



Smart Grid 101

State of Washington
House Tech., Energy, and Comm. Committee
Work Session on Smart Grid/Smart Metering



Wade O. Troxell, Ph.D.
970.491.6618
Wade.Troxell@ColoState.edu

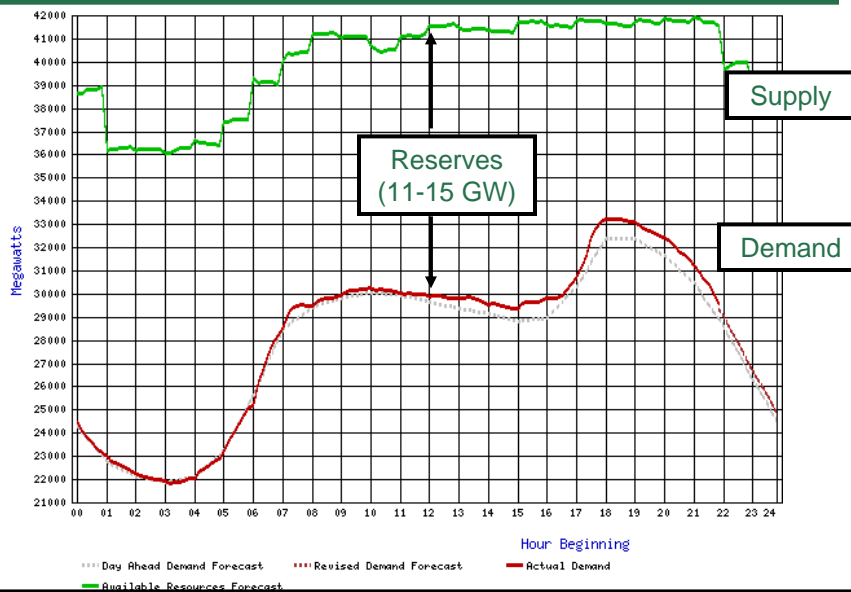
College of Engineering
Colorado State University

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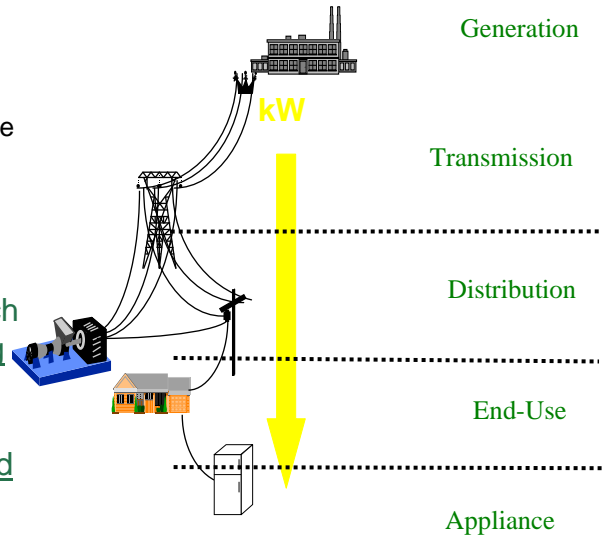
01/24/08 CAISO Snapshot of Power Supply and Demand



Centralized Power Generation and Transmission: A 1930's Construct

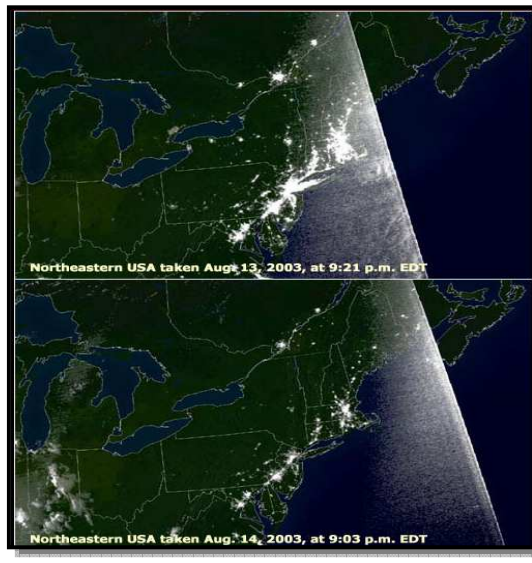
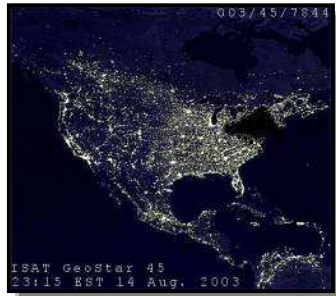
- Has served us well, but...
 - Average U.S. generating plants are old (avg. 35 years)
 - Wasteful (33% delivered efficiency)

Can no longer rely on centralized approach in light of increasing percentage of renewable energy and other distributed energy resources.

