



The Economics of Electricity Networks and the Evolution of the U.S. Electric Utility Industry, 1882-1935

William J. Hausman and John L. Neufeld

The widespread and costly electricity blackout in the Midwestern and Northeastern United States and Ontario, Canada in August 2003 highlighted the imperfectly constructed North American electricity transmission network. In this paper, we examine aspects of the development of the U.S. electricity transmission network from the formative years of the industry to 1935. We first discuss the economics of electricity networks, focusing on two salient characteristics, their great economic value, and their problematic control. We then discuss several historical episodes describing the ascendancy of alternating current over direct current, the rise of the holding company, the “Superpower” and “Giant Power” proposals of the 1920s, and the passage of the Public Utility Holding Company Act in 1935 where these two characteristics interacted to shape the structure of the industry, often by stimulating government action.

Large electricity networks have had a profound effect on the structural development of the U.S. electric utility industry. Such networks possess significant economic advantages, an attractive characteristic prompting industry adoption of institutional and technological characteristics to facilitate their use. An electricity network, however, also presents special control problems, particularly when the network is to be shared by multiple firms or decision makers. Developing an institutional structure for large electricity networks in which the incentives faced by decision-making managers align with social efficiency has proved elusive. The institutional arrangements the industry tended to adopt to facilitate the use of large networks often raised public policy concerns resulting in legal changes that redefined the institutional structure of the industry. Legally-imposed structures constrained the industry’s ability to make full use of large networks but did not eliminate their desirability or the tendency of the industry to adopt new techniques that facilitated their use. These new

William J. Hausman is Chancellor Professor of Economics at the College of William & Mary and **John L. Neufeld** is Professor of Economics, at the University of North Carolina, Greensboro.

techniques for incorporating large networks interacted with some unintended consequences of previous policy to create new public policy concerns and reactions.

We discuss the two salient characteristics of electricity networks, their economic value and their problematic control, as well as the pre-World War II series of events in the evolution of the U.S. industry, when the nature of networks and public policy interacted to shape the evolution of the industry's institutional structure.

The Nature of Electricity Networks

The physical capital equipment required by an integrated electric utility is traditionally assigned to three functional categories: generation, transmission, and distribution. The combination of these three components comprises an electricity network. Electricity can be produced and consumed in the absence of a network, but each electricity user would have to possess the means to self-generate the desired electricity. By conventional accounting measures, most of the capital costs of an electricity network are in the generation category.¹ Nevertheless, the economic issues associated with transmission and distribution are more complex and more problematic than those associated with generation and complicate the choices associated with generation. These characteristics of electricity networks are atypical of other economic goods.

First, an electricity network is a valuable economic good. This value comes from the fact that networks reduce the amount of investment in generating equipment that would otherwise be needed to supply the same value of service from electricity. The development of alternative means of reducing the required levels of investment in generation would reduce the benefit of electricity networks. A technological revolution that drastically reduced the cost of generating equipment (particularly efficient, small-scale units) would obviate the need for networks. Furthermore, if low-cost methods were developed for the efficient storage of electricity, the need for investment in generating equipment would be sharply reduced. Generation and transmission have the characteristics both of substitutes and complements in production. Transmission and distribution systems are economic goods because they are themselves costly to create and, once built, their capacity is limited because any conductor (such as a transmission line) can conduct only a limited amount of current.

¹ For Investor Owned Utilities in the United States in 1996 (the last available date), generation accounted for 55% of the total value of the electric plant in service. Transmission and distribution accounted for 12% and 29%, respectively. In terms of operating and maintenance expenses, generation accounted for 74% of total electric expenses while transmission and distribution accounted for 2% and 6%, respectively U.S. Department of Energy, *Financial Statistics of Major U.S. Investor-Owned Electric Utilities 1997* [Web Page, accessed 27 April 2004, http://www.eia.doe.gov/cneaf/electricity/invest/invest_sum.html.]

The second characteristic of a network is that it creates severe coordination problems that are difficult to manage, particularly in a decentralized manner. Hence, the business structure of the industry is important for the creation and maintenance of networks. A complete discussion of the engineering problems associated with the stable maintenance of a modern alternating current (AC) transmission network would be quite lengthy, but the two most important can be simplified: at each instant in time the amount of electricity generated and put on the network must exactly equal the amount taken off and consumed, and the precise path across the network taken by electricity from generator to consumer is both uncontrollable and unpredictable. The operators of electricity networks have often had some control over the quantities of electricity generated at each point in time but have not had control over the amounts consumed. Thus, the amount of electricity in the network has a random component. Although consumption in the near term can be forecast with fair accuracy, and small fluctuations can be handled with automatic equipment, unexpected events can lead to emergencies that require quick human reaction. The unpredictability and uncontrollability of the path electricity takes through a network makes decentralized control of these systems problematic and a challenge to the businesses that own and operate them.

Benefits of Electricity Networks

Physical measures of electricity are relevant to understanding the economics of the electric power industry. We discuss direct current (DC) rather than AC. The characteristics of AC are more complicated because its constantly changing nature requires discussion of reactive power and issues of frequency and phase (which also complicate the work of electrical engineers). The most important economic benefits and control problems are present in the simpler DC networks.

A flow of electricity has *voltage* or *pressure* (measured in volts) and *current* (measured in amps). When electricity flows through a conductor, the conductor *resists* the flow and converts some of the electricity to heat. This resistance is measured in ohms. The current and pressure of a flow of electricity is related to the resistance of the conductor through which it flows by Ohm's law, which states that the current equals the voltage of the electrical flow divided by the resistance of the conductor. The resistance of a conductor of a given material and of a given length is related to the cross-sectional size of the conductor; large conductors have lower resistance than small conductors. Thus, if voltage is held constant, more current (amps) can flow through a thick wire of a given length than through a thin wire of the same length and material. Materials differ considerably in their ability to conduct electricity.

To use electricity its flow must be controlled. Those materials offering relatively low resistance to electricity are classified as conductors while those offering high resistance are classified as insulators. There are

sharp differences in conductivity between conductors and insulators, but the ability of electricity to flow through any material also depends on the voltage of the current. When voltages are very high, significant amount of current can flow through materials usually classified as insulators. The control of very high voltage electricity is complicated by the relative difficulty in using materials that can provide effective insulation.

For most uses, electricity serves as an intermediate form for power or energy. It is created from the transformation of burning fuel or falling water, for example, and is useful only when it converted to something else, such as illumination, heat, or movement. The ability of electricity to be converted to a useful amount of something else depends on two physical measures applicable both to electricity and to many of the forms to which electricity is converted: power and energy. Electric power is commonly measured in watts (or kilowatts or megawatts), but other units of power such as horsepower are equally valid measures. The product of the voltage and the amperage determines the amount of power in a flow of electricity. Electric energy is also usually measured in watt-hours (or kilowatt-hours or megawatt-hours), but could be measured in BTUs or calories. Energy involves the application of power over time; for example, the generation of a kilowatt of power for a period of one hour produces a kilowatt-hour of energy. Generating two kilowatts of power for half an hour or one-half kilowatt for two hours could produce the same amount of energy (one kilowatt hour). An electric motor powerful enough to move a heavy load requires many kilowatts of electricity. To move the weight a great distance requires more time and thus more energy (kilowatt-hours) than to move the same weight a short distance.

