Metrics for Addressing Smart Grid Issues, Including the Importance and Necessity of Protocols

Presentation to the
U.S. Department of Energy
by the IEEE Joint Task Force on QER

U.S. DOE Requested Insights on:

- Recommendations for metrics for addressing Smart Grid issues, especially to help policymakers determine the importance and necessity of protocols
  - Is there any ability to tie grading on SG metrics to achievement of any subset or portion of the seven key characteristics of the smart grid?
  - Is there an ability to iteratively build, construct, and expand smart grid capability through incremental improvement / investment to achieve measured gains?

What is a Smart Grid?

- It depends…
  - There are many differing expectations as to what will be facilitated by the Smart Grid
  - Must decide on what it is before it is possible to develop a metric
  - DEFINITION: Decision on the priorities and timing of various elements of the ultimate functionality

Smart Grid Metric
Depends on the Definition of the Smart Grid

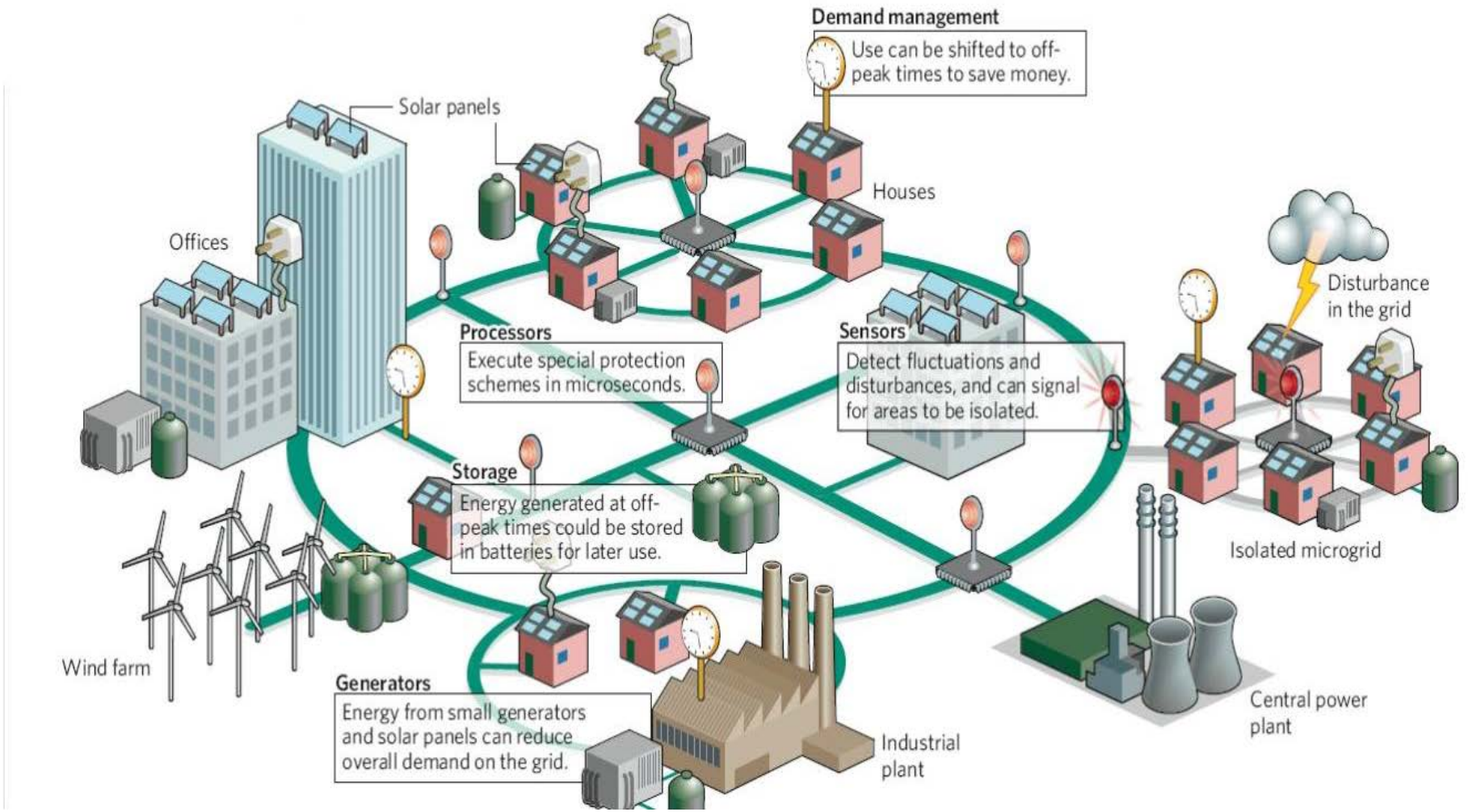
Energy Independence and Security Act

- Passed by U.S. Congress in 2007
- "It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system … that can meet future demand growth and to achieve each of the following, which together characterize a Smart Grid:
  - Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.
  - Dynamic optimization of grid operations and resources, with full cyber-security…"

