

Strategizing the Grid: Who Should Worry About the Long Term?

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Florida Power Outage

- ◆ On February 26, 2008, a technician performing a checking function at a substation in mid-Florida shut down two safety systems to carry out a task.
- ◆ Moments later, the substation failed, and
- ◆ Power was cut to two nuclear power stations, which shut down, and
- ◆ 2 to 3 million Florida customers were left in the dark

More, Bigger Outages?

- ◆ Big outages make the news – NE 1995, Western US 1996, US-Canada 2003, Italy 2003, Florida 2008
- ◆ There seem to be “more” big outages, and more than statistically predicted: outages map to power law distributions
- ◆ Outages, interruptions and “dirty power” (spikes and sags) have more impact because of computerized “everything” in homes, offices, hospitals, factories ...
- ◆ 2002-2004 outages affected more than 130 million worldwide

How Come? The “Usual Suspects”

- ◆ “Old” grid infrastructure connected, stressed by growth, trading, bottlenecks, economic disincentives to investment
- ◆ Poor maintenance or operating practices
- ◆ “Deregulation’s” unanticipated consequences:
 - ◆ Decoupled generation, transmission, utilities, trading
 - ◆ Escalated transmission (with no infrastructure relief)
 - ◆ Exacerbated “Minimize cost/Maximize revenue” thinking

What to do?

The Usual Responses

- ◆ “Old” infrastructure: *Build more, newer infrastructure*
- ◆ Poor maintenance or operating: *Train, penalize, enforce*
- ◆ “Deregulation’s” unanticipated consequences: *Reconsider deregulation, tweak it or roll it back*



BUT:

- ◆ *All of these assume the same general pattern, technology and system – essentially unchanged*
- ◆ *Fundamental rethinking is dismissed as impractical*
- ◆ *Looming Threats and Opportunities are out of sight*

Electricity's Wicked Problem

- ◆ *The Grid Itself:* Its system links, behavior and performance characteristics, interconnection, potential for entrainment and cascade effects
- ◆ *The Consequences of Outages:* Currently borne entirely by ratepayers, with little/no enforcement on reliability
- ◆ *Security Implications of Increasing Dependence:* consequences (increasingly frequent) low probability, high impact events
- ◆ *Technology and Convergence:* Potential for blind-siding the industry