The capital equipment used by an electric utility generally must be sized according to the maximum amount of power that equipment may be required to handle. A unit of power (such as megawatt) is used to measure the size of a generator or a transformer (as well as of the size of engines or turbines used to drive a generator). These units are measures of maximum power capacity, but most equipment can be used at less than full power. The rate at which the prime mover powering a generator is consuming fuel will be closely related to the amount of power being produced, but the total amount of fuel consumed during a time period will be more a function of the energy produced. For a generating plant serving many electricity users, the amount of power the generator must produce will be determined by the sum of the power requirements of all the plant's users at each instant of time. When a central generating station serves many users, the power of the generating station will far exceed the power requirements of any individual user. The maximum amount of power the generating station must be capable of producing (its capacity) is determined by the expected maximum simultaneous power requirements (the "peak period demand") of all the plant's users. This may or may not correspond to the time of any individual user's peak power usage.

Because capital costs have always been relatively more burdensome than fuel costs, the evenness of electricity use has an enormous effect on the cost of electric energy from a central plant. Consider the simple case of an electric utility that has ten customers. Each customer operates a motor for one hour per day that requires a kilowatt of power. Thus, each customer uses one kilowatt-hour of electrical energy per day. If all ten customers use their motors simultaneously, the central utility supplying them will need a generator capable of providing ten kilowatts of power (neglecting distribution losses). If, on the other hand, each customer uses the motor during a different hour of the day, the utility would need only one kilowatt of generating capacity to meet the needs of all customers, a far cheaper proposition.

If a network serves consumers of electricity whose peak demands do not occur at the same point in time, the total generating capacity required to meet everyone's demand will be less than the sum of the capacities each would require to meet his or her own individual demand. The increase in generating capacity required to serve a new user added to the network is not determined by that user's peak usage but by that user's requirements during the network's system peak. The worst situation would happen if the new user's peak happened to coincide with the system peak; in that case the increase in needed generating capacity would be the same as the generating capacity needed if that user had to provide for their own generation. If, however, the new user's consumption during the network's system peak was less than his or her individual peak, the required addition to the network's generating capacity would be less than the capacity that user would have to self-supply in the absence of a network. Similarly, if two networks have system peaks that occur at different times, consolidation of the two networks into a single network would reduce the combined generating capacity required to serve all users of the two original networks.

If electricity could be inexpensively stored, a central utility would not have to match its generating equipment to the maximum simultaneous power demanded by its customers. Instead, the utility could size its generating equipment to the average power demand. When power demand was less than that average, the utility would produce additional electricity that would be stored and used when power demand was above average. The total capacity of the network would be the sum of the average power needs of the individual users on the network; no savings in capacity would be obtained. Despite considerable effort, no method has ever been discovered to inexpensively store the magnitude of electric power relevant to central generation.²

² Batteries, of course, are capable of storing electricity, but they have always been large and expensive for the amount of energy stored. In the earliest days of the electric power industry, storage batteries were a common feature of central stations providing DC. More recently, a number of utilities have built and used

In addition to reducing the necessary amount of total generating capacity, an electricity network can provide other economies. These include: the ability to take advantage of large scale economies; the freedom to separate the decisions of generator location from the location of electricity use; the reduced cost of improved reliability through the use of backup; the reduced cost of supplying generating equipment to users whose consumption of electricity is not steady throughout the day and not perfectly correlated; and the ability to make more efficient use of hydroelectricity.

If there are many generating stations, the size of each station can be based on scale economies. During much of the history of the electric power industry, technology resulted in constant increases in the size of the most economical generator. Once that size exceeded the needs of individual users, capacity could be provided more economically by a network utilizing optimum-sized equipment than would have been the case if the same capacity were provided by individual users, at least some of whom would have had to use smaller and less economical generators. Networks also offered an important advantage to utilities with a mix of generating technologies. This became a common situation as technological improvements led to the purchase of newer generating equipment although the older equipment was still functional. With a network, a utility could efficiently use both the older and newer equipment. Generators with the highest operating costs, perhaps the oldest, could be used only occasionally, during times of system peaks. Other generators could be used frequently, but not continuously. Such generators might be used only during the day, for example. Still other generators could be used to supply the "base load," the consumption of electricity, which occurred continuously day and night. Generators differ in their capital and operating costs. Technological progress continuously provides utilities the opportunity to acquire generators whose operating costs are lower than those already in use, but such acquisition requires new capital expenditures. Using the newest generators with the lowest operating costs to provide the base load could reduce these capital expenditures. Continuous use of these generators at full capacity would maximize their operating cost advantage. Older, "peaking" generators with higher operating costs could be used infrequently, but the savings from not having to buy newer equipment in this case would offset the higher operating costs of the older technology. The ability to supply all uses from a changing mix of generating equipment whose usage depended

pumped storage facilities. These use electricity to pump water up a hill. That energy (minus efficiency losses) is stored as potential energy, which is recaptured as electricity by allowing the water to flow downhill through hydroelectric turbines. Although cheaper than batteries as a medium for storing relatively large amounts of energy, these facilities are quite expensive.

only on the nature of the total load is another advantage electricity networks provided.

A network permits the location of a generating plant to be determined independently of the location of electricity users. Steam generating technologies require access to both fuel and cooling and generators were often located near bodies of water to provide cooling. The locational freedom provided by a network also permits generating stations to be located where real estate costs are lower and where the negative externalities of a generating plant may be lower. Hydroelectricity can be generated only where there is a supply of falling water. These sites are inflexibly provided by nature and must be used where they are found. A large network gives the users of hydroelectricity more flexibility in exploiting hydroelectric sites.

The presence of multiple generating stations also reduces the cost of providing backup generating capacity to cover unexpected needs caused, for example, by unplanned failures of generators. A network with many generators permits the same level of reliability to be provided with a smaller proportion of reserve generating capacity. Consider the following simplified example. Suppose a single generator has a 10 percent chance of failing on any day. A user (such as an isolated plant) employing two generators (with one as backup) would be able to provide power 99 percent of the time.³ Next, consider a network with ten working generators required to meet users' consumption needs. It now takes a reserve of four generators to provide the same 99 percent level of reliability as that for the isolated plant with one backup generator (99 percent of the time at least 10 of the 14 generators would be working). Thus, the network requires a reserve capacity of 40 percent of generating capacity to achieve the same reliability as an isolated plant that requires 100 percent reserve capacity. For a network with 100 working generators, the same reliability could be achieved with a 20 percent reserve capacity. This reliability benefit of networks must, of course, be balanced with the fact that a transmission and distribution network provides failure points other than the generator that can prevent an electricity user from receiving current. In fact, most major blackouts are caused by transmission failure.

