A Vision for the Smart Grid

What will the Smart Grid Look Like?

Background

Before we can begin to modernize today's electric grid, we first need a clear vision of the power system required for the future. Given that vision, we can create the alignment necessary to inspire passion, investment, and progress toward a U.S. Smart Grid for the 21st century.

Smart Grid Values

The grid must be more reliable. A reliable grid dependably provides power, when and where its users need it and of the quality they value.

The grid must be more secure. A secure grid withstands physical and cyber attacks without suffering massive blackouts or exorbitant recovery costs. It is also less vulnerable to natural disasters and recovers more quickly.

The grid must be more economic. An economic grid operates under the basic laws of supply and demand, resulting in fair prices and adequate supplies.

The grid must be more efficient. An efficient grid takes advantage of investments that lead to cost control, reduced transmission and distribution electrical losses, more efficient power production, and improved asset utilization.

The grid must be more environmentally friendly. An environmentally friendly grid reduces environmental impacts through initiatives in generation, transmission, distribution, storage, and consumption.

The grid must be safer. A safe grid does no harm to the public or to grid workers and is sensitive to users who depend on it as a medical necessity.

The Smart Grid Vision

First, it will enable active participation by consumers. The smart grid will give consumers information, control, and new options to enable them to engage in the "electricity markets." Grid operators will utilize willing consumers as resources in the day-to-day operation of the grid. The active participation of consumers in electricity markets brings tangible benefits to both the grid and the environment, while reducing the cost of delivered electricity. Well-informed consumers will modify consumption based on the balancing of their demands and the electric system's capability to meet those demands.

Second, it will accommodate all generation and storage options. It will seamlessly integrate all types and sizes of electrical generation and storage systems using simplified interconnection processes and universal interoperability standards to support a "plug-and-play" level of convenience. Large central power plants including environmentally friendly sources, such as wind and solar farms and advanced nuclear plants, will continue to play a major role in the Smart Grid as large numbers of smaller sources, including Plug-in Electric Vehicles, are deployed.

Third, it will enable new products, services, and markets. The Smart Grid will link buyers and sellers together – from the consumer to the Regional Transmission Organization. It will support the creation of new electricity markets from the home energy management system at the consumer's premise to technologies that allow consumers to bid their energy resources into the electricity market. The Smart Grid will support consistent market operation across regions.

Fourth, it will provide power quality for the digital economy. The Smart Grid will provide various levels of power quality at different pricing levels. It will monitor, diagnose, and respond to power quality deficiencies before loads are negatively affected, resulting in a dramatic reduction in the business losses currently experienced by consumers (~$25B annually) due to insufficient power quality. New power quality standards will balance load sensitivity with deliverable power quality.

Fifth, it will optimize asset utilization and operate efficiently. Asset management and operation of the grid will be fine-tuned to deliver the desired functionality at a minimum cost. Operationally, the Smart Grid will improve load factors, lower system losses, and dramatically improve outage management. Operators will have access to sophisticated risk management capabilities. The availability of additional grid information will give planners and engineers the knowledge they need to build what is needed when it is needed, extend the life of assets, repair equipment before it fails unexpectedly, and more effectively manage the work force. Operational and maintenance costs and the cost for capital investments will be reduced.

Sixth, it will anticipate and respond to system disturbances. It will heal itself by performing continuous self-assessments to detect issues, analyze them, take corrective action to mitigate and, if needed, rapidly restore grid components or network sections. It will handle problems too large or too fast-moving for human intervention. Acting as the grid's "immune system," the self-healing Smart Grid will help maintain grid reliability, security, affordability, power quality, and efficiency.

And finally, the Smart Grid will operate resiliently against attack and natural disaster. It will incorporate a system-wide solution that reduces physical and cyber vulnerabilities and enables a rapid recovery from disruptions. Its resilience will create an image that intimidates would-be attackers. It will also be less vulnerable to natural disasters.

The seven characteristics described above represent unique yet interdependent features that define the vision of the Smart Grid. Table 1 below summarizes these seven points and compares today's grid with the vision of the Smart Grid.

Characteristic	*Today's Grid*	*Smart Grid*
Enables active participation by consumers	Consumers are uninformed and non-participative with the power system	Informed, involved, and active consumers – DR and DER
Accommodates all generation & storage options	Dominated by central generation – many obstacles exist for DER interconnection	Many distributed energy resources with "plug-and-play" convenience – focus on renewables
Enables new products, services and markets	Limited wholesale markets, not well integrated – limited opportunities for consumers	Mature, well-integrated wholesale markets, growth of new electricity markets for consumers
Provides PQ for the digital economy	Focus on outages – slow response to PQ issues	PQ a priority with a variety of quality/price options – rapid resolution of issues
Optimizes assets & operates efficiently	Little integration of operational data with asset management – business process silos	Greatly expanded data acquisition of grid parameters – deeply integrated with asset management processes
Anticipates and responds to system disturbances (self-heals)	Responds to prevent further damage-focus is on protecting assets following fault	Automatically detects and responds to problems – focus on prevention, minimizing impact to consumer
Operates resiliently against attack and natural disaster	Vulnerable to malicious acts of terror and natural disasters	Resilient to attack and natural disasters with rapid restoration capabilities

Table 1: Comparison between Today's Grid and the Smart Grid