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The Electrical Divide: New Energy Technologies and Avoiding an Electric Service Gap

By Richard W. Caperton and Mari Hernandez July 15, 2013

In the United States we have universal access to electricity. It is not only available to Americans who live in densely populated areas, wealthy Americans, or Americans with the technical ingenuity to generate electricity. It is available to 100 percent of Americans and accessible to any who wish to tap into it.[1]

This universal access to electricity arose from a very intentional set of policies put in place throughout the 20th century, mostly requiring utilities to provide service to everyone in their service territory and then using government support for the development of new electricity infrastructure to ensure that every home could be part of that utility's service territory. This was a moral and legal contract that electric companies entered into with the American people, and it generated a great amount of business for them as it fueled the rapid growth of our nation's middle class.

The same conditions exist in traditional telephones. Every American has access to a landline, whether or not they use it. But with significant technological changes in telephones and information technology—such as the rapid growth of wireless and data services—our commitment to providing universal access to high-quality communications services such as broadband Internet or cell-phone service to every American is running into challenges, resulting in what is known as the "digital divide." The emergence of an information economy and the rapid transition in both physical infrastructure and corporate business models were powerful engines of growth and prosperity for our nation, and they were a welcome boost to the U.S. economy. But it was also disruptive, and while the situation is improving, the polarizing divide has not been entirely averted.

The electricity industry is now entering a similar period of rapid change as that faced by the telecom industry a decade ago. New technologies from smart grids and solar panels to superefficient homes and electricity storage are all coming on-line rapidly at the same time that our legacy infrastructure faces the unanswered challenges of an aging fleet of power plants and transmission lines. This is coupled with destabilizing pollution threats and the disruptive force of rapidly changing fuel costs due to the collapse of natural gas prices.

If these deeply transformative changes in the U.S. power sector are not managed properly, 21st century America could see an emerging electrical divide not unlike the digital divide of the late 20th century. Again, these changes and innovations are to be welcomed for what they can bring in terms of economic opportunity, technological leadership, and the stewardship of our environmental resources. But they must be managed with an eye toward inclusion and aim to bridge any potential electrical divide that emerges.

In this issue brief we explain how this electrical divide could come to pass and how it can still be avoided, drawing on lessons learned from America's earliest history with electrification, as well as from the recent growth of the telecom industry and the emergent challenges of the digital divide.

Electrification in the United States

> *Electricity is no longer a luxury. It is a definite necessity. It lights our homes, our places of work and our streets. It turns the wheels of most of our transportation and our factories. In our homes it serves not only for light, but it can become the willing servant of the family in countless ways. It can relieve the drudgery of the housewife and lift the great burden off the shoulders of the hardworking farmer. — President Franklin D. Roosevelt, September 21, 1932*[2]

It is hard to imagine life in the United States without electricity. It is so ingrained in our everyday lives that it is easy to forget that it was not always available to all Americans. But universal access to electricity actually took half a century to materialize.

In the 1880s many small-scale electric companies began to emerge as they saw an opportunity to offer a safer alternative to gas lighting.[3] Initially focused on providing streetlights and commercial illumination, these companies expanded their service to include industrial customers in the 1890s and eventually added residential customers after the turn of the century.[4] But the transition to residential customers was slow and inequitable, especially for low-income and rural Americans.

Residential electricity service was limited to the wealthy at first, as privately owned utilities could make more of a profit off of customers who could afford to purchase electric appliances that boosted a household's electricity use.[5] Utilities eventually began to offer service to most urban residents, not just the wealthy. But rural households were literally left in the dark because utilities were not economically motivated to provide electricity service to houses that were far away from their central power stations.[6] Distribution lines were expensive and a particularly unattractive investment since many utilities thought farmers would not be able to afford electric service.[7]