In addition to the ability of a network to allow flexibility in the siting of a hydroelectric plant, networks facilitate the exploitation of hydroelectricity in other ways. The amount of electricity that can be generated at a hydroelectricity site depends on the volume of falling water and on the distance ("head") it falls. For most hydroelectric sites, the volume of water depends on the amount of rainfall. Rainfall fluctuates in both seasonal (predictable) and random (unpredictable) ways. This means

³ The main generator would work 90% of the time. During the 10% of the days on which it failed, the backup generator would work 90% of the time. The remaining 1% of the days (.10 x .10) would be ones in which both of the generators failed.

that at least a portion of the power capacity of a hydroelectric plant is sometimes unavailable; that capacity is not fully reliable. The reliability of electricity supply has enormous impact on its value. Many industrial processes cannot tolerate unexpected losses of electric power without damage and expense. Users of hydroelectricity often contract for the purchase of electricity according to the reliability of supply, and that reliability is a major determinant of price and value. "Firm" power is the most reliable; the amount of firm power is determined by the amount of generation which can be produced when water levels are at their lowest. Because it is most reliable, firm power is most valuable, and it can be sold at the highest price. "Secondary" power is unavailable during periodic (and partly predictable) times of low water when its supply must be interrupted. Its value and price is much lower than firm power. Large amounts of water available infrequently, unpredictably, and for short periods produce "dump" power, which must be consumed opportunistically when it is available. This energy is sold at very low prices. Any method that converts secondary power to firm power increases the value of a hydroelectric site even if it does not increase its total output of electrical energy. This value-increasing conversion is achieved by connecting a hydroelectric site to an electricity supply network.

One way to "firm" the output of a hydroelectric site is to connect it to steam plants. The steam plants can then be used to balance variations in the output of the hydroelectric plant. When water flows are large, the hydroelectricity supplants the steam power, thereby reducing fuel costs. There are expenses associated with steam plants, of course, especially when they are substantially underutilized. Hydroelectricity adds considerably to the incentive for large electrical supply networks because such networks maximize the value of variable hydroelectric output. When a dam is blessed with large amounts of "dump" power, the network provides it with a large number of potential customers who can use it as a substitute for steam power, some of whom might otherwise use inefficient "peaking" steam plants. The network also provides a substitute supply source for the customers of hydroelectricity when water flows are low. If hydroelectricity plants in the same network are in different drainage basins, weather variations may allow low flows for some plants to be offset by high flows for others.

The comprehensive development of a single river system provides other benefits to hydroelectricity. Such a development consists of multiple electrically interconnected hydroelectric sites, some on tributaries and others on the main river. An upstream dam could reduce flow variations at downstream river sites. The upstream dam functions as a reservoir. During times of heavy water flow, it holds back some water, reducing the amount of flow at the primary site. When the supply of water slackens, the upstream dam releases the water it is holding. This release would occur at a time when production at the primary site would otherwise be low. If the

generators at the upstream dam are connected in a network with those of the primary site, the upstream site's generation increases the total amount available, thus reducing the system's variability. When the water released by the upstream dam reaches the primary site, it enables more production, further reducing variability. In order for this to work, the two (or more) dams have to be jointly operated. Much of the benefit of the operation of the upstream dams comes from externalities that they provide downstream hydroelectric sites. Without the downstream benefit, which requires incorporation of the entire system in a single network, construction and operation of the upstream dam might not be justified.

The Problematic Control of Electricity Networks

The safe and effective operation of electricity networks requires the coordination of a large number of facilities. In this respect, it does not differ from the operation of many other institutions, including any market. However, the technological characteristics of electricity networks, especially transmission and distribution, complicate the development of an institutional structure to achieve this coordination, because they make it difficult to decentralize decisions about operation or investment. Economic institutions are most successful when they present each decision-maker or owner with a set of incentives in which the maximization of individual wellbeing produces a desirable outcome for society as a whole.

Both transmission and distribution systems are typically components of a "grid," in which there are multiple paths through which electricity can flow from source to use. When an increased amount of electricity is taken off the grid at one point, it must be met by an increased supply to the grid at one or more other points. Even if the increased supply enters the grid at a single point, that electricity will flow simultaneously to the point of use over all available conductive paths in amounts inversely proportional to the impedance of each path. The impedance of each path is partly determined by its physical characteristics (such as the size of the wire) and partly by the total amount of current already moving through that path at that instant. Thus, the impedance of any individual path will change as consumption and generation vary at many different points on the grid. Suppose a unit increase in the use of electricity at one point on the grid is supplied by an increase in generation at one other point. Although clearly electricity has moved through the grid, it is difficult to quantify the contribution made by individual lines and even more difficult to predict those contributions in advance because of the effects of random consumption decisions made throughout the grid. An electricity network is, in this sense, inherently different from a telephone network or a computer network. Although there are multiple routes an individual telephone call or computer packet could take through its corresponding network, each call or packet is ultimately switched along a single route. The switches completely determine what that route will be.

There is essentially nothing on an electricity grid that corresponds to the switches in telephone or computer networks.⁴ This characteristic has the benefit of minimizing power losses that inevitably occur in a transmission or distribution grid.

Clearly, the requirements to maintain instantaneous balance make it difficult for shared operation of a transmission or distribution grid. The way in which electricity flows through a grid creates another problem: establishing a structure that encourages investment enabling the optimal evolution of a grid over time. The most decentralized market-like institution would encourage individual entrepreneurs to add transmission capacity (for example, a new transmission line) when the benefits of that line to the grid would exceed its costs. In a system where decision-makers are fully accountable (all marginal benefits and costs accrue completely to them), market forces would tend to encourage optimal grid growth. Admittedly, some transmission line costs, such as environmental costs and land use issues, may be difficult for markets to handle efficiently. To these problems are added the problem of quantifying the benefit a new line would add and providing a payment mechanism that recognizes that all users of the grid receive some benefit.

It is hard to imagine a system where individual owners of transmission lines could independently price the services provided by their property, and compete with other owners of transmission lines, because no user of the grid would be able to decline the services of overpriced lines. This is a problem of externalities; a decision by any individual on the grid unavoidably affects the capacity (positively or negatively) of all of the conductors on the grid. An entire grid placed under unitary ownership where that owner faces an incentive to minimize the cost of electricity transmission and distribution, could lead to an efficiently evolving network. But designing the institutional mechanisms to effect these incentives is not trivial, particularly when the institutional structure reduces or precludes market competition. This is one of the main reasons the industry has been so politically contentious.

