Smart Grid: Is It Friendly?

Vermont Law School

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Richard Sedano
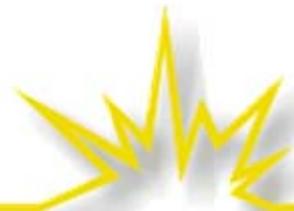
The Regulatory Assistance Project

50 State Street, Suite 3
Montpelier, Vermont USA 05602
Tel: 802.223.8199
Fax: 802.223.8172

27 Penny Lane
Cedar Crest, New Mexico USA 87008
Tel: 505.286.4486
Fax: 773.347.1512

PO Box 210
Volcano, California 95689
Office: 209.296.4979
Fax: 209.296.4979

P.O. Box 507
Hallowell, Maine USA 04347
Tel: 207.623.8393
Fax: 207.623.8369

About the
Regulatory Assistance Project

➢ RAP is a non-profit organization providing technical and educational assistance to government officials on energy and environmental issues. RAP Principals all have extensive utility regulatory experience.

– Richard Sedano was commissioner of the Vermont Department of Public Service from 1991-2001 and is an engineer.

➢ Funded by US Department Of Energy & Environmental Protection Agency, foundations, and international agencies. We have worked in nearly every state and 16 nations.

➢ Also provides educational assistance to stakeholders, utilities, advocates.

Overview

➤ What we'll talk about today

- Smart grid and the electricity food chain
- Smart rates
- Policy

➤ Until you see it work, smart "grid" can be hard to appreciate

➤ This presentation owes most of its coherence to Alison Silverstein
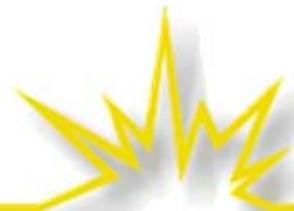
What is Smart Grid?
Several answers

➤ It's all about smart meters and AMI

➤ If you get smart meters and AMI, demand response happens

– Customers respond to price signals

➤ It's about making the bulk power grid work better and meet new challenges

– So we can better integrate wind, for example
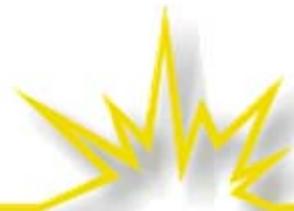
Several Answers Because It Can Affect Many Systems

Smart grid:

➢ Two way communication and information storage -- **NEW**

➢ Enables automated responses representing intelligence from customer or utility system operator with better information -- **BETTER**

– People still make decisions and choices

# Connected to Smart Grid is Smart Rates

➢One definition (Ahmad Faruqui):

A **smart rate** provides cost-based, forward looking information on the price of electricity that allows consumers to make wise decisions about how much electricity to purchase and when to purchase it, both in the near term and the long term.

➢Do you want a smart rate?

