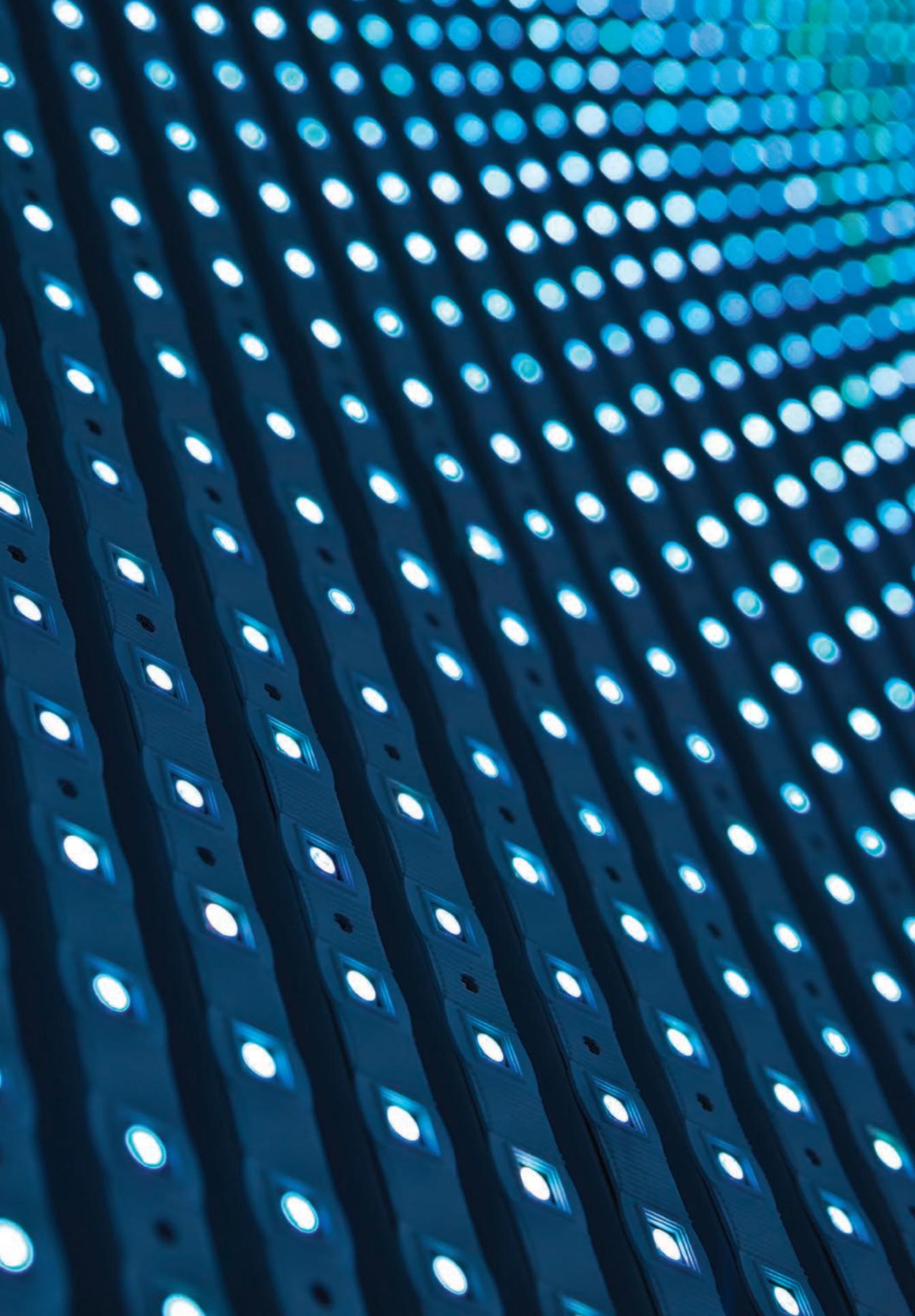




THOUGHT LEADERS SPEAK OUT:

Key Trends Driving Change in the Electric Power Industry

VOLUME II



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Edited by:

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with

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June 2016

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*“ Significant changes
have already occurred
in the electric power
industry—and more
change is on the way. In
the energy sector, the
third wave is here. ”*

-LISA WOOD

Introduction

LISA WOOD

*Vice President, The Edison Foundation and
Executive Director, Institute for Electric Innovation*

Make no mistake. The electric power industry is in the midst of a profound transformation—the generation mix is changing; the power grid is becoming more digital and more distributed; and customers have new and more defined expectations.

