In Front Of The Third Electrical Systems Revolution in United States

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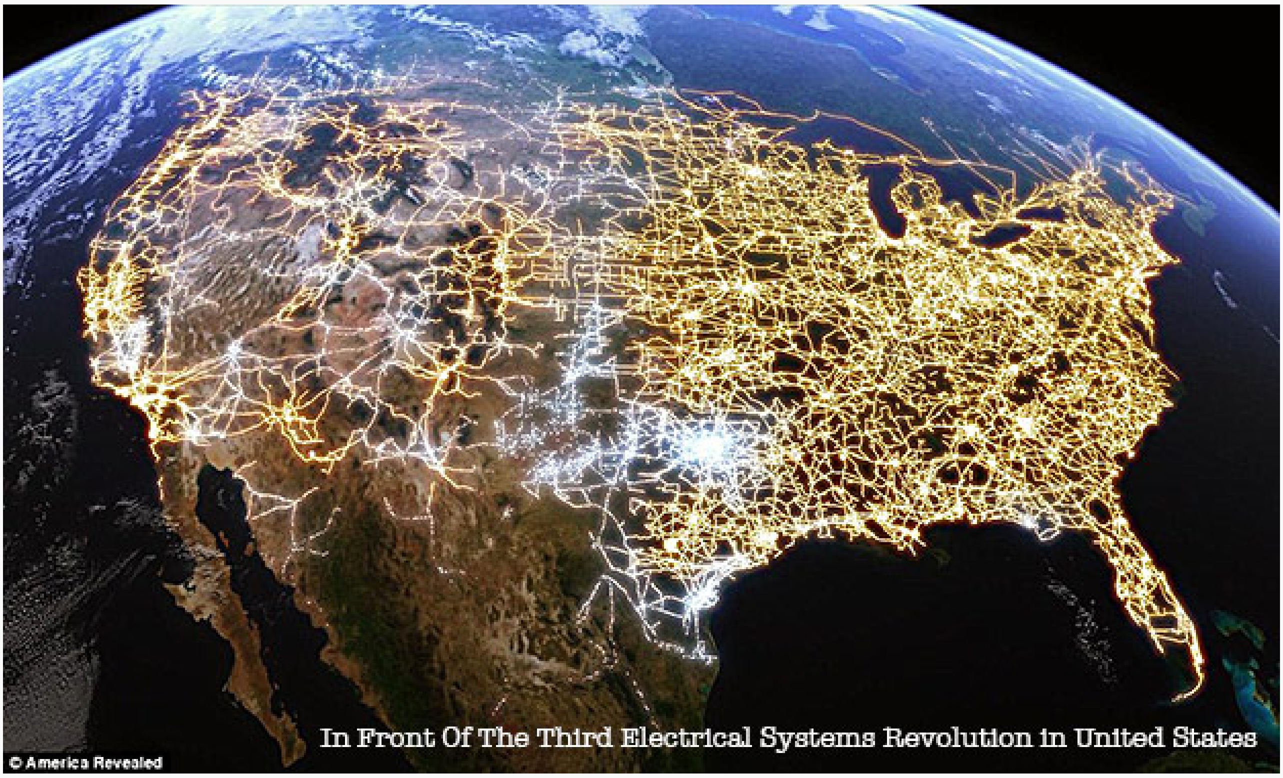


The U.S. electricity seen as never before, with its cities connected through a vast network (photo credit to dailymail.co.uk)

Power Demand as a Power Resource

A dizzying array of new energy technologies are reaching or nearing the marketplace. Newer choices to generate electricity include fuel cells, wind turbines, solar cells and microturbines.

Energy storage is approaching practicality, for example through reversible fuel cells and flywheels. Under development are smart home appliances that can sense and adjust to grid conditions and commercial heating-ventilation-air conditioning systems that allow remote diagnosis and control.

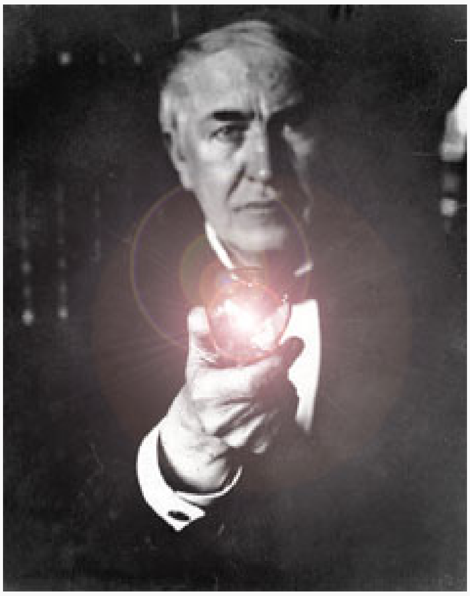
In the background is the most powerful energy technology of all, **the microprocessor**.

