Where is the Smart Grid Going From Here?*

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Where will the Smart Grid industry trend and what choices will utilities be facing once the stimulus period ends in two or three years? Most likely it will be different than what we imagine today.

THE PROMISE OF SMART GRID

Smart Grid investments are encouraging new technologies, solutions, companies, and market interactions. They are ushering in the possibility of new ways for utilities to: interact with customers; balance generation, load and losses in real-time; facilitate the deployment of various forms of distributed generation; re-shape load duration curves and dampen load and price volatility; and help contain distribution system operating costs as the system is asked to do more and more. It's exciting and complex.

Expectations around Smart Grid are often revealed by language some find hyperbolic. Consider some phrases cited by DOE in its Smart Grid Handbook for example: "transformational," "the internet brought to the electric system," "history-making," "enabling engine of our economy," "revolutionizing," and "there will also come a time when you won't remember life before the Smart Grid." As programs move forward and successes and failures emerge, it is likely that expectations and language will change also.

NAVIGATING CHANGE

To effectively navigate change, Smart Grid implementation and outcomes must be manageable and within reach. Smart Grid plans reflect optimism that the investments are definable, and neat and orderly both in substance and in process. The implementation efforts are expected to result in concrete new systems, solutions, services and capabilities. This is all reasonable and rational. It is what good planners, system architects and integrators and others involved with Smart Grid programs do.

However, the current view and expectations of Smart Grid may not adequately address the importance of organizational and institutional adaptation required to realize the promise of Smart Grid. For Smart Grid to transform utilities and usher in the kind of change that is possible, the organizational and institutional "networks" are equally important as the physical systems and solutions.

SMART GRID IMPLEMENTATION COMPLEXITY

The current Smart Grid programs and their implementation represent the first step towards realizing the Smart Grid vision. Today smart metering projects predominate and are typically coupled with price-driven demand response and energy efficiency programs. Sophisticated meter data management, systems integration and configuration management investments are also part of a several year work plan. A network component may span up to four or five layers of network connectivity and build out … from substation fiber to distribution-level collectors to meters and to in-premise. Often, to make it all work, the billing and customer care systems need re-engineered. To drive operational improvements outage management systems also need to be re-engineered, to offer but one example.

Beyond smart metering some utilities are moving aggressively into architecting and

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implementing advanced distribution management systems (DMS), a key enabler, for example, of the utility's ability to manage variable, dispatchable distributed generation. DMS projects rival the smart metering programs for scale, scope and complexity.

For a large electric utility, the smart metering investments alone represent complex, expensive, multi-year efforts involving dozens of vendors and dozens if not hundreds of vendor employees, the participation of hundreds of utility personnel, and hundreds of millions of dollars of customer money. Baltimore Gas & Electric, as one example, recently proposed a multi-year smart metering and demand response program costing $835 million, or roughly $650 per customer. Sacramento Municipal Utility District's DOE grant-supported program runs $512 per customer. These levels of investment are typical.[1] Experience also says to expect cost overruns when programs get big and complex. PG&E was authorized an additional $467 million in recovery to move its smart metering initiative along after recognizing the insufficiency of its initial $1.74 billion authorization.

ORGANIZATIONAL AND INSTITUTIONAL CHALLENGES

As these complex systems are implemented, the organizational and institutional challenges associated with realizing the potential of these systems will become more apparent. To start, utilities face cost containment pressures as rate caps expire, renewable portfolio costs increase, and new Smart Grid and energy efficiency investments get paid down. Retirements due to an aging workforce will impact what activities and responsibilities a utility can retain and what it must outsource. They will also impact how responsive, creative and innovative the utility will be to the challenges brought on by expanding Smart Grid system capabilities.

All these pressures will call into question just how much the utilities will be able to do with these new networks. Will the utility possess the time, leadership, commitment, and other resources necessary to drive innovation in the use of these new tools? Will it be able to have the kind of sustained, interconnected discussions with an expanding set of marketplace participants necessary to help promote the institutions and collaborations which, in turn, will provide customers greater choice, convenience and control in their energy use? How, for example will utilities work with car companies, appliance manufacturers, cellular companies, and home goods retailers (to name a few) to devise ways to get new services and products into the hands of energy customers?

These human networks require attention as much as the physical ones and are part of the domain of "change management." Watch for change management to grow in importance and take on new meanings for fostering innovation.

LESSONS LEARNED FROM THE CALIFORNIA ELECTRICITY CRISIS

It is possible to learn from the experiences of others implementing complex programs. Take for example, the Electric Power Research Institute (EPRI) study of the operations and institutional arrangements associated with grid operations during the California electricity

[1] The DOE reported $8.2 billion in investment as part of the Smart Grid Investment Grant program. This program reflects the 50% government match. However, there are several other DOE funding programs impacting Smart Grid investments in addition to this grant program.

crisis. [2] This was a period of enormous change in the state's utility system. EPRI offered the concept of "persistent incompleteness" to explain the institutional and policy challenges associated with ensuring real-time grid reliability:

> "Whenever such a [high reliability real-time] network is established… it never fits all together. Gaps, mismatches and unintended consequences inevitably emerge, some as insurmountable obstacles, others as unexpected opportunities to be exploited. Not only is complexity an emerging property, but the sporadic attempts to rectify the unfinished designs are also ultimately overtaken by dynamically changing events."[3]

In other words, there is no final end-state at the conclusion of a well-ordered transition period. Rather, planners and grid operators continuously face an evolving set of demands and expectations from regulators, customers, and other market participants. It's incomplete, complex and dynamic.

The researchers found that a key ingredient to success in ensuring grid reliability during this crisis period involved appreciating the role and value of improvisation, non-routine work practices, flexible authority patterns and teams, shared professional norms, and information exchange and accountability. "Many policy proposals are currently being made to change the electricity system, but recognizing and supporting the professionals responsible for reliability management may be more important than particular design issues."[4]

The researchers also found that "persistently incomplete design" has many potential ***positive*** implications. Overlapping mandates introduce opportunities for positive redundancy; fragmented agency mandates may create opportunities for greater interagency cooperation and allow for greater functional specialization; conflicts in large scale systems can help ensure that a wider set of considerations are taken into account. "In light of the positive features of incomplete design, a more compelling case can be made anyway for incremental and emergent change, which is not only a realistic model of design of critical service provision, but according to well-known policy experts the more rational one in a networked setting of divergent interests."[5]

The EPRI findings may add valuable perspectives on where to put Smart Grid planning and implementation emphasis. Complexity and incompleteness are emergent properties, and they may offer unexpected benefits, but don't expect that they can be managed out of the process. And how people work, interact and collaborate are essential if not vital questions for leadership as it seeks to maintain high levels of service reliability and cost performance while exploiting further opportunities for investment and change.

MANAGING COMPLEXITY AND CHANGE

Smart Grid implementations are complex undertakings. It is likely that utilities will struggle with realizing the full scope of operational benefits associated with their use, let alone achieve the full scope of societal benefits in areas like demand response. As EPRI

[2] *California' s Electricity Restructuring: The Challenge to Providing Service and Grid Reliability*, EPRI, Palo Alto, CA, California Energy Commission, Sacramento, CA: 2002. 1007388.

3 Ibid. Page 5-6.

[4] Ibid. Page vi.

[5] Ibid. Page 5-12.

unearthed in its research, success may not be about the structures, but "about the skills that matter under changing performance conditions in real time."[6] Appreciating this soft side of Smart Grid will put greater emphasis on the challenges of change management programs and utility internal resources to foster change and drive innovation.

About the author

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[6] Ibid, Page vi.