Technology, policy, and customers are all playing a key role in driving this transformation, but technology is the principal driver. While the exact course of the change is unclear, it's likely that a decade from now the electric power industry will look much different than it does today.

It is no secret that our society is more dependent than ever on electricity, and customers want safe, reliable, affordable, and clean energy. Tomorrow's customers will want even cleaner energy; greater grid reliability and resilience; increasingly individualized services; and the ability to connect more distributed energy resources and devices. And, they will get it!

At minimum this means:

- The mix of resources used to generate electricity will be cleaner, and a combination of entities will provide these resources;
- The power grid will increasingly integrate and orchestrate a more complex mix of central and distributed energy resources;
- The power grid will become more digital, more controllable, and more interconnected—a Grid of Things.™
- Diverse suppliers, including utilities, will provide a range of individualized services to customers.

But, what else? As Steve Case describes in *The Third Wave*, we are at the beginning of the third wave of the Internet, which he aptly calls the “Internet of Everything,” where the Internet will become integrated into every aspect of our lives. In this third wave, Case projects, major sectors of the economy—including health care, education, food, and energy—will be disrupted.¹

In this second volume of essays, *Key Trends Driving Change in the Electric Power Industry*, we examine some of the drivers of change in the industry—the need to collaborate and innovate with customers, nimbly and creatively; to lead in the application of smart storage; and to look beyond traditional electricity service boundaries toward smarter cities. We also glimpse our energy future from different perspectives.

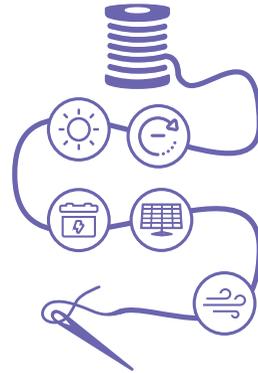
The trends in this second volume are more specific than the broad trends we covered in the first volume of essays. What these newer trends show, specifically, is how the digital grid is a critical building block to more innovation with customers, with communities, and with technology.

The authors of the essays that follow provide their unique views in three key areas—innovating with customers; smart storage, smart cities, smarter grid; and a transition to our energy future—the beginning of the third wave.²

Significant changes have already occurred in the electric power industry—and more change is on the way. In the energy sector, the third wave is here.

1. Steve Case. *The Third Wave: An Entrepreneur's Vision of the Future*. Simon & Schuster. 2016.

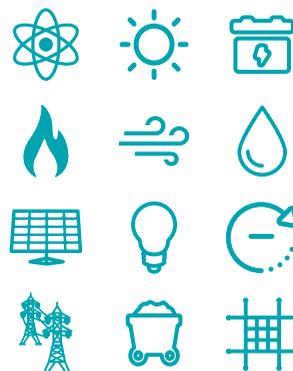
2. Many of the essays in this book are drawn from dialogues that occurred at the Institute for Electric Innovation's *Powering the People: Key Trends Driving Change* event on March 17, 2016, in Washington, D.C.



Innovating with Customers



**Smart Storage, Smart Cities,
Smarter Grid**



Energy Future

“ All of us in the energy arena need to work together as never before to build a system that benefits all customers. It’s imperative that we get this right. ”

– PEDRO J. PIZARRO

Foreword

PEDRO J. PIZARRO

President, Edison International

If you didn't know it already, *Thought Leaders Speak Out: Key Trends Driving Change in the Electric Power Industry, Volume II* will confirm for you that the electric power industry has begun a remarkable era of self-reinvention. Our industry hasn't seen an opportunity to chart our forward course like this since the early 20th century.