Smart Grid version 1
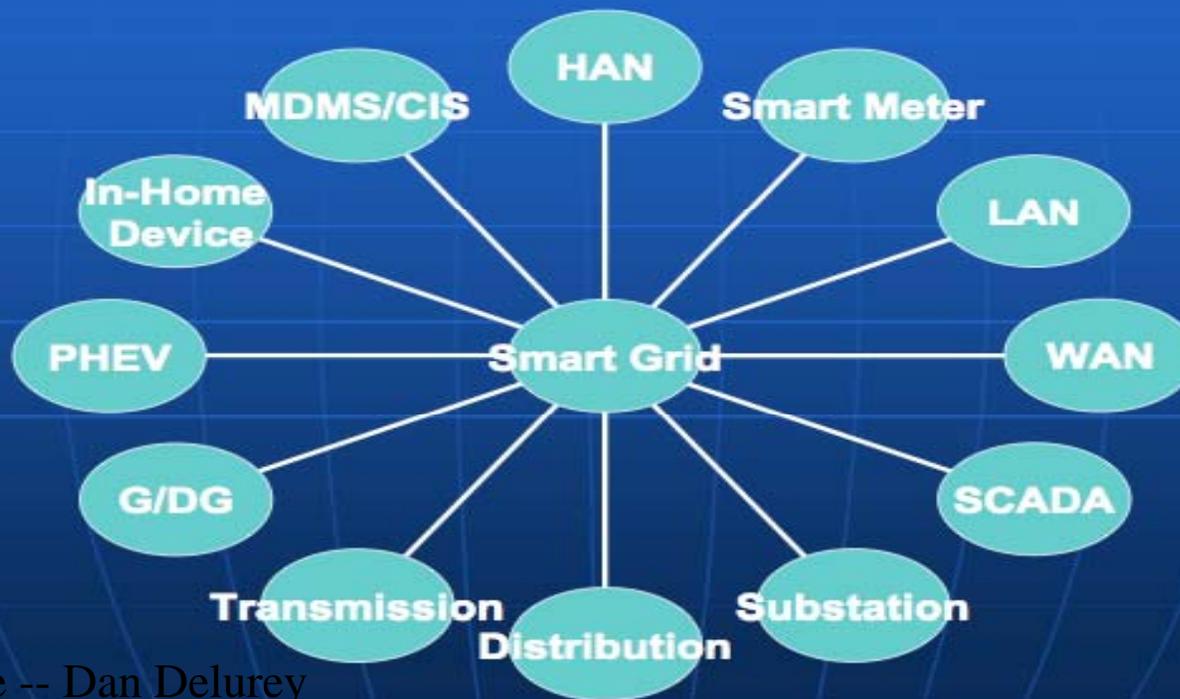# the attributes

