Strategic Adaptations:

Lessons from U.S. Electricity Industry in the 20th Century

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Abstract: Several patterns emerge from a review of historical developments in the electricity industry: (1) conflicts arise from a number of sources; (2) responses to events and perceived crises tend to involve national (and state) legislation; (3) a lack of broad public (and political) consensus regarding the appropriate role of market mechanisms vs. government regulations; (4) absence of significant changes in response to events—changes appear to be incremental rather than transformational. The article provides an overview of developments in the past half century—placing current debates in a broader context.

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I. Introduction

Sometimes we need to step back from fighting fires to better understand the sources of fires, to improve our ability to combat them, and to anticipate where fires are likely to arise in the future. Here, fighting fires should be taken to be addressing electricity issues that are of concern to citizens. In the run-up to the November election, energy is likely to be an issue that keeps popping up, but it is unlikely to be dealt with in any systematic way. The reasons for "benign neglect" are many, including a lack of consensus regarding the appropriate role of government in energy markets. The lack of a current consensus on energy issues reflects

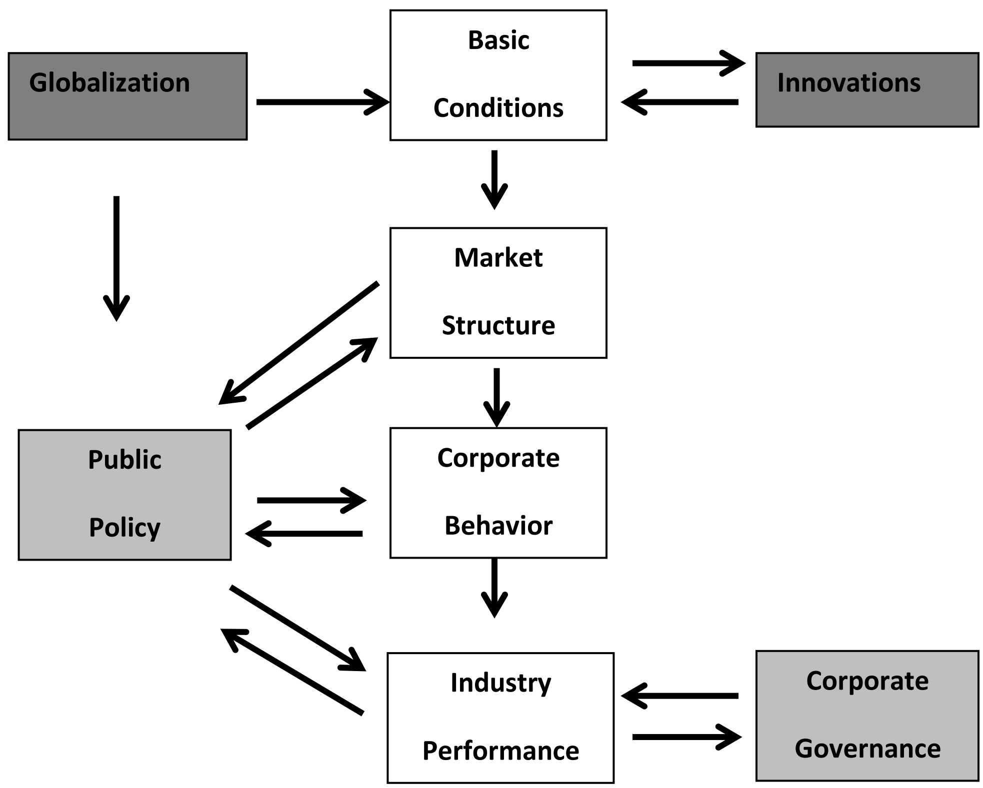
(1) disagreements regarding evidence about harmful environmental impacts,
(2) left/right ideological differences (reflecting both different values and risk assessments),
(3) competing interest groups (with their agendas promoting particular technologies, and
(4) Jurisdictional battles among federal, state, and local authorities.

These sources of conflict will be examined in a historical context. The lessons underscore the need for a better public understanding of energy issues, and for industry leaders to speak out more forcefully on what is known and not known about likely future energy scenarios. A few selective references to recent *Electricity Journal* articles illustrate some of thoughtful ideas bouncing around the industry: the challenge is to get the points before a wider audience.

The electricity sector in the United States has changed due to supply, demand and institutional pressures. Legislation and its implementation have tended to be incremental in nature, reflecting a rational response when assets will be operating for many decades. This short historical review expands on an earlier study (Berg, 2007); it attempts to identify lessons in business strategy for network industries facing emerging substitutes (and slow growth), changing demand patterns, and new production processes. The sector can be characterized by an industry structure that initially was based on a certain set of technologies: those structures became embedded in sector regulations. Since the 1990s, greater liberalization and associated restructuring has characterized the industry in the United States and elsewhere. However, as Hogan (2008) has emphasized: "electricity restructuring is not electricity deregulation." Regional Transmission Organizations (RTOs), the North American Electricity Reliability Corporation (NERC), state public utility commissions (PUCs), the Federal Energy Regulatory Commission (FERC), and the Environmental Protection Agency (EPA) are just a few of the entities monitoring and regulating managerial decisions and electric utility performance.