Devising institutional controls over electricity networks is even more complicated when the issues of generation planning are added to those of the transmission and distribution grids. A vertically-integrated utility responsible for generation, transmission, and distribution, provided an inducement to minimize the total cost of supplying the optimum amount of electricity would have the incentive to develop an optimal electricity network. The U.S. experience with cost-based rate-of-return

⁴ There are some modern technologies that can control bulk power flows and are used in a few locations today. They are still too costly for widespread use. *Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations* [Web, U.S.-Canada Power System Outage Task Force, 2004, accessed 26 April 2004, <https://reports.energy.gov> or <http://www.nerc.com/~filez/blackout.html>.]

regulation may show that it is possible under these conditions to develop a sophisticated and effective electricity network, although there has been perennial dissatisfaction with that system. A special problem arises when an optimally-integrated network should span the service areas of more than one vertically-integrated utility, and there are barriers to both utilities coming under common ownership. This problem arises from the fact that an integrated electricity network shared by independent vertically-integrated utilities requires expensive capital investment that is transaction-specific, immobile, and long-lived. Oliver Williamson offers insight into this problem.⁵

The Battle of the Systems

Although both AC and DC were used in the arc lighting systems that preceded the development of the practical incandescent lamp, Edison chose to use DC for the incandescent lighting system he pioneered. In one fundamental respect, this choice was unfortunate: it is easier and cheaper to change the voltage of AC than it is to change the voltage of DC. Thus, AC could better deal with an important problem in electricity networks, namely, the losses that unavoidably occur in a transmission or distribution grid where there are long conductors. These losses are proportional to the product of the square of the amperage of the current and the resistance of the conductor. The resistance of a conductor increases with its length (and decreases with its cross-sectional area). Thus, long transmission lines tend to have high resistance unless they are also impractically large in cross-section. The power of an electrical current (usually measured in watts) is the product of that current's voltage and amperage. Thus, for example, doubling the voltage of a current would enable the amperage to be cut in half without reducing total power. Cutting the amperage in half reduces transmission losses by 75 percent for a given transmission line.

Despite this important advantage, the switch from DC to AC did not happen quickly. Many of the devices Edison developed for his system, such as the electric meter, had to be reinvented for AC. DC also held an advantage for the powering of motors, particularly motors that had to maintain high torque at varying speeds (elevators, for example). The period between 1887 and 1892 in the U.S. electric power industry is often referred to as the "Battle of the Systems" (or "Battle of the Currents"), as commercial rivalry between the DC systems offered by Edison General Electric and its rival Thomson-Houston and the AC systems offered by Westinghouse and by Thomson-Houston raged. The ascendancy of AC was symbolized by its adoption in 1893 for both the Chicago World's Fair and the (then) gigantic hydroelectric facility built at Niagara Falls. In 1892, Edison General Electric and Thomson-Houston merged to form the

⁵ Oliver E. Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting* (New York, 1985).

modern General Electric Company, and after 1893, along with Westinghouse, concentrated on marketing AC generating equipment to utilities. Even so, a number of years elapsed before AC equipment completely replaced DC equipment in utility generating plants.

Although the benefit of AC over DC has sometimes been described as “saving copper,” this mischaracterizes the qualitative shift AC brought to the electric power industry.⁶ AC was adopted because it enabled the creation of substantially larger electricity networks. Its ability to handle long distance transmission was doubtless the initial impetus, but technological developments accelerated with the development of interface devices allowing conversion of standard AC to other types of current. For example, motor-generators and rotary converters were developed that enabled AC to be converted to DC. Arc lighting with DC involved the use of generating equipment that maintained constant amperage with varying load. Incandescent lighting, on the other hand, required maintaining constant voltage. Thus, separate generating equipment was required for arc and incandescent lighting circuits. In the case of AC, the different requirements could be handled by different transformers designed either to maintain constant voltage or constant amperage, resulting in one type of generating equipment for both uses.⁷

The U.S. Commissioner of Labor undertook a detailed survey of electric utilities from 1897 to 1898.⁸ Although ostensibly 5 years after the end of the “Battle of the Systems,” only 16 percent of the plants in the study were generating only AC, while 25 percent were still generating only DC. The largest plants tended to have a DC-generating capacity at least twice that of the AC capacity. Use of copper per mile of mains and feeders did tend to fall with the proportion devoted to AC generation, but copper was on average a relatively small (5.1-6.6 percent) proportion of the total value of investment in a plant. Increased use of AC showed another benefit, however. The higher the proportion of AC generation, the lower the total generating capacity required to serve a fixed connected load. This indicates an improved “load factor,” or “diversity,” a tendency for the demands by particular electricity-using equipment to occur at different times, one of the primary benefits of an electricity network. These benefits had clearly only begun to be exploited, however. When placed into groups according to the proportion of AC generation, only those plants that were 100 percent AC were able to have a generating capacity less than their total

⁶ This discussion is based on William J. Hausman and John L. Neufeld, “Battle of the Systems Revisited: The Role of Copper,” *IEEE Technology and Society Magazine* 11 (Fall 1992): 18-25.

⁷ U.S. Bureau of the Census, *Central Electric Light and Power Stations, 1902* (Washington, 1905), 98-99.

⁸ U.S. Commissioner of Labor, *Fourteenth Annual Report of the Commissioner of Labor, 1899: Water, Gas, and Electric-Light Plants under Private and Municipal Ownership*, (Washington, 1900).

connected load. At this early date, the adoption of AC first enabled utilities to participate in the benefits of electricity networking.

The beginning of the twentieth century saw a consolidation of utilities in major metropolitan areas, probably helped by the networking advantages gained by larger over smaller utilities, even in a single metropolitan area. This was also a period when electric utilities were concerned about competition, often did not make much profit, and increasingly faced an ideological battle over government-owned versus privately-owned utilities. These stresses ultimately led the industry to embrace state regulation, an institutional arrangement Progressive reformers also favored. Between 1907 and 1914, a majority of states adopted this system of regulation directed by quasi-judicial regulatory commissions that were part of state government.

The Rise of State Regulation

The methodology underlying state regulation had already been applied to railroads, but it continued to evolve. Under state regulation, utilities received franchises of indefinite length, replacing the fixed-term franchises previously issued by municipalities.⁹ The regulated utilities accepted uniform accounting rules, and regulatory commissions were provided detailed records of all operating expenses. Before new investments could be undertaken, the regulatory commission had to issue a certificate of "Convenience and Necessity" for the new facility. This requirement protected the regulated utility's monopoly because such certification was unavailable to any would-be competitor who also wanted to offer utility service to the public. The primary job of the commissions was to ensure by setting the utility's rates that the profits earned by the regulated utilities were not excessive. The rates were supposed to be set at a level that just enabled the utility to cover its operating expenses and receive a "fair" return on the value of its capital facilities. What constituted a "fair" return depended on the utility's capital cost: what it had to pay bondholders and stockholders to obtain the funds needed for investment. This system reduced the apparent risk to utility bond and stock investors, and modestly reduced the interest rate regulated utilities paid for borrowed money.¹⁰

At the time regulation was established, electricity networks were much smaller than they would become. There is evidence, however, that the institutional framework created by regulation may have inhibited the development of fully optimal electricity networks. Regulation maintained and strengthened the vertical integration of electric utilities. The utilities

⁹ Government franchises were necessary for an electric utility to be able to use the public streets rights-of-way for their distribution systems.

¹⁰ William J. Hausman and John L. Neufeld, "The Market for Capital and the Origins of State Regulation of Electric Utilities in the United States," *Journal of Economic History* 47 (Dec. 2002): 1050-73.

that were in operation when regulation began were already involved in generation, transmission, and distribution. Although long-distance transmission (especially interstate) was rare at the start of state regulation, the commission certification requirements made it difficult for any entity other than the existing utilities to invest in transmission facilities. Thus, the pattern of a single company providing generation, transmission, and distribution became fixed.¹¹

It was not uncommon for two adjacent utilities to interconnect, putting them, in a sense in a common network, and enabling them to share some of the benefits of a network. This type of interconnection, however, was not the same as a fully integrated network. On the continuum of integration that can occur between two utilities, an interconnection occasionally and opportunistically used for power interchange when both utilities can benefit lies at one extreme. At the other extreme is the unification of the two utilities so that they operate as single entity. In the latter case, both utilities jointly undertake long-range planning with the needs of both utilities in mind, while in the former case the interconnection has no effect on either utility's long-range planning. Intermediate degrees of integration can occur if the two utilities partially keep the needs of other network partners in mind when planning.

