Underemphasized Challenges to the Electricity Sector Transition

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Introduction

In the United States and throughout the developed world, the electric utility sector is at the beginning of a fundamental transformation. Technological innovation promises dramatic changes in risks and rewards for the current utility structure – competitive, financial, cyber, and physical risks; rewards from lower costs of service and reliability, greater energy source diversity and ubiquity, and the first opportunities for meaningful energy storage and customer participation in price-setting. Dramatic changes will follow in customer attitudes about their own role in producing, managing, and saving energy – and about what constitutes acceptable performance by their utility. Yet the system remains constrained by statutes and regulations designed for the world of our great-grandparents. Ironically, after electricity revolutionized the modern world in the 20th century, the very inventions it made possible – computerization, telecommunication, miniaturization, automation, ubiquitous monitoring and controls – are about to return the favor in the 21st, revolutionizing how the grid itself works and how we all work with it.

The grid of the future beckons, with a vision of hundreds of millions of diverse, low-carbon power sources integrated seamlessly into a more reliable and secure network, but also capable of operating independently; a system where new competitive forces keep minimizing costs while offering new products and services at all levels. Demand for power from new electricity applications, including vehicles, will be offset by continually increasing efficiency of use. Electric and thermal storage will join time-sensitive pricing and demand-response management, flattening the peaks and valleys in demand, and reducing the need for costly fossil-fired peak-load generation while accommodating variable renewable generation. We will be able to meet our climate-change targets affordably, with reliability, security, privacy, and increased flexibility in services delivered to consumers who are newly conscious of the value received and the reasons not to take it for granted.

This is a future we should want. What is more, much of this transition is inevitable. It is well under way. No one can put the new technologies or incentives back into a bottle, or deny customers their new options, and no one should try.

But it must be managed well. No sector of our modern economy is more important to the economy and society as a whole than the electricity sector. Reliable, ubiquitous, affordable electricity is essential to our homes, businesses, communications, and increasingly our transportation. So while creative destruction from technological, economic, and cultural forces is inherent in our modern economy, even in regulated sectors, minimizing the destruction of current asset and business value is also very much in society's best interests. Guiding the electric sector through this transition will require a deft hand to avoid potential pitfalls. Inevitability does not confer infallibility.

This paper identifies **eight challenges** that must not be ignored by thought leaders, public advocates, utilities, and policymakers who are engaged in designing and managing the transformation to the electric utility of the future. In summary, as we work to modernize the electric sector, we should:

1. Make today's utilities part of the solution.
2. Ensure that consumers are well aware of the potential benefits.

3. Make sure the new technologies deliver as promised.
4. Strengthen the central grid as an essential platform for distributed resources.
5. Recognize the inertia of existing law and regulation.
6. Engage the missing stakeholder groups.
7. Incentivize utility performance that benefits consumers.
8. Steer clear of party politics.

Creative solutions are needed, but a broad discussion of preemptive actions would at least build confidence and momentum. Failure to do so might lead those afraid of such change, or who profit most from the status quo, to try to reverse the coming transition, freeze it in place, or outlaw it in the name of protecting the public interest.

There is direct precedent for this fear: the short-circuiting in 2000-2002 of the sector's restructuring to competitive retail power markets because of the implosion of the California market design. The California "Blue Book" restructuring plan resulted from a political consensus among key stakeholder groups that put great faith in an untested regional market and denied California's utilities short-term supply options they assumed the regional market would provide. The entire California Congressional delegation asked the Congressional Committee with jurisdiction, then considering parallel national legislation, to leave this plan alone to work its magic -- just two years before it collapsed, undermined by market manipulators and rocked by utility bankruptcies, consumer price shocks, and direct governmental takeovers. This so-called "California energy crisis" stopped cold the "restructuring process" in the other 49 states and in Congress, leaving a hodge-podge of state and regional market structures still in suspended animation more than a decade later. A similar failure to anticipate problems and contingencies could cause this new transition, which should otherwise play out over a couple of decades, to take much longer, causing unnecessary disruption, cost, and pain along the way.

A more broadly-based stakeholder dialogue now could help ensure that the imminent revolution in the electric sector causes the least collateral damage and minimizes delays and confusion on the way to a brighter, cleaner, more diverse, and even more thoroughly electrified society.

1. Make today's utilities part of the solution.

Some advocates see the large investor-owned utilities that dominate the grid as slow-moving cold-blooded dinosaurs whose extinction will clear the way for the small competitive mammals that will evolve into the new dominant species. And certainly a number of major utilities do not seem to realize how strongly they reinforce that stereotype in their actions and attitude. Some of them may not survive the coming transition. But it would be a major mistake to think that the system can be managed better or more quickly by eliminating or sidelining the electric utility companies altogether.

There is today no technically feasible replacement for the grid and no practical replacement for a utility of some description as the entity that erects, repairs, maintains, finances, and – logically – owns the wires and equipment that enable electricity to be transmitted and distributed. The revolution that displaced regulated utilities in the telecommunications sector was made possible by technological choice and competition – land-line wires *versus* coaxial cable *versus* wireless bandwidth *versus* fiber-optics. For electricity, there is only one mode of delivery: wires. Nor would it make sense to try to replicate the system with competing wires. The electric utility has long been recognized as a natural monopoly.