There are a number of ways to organize ideas about sources of conflict in the electricity industry. Figure 1 presents a highly stylized version of the factors and forces affecting public policy and industry performance. *Globalization* and *Innovation* are beyond the direct control of any one firm, and are major drivers behind *Basic Industry Conditions*. Thus, the figure depicts the circular dynamics of the larger decision environment in which government policymakers, regulators, firms, and public and private sector investors operate and interact. Changes in basic conditions generally result in altered market structures, corporate behavior, and sector performance. Similarly, changes in public perceptions can lead to legislative and regulatory initiatives.

Figure 1: Internal and External Changes



Note that the Figure shows arrows that point in several directions, indicating that unidirectional causation does not characterize the complex interrelationships within the electric utility industry.

Globalization and Innovation: *International experiences and technological change have affected the U.S. electric utility industry.* The United Kingdom and Chile served as models for liberalizing the generation market in the United States, though the restructuring was left to the states. At the same time, incremental innovations resulted in improvements in production processes and reductions in scale economies. In the 1990s, some domestic utilities acquired assets in other countries (following the Enron business model).

Basic Industry Conditions: *Basic conditions include production technologies, input prices (fuel, capacity, materials, and labor), demand patterns (and growth), and ownership patterns.* When the scale economies for generation are large relative to the market size, a natural monopoly may exist: having a single (vertically integrated) supplier can be least-cost. Historically, in response to potential abuse of market power, state regulatory commissions were created to constrain the exercise of such power by the single supplier. If demand grows substantially or small-scale production becomes economical (as with combined cycle gas turbines or distributed generation), generation becomes potentially competitive, which leads to pressures by potential suppliers to eliminate artificial entry barriers.

Some inputs are not “priced” in the market: *common property resources* (clean air or water) create situations that invite government intervention. To some extent, technical standards (such as those developed under the auspices of the Institute of Electrical and Electronics Engineers) or energy efficiency standards mandated by law represent part of the information structure constraining corporate decisions. Basic industry conditions change with national expenditures on basic research and on innovations that emerge from firms in the supply chain. Public ownership is another factor affecting downstream activities: the type of oversight/governance is different as is the tax treatment accorded publicly-owned utilities. Municipal utilities provide services to almost 15 percent of the total U.S. electric customer base. Rural electric cooperatives serve an additional 12-13 percent. In contrast to investor-owned electric utilities, U.S. publicly-owned utilities have been allowed to opt-out of restructuring requirements. Changes in basic conditions affect sector regulation in other ways. For example, the development of nuclear power precipitated the creation of specialized agencies responsible for setting standards for safety and public health aspects of the technology (including storage and disposal). National agencies like the Nuclear Regulatory Commission illustrate the increase in regulatory institutions.

Public Policy: *Government policy influences the Basic Conditions that determine the structure of a capital-intensive infrastructure sector. Regulatory governance includes the legal mandate given to a government agency, resources available for policy implementation, the organizational design of the agency, and the processes adopted by the agency, all of which affect the implementation of public policy*. In addition, if there is no clarity regarding which agency is responsible for implementing particular policies, public policy is likely to be compromised by intra-governmental jurisdictional rivalries. Resulting policy incentives affect the structure of the infrastructure sector, the behavior of corporations, and (ultimately) industry performance. Long term planning becomes very difficult when there is substantial uncertainty about future government policies. Of course, delaying investments and devoting resources to flexible production processes makes sense when uncertainty clouds forecasts of the future. Government policies include structural constraints (antitrust and regulation), behavioral restraints (related to siting, pricing, and safety, for example), and performance-based initiatives: cost-of-service regulation and allowed returns, price caps, and other incentive plans (hybrids).

Policy incentives include taxes and subsidies to discourage and encourage a variety of activities. A key policy issue involves designing incentives that promote cost-containment, service quality improvements, and network expansion. In some cases, changes in public policy can significantly lower the cash flows obtainable from productive assets. For example, allowing additional entry into the production of electricity often meant that “old” plants were operated for fewer hours per year: the net cash flows associated with those plants decline. Analysts can debate whether (and when) regulatory policy changes could have been anticipated and factored into investment decisions However, if a *restructuring* initiative is adopted (to unbundle what was traditionally a vertically integrated industry), policymakers generally try to address the issue of how to deal with the lost economic values stemming from the policy change. U.S. states have typically imposed competitive transition charges to have consumers bear some of the burden of moving to a new market structure and new regulatory framework (sometimes labeled “stranded costs”). Some states allowed greater depreciation, to bring the book value of assets more in line with their (expected) economic value. Thus, liberalization has tended to be accompanied by rules (such as accelerated depreciation or stranded asset payments) that ameliorated the impact on private investors in moving toward a restructured delivery system. Joskow’s 2003 overview of public policies underscores the changes confronting industry decision-makers over several decades.