There are few certainties about the transitions ahead, but I believe that Southern California Edison's (SCE's) central mission—shared by utilities all over the world—to safely deliver reliable, affordable, and clean energy to our customers will last well into the future.¹ The issues surrounding just how that will be accomplished, in partnership with whom, and what needs to happen next, are what this collection of essays examines in thought-provoking detail.

Here's another certainty: All of us in the energy arena—utilities, regulators, technology providers, distributed energy resource (DER) advocates, customer representatives, and a range of committed stakeholders—need to work together as never before to build a system that benefits all customers. It's imperative

that together we “get this right” in terms of technology, regulatory policies, market models, fair and equitable cost allocation, and more. To borrow a phrase from Commissioner Bob Stump's essay in these pages, we're all “attached for life” and learning how to live together productively and beneficially.

In California, the facts on the ground tell a compelling story. Our state hosts more than 50 percent of the nation's distributed solar generation capacity, and more than 40 percent of U.S. plug-in electric vehicle sales. These numbers attest to how rapid technology advancement, the state's ambitious environmental policy goals, and the need to satisfy customers' growing appetite for choices—of energy sources, rate structures, and service offerings—act as powerful forces for change in the energy landscape.

The expected growth of DERs is particularly exciting as they are able to provide significant value to their owners, the utility, and society as a whole. At the same time, this growth introduces its own complexity into the energy system.

At the time of this writing, the role of utilities in a DER-filled future figures prominently in multiple proceedings at the California Public Utilities Commission. Our Commission is considering a number of critical topics, including the utility's role in DER integration and adoption, future utility business models and incentives, DER benefits and costs, and DER compensation mechanisms, among others.

A common thread weaving through these proceedings is the utility's transition, over time, from centralized system planner to the new model of managing and supporting a modernized grid that enables greater customer choice. Traditionally, central generation and the bulk power transmission system were considered the core of the electric power universe. Yet, with public policy tilting toward greater DER deployment, SCE sees that proverbial center of gravity shifting to the distribution side, as the interplay between distributed and centralized resources continues to evolve.

SCE envisions a future where we play a key role in supporting widespread deployment of DERs, incorporating the following key elements:

- **System planning** for future grid needs, incorporating DERs into the system planning toolkit as an alternative to traditional distribution solutions;
- **Grid operations** to maintain safe, reliable, and affordable service for all our customers, as well as building out, operating, and maintaining a modernized "plug and play" grid into which customers can plug in any technology—electric vehicles, solar panels, battery storage—and have it work seamlessly;
- **DER procurement** through competitive solicitations to defer or avoid costly system upgrades; and,
- **Market operations** where customers can provide grid services and be compensated fairly.

