

# Network Economics and the Future of Electric Power

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# Game plan

- ★ Overview/refresher on natural monopoly theory as the economic foundation of regulation
- ★ Overview of smart grid technologies and potential value propositions, and the role of regulatory institutions in enabling them
- ★ Interoperability and smart grid standards-setting processes
- ★ Policy implications

# Natural monopoly model

- ✦ History: developed during the late 19th-early 20th century; supported Progressive Era concepts of “scientific management”
- ✦ Static neoclassical model
- ✦ “Standing in for competition” and aiming for point d on the graph
  - ✦ Pricing based on cost recovery and on average revenue per unit of output
- ✦ Information requirements, and implications of asymmetric information

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# Consequences of innovation

- ✦ Dynamic change is pervasive, including external technological change affecting the electricity industry
- ✦ In the presence of dynamic change and evolution, static models do not lead to efficiency ... and yet static regulatory institutions persist
  - ✦ Other policy objectives
  - ✦ Public choice incentives of regulators and regulated
  - ✦ Human nature -- inertia, status quo bias, risk aversion

# Is this a natural monopoly?

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# Issues in smart grid technology and economics

- ✦ Smart grid as a communications network overlay of the electric network
- ✦ Wide variety of technologies throughout the network, with different implications for cost and value
- ✦ Technology enables a paradigm shift from centralized control to **decentralized coordination**

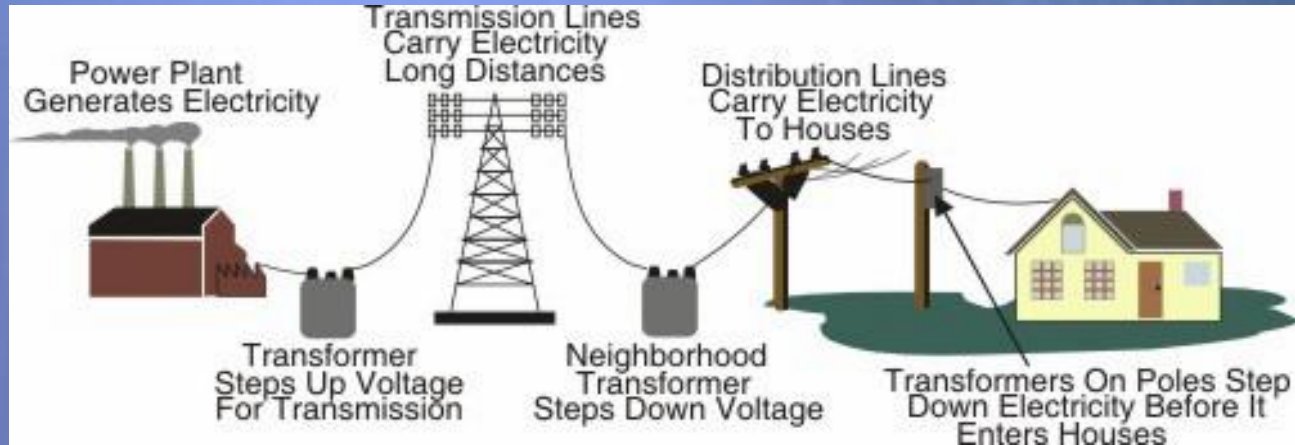
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Source: GridPoint, <http://www.gridpoint.com/smartgridsolutions.aspx>

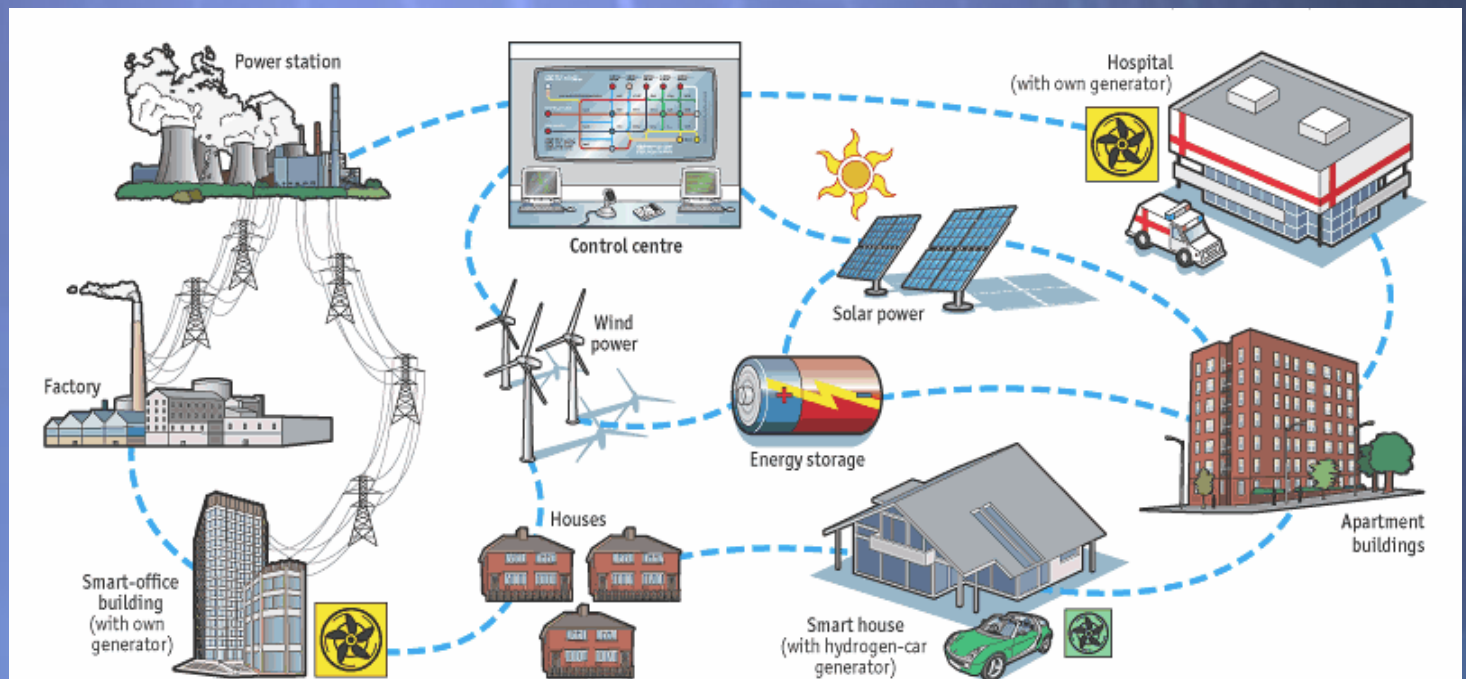
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# Present and future: from value chain to value network