Virtually all new energy technologies come with embedded electronic intelligence that controls their operations and enables them to link with other devices, buildings and the overall grid.

Perhaps the most important message about the energy technology revolution is that, remarkable as each of the new devices is on its own, their value is fully unleashed only when they are linked together in coherent systems. Information technology represents the connective tissue.

The originator of the first great electrical revolution knew that innovative devices are important, but the key is creating systems that make them useful.

Thomas Edison’s decision to create a practical incandescent light bulb was only part of a larger scheme. Electrical power was already finding niche applications such as arc lighting powered on-site. Edison’s vision was to pipe electricity into people’s houses to supplant the gas light industry. So he mimicked its systems as he plottec out the first power grids.



Thomas Edison holding the light bulb

When he opened the first central power stations and grids in 1882, Edison’s new power system vastly increased the usefulness of electrical devices, setting off an explosion in their use.

Nicola Tesla believed he had a better idea. Instead of Edison’s Direct Current (DC), which then could travel only short distances, he would invent a system of Alternating Current (AC), which by cycling back and forth could move over longer distances.

In 1895 George Westinghouse used Tesla’s technology to harness Niagara Falls and transmit AC power 22 miles to Buffalo.

The Tesla- Westinghouse system created the second great revolution in electricity’s usefulness by multiplying electric generating potential. The grid of today, with large central power plants and thousand-mile-plus transmission lines, is more a child of Westinghouse and Tesla than Edison.

Edison is having some revenge on his great rivals, though. The smart energy network represents a partial swing back to Edison’s original idea of localized DC power distribution.

Nikola Tesla standing next to his suite at the Hotel New Yorker - circa 1934

The concept of the smart energy network is the third and greatest revolution of electricity.

The infusion of ubiquitous information technology throughout the grid makes it a far different and even more useful animal than either Edison’s or Tesla’s creations. Each of the earlier grids was oriented around central power plants and central control. The smart energy network will distribute the control and generation of electricity throughout the power network, producing a system that operates in fundamentally different and unprecedented ways.

One driver toward this new system is electrical industry restructuring.

A grid composed of relatively few regulated utility monopolies is evolving into a network of many competitive power producers and other new players. This trend itself was kick-started by technology, the rise of competitive natural gas turbine electricity. Large power customers demanding access to this cheap power spurred the opening of wholesale power markets to competition a decade ago, beginning the restructuring process.

Restructuring ran into roadblocks after the 2001 western states power crisis. But the trend toward competitive power markets is unlikely to abate, particularly with the emergence of economical, small-scale, distributed energy generation.

2013 Report Card for America's Infrastructure – Energy and The National Power Grid

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Put the new energy technologies and economics together, and the picture that emerges is a shift from top-down control to bottom-up management. Spontaneous patterns of organization described as complex adaptive systems emerge from the bottom. In the smart energy network every software agent is an actor capable of optimizing power operations in its own venue.

