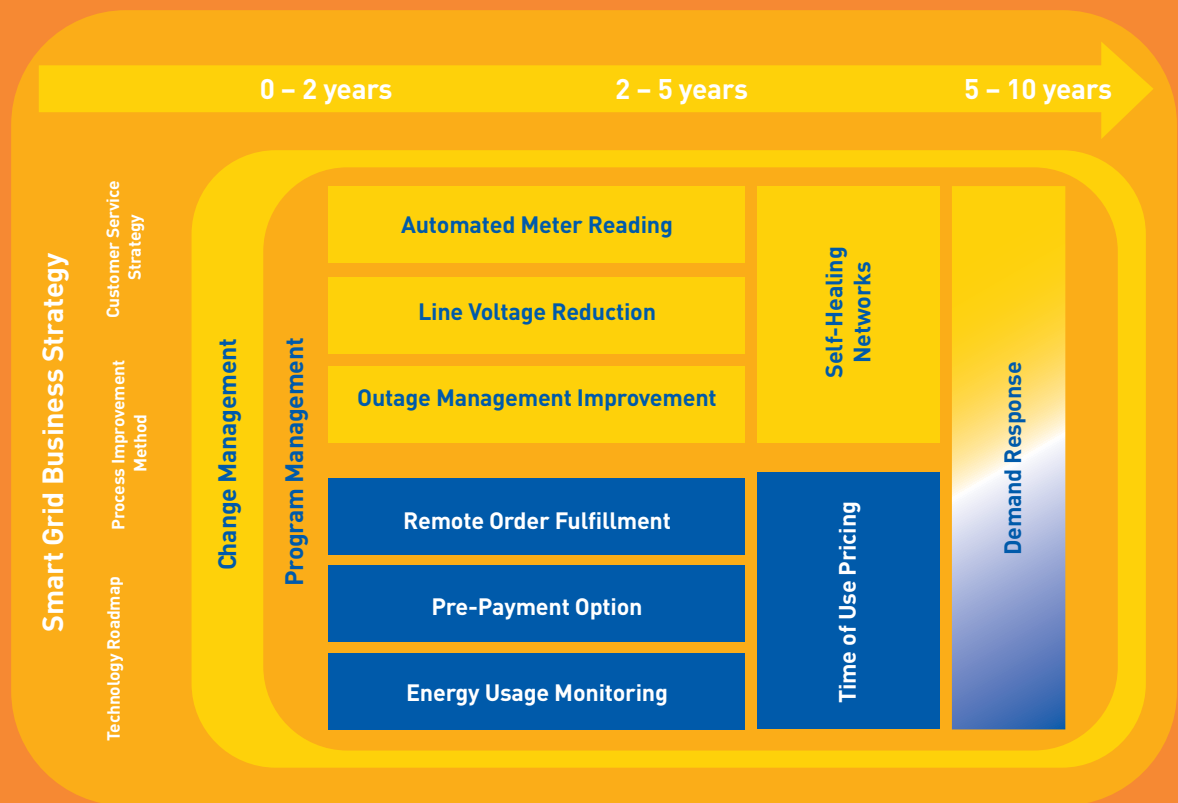
While the quick-hit benefits are attractive to both providers and consumers, even greater value can be driven from a Smart Grid as it lays the foundation for more advanced energy management. With an AMI fully in place, utilities can begin to address issues such as demand management and power quality. Additional investments in technology will be required in the distribution network, such as digital switches and storage technology, as well as inside the premise, such as home area networks and commercial building control systems, in order to make progress on these issues. The following components should be strongly considered for inclusion in the initial scope of every Smart Grid initiative:

Self Healing Networks – Beyond the real-time monitoring a Smart Grid provides, a self-healing network automates decision-making about outage events and extends it into the field. Systems will allow for the outage to be localized by opening and closing switches to reroute electricity—thereby minimizing the impact to customers as well as the degree of revenue lost due to an outage.

Demand Response – While programs have been in place for decades with commercial and industrial customers, demand response—incentives for reducing consumption during periods of peak demand—has not had widespread penetration with residential customers. Smart Grids offer the ability to dramatically scale demand response to millions of households by more effectively controlling the use of energy by major appliances, with little or no noticeable impact to the customer. The win-win nature of demand response—utilities curbing the growing need for generation assets while customers save money on their energy bills—makes it one of the highest probability applications to gain widespread market penetration. Additional technology will be required inside the home; who installs, services, and owns that equipment (utility? customer? third-party provider?) remains an open question, but the potential is too great to not include demand response in the initial scope of a Smart Grid initiative.

Time of Use Pricing – Another high-value service for residential customers will be the ability to get different rates for energy depending on the time of day when it is consumed. With average annual consumption at the household level continuing to increase, spreading energy demand throughout the day will help utilities forecast demand and balance loads while saving money for consumers.

Smart Grid Program Model – Prioritization of Initiatives



The Bleeding Edge is Still Maturing

There are a number of potential benefits posed by Smart Grid that receive a lot of attention and are indeed very attractive due to their potential to transform the current model for power delivery, but they are too early in their maturity curve to be considered part of a program that has to return value in the next 5 years. Among these are:

Distributed Generation – The extension of generating assets into the distribution network—whether at a substation or individual premise—can speed integration of renewable sources while also contributing to energy efficiency. However, major advances in storage assets and solar technology will be required for distributed generation to be truly affordable.

Electric Vehicles – Plug-in Hybrid Electric Vehicles (PHEVs) continue to make a splash in the media, but their actual market penetration is miniscule and their demand on the grid will be minor for years to come. Standards for home charging are not fully established, and many logistical hurdles remain in extending vehicle charging stations into the transportation network. Vehicle to Grid (V2G)—a concept of using vehicle batteries to provide power back into the grid—is impractical given the current level of engineering methods and the inadequacies of storage.

Utility control systems – As utility control systems continue to evolve and interoperate, the opportunity exists to continue the advances made in self-healing networks by replacing more manual, operator-driven decision-making with real-time decision support systems (parallels exist in the financial services industry with automated brokerage/trading systems). The level of integration between disparate systems required to bring these applications to realization is still years away in the power delivery industry, but developing a robust technology roadmap that at least sets a course towards this goal is something that can be done today.

In general, power companies should explore how these applications of the technology fit into their long-term strategy, but keep these projects at a research and development stage rather than include them in the scope of an initial Smart Grid initiative where they could dilute funding and distract from other, more achievable goals.

CONCLUSION

Even with measured steps, the Smart Grid is an expensive undertaking. The power delivery industry is expected to invest more than \$150 billion in the United States alone to develop and deploy intelligence in its distribution networks. As vendor companies and their products and services stabilize, the cost of deployment will fall, but not before consolidation and obsolescence have impacted many providers and their partners.

Which brings us to the question: *Will the Smart Grid be transformative for utilities?* The answer is yes, over time. But the transformation will be evolutionary rather than revolutionary. Meanwhile, initiating your Smart Grid program need not be a leap in the dark. If you develop a Smart Grid strategy, cover the fundamental bases of any large change initiative, and focus on quick hits while prioritizing higher return applications and services, you can achieve remarkable results with your program. These best practices will help you take the evolutionary steps necessary to make Smart Grid a reality and set the stage for conducting business in innovative and transformative ways in the future.

ABOUT THE AUTHORS

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Tim leads North Highland's Energy and Utilities international community. He has over 20 years of experience in consulting and information technology, with much of that time spent working with electric and gas utility clients. Tim's areas of expertise include IT strategy and process, organizational design, and portfolio planning and management. He is a frequent speaker on the topic of Smart Grid and its transformative potential for customer products and services in the industry.

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