Definitions: U.S. DOE & IEEE

1. Enable active participation by consumers
2. Accommodate all generation and storage options
3. Enable new products, services, and markets
4. Provide power quality for the range of needs in a digital economy
5. Optimize asset utilization and operating efficiency
6. Anticipate and respond to system disturbances in a self-healing manner
7. Operate resiliently against physical and cyber-attack and natural disaster

Upgrading the Grid



Source: Adapted from Interview with Massoud Amin, “Upgrading the grid,” Nature, vol. 454, pp. 570–573, 30 July 2008

Is there a unique definition?

- The definition may represent the ultimate functionality or an intermediate goal
- Smart Grid definition reflects the perspective and framework of a stakeholder
- For example:

European Technology Platform SmartGrids

A Smart Grid is an electricity network that can intelligently integrate the actions of all users connected to it -- generators, consumers, and those that do both -- to efficiently deliver sustainable, economic and secure electricity supplies.

What is a metric?

A metric is a set of measurable (qualitative or quantitative) attributes of a system or portfolio, which individually or jointly provide a figure of merit for the system or its elements

SMART GRID METRICS AND FIGURES OF MERIT DEPEND ON THE "EYE OF THE BEHOLDER"

Metrics: Commonwealth Edison Example

- A metric for use in tracking progress of its Smart Grid Advanced Metering Infrastructure Deployment Plan:
  - **Number of customers** enrolled on a Net Metering tariff and the total aggregate capacity of the group
  - Load impact in **MW of peak load reduction** from the summer peak due to AMI-enabled demand response programs as a percentage of all demand response in portfolio
  - Number and percentage of **substations monitored or controlled** via Supervisory Control and Data Acquisition (SCADA) systems
  - Number and percentage of **distribution circuits equipped with automation or remote control equipment** including monitor or control via SCADA
  - **Average number of customers per automated three phase 12 kV line segment** (an "automated line segment" is a segment of 12 kV three phase mainline circuit between automated devices which include circuit breakers, reclosers, automated switches, etc.)

Metrics: An Approach

- Categories of Performance/Functionality
  - Economic Performance
  - Technical Performance
  - **Customer Quality**
  - Environmental Friendliness
  - Safety
- Translate into measurable attributes, e.g.,
  - **Outages, response time, tariffs, …**

Metrics: Value of grid upgrades example

Measured by the contribution of the individual improvements/investments to the attributes

GRID/OPERATIONS UPGRADES

MEASURABLE ATTRIBUTES	Voltage support by distributed storage	Active power balancing by distributed generation	Grid relief by distributed generation	Notification of consumption	Smart Meter / Meter Data Management System					
Numbers of interruptions per customer										
Duration of interruptions per customer										
Numbers of outages per grid element	*Enter positive or negative contribution to attribute*									
Duration of outages per grid element										
Share of non-technical losses										

Major Sources of Value

- DEMAND RESPONSE AND SYSTEM EFFICIENCY
  - Achieved by better information
- REDUCED OUTAGE COST

Reduced Outage Costs

"A smarter, stronger grid would reduce the low-end estimate of current outage costs -- $80 billion annually – by $49 billion. This smarter grid would increase the system's efficiency by about 4.5 percent, which is worth another $20.4 billion, annually. Together, improving just those two aspects – reducing outages, improving efficiency – brings about $70 billion in annual benefits".

Recommendations: Metrics & Priorities of Smart Grid Elements

- Secure support of both federal and state regulators for development of **two sets of metrics**
  - One driven by electricity users' needs and preferences and
  - Another, driven by national, regional, and state priorities
- Support ongoing private sector development of metrics and combine the results into a **"super-metric"** that could be configured by users to reflect the stakeholder and regional needs
- Increase emphasis on providing Smart Grid functions to the commercial customer sector (incl. small commercial)

Recommendations: Protocols and Interoperability

- Standardized, inter-operating protocols are key to successful implementation & long-term viability of Smart Systems
  - **Standards:** Work with IEEE's Standards Association, other Standards Developing Organizations, and the stakeholder community to improve the timely development of Smart Grid standards, and promote their widespread deployment, including putting selected standard development on a "fast-track"
  - **Smart Grid Interoperability Panel**: Continue support for the Smart Grid Interoperability Panel as the principal coordinator of Smart Grid standards under EISA 2007
  - **Testing and Product Certification:** Develop an institutional infrastructure for testing and certification of products claimed to be compliant with Smart Grid standards; and means for rapidly resolving any technical issues and ambiguities
  - **Broadband Communications:** Support the advancement and the deployment of broadband and other communication technologies that are essential for achievement of Smart Grid benefits

IEEE REPORT TO DOE QER ON PRIORITY ISSUES

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