A Vision for the Smart Grid

What is the Smart Grid?

Introduction

Many people are asking, "What is the Smart Grid?" Many more are trying to define it with short "sound bite" descriptions. These short statements cannot adequately convey the level of detail needed to provide a clear understanding. The Smart Grid isn't a "thing" but rather a "vision" and to be complete, that vision must be expressed from various perspectives - its values, its characteristics, and the milestones for achieving it.

Smart Grid Values

The transformation to the Smart Grid will require new investment and commitment by its many stakeholders. These stakeholders expect significant value in return. Understanding how this value will be created is an important step in defining the vision. Expectations for the Smart Grid are great and will be realized through advances in each of the six value areas described below:

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

It 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 quickly.

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

It must be more efficient. An efficient grid employs strategies that lead to cost control, minimal transmission and distribution losses, efficient power production, and optimal asset utilization while providing consumers options for managing their energy usage.

It must be more environmentally friendly. An environmentally friendly grid reduces environmental impacts through improvements in efficiency and by enabling the integration of a larger percentage of intermittent resources than could otherwise be reliably supported.

It 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.

Smart Grid Principal Characteristics

The Smart Grid can be considered a "transactive" agent. That is, it will enable financial, informational, as well as "electrical" transactions among consumers, grid assets, and other authorized users. Its functionality is defined by the following seven principal characteristics:

First, it will enable active participation by consumers. The smart grid will give consumers information, control, and options that enable them to engage in new "electricity markets." Grid operators will treat willing consumers as resources in the day-to-day operation of the grid. Well-informed consumers will modify consumption based on the balancing of their demands and resources with 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 even as large numbers of smaller distributed resources, 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 and third parties 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. It will monitor, diagnose, and respond to power quality deficiencies resulting in a dramatic reduction in the business losses currently experienced by consumers due to insufficient power quality.

Fifth, it will optimize asset utilization and operate efficiently. Operationally, the Smart Grid will improve load factors, lower system losses, and dramatically improve outage management performance. The availability of additional grid intelligence will give planners and engineers the knowledge to build what is needed, when it is needed, to extend the life of assets, to repair equipment before it fails unexpectedly, and to more effectively manage the work force. Operational, maintenance, and capital costs will be reduced thereby keeping downward pressure on prices.

Sixth, it will anticipate and respond to system disturbances (self-heal). It will heal itself by performing continuous self-assessments to detect and analyze issues, take corrective action to mitigate them and, if needed, rapidly restore grid components or network sections. It will also handle problems too large or too fast-moving for human intervention.

And finally, the Smart Grid will operate resiliently against attack and natural disaster. The Smart Grid 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.

Smart Grid Milestones

Smart Grid milestones represent the building blocks of the Smart Grid. Completion of each requires the deployment and integration of various technologies and applications. "One size does not fit all" – the sequence for implementing these milestones and the degree of implementation will depend on the specific circumstances of those involved.

Consumer Enablement (CE) empowers consumers by giving them the information and education they need to effectively utilize the new options provided by the Smart Grid. CE includes solutions such as Advanced Metering Infrastructure (AMI), home area networks with in-home displays, distributed energy resources (DER), and demand response programs as well as upgrades to utility information technology architecture and applications that will support "plug-and-play" integration with all future Smart Grid technologies.

Advanced Distribution Operations (ADO) improves reliability and enables "self-healing." ADO includes solutions such as smart sensors and control devices, advanced outage management, distribution management and distribution automation systems, geographical information and other technologies to support 2-way power flow and micro-grid operation.

Advanced Transmission Operations (ATO) integrates the distribution system with Regional Transmission Organization operational and market applications to enable improved overall grid operations and reduced transmission congestion. ATO includes substation automation, integrated wide area measurement applications, power electronics, advanced system monitoring and protection schemes and modeling, simulation, and visualization tools to increase situational awareness and provide a better understanding of real time and future operating risks.

Advanced Asset Management (AAM) integrates the grid intelligence acquired in achieving the other milestones with new and existing asset management applications. This integration enables utilities to reduce Operations and Maintenance and capital costs and better utilize assets during day-to-day operations. Additionally, it significantly improves the performance of capacity planning, maintenance, engineering and facility design, customer service processes, and work and resource management.

Summary

It is this combination of values, principal characteristics, and milestones that answers the question, "What is the Smart Grid?" Brief "sound bite" descriptions cannot do justice to this complex subject.