Smart Grid – The Desirable Attributes
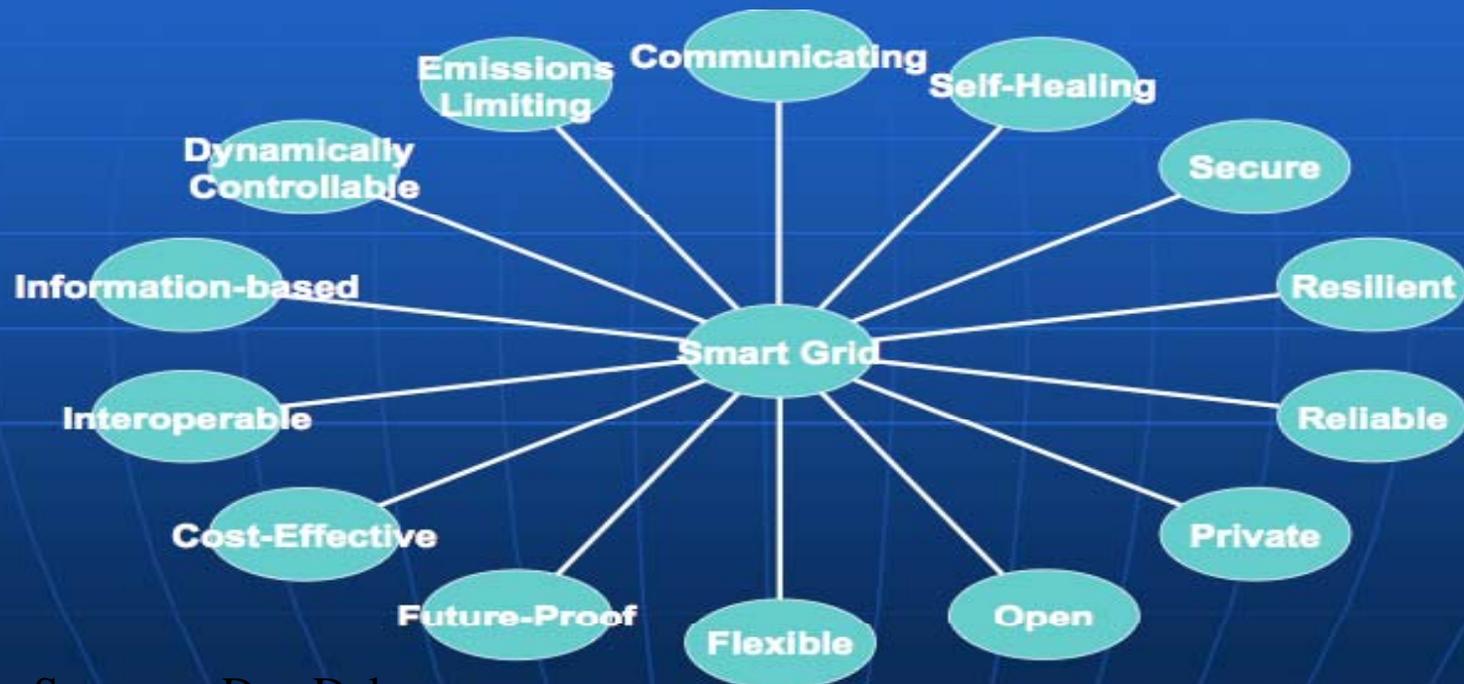
Source -- Dan Delurey

