

The Implications of Network Governance, Regulation and Pricing Policies for Distributed and Renewable Energy: A Personal View

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*The Impact of Electricity Network Organization,
Regulation and Pricing on Renewables and Distributed Generation*

Organizational Meeting

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RADICAL CHANGE IS EVERYWHERE

- **In the US, A Number of Sectors Have Restructured**

Manufacturing	→	1970's
Financial Services	→	1980's
Health Care	→	1980's - 90's
Utilities	→	late 1990's
Universities	→	??

- **Change Driven by Markets, Regulation and Technology**

- **Each Sector Had to:**

- Learn new decision-making models
- Value & deploy radically new technologies/processes
- Understand its costs and the value of information

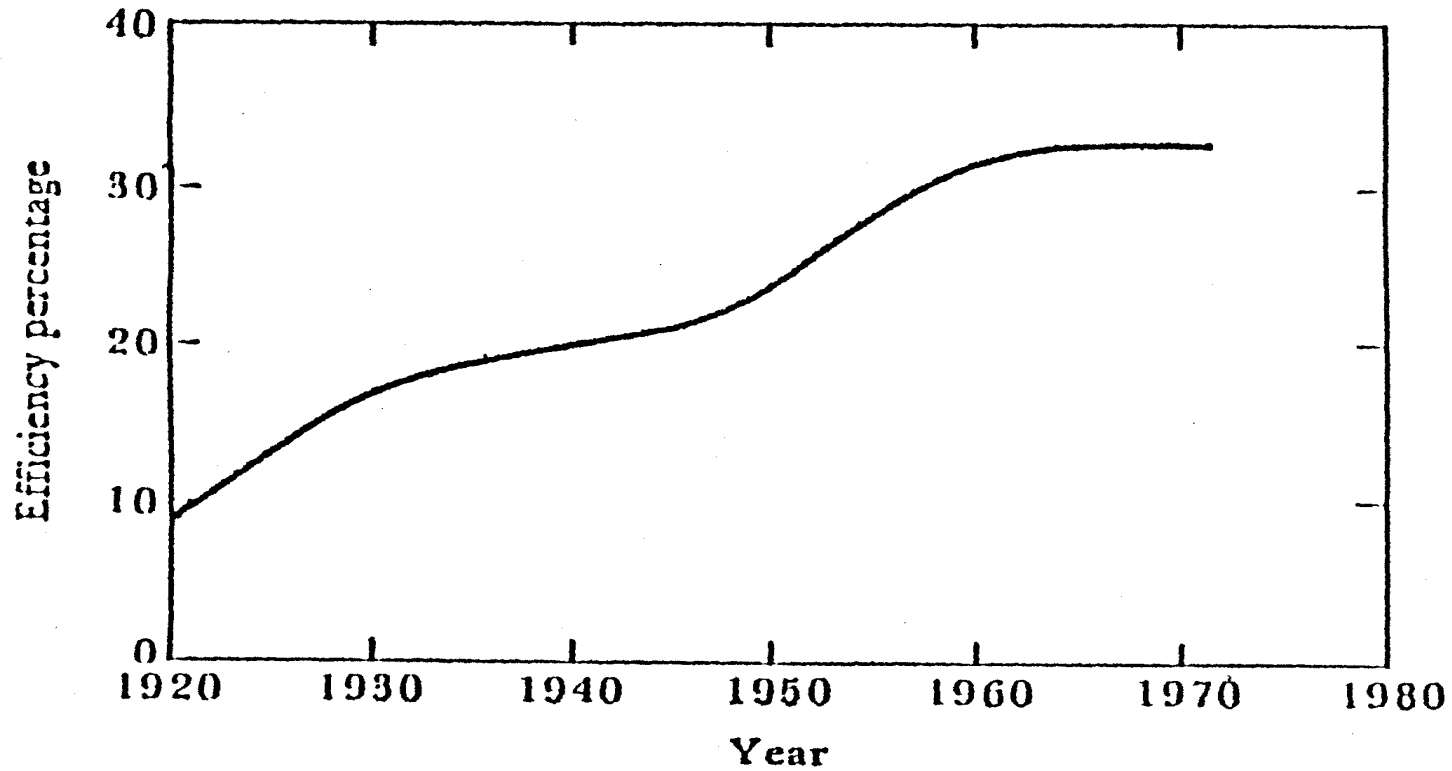
EVOLUTION AND EXPANSION OF TRANSMISSION & DISTRIBUTION FUNCTIONS IN THE US

TRANSMISSION		DISTRIBUTION	
FUNCTION	DATE		
1. Transport electricity long distance: low-cost power to load centers; generators site at most economic locations.	1896 – Power line from Niagara Falls	Monopoly or Provider of Last Resort	Reliably distribute low-cost power
2. Connect diverse loads: improve load factor—reduce idle capacity.	Early 1900s – Connect Chicago with suburbs		Same
3. Enable regional systems: enhance economy and reliability by pooling generating resources.	1927 PNJ Agreement		??
4. Strengthen inter-regional connections: Further improve reliability; systematize operating rules.	1965 Blackout— NERC		??
5. Facilitate bulk power transactions: Support emerging competition in generation.	1992 EPA— open transmission access		
6. Arbitrage/Market Making: move power from low- to high-value locations;	Requires properly regulated & incentivized network companies & new operating protocols to support distributed <i>virtual utilities</i>	Seller-Transporter and Market Enhancer	Facilitate DG/RE for power & Distribution Augmentation
7. Facilitate Information – support <i>parallel information network</i> <ul style="list-style-type: none"> – electron's <i>info</i> content > its <i>energy</i> content – AA Sabre System 			Crucial— smart metering

THE DISTRIBUTED/VIRTUAL UTILITY: *RADICAL ARCHITECTURAL INNOVATION*

- **Radical Architectural Innovation: New components & architecture in electricity generation/delivery**
 - Fundamentally alters nature of the product:
 - Still electrons, but their generation, availability, quality and delivery options are significantly altered
 - Current network organization cannot fully exploit VU ideas
- **DU/VU: First Reorganization Around New Technology in 100 years**
 - Electricity analog to Computer Integrated/Flexible Manufacturing and Mass Customization
