The Great Reinvention of the Electric Utility

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Introduction

Electric utilities were at the core of America's transformation from a rural, agrarian society to the world's most advanced industrial economy. They now provide the very metabolism of modern society. But electric utilities are at a remarkable transition point—described by some as a death spiral, and by others as a vast opportunity. The way it plays out will substantially determine how reliable and affordable it is to power our economy, and whether we have a decent climate future or not.

What is driving this great reinvention? It is a confluence of factors—technological, economic, and environmental. All these forces are inexorable, and unless utilities, and their fate-makers, the public utilities commissions, pay attention and rethink the role of the utility, there will be blood in the water. Conversely, if they get it right, utilities will become, again, an engine for the American future.

Three Factors Drive This Change:

1. **Technology**. A whole suite of technologies have experienced dramatic cost and performance improvements in the last five to ten years—from renewable energy, to the lights and windows in houses, to the way whole building and industrial systems work. The price of solar electricity from PV cells has dropped 80 percent in the last five years; wind is down by about half. New LED lighting technologies that use only one-fifth as much energy as their predecessors are becoming ubiquitous. There are technologies for the grid, too, that deserve attention: It is now possible to divide the grid, historically prone to cascading failure at a massive scale, into connected "microgrids," which take advantage of scale, but can still motor along independently if there is a problem elsewhere in the system. Such was the case at Princeton University during Hurricane Sandy, in which the University's microgrid system was able to provide heat and power to part of the campus for nearly two days.

Another realm on the technology side could be fairly called "system optimization." Using a combination of advanced sensors, microelectronic controls, and big data, it is possible to significantly reduce energy demand in every single application. The Nest thermostat is an example of this: simply installing it in your house will, over time, reduce energy usage by 10 to 15 percent as it learns your behavior. Use them en masse, and Nest houses become a quiet thermal battery of sorts that can offset the variability of renewable energy sources, dispatching demand increments small enough to be invisible to households, but large enough in aggregate to complement the variability of, say, wind energy. There are similar compelling examples of the gains that can be made with system optimization in Walmart's truck fleet, jet engines from GE, bus and train schedules, and even the lowly hot water heater.

2. **Declining demand**. As the electricity system incorporates new technologies that promote productivity and efficiency, energy demand drops. This can reduce consumer costs and environmental damage, but it wreaks havoc on the traditional utility business model. Utilities are facing a long list of fixed costs to modernize the grid, but their revenues tend to vary with the volume of electricity sold. Rising fixed costs and declining revenues is a tough road for any business. This trend requires utilities to rethink their business model.

3. America is finally getting serious about **climate change**. The EPA has issued regulations, as required by the Supreme Court and authorized under the Clean Air Act, to reduce CO_2 emissions from the electric system. The EPA draft rules give every state clear CO_2 emissions reduction requirements, but they also offer a great deal of flexibility in *how* to achieve those reductions. If states use this flexibility intelligently, they can reduce emissions even as they cut energy bills and increase reliability. But the traditional model of regulating utilities will not get them there.

When you add these three factors together, and consider carefully the financial implications for utilities, it becomes clear that the old utility business model is in trouble. With demand declining and costs rising, in order to break even, utilities must charge more for every unit of electricity they sell. At the same time that electricity prices are increasing, self-generation, with solar PV, for example, is becoming more cost-effective. If utilities raise rates, more of their customers will leave them to pursue self-generation options, which requires utilities to raise rates even further. Add in the vast potential for energy efficiency, and you have what looks like a death spiral for the utility business.

So what can be done?

The solution to this quandary has two parts, both of which are obvious in concept but foreign in practice: (1) Put the utility in charge of system optimization, rather than simply the supply of electrons; and (2) reward the utility for performance rather than sales.

"System optimization" means that the utility should compare demand-side options (e.g. efficient appliance rebates) with those from the supply-side (new power plants). It means determining whether to build a power plant, or buy power from an independent producer, or whether to invest in local distributed generation or in transmission lines to import power. The utility should use all these options to assemble the suite that best meets customer energy *service* needs. At the end of the day, customers care about warmth, coolth, mobility, and so forth, not about kilowatt-hours. So if it is cheaper to replace an office building's old light bulbs than to build a new gas turbine, that's where the money should land. If it is cheaper to import wind from the Midwest than to run a coal plant, the utility should be rewarded for that choice. And so forth.

