Electric Utilities and their Rates: Evolution and Economic Efficiency

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. Introduction

Changes in technology and the availability of information have impacted retail energy rates in the past and will do so at an increasing rate in the future. Although we do not know with perfect precision the exact change in information or technology that resulted in a particular rate paradigm during any epoch, we can observe the changes in information and technology and the changes in rates and rate structures. We can then correlate the two sets of changes and theorize about the relationship between the two. For example, real-time pricing was not an option until technology was sufficiently low cost to track usage by hour and efficiently communicate costs from the end-user. Adoption of such technologies takes time and is related to the both the accepted pricing structure and the inherent cost structure of that era.

We know the current situation and the future with even less precision. We observe facts and behavior today, but we typically have only hypotheses—often based on past experience—about how the facts and behavior are related. For the future, we have only hopes and theories about facts and behavior and how they will interact. But like Dicken's Scrooge, we might clearly see disastrous outcomes if we do not change, and hope for better outcomes if we do change. Hence, this article examines the ghosts of the past, present, and future to see if we can identify changes that lead us from the course of current practices to more hopeful outcomes in the future.

Before exploring the past, present, and future, it is desirable to grapple with the concepts of technology and information. Information refers to data and facts, which are typically considered objective, and knowledge, which can be subjective and open to personal interpretation. Knowledge generally refers to an accumulation of data and facts, and some understanding, organization, or relationship between those facts. For example, the utility rates, measured costs, and calculated rates of return by a specific formula are facts. The accumulation of those facts along with a rate paradigm, such as the allowed rate or return should be comparable to firms with comparable risk, is a set of knowledge. Technology is the application of knowledge to specific tasks, such as reading and recording electric meters and calculating the rate of return.

Information and technology are intertwined like space and time. Information on the operation of electronic and digital processes allow for the real-time reading of meters and the communication of prices through technology. The real-time reading of meters allow for more information. Technology that relays the real-time meter information to end-uses in turn provides more information on the relationship between usage and prices. This, in turn, can affect forecasts of necessary generation capacity and future costs.

Information and technology are not limited to the hardware and processes of operating a regulated utility. Information and technology also can refer to the regulatory paradigms used to set rates and allowed activities for regulated utilities. These paradigms are based upon a set of knowledge and beliefs that people have at any given time. As available facts and knowledge change, the desire for a particular paradigm change as well.

We now turn to the past, present and future.

The Ghost of the Past

The benefits of rate regulation to the owners of electricity electric utilities have varied over time. As is typical for new and innovative products, initially there was little or no regulation of electric utility rates. Electric energy was initially a product of the rich, with prices around $3/kWh in real terms today.[1] This is about 25 times current average prices for residential customers. The main form of regulation was municipal franchise authority, which restricted the number of competitors. Municipalities often authorized multiple systems, and the resulting competition and advances in technology dropped prices down to about $0.38/kWh in real terms by 1909.[1]

In 1898 Samuel Insull, the founder of Chicago Edison, proposed a different business model for electric utilities.[2] He proposed a regulatory compact in which exclusive franchise territories would be granted by the states in exchange for cost-of-service regulation of pricing. This new form of regulation began in Wisconsin and New York in 1908 and by 1917 45 states had adopted state-wide regulation of electric utilities.[3] The regulation was very successful at achieving Insull's goals. Jarrell (1978) reports that the state regulation was associated with a 25 percent increase in average prices and 40 percent increase in average profits.

This change to state-wide regulation of entry and rates was based on a theory that had been growing for at least 60 years by that time, the theory of natural monopoly. Classical economists had used the term natural monopoly to distinguish a sole seller of a product that was due to circumstances rather than a grant by the government. For example, a vineyard with a certain type of soil may produce wine with a particular flavor that is distinguishable from other types of wine. The term was first applied to businesses that we today consider natural monopolies by John Stuart Mill in 1848 when he applied it to the production of gas and water. Walrus in 1875 applied the term to transportation industries such as railways, roads, and canals. The theory of natural monopoly as we know it today was first put forth by Alfred Marshal in 1890 when he proposed a different definition, that of "indivisible industries." To state the concept of the time in today's language, natural monopolies were industries where the least-cost provision of the good would be provided by a single company. Hence, in theory, the least-cost provision of electric energy could be accomplished by a single company, which justified the restrictions on competing companies. And because the market was left with one, or a very small number of sellers, rate regulation was necessary to constrain the pricing of the monopoly seller.