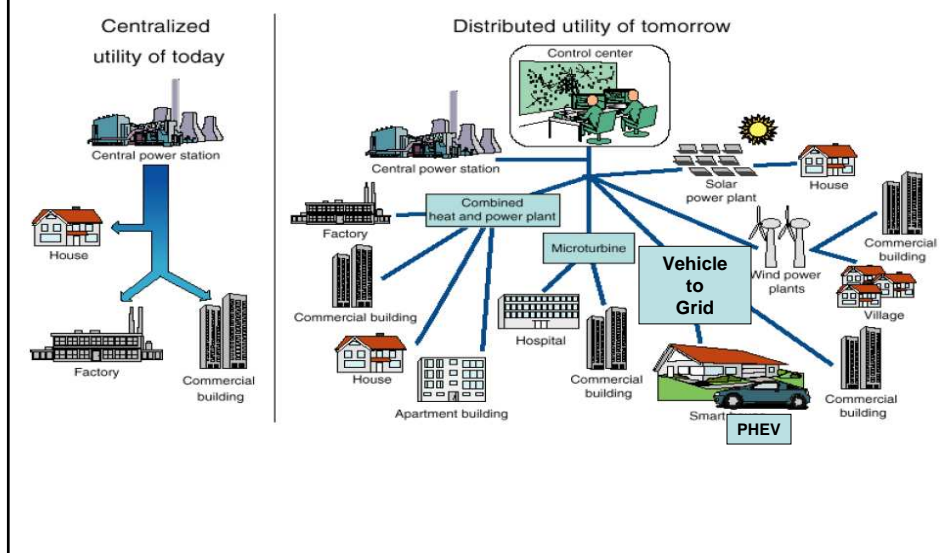


Vulnerabilities of Centralization

August 14th, 2003
Northeast USA Blackout



Transformation of Today's Electric Power System



Big Picture Shift

Smart Grid:

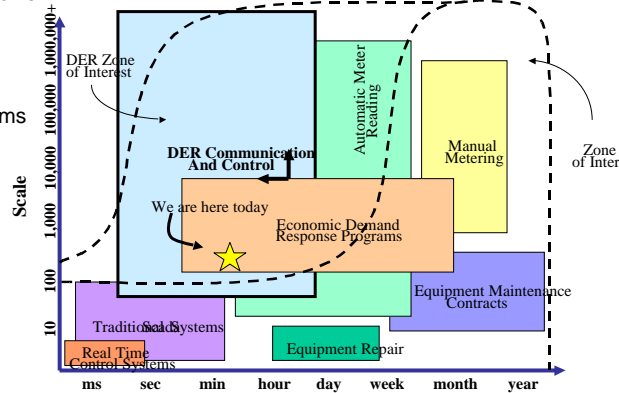
- A fundamental shift from central electric generation and “dumb” delivery infrastructure serving rate payers.

To

- Large number and mix of heterogeneous distributed (and some central) generation sources (including renewables and distributed storage) in load centers cooperating seamlessly to provide real-time 1:1 match of continually changing demand requirements.

A Fragmented Energy System

- Energy recycling (increased efficiency)
 - e.g., combined heat and power
- Energy producing
 - e.g., generators
- Energy consuming
 - e.g., building control systems
- Energy storage
 - e.g., vehicle to grid
- Energy monitoring
 - e.g., meters
- Energy routing and switching
 - e.g., switch gear
- Energy conditioning devices
 - e.g., power electronics



Network them together for value-added products and services for a more robust electric system.