Rewarding *performance* instead of sales means that the utility should have clear goals, set by the public utilities commission, for reliability, affordability, and environmental performance. The utility should make a good profit when it meets or beats these goals, and it should be penalized when it fails. A mandate for system optimization, together with clear financial incentives to deliver public goods (affordability, reliability, and cleanliness), sets the utility up to become an engine for innovation, service delivery, and financial efficiency.

Electric utilities are physical monopolies: there is only one set of wires that run to each address in America. This means that they get their operating mandates—and incentives—from state public utilities commissions (PUCs). In the past, PUCs have obliged utilities to serve rural customers and offer lifeline rates to the poor. More recently, utilities have had to reduce air pollution, install renewable energy, and support energy efficiency. Today, they are under a mandate to reduce CO_2 emissions, under new rules set by the EPA.

Utility regulation in the U.S. varies greatly from state-to-state, from the vertically-integrated monopoly that dominated throughout most of the last century, to the largely deregulated bilateral market that is used today in Texas. In all these cases, however, the wires – along with a handful of other important utility functions, like maintaining system reliability – continue to be heavily regulated.

This gives PUCs the option to either hand out detailed regulations for utility operations, or set clear incentives for utilities to meet key goals. The latter strategy, known as performance-based regulation, can enable utilities to meet social goals while unleashing the inventiveness and dynamism of competition. In particular, the utility should be given clear, quantitative goals for (1) reliability, (2) affordability, and (3) environmental performance, set five to seven years out. Meet those goals and the utility gets a reasonable profit; beat them, and they make real money; miss them, and they face financial repercussions. Along the way they can be judged by how close they are to the proper trend line, and be rewarded or penalized accordingly.

A utility executive with this freedom and these motivations will, for example:

- Think about volatile natural gas prices, since those could kill the affordability goal (today, in most states, gas prices are passed on to consumers);
- Invest in new microgrid technologies that prevent cascading electric failure, so the next ice storm doesn't bring down power for the entire grid;
- Assiduously fight for lower prices of renewable energy through mechanisms like "reverse auctions," enabling the company to hit environmental and affordability goals at the same time;
- Work both sides of the meter, choosing customer energy efficiency or new power supplies to balance the system, depending on which is cheaper, more reliable, and cleaner;
- Really learn about customers and their needs, so the utility can invest in the most promising new technologies and services.

And so forth. The point is that the utility will get paid for making smart choices over the long-term and for making the system cleaner and more reliable. Utilities will thus make explicit trade-offs between reliability (more investment in the grid) and affordability (less investment in the grid), based on their goals, rather than in a line-by-line accounting debate with a regulator. They will bring in new technologies that can meet two or three of their goals at once, and will form partnerships with companies that can deliver energy services more efficiently than they can.

The demise of the old utility economic model is one reason for the switch, but alongside that is the need in America to take advantage of new technology, increase grid reliability, reduce carbon emissions and other pollutants, and use the great utility infrastructure as an engine to get this all done. Utilities are amazing assets to apply towards these goals. Consider what they have to offer:

- 100 percent market penetration
- Fantastic information on customer energy use, and the chance to accumulate that into big data patterns
- 100 percent billing efficacy
- 100 percent communications reach
- Trained blue-collar workers with trucks in every community in America
- Good credit ratings, with the ability to obtain and deploy large sums of capital very efficiently
- Public supervision and trust.

Utilities know how to plan, how to build things, and how to run what they build. They have deep safety cultures, and deep technical knowledge. There is no other entity in America with these attributes—in fact, none even comes close. If properly motivated, the utility can be a driver of economic growth and innovation; it can become the "principal delivery vehicle for decarbonization."[1]

HOW TO GET THERE

Capturing these benefits requires the PUCs to rethink their methods and restructure their regulations. In particular, they will need to enunciate public goals, and then carefully devise benchmarks to meet those goals. Consider reliability, for example: Systems can fail to deliver electricity because of bad system design or maintenance, extreme weather, cascading failure from neighboring or distant utilities, or a combination of all three. Failure can be measured in customer-hours of blackout per year—but the measurement of reliability needs to be more sophisticated because most of our systems can "ride-through" two or three hours of blackout, but encounter serious costs when they stretch into days. A freezer will defrost after 12 or so hours without electricity; a production line will need an extensive "cold-start" after a long hiatus.

[1] Private communication, Jim Williams, E3.

