WHITEPAPER

A public power guide to building a low-risk, low-cost smarter grid

Executive summary

For any utility, deciding on the optimal smart grid solution that maximizes both customer service and operational effectiveness can be difficult under the best of circumstances. Combine that with constrained budgets, personnel challenges and the return-on-investment demands for a public power utility and the decision becomes even more complex. Most utilities recognize that there are potential benefits to a smart grid implementation but may be unclear how best to proceed – fearing they might implement technology that won‘t provide adequate ROI, or worse, may not integrate into future systems. This paper outlines a five-step incremental approach to implementing smart grid technology that helps ensure an adequate ROI while providing a firm foundation for future enhancements

Low risk, low cost, high tech

The smart grid presents tremendous potential for public power, especially municipal electric utility companies. Most companies recognize that there are benefits to be realized from smart grid related innovation. However, finding the right operational and financial benefits for public utilities can be challenging.

Many utility managers are concerned about the scale of investment and effort required. They hesitate to engage because they fear major missteps will fail to return the expected ROI and prove to be a costly wrong turn on the road to improvement.

The fact is that smart grid solutions are available on the relatively small scale of public utilities, not just on the larger scale of large investor-owned utilities (IOUs). The scale is different, the connectivity is different and the justification model is different. Still, the needs of both the IOUs and the public utilities as they relate to the smart grid are very much in synch.

It is possible, and prudent, for utilities to begin with affordable, incremental steps that provide immediate benefits and lay the foundation for future investments. With relatively modest investments, public power utilities can begin making strides toward a scalable smart grid implementation. The goal should not be to simply join the smart grid effort; it should be to identify the network enhancements with real, measurable benefits that move them toward the smart grid.

The five-step process begins by sketching the roadmap they will follow.

Step 1: Begin with a roadmap

Utility managers are well-acquainted with the unique set of challenges they face and the issues of greatest concern to their organization and customers.

The most common challenges include:

- **Reliability:** Every electrical energy supplier strives to improve reliability, avoiding outages to the greatest degree possible and quickly restoring power when outages occur.
- **Cost reduction:** The smart grid offers many avenues to reduce costs, including labor savings, efficiency improvements and asset life extension. Conversely, the smart grid also offers new revenue opportunities.
- **Compliance (regulatory requirements)**: Public power companies must comply with the same laws as IOUs regarding cyber-security, distributed generation and others.
- **Fine avoidance:** The importance of this challenge varies depending on the utility's regulators, but for those that face penalties for outages, smart grid technology can help reduce these costs.
- **Efficiency:** The smart grid is one of the most powerful avenues to achieve peak load demand reduction.
- **Green initiatives:** For most public utilities, incorporating renewable energy sources is unlikely to be profitable, but it is a challenge the roadmap must address. No utility can refuse adding renewable energy resources on their grid. It may be an opportunity, it is definitely a challenge and — the bottom line is — it is a reality.

"As utility managers consider these challenges, it may be helpful to frame them in terms of value streams," suggests Daniel O'Neill, President & Managing Consultant of O'Neill Management Consulting, a specialty firm dedicated to providing consulting services to the utility industry. "They will always face multiple, competing challenges, but they should consider the value of solving each of them. Meeting certain challenges may provide greater value or be more achievable at a relatively lower cost."

With the highest-value challenges in mind, utilities can begin to develop a general roadmap for their smart grid effort. Considering the current state of the network and existing business environment, they can sketch out their broad vision of the utility's future state, both short- and long-term.

"There are some public utilities that have a clear roadmap and are far down the path toward implementing smart grid enhancements," says O'Neill. "Surprisingly though, many public utilities don't really have a clear direction set for how, when and why they will move in this direction."

Electrical co-ops, with their long last-mile coverage and relatively small number of customers, may find it more difficult to see profitable opportunities for smart grid technology, but they are there for the taking. A very real benefit is the reduced need to dispatch crews to far-flung trouble spots and send meter readers to visit widely dispersed customers.

For public power providers, particularly the municipal power companies in the 20,000- to 100,000-meter size range, the benefits are much clearer. They tend to have a geographically compact service territory that lends itself to profitable deployment of smart grid technology.

In light of the constantly shifting legislative environment, unstable energy market and swings in the economy, even the most carefully conceived roadmap will only be a reliable guide for a relatively short timeframe. The roadmap and its authors need to be flexible and ready to adapt.
"To ensure that the roadmap will accommodate a long-term migration toward smart grid implementation, it needs to be scalable," according to Doug Voda, ABB Smart Grid Global Segment Leader for Medium Voltage Products. "It should consider potential tactics from the device to network level. The roadmap should allow up scaling a limited technology implementation to network-wide scale. A critical approach is to seek out open protocols and standardized technology that will be adaptable and ensure that a technology deployed today will integrate with future technologies."The important thing to remember, Voda states, is that it's not okay to do nothing.