By 1932 more than 80 percent of urban households had access to electricity, while just 11 percent of farms were hooked up to the grid.[8] Recognizing the need to provide electricity to rural areas of the country, President Franklin Roosevelt issued Executive Order 7037 on May 11, 1935, and then signed the Rural Electrification Act into law in 1936.[9] These actions established the Rural Electrification Administration, which provided low-interest loans and assistance to rural electricity cooperative utilities to help finance the construction of distribution facilities—and in later years generation facilities—that would provide electricity to farms. The government also created the Tennessee Valley Authority and other electric-power providers to generate electricity that would serve rural America.[10] The government also authorized and provided funding for the construction of the Hoover Dam to electrify the Southwest.[11] This combined effort was successful: Rural access to electricity went from 11.6 percent in 1935 to nearly 50 percent in 1945.[12] By 1953 more than 90 percent of farms had the ability to connect to the grid.[13]

Every American now has access to affordable, reliable, and safe electricity. This is an impressive accomplishment that required government action to make it happen.

Universal electricity access

Universal access to electricity arose out of a policy commitment, not from free-market business practices. The fact is that a free market dominated by rational profit-maximizing businesses would result in some people not being served. Absent a policy directive to provide universal service, profit-maximizing utilities would only provide service to customers in cases where the revenue from that customer was greater than the additional cost of serving that customer. In economic terms, the utility would serve to a point where marginal revenue equaled marginal cost.

The problem is that some customers may not be profitable to serve, as was the case in the early days of American electrification. Customers in remote areas, who require long copper wires in order to be reached, or low-income customers, who use very little electricity—not having air conditioning or a television can lead to very little usage—would be particularly susceptible to not getting high-quality, reliable, and affordable service.

The solution is to have some amount of cross-subsidization among customers; that is, some customers may pay more for electricity than it costs to serve them, while others may pay less. This is not necessarily economically efficient, but the beneficial outcomes of universal access to electricity more than outweigh the costs. This cross-subsidization is supplemented with government spending through programs such as the Low-Income Home Energy Assistance Program, which helps vulnerable families pay their energy bills.[14]

The benefits of universal access are tremendous, but we sometimes take them for granted in the United States. Countries that have universal access to electricity benefit from social and economic opportunities that are critical to the modern economy. Electricity access offers efficient lighting and cooking options, as well as gateways to income-generating activities, communication tools, educational resources, modern health care services, and increased productivity and competitiveness. Universal access to electricity also ensures a broad customer base for the manufacturers of modern products—from manufactured appliances to modern computing and communications tools—and it has powered the growth of the American middle class. Universal energy access is so fundamental that the United Nations has launched a major global initiative that calls for universal access to modern energy services by 2030.[15] This effort will attempt to address the 1.3 billion people who lack access to electricity worldwide, including nearly 300 million people in India alone.[16]

As the U.S. electricity system evolves in response to technological change, an aging infrastructure, and mounting pressure to reduce the pollution that is causing climate change, it is more important than ever to renew the commitment to this great and uniquely American value and ensure that safe, reliable, and affordable electricity continues to be available to all citizens.

The utility death spiral

There are dramatic changes currently afoot on the electric grid, driven by both innovative business models based on new technologies and the imperative to decarbonize electricity generation. With the costs of rooftop solar declining rapidly—solar photovoltaic panel prices have dropped 80 percent since 2008[17]—and with grid-scale energy-storage systems on the verge of greater commercialization,[18] it is conceivable to imagine a future in which people are no longer connected to a utility's wires or are generating their own power and connecting only to the grid as a convenient backup service or insurance policy. When those people leave the core service area of a utility company, however, the fixed costs of maintaining the grid as a shared infrastructure do not decline because almost all of the grid is still needed to serve other customers.

As an example, imagine that your neighbor disconnected from the grid. If you are still connected to the grid, then the number of wires coming into your neighborhood will not change; the substation located on the edge of your neighborhood will not change; the wires running down your street will not change; and the transformers hanging on the poles will not change. What will change, though, is the number of customers paying for all that infrastructure. Since the grid must be maintained despite the loss of one paying customer, your electric rates will go up slightly.