It should be noted that price regulation dealt with the provision of a commodity—electric energy. The business model was to produce electric energy and then deliver that energy to end users. Just like natural gas and water, electric energy was largely a homogeneous commodity service and one did not worry much about quality or differentiation of multiple products. This provided for a relatively simple regulatory paradigm that worked with relatively few hiccups until the 1970s.

The 1970s brought many challenges to investor-owned electric utilities in the United States, of which I will name only a few. A command and control mindset left over from the 1930s and 1940s pervaded the government in the early 1970s. One facet of this mindset was price controls for natural gas and oil, which created substantial shortages as a result of inflation and oil embargos by OPEC. Utilities turned to coal and nuclear energy to power new power plants, but these also ran into substantial issues. The environmental movement was growing in the U.S., resulting in Congress and the EPA putting new restrictions on coal-fired power plants. Some of these restrictions could be met by the low-sulfur coals of the Powder River Basin, but others required costly equipment upgrades at the plants. Fears surrounding the safety of nuclear energy resulted in modifications of plants under construction, which greatly increased the cost of nuclear power. When the costs of higher fuel prices and higher capital costs were passed along to consumers, the growth rate of electric consumption declined substantially. Growth rates averaged about 10 percent in the 1950s, 7.5 percent in the 1960s, and less than 5 percent in the 1970s.[4] The growth rate from 1973 to 1985 was only 2.5 percent.[5] Some utilities found that substantial rate increases could even lead to absolute declines in consumption.

The 1970s produced three lasting legacies. The first is the implementation of automatic rate adjustments for changes in fuel and purchased power costs. The rapid rise in fuel costs during the 1970s presented the biggest risk for utilities. Traditionally, a regulated utility facing increased purchased power or fuel costs would have needed to file a new rate case, which was both costly and time consuming for the utility. Automatic rate adjustment mechanisms eliminated the need for utilities to submit new rate case filings. By the end of the 1970s, the vast majority of states had adopted procedures to allow utilities to adjust rates for changes in fuel costs without the need to submit a full rate case filing.

Secondly, the 1970s brought increasing skepticism of the efficacy of regulation and the natural monopoly theory of the provision of electric energy. The attack of the regulatory framework came from two directions. First, the spread of electric and then electronic computing power reduced the costs of statistical studies of prices and costs in the industry. In a seminal article in 1962, George Stigler and Claire Friedland questioned whether rate regulation actually lowered rates to consumers. This work was followed by many similar works in the 1970s, such as Jarrell (1978), who suggested that regulation actually raised rates. Others, such as Alfred Kahn, questioned not only the rates of regulated companies, but also the quality of the service offerings. Kahn argued that it was much easier to regulate the rates for existing products and service offerings than to regulate whether the current offerings were really the correct offerings or whether a utility should offer more variety in terms of products, services, and rate structure.[6] Moreover, both lines of analysis found that competition, even highly imperfect and flawed competition, was often much better at providing the value that consumers ultimately desire.

The third legacy is a crack in the paradigm that electric utilities simply supply a commodity that is easy to determine costs and regulate. The Public Utility Regulatory Policy Act of 1978 ("PURPA") and the Natural Gas Policy Act of 1978 ("NGPA"), depending on perspective, are either the most flawed pieces of legislation ever or the most ingenious. As written, both acts have severe flaws and substantial economic inefficiencies. But both provided information of inestimable value. The NGPA very quickly showed that the "shortage" of natural gas is nothing more than the traditional shortage that develops when regulators attempt to keep a price below a competitive level for a substantial period.