"The smart grid train is coming and utilities need to get on or be passed by. There are so many options, so many paths a utility can take, that it's creating some paralysis in the market. The good news is that, regardless of the roadmap the utility has drawn, there are lower-risk, bits-and-pieces opportunities that can be deployed. They need to make the first, foundational investments in their smart grid efforts," Voda said.

—

Step 2: Add intelligence

For most public utilities, the first stop on the roadmap is adding intelligence to their network. This includes incorporating sensors, monitors and automation, either retrofitting these capabilities into existing devices or upgrading devices to modern technology that include them.

"Adding intelligence represents a relatively low-level investment that can be done incrementally," says Gary Rackliffe, VP of the ABB Smart Grid division in North America. "When using IEC 61850 and DNP standards, it is a very low risk investment.

These standards ensure that devices will be able to seamlessly share data, building an open dialogue between devices and across the network. This provides the required foundation for implementing other smart grid technology and higher-level system monitoring/management.”

“Most utilities today have very limited information on how their system is performing at the device level,” Voda says. “What are the current voltage consumption levels? Where are the hot spots? Are there weaknesses in the circuit-switching schemes? That kind of data can’t be collected by sending techs out to make on-site observations or plug in a laptop to do occasional data dumps. Managers need better performance information, so most are adding intelligence or automation to help them understand how well they are delivering power. Having a oneline circuit diagram showing current and voltage at the nodes is tremendously valuable.”

Adding intelligence and automation provides immediate operational benefits:

- Reduces costs because potential device problems can be identified — and possibly corrected — remotely rather than dispatching a crew.
- Enhances reliability because potential problems can be identified more quickly and addressed proactively, or even automatically, rather than after a fault or outage. This enables reliability-centered maintenance instead of time-based maintenance.
- Compensate for the brain drain created when experienced field techs retire by automating devices to minimize manual, labor-intensive activities.
- Incorporates required components for future smart grid initiatives, including automated applications such as FDIR, Volt/VAR control, smart metering and asset health management, discussed later in this paper.

In one way, adding intelligence and automation pushes public utilities beyond the traditional paradigm of central control. They need to feel confident in letting devices heal themselves locally. Automation at the lowest level means faster response to anomalies on the grid.

“From another perspective, the more intelligent network enables a new level of centralized control,” Rackliffe says. “To effectively manage and capitalize on the device data, utilities are pushed toward new or expanded central operations centers. It will house the supervisory control layer, running applications like a distribution management system (DMS), demand response and Volt/VAR. These applications are needed to manage distribution assets in a coordinated fashion. Relying on them, managers are positioned to take their network to the next level of performance and achieve new levels of grid optimization.”

Step 3: Discover system enhancement opportunities

With real-time data collection and analysis enabled by intelligent devices, public utility analysts will be populated with a flood of data. Every bit of device-level data is potentially valuable, but network managers will be overwhelmed without appropriate data analysis and management tools.

The value of the data is magnified by applying analytical tools to realize the true, high-value opportunities. With the appropriate analytics, utilities can create fact-based cost-benefit analyses that guide them in the discovery of the most valuable distribution system enhancements.

This is a critical step when dealing with "smart grid" investments because the term holds different promises for different people. Depending on their position in the energy production, delivery and consumption chain, different groups focus on the benefits that most directly affect them. That's why it is essential to identify, articulate and quantify the specific benefits expected as the return on the smart grid investment. What are the pain points to be addressed? What revenue gain is expected? What customer value will be enhanced? How does it prepare the network for future enhancements?

This analysis should be used to validate the course outlined in the roadmap, enabling appropriate corrections or providing confidence in continued forward progress. The roadmap also provides a definition of the planned future state, ensuring that all interested parties share a common vision of the path and the goal.

An added benefit of the new stream of real-time data is that it moves the utility toward a formal asset management strategy. It becomes possible to further extend asset life by enabling utility managers to constantly monitor equipment health. Rather than the occasional, and typically infrequent, visit to substations and other distribution points to check equipment condition, vital signs are constantly monitored. Temperature, partial discharge, gas analysis and other asset health information can be assessed.

With the appropriate intelligence in place, alarms are triggered and corrective action taken at the first sign equipment is acting up. Having a finger on each device's pulse makes it possible to identify the components that are most troublesome or costly to operate so they can be properly prioritized for attention or replacement. This enables the most efficient deployment of maintenance technicians based on a planned, proactive work schedule rather than constantly responding reactively to crises. It also allows optimum equipment lifecycle management.

Step 4: Select appropriate technologies and applications

Mention "smart grid technology," and the first thought for many is the smart meter. These meters can be a useful source of network intelligence and a key component in a smart grid strategy, but need to be deployed appropriately to provide the highest return on investment.