Power System Characteristics

Sec	W	#
10^{-6} <	10^{12}	
Lightning, surges	NA's total elec. generation	
10^{-4}	10^9	10^2
Sub synch. resonance	Central power plant	Central Generators
10^{-3}	10^8	10^3
Frequency control	Large factories	Transmission system
10^{-2}	10^7	10^4
Voltage control	Factories, large buildings	Substations
10^{-1}	10^5	10^4
SCADA communications	Car engine, supermarket	Distribution feeders
10^0	10^3	10^7
Dynamic stability	US home electricity use	Onsite energy system
10^1	10^2	10^8
Ramping, load following	Computer, television, lamp	End use devices
10^2	10^1	
Economic dispatch	Notebook, 1m ² of US office	
10^3	10^0	
Unit commitment, trading	Cellular phone	
$10^{6>}$	10^{-1}	
Generation, T&D Planning	Small Portable radio	

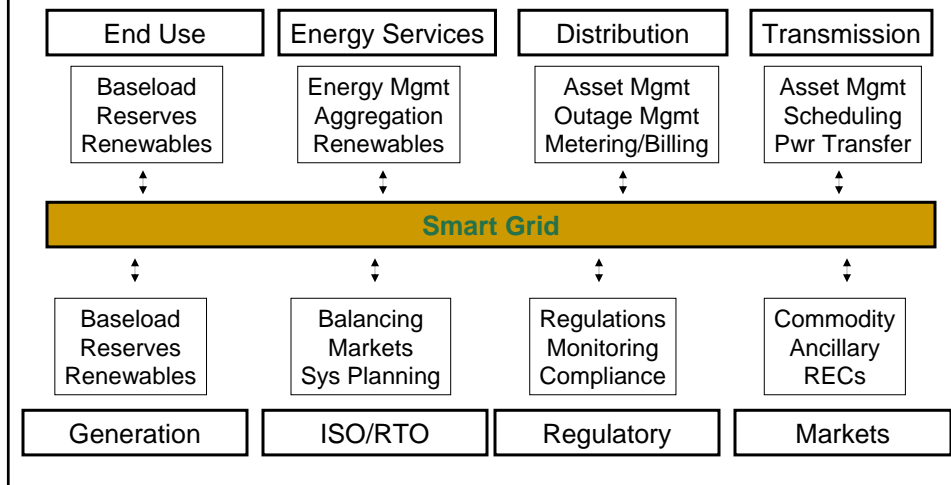
Timescales within the energy system
Source: RMI

Energy generation and consumption range
Source: RMI

Devices within the energy system—
Western US. Source: PNNL

What are the Smart Grid's components?

- Common infrastructure for electric management and services.

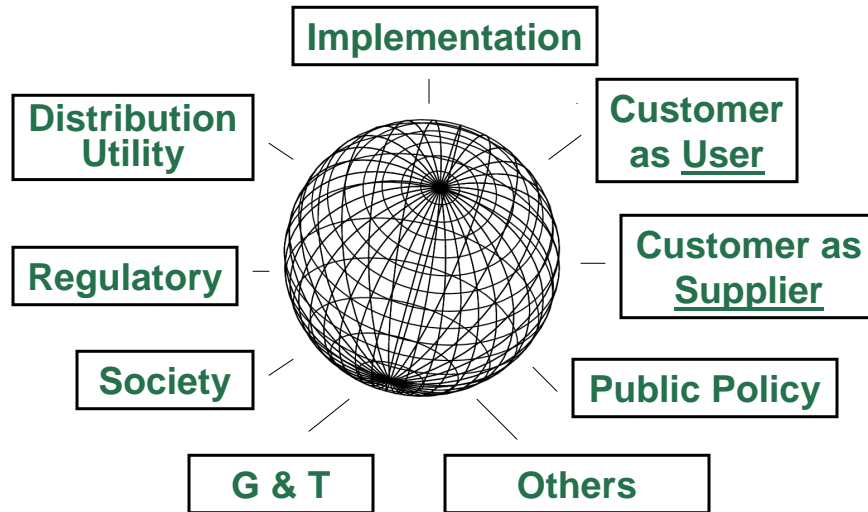


Why Smart Grid Matters...

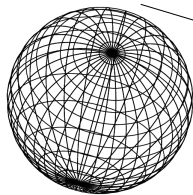
Smart Grid provides for:

- ability to recover under utilized and wasted energy.
- less reliance on vulnerable centralized power generation and transmission systems,
- integration of renewable generation and can deal with capacity factor as system attribute (not aberration),
- an increase in the overall system efficiency,
- the ability to match power quality to diverse end user needs, and
- a more robust electrical system.