Smart Grid version 2
the pieces

Smart Grid – Disassembled

Source -- Dan Delurey

Smart Grid version 3
what does 2-way mean?

Deployment Strategies

Sources: The Economist; ABB
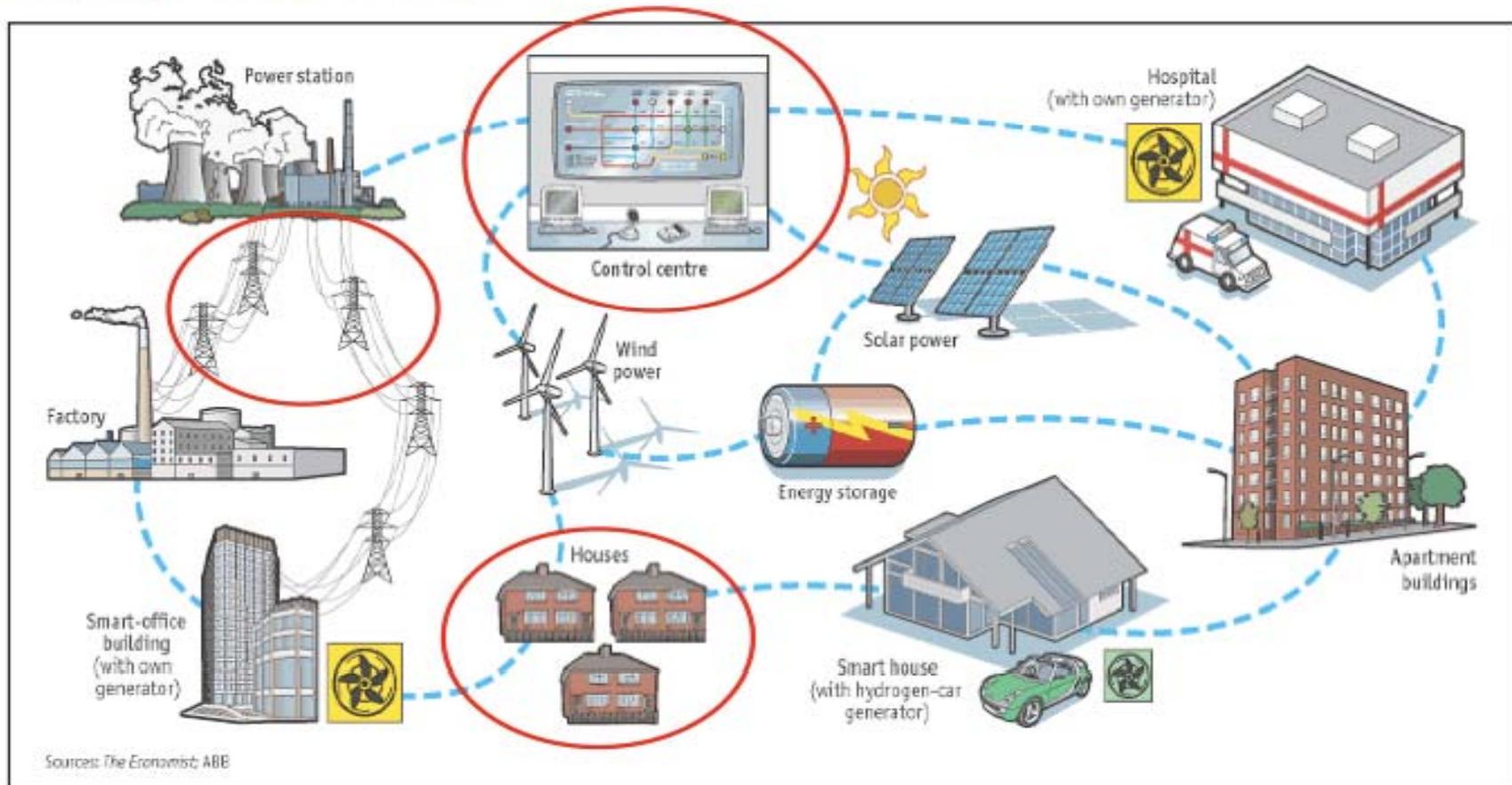
The electricity system isn't just about electricity