The problem with a network encompassing two or more integrated utilities occurs when one of the participants must undertake an investment whose benefits will substantially accrue to the other participants—exactly the type of activity that distinguishes an integrated network from one involving mere interconnection to facilitate short-run power exchange.¹² If a transaction participant must make a large capital investment with no value except for that specific transaction, the use of markets to mediate that transaction will be problematic. Capital investments always entail some risk; an investment is undertaken in the expectation that the services provided by the capital equipment will be needed in the future. That expectation may be incorrect. This risk is independent of the institutional form within which the transaction occurs. The problem with a market transaction involving highly transaction-specific capital is that the party

¹¹ Municipally-owned utilities often were an exception. By the end of the 1920s, although a number of the early municipal utilities were bought out by privately-owned, vertically-integrated utilities, others switched their operation to distribution only, purchasing power at wholesale from the private, integrated utilities. Herbert B. Dorau, *The Changing Character and Extent of Municipal Ownership in the Electric Light and Power Industry* (Chicago, 1929), 3-5.

¹² This section is based on the theoretical work of Oliver Williamson, who articulated a theory of "transaction-cost economics." A good summary can be found in Williamson, *The Economic Institutions of Capitalism*. An application of these ideas to this issue can be found in Paul L. Joskow and Richard Schmalensee, *Markets for Power: An Analysis of Electric Utility Deregulation* (Cambridge, Mass., 1983).

not making the investment may renege. If, for example, expected conditions do not materialize, a renegotiation may be in order. In such a situation, however, the bargaining position of the participant already incurring the cost of transaction-specific capital equipment is much weaker than it was prior to incurring those costs. If a breakdown in the agreement renders the capital equipment useless, the investment cost of that equipment is truly sunk. This is not so, of course, if the capital is “mobile,” that is, has some other use. An opportunity cost remains of using the capital as originally intended, and the investment costs are not entirely sunk. Long-run contracts with penalty clauses, of course, are designed to deal with this situation, but it is impossible to write a contract to fully anticipate the future. If a transaction requires investment in capital with no alternate use, a party to a market transaction who agrees to undertake the investment faces a risk exceeding the normal market risk. If the ownership structure changes so that both parties are in the same firm, this additional risk disappears and only the normal market risk remains. When a transaction occurs within the same firm, renegeing is impossible; a kind of insurance is provided against unforeseen contingencies and the consequent risks associated with renegotiation.

For adjacent vertically-integrated utilities that are components of a single integrated electricity network, any investment, such as a generation plant, is likely to be highly “immobile” because, once built, there is no alternative use for the facility. It is possible such an investment might have considerable “mobility” in an alternative market structure where the owners of transmission facilities are different from those of generation facilities, and where generators can compete to supply different consumers. Although it could not physically be moved, if it could transmit its generated electricity to consumers outside the network it would have value outside the original transaction. With an industry structure consisting of vertically-integrated utilities, we would expect network growth to be associated with the extension of common ownership over previously independent entities combining to form an integrated electricity network. This is exactly what happened. After expanding from 2,805 in 1902 to 4,224 in 1917, the number of privately-owned utilities then declined by 61 percent to 1,627 in 1932.¹³

Despite the fact that consolidation occurred under state regulation, its existence created barriers by creating a type of property rights to a service area: only the incumbent could build facilities in that area. This meant that an expanding network required positive assent of the existing companies, in contrast to competitive markets where firms operating at a more efficient scale can replace other firms entirely through market competition. Although successful firms may ultimately acquire unsuccessful firms assets, the experience of market competition reduces

¹³ U.S. Bureau of the Census, *Census of Electrical Industries 1932: Central Electric Light and Power Stations* (Washington, 1934), 4.

the bargaining power of the unsuccessful firms, reducing their acquisition price and facilitating the consolidation. In a competitive market, the unsuccessful firm's value is simply the opportunity cost of its assets. Under state regulation, a firm could hold on to its service area even if serving it inefficiently, and could demand as part of the cost of acquisition, not only its assets' opportunity cost, but also a benefit share of the increased efficiency of including its service area in a larger integrated electricity network. The extent of those gains depended partly on bargaining power and is conjectural; different parties to a proposed consolidation would have different evaluations that contribute to the transaction costs of a consolidation. Thus, the system of state regulation created an environment that discouraged the growth of electricity networks that were jointly-owned and increased the barriers to unified ownership of an expanded electricity network.¹⁴

The Rise of Holding Companies

There were a number of legal approaches by which one firm could gain control of several regulated utilities and create the conditions for a larger electricity network. Several methods existed for consolidating multiple companies into a single company. There were advantages to an alternative approach, however: the holding company. Electric utility holding companies became very popular through the 1920s, acquiring control of electric utilities simply by purchasing the utility's stock. As long as the holding company's intentions were unknown, the price of the utility's stock would generally be based on the expectation of the *status quo*—no premium for the advantages of a larger network would be included. This method of acquiring control avoided many of the obstacles to outright acquisition of the utility.¹⁵

The importance of electric utility holding companies grew until, by 1929, the largest holding company controlled over 19 percent of private electricity generation in the U.S., and the half-dozen largest controlled

¹⁴ Jointly-owned integrated electricity networks have arisen under state regulation despite these impediments. Electric utilities have occasionally formed "power pools," that involve some degree of joint operation. Those classified as "tight" power pools may have achieved the same type of integration that could have occurred under unitary ownership. In 1981 there were four such pools involving utilities under separate ownership. The agreements permitting these arrangements have required frequent renegotiation, and frictions within the pool often arose. At least one observer remarked that the benefits of the integrated network might best be achieved through consolidation. See Joskow and Schmalensee, *Markets for Power*, 66-77.

¹⁵ A more complete discussion of the advantages (and disadvantages) of the use of holding companies to effect a consolidation of several independent companies can be found in James C. Bonbright and Gardiner C. Means, *The Holding Company: Its Public Significance and Its Regulation* (New York, 1932), 21-54.

more than 70 percent. Holding company stocks were among the highest of the high flyers during the great bull market that preceded the 1929 crash. In 1935, Congress passed the Public Utility Holding Company Act forcing dissolution of most of the holding companies and instituting regulations that essentially prevented forming new holding companies. Holding companies in control of fully-integrated interstate electricity networks were allowed to continue but were subject to special regulations affecting their financing and operations.