If this pattern of people leaving the grid becomes a trend, then the loss of this first person could signal the beginning of a so-called utility death spiral. Your power rates will go up slightly, and all of a sudden it makes sense for you or your neighbor to install solar panels, invest in energy efficiency, hook up some batteries, and maybe even fully disconnect from the grid as well. Everyone else's power rates go up a little more, and more people leave the grid. This can happen slowly at first, but the effect gets more and more serious as more people disconnect.

If unaddressed, such a feedback loop can ultimately result in a highly inequitable circumstance where only those ratepayers unable to afford leaving the system must shoulder the burden of sustaining the public infrastructure that provides insurance to the rest of the economy. This type of death spiral is a serious and mounting threat to the principle of universal access, and it has already been seen within the telecom industry, which we detail below. This experience in information and communications technology should be seen as a cautionary tale from which the utility sector can learn.

The telecom industry death spiral

Since 1934 telephone-service providers have been required by the Federal Communications Commission to offer wired telephone service to all U.S. households. Over the past 15 years, these providers have had to adapt to changing technology, as more and more customers have either added wireless service to their landline service or have switched over to wireless entirely. According to the Center for Disease Control and Prevention, 35.8 percent of U.S. households were wireless-only subscribers in 2012—a 77 percent increase since 2008.[19] During the same period, the percentage of landline-only customers dropped nearly by half, going from 17.4 percent to 9.4 percent.[20] Currently, 52.5 percent of U.S. households have both wireless and landline service.[21]

The rising number of customers who opt out of landline service leaves a smaller and smaller share of customers left to pay for a system with a massive amount of infrastructure that must be maintained, as well as expanded to every new home whether it will be used or not. This leads to higher service costs for remaining landline users, which in turn leads more customers to choose to cancel or go without landline service to avoid the increasing prices. In California, for example, some customers have seen landline rate hikes of up to 50 percent over the past two years alone, causing those customers to consider a move to wireless-only service.[22]

The utility death spiral is not necessarily a bad thing. Even though traditional landline telephone-service providers have suffered, most Americans now have dramatically better communications services. The same will be true in energy because people will only switch away from current providers if the alternatives are better. The problem arises

because the principle of universal service is deeply embedded in the companies that are harmed by the utility death spiral, and universal access is not a core value for the new service providers.

The digital divide

The move to other telecom services has not only led to a decline in landline-service users, it has also opened up the digital divide, which is the gap between those individuals who have and those who do not have access to certain services.

Telecom services such as broadband Internet and cell-phone service have recently become almost as essential to everyday life as access to electricity. And, as with electricity, it is important that these services are available to every American. Access to some of these telecom services, however, is not universal.

Some rural areas are still experiencing limited access to the new technologies and services being offered by telecom companies such as broadband and cell-phone service. There are, in fact, rural parts of the country that still rely on dial-up Internet service and are stuck with unreliable cell-phone service.[23] An estimated 19 million Americans live in areas deemed too expensive to serve by high-speed Internet companies, much like the farmers in the early days of electrification.[24] Overall, nearly a third of the country—about 100 million Americans—lack high-speed or broadband Internet access.[25]

Internet accessibility, however, is not just a function of where you live. Income level is a major factor in determining Internet accessibility as well. A 2012 Pew Research Center report found that adults living in households earning less than $30,000 per year are 35 percent less likely to have Internet access than those in households earning $75,000 or more.[26] Pew also found that a third of dial-up Internet users cited price as a barrier to broadband service, while 17 percent said that broadband was not available where they live.[27]

Additionally, a 2010 study of the early deployment of broadband telecommunications technologies showed that minorities were left behind.[28] This is a huge drain on those economies and forecloses those citizens' access to the advantages and opportunities of engaging with an increasingly wired world.

The electrical divide

This digital divide offers a learning opportunity for utilities and policymakers as they look to the future of electricity. If everyone has the same ability to embrace new technologies and leave the grid, then there likely would not be any reason for concern. But, as

the experience in telecom shows, not everyone will have the same access to high-quality alternatives such as rooftop solar power and energy storage systems either because of a lack of service available or a cost issue.