Market Structure: *Market structure can be characterized in terms of entry conditions, degree of vertical integration, extent of product differentiation, and other factors.* Government policies greatly influence the number and size distribution of suppliers through merger policy and the creation of franchise territories. Until the last few decades, the electricity sector generally involved local monopolies, where entry was restricted by law. In the United States, these firms were often privately owned but regulated. Often, the governance system for publicly owned utilities was not very transparent, with policy-making, policy implementation, and operations often conducted within a municipality. In the past two decades, policymakers in the U.S. have explored the extent to which competition can substitute for regulation: of course, effective competition requires a sufficient number of firms that are operating independently from one another—so they become “price takers” (and lack market power). There is substantial evidence that competition can substitute for regulation when economies of scale and multi-product economies make entry feasible. Thus, policies affecting market structure, vertical integration, and corporate ownership have shaped the evolution of the energy sector.

Corporate Behavior*: Citizen Perceptions regarding corporate behavior (including pricing, product quality and safety, and production processes affecting the environment) influence public policy.* Public policy also creates incentives involving behavioral restraints. These incentives are related to price, quality-of-service requirements, and mandates for system expansion (including transmission extensions). Sector regulators use cost of service (or rate-of-return regulation), price and revenue caps, and other mechanisms for constraining prices. For example, electricity regulators often include some fuel cost adjustment in the price mechanism to pass prudently incurred cost increases (and externally-drive input price decreases) through to consumers. The customer's bill is changed as the actual cost of fuel at the supplier’s generating stations varies from a previously specified unit cost. Such clauses can mitigate the cost of input price fluctuations, but they also reduce managerial incentives to seek low prices or to reduce risk through hedging instruments. Other automatic adjustment clauses fund conservation programs or environmental programs (including “green” energy). Every regulatory rule has some impact on corporate behavior: constraining managers, influencing investment decisions, and (sometimes) creating new opportunities.

Sector Performance: *Sector performance relates to levels of profitability commensurate with risk, public perceptions of environmental impacts, and other sector outcomes (including production and pricing efficiency).* In the case of energy, regulators mandate reliability requirements, set network expansion targets, or limit profits through rate-of-return limitations (with associated weak incentives for cost containment), price caps, or hybrid incentive plans. Meeting targets is often encouraged through performance-based ratemaking (PBR), which fits into a broad category of rate-setting mechanisms that link rewards to desired results or targets by setting rates (or rate components) for a given time according to external indices rather than a utility’s actual cost of service. This type of regulation theoretically gives utilities better cost-reduction incentives than cost-of-service regulation.

Corporate Governance: Traditionally, activities internal to a firm have not been micro-managed by regulators, but public perceptions about potential problems have changed in recent years. Corporate governance involves the allocation of decision rights within the firm, the design of pay plans that compensate people for high levels of effort and performance, the development of performance evaluation mechanisms that monitor the effectiveness of internal reward systems, and dissemination of material about corporate activities. Policy requires that suppliers introduce reporting procedures that limit how insiders might adversely affect investor interests and sector performance. There have been substantial revisions in electric utility reporting requirements in the United States over time (Forrester and Astolfi, 2011).

The vantage point of actions and reactions highlights how changes in government policies, demand, and technology impact each other and prompt strategic responses that in turn affect policies, demand, and technology. Furthermore, social media may be altering the way citizen perceptions are created and shared—further complicating the way events lead to calls for policy changes. A value chain perspective focuses on the stages of production and examines how events impact each stage and how the stages themselves evolve over time. The rest of this survey is organized as follows. The next section describes electricity using the theme perspective. Sections III, IV, and V provide the timing, actions and reactions, and value chain perspectives respectively. Section VI presents some concluding observations.