Since central ownership of a monopoly grid will not change, it also makes little sense to separate the key functions that will remain necessary, including maintenance, outage restoration, extension, upgrading associated technology, power flow measurement, balancing supply and demand in real time, metering, interconnection, and the direct consumer interface. Even the ancillary services that are required, while they can and should be supported to the extent feasible through competitive offers, will continue to be most efficiently operated and procured by the owner of the grid, including voltage regulation, frequency control, black-start capability, centralized resource dispatch, cyber-security protection of system operations, and maintenance of necessary contingency reserve margins.

It does make sense to separate utilities from the making of markets on their wires for energy, demand response, efficiency, transmission rights, and other contestable commodity offerings. The potential success of such markets is no longer in doubt, but it will be necessary to avoid conflicts of interest for utilities or their affiliates that are for-profit participants in those markets. Utilities could be permitted to supervise and manage such markets on their systems as long as they do not also participate in them. It similarly makes sense for utilities to continue owning and installing meters, monitors, and SCADA systems, albeit the smarter the better, to ensure even-handed opportunities and treatment for all customers. While the utility must therefore have access to the data collected, that data should be seen as the customer's for purposes of protection of confidential operations, economics, behind-the-meter applications, and collaboration with third-party service-providers.

All of these functions need to be supervised by regulators to protect the public from potential abuse and market power. Regulators will have to work harder and longer if they govern multiple entities rather than a single utility engaged in all of them.

Some have argued that there are good reasons to undertake at the retail level the bifurcation of facilities ownership and facilities operation that we have seen work well at the regional bulk-power interstate and wholesale level, using Independent System Operators and organized bulk power markets. However, to justify the extra costs needed for personnel and equipment, and the extra time required to coordinate the physical assets of the grid with operations, as well as the potential for miscommunication and resulting problems, significant efficiency or financial advantages ought to be clearly created by removing the utilities from the role of operating their own systems. Today those savings are hard to see.

It is a tougher call whether to encourage or even allow utilities to invest and earn returns in equipment and services on the "customer's side of the meter." On one hand, the potential capital requirements for bringing an entire customer population into the smart-grid era are huge, utilities are used to managing such sums, and they would promote uniformity in technology selection that should ensure that the benefits extend to the operation of the full system. On the other hand, customer-side innovation is the most fertile ground for new and innovative third parties trying out diverse services and technologies in the vicious proving ground of a competitive market, and therefore likely to achieve more and faster proven customer benefit than even the most open-eyed utility operating with regulatory approval and cost-recovery. The answer may depend on whether utilities must be permitted to invest in demand-side services and devices to maintain their system integrity or financial viability. Certainly it would be more feasible to allow third-party competitive entry to take over in the face of a utility's inability to seize the potential benefits of the new electric paradigm than to ask a utility to take over to reestablish order if a myriad of entrepreneurial demand-side options and offerings proved unmanageable for the system as a whole.

In addition to the physical assets, management experience, and established presence the utilities bring to the table, they offer a potential financial advantage that no substitute could duplicate in the near term. Their century-long stability, profitability, monopolists' invulnerability to competition, and the book value of their investments have combined to give them an enviable cost of capital, which benefits consumers as well as shareholders. There may be a competitive case to split ownership of a utility distribution system from its active operation, but there must also be an economic case that makes sense for consumers. Both cases should be developed before any such decision is undertaken.

Nor will utilities be dislodged easily from their turf. Other industries facing such major transitions have also experienced dramatic consolidation, as the more nimble and successful pioneers into the new world have used some of their earnings to acquire their slower, stodgier brethren. This was a major part of the transition story in the airline industry, the natural gas pipeline industry, the telecommunications industry, the computer industry, and others; there is no reason the electric utility industry will be an exception. Numerous major mergers have already occurred. Many others should be expected as successful companies seek to turn their winnings into growth in a regulated market where entry is already limited by law to incumbents or their successors. Thus the transition is likely to trend toward fewer, larger, but more readily adaptable – or more effectively defensive – companies. They will be harder to push aside by law or policy, not easier. They will be more potent in defending their turf and their services in legislatures, utility commissions, and courts.

None of this is to suggest that the utilities' business and roles should not change in significant ways in this transition. They are likely to be very different in structure and operation and business model. But transition planners should be looking for ways to help utilities thrive as they confront a new market environment where customers can choose other generators or become generators themselves, where demand for grid power is flat or declining, and where the difficulty of running a newly complex, competitive system has greatly increased. The challenges of maintaining voltage and frequency can only increase with a plethora of distributed, diverse and often intermittent resources, broad regional interconnections, increasing cyber threats, potential physical threats, and integration of storage and customer-side devices. Meeting these challenges will require new skills from new and retrained staff, sophisticated new equipment, and new capital investment. Today's utilities can and should evolve to continue providing these critical functions, and should be compensated for doing so commensurately with the costs they incur and the level of performance they demonstrate. To attempt this transition while shoving today's utilities aside, even if some of them still actively resist the transition, is hard to square with the broader public interest.