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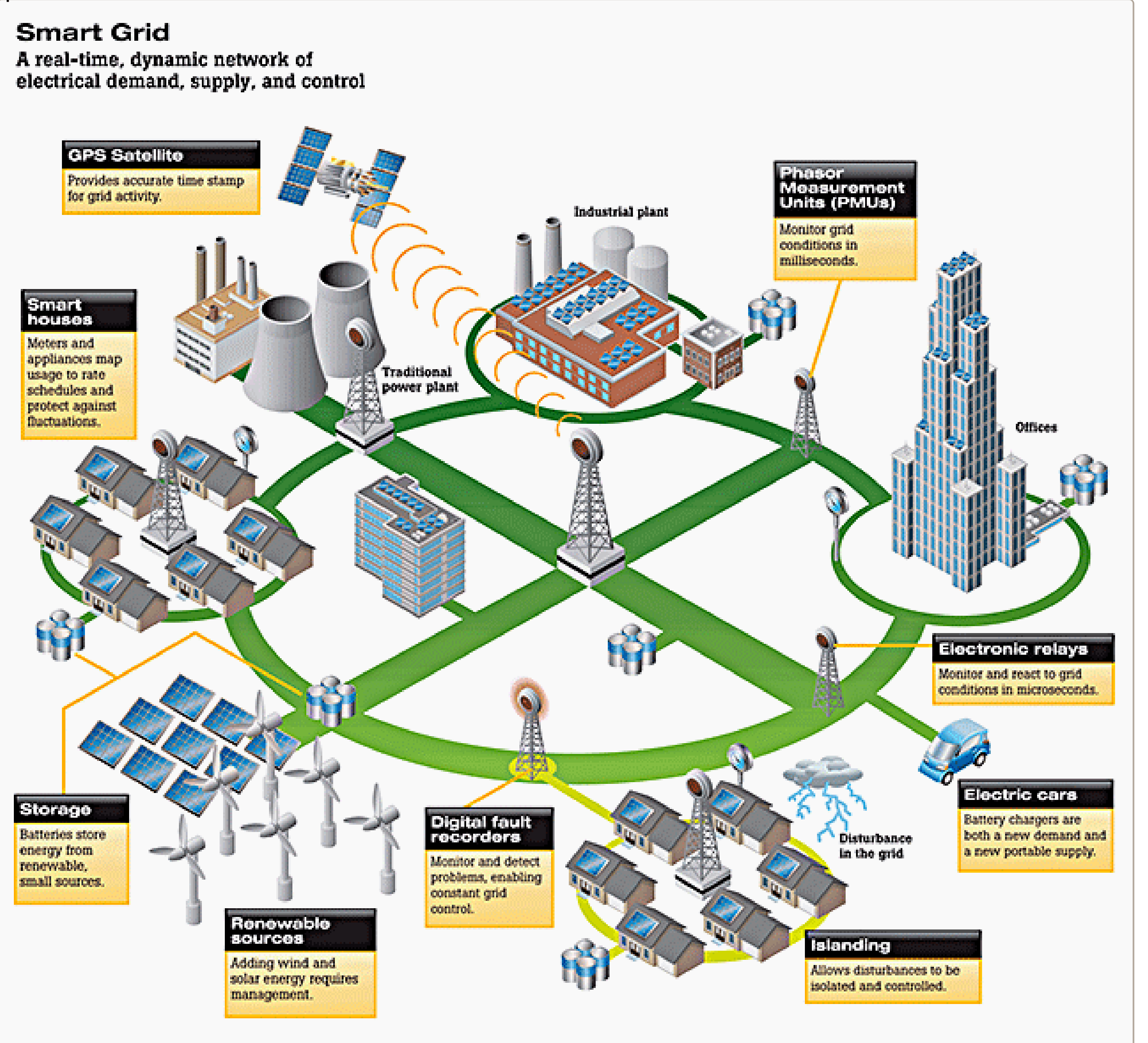

SMART GRID - A real-time dynamic network of electrical demand, supply and control (photo credit to utilityproducts.com)

cumulative outcome is a complex adaptive system that collaboratively directs the energy network.

Networks of smart devices take complexity to "***a scale where we cannot manage things centrally,***" notes Ron Ambrosio of IBM Research.

Smart software agents within each device must be able to assess conditions of their operating environment and respond independently. Those assessments and responses produce an environment with far more complex interactions that today's power grid. On the traditional grid energy flows outward to customers, while information concentrates in command centers and money flows from customers to billing departments.

In the smart energy network, software agents conduct transactions on their owners' behalf, and information, energy and money stream in all directions.

But will a system of millions of linked smart devices work without boggling on its own complexity? How will traditional energy providers relate to all the new players? The situation resembles an auditorium with one speaker on stage, but where the entire audience suddenly wants to join in the conversation.

Architecture of a Smart Grid

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The result will be pandemonium unless the crowd somehow organizes itself and sets up protocols for communication. As the grid moves from central to distributed control, this is exactly what must develop. The speaker up on stage may still facilitate the discussion but much of the action will move to the floor.

Talk of moving from centralized to distributed systems raises other concerns.

1. Who will be accountable when the grid runs into problems?
2. Can we trust the grid to "run itself?"
3. Will difficulties in integrating many new energy technologies forestall or delay realization of their benefits?
4. Will interactions and transactions of smart devices produce instabilities?
5. Can the system be worked by price gougers or hijacked by terrorists?

Such questions indicate why it is absolutely critical to comprehensively explore ***how the new technologies mesh together in systems***.

Developing this comprehensive approach is the point of ***Pacific Northwest National Laboratory*** – PNNL's work related to energy system transformation. The Laboratory's ambitious overview includes developing basic architecture that enables smart energy devices to communicate, creating a virtual grid in a supercomputer to model new energy networks, and mounting real-world physical tests to see how energy devices work together.

PNNL researchers aim to ground the emergence of the smart energy network by creating a framework for all its aspects from fuels and power generation through transmission and delivery to end-use.

"We're putting together the whole story and creating a transformation – not just a business, not just a technology, not just science," PNNL Power Systems Program Director Steve Hauser says. "We need all those elements for success."

Reference: The Smart Energy Network: Electricity's Third Great Revolution By Patrick Mazza

Source:
http://electrical-engineering-portal.com/an-overview-of-the-transmission-and-distribution-network-of-new-zealand