II. Themes in Electricity Industry Change

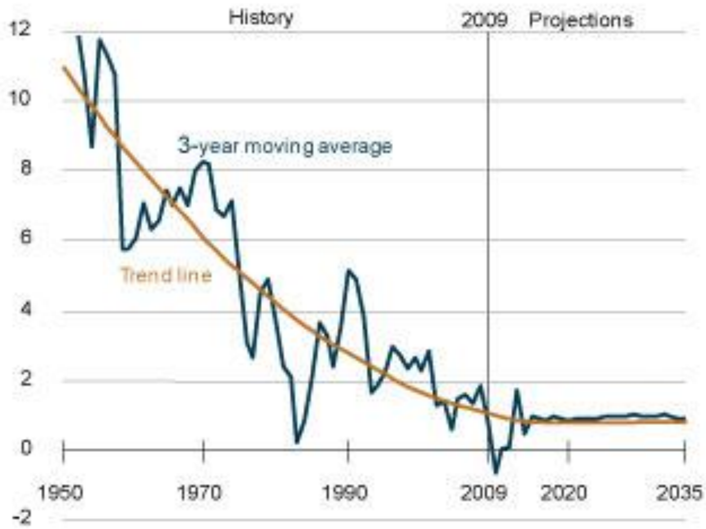
In the United States, the industry structure in electricity has undergone, and is still undergoing, significant changes, but in ways different from those in other infrastructure sectors. Today, managers face slow demand growth, incremental innovations, and changing (and unpredictable) public policy. Even as new uses for electricity emerge (and electric automobile sales rise), industrial, commercial, and residential customers have found ways to conserve electricity (often through replacement products that reduce consumption). On the technology side, as scale economies became less important in the generation of electricity, public policy introduced competition into that stage of production. Large customers' interests in obtaining power at a price lower than what the traditional utility would offer drove many U.S. states to restructure their electric industries. *Unbundling* the potentially competitive portion of the industry – generation – from the non-competitive portions and establishing independent organizations to manage the transmission system was considered essential for fostering competition because a vertically integrated generator could have an interest in discriminating against its rivals, in terms of market access.

As in telecommunications, in the electricity sector government intervention into market structure unleashed economic forces that continue to reshape the industry through incumbent mergers and the creation of new firms—particularly in the supply chain. Government R&D investment in the sector also influences the industry structure by favoring one type of technology over another type, providing a mechanism for political interference in commercial decisions. Increased use of renewable energy sources, whether through government mandated programs or on a strictly commercial basis, is also reshaping the industry. The changes involve alterations in locations for generation, introduction of new service providers, the need in certain regions for upgraded transmission facilities and back-up generation, different forms of subsidies to increase cost competitiveness, and the like.

Before referring to the timing of events and related actions taken by policy-makers, it is helpful to place the current electric utility industry in perspective.

Demand Growth: According to the Energy Information Administration, demand growth in the United States has leveled off to about one percent per year: "Electricity demand growth has slowed progressively by decade since 1950, from 9% per year in the 1950s to less than 2.5% per year in the 1990s. From 2000 to 2009, increases in electricity demand averaged 0.5% per year. Demand growth is projected to continue at about 1% per year through 2035."

Figure 76. U.S. electricity demand growth, 1950-2035
(percent, 3-year moving average)

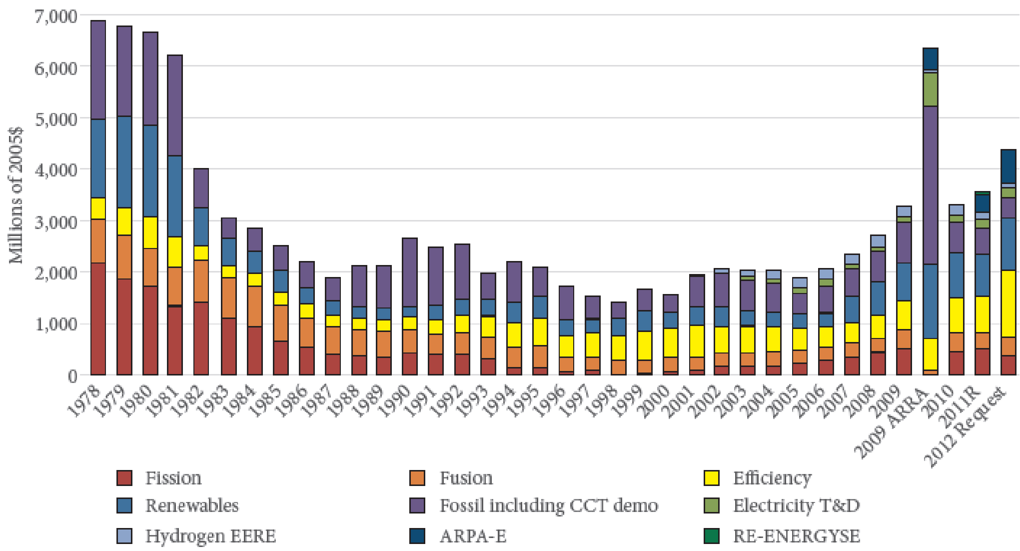


The dramatic slowing of demand growth reflects efficiency improvements in electricity end-use, partly counteracted by increases in housing size. The consumption shares indicate current usage patterns: Residential (39%), Commercial (35%), and Industrial (26%).