Working with utility companies to ease their progress into the future, rather than fight them over it, may make them less hostile to the progress the transition represents for the society as a whole. Today they are wary and tentative about such discussions, in part perhaps because of a reluctance to give up any of their monopoly powers and in part because they have not been offered a clear and attractive role in the future. There is a need for candid discussion between utilities and other stakeholders on new business models, services, levels of competitive entry, embrace of new technologies and public purposes, with an eye to launching at least pilot tests of such innovations. The dangers of jumping to a different electric sector paradigm without involvement and support of its current major players are that they will fight its adoption, ensuring a long delay at a minimum, or that it will simply not work well enough to offer the public the outcome it wants.

2. Educate consumers about the potential benefits.

The very nature of today's vertically-integrated hindsight-regulated system makes electricity customers passive and disengaged. Reliant on a monopoly supplier, and only aware of their own consumption weeks after the fact when a typically uninformative invoice arrives, most consumers not only don't know the cost of the power they consumed per unit, they could not identify the units, or much of anything beyond their electrical outlets or service line. (By contrast, drivers often know to the penny what they last paid for a gallon of gasoline.) This helpless and powerless position likely contributes to the surprise and anger electric consumers show at approved rate increases or higher bills than normal, even when clearly due to worse weather than normal or well-noted events.

Consumer advocates have typically focused not on consumer services, but on opposing anything that would increase rates (not necessarily total bills). Some have difficulty accepting the notion that a new paradigm featuring empowered and potentially self-sufficient consumers in a competitively driven market, informed to be more efficient and frugal, using supply options as well as automated digital devices to reduce demand, and facing actual costs that vary significantly on a daily and weekly basis, could constitute a better world than one where consumers resist rate increases and require the utility to maintain reliability anyway. In contrast, of course, telecommunication-service consumers motivated dramatic improvements and cost competition– once they did have options, information, and incentives – and this is an instance where the analogy holds. If the electric services of the future are attractive and economical enough, consumers will demand them.

Nonetheless, those who already see the value proposition in the electric sector transition would be foolish to assume that consumers do so as well. Typically they do not. Most are unaware of what is looming in terms of the options they may elect in their electricity service, including self-service. They may see solar panels on other peoples' roofs, or know someone with an electric-battery vehicle, but they are not being drawn to the electricity transition by the kinds of compelling consumer devices and capabilities that have drawn them to the high-tech world in telecom, computer aps, and home entertainment. For most, the small share of their income required to keep the power on is too low to warrant major investments of time or money to achieve further economies. They see outages as unavoidable. They have little tolerance for transaction costs and adding new technical tasks to their schedules. And many are indeed going to be very slow to change. The opposition to smart meters, based on the fear that they are cancer-causing, privacy-invading devices rather than critical and secure information hubs enabling a variety of savings and advantages, is evidence that utilities are not adept at creating customer awareness and support for innovation. To date the transition at the customers' end of the market has been all about provider push, not consumer pull. That is not a recipe for success in a consumption-driven economy.

Most utilities play the role of service provider without much finesse, and often without any conviction or enthusiasm. Too often they see their customers as captive ratepayers, like *babushkas* in a Soviet bread store. Customer service centers exist to receive complaints, not to provide beneficial offers or support. Many consumers, in turn, take electricity service for granted, believe that the government can fix its cost to them at any level, undervalue the benefits of electric service, resent outages, and are negative about both their utility and their regulators – even as they generally receive stable, reliable, reasonable electric service. This toxic relationship makes any change difficult. Any innovation that requires broad-based

adoption but does not offer sufficient savings to motivate the average consumer is likely to encounter resistance.

To deal with this dilemma, both the enterprises that have invested in the transition and the utilities who recognize its promise must engage in much stronger efforts to share their vision and the benefits of achieving it with consumers in convincing ways, or change will be much slower and harder than necessary. Indeed, the electric utility transition, viewed in hindsight from the future, will probably be notable for a profound change in utility-customer relationships and a new bidirectional dependence. Any electric utility that fails to develop more in-depth, personalized, economically sensitive, and technically savvy customer relationships is likely to be succeeded by a new entity that can manage such relationships – like the other 21st century customer-oriented businesses we deal with every day.

As with other modern, high-tech industries, there may well be generational differences in readiness to embrace the future. While longtime utility customers may simply expect continual service of their basic power needs, the Baby Boom and Gen X cohorts have clearly shown that they can react positively to new apps and devices, and Millennials seem to have confidence that whatever they can imagine can be created for them. Not everyone will see the electric sector of the future alike, and regulators may need to permit a variety of customer options, even at the risk of differentiating service on a willingness-to-pay basis.