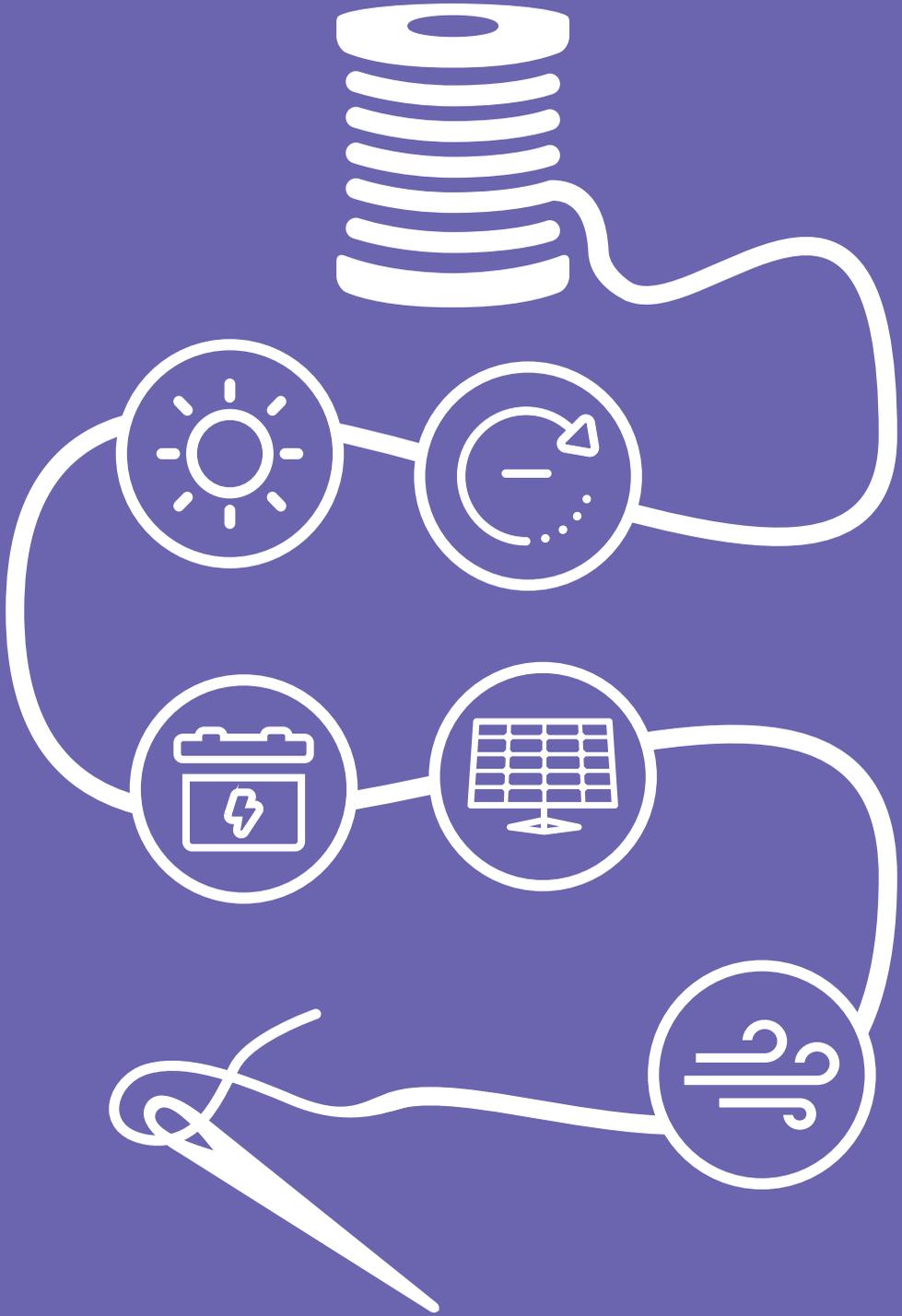
This future role of the utility serving as the Distribution System Operator (DSO) is a natural and logical progression, since all but the last of the above functions are thoroughly integrated into SCE's current operating model. Further, a utility DSO will be well-suited to bringing "smart cities" off the drawing board and into reality. As Itron's Russell Vanos says in his essay, "Electric utilities need to be principal players in implementing what we might call the next generation power grid, an active and intuitive grid that responds to system changes and makes decisions in real-time at the edges of the distribution network."

This represents not only a shift in technology and grid architecture but also a *cultural* shift. For companies to navigate successfully through this

transformational era, being operationally agile and nimble will be essential to meeting customers' rising expectations. Letha Tawney of the World Resources Institute says it best in her thought piece, stating that customers can be "open to exploring solutions with their utility-provided that utility is nimble, solution-oriented, and customer-centric."

The successful transition to the next generation electric power system requires thinking about our industry in entirely new ways. The perspectives provided by Bob Stump, Russell Vanos, Letha Tawney, and the other contributors to this volume represent the kind of creative and forward thinking needed at this critical time. I was inspired by their essays, and I think you will be too.

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1. SCE, one of the nation's largest investor-owned electric utilities, delivers power to more than 14 million people in a 50,000-square-mile service area in southern California.



INNOVATING WITH CUSTOMERS

As the power grid becomes increasingly digital and distributed, electric utility companies are providing more individualized services to their customers. The essays in this chapter explore some of those customized solutions.