Although slow demand growth is forecast, additional capacity investments will be required as generating units are retired due to environmental regulations and aged infrastructure. Transmission investments will accompany changing production patterns (for example, if wind generation in the mid-West increases dramatically)

Research, Development, and Demonstration (RD&D) and Innovation: Federal expenditures on RD&D have tended to be organized around specific program lines (solar, bioenergy, industry efficiency, transmission, and distribution). Special interests have coalesced around these technologies, bringing regional politics into the fray. Renewables were subsidized via RD&D to a great extent after the Iraqi oil embargos, but the support declined under President Reagan. Funding increased again after passage of Energy Policy Act of 2005 and there was a big infusion with the American Recovery and Reinvestment Act of 2009 (ARRA)—including an emphasis on smart grids (Sioshansi, 2011). However, over time, the mix of RD&D investments has changed. The annual budgets dropped (in real terms) in the 1980s, leveling off through 2006 to under two billion a year (in real dollars, $2005). Federal stimulus funding under ARRA of 2009 led to a spike in Department of Energy (DOE) RD&D of over $6 billion in 2009—nearly back up to the amount (in real dollars) authorized for 1978. Anadon (2011) notes the large budget volatility in the different programs creates commercial uncertainty which, in turn, limits private investments in complementary research. Note that the National Science Foundation also funds basic research in energy systems. In addition, outlays by private industry are substantial. As technologies come closer to commercialization, the scientific basis for the technology may become better understood, but the commercial risks remain. Those risks may be best borne by investors who are able to diversify the risks (Costello, 2012). However, policy makers often find it difficult to terminate government-funded programs when well-organized special interests lobby for continued subsidies.

Figure U.S. energy RD&D Investments at the Department of Energy, 1978-2012R



Technological developments outside the traditional electricity sector affect both the demand and supply side of market. These developments include microprocessors, spectrum-based telecommunications, information technology improvements, science-based engineering in Power electronics, superconductivity, advanced materials, power storage, and photovoltaics, to list a few.
Of course, policy intermittency increases the uncertainty for payoffs to RD&D. For example, availability of a technology is necessary, but not sufficient, for changes: the demand side matters. For example, the price of gasoline is a major determinant the demand for hybrid and all-electric vehicles. The growth of such vehicles will determine the size of the infrastructure available to support the new technology. Similarly, smart grids are viewed by some as having significant impacts on operational efficiencies and load patterns (in conjunction with real time pricing).

We do not know the extent to which innovations can be anticipated, or whether they represent unpredicted (and unpredictable) developments. However, on the supply side, the cost and performance of new technologies depends partly upon scientific developments. On the demand side, innovations also depend upon demand-induced developments (as market size and growth determine the expected profitability of developing new products and processes).

The future holds incremental improvements to existing technologies as well as discontinuities associated with dramatic innovations. Nevertheless, while the pace and pattern of technological advance is unpredictable, it is certain to alter the industry in the future (distributed generation, real time pricing, nanotechnology, advanced fuel cells, storage technologies, and carbon capture with sequestration)

III. Timing: Chronology of Events and Actions

Table 1 in the appendix provides an overview of events and actions in the electricity sector, primarily covering the past fifty years. Responses to events tended to come in the form of national legislation. In some cases, individual states have adopted policies in the absence of national consensus. Some argue that the U.S. is characterized by a lack of overarching government policy, but it may be that there is more a disagreement on what constitutes policy than a lack of policy. For example, some people argue that there is no policy because the government has not said how much renewable energy is appropriate

for a national portfolio. Others would argue this decision should be made by energy suppliers based on criteria of being economical in how they achieve their environmental and reliability requirements. Thus, focusing on market mechanisms would be viewed as "the" policy. The bottom line is that at present, one side (mostly Democrats) tends to favor carbon restrictions, with subsidies and mandates for renewable energy. This side would favor restrictions on fossil fuels (e.g., limits on drilling), while the other side (mostly Republicans) tends to be unconvinced of the need for carbon restrictions, at least at this time. They would tend to support fuel choices being left to private investment decision making, including choices of obtaining and using fossil fuels. It is interesting to note that there is a general recognition that market mechanisms were effective for SO2. However, there are disagreements about the need for and effectiveness of market mechanisms for other pollutants, particularly the case of Greenhouse Gases (GHG).
The Political Economy of Regulation suggests that concentrated groups know the impacts of potential policies or rules. More diffuse interests have low per-capita impacts. The next section includes disagreements among stakeholders (special interests) as a source of conflict in the development of energy policy.

IV. Sources of Political Disagreements

National and state elections are driven by issues "other" than energy. The result is that events (outlined in the chronology) tend to trigger piecemeal energy legislation. The lack of current consensus on energy issues reflects disagreements regarding facts, values, interests, and authority.

Factual Disagreements: Stakeholders disagree on science—both facts and interpretation.
1. No political consensus on the existence, magnitude or causes of climate change;
2. No consensus on policy initiatives to reduce greenhouse gas emissions;
3. No consensus on effectiveness of government vs. markets to reduce greenhouse gas emissions.

Values Disagreements: There is no consensus on weights given to potential goals. Those goals are noted below.
1. Production efficiency;
2. Allocative efficiency (Efficient price signals—promote conservation and energy saving innovations);
3. Environmental mitigation (including GHG stabilization targets);
4. Increase energy security and reliability.