Utilities and regulators must recognize that the transition will only be a positive experience for consumers if they know it is coming and like the changes it promises to bring, or it can readily be derailed. To date there has been far too little effort extended to create that positive public attitude. Instead, there is a danger of presenting electricity consumers with a consensus *fait accompli* agreed on by utilities, stakeholders, and regulators that may strike them as unneeded, unwanted, unjustified, and too expensive. Once such a negative reaction occurs, it is usually too late to avoid its political effect.

3. Ensure that the new technologies deliver as promised.

The foundational driver of the coming transition is the wave of new technologies that are already remaking the electric sector from generation to end use. This includes dramatically improving and cheapening renewable generation technologies like photovoltaics, wind turbines, and fuel cells; digital monitors, controls, and big-data analytics facilitating the coordinated management of billions of separate sources and uses of energy with quadrillions of bits of digital information; the introduction of intelligent devices that can autonomously optimize energy use with a consumer's wishes or with the market; dramatically more efficient lighting and motors; emerging capacity to store meaningful quantities of power economically; the affordable electrification of individual personal transportation; etc. This flood of innovation is doing what floods do – changing the landscape uncontrollably.

The danger here is that those trying to facilitate the transition will promise or plan on more than the technology can currently deliver, or lock in market or regulatory structures premised on technologies that cannot yet carry the assigned weight. The flip-side danger is that policymakers, regulators, or utilities will prematurely adopt policies that constrain the market and fail to tap the technical potential that is emerging. The transition needs to walk, carefully and iteratively, a fine line between deploying new technologies that promise meaningful new value without deploying unproven technologies that do not work as promised or committing scarce capital to those that are quickly obsolete in the face of further innovation. The recent deployment of millions of electric meters with remote-reading capability

but no bidirectional communication options for the customer, no ability to separately measure inflows versus outflows of energy, and no ability to distinguish different uses on the customer side of the meter – i.e., not truly smart meters – is an example.

Many of the most promising innovations are still in their beta versions. It will take time for these technologies to sort themselves out in the market and in the eyes of users. The ultimate decisions on winning technologies will not be up to regulators, policymakers, or transition advocates, and they should not presume to make them. Some will be adopted because of their "cool factor," but end-use consumer economics will be the most important factor, a tough standard in a sector where consumer costs are already minimized by law. Where new devices can meet economic thresholds and keep improving, as with photovoltaic arrays, or where new business models limit their risks, as with rooftop solar leasing, customers take notice and take advantage. But mandated investments that exceed the immediately perceived benefits will elicit protests and pushback against the transition itself, as has been seen with the smart-meter rollout.

Given the proliferation of distributed generation and smart demand-side applications, a grid monitoring, communication, and control system capable of accepting, analyzing, and acting on the countless messages these millions of devices will send, while keeping the overall grid stable and reliable, is a *sine qua non* of the modern utility. No one has yet demonstrated this capability to the extent necessary, and it should not be presumed to exist and operate well until it clearly does – otherwise, those installing distributed resources in large numbers across the system will be at risk, and so will the transition itself. One key here is to proceed with steps that open the doors to progress without limiting the offerings that can benefit – for example, interoperability standards that enable any grid-resident device to cooperate with the grid and speak the same language as other devices, leveling the competitive playing field to reward substantive merit, not connections or utility profit. Another step is to foster an ongoing integrated dialogue among stakeholders about the degree to which the new technology foundation for the electric utility of the future is ready to build upon, and to focus near-term efforts on completing that foundation. What is clear, however, is that the obstacle of assuring that the new technology is truly plug-and-play and cost-effective and the prior obstacle of encouraging consumer eagerness for a new electric system relationship are tightly related.

Some would argue that the ferment of thousands of entrepreneurs and high-tech inventors turning their attention to the power grid is the factor that will accelerate the new age for electric services and devices, and that, by its nature, such a ferment cannot be planned for or controlled. But the grid must also continue to function as an integrated, fully monitored and directed single machine that cannot tolerate an unlimited license to experiment with connected devices and actions without risking reliability. How the transition balances these factors will be crucial to its success.

4. Strengthen the central grid as an essential platform for distributed resources.

Small-scale distributed energy resources are clearly a major element of the transformation of the grid that is under way. Low-cost digital monitoring and controls, together with price signals delivered by smart meters, allow programmed devices to generate, consume, or avoid consuming energy when it makes the best economic sense or brings the best value back to the grid. With miniaturization and mass production, the costs of these devices and the power they generate have fallen sharply over the last several years, and appear likely to continue falling. More and more remote locations are able to install generation that is competitive with the offerings from the grid. And more consumers are willing to

invest in greater autonomy and self-sufficiency to avoid the costs and inconvenience of outages in a world where reliable electricity is essential not just for light, heat, and connections to the outside world, but often for livelihoods or personal health. Some simply want to be self-sufficient, not relying on a government-chosen monopoly for this critical aspect of modern life.