Three flows across three integrated networks:

➢ Electricity

➢ Information (**New for most regulators**)

➢ Money

The smart grid is a way to better facilitate and manage all those flows and transactions into a cooperative, collaborative, transactive, reliable system

Smart Grid version 4
more graphics

Electric system

Communication system + information

What you do with them

Real-time Simulation and Contingency Analysis

Distributed Generation and Alternate Energy Sources

Self-Healing Wide-Area Protection and Islanding

Asset Management and On-Line Equipment Monitoring

Demand Response and Dynamic Pricing

Participation in Energy Markets

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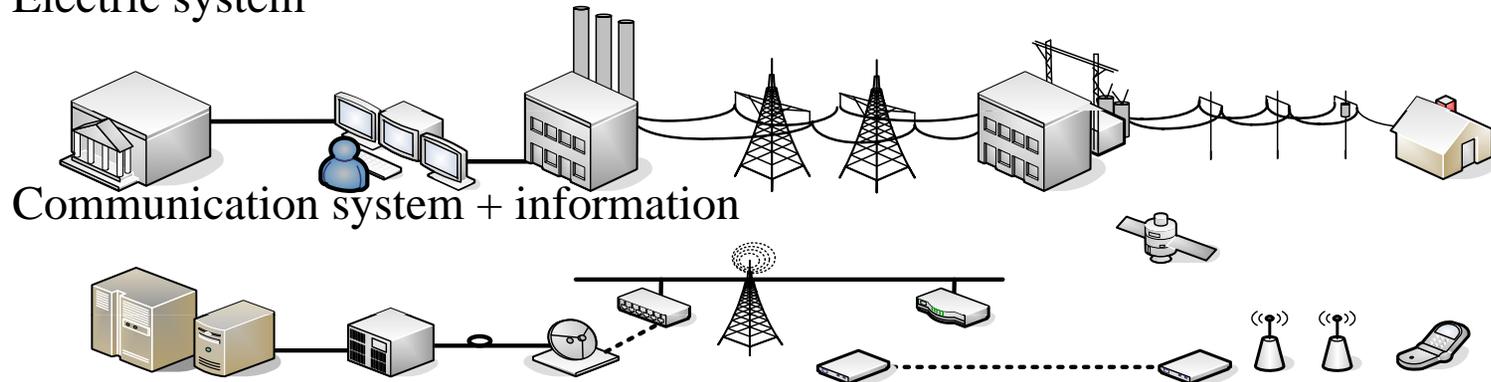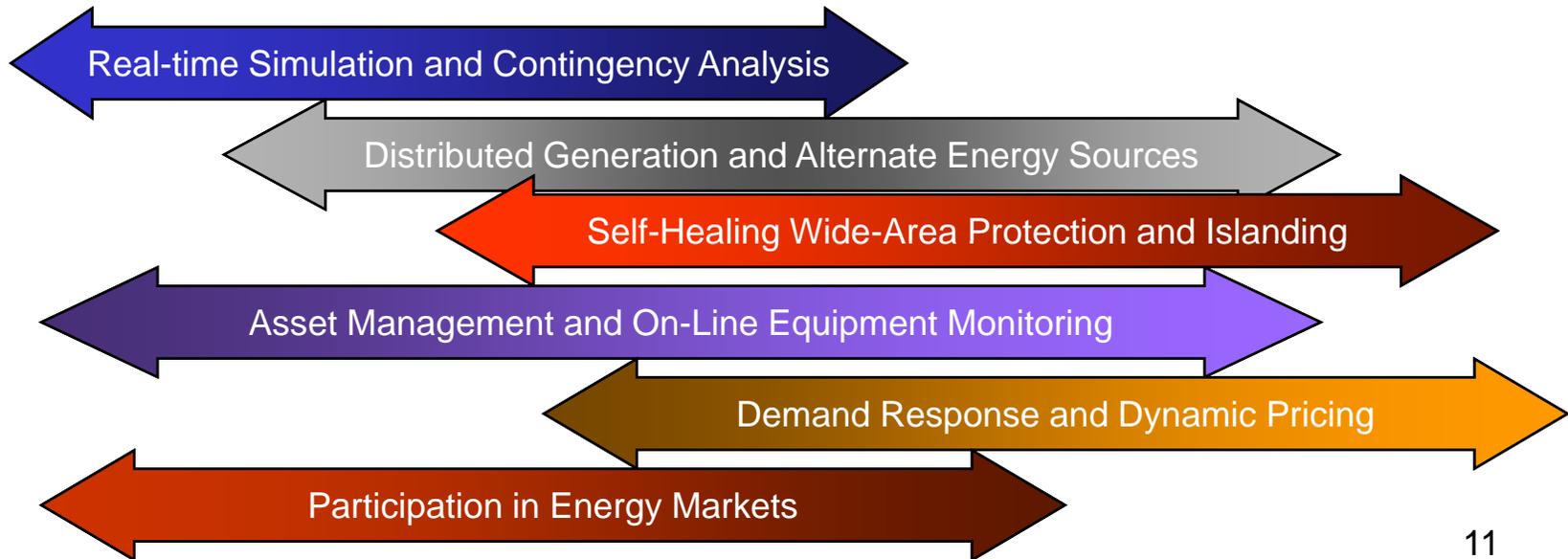
More specific