Smart Grid Perspectives



Customer Point of View



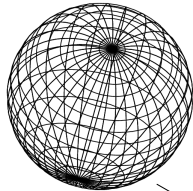
Customer as User

- Lower energy costs
- Renewable energy choices
- “Actionable” information
- Independent on-premise energy management
- Ease of use

Customer as Supplier

- Fair compensation for system benefit
- Ancillary Services will increasing use of private distributed energy supply

Utility Point of View



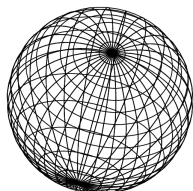
Distribution Utility

- Energy service platform
- Source for innovative economic development
- Demand elasticity

G & T

- More reliable, efficient, resilient grid
- Optimize operations
- Return on investment
- Regulatory compliance

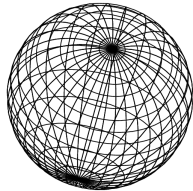
Society Point of View



Society

- Maximize renewables
- Minimize environmental/carbon impact
- Stimulate economic development
- Enable 21st century energy infrastructure

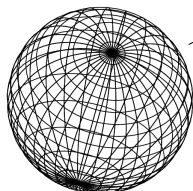
Implementation Point of View



Implementation

- Legacy integration
- Standards and interoperability
- Clear boundaries between:
 - Equipment
 - Smart Grid Platform
 - Applications
 - Customer Programs

Policy and Regulatory Point of View



Regulatory

- Enabling supportive regulations
- Standards and interoperability
- Balancing tradeoffs between:
 - Universal service
 - Customized energy services
 - Innovation
 - Competition

Public Policy

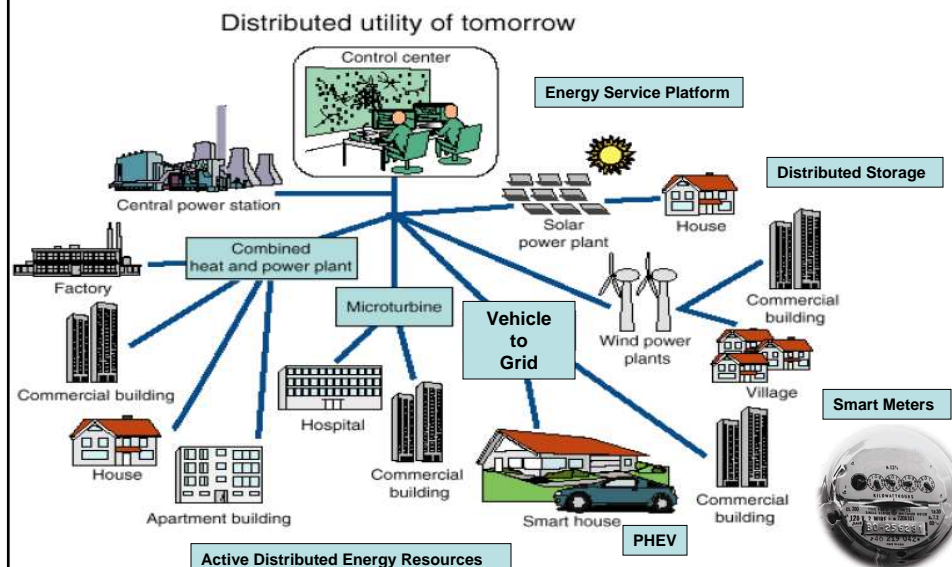
- Informed decision making
- Measurable public benefit

The New Main Stage Player

Distribution Utility:

- Given the large number and mix of distributed generation sources in urban centers cooperating seamlessly to provide near 1:1 match of continually changing demand requirements, places unprecedented responsibility on the Distribution Utility.
- Distribution Utility provide the energy service platform for products and services in a dynamic market (supply and demand) serving end use customers.
- Based upon use and providing a system benefit as a function of:
 - Point of Use
 - Time of Use

Distribution Utility of tomorrow



Delivery of Value to End Users



- Requirements involving the distribution utility, regulators, public policy, and other stakeholders
 - Communications and Smart Meters
 - Easy integration of demand side resources
 - Integration of renewables, storage, vehicles
 - Access to value-added applications
 - Access to services, providers, and markets
 - Innovation energy services platform

Distribution utility of the 21st century will now provide the innovative energy service platform for products and services in a dynamic market (supply and demand) serving end use customers.

Thank you!



The image shows a presentation slide titled "Smart Grid Engineering Global Solutions". The slide features the Colorado State University logo and a large graphic of a smart grid with various energy sources and a central orange hexagon labeled "THE SMART GRID: AN INTRODUCTION". Below the graphic, there is a photograph of a sign for "CSU RESEARCH FOUNDATION MAXWELL RANCH" with a silhouette of a cowboy on a horse. The URL <http://energy.colostate.edu> is displayed at the bottom.

<http://energy.colostate.edu>