Berkshire Hathaway Energy's Jonathan Weisgall details the experience of one of its businesses, NV Energy, and one large customer, Switch. Switch wanted something NV Energy initially wasn't sure it could provide: 100-percent renewable energy. But NV Energy responded, negotiated, collaborated, and figured out how it could meet Switch's needs and still show benefits to its other customers from the arrangement. Now, other corporate customers are eager to participate in similar arrangements.

World Resources Institute's Letha Tawney, working with a group of corporate renewable energy buyers that represent millions of megawatt-hours, discusses how dozens of corporations want to meet sustainability goals and lower their costs. They are forging new deals with electric companies to access large-scale renewable energy solutions.

Rocky Mountain Power (RMP) CEO Cindy Crane describes her company's Subscriber Solar program, which enables customers to subscribe, in 200-kilowatt-hour blocks, to a new solar farm that RMP is building. After a survey revealed that most RMP customers would choose a solar subscription over having their own rooftop installation, because a subscription provides more benefits and flexibility, RMP decided to offer just that.

Solar is indeed popular, but meeting customers' needs is not all about solar. Chris Black, Tendril's Chief Technology Officer, envisions a new form of demand management—one that turns traditional demand response for residential customers from "a blunt object" that rations energy to "a nimble tool that meets customers' needs."

Assistant Secretary of the Navy Dennis McGinn extends the scope of the military's relationship with electric companies—from providing the reliable, resilient energy services required on military bases—to the communities that adjoin and support them. When the three work together—the military, the electric company, and communities—both the military and nearby communities can have the crucial services they need.

Really, it's all a piece of the new normal. From large corporate buyers with sustainability goals, to small customers who want specific types of energy services, to military bases and communities that support them, electric companies are positioned to offer their customers more individualized services and innovative solutions than ever before.

“Be open-minded and innovative. Look for solutions, not roadblocks. Work collaboratively with your customers and your regulators. That’s the recipe for becoming an ‘agile’ electric company.”

– JONATHAN WEISGALL

Individualizing Green Energy Solutions to Meet Customer Needs

JONATHAN WEISGALL

Vice President, Government Relations, Berkshire Hathaway Energy

Reliable, affordable, and clean energy. This three-part formula defines today's demands on the electric power sector. Now it's time to add a fourth adjective: agile. Today's electric companies must be more responsive to customers and move quickly to come up with innovative solutions to meet customer needs.

REAL LIFE LESSON

Switch, a data storage company with deep roots in Nevada, approached NV Energy—Berkshire Hathaway Energy's regulated electric company in Nevada—to request 100-percent renewable energy to meet its growing electricity needs. It wasn't readily apparent to Switch how NV Energy could satisfy that type of request—under existing regulations, NV Energy could only offer system power. So Switch decided to switch! Switch filed an application with the Public Utilities Commission of Nevada to leave NV Energy's system and obtain renewable energy from a third party.

NV Energy immediately responded. A potentially adverse relationship quickly led to negotiations and collaboration among NV Energy, Switch, and state regulators; the parties soon reached an agreement. Under Nevada's green energy rider tariff, NV Energy could, in fact, provide 100-percent renewable energy to Switch.

Switch is now NV Energy's first southern Nevada customer to receive 100-percent renewable energy under the green tariff. Bringing on a new carbon-free resource with an energy output equivalent to Switch's load assures that no new carbon-emitting energy is produced to serve them. Switch will receive power from a new dedicated 100-megawatt (MW) photovoltaic system (aptly named Switch Station) that will go online later this year and pay a small premium per kilowatt-hour (kWh) for that power.

How did NV Energy meet the regulatory standard of showing that this

arrangement would not shift costs to its other customers? In fact, NV Energy was able to show beneficial impacts, primarily because Switch's payments will help buy down the cost of this new solar plant more quickly.

As a result of the collaboration and negotiation, Switch gets 100-percent renewable energy from NV Energy and remains a full-requirements customer. Indeed, the deal was so successful that the parties have negotiated another agreement for 79 MW of solar power to facilitate Switch's expansion in both northern and southern Nevada.

INNOVATION BRED MORE INNOVATION

Within a matter of months, this basic template was repeated with the City of Las Vegas, whose full retail load will now be served by renewable energy—every streetlight, park, community center, public building, and fire station.