Within 11 years of its implementation, natural gas prices were completely deregulated at the wellhead level and much of the NGPA repealed, due in large part to the plentiful gas supplies brought forth with higher price ceilings. PURPA forced electric utilities to connect and purchase from certain classes of generators called qualifying facilities (QFs). The interconnection requirements and the new supplies of natural gas by the mid-1980s revealed that gas-fired generation could be provided at much lower-cost than newly proposed coal-fired and nuclear generation. Although this had substantial impacts on utility regulation, it was the interconnection and purchase requirements that changed the fundamental characteristics of electric utilities from simply providers of electric energy to network operators.

The concept of utilities as network operators at the wholesale level was codified in the National Energy Policy Act of 1992, which required transmission-owning utilities to open their transmission systems to all who were willing to pay for transmission service. FERC formalized this requirement four years later in Order No. 888. Since then FERC has issued over 250 "landmark" orders in the industry.[7] The range of these landmark orders goes from transmission reliability standards to market-rate authority for generation owners, but the majority deal with transmission access issues such generation interconnection and refining the definition of nondiscriminatory transmission access.

Upheavals in the cost of generation and the advent of transmission access led to major restructuring in many states in the 1990s. Many of the eastern states adopted competitive retail access and back-up, provider of last resort, or standard offer service for the utilities. Instead of being vertically integrated from generation, through transmission, to distribution, and retail sales, many utilities became "wires-only" companies. Rather than primarily being in the business of selling a commodity, they became primarily in the business of delivering a commodity. In this respect, they became more like common carriers and less like merchant operators. The crack created by PURPA suddenly was a large hole in the dike with competition rushing in.

Technology has advanced tremendously since PURPA was passed in 1978. On August 12, 1981, IBM introduced the IBM 5150, its first personal computer. Although personal computers were available before then, the IBM 5150 legitimized PCs and began the mass marketing of personal computers. The accompanying explosion of computing and communications technology has radically changed our lives, and also changed opportunities in the electric utility industry. The advent of real-time metering and communications allows many new opportunities to manage energy infrastructure and usage. These technologies now present opportunities for electric utilities.

The Ghost of the Present

Today electric utilities are in a transition period. Most electric utilities fall into two categories: traditional vertically integrated utilities and those that have unbundled generation services from the business of transmission and distribution wires.[8] But regardless of structure, the old paradigm treated an electricity utility as one that either sells or delivers the commodity of electricity. This paradigm, along with common rate structures, has created rate issues for many utilities.

The technologies of electric generation, transmission, and distribution each currently feature two attributes that create pricing issues. First, investments create substantial site-specific, sunk costs. The economic problem created by such investments is that without some long-term contracting mechanism, the buyers of these goods are often in a position to expropriate the value of the site-specific sunk investments. Exclusive franchise territories can solve this issue, but that creates another risk: regulators can set rates so as to transfer the value of the sunk costs to the customers. Fortunately, the Supreme Court decisions in Smith v. Ames, 169 U.S. 467 (1898) and Bluefield Water Works v. Public Service Comm'n, 262 U.S. 679 (1923) have limited the ability of regulators to take such actions. But there is still a risk that regulators will set rates in a manner that does not allow for full recoupment of costs. Second, investments represent a substantial amount of joint costs. A 13kV transmission line running down a street often costs the same whether there are 12 or 15 houses connected to the line. So, if 12 houses are being served and a 13th house desires service, is the economically efficient rate one in which the 13th house pays the low incremental costs or a rate in which it pays the average cost of serving all the houses? Either choice creates incentives that can either increase of decrease social welfare depending upon the specific circumstances.

Attempting to reconcile these issues, and likely other issues, electric utility rates evolved so that non-trivial portions of what economists call "fixed" costs have been recovered in the variable portion of electric rates. In essence, the usage of electric energy subsidizes the cost of providing access to electric energy through a wired network. Such a rate structure can give incentives for end-users to install generation that is higher-cost than the centralized generation services provided by utilities or large merchant generators. Knowing the PURPA mandates, some utilities foresaw these incentives and revised tariffs to eliminate or reduce such incentives. Other utilities attempted to revise tariffs to reduce the inefficient incentives, but were thwarted by state regulatory commissions. Other utilities did not take action until the entry of small-scale distributed generation began to have significant financial impact. So today, we have utilities in each of these categories.