Interest Disagreements: Special interests benefit (or bear costs) differentially, depending on policies.
1. Regional impacts (jobs and prices);
2. Energy producers vs. consumers;
3. Taxes and subsidies: who pays, who collects?
4. Established suppliers vs. potential entrants.

Jurisdictional Conflicts: which authority or level of government has the decision-rights over particular issues?
1. National Departments (EPA vs. DOE);
2. National vs. State (FERC vs. state PUCs);
3. State vs. Local;
4. Courts determine constitutionality.

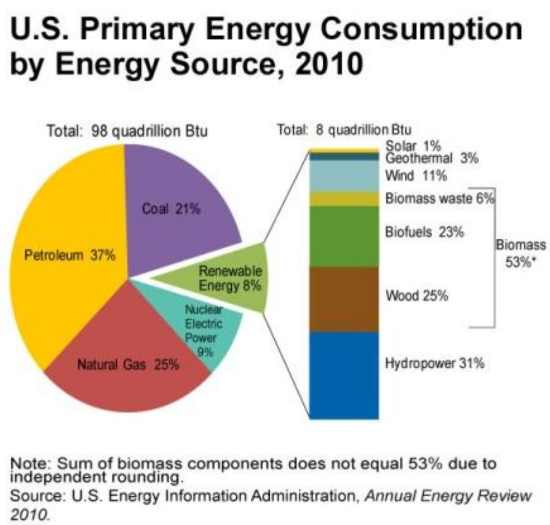
Political processes are partially designed to resolve conflicts. However, as the chronology suggests, the swinging pendulum (left to right and back again) results in some issues being revisited and policies changing, which makes planning very difficult for utilities. In terms of future generation mix, "All of the above" is endorsed by both parties at present, but the emphasis greatly differs between liberal vs. conservative wings of the parties. An illustrative unresolved conflict is the location for nuclear waste storage, an issue that has remained a political hot potato for decades. Another conflict is the national debate over the environmental impacts of hydraulic fracturing ("fracking"). In situations where local, state and regional interests may diverge, stakeholders are able to go "jurisdiction-shopping" to find policies that are favorable to their narrow concerns. One response to uncertain government policy is to delay investments until more information is available.

V. Changes to the Value Chain

Here we briefly survey the five stages in the value chain: manufacturing/extraction, generation, transmission, distribution, and demand.

Manufacturing: Provides inputs to producers of generation, transmission, and distribution services. In addition, manufacturing produced products that create a derived demand for electricity as new electricity-using devices are introduced into the economy: computers and Information Technology in general has been a source of demand growth.

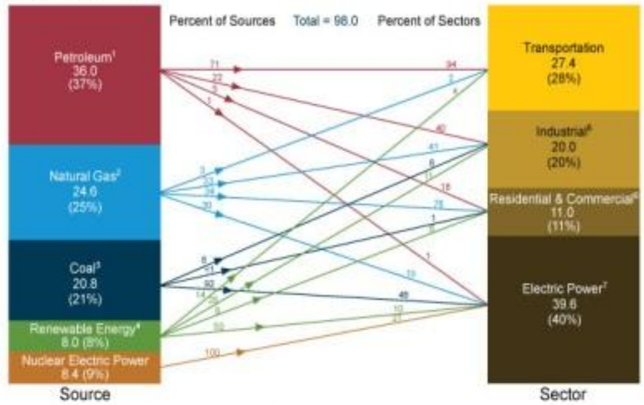
Resource Extraction: First consider primary energy consumption in the U.S.



Second, Electric Power uses about 40% of primary energy within the U.S. The growth in natural gas utilization by electricity reflects opportunities stemming from combined cycle gas turbine efficiencies and to low natural gas prices in different time periods.

Primary Energy Consumption By Source and Sector, 2010

Quadrillion Btu



Sources: U.S. Energy Information Administration, *Annual Energy Review 2010*, Tables 1.3, 2.1b-2.1f , 10.3, and 10.4 (October 2011).

Thus, the electricity sector is a major consumer of primary energy. Natural gas from shale may be a game changer as it affects long-term generation investments that utilities may make. However, significant uncertainties remain, even in the wake of the shale gas revolution. First, proposed EPA regulations regarding the capture of pollutants at well sites are scheduled to be implemented in 2015. Second, U.S. Department of the Interior regulations on well integrity and chemical disclosure requirements are sure to increase production costs, but the costs remain uncertain until the full scope of the regulations are known. Finally, with the FERC approval of the Sabine Pass LNG export facility, and the future development of other such facilities in North America, the rate of natural gas export is forecast to increase in the future, with Department of Energy projections showing that the U.S. will become a net exporter of LNG by 2016, and a net exporter of all natural gas by 2021. The next three stages have tended to be bundled into the activities of vertically integrated firms. The largest 200 utility systems serve approximately 80% of the retail customer load and hold about 90% of U.S. electric generating capacity.