This approach has become so successful that on May 3, 2016, borrowing from the natural gas pipeline playbook, NV Energy announced it would accept customer requests to be served by more renewable energy. NV Energy, which has already issued a request for proposals for new renewable resources, will now offer a price and a delivery timeline and will learn how many customers want to

participate in building a new renewable energy project along with NV Energy, and for what participation period.

Within a span of less than two years, NV Energy is building or has already built more than 329 MW of large-scale solar plants, with much of that capacity going to meet specific customer needs for 100-percent renewable energy. Now more customers want to participate. And, NV Energy is currently exceeding its state's renewable portfolio standard of 20 percent.



Utility



Customer Solutions

The green energy tariff approach that NV Energy used works, and it works for all parties. The customer that wants to be 100-percent green gets the energy solution it wants—together with long-term energy price stability. The electric company, in collaboration with customers and regulators, is able to provide a customized service to meet the customer's needs. And, the customer now views its electric company—not some third party—as the provider of choice.

Will this model work for other electric companies? First, you need customers

that want to be served by more renewable energy, and are willing to pay a small premium for it. That type of customer is growing, as more and more companies have public sustainability goals and are making clean energy pledges. Second, the electric company must be able to provide the renewable energy to the customer.

What lessons did NV Energy and Berkshire Hathaway Energy learn from these developments? And what lessons might a like-minded electric company draw from them?

- Engage with your customers;
- Communicate;
- Be open-minded and innovative: look for solutions, not roadblocks; and
- Work collaboratively with your customers and your regulators.

In the case of Switch, NV Energy took the initiative to engage its regulators in finding a solution that would meet Switch's needs. Specifically, the company was able to pursue and receive approval to offer the green energy tariff in southern Nevada; previously, this tariff was only available to customers of NV Energy's northern utility. Overall, the time between Switch filing an application to leave the NV Energy system and the signed agreement between NV

Energy and Switch for the new 100-MW solar system was seven months.

To meet the customer's expectation in a very cost-effective way, NV Energy was able to provide the lowest-cost solar resource known up to that point, a power purchase agreement with First Solar for 100 MW of output at \$0.0387 per kWh. Switch was able to support a project built in Nevada—meeting a primary criteria of having a local renewable resource—and NV Energy was able to make further progress toward reducing carbon intensity and adding further diversity to its resource mix.

From my perspective, that's the recipe for becoming an "agile" electric company.

“ Utilities will find allies in their corporate customers who value reliable, affordable, and sustainable electricity. Utilities just have to be agile enough to meet all three benchmarks— and quickly! ”

-LETHA TAWNEY

Energy Solutions for Corporate Buyers

LETHA TAWNEY

Director of Utility Innovation, World Resources Institute

Large commercial and industrial energy users, including Procter and Gamble, Amazon, Microsoft, Kaiser Permanente, and many more, are looking for cleaner energy that meets their sustainability goals and lowers their costs. They are moving beyond the green power products of the last decade and forging new deals and regulatory approaches to access the financial benefits of large-scale renewable energy projects. From Nevada to Virginia to North Carolina, these large corporate customers are crafting new solutions together with their electric utility companies.

Driven by the economics of renewable energy, demands from their own customers, and a desire to address climate change in the interest of their bottom line, these corporations have set forth what they need from the marketplace in six Renewable Energy Buyers' Principles, and they want to scale up their buying very quickly.¹ More than 55 iconic companies are signatories to the

Buyers' Principles. Their requirements will exceed 44 million megawatt-hours (MWh) of renewable energy annually by 2020.

Large corporate buyers are aware that utilities can bring substantive value to the customer relationship. The utility is expert at power purchasing, deeply experienced at integrating power into the system, and is a reliable partner as well as being financially stable. These attributes make corporate buyers open to exploring solutions with their utility—provided that utility is nimble, solution-oriented, and customer-centric.