A complete discussion of the reasons for the rise and fall of public utility holding companies is beyond the scope of this paper. It is clear, however, that some of the more prominent holding companies were active in the formation of interstate electricity networks. The modern American Electric Power Company and the Southern Company are remnants of the old holding companies and still rank among the largest generators of electric power in the U.S. today. It is also clear that the holding companies took advantage of their special ability to exploit state regulation to the detriment of electricity users. Unlike operating companies, holding companies were not subject to state regulation. In order for regulation to work, the regulatory commission must be able to determine the costs of the regulated utility. As long as the utility acquires the resources it needs in markets, this is possible. Many holding companies, however, provided significant technical and managerial services to the operating companies and charged them a service fee. These services were not available to operating companies through market transactions; they were only provided by holding companies to their operating subsidiaries. While utility commissions could easily determine the amount of fees paid by the operating companies, they did not have the power to determine what it cost the holding companies to provide these services. Because legitimate operating costs were, under regulation, passed on to the utility's customers, the holding companies had an incentive to inflate these charges. A Federal Trade Commission report revealed this to be a common practice.¹⁶ A financing boom seems to have propelled the acquisition of operating companies in the 1920s and may have constituted a bubble. Although, as noted, a number of holding companies reorganized at least some of their operating companies into large integrated electricity networks, it was quite common for holding companies to also acquire operating companies with non-contiguous service areas. These operating companies could not have become part of larger integrated networks without some fundamental ownership changes.

¹⁶ U.S. Federal Trade Commission, *Utility Corporations: Economic, Financial, and Corporate Phases of Holding and Operating Companies of Electric and Gas Utilities* (Washington, D.C., 1935).

Proposed Regional Electricity Networks in the 1920s

An appreciation in the 1920s of the benefits accruing to larger electricity networks resulted in two well-publicized plans advocating massive changes in the structure of electric power facilities in the northeastern United States. Despite the fact that the two proposals had similar names (“Superpower” and “Giant Power”), there were fundamental differences in their objectives. The Superpower proposal is a clearer demonstration both of the potential advantages of a larger, fully-integrated electricity network and of the fact that industry observers knew those advantages at the time. It also illustrates the extent to which existing institutional structures could impede efficient restructuring of the electric power industry.

William S. Murray, an electrical engineer whose consulting work had included evaluating the benefits of utility consolidations, authored the Superpower proposal.¹⁷ His enthusiasm for consolidation apparently led him to advocate a large-scale study to measure the benefits of an electricity network in the industrial Northeast, the region between Boston and Washington, D.C., which was called the Superpower zone. He promoted this idea at professional engineering meetings and lobbied executives of utilities, railroads, and industries in the region. His views were particularly well received by Secretary of the Interior Franklin K. Lane, and in 1920, Congress appropriated funds for a study, to be conducted by the U.S. Geological Survey. Murray was appointed director of the study and was given authority to name an engineering staff and an advisory board. The work was completed in 12 months, and the resulting “Superpower Report” was published in 1921.¹⁸

The objective of the engineering staff was to design a completely integrated electricity network to be in full operation by 1930. This involved collecting several different types of information. Considerable effort was devoted to developing a forecast of demand by location within the Superpower zone. Railroads were regarded as a major customer, and engineers assumed that the railroads in the area would operate in a unified fashion. The staff also examined the extent to which it was economically feasible to convert locomotives, particularly heavy-traction, from steam to network-provided electricity. A separate analysis was undertaken of industrial demand to determine how much could economically be converted from isolated plants to network supply. A special tabulation of the Census of Manufactures was prepared for that purpose, and a survey of the electric utilities in the Superpower zone determined the status of generation and transmission facilities as of 1919.

Based upon the information on current facilities and on estimated demand, the engineering staff undertook the kind of long-run investment

¹⁷ William Spencer Murray, *Superpower: Its Genesis and Future* (New York, 1925), 46.

¹⁸ William S. Murray et al., *A Superpower System for the Region between Boston and Washington* (Washington, D.C., 1921).

planning possible only with an integrated network. Only the most efficient plants were to be retained, for operation during system peaks, and new plants were to be built to serve the base load. By 1930, the latter would generate 83 percent of all utility-provided electricity in the zone, and by contemporary standards, the new plants were huge. In 1919, the average capacity of steam plants in the Superpower zone was 10,000 kw, compared to 218,000 kw for the 18 new steam plants proposed. These would be located to minimize fuel, cooling, and supply costs. Only the largest older steam plants would be retained, those with an average capacity of 44,600 kw. Existing hydroelectric plants would be kept, but new plants would more than triple total hydroelectric capacity.

The essence of an integrated electricity network is transmission. In 1919, the zone had 1,200 miles of transmission lines greater than 30,000 volts, including 37 miles of 110,000-volt lines. The proposed Superpower system would have 970 miles of 220,000-volt lines and 4,696 miles of 110,000-volt lines by 1930. Hydroelectric developments at Niagara and along the St. Lawrence River would require an additional 3,140 miles of 220,000 volt lines.

The promised benefits of the Superpower network were stupendous. The engineering staff estimated the costs of electricity supply both with and without integration. Initial investment would be about \$90.6 million annually for the first 5 years and \$48 million annually for the next 5 years. The higher initial costs stemmed from the new transmission lines. By contrast, the capital needs of the unintegrated system were estimated at about \$85.6 million annually for the entire 10 years.¹⁹ The report compared the sums of these two investment streams and concluded that the Superpower system would save \$163 million. The predicted savings in annual total costs were even more dramatic. The net annual cost advantage of the Superpower system was estimated at \$151 million by 1925 and \$239 million by 1930.²⁰ By comparison, the annual total operating cost of the nonintegrated supply system was estimated at \$603 million by 1930. The network thus would save about 40 percent of total costs. Despite the ensuing controversy over the organization of electricity networks, there was little or no dissent from these technical and economic conclusions. Four years later Herbert Hoover was to say of them: "No one has yet been able to kick a hole in it."²¹

The Superpower Report's major achievement was to measure clearly the benefits from an integrated network. The careful engineering work on the physical description of the proposed network contrasts with the absence of discussion of its business organization. Apparently, a new entity separate from the existing utilities would own the new generating stations and

¹⁹ Ibid., 167.

²⁰ Ibid., 169. The cost comparison included "fixed charges," and it is not clear if it incorporated annualized capital cost.

²¹ Murray, *Superpower: Its Genesis and Future*, 44.

transmission lines. This was never stated, however, and the report explicitly retreated from any position on the business organization of Superpower: "It will make no difference whether the system is a single great superutility or several utilities built up separately and functioning in close relation to one another."²² Great care was taken to provide assurance that the plan fit harmoniously with the existing order. Even though the network would supply more than 83 percent of electricity generation, "the superpower system would and should fail to achieve its purpose if it should seek to supplant or even to compete with the existing electric utilities."²³

The Superpower Advisory Board consisted primarily of officials representing electric utilities user industries and included Secretary of Commerce Herbert Hoover as a member. Although it was absent from the report, the Board did consider the issue of financial and business organization, and these discussions revealed the serious organizational and financial problems the Superpower system would have to overcome. The Board urged the creation of a Superpower Corporation chartered by the federal government and subject, at least in part, to federal regulation, but this raised a number of major problems: the authority the Superpower Corporation would have over local utilities, mechanisms for day-to-day coordination, and the scope of federal regulation.²⁴ In May 1921, a meeting with utility executives to enlist their support revealed serious objections involving corporate and financial issues rather than technical problems.