It would be a mistake, however, to see distributed energy as a replacement for the grid, rather than a potent supplement to it and hopefully a partner with it. The transformation should lead to a fully integrated combination of central and distributed systems. Consumer devices that place a particularly heavy draw on power, such as an electric clothes dryer, self-cleaning oven, or air-conditioning compressor will not start or function on distributed solar power from a single roof. Devices that implicate personal danger, like elevators or medical equipment, probably should not be connected solely to small or variable local power sources, rather than a network grid resource. Markets for energy and demand response operate through the interconnected grid; the more interconnected and widespread the grid, the more transparent and competitive the markets will be. Distributed resources smaller than major industrial-scale combined heat and power facilities or district-energy systems are unlikely to provide the high-voltage power required for major industrial applications, campuses of multiple significant buildings, hospital complexes, central city high-rises, or other larger power demands that combine heating and cooling loads. While microgrids are feasible, they are probably only advisable if they can supplement the grid on a normal operating basis, not simply sit idle as an expensive stand-by substitute until there is a system-wide outage.

The goal of moving the economy as a whole to clean energy, moreover, probably cannot be met without access to the abundant but remote resources of wind and solar energy located far from the major load centers. So new transmission must not only be built to move that renewable power to load, but it must be built in anticipation of new generating capacity, which requires only a fraction of the lead time that transmission projects require. As promising as distributed energy resources are, major population centers will need access to the best renewable resources, with their superior economics and higher aggregate capacity.

The central grid can be enhanced by distributed energy resources such as fuel cells, CHP, battery storage, smart building management systems, price-sensitive applications, and many others. It cannot be replaced by them, however, at least not in the next few decades. The technological innovation is still needed to coordinate a myriad of small and distributed devices seamlessly with the central distribution grid in a manner that allows its operator to keep it stable and reliable. It would be a major mistake to focus exclusively on developing distributed energy as a means of accelerating the electric sector's transition, at the expense of extending and modernizing the interconnected grid and broadening its regional strength and ability to host competitive markets and services. All of these are equally important to the transition, especially a transition to a clean-energy economy.

5. Recognize the constraints of existing law and regulation.

Advocates for the electric sector transformation focus first on technology innovations and infrastructure changes and on the economic and functional benefits that should follow. Then they turn to the business model and private-sector changes that the new physical and economic realities imply. But the slowest and toughest stage of the transition must take place in the intangible and tradition-bound world of law and policy. This regulatory structure is, generally, older than any of the people now running it or governed by it and cannot be assumed to change or disappear as the technology or business practices

do. Unless today's judges and regulators get new authority from legislators – or in some cases from state constitutional amendments – they must continue to operate under anachronistic legal and regulatory requirements and standards set in place many decades ago.

When the DC Circuit Court of Appeals threw out FERC's Order 745, eliminating demand response as a bulk-power market function under federal control, it did so in service to a statute written in 1935 that placed the retail market squarely in the hands of state regulators. The idea of regional interconnections and markets in which energy, and the willingness to forego energy use, would both be competitively offered and sold, is an idea that was generations beyond the horizons of the Depression-era framers of that law. But 80 years later, the Federal Power Act is still the law, and federal courts are still constrained to interpret it as it was understood by those who drafted it.

In many states, the definition of an electric utility, and how such an entity must submit to regulation in the public interest, is prescribed in the state constitution. Under that definition in numerous states a solar-panel company cannot own the rooftop photovoltaic panels it installs and sell the power to the people who live or work under those roofs without first submitting to regulation as a public utility, filing a rate case based on its investment costs and the opportunity to earn a fair return. To cross those hurdles, it would likely face opposition from the local utility asserting its franchised monopoly rights. The regulators in those states have little choice under their guiding statutes and constitution but to side with the utilities. And state courts can offer little relief: they are as bound to interpret those provisions by the drafters' original intent as are their federal judicial colleagues.

Similarly, electric service is provided by some 2800 municipal and cooperative entities, large and small, across the country. In many cases it may be true that their customers and communities would be better served within a larger integrated system. But munis and coops are proudly autonomous and self-governed. Whether at the level of a municipal electric utility serving a small rural community or a rural cooperative built to reach scattered farms but now serving the suburbs of a megalopolis, local incumbents will resist being absorbed or combined into a larger entity and losing their longtime autonomy. States also will fight any infringement on their authority, even if they may deprive a multi-state regional area and their own constituents of greater opportunities at lower cost.

It is often noted that if we had the power to reinvent the electric system from scratch, knowing what we know now about how to make, transmit, and use electricity, we would invent a system drastically different from the one we have inherited in law, policy, institutional structure, regulation, and market competition. That is true, but we don't have that power. For starters we are stuck with anachronistic institutions, laws and policy that are putting electric utilities increasingly out of synch with their new technological and economic realities. This structure will remain a huge drag on our ability to adopt and benefit from new advances until the powers that be decide to change these laws and policies, and until we know with confidence what the revised laws and policies should provide. The telecommunications industry was able to change because the new alternatives – wireless, cable, satellite, fiber – fell outside its pre-existing legal and regulatory structure. The electric industry does not have such external drivers.