Finding a performance-based system that takes into account the different causes (utility error, natural cause but utility-avoidable, natural cause but utility-unavoidable) and different impacts (lots of customers for few hours, or few customers for many hours) of system failure is not trivial. But it need not be impossibly complex either. Using weather statistics, reliability data from the home utility and those of other states, and a little sensitivity testing, PUCs can find a fair incentive for utilities to increase reliability.

The PUCs need not toss out the current system in order to start performance-based regulation. It can test one factor at a time, as well as one utility at a time. For example, a utility can set a reliability incentive while leaving other issues untouched. Sixteen states have already made it profitable for utilities to invest in customer energy efficiency through a technique called "revenue decoupling." This technique could be expanded to many more states. And within a leader state, the scope of the program could be expanded so that utilities really have the latitude to build out the program whenever it lowers costs, increases reliability, and reduces pollution.

This will require a visionary PUC, supported by its Governor and capable public-interest interveners. Devising a system that creates strong incentives, while also avoiding over-the-top rewards or penalties, is not uncomplicated. Weighing the different factors of such a system is likewise tricky. But it is worth noting that PUCs *already do this* every day: just indirectly, rather than explicitly. Every standard and rule that a PUC issues is, in essence, an incentive program for a company: It's just that most of them are indirect, and they restrict competition and flexibility, thereby making them rather inefficient.

America's PUCs hold the keys to this new utility world. They control the DNA of the electric system. New technologies make it possible to slash both conventional and carbon pollution, increase reliability, and sharply reduce energy commodity price-shock. Those technologies will be deployed, or they won't; it all depends on the rule-making in our fifty-state PUC system. The cash flow is there: Americans spend some $360 billion per year on electricity. Where those funds land depends on PUC rules.

Avoiding gaming and traps

Every PUC incentive carries with it the threat of utilities gaming the system. When President Gerald Ford signed fuel efficiency laws into place back in 1975, he set a separate, lower standard for trucks, under the logic that farmers' needs could not be met with econo-boxes. This created an incentive for manufacturers to classify evermore cars as trucks—ergo the SUV boom.

So when PUCs modify their utility rules to create incentives for public values, they have to be alert to unintended consequences. The original design of the incentive is the most important step, and there are good examples of what to do—and what to avoid. But there are two additional actions PUCs can take to protect the public: Design them step-by-step, and put in place “collars,” or safety-valves. The step-by-step approach would have a PUC select one attribute, set a time-frame and performance standard, and watch what happens. Then the PUC can update the rule for the next run to take into account unexpected outcomes.

For example, let’s assume that a PUC wants to increase carbon–free electricity. It can ask a utility to build, or buy, 10 percent of its ten year goal, using efficiency or supply-side options. It can create an incentive for the utility to get a good deal on this purchase by allowing them to keep a fraction of the savings beyond a benchmark. It can also allow them to set a ten-year contract for the purchase, providing vendors enough certainty to build a business plan around it.

Then the PUC watches the action unfold. If the bids for services are cheaper than expected, and the utility has an exorbitantly high profit, well, that’s OK, because it is just for 10 percent of the *incremental* need, and the PUC can tighten the standards for the next round without upsetting the sanctity of the contracts in the first. Conversely, if the bids preclude a utility profit, the PUC can adjust the incentive. This sort of adaptive structure gives firms a healthy incentive without jeopardizing the public interest.

Safety valves and collars are simply boundaries beyond which the utility is protected from excess loss, and symmetrically prohibited from excess profit.

Conclusion

Our national economy, and, in many instances, our national character, has been significantly shaped by a few large infrastructure decisions. The network of canals that enabled commerce in the early years, the transcontinental railroad, the state land-grant universities, the great dams of the Northwest, the electrification of America, and the Interstate highway system all show how important these pattern-setting decisions are.

The next great prize is in rethinking the electric utility system. This transformation can ride on an amazing set of technology advances, and a symmetrical, worrisome set of climate imperatives. Unlike most big policy decisions in America, this one does not rely on a rational Congress: Instead this will be worked out in public utility commissions, state-by-state, across the country. And while those commissions vary in character, they are strongly motivated by reliability and affordability, and, for many, by reducing environmental harms as well. Their processes are open and their methods are quasi-judicial. In other words, they are accessible and functional decision-making bodies. They need our attention. The stakes could hardly be higher.