Smart grid = an electric system that leverages technology and physical assets with:

➢ Advanced hardware (power electronics, more efficient generation, meters, appliances and end-use devices, communications networks)

➢ Advanced software (better modeling and data analysis, linkage between applications, communications)

➢ Advanced materials (cables, silicon, superconductors, semiconductors)

To produce better grid efficiency and reliability using interoperability and distributed, interactive intelligence embedded across the network and its actors.

Smart grid will encompass and enable efficiency, demand response, renewables, distributed generation, PHEVs….

Add in:

➢ **Information**
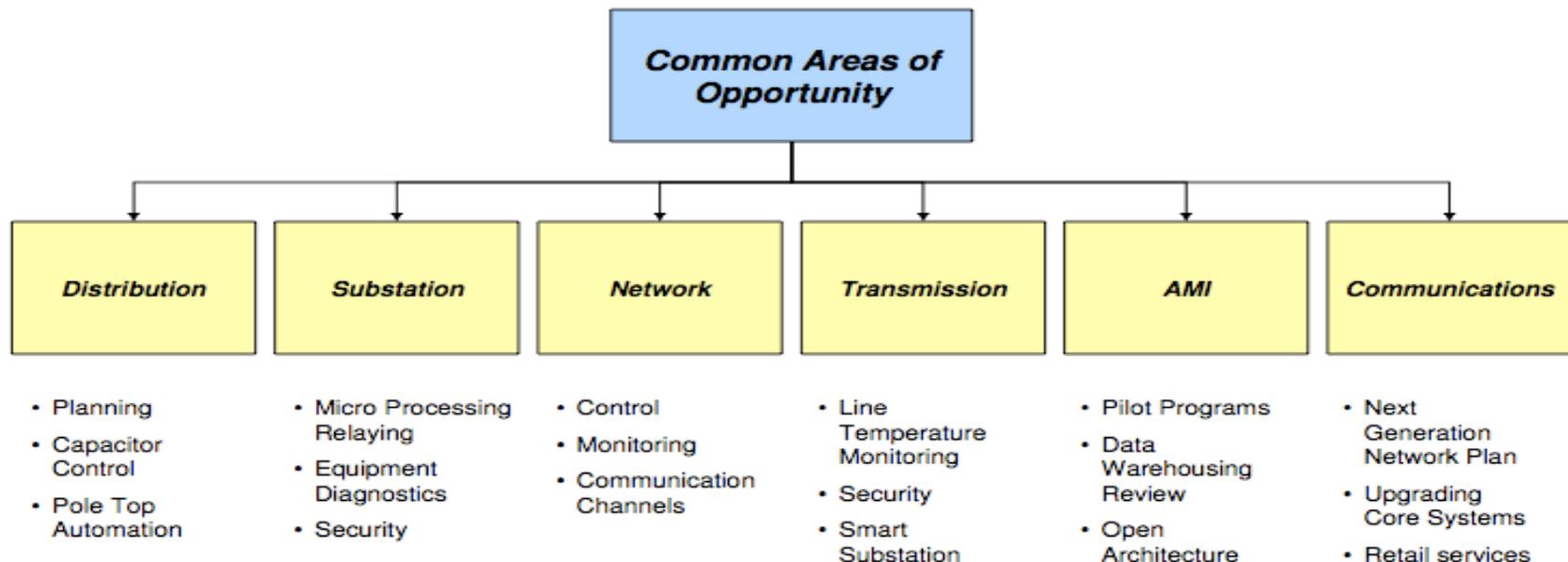 - The value of electricity across time and place
  - The condition of the grid
  - The condition of the various elements of the grid
  - Presented to entities (people, institutions, devices) that can use it, in ways that they can understand and act on
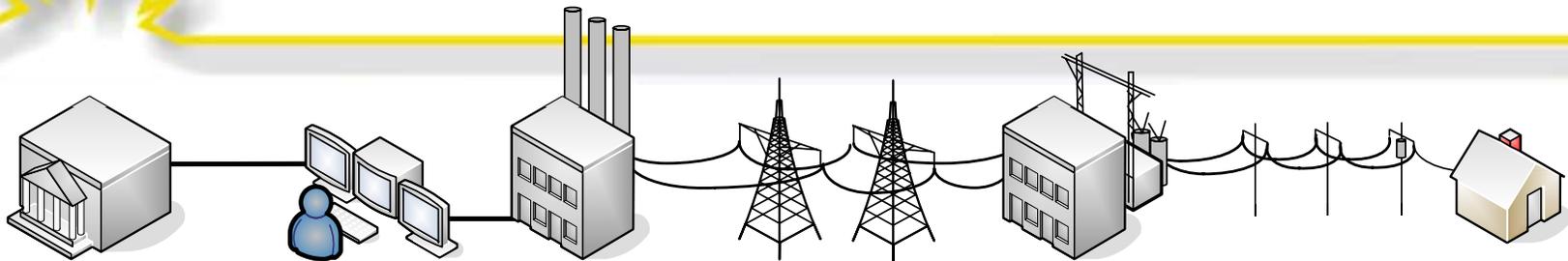
➢ **Customers**
  - They consume, consider, respond, interact
  - They respond for reasons that may have nothing to do with what utilities or regulators value

Smart grid from the utility engineer's perspective

There are a number of key areas that can yield synergies between existing initiatives and smart grid efforts

Common Areas of Opportunity

Distribution	Substation	Network	Transmission	AMI	Communications
• Planning • Capacitor Control • Pole Top Automation	• Micro Processing Relaying • Equipment Diagnostics • Security	• Control • Monitoring • Communication Channels	• Line Temperature Monitoring • Security • Smart Substation	• Pilot Programs • Data Warehousing Review • Open Architecture	• Next Generation Network Plan • Upgrading Core Systems • Retail services