The advantages of these distributed energy technologies are further amplified when they are networked through access to a robust electricity grid. Even in an energy environment that is increasingly dominated by smart and distributed power generation close to the point of use, the public infrastructure of our electricity grid will be essential to deriving the maximum economic potential from these emerging technologies.[29]

There are a few reasons that many people will not be able to switch away from the grid, no matter how cost-effective it may be. For renters, making expensive investments in solar panels, energy efficiency, and batteries simply would not be an option, and the property owner would be unlikely to make the investments if they are not paying the electricity bills. Some people may live in a house that is geographically ill-suited for renewable energy—if the roof is always covered by shade and nearby buildings block the wind that could turn a micro turbine, for example. People with low credit scores may not be able to get financing to install new technologies and may not have the cash on hand to make the upfront investments.

The combined result of all these factors will be that some people are stuck paying increasingly higher electric rates, while other people—homeowners with good credit scores who live in ideal locations, among many other factors—are able to switch to cheaper alternatives. The people remaining on the grid will still have electrical service, but the service will be increasingly expensive. And as the cost to maintain the grid—which is likely to increase, not decrease, as the grid ages—gets spread among fewer and fewer people, the level of maintenance will almost certainly decline, leading to lower reliability for those customers. In short, we could have an outcome in electricity much the same as in telecom, where an electrical divide arises between those with and without the ability to access new electric services.

To be clear, this scenario is not going to happen next year and is unlikely to happen in the next decade. But given the pace of change in energy technologies happening today, we need to consider the possibility that this could take place much faster than we expect. The possibility of an electrical divide is no reason to stall the deployment of clean, efficient, and distributed energy generation. This would be as absurd as trying to avoid the digital divide by standing in the way of mobile telephones or advanced data and Internet services. Quite the opposite is in fact true: Climate change requires America to rapidly shift to smart and efficient technology powered by clean renewable energy.

Further, it makes no sense to attempt to stand in the way of people disconnecting from the grid or bringing smarter tools to the marketplace when there are better ways to meet customer's energy needs and power the nation's economy. Being aware of the potential

downside that could accompany this exciting technology disruption requires a clear-eyed analysis backed by the strong intention to widen access to the opportunity that can come with clean, smart, and distributed energy.

The possibility of an electrical divide does mean that we need to make a serious commitment to universal access to high-quality electricity service. As we have seen with the original electrification of America, simply espousing universal access as a goal is insufficient: We need the policies to make universal access a reality as we quicken the emergence of a new distributed and highly efficient networked energy web. The market will fail to provide universal access if left to its own devices.

The changing electricity sector

Current and emerging technologies will change the power sector and need to be taken into consideration in future planning in order to preserve universal access and avoid the pitfalls of the telecom industry. Utility companies are aware that higher penetrations of distributed generation will require some new business-model thinking, but they are also counting on a future of innovative technologies that will continue to be grid dependent. The reality is that the possibility for some to disconnect from the grid may not be too far off.

NRG Energy Inc., through its subsidiary NRG Residential Solar, is currently testing residential solar photovoltaic, or PV, systems with battery storage.[30] These systems would function as either off-grid or grid-tied structures and would allow customers to store any excess solar-energy generation in the batteries. President and CEO of NRG Energy David Crane also mentioned an even more groundbreaking distributed energy system that will be offered in the future during the MIT Energy Conference in March: an NRG system that would combine both solar PV and natural gas-fired generation, allowing homeowners to completely disconnect from the grid.[31] Aside from solar panels, this new system would include natural-gas-powered fuel cells and microturbines that would produce electricity whenever the solar panels did not.[32]

New energy systems such as the ones being proposed by NRG will further disrupt the utility business model since utilities will not be able to recover any fixed costs from homeowners who opt to power their homes using an off-grid energy system. It is too early to speculate about the amount of the market share that future grid-independent energy systems will enjoy, but it is certainly not too early to start planning for an electricity future that will include more distributed generation, as well as the option for some customers to disconnect from the grid intermittently as the economics of doing so make sense.