The result has been a boom in special contracts and green tariffs that mirror the overall growth in corporate renewable energy purchasing. In 2015, corporate buyers signed more than 3 gigawatts (GW) of renewable energy contracts with suppliers across the U.S.² At least 350 megawatts (MW) of those contracts are with local, vertically integrated utilities.

The utilities that are successful in signing these deals have two things in common.

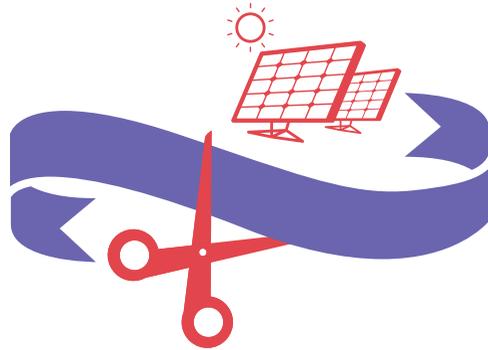
- They are bringing very senior level attention to meeting these customers' needs.
- Their customer service people are including their rates and power supply counterparts in the collaboration, and this is leading to more creative solutions.

A WIDE RANGE OF MODELS

The deals in 2015 included an agreement in October between data storage company Switch and NV Energy that enables Switch to receive solar energy using NV Energy's Green Energy Rider. NV Energy is also providing solar energy to Apple's data center via a 20 MW solar project near Reno. Since October, both Switch and Apple went back to buy more solar from NV Energy and the City of Las Vegas also contracted for a share of solar as part of these deals. By the end of November 2015, NV Energy had sought PUC approval for nearly 250 MW of renewable power for corporate buyers under its Green Energy Rider.³

The Nevada deals were some of the first to emerge from green tariffs—standard utility offerings that bundle together the energy from a renewable energy project and renewable energy certificates (RECs).

In the fall of 2015, Duke Energy followed a similar approach, using its Green Source Rider to provide renewable energy to three customers, including a deal with Google for a 61 MW solar farm.



Recently, Dominion Virginia Power joined the ranks of these innovators. Working with the Commonwealth of Virginia and Microsoft, Dominion Virginia Power moved a 20 MW solar project forward in March 2016, after state regulators had previously disallowed cost recovery for it. Certain Virginia state agencies have the right to contract for power outside the state's general power purchases and are buying power from this solar project. In connection with it, Microsoft will buy the project's green attributes—RECs—to match the Dominion power that serves its local data centers. Microsoft found the price of RECs competitive with its internal cost of carbon, which it wanted to offset; it values the option of

bringing local renewables to the grid. Dominion’s creativity met two customers’ needs without adversely impacting its other customers.

Stretching beyond this unique deal, Dominion Virginia Power has used its access to the PJM wholesale market to enable an entirely different arrangement with another large data center that allows the customer to take on the full price risk and benefit of the renewable energy. Through a special contract, the utility is taking over energy management of four existing renewable energy power purchase agreements (PPAs), including one with Virginia’s largest solar farm to date—an 80 MW project in Accomack County. Dominion will settle the difference between PJM prices and the renewable energy PPAs on the customer’s bill, while delivering reliable, firm power to the facilities. This approach allows the customer to benefit economically when their PPA obligations are cheaper than PJM wholesale prices, but the customer also takes the risk when PJM prices are lower than the PPAs.

PROPOSALS EMERGING AROUND THE COUNTRY

Utilities around the country are now crafting green tariffs that build on the Buyers’ Principles. In November 2015, Xcel Energy sought approval

for Renewable*Connect—a fixed-price, long-term renewable energy product that will provide wind and solar energy to customers with no up-front costs—from Minnesota regulators. Xcel Energy’s Colorado affiliate followed up with a similar filing at the Colorado Public Utilities Commission, introducing Solar*Connect. This approach replaces the energy portion of the customer’s standard retail bill with solar and wind PPAs. While other customers’ energy costs will rise and fall with natural gas prices, Renewable*Connect customers will pay the stable PPA price for five to 10 years.

At least six other large investor-owned utilities are currently designing similar products for corporate buyers.

As utilities grapple with questions of new regulatory and business models in the fast-changing electric power industry, they will find allies in their corporate customers, who value reliable, affordable—and sustainable—electricity. Utilities just have to be agile enough to meet all three benchmarks—and quickly!