Unfortunately, we cannot expect the policy makers to provide leadership. They will respond – at best – to strong and unified signals that policy must change coming from constituents and stakeholders, and even a constructive response is hard to be confident about in the face of today's gridlocked partisan politics. Permission to change will ultimately have to come from the voters – i.e., consumers – who will need to see the benefits of change, as noted above. Ideally, utility laws and policies would be reformed

to accommodate the potential of the transition to new technology, market and business models, and competitive options. Realistically, they are unlikely to change quickly, if at all, and it would be a mistake to assume that they can be ignored or avoided.

6. Engage the missing stakeholder groups.

Since every participant in the modern economy necessarily uses electricity, and most place high and increasing value on electric service, everyone is to some degree a stakeholder in how the transition for this critical industry proceeds. But not everyone is currently at the table or even attuned to how much the coming changes might affect their lives and fortunes. Ordinary consumers are perhaps the most important of these largely silent but key stakeholder interests, but there are also others who have a large stake in the outcome, and some who have the political sway to ease or block the transition. Some of these are described below.

Utility workers. Trade unions represent many of the highly skilled workers who build, maintain, operate, and repair the grid. The investor-owned electric utility industry may be among the most unionized major sectors in the economy, and these workers generally draw attractive compensation and benefits negotiated with the utilities and then passed through the regulatory compact to the public. The cost of employing competent and always available electrical workers is not frequently challenged by regulators or even by consumer advocates.

Perhaps because of the mutually satisfactory nature of these jobs to workers and utilities alike, the current occupants have aged in place to the point that the utility industry faces a massive age-out of key workers with skills and experience – just as they will be needed to adjust the system to accommodate major change. Some have focused attention on this "great shift change," but there has been little focus on how it will mesh with the great transition also going on. Utilities are staring into a future that will change their technological operations, their needed skill sets, their business models, and their customer relations over coming decades. That cannot happen without changing the nature or location of many of the jobs of their workers.

Utilities and their unions are unlikely to be fully aligned about what these changes should mean for workers, owners, and managers. Utilities under revenue and cost pressure may well look to their labor pools as a source of potential savings. The smaller, younger, and leaner companies that occupy much of the tech space and renewable energy sector tend to be non-union. Whatever this might mean for the public interest, it is certainly important for the electric workers to be involved in the dialogue about the transition. While it would be an extreme result if the transition were to engender strikes or other labor actions out of discontent with what it meant for their jobs or compensation, but highly likely that the transition will have impacts on both, and utility worker labor actions are common in other countries.

Wall Street. The financial community that analyzes the utilities as private businesses and then provides debt, equity, and other financial services to them is waking up to the importance of the sector's transition, but does not appear to have reached a consensus about what it means any more finely detailed than the utilities themselves. When investor-owned utilities and their trade association are themselves openly discussing potential "death spirals," that concern naturally begins to be reflected in the bond ratings and stock prices of the private companies whose "deaths" would devastate their investors. Some bond-rating downgrades have indeed begun to occur, but there is not a general recognition of the sector's emerging new risk-return profile. Utilities with very similar current operations

are beginning to explain to investors some very different strategies for surviving in the coming new electric sector paradigm. One must anticipate very different financial outcomes. Which ones are realistic? Which ones are profitable?

By and large, utility stocks are still seen as conservative long-term investments with stable if unspectacular returns. Utilities still benefit from relatively low costs of capital that imply relatively low levels of business risk, even as they make 30-year investments in generation, transmission, and distribution facilities that could be stranded if self-generation and efficiency continue to grow as current trends suggest. But any investor who reads outlooks such as NRG President David Crane's 2014 letter to his investors (http://www.nrg.com/about/what-we-are-about/ceo-letter/) and continues to invest in utilities that ignore opportunities to participate in the transition process probably deserves what is coming.

Not only investors will be at risk, however. Utilities themselves and all their stakeholders will be affected if the financial markets downgrade their stocks and bonds, reducing their ability to attract equity capital for the transition or float low-cost debt. This would have the effect of raising the cost of capital and would flow through to customers as higher rates, increasing the incentive to reduce demand and increase self-generation that was creating the risk in the first place. The financial community needs to be more deeply and actively involved now, if its requirements are to be met during a smooth transition. And the public policy analysts and activists who are attempting to provide guidance that regulators and legislators can use to navigate the transition smoothly, not to mention utilities themselves, are equally in need of knowing how changes in investment responsibilities, business practices, institutional organization, competition, and customer relationships will affect the perception held on Wall Street of these companies and their prospects.

Other key players who are not now at the table include:

- **Automobile companies** are developing battery-electric vehicle offerings that could create a major potential new load on the grid, a new means of regulating and providing back-up service to it, and a new means of supporting individual independence from it. They could potentially form deep and productive collaborations with utilities, or they could offer disruptive competing electricity market technologies.

- **Consumer advocates** should be working to identify costs and benefits the transition could and will bring to their constituents, and should work for the most appropriate new regulatory decisions to allocate those in a consumer-friendly and equitable manner. Driven by small budgets and staffs, however, most of those have all they can do to serve the traditional need to participate before the PUCs in regular rate cases and utility proposals. In some cases, their ingrained adversarial posture to utilities seems to leave them unduly skeptical about what benefits the transition might bring, and initially likely to seek to block the transition through the regulatory process, keeping the utilities in the same position as they are now. They are particularly sensitive to the needs of those consumers who are low-income and slow in adoption of new technologies, and fear they would be the last to benefit. Engagement focused on the transition process and new electric sector paradigm that could result could enlist them as allies for adopting good policy before the PUCs, allies with others who understand that consumers will

ultimately benefit enormously from a successful transition, and even with utilities themselves who have reached that stage of enlightenment.