The debates about utility rates and what is an efficient rate structure today are largely discussed from the point of view of the old paradigm that electric utilities are primarily in the business of selling or delivering electric energy. End-use installation of generation resources are viewed mainly as substitute sources of energy that do not obviate the need for distribution (or transmission) systems, nor affect total system demand for services. The purpose of electric distribution utilities is not questioned.

Programs instituting performance-based ratemaking ("PBR") typically do not change this paradigm. Traditionally PBR sets price-caps that allow the utility to earn higher profits if costs are below the level used to set the cap, and incur losses if costs were above the benchmark. Share the savings programs with fuel costs is one type of PBR in the electric utility industry.

Unfortunately, these programs are often set so that the utility has little ability to profit. Price-cap PBR can lead to adverse incentives for utility performance, including the incentive for poor quality service.

Performance incentive mechanisms (PIMs) are another form of PBR. For example, some gain or profit to the utility is allowed or a penalty incurred if it meets a performance goal such as restoring service within some period of time after an outage. PIMs are often ad hoc based on the preferences or desires of regulatory commissions as opposed to true incentive mechanisms that match consumer demands to utility service. Yet, PIMs do provide the potential for reliably serving consumer demand. For example, estimates could be made of the benefits of greater reliability and the reliability increases from installing underground wiring. These two estimates would establish the consumer value associated with underground wiring.[9] A regulatory agency could then allow the utility to install underground wiring in all areas where the collective consumer value is greater than the costs, and then place the added capital into the rate base. Because competitive firms would collect more than cost for some period before entry eroded the profitability of the innovation, same added benefit could be added for regulated utilities such that consumers receive greater net value and the utility receives higher profits than they would by simply maintaining overhead distribution lines.

Finally, the substantial incentives to install distributed generation have created significant amounts of distributed generation in some locations. End-users do not intrinsically desire solar panels and wind turbines to be installed at their homes. Solar panels and wind turbines are installed mainly because economic incentives have been created for their installation. The cost of utility scale photovoltaic ("PV") solar is less than one-half of residential scale cost.[10] The main driver of the cost difference is the marketing costs involved with residential scale installations. It is more efficient to install utility scale solar and deliver the energy over distribution wires rather than have distributed installations.

Distributed generation installations are supported by utility rates with energy charges that contribute to fixed-cost recovery. Federal tax credits reduce the cost of installation by 30 percent. States can also provide subsidies, such as California providing over $2 billion in rebates for distributed solar installations. Renewable portfolio standards (RPS) also provide incentives. RPS often provide for within-jurisdiction requirements for wind and solar energy and penalties for not meeting these standards. In the District of Columbia, the penalty for solar shortfalls is $500/MWh, or $0.50/kWh. As a result, the value of a solar renewable energy credit (SREC) in 2017 was around $400/MWh. Given these incentives and the desire for lower net costs of energy, it is not surprising that distributed technologies have been adopted.

The Ghost of the Future

The adoption of distributed energy resources (DERs) will increase. The future is driven by consumer demand, technology, and the incentives created by government. Consumer demand, in some respects, is quite simple. All consumers desire free, limitless, usable energy. Technology, however, does not allow this. Available energy is finite and costly. Changes in the deployment of technology that increase availability and reduce net costs are valued by consumers. Given current low interest rates, the federal government's proclivity to borrow money, and desire of Congress to give benefits to homeowners, DERs are likely here to stay. Moreover, technology increases at an increasing rate. New technology allows more production with fewer human resources, which frees additional human resources to pursue new and better technologies. Given the trends using fewer resources for a given amount of work, the cost of DERs are likely to fall relative to utility-scale energy resources. For PV technologies today, other than marketing costs the cost of home installations are not substantially higher than utility scale. So fundamental economic changes will drive DERs as well government policies.

DERs substantially change the nature of electricity distribution. Rather than being used as a system to deliver energy to end-users, electricity distribution systems become networks more like the internet that transmit messages along an ever changing array of paths. Real-time communication between end users and the utility, which is clearly feasible with wireless communication and standardized TCP/IP, will unleash the potential for the electric grid. Two potential paradigms come to mind.