 - Exploits new economics of commodity electrons
 - information value/kWh > energy value/kWh
 - Provides appropriate quality, just-in-time energy
 - Minimizes non-value-adding activities:
 - Excess transactions costs, excess reserves & generation capacity

TECHNOLOGIES MATURE BECAUSE THEY EXHAUST EFFICIENCY GAINS



U.S. Average Efficiency for Base-load Steam-Electric Utility Plants

UNDERSTANDING & VALUING DISTRIBUTED/VU

THE IMPORTANCE OF ORGANIZATIONAL CONTEXT

- **Cannot Be Understood in the Context of Existing (19th Century) Utility Organization**
 - Difficult to conceptualize/measure benefits
 - *Fundamental limitations* in our measurement systems and accounting vocabulary
- **Experience in other industries suggests that:**
 - Exploitation of radical innovation requires changes in organizations, supporting systems and infra-structure and can produce benefits not easily conceived in advance**
 - Example: Bessemer Steel: Factory reorganization, new floor-plans, plus upstream & downstream flow-control quadruples productivity (Clark)
 - RE/DG: changes in network organization, regulation & pricing
 - Basis for re-conceptualized electricity production/delivery system

UNDERSTANDING/VALUING DISTRIBUTED/VU THE IMPORTANCE OF ORGANIZATIONAL CONTEXT (CONTINUED)

- **The Problem of Sunk Costs and Embedded Capabilities**
 - Organizational Bias Against Radical Innovation (Chandler)
 - IBM and Mainframes vs. PC's
 - Swiss Movements vs. Digital Watches

***New RE/DG Technologies Are as Much a Substitute for
Central Generation Plants
as
Computers Were a “Substitute” for Typewriters & Calculators***

NETWORK ORGANIZATION, REGULATION AND PRICING: KEY POLICY MECHANISMS FOR ACCELERATING DISTRIBUTED GENERATION (DG) AND RENEWABLE ENERGY (RE)

- **Transmission is an Essential Element of the Restructuring Picture**
 - It is the “Enabler” for achieving promised benefits of restructuring
 - Competitive generation markets require robust, open networks to connect generators and loads
 - Increasing the *number* and *diversity* of suppliers connected to the network enhances competition/reduces market power
 - Potentially important role for DG/RE
- **Existing network protocols evolved to support central-station technology under cost-of-service (ratebase) regulation**
 - Centralized AGC Protocol
- **RE/DG require “Informed” networks and new protocols**
 - Decentralized operation & decision-making
 - Loads provide own load-following and other ancillary services
 - Bi-lateral contracting
 - Analogous to manufacturing “Mass-customization,” e.g.- Dell computer

MASS CUSTOMIZATION IN ELECTRICITY: *TRANSACTIONS-BASED NETWORKS* (A.M. BORBELY)