"Consider the time required to see the payback on a $150 smart meter installed on the typical residential consumer," advises O'Neill. "In terms of demand management and power conservation, a 15% use reduction by a residential user with 1,500 kW load doesn't get you much and may require many years to recoup the meter's cost. Of course, there is the added benefit gained by automatically capturing energy usage data rather than sending meter readers to each customer." Still, with his PhD in economics, O'Neill sees the advantage of a more targeted approach to maximizing value.

"You can be smart about which strata of load classes would be most cost-beneficial. It makes much more sense to be selective in smart meter-deployment, focusing on the band or level of commercial consumers where managing demand will have a fast and significant payback for both the customer and the utility," he says. The strategy of equipping only the higher energy-using customers

with smart meters may cause some pushback from regulators and conservationists who want every customer to realize the potential benefits, but O'Neill believes a strong case can be made for this approach.

"Focus first on smart metering the customer bands that will harvest the highest return on the investment at the lowest initial cost," O'Neill says. "Then you can piggyback on those profits to create the broader smart meter infrastructure. Whether deployed broadly or more-selectively, smart meters enable one of the most desirable benefits of the smart grid — price-based demand response."
Smart meters aside, larger and more-easily captured benefits can be attained by focusing on distribution system-level smart grid technologies, adding intelligence and automation between the substation and the meter. With smart switches, capacitors, sensing devices and other current-generation distribution automation hardware in place, higher-level applications and strategies can be implemented.

Smart grid applications
The hardware that comprises the smart grid enables a range of new, advanced approaches to better distributing and managing electric power.

Incentive-based demand response provides the most significant and speedy payback when implemented in a targeted strategy that focuses on the higher-kWh users. The municipals, because of their compact and well-defined service area, have the ability to manage customer classes and their loads better than larger energy distribution organizations. Encouraging large customers to selectively reduce demand gives utilities a giant step toward demand response. "Industrial interrupt-ability is a great first step that delivers quite a reward," O'Neill believes. Utilities would benefit by capturing this opportunity.
Fault detection, isolation and restoration (FDIR) is a distribution automation technology also known by the acronyms, FLISR, FLIR or ASR. It encompasses various approaches to autonomously sense network disruptions. Once detected, FDIR devices automatically attempt to isolate any disruption and then self-heal or route around the problem. As an example, grid automation controllers can be built into feeders or substations. At the feeder level, it addresses only local issues. Installed at the substation level, these controllers can work across substations, making decisions about how to reroute power as necessary.

Volt/VAR optimization can be thought of as helping the energy arrive at its destination most efficiently. Just as there are hills and construction diversions that impact your speed when traveling between Point A and Point B by car, there are many routes energy can take from the substation to a customer's home — Volt/VAR optimizes those routes, and is a key smart grid application. Volt/VAR applications can act as a virtual operator, automatically issuing optimal control settings. In doing so, it optimizes reactive power and voltage regulation resources on the distribution system to achieve power factor correction, voltage correction, conservation voltage reduction or loss reduction.

Conservation voltage reduction (CVR) is a Volt/VAR control technology that is widely used at the feeder/substation level. While mostly used by investor-owned utilities, it's also possible for public utilities to capture the benefit of this technology. CVR is based on the long-known fact that energy providers can slightly reduce voltage to customers without affecting the performance of appliances and lighting. Reductions of 5% to 6% can safely be made. CVR can be implemented without smart-metering every home. Instead, utilities can optimize distribution line voltage profiles and capture almost all of the value of CVR with a single intelligent device at the final distribution point.

