The Power Innovation Process: Electric Technology Effects on Policy and Electricity Policy Effects on Technology

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Thank you for inviting me to discuss the power innovation process. What I will explore is the relationship of electric technology effects on policy and electricity policy effects on technology. I want to provide an overview of the technology-policy interaction and discuss some illustrative case studies. I then draw some implications from this.

To begin, let me note that electric technology and systems advance within complex economic and political systems. This has been true almost from the beginning of the electric power industry. It is important to appreciate that the feedback flows in both directions. In other words, technology causes some policy changes and policy can cause some technology changes.

There are at least four important types of policy to mention relevant to electric power. First, there is federal regulation of investor-owned utilities. Second, there is state regulation of investor-owned utilities. Third, there are public power entities, such as Tennessee Valley Authority, the Bonneville Power Administration and other entities, such as municipal utilities and co-ops. Fourth, there is electric power research and development policy, which provides some funding for the development of technology and which can influence directions technology takes.

It is important to understand that federal energy politics are complex, and not typical of the policies that surround many political issues. For example, energy politics are generally non-partisan. They do not divide along Republican and Democratic Party lines. Energy politics tend to be regional. They are producer-area regions and consumer-

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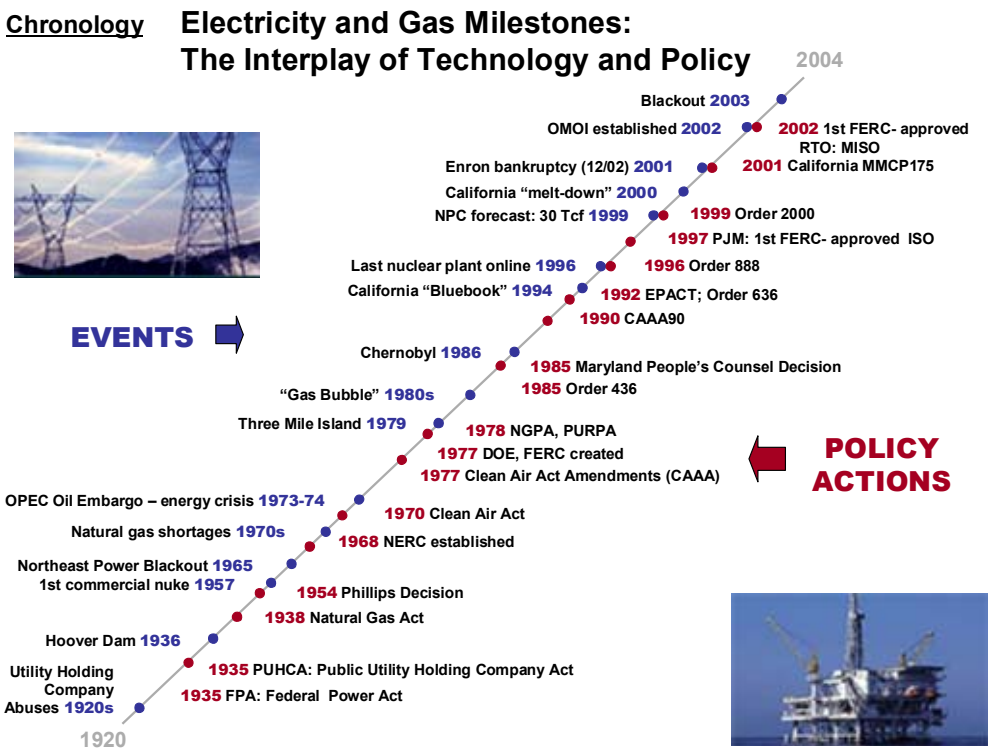
area regions. It can be a coal region versus an oil region, a fuel supply region versus a fuel consumption region. You will find that senators and congressmen from one state can be more closely related, even if they are from different parties, than you will see people from different regions of the country who are in the same parties but representing different industry or market segments. This can also be idiosyncratic and relate to specific congressmen. For example, a senator from a coal state, who has been there many terms and has great seniority, can have a great deal of influence on the direction of coal and air quality policy, far more than he would have given his one vote -- but it is based on his senate leadership position.

Let me turn to the overview and illustrative types of interactions that one might see. First, let's start with policy changes. A policy change might allow, if you will, normal evolution of the technology, which would include many incremental improvements. Some policy changes open opportunities for revolutionary advances and real leaps, either in the technology or the application of an existing technology. Some other policy changes may create a need for technology fix.

On the other side of this, if you start with a technology advance, some such technological advance may make current policy obsolete. Other technology advances may raise new needs or opportunities or questions related to policies that are in place or about the development of future policy.

Now, referring to the figure on electricity and gas milestones, I would like to point out that you can see that there have been important advances over the years, and I will just note a few examples from the selected events and the selected policy actions on

this chart. There has been a "real dance," back and forth at times, between what the implications are from a policy decision or from a technical or other kind of event.



Consider the following illustrative examples. To go back to the 1920s and the public utility holding company abuses that led to the Public Utility Holding Company Act in 1935, this was a financial scandal of the first order. It involved essentially pyramid-scheme type of funding of utility holding companies, and no one could tell what the fundamentals of those energy companies were -- a familiar event in the immediate post-Enron world.