Before



After



# Role of interoperability

- ✦ Definition: The ability of different systems/agents/devices to interact across a boundary (technology, firm, market, policy) with little or no human intervention
- ✦ Examples: Global ATM network, mobile phone networks, Internet
- ✦ Loosely-coupled system of systems
- ✦ Enables the use of digital technology to broker transactions
  - ✦ Energy sales and purchases
  - ✦ Renewables interconnection
  - ✦ Peer to peer power -- microgrids, PEVs
- ✦ NIST smart grid interoperability roadmap process is under way
  - ✦ Provides a focal point around which interoperability standards can coalesce

# A high-level smart grid standards map

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# Renewables integration

- ✦ Physical challenges of integrating distributed, variable resources into a network with little storage and little information
- ✦ Smart grid technologies enable
  - ✦ The coupling of supply/demand forecasting in ways to enable the use of renewables (and wind can be a low-cost resource)
  - ✦ Negotiating the handshake -- physical interconnection
  - ✦ Transactions that reflect consumer preferences over their "green-grey mix"
  - ✦ Measurement and verification that are crucial for REC markets and/or carbon markets
- ✦ Renewables and product differentiation

# Regulatory policy and smart grid

- ✦ Adaptation of regulatory institutions to technological change
- ✦ Are our historical cost recovery-based regulatory institutions consistent with such innovation, or do they stifle innovation?
- ✦ Decisions about who makes and pays for smart grid investments
  - ✦ Private parties willing to pay, but utilities want control (and rate recovery)
  - ✦ Some private parties not willing to pay, but utilities want control (and rate recovery)
- ✦ Ultimate issue: **control vs. choice**

# Some policy implications of the potential value of smart grid

- ✦ A network is not transactive, and thus not a smart grid, without the choice of dynamic pricing for retail customers
- ✦ A smart grid enables, and indeed requires, looking beyond the regulated utility business model
  - ✦ Removing barriers to retail competition
  - ✦ Removing barriers to non-utility agents making technology investments
  - ✦ Institutional change => technology pull

# Competition policy in electric power

- ✦ “Perfect competition” is about an equilibrium outcome: a static place where  $P=MC$ 
  - ✦ Rests on assumptions that basically assume away the process of competition
- ✦ But competition is inherently a dynamic process of *rivalry* among heterogeneous producers
- ✦ In electricity, as the natural monopoly disintegrates, applying this concept of competition suggests policies that focus on reducing entry barriers (except for wires, for now)

# Ideas for change

- ✦ Recognize that our society is increasingly one in which *decentralized coordination* is more possible, and more preferable and valuable, than centralized physical\* and economic control
  - ✦ Retail competition delivers consumer value and the self-correcting dynamics that reduce waste; without it, smart grid has limited value
  - ✦ Regulatory transition from rate setting to *ex post* consumer protection
  - ✦ Digital technologies enable consumers to protect themselves and derive their own value!
- ✦ Learn from Alfred Kahn: to achieve a long-run vision of economic welfare and environmental quality, regulatory institutions must be *pro-market, not pro-business*
- ✦ Focus on consumers
- ✦ Identify out-of-date regulations that undermine 21st-c. policy objectives: federal, state, local
  - ✦ “Maximize the ratio of societal gain to political pain” - Sean Casten, RED

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# The knowledge problem and the value of competition and retail choice

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“The economic problem of society is thus not merely a problem of how to allocate “given” resources ... It is rather a problem of how to secure the best use of resources known to any of the members of society, for ends whose relative importance only those individuals know.”

-F.A. Hayek, *The Use of Knowledge in Society*

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**“Civilization advances by  
extending the number of  
important operations  
which we can perform  
without thinking of  
them.”**

**-Alfred North Whitehead**