The electricity value chain and the smart grid

Everything above the meter should be integrated into the smart grid too, with

- Distributed intelligence
- Communications
- Analytics
- Automated controls and sensors

So all the pieces of the grid -- including customers' decisions become complementary parts of a greater system

Some of the other technologies

- ➢ **Generation**
  - – All sizes, intermittence (central-station to micro)
  - – All fuels and technologies (fossil, nuclear, renewables)
  - – Sensors and monitoring devices
  - – Dispatch system and automated controls
- ➢ **Storage**
  - – All sizes (pumped storage and solar thermal to ice blocks, flywheels and power electronics)
  - – All locations (stand-alone like generators, at substations, co-located with intermittents, and at customer premises)

More technologies

➢ Transmission and distribution

– Automation to get better understanding of what's happening on the grid and improve operation of all those elements in real time

– A mix of old and new technologies (conductors, microprocessors, power electronics, poles and towers, storage and distributed generation, transformers, microgrids to EHV (extra-high voltage), AC and DC)

– Better information, with more granularity of detail (up to 30 samples/second, time-synched, measuring specific conditions across the grid and with respect to each operating element)

– Better controls (relays, breakers, reclosers, transformers, power electronics, etc.)

Communications and IT

- ➢ **Communications networks**
  - – Multiple technologies and scale (radio, powerline, wireless, internet, phone, internal and public….)
  - – Standard communications protocols and systems

- ➢ **Monitoring and feedback systems**
  - – Widely distributed monitoring (SCADA, synchrophasors, meters, relays, …)
  - – Merged and interpreted by sophisticated analytics

- ➢ **Control systems**
  - – Distributed across and controlling all key parts of the electricity value chain

- ➢ **Information**
  - – Real-time, time-synched, high-sampling rates
  - – About all the things that matter (current, voltage, frequency, price, emissions), delivered to the actors who care about it

Observation:
Information and rates

- ➢ Customers only react to what they understand
  - – Information has to have meaning and relevance to the customer (prices, times, consequences, relationship)
  - – Information has to be clear and usable
  - – And not all customers will respond
- ➢ Customers only respond if they care about the stakes
  - – What's the cost?
  - – What happens if I do or don't respond?

SO DON'T SPEND A FORTUNE ON AMI AND THEN SET UP DUMB RATE DESIGNS AND BLAME DEMAND RESPONSE WHEN CUSTOMERS DON'T RESPOND

Observation: Automation

➢ **Customers respond best if they have the capability to respond easily**

   – Automation is the enabling technology to making the customer, on-premise side of the smart grid work

   – But not everything has to be automated

   • Turn stuff that matters on and off

   • Not all the automation has to be inside the device (i.e., you don't need a smart appliance if you have a smart controller that can reach the device)

   • System operators will always drive the system

Observation: Optimality

- Most smart grid descriptions talk about optimizing
  - Minimal cost or Optimized for this or that
  - But optimization can only happen in a command-and-control network
- But the essence of the smart grid is that multiple actors make independent decisions within a network of interrelated devices
  - Absent centralized analytics and command-and-control, we can't optimize, we can only make the various parts of the system work better internally, and then work well together
  - Lots of local optimization and cooperation will produce a very good outcome even if it's not "optimal"
- Is this "letting go" possible?

Observation: interoperability

Cooperation and integration don't occur unless things work together effectively

Interoperability = The ability of two or more networks, systems, devices, applications or components to exchange information between them and to use the information so exchanged, in ways that don't inconvenience the user

➢ Interoperability requires interconnectivity and interaction agreement between hardware and software to enable effective communications, coordination and control.

➢ Interoperability is achieved when users' *expectations* to exchange and use information among various devices and software applications from multiple vendors or service providers are met or exceeded.

What's the big deal?
Why not just do it?

➢ Smart grid can be seen simply as an evolution

➢ But it is a paradigm shift in design and use of the electric system

➢ And this shift is expensive, while many of the benefits are uncertain, or even unimagined

➢ Leap or not? When would conditions be right?

➢ 2009 Recovery Act features $B for smart grid