- **High-tech equipment manufacturers** are developing and promoting new energy-saving and producing devices, but they seem generally content to leave the course and timing of the transition to the utilities, regulators, and customers with little or no input as to how and by when their products will change the grid's operations, economics, regulatory structures, and competitive possibilities. As the makers of the wave of new devices that is breaking over the current grid, they are in a better position than anyone else to help anticipate the kinds of changes that could and should result. That a number of them are participating through AEE in the New York REV process is an encouraging sign of increased engagement.

- **Industrial and other high-voltage and high-volume electricity customers** have in many cases already made significant investments in self-generation, efficiency, and system automation to take advantage of time-sensitive rates and demand-response options. These companies traditionally have had no interest in supporting through their rates the progress of other smaller commercial and residential customers toward the same ends. They are comfortable dealing with large utilities as equals, and have the negotiating leverage to get favorable treatment. They are not calling for this transition to occur and may find reasons to actively resist it in the policy and regulatory forums, where they also tend to have significant leverage.

- **Municipal and cooperative utilities** have their customers as their owners, avoiding one source of conflict, but they still will have to surf the waves of technology and develop different relationships with those customers. To date, the focus of "death spiral" concerns has been on investor-owned utilities with profit and dividend expectations to meet for their shareholders, but there is nothing about losing customers to self-generation and raising rates for remaining customers that couldn't also apply to munis and coops. They are not generally subject to state regulators, but have support from mayors, state legislators and members of Congress, since they share boundaries and often the attributes of governmental decision-making. They tend to oppose regionalization and federalization of the grid for fear of losing their self-governance and local customer focus, but much of the value in the transition will come from the technological and economic potential derived from a more integrated grid supporting transparent wholesale and retail competitive markets for power and related services. They will not hesitate to use their legislative influence to protect their turf and their autonomy if they are not convinced that the transition is working for them, and through them for their constituents. At this point, they are far from convinced, even as they explore the new technology options that make the transition possible.

- **Telecommunication companies** will be expected to provide the means for the utility sector to send and receive trillions of data points every day, even when the electric utilities' own grids are down. The new electricity industry will be as dependent on the new telecom services as the new telecom services are on their electricity supply. But the telecom companies appear much more cognizant of their mutual dependence than do the electric utilities. Policymakers, concept developers, and reformers at work on reconstituting the utility sector appear to be paying little

attention to the industry's dramatically increasing need for data communication services. The Utility Telecom Council focuses on the shared interests of the electric and telecommunications sectors, and has focused its outreach on the utilities themselves. A stronger sharing of facts, insights on telecommunication investment needs, costs and necessary policy and institutional arrangements would enable the activists working on utility transition issues to take this critical facet into great account. The electric sector could complete every other aspect of a successful transition yet find that it was all for naught if the telecommunication capacity, protocols, economics, and priorities did not support the new electric system with its lifeblood of data and instant notice over a network of billions of points. Only by having the telecom companies and policymakers at the table throughout the design process for the new electric industry can there be any assurance that this critical aspect will be managed appropriately from a technical, economic, and policy perspective.

7. Incentivize performance that benefits consumers.

The transition should bring significant economic savings to electricity customers because of the efficiencies it will make possible, but no one can currently anticipate with any confidence what the breakdown of costs and benefits will be, and whether those providing the benefits will achieve sufficient revenue flow to keep them whole and create the necessary incentives to continue.

To the extent the transition involves competitive market economics – as it must in the case of distributed generation displacing utility service, demand response, wholesale and potentially retail energy generation and sales, efficiency improvements, time-of-use rates, use of storage, and other expected changes – the transition will move the utility sector away from regulatory economics, where agreed rates are held stable over an agreed period and are calculated to ensure cost coverage and the right mix of rewards and obligations to the key parties. In instances where competitive offerings supplant regulated services at regulated rates, utilities – if they are permitted to participate at all -- will recover their capital investment only if the market price they can charge exceeds the variable cost of the service they are offering. All competing services will obtain the same price in the market, the marginal cost experienced by the marginal provider. There will be no guarantee of capital cost recovery. The transition could make the electric system's health and operations more dependent on the broader economy's pace, and more vulnerable to its volatility.

Where utilities continue to offer monopoly services, many are suggesting that those services should be rewarded based on performance criteria set by regulators, with better performance winning better compensation. The movement to performance-based rates appears at present to be a consensus-driven transition within the larger sectoral transition, with numerous ongoing experiments like the UK's RIIO formula and many thoughtful proposals for how this should be handled.