In one paradigm, the utility would serve as a central dispatcher, much like RTO operators operate the bulk transmission system. There are some precedents for this at the retail level. Cable operators, for example, gained control of their networks by requiring set-top boxes as an interface between the cable system and viewing screens. Another example is "energy savings" solutions today where utilities have control over high-demand equipment such as air conditioners in order to reduce peak demand. In such a system, an end-user could place clothes in a dryer before going to work and the utility would decide the optimal time for the drying to occur. Given control over the system, including end-use generation, storage, and large demands, the utility would then operate the system to achieve some objective. For example, the object could be to minimize total energy costs for the end user. But many other objectives come to mind, such as minimizing total energy costs for a group of users, minimizing carbon emissions for individual users, or minimizing carbon emissions for a group of users. Utilities would offer an array of choices, and let end-users decide which preferences should be pursued by the utility. Utility compensation would be based, at least in part, on how well it achieves its goals.

The other paradigm is that the utility would send price signals to each end-user, and the end-user would be free to make all its choices based upon the price signals sent by the utility. For example, the end-user might program its battery to store energy when real-time energy prices are less than 20 cents per kWh and to release energy when real-time prices are above 80 cents per kWh. This paradigm would not achieve the full benefits from central coordination, but it may be more palatable to end-users.

Standards and requirements for appliances are necessary to facilitate the transition to the modern utility. The federal government has established minimum energy standards for appliances, and the Energy Star program has encouraged companies to go beyond these standards. The next step is to create a standard communication protocol and options built into the appliances to allow for remote operation. The protocols will allow for end-user control or for control by another with the end-user's permission. Given the ubiquitous use of electronic control and communication today such a standard will not substantially increase the cost of most large appliances.

The difficult part of any change is to know which changes are economically efficient and which are not. In competitive markets, companies compete with different service offerings, whether the difference is in terms of features, options, or prices. Those with superior offerings drive out those with inferior offerings. Through the market test, the more efficient providers prevail over the less efficient. Although there are over 40 utility holding companies and at least fifty-one jurisdictions, differences across utilities will not provide enough variety to determine the most desirable choices for end-users. A program that is successful in California may have little applicability in North Dakota. Instead, utilities will offer pilot programs in select areas to see the share of end-users that prefer the new option. If sufficient demand exists to support the option, then it would be economically efficient to give that choice to consumers.

Before these changes occur, state regulatory agencies will need to shift their regulatory paradigm. Rather than focusing on a specific set of prices, regulatory agencies will need to shift to focusing on consumer value. A utility that delivers 60 percent of end-use consumption may have 10 percent higher distribution rates than a utility that deliveries 80 percent of consumption, but may be delivering greater value to its end-users because of the savings the end-users receive on the additional 20 percent of self-generation. Similarly, a utility offering centralized communications and dispatch functions would have higher costs than a utility that does not, but may provide greater value to consumers because of the energy cost savings from the centralized dispatch services.

Conclusion

The conclusion is simple: the past is prologue. The changes in technology and fundamental economics in the past have driven changes in regulation and rate structures, and they will drive changes in the future. Moreover, the rate of change will be increasing, which means that more flexible rate structures will be necessary. The fuel cost adjustment clauses and formula rates electric transmission service are two examples of rate structures that automatically adjust for changes in cost and demand. Rate structures will also change to accommodate DERs and the challenges that they present. Innovative utilities will develop new services that that will take advantage of new technologies and provide greater net benefits to end-users—and keep some of the benefits for themselves. In other words, perhaps Scrooge was able to save Tiny Tim and still salt away enough money for a comfortable retirement.

Footnotes

[1] See Wren, Strain & Britt (2018), at 3, reporting that prices were $0.20/kWh in 1892.

[2] Id.

[3] Id.

[4] Id.

[5] EIA.

[6] Geddes (1992).

[7] Kahn (1970), Volume 2, at 325-6.

[8] See https://www.ferc.gov/legal/maj-ord-reg.asp?new=sc3.

[9] A few utilities fall into other categories such as owning generation and distribution wires but not transmission, or unbundled from both generation and transmission.

[10] Another methodology would be to observe what end-users are willing to pay for underground wiring in new developments.

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