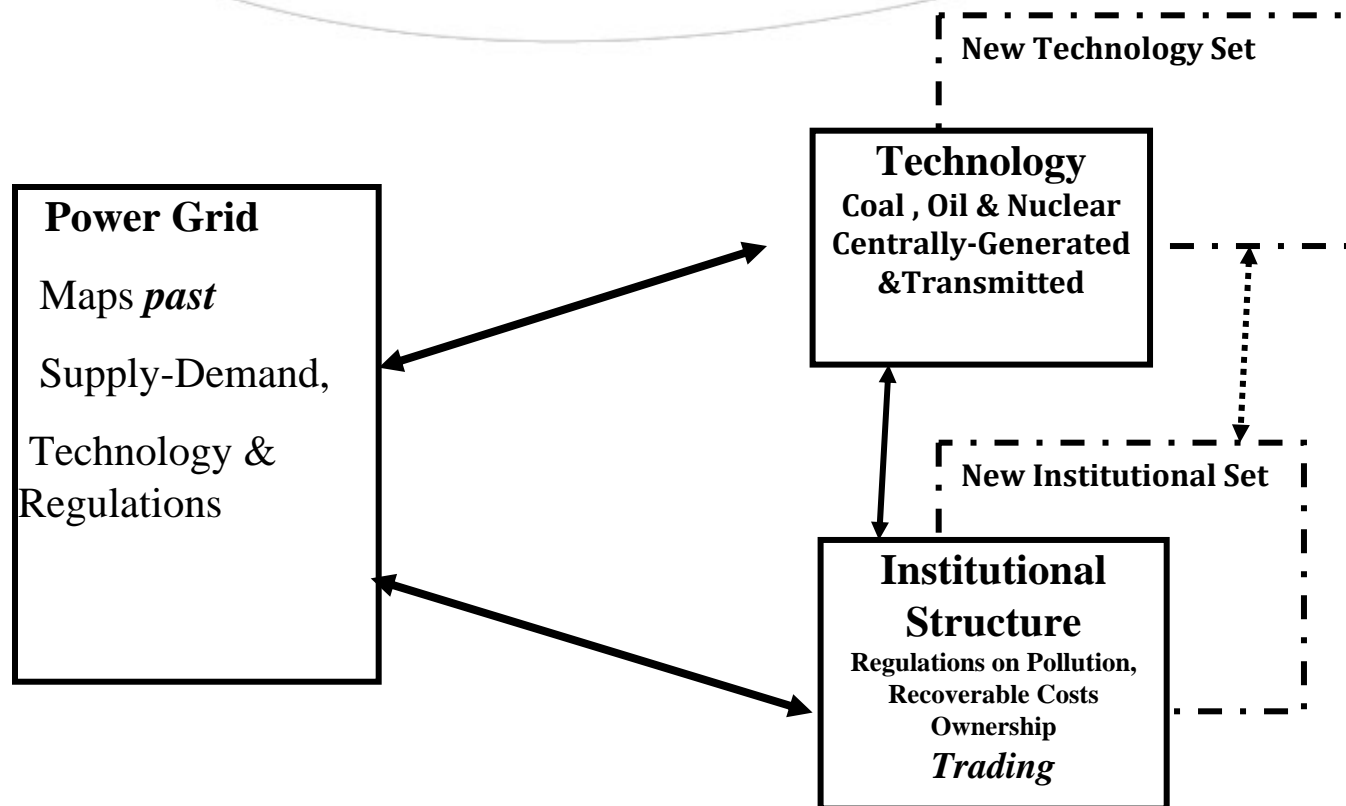
Critical Issues:

- ◆ *Reliability and security of a given firm's grid*
- ◆ *Reliability, security and robustness of grid as a whole*
- ◆ *\$100 bbl + Oil, Expensive Natural Gas, Environmentally-Constrained Coal & Nuclear*
- ◆ *The Attractiveness of alternatives accelerates ...*
- ◆ *The potential for Different Regulatory Regimes*

Strategizing the Grid

- ◆ *Geography of Demand* has driven supply location, rather than survivability of localized grid segments
- ◆ *The Physics of Electricity* is rooted in the system that is; Alternatives? 90-sec cascade sequence vs femto sec switches, buffers, and automated controls
- ◆ *Multiple Technology Factors:* Solar thermal, wind, geothermal *and* auto load shedding, isolation, phase match

Overview of Grid



Strategic Vulnerabilities

- ◆ Older, in-place technology, capital investments, P&E
- ◆ Human resources trained in older technology and business models
- ◆ “Learned Strategic Blindness” (cf Bethlehem Steel versus the minimills, or the Big Three versus Japanese automakers)
- ◆ “Incomprehensible” New Analysis Tools and Business Models

National Security

- ◆ *Without power, our cities are essentially uninhabitable*
- ◆ *Grid Vulnerabilities are potential targets: choke points and transmission lines, even individual plants*
- ◆ *Capacity issues make the Grid vulnerable to gaming: Enron spiked prices by overloading transmission lines and diddling supply by closing plants*
- ◆ *Unacknowledged vulnerabilities are subject to Murphy's Law*

Company Security

- ◆ Complexity Science suggests the current system is “at the edge of chaos” – more, bigger outages are likely
- ◆ Simulations say outages follow Power Laws, not Normal distributions
- ◆ Network Analytics suggest alternative designs: an Internet-like Grid with multiple paths
- ◆ Pent-up customer resentment plus burgeoning technical possibilities generate rapidly change



Let the Games Begin!