In the next section, we recommend several policies to address the changing electricity sector and how to avoid the electrical divide.

Solving the electrical divide

This issue brief is intended to raise awareness of a potential challenge in the future and is a call for policymakers, utilities, and consumers to start thinking about ways to address the problem. We unfortunately do not yet know the perfect policy response. In fact, the ideas we present below make it clear that it is doubtful that a perfect policy response actually exists. For one thing, many of the policy options we identify have obvious downsides, which would have to be weighed against the benefits. Another issue is that electric utility structures vary across the country, so solutions that work in some places may be impossible in others.

With that disclaimer, there are a few policy tools that could help provide universal access to high-quality, clean electricity in a world powered by exciting new technologies.

Repurposing existing electric service programs

One option is to redirect existing energy-spending programs toward solving the electrical divide. The federally funded Low Income Home Energy Assistance Program, or LIHEAP, for example, could be expanded to include renewable-energy funding for low-income households. In its current form, LIHEAP provides home energy-bill assistance to low-income households.[33] If expanded at the state or federal level to include funding for renewable energy access, LIHEAP could help address unequal access to distributed-generation resources and provide an "electric safety net" for those who may not be able to afford the higher electricity rates that will result from costs concentrated among fewer customers. The Weatherization Assistance Program could be used in much the same way.[34]

In 2010 California demonstrated that this type of solar program is a viable option by setting aside $14.7 million from its LIHEAP to fund the Solar For All California pilot program. In total, the program helped install solar systems for 1,482 low-income households, including both single- and multifamily residences.[35] In order to be successful, the program used a competitive bid process and worked with energy providers to offer a free system to low-income residents, increase home energy efficiency, and create jobs for low-income workers.[36] In addition, more than $3.5 million was leveraged through local and other private partners, which allowed more households to participate in the program.[37]

The Rural Utilities Service, or RUS, is another federal program that provides financing for electric systems across rural America. RUS is in the process of approving a new program that would provide loans to households that want to install distributed generation and energy-efficiency tools. This program could be expanded, and portions of it could specifically be targeted to address any future electrical divide.[38]

Various state programs exist to fund electric service, and these could all be transformed to specifically address the electrical divide. Many states, for instance, collect funds from a "public benefits charge" to pay for special electricity programs such as low-income assistance or innovative technologies.

The biggest challenge for this approach is that there are existing stakeholders for each of these programs who could suffer if their funding were repurposed. The programs are presumably already paying for good things, and using the money for other purposes would mean these good things would no longer be funded. This may be a worthwhile trade-off, but it is a trade-off nonetheless.

Regulatory changes to the electric industry

The companies providing the tools that let people disconnect from the grid could be required by law to provide solutions to everybody in an area, not just those who can afford it. In effect, this would treat these new companies the same as the utilities that previously served the same customers. Similar to how today's utilities are given the right to operate a profitable business in exchange for providing equal service to everyone in an area, tomorrow's energy companies could be given beneficial treatment while offering equal service to all customers.

This is a very straightforward solution, but it has drawbacks. For one, the new energy companies will own their power-generation assets, but 19 states have declared that utilities are not allowed to own generation facilities as a result of electric-industry restructuring in the 1990s. More problematic, however, is the fact that the new companies would have to be offered some sort of enticement to agree to this solution. It would also look very different in regulated electricity markets and in those markets that allow retail competition. With today's utilities, that offered enticement was the ability to operate as a monopoly with a guaranteed rate of return. It is hard to imagine policymakers offering that same deal to new energy companies today.