Electricity Generation: In the 1990's, the apparent success of the Enron Business model led to initiatives from "traditional" electric utilities. Some adopted a "high flier" strategy involving the promotion of deregulation and international investments (in the UK and Argentina, for example). Some of these ventures were profitable, others were quite costly. Ultimately, non-transparent initiatives doomed Enron. Meanwhile, national legislation and FERC Orders have promoted competition in generation. Substantial vertical disintegration occurred as integrated utilities sold generation. Some early retirements are expected, particularly of coal plants, in anticipation of potential regulatory mandates. The outlook for a market price for CO2 emissions in North America remains uncertain, with no movement likely if there is a change of administration in November. However, the EPA has assumed the role of energy policy leader in the United States with three major initiatives in the past year. First, the Cross State Air Pollution Rule, currently stayed in federal court, would force utilities throughout the eastern U.S. to curb emissions levels, as the current allowance allocation is insufficient to meet actual emissions in 2010. Second, the Mercury and Air Toxic Standards would apply new regulations to all coal and oil fired generation 25 MW and greater, and would, under modeling assumptions by the Department of Energy, result in the retirement of 9 to 30 GW of coal fired generation by 2016, and the retrofit of almost 400 GW more. Finally, a draft rule governing CO2 emissions from new power plants places the annual limit for emissions below what is achievable with current coal technology, but above what is achievable under current combined cycle gas technology. While the draft rule does permit each plant to average the targeted emissions rate over its 30 year life, it is unlikely that investors will be willing to enter to such an arrangement before they know that CO2 mitigation technologies are technically and commercially feasible (Hanser, Celebi, and Zhou, 2012). Finally, the post-Fukushima world carries new uncertainties for those investing in nuclear plants (Glaser, 2011).

Electricity Transmission: Access mandated via FERC orders. There have been delays in major transmission investments due to policy uncertainty, siting problems, low allowed returns, and impacts on local markets. Many of these problems have manifest themselves in the form of significant differences in locational marginal price within the MISO region. It is not uncommon to observe negative hourly prices at the Minnesota Hub, while hourly prices exceed $100 at the Michigan Hub. With RPS policies adopted by nearly every MISO state, the need to integrate renewable generation into the resource base of this region is going to make greater transmission investment critical. If this investment does not occur, these regional price differences are going to be exacerbated. In October 2011, FERC issued Order 1000, an effort to standardize the regional transmission planning process. The Order requires a transparent planning process with regional authorities responsible for resource planning, incorporating any public policy concerns (without explicitly mentioning the integration of renewables into the grid) into the process. It also requires regional organizations to establish a regional cost allocation method incorporating several principles:

- Costs 'roughly commensurate' with benefits
- Transparent cost allocation and identification of beneficiaries
- Only beneficiaries pay
- Must consider net benefits as well as benefit-cost ratios
- No extra-regional allocation
- Different allocation methods can apply to different types of transmission facilities

Electricity Distribution: Retail competition has been introduced in some states, but the impacts on sector performance are not clear. Federal government stimulus money has supported demonstration projects related to distribution. The current emphasis on smart grid investments has an impact on operations. However, as long as PUCs support "dumb pricing," the lack of real-time price signals will continue for most utilities. While there is valid concern over the impact of more flexible retail pricing on electricity consumers, regulatory insistence that 'other' jurisdictions test the impact of these policies before they allow them in their own jurisdiction creates a 'chicken and egg' type of quandary.

Electricity Demand: This topic was discussed earlier. Clearly, overall demand growth has slowed, but regional differences arise from demographic and industrial shifts. Furthermore, impacts of a carbon tax on the demand for electricity for automobiles could be substantial.

VI. Concluding observations

The above overview of the forces affecting the performance of regulators and suppliers in the electricity industry underscores the complexity of the problems facing people: regulators implementing policy, courts determining the legality of new rules, investors evaluating the political and regulatory climate in different states, managers devising strategies for meeting regulatory initiatives, political leaders responding to (and shaping) the views of stakeholders, and consumers expressing concern over prices and service quality. The framework offers some important lessons for managers can succeed in a world characterized by uncertainty.

Jurisdictional structures for decision-making have a tremendous impact on the uncertainty affecting investments throughout the electricity supply chain. The U.S. has a mix of states that are restructured and states that are not, RTOs that operate under different rules, and a mix of federal and state environmental rules. Decision-makers in the U.S. and elsewhere will all have to deal with breakthrough technologies affecting investment choices, reliability issues, pressures to keep prices down, and environmental compliance requirements.