Murray in a National Electric Light Association (NELA) periodical in June 1921 outlined the Board's position on a Superpower Corporation.²⁵ He previewed summaries of the appendices, which were to be the bulk of the Superpower report; the actual appendices closely followed his previews, except for Appendix A. In that appendix, Murray had promised to discuss financial principles of the Superpower system and outline necessary legislative actions. The actual appendix contains none of this, suggesting an inability to resolve differences over these issues.

Once the report was submitted, Herbert Hoover, who invited the region's governors and members of regulatory agencies to a conference, assumed leadership of the Superpower movement. There the Northeast Super Power Commission was formed, but it achieved little, despite Hoover's emphasis on voluntary agreement and his initial goal of simply increasing utility interconnection.²⁶ Superpower remained a topic of discussion for decades, although it was sometimes used to refer to simple interconnection

²² Murray, *A Superpower System for the Region*, 11.

²³ *Ibid.*, 14.

²⁴ This discussion draws largely from Leonard DeGraaf, "Corporate Liberalism and Electric Power System Planning in the 1920s," *Business History Review* 64 (Spring 1990): 7-12.

²⁵ William S. Murray, "The Superpower System--Its Scope and Relation to the United States Government," *NELA Bulletin* 8, no. 6 New Series (1921): 335-41.

²⁶ DeGraaf, "Corporate Liberalism and Electric Power System Planning," 22-29.

rather than network integration. In 1925, Murray acknowledged that the business organization problem was more difficult than he had originally believed, and that unified ownership of the utilities (via holding companies) was probably a necessary precursor to their participation in an integrated network.²⁷ He became a vocal opponent of increased governmental involvement in electric utilities, particularly government ownership.

The proponents of Superpower were striving for a plan so attractive that all concerned parties would automatically embrace it. They succeeded in developing the technical details of an integrated network whose undisputed benefits would have been enormous. To achieve industry acceptance, the plan required two missing features: a workable business and financial organization for the network and a transition plan ensuring that the parties involved, particularly the existing electric utilities, would individually benefit from both the transition and the eventual integrated network. Voluntary agreement required this last feature, and would have assured that distribution of the large total net benefits was done in such a way that there would be no losers.

The tendency to concentrate ownership within the industry provided a major stimulus for another integrated network proposal during the 1920s, the Giant Power plan.²⁸ The problems of devising a business and financial structure for an integrated network stymied the developers of Superpower. In contrast, a primary objective of the newer plan was to offer a specific structure as an alternative to the one that appeared to be emerging within the industry. Unlike the Superpower plan, the Giant Power proposal was a Pennsylvania state legislative proposal backed by the governor, Gifford Pinchot, and applied only to Pennsylvania. Although western Pennsylvania was a major coal-producing region, the heavily industrialized eastern portion of the state, a major component of the Superpower zone, was a promising area for an integrated electricity supply network. Giant Power proponents intended Pennsylvania as a model for the national industry.

In many respects the Giant Power plan was similar to the Superpower proposal. Both envisioned huge generating plants situated without regard to existing utilities' service areas to provide the entire network base load. As with Superpower, most existing facilities would be abandoned, with only the most efficient retained for use during system peaks. Both proposed a massive network of high-voltage transmission lines linking the new generating facilities with population centers. The Giant Power plan was much less conservative in its approach to technology, however. Rather than being solidly based on the best available technology, as was the Superpower plan, Giant Power advocated approaches that were outside the norm of U.S.

²⁷ Murray, *Superpower: Its Genesis and Future*, 154.

²⁸ Morris Llewellyn Cooke and Judson C. Dickerman, *Report of the Giant Power Survey Board to the General Assembly of the Commonwealth of Pennsylvania* (Harrisburg, Pa., 1925).

industry practice and were arguably unworkable. This laid it open to the charge of being too “radical.”²⁹

The most interesting feature of the Giant Power plan was its proposed industry structure, which attempted to simultaneously check the growth of monopoly power, improve public regulation, and support the development of a fully integrated network. The existing regulatory commission would continue to operate but would be given new authority to regulate the financing of companies under its authority. Valuation of the rate base was to shift from “present value” to “prudent investment,” a change then popular among utility reformers. Interstate regulatory interests were to be handled through interstate compacts rather than by the federal government. A new state agency, the Giant Power Board, was to be created and would have primary responsibility for network coordination. The electric utility industry was to be divided into three segments: generation, transmission, and distribution. A single company would operate in only one of these segments. The existing utilities would all become distributors, although, as noted, some would remain generators of peak power. In order to encourage rural electrification, utilities previously restricted to serving a single city (such as those under municipal ownership) would be able to distribute electricity in surrounding rural areas. Aid and encouragement were to be given to forming rural electric districts (which would have taxation powers) and consumers’ mutual distribution companies (which would serve the areas neglected by private utilities). New Giant Power generation and transmission companies would receive 50-year permits from the Giant Power Board, after which either the state or successor permittees could acquire the assets of the previous permittee by repaying its prudently invested capital. The Giant Power Board was to have ultimate authority over the siting of both generating plants and transmission lines, but the permittees would have the power of eminent domain to acquire the resources (including coalfields) needed for operation. In addition to electricity generation, these companies would be engaged in coal mining and coal byproduct recovery. Transmission companies were to function as common carriers, required to transmit the power produced by a Giant Power generator or anyone else at published rates. Generators would sell their electricity directly to distributors; transmitters would simply charge a transport fee for their service.

Implementation of the Superpower plan ultimately failed because existing utilities could not reach a joint agreement. By contrast, existing utilities were of one mind about Giant Power: strong opposition. William S. Murray referred to the plan as “communistic.”³⁰ Despite a long political battle, the Pennsylvania legislature never accepted the proposal.

²⁹ Thomas P. Hughes, “Technology and Public Policy: The Failure of Giant Power,” *Proceedings of the IEEE* 64, no. 9 (1976): 1361-71.

³⁰ *Ibid.*, 1369.

The Public Utility Holding Company Act

The growing importance of holding companies in the electric utility industry stimulated controversy that had little to do with the efficiency of electricity networks. From the industry's earliest days, there was controversy over whether private companies or government agencies should own and operate utilities. Although private companies had always been responsible for most of the nation's electric utility generation, some of the earliest electric utilities were agencies of the municipalities they served.

Americans had long been suspicious of big business, and giant holding companies' rapid growth and financial swagger made them an object of considerable concern. These feelings intensified in the 1920s. Many suspected that the U.S. electric utility industry was coming under the control of a secret national monopoly, a "Power Trust." These concerns led to government scrutiny, notably a massive Federal Trade Commission (FTC) investigation beginning in 1928, which uncovered a number of financial excesses.³¹ The Commission's findings were released piecemeal until 1935; the Great Depression had sharpened the public suspicion about the damage that unconstrained private enterprise could wreak.