A twist on this policy solution would be to mandate that existing utilities offer the technologies that would allow customers to disconnect from the grid. Duke Energy, for example, is exploring this path.[39]

Give companies incentives to address the electrical divide

While the idea of repurposing existing programs is primarily focused on giving solutions to consumers, there may be a blunter tool: giving money to companies to solve the problem. A distributed generation company, for example, could earn a tax credit by putting solar panels on a low-income household. Existing tax incentives for renewable energy have been a tremendous success, proving that these companies are responsive to these tools.

This solution, of course, involves new government spending. This means that policymakers would likely need to find a new source of revenue. The first source policymakers could consider would likely be some sort of fee on electric bills, but this fee would have its own death spiral: As more people leave the grid and avoid paying the fee, the remaining people on the grid would have to pay a larger and larger fee to end up with the same amount of money. Finding a stable, sufficient revenue stream is critical.

Create a federally owned provider of new energy resources

When the government wanted to electrify rural America, they could not find a private company that would provide the power. So instead of waiting for a business to see the light, it simply created a new company, the Tennessee Valley Authority, or TVA. TVA has been an overwhelming success story at providing affordable, reliable power to rural America.

The government could do the same thing with new energy technologies. If there are places for which or people for whom a for-profit company would not provide distributed generation, energy storage, energy efficiency, and smart appliances, the government could step in as the provider. There are certainly people who would argue that this is not an appropriate role for government, but the history of government assistance and the TVA show that this model can be a success.

Dialogue processes to identify solutions

Another option is to admit that we do not know the perfect solution and to proactively move forward through official dialogues. One way to do this would be to have utilities, consumer advocates, and regulators meet to discuss the challenges that they will face as a result of the increased use of distributed energy resources. This planning exercise could involve the analysis of several scenarios to examine the revenue and load impacts of differing penetration levels of distributed generation. Through the analysis, utilities and regulators would be able to determine the appropriate fixed cost allocation at each level and the optimal amount of distributed resources in terms of operational efficiency and cost recovery. If, for example, the most optimal penetration level for distributed generation is determined to be 40 percent, then utilities could align their incentives and policies with that goal in mind. Incentives that encourage investment in distributed generation, such as net metering, could then be used until the optimal level is met.

Another possibility would be to set up a task force potentially housed at the National Academy of Sciences that would set best practices and make recommendations on how to ensure affordable and universal access to electricity going forward. This task force should include ratepayer advocates, utility representatives, senior city officials, and util-

ity regulators. The panel could be tasked with investigating the impacts of increased use of distributed generation—including the possibility of off-grid generation—within a utility service area on both ratepayers and utilities. The task force could then determine ways to mitigate any short- and long-term impacts and present a road map to continued universal electricity service.

These solutions are the easiest next steps but also the least satisfactory. Simply put, they are not "solutions" at all so much as they are steps that hopefully would result in identifying solutions.

Conclusion

The current electricity system in the United States is one that is available to all Americans, but it is overly centralized and polluting. As the system inevitably evolves to include more clean distributed generation and more information technology to improve efficiency at the point of use, we must maintain our commitment to universal electricity access even as the fundamental design of our energy grid is transformed. If we fail to meet this challenge, our future electricity services will be distributed unevenly—much like new telecommunications services such as broadband Internet and cell-phone service—with a harmful effect on citizens, communities, and the larger economy.

Ensuring universal access to electricity will require real leadership and a commitment to implement a new suite of policies that take into account the needs of low-income and rural Americans. Utilities also need to start planning now for the coming technology changes, pricing structures, and evolving business models that will enable greater adoption of distributed generation without erecting barriers to these market shifts in order to allow the development of a more distributed energy grid with more adaptable relationships to customers who relate to the grid in new and more flexible ways.

In this issue brief we laid out some initial policy approaches to begin to address the impending changes in the electricity sector. While there is no silver bullet, these policies could help utilities, consumers, and regulators tackle the emerging issues that utilities and ratepayers alike will face as more distributed generation comes online, challenging the traditional utility model to adapt. Policymakers must plan for these changes today without allowing America's historic commitment to universal service to be threatened.

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