Let's look at another one – the Northeast blackout in 1965. That led to the development of the North American Electric Reliability Council (NERC), a volunteer organization that created reliability standards. These standards served the country, and,

in fact, the United States and Canada well for decades as other changes evolved, however, there was more reliance on the bulk power transmission grid than it was designed to handle. In the Energy Policy Act of 2005 there was a reform that moved the NERC regime from voluntary to one that is mandatory. Now, the reliability standards that came to be viewed almost as suggestions have become mandates and violators of these regulations face severe fines.

If we go back to 1954 on the figure, we see the *Phillips* decision. This was an odd interpretation by the Supreme Court that tried to apply cost of service rate base principles to the exploration and production of natural gas. It led to bizarre separation and the dual markets of intrastate and interstate supplies of gas. The interstate supplies subject to the federal regulation became quite short while intrastate supplies remained reasonably robust because they were not subject to price controls. This, in turn, led to a Natural Gas Policy Act of 1978, as well as some absurd rules, such as prohibitions on the use of natural gas in boilers or certain kinds of power generation. Nevertheless, that 1978 set of new energy legislation also included important provisions that ultimately opened up the gradual restructuring of the natural gas industry. This has served the country well, unleashing significant new supply and serious competitive pressures that have improved efficiencies. It also was the seed of what became an effort to restructure the power industry which, of course, in 2001 fell apart in California with the very flawed restructuring system that was attempted there.

Given that big picture of the grand march of electricity and natural gas through the 20th Century, let's look at some specific illustrative case studies. Again, we will start with technology-driven policy changes here. If you look at the generation "economies of

scale," (when there were major economies of sale), a cost-of-service regulation system that allowed a rate of return on rate based that was reviewed for being just and reasonable and a rate of return that was viewed as just and reasonable allowed those economies to be realized with plants growing up to size beyond 1,000 megawatts. On transmission side for power, there also were economies of scale. It did not make sense to put two sets of wires for two different companies, either on long-haul transmission or local distribution. Again, cost of service rate principles were put in effect.

Next, if you consider high efficiency gas-fired combined cycle generation which arrived in the 1980s, this contributed to the push to restructure the power industries because these units could be much smaller than the massive coal-fired and nuclear units, and they could be, say, a couple of hundred megawatts instead of 1,000 megawatts. This disrupted the traditional economies of scale and then suggested that there was potential for competition in the generation business.

A less positive example of technology-driven policy changes -- the blackout situation -- which I mentioned earlier, was the reform of the reliability organizations and the development of mandatory standards.

An interesting sidebar on technology-driven policy change, relates to capital punishment. Although we are all aware of the electric chair, how did this come to be? Interesting, Thomas Edison was a major player in this policy development. He was a proponent of direct current (DC) and was concerned about the dangers of alternating current (AC). He supported the development of the electric chair, which used alternating current, because he felt that this pointed out the dangers of the AC system competing

with his DC system. Thus, an interesting sidebar to the competitive contest underway in the early days of the power industry was a new form of state execution.

Looking at policy-driven technology developments, we mentioned the traditional cost-of-service rate on return on rate based approach to regulation. That could be viewed as driving an interest in larger and larger rate-based investments and, certainly, nuclear power plants were near-infinite rate-base investments with near zero O&M pass-through costs. Such capital intense supply allowed the greatest profitability for the utilities.

Consider also the phased natural gas wellhead price control, which came out of the 1978 Natural Gas Policy Act, and other changes after NGPA and combine that with the advances in production exploration technology that that decontrol allowed. These changes created massive new gas supplies. Then incorporate the military gas turbine technology development, which allowed for these high-efficiency gas fired aero-derivative power generation technologies. All this changed the whole structure and environment for power generation.

Another important example was with PURPA, the "Public Utility Regulatory Policy Act of 1978." The rules there, plus the gas bubble and wellhead price decontrol, created significant industry cogeneration and as that accelerated, this contributed to the belief that there could be a competitive generation industry.

More recently, production tax credits for wind production and green energy purchase options within retail restructured markets, plus the transmission access policy that allows open access, all contribute to the accelerated development of wind energy, which had been the greatest percentage-wise growth of any power option.

So, what are the implications of all of this? I think it shows that a technology push or pull alone does not make for innovation success in the electric policy marketplace. Market pull, along with enabling technology ready and appropriate to move forward, and appropriate policy options -- that whole combination -- works best.

I think it is also important to observe that the electric power industry overcame the chicken and egg problem in its early days by investing and adopting not in one technology or another, but by adopting full systems thinking and solutions. Again, look first at Thomas Edison. They had not only the Pearl Street Generator in New York City but they had light bulbs plus the customers for electric lighting. Edison pulled all of that together. When we look at Nikola Tesla, we can see that they not only had a Niagara Falls Hydropower station, they had industrial load. They also added lighting load in Buffalo, which required the development of a long transmission line which took advantage of Tesla's AC system.

Thank you very much.