But this ratemaking transition raises numerous questions that must be addressed. These include:

- What elements of utility performance will regulators or policymakers establish as the basis for financial compensation?
- What yardstick and standard units of measure will be used for each of those elements?
- How will the judges of performance be selected and instructed?
- How will they inform their judgments of performance with actual data and customer input?

- What monetary value should be assigned to those units and separate elements of service?
- Will the utility or the customers have any basis for appeal if the result appears too low or too high?

Performance-based ratemaking could all too easily become the energy-sector equivalent of judging figure skating in the Winter Olympics, nominally objective but exposed to so much obvious subjectivity, personal prejudice, and tunnel vision on particular factors that participants and onlookers often see the results as effectively rigged. If many customers judge their own experience with the utility's performance as poor and react badly and publicly to a performance-driven rate increase, it could drive the whole process into the political arena.

It further seems inevitable that total utility revenues will decline if utility functions are turned over to a competitive market without new utility services being added. This would put economic pressure on utilities, send negative signals to the financial community (with implications for the cost of capital), and might incline regulators to be overly generous in setting performance-based compensation for other areas of utility service. Overall consumer costs might then go up rather than down, despite the new benefits of competition in some aspects of electric service. This too could lead to the political arena.

Nothing will so surely torpedo the transition as an inability by utilities to cover the costs of their critical services, or a need to raise rates so high to repay legacy investments that they drive customers off the system. There is a non-trivial chance that the transition will leave utilities with obligations and assets whose costs cannot be recovered at the rates the market will tolerate.

8. Steer clear of party politics.

Until now the issues associated with the electric utility transition have generally not caused partisan division. They are generally handled at the state level, often with single-party government of one flavor or the other, or are seen as technical issues that do not lend themselves to be appropriately settled by an up-or-down vote in a legislative body.

Pricing of utility services, either by competition or as a function of performance, at least implicitly suggests that those willing to pay more for better service should be able to do so and obtain it. Electricity service, traditionally regulated on a uniform one-service-fits-all basis, could become more differentiated among customers who elect different basket of services and are willing and able to pay their differing prices. And utilities might well take full advantage of new powers to propose differential service to different customers for greater revenue, discriminating among customer classes of service the way airlines do. The question is whether this would cross the line drawn by the standard regulatory requirement of rates that are regulated to be "just and reasonable," and "not unduly discriminatory."

Such discrimination could be seen through a rich vs. poor lens, polarizing the body politic along partisan lines. Upgrades to accommodate electric vehicles, for example, could be seen as elitist; requiring fully equal service, power quality, and reliability for all could be seen as an entitlement program for the poor. If the electric sector transition were ever viewed by the public as being for the benefit of the rich or the poor, or for the benefit of the Republicans or the Democrats, and thrown into the legislative process, it could be frozen there for a long period of time.

Yet differentiation of costs is natural and inevitable if customers are allowed options in equipment, level of service, and quality of service, as occurs without complaint in the market-driven segments of the

economy. It is just not the norm or the working principle of the electric utility's universal service offering to date, and is bound to rouse jealousies and complaints when it is introduced. Those hoping to guide the electric sector to new customer relationships and business models must pay close attention to how appropriate price-driven service differentiation is presented, defended, and conducted, while ensuring that universal rights to equivalent and effective electric service are not seen as being lost.

Those hoping for a smooth and quick transition to a new electric sector paradigm should be alert to other issues that opponents may use to politicize the process and slow it down – such as:

- Who bears the burden of meeting environmental standards now assigned to utilities?
- What environmental standards should be required of distributed private energy producers?
- Do distributed energy producers have air rights to the wind or direct-sun rights that must be respected by others?
- Who is the energy provider of last resort for consumers who fail to procure or pay for service, but who are at risk of injury or damage if their power is cut off?
- Can the right of eminent domain be used to enable the taking of private property for newly competitive or privately targeted utility services?

Conclusions

Eight areas of potential problems for a smooth and progressive transition in the electricity industry have been identified and discussed above. There are certainly others, such as the need to recognize that electric, natural gas, water, and telecommunication utilities have many attributes that are similar in relating to their customer base, their requirements of rights of way, natural monopoly economics, and geographic commitment – the likelihood of common regulatory regimes, policy outlooks, and increased interrelationships among such utilities is probably high. The reason for calling attention to these challenges is that the process is still in early enough stages that a conscious effort to address potholes in the road ahead may prevent damage to the vehicle we are all riding in. To achieve a smooth and rapid transition to the electric utility model and system of the future requires attention to be paid to the following tasks:

- Engaging with utilities in looking for win-win outcomes.
- Educating and involving customers in the benefits to be gained.
- Anticipating conservatively when and how new technologies can bring their benefit to the grid.
- Understanding the separate and complementary roles of distributed resources and central resources on the grid.
- Recognizing that structural legal changes must accompany technical and economic progress.
- Bringing critical stakeholder interests into the process earlier rather than later.
- Recognizing the pros and cons of alternatives to traditional cost-of-service rate setting.
- Avoiding the polarization of transition issues along party lines.

Addressing these challenges is a prerequisite to success for those who seek a productive, progressive transition to a reinvented electric industry for the 21st century.