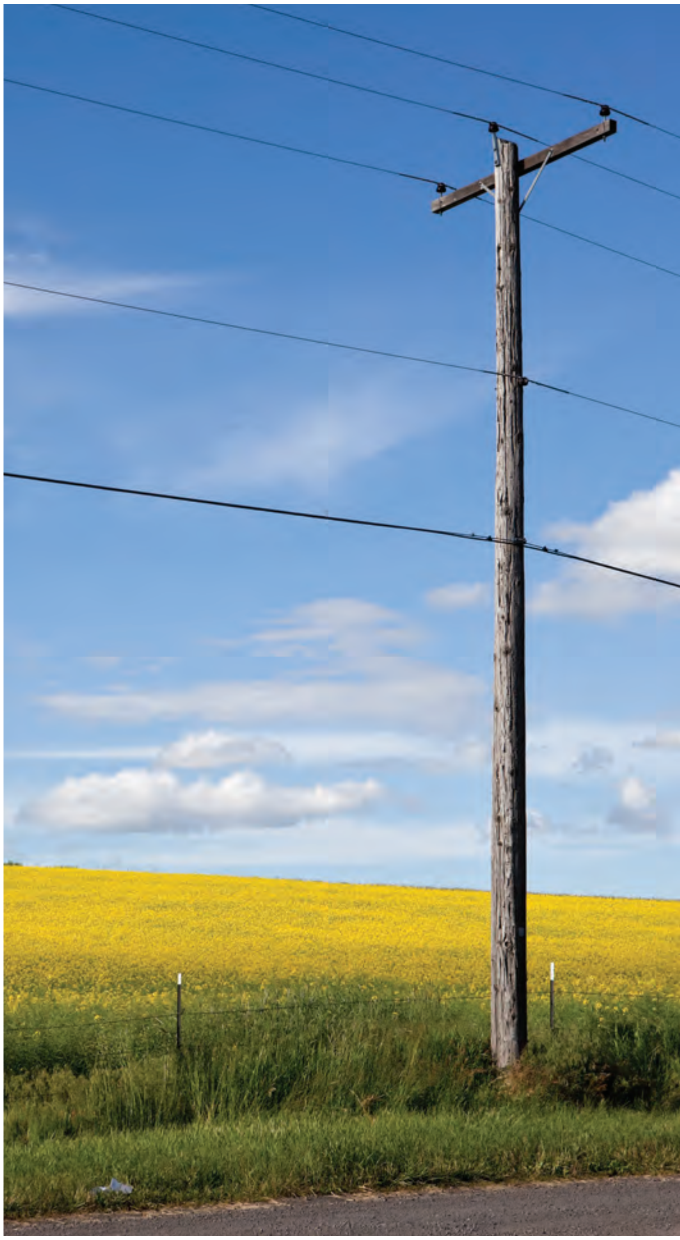
Distributed energy storage (DES) is an essential element of the smart grid. In communities where renewable energy sources are coming on line, these storage systems may be good investments. In almost every utility, the probability is that they will be a requirement. The smart grid of the future won't work without storage.

Step 5: Implementation, integration, execution & beyond

Guided by the roadmap, and armed with operational data, network managers can select the smart grid enhancements that will have the greatest positive effect on their utility. The right enhancements will help each utility achieve its unique set of goals, which may include addressing issues related to operations, customer satisfaction, regulatory compliance and others.

Public utilities with a clear roadmap and high level of confidence in their strategy will likely take a staged, smart grid implementation. Based on their budget and the anticipated value or return on investment expected. They can build their smart grid in logical increments based on geography, customer band/level or device type. As public utilities begin to realize the returns on their initial investment, and gain confidence in the wisdom of their roadmap, they can continue to implement additional elements of their strategy and advance toward the planned, future state.

Many power providers prefer a proof-of-concept approach, deploying one or more pilot programs that selectively implement smart grid technology



in a way that facilitates gathering quantifiable results. Based on this real-world data, they can more confidently move into larger-scale implementation. Regardless of the strategy, the investments made through any aspect of the smart grid implementation typically enables or supports other aspects, e.g. investment in Volt/VAR also supports FDIR. The investment usually isn't one-to-one. There is a leveraging effect that enables multiple benefits. And as each element is installed, the utility gains additional operational data that lets them more accurately assess the results achieved and further refine their roadmap for future deployments. desirable benefits of the smart grid — price-based demand response."

Summary

At every step in the process … generation, transmission, distribution and consumption … the smart grid will deliver benefits. Public power companies and municipals can each find and implement technologies that will move them in a logical way to the smart grid, guided by their roadmap.

A building can't be constructed in a single step. There are many discrete steps in the process. While certain steps must follow others, there are a range of activities that all create the foundation for the final structure. The same is true of smart grid implementation. There are many foundational steps that can be taken in a step-wise and budget-friendly approach to deployment.

Small, relatively low-cost investments will provide immediate benefits, possibly creating system efficiencies that provide the revenue needed for the next phase of deployment. They also create a synergistic effect, enabling multiple benefits while building the foundation for future system enhancements. The smart grid is such an expansive and complex concept that many utilities are justifiably hesitant to launch an implementation effort.

Using the five-step process described in this white paper, they can take safe, logical incremental steps, and begin to realize the vast potential benefits of adopting smart grid technologies to achieve their unique business goals.

Note:
We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document. We reserve all rights in this document and in the subject matter and illustrations contained therein. Any reproduction, disclosure to third parties or utilization of its contents – in whole or in parts – is forbidden without prior written consent of ABB.

© Copyright August, 2012 ABB Inc. All rights reserved.

—

ABB Inc.
Power Grids
901 Main Campus Drive
Raleigh, NC 27606 USA
Phone: 1-800-HELP-365

new.abb.com/us/public-power

© Copyright 2017 ABB. All rights reserved.
Specifications subject to change without notice.

9AKK105713A0334 REV A 18.5.2010 #14995