Even today it is difficult to evaluate the argument that public utility holding companies encouraged financial mismanagement or the defrauding of investors, although it is clear that both occurred. In the 1920s, public utility holding companies comprised a major portion of all new financial instruments, yet there were no existing federal regulations. The FTC investigation of holding companies was unique. It found that some, but by no means all, or even most, holding companies were involved in financial abuses. Unfortunately, there was no standard of comparison to determine if this industry was unusually abusive. Certainly, despite the Securities and Exchange Commission (SEC) regulation of financial markets, there are still dramatic cases of firms involved in financial market abuses. This does not imply, however, that the regulation has not been effective or beneficial; it simply has not been perfect.

The Great Crash in 1929 and the Depression that followed produced a major shift in the American political climate. The collapse of Samuel Insull's holding company empire was the biggest business failure the United States had experienced, rendering worthless stock widely held by people who did not consider themselves wealthy. Insull, who made Chicago the most electrified city in the world, had become an avatar for privately-owned electric utilities in the U.S. Franklin Roosevelt's election brought to the Presidency a man whose experience as governor of New York had immersed him in the ideological battles surrounding privately-

³¹A summary of the Commission's finding can be found in U.S. Federal Trade Commission, *Utility Corporations: Summary Report of the Federal Trade Commission*, United States Senate, 70th Congress, 1st session, Document 92, part 73-A, 1935.

owned utilities and the role of holding companies. The financial excesses revealed by the FTC reports convinced many that the only solution was a punitive restructuring of the industry. In 1935 the Public Utility Holding Company Act was passed, and it contained what was widely referred to as the “death sentence.”³² By January 1, 1940, every holding company was to dissolve. The only exceptions were cases where the Federal Power Commission (FPC) issued a finding that a holding company was necessary to the continued operation of an existing integrated multistate or international supply system, and that any other business organization was legally impossible.³³ Holding companies allowed to continue under this provision were subject to extra SEC regulation, including prior approval for issuing any financial instruments. The law specifically targeted electric and gas utilities holding companies. It did not apply to holding companies in general or to telephone holding companies, even though American Telephone & Telegraph (AT&T) dominated that industry.

Although the exemption for holding companies owning interstate integrated networks shows that Congress did not want to eliminate such networks, the law doubtless inhibited the holding companies’ creation of new networks. In principle, holding companies could have responded to the law by trading operating companies with geographically-contiguous service areas, thereby creating integrated networks and avoiding dissolution. The special SEC regulations applied to these companies did not make this status very attractive, however.³⁴ In any event, once the law was fully in effect, network-building by holding companies was impossible.

The original proposal for the Public Utilities Holding Company Act included provision for significant new federal regulation to oversee and encourage the development of new integrated utility networks.³⁵ This was contained in a proposed “Title II” of the bill that would have amended the Federal Water Power Act giving the FPC broad power over interstate networks. The dramatic expansion of FPC authority proposed in Title II

³² For an excellent discussion of the passage of the act see Philip J. Funigiello, *Toward a National Power Policy: The New Deal and the Electric Utility Industry, 1933-1941* (Pittsburgh, Pa., 1973).

³³ The text of the bill can be found in United States Congress, Senate, Committee on Interstate Commerce, *Public Utility Holding Company Act of 1935: Hearings on S. 1725*, 74th Cong., 1st sess., 1935, 9-49. The original “death sentence” is on p. 20. The law did not apply to a holding company whose operating companies were all located in a single state.

³⁴ Texas has a wholly intrastate holding company, TXU Energy (formerly Texas Utilities) that, because of its operation in a single state, is exempt from the law. The company has been so anxious to avoid any possibility of being subject to the SEC holding company regulation that to this day, except for a few DC lines, there is no electrical interconnection between a utility in Texas and one outside the state.

³⁵ U.S. Department of Commerce, *Public Utility Holding Company Act of 1935: Hearings on S. 1725*, 39-44.

included the ability to coordinate a regional network. Because all public utilities would be compelled to provide transmission services in response to any reasonable request at reasonable rates, the FPC was given the power to order:

...a public utility to make additions, extensions, repairs, or improvements to or changes in its facilities, to establish physical connection with the facilities of one or more other persons, to permit the use of its facilities by one or more persons, or to utilize the facilities of, sell energy to, purchase energy from, transmit energy for, or exchange energy with, one or more other persons.³⁶

It is, of course, not at all clear that an effective network could have developed under a regulatory aegis, but it was never tried. The proposal faced stiff opposition, especially from state regulators. This protest came in the form of telegrams from individual commissions and testimony from officials of the National Association of Railroad and Utility Commissioners (NARUC). Although a primary criticism of holding companies was their ability to thwart state regulation, regulators strongly opposed the bill as a threat to state regulation. In the face of such a threat to their power, state regulators failed to see any particular virtue in the creation of integrated supply networks. NARUC's position was that "Electric energy is essentially a local commodity," not interstate in character, and that state regulation was far preferable to the federal regulation they feared would inevitably supplant state regulation if the Act were passed.³⁷ Regional multistate systems were not considered important or desirable.

Following the hearings, the bill was substantially revised. Title II was gutted, eliminating all the features that would have given the FPC real power to coordinate and integrate regional supply systems. Although the FPC was empowered to establish regions, it could only encourage voluntary cooperation by utilities in those regions. The influence of state regulators is obvious in the final law, which reiterates that the regulatory powers of the FPC extend only to areas not subject to state jurisdiction. On several issues, the FPC was required to consult with state commissions before taking any action. In its annual report following passage of the Federal Power Act, the FPC summarized its new role: "In its procedural, no less than in its substantive provisions, the Federal Power Act undertakes to assist and cooperate with the States in the regulation of electric utilities."³⁸ Title I, particularly the holding company "death sentence," was also softened, but

³⁶ Ibid., 40, section 203. The requirement to provide transmission services is in section 202 on the same page.

³⁷ Testimony of H. Lester Hooker, Chairman of the Legislative Committee of the National Association of Railroad and Utility Commissioners, U.S. Congress, Senate, Committee on Interstate Commerce, *Public Utility Holding Company Act of 1935: Hearings on S. 1725*, 74th Cong., 1st sess., 730.

³⁸ U.S. Federal Power Commission, *Fifteenth Annual Report* (Washington, D.C., 1935), 2.

the remaining act did not make it easier for common ownership to precede the creation of new, large, integrated supply networks.

Conclusion

Although electricity networks are a valuable economic resource for electric utilities, the development of an institutional structure that can encourage the creation of efficient networks has been elusive. The economic benefits and the control problems of electricity networks have repeatedly created situations where public policy has intervened in the structure of the industry, often as a result of unintended consequences arising from the interaction of previous policy and the desirability of larger integrated electricity networks. AC introduced the possibility of electricity networks, and the benefit of those networks prompted the entire industry to adopt this technology. The rise of these networks, albeit on a small scale, helped to create the conditions that led to state regulation. That system, in turn, inhibited the development of larger and more economical networks. The growing recognition of the benefits of those networks, combined with the impediments of state regulation, help create the holding company system. Problems with the holding company system resulted in proposals to radically restructure the industry. The greater difficulty associated with unitary ownership of networks would be partly offset by increased Federal Power Commission regulatory authority. The fact that State regulatory commissions saw this as a threat to their power resulted in passage of a law inhibiting the more efficient deployment of electricity resources in the nation, creating an environment likely to produce more difficulties with the organization of U.S. electricity networks.