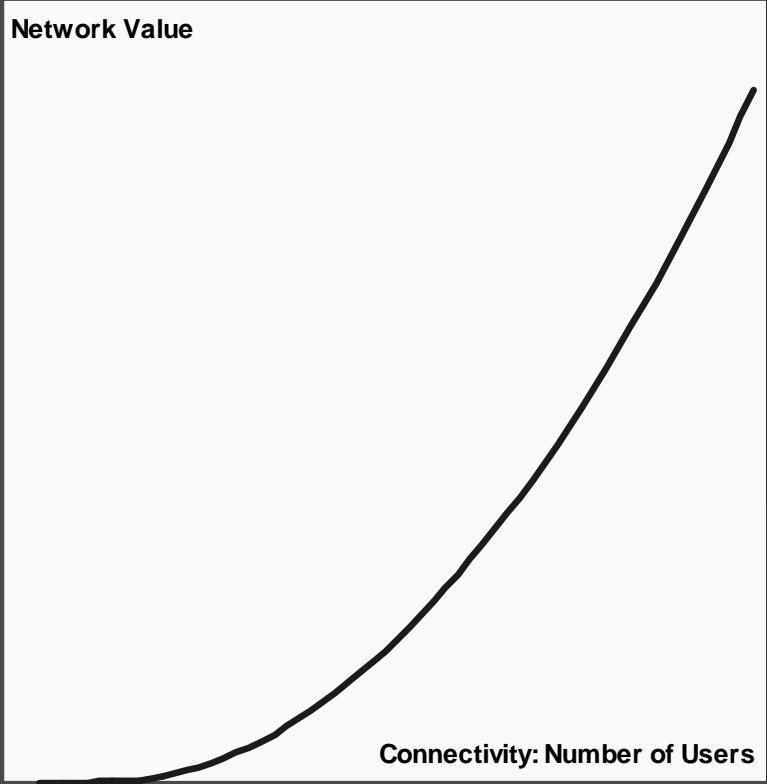
- **Move away from reliance on singular total network load figures**
 - Masks underlying dynamics of millions of transactions
 - Inhibits integration of “Intermittent” resources
 - Induces us to make all supply look like GT or other fossil source – e.g. NETA
- **Decentralized decision-making -- *discrete load matching***
 - Continuous matching of generation and individual loads
 - e.g.: Intermittent loads and intermittent resources
 - Requires real-time pricing (Vickery) to mitigate system overloads, large information volumes and broad connectivity
- **Different from the idea of centralized control of DG/RE**

NETWORK ORGANIZATION, REGULATION AND PRICING: PRIMARY OBJECTIVES

- **Lay the regulatory and institutional groundwork for decentralized, *transactions-based* network of the future**
- **Promote Efficient Utilization of Existing Assets**
 - Maximizing throughput
 - Alfred Kahn: “The only sin worse than the sin of excess capacity is the sin of not using it!”
- **Promote Efficient Increased Access for Loads and Suppliers**
 - Exploit Moore’s Law ^x
 - Cost-effectively meet peak demands
- **Maintain broad, non-discriminatory access for RE/DG, retail sellers and ancillary service providers**
 - Incentives will work better than administrative requirements
 - Telecoms also said you can not hook up

NETWORK CONNECTIVITY CREATES VALUABLE EXTERNALITIES

Value of the Network: Metcalf's Law
Network value dramatically increases with each additional node



As cited in Downes and Mui, *Unleashing the Killer App*, Harvard Business School Press, 1998, p. 25.

NETWORK ORGANIZATION, REGULATION AND PRICING: THE PRIMARY OBJECTIVES -- CONTINUED

- **Promote effective and efficient integration of so-called “intermittent” renewables**
 - Provide incentives that induce network owner/operator to learn to exploit intermittency
 - Resources have different attributes: making them all behave like a GT is inefficient
- **Promote transactions and commerce along the network**
 - Promote efficient, technology-neutral investment decision
 - Promote needed system investments to maintain “optimal” (or at least “appropriate”) congestion levels

PROMOTING INCREASED ACCESS FOR RE/DG: MITIGATING THE CONCENTRATIONS OF MARKET-POWER

- **Market-Power Concentrations are Suspected in California and Elsewhere**
 - Illustrates Problems of Establishing Electricity Markets Dominated by Formerly Regulated Giants
- **Network governance & regulation issues are critical in promoting “third-party” open access**
 - Network system owners/operators must have a stake in promoting access and kWh throughput
 - Can be accomplished with for-profit network operators under price cap or performance based regulation (PBR)
- **Appropriate network organization and regulatory regime will help meet recent EC renewables targets in an efficient (cost-minimum) manner**

THE ROLE OF QUALITY IN ELECTRICITY GENERATION/DELIVERY

<i>Manufactured Products</i>	<i>Electricity</i>
<ul style="list-style-type: none"> - Lower energy & labor content - Higher info-content - More value to customer <p style="text-align: right;">(Drucker)</p>	<p>Fewer kWh's with higher info-content and greater value:</p> <p style="text-align: center;"><i>“Fewer, Smarter kWh's”</i></p>
<p style="text-align: center;">Mass-production Versus Flexible, just-in-time Manufacturing and Mass Customization</p>	<ul style="list-style-type: none"> - Distributed generation - Virtual utilities - Lower reserve requirements - Reduced excess capacity - Lower overhead technologies

Source: S. Awerbuch, L. Hyman and A. Vesey,
Unlocking the Benefits of Restructuring: A Blueprint for Transmission, Arlington VA: PUR, 1999; Chapter 4.