As would be expected, there is no simple "solution" to the complicated set of issues facing policy-makers, regulators, and executives in infrastructure industries. When projects are huge, the costs of mistakes can bring down an organization. Smaller, staged projects may lose scale economies, but the associated reduction in risk can make the switch profitable. Different state approaches allow for experimentation, but the gains from learning must be balanced against the potential loss of some scale economics. In the current environment, executives need to recognize trade-offs between short-term cash flows and long-term adaptation to changing conditions. As my PURC colleagues have emphasized, the ". . . system needs to be steered, not in the sense of leading a particular direction, but rather ensuring learning, providing opportunities for resolving conflict, and orchestrating experiments into next practices" (Jamison and Castaneda, 2011, p. 91). Current financial constraints tend to drive utility decisions, but a focus on improved operating efficiencies is inadequate. It is necessary to monitor developments in public policy and prepare (to the extent possible) for technological and economic shocks. While decision-makers are fighting fires, they also need to develop better fire-fighting equipment. In addition, leaders need to educate civil society regarding the sources of policy conflicts—without demonizing those holding different viewpoints.

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Table 1. Chronology of Events and Actions in the Electricity Sector

	Events or Actions	**Consequences**
	Great Depression and New Deal Sector Reforms	New Powers to Regulatory Agencies: Tennessee Valley Authority (1933) Federal Power Act (1935); Interstate Gas Act (1938)
	Concerns over geographic integration and governance	Public Utility Holding Company Act of 1935
	Fast-forward	
	Northeast Blackout (1968)	North American Electric Reliability Council (NERC) formed (1968)
	Growing concern over environmental impacts of economic activity, with electric utilities being a primary stationary source of emissions	Environmental Protection Agency (1970) Clean Air Act (1970) Clean Water Act (1972)
	First OPEC price rise ($4 to $12 per barrel (1973)	
	Concern over efficiency in the utility industry and whether potential suppliers were being excluded Natural gas shortages and gasoline lines	Public Utility Regulatory Policies Act (1978) Natural Gas Policy Act (1978) Plus inflation led to skyrocketing cost of nuclear

	Three Mile Island Nuclear Accident (1979)	plants
	Second OPEC price rise (1979)	Energy Security Act (1979) created the Synthetic Fuels Corporation
	Focus on national vulnerability to input price shocks	Energy Security Act (1980) Required utilities to purchase electricity supplied by “Qualifying Facilities” Iowa passed the first Renewable Energy Standard (1983)
	Oil Prices decline	Synthetic Fuels Corporation abolished (1985) FERC Order 436 (1985, pipelines as potential open-access transporters of natural gas
	Growing interest in renewables and energy efficiency	Tax and direct subsidies for alternative energy and energy efficiency
	Proliferation of States passing energy efficiency appliance standards	National Appliance Energy Conservation Act (1987) National standards (at request of appliance manufactures—to achieve some uniformity)
	Chernobyl nuclear accident (USSR, 1986)	
	Increased attention to role of markets in promoting energy efficiency	Natural Gas Wellhead Decontrol Act (1989) Removed price controls, with field price regulation ending in 1993
	Growing consensus on damage from Acid Rain [Alliance of environmentalists, northeast industrialists (interested in raising costs for other states), and Appalachian coal interests]	Clean Air Act Amendments (1990) Additional pollution controls mandated: Cap and trade system for SO2 from electric generating plants
	Energy Policy Act (1992)	Only major piece of National Energy legislation of the 1990s. Promoting energy conservation and renewables. Facilitated industry restructuring. Particular States take the lead on liberalization
	High electricity prices in California leads state PUC to explore liberalization options	FERC Order 636 (1992), mandates market restructuring through unbundling of pipelines
	FERC Order 888 (1996)	Established framework for electricity market restructuring and open access to the electricity transmission system
		California Liberalization (1996). In response to the California PUC’s market liberalization, the

		legislature froze electricity prices
	ISO New England (first ISO) begins operations (1997)	New England Electric sells power plants (first major plant divestiture (1997)
	FERC Order 2000 (December 1999)	Order 2000 promoting regional transmission organizations (RTOs)
	California Electricity Crisis (2000-2001)	California: Blackouts, likely market manipulation, financial collapse of distribution utilities
	Exploration of potential benefits from greater competition in electricity	Energy Policy Act of 2005 Embraces wholesale competition as national policy Promotes coal through clean coal technologies PUHCA Repealed (Perceived as outdated, with investor protections provided by other securities laws)
	Some concern over Climate Change, but no national consensus	By 2007, 25 states had adopted renewable portfolio standards (generally goals without penalties) Other state policies: CO2 emission targets, feed-in tariffs, renewable subsidies, and other actions Proposed EPA regulations related to “fracking” EPA initiatives in energy policy (Cross State Air Pollution Rule, Mercury and Air Toxic Standards, and CO2 emissions from new plants)
	Fukushima Daiichi nuclear disaster (2011)	Still no site for nuclear waste storage in the U.S.
	Continued concern over transmission investment and cost allocations	FERC Order 1000 (standardizing transmission planning processes and establishing principles for regional cost allocation)