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1. <http://www.wri.org/publication/corporate-renewable-energy-buyers-principles>.
 2. Business Renewables Center Deal Tracker, <http://www.businessrenewables.org/corporate-transactions>.
 3. For more information on the NV Energy approach, see Jonathan Weisgall’s essay in this volume.

“ Our businesses are facing competition to keep and find customers who are demanding more options. Rocky Mountain Power's Subscriber Solar program gives our customers what most consider a better choice. ”

- CINDY CRANE

Offering Customers More Energy Choices

CINDY CRANE

President and CEO, Rocky Mountain Power

Energy companies like Rocky Mountain Power are regulated, but are not really monopolies in the strict sense of the term. While the electric power and related services we provide are strictly regulated, increasingly our customers have other options to meet their energy needs. That means our businesses are facing competition to keep and find customers. At the same time, customers are demanding more choices. Many who want to choose their energy source have more options to choose rates and costs.

At Rocky Mountain Power, we listen to our customers, and, as a result, we are launching our Subscriber Solar program this year. Our customers will be able to subscribe to universal and cost-effective solar power from a new 20-megawatt solar farm that's under construction in central Utah—even if these customers can't afford their own solar system, don't want to maintain solar panels, or

perhaps live in a building that precludes them from having their own private or rooftop solar installation.

THE CHALLENGE

Utah is one of the sunniest states in the West. Representatives of private solar installers are often seen in our neighborhoods knocking on doors, as they pursue more customers. The number of residential customers with private solar photovoltaic (PV) panels has grown exponentially in Utah over the past five years, from 380 customers in 2011 to 3,091 in 2015. Just between 2014 and 2015, the number of residential customers with private solar PV panels more than doubled!

More and more, Utah customers like the idea of generating their own energy, "greening" their personal lives, and lowering their power bills, even if it takes years to recoup the cost of their private solar systems.

THE SPARK: THE BLUE SKY PROGRAM

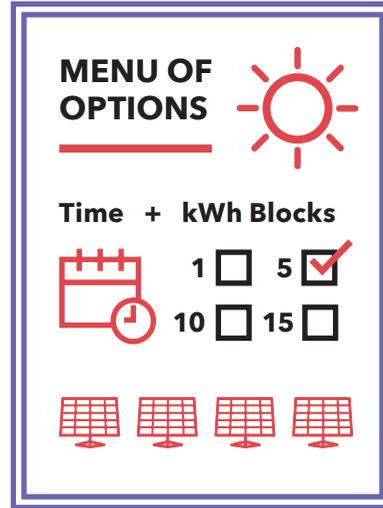
The genesis of Rocky Mountain Power’s Subscriber Solar program grew out of our Blue Sky program. For as little as \$1.95 a month, Blue Sky allows customers to voluntarily support solar projects at local schools, nonprofit organizations, and community installations.

Blue Sky is also used to support large clean energy projects by purchasing Renewable Energy Credits. During the past 15 years, Blue Sky customers in the six states served by our parent company, PacifiCorp, supported more than 5 billion kilowatt-hours of renewable energy—enough energy to power more than 500,000 homes for one year.

Rocky Mountain Power’s survey of more than 2,000 residential and Blue Sky customers found the following:

- 75 percent of residential customers and 90 percent of Blue Sky customers *are likely* to subscribe to universal solar energy.
- 50 percent of residential customers and 65 percent of Blue Sky customers would choose a universal subscription over a private rooftop solar installation.

Customers don’t want to just support renewable energy; they also want to buy it for their own use. *But they don’t necessarily want to install it.* Another independent study found that Utahans want more clean energy but they don’t want to pay too much more for it.



THE SOLUTION: THE SUBSCRIBER SOLAR PROGRAM

Our Subscriber Solar program gives our customers what most consider a better choice: get access to solar, but without the investment and long-term payback period associated with installing solar panels. This voluntary, affordable program offers customers the ability to buy some or all of their energy from efficient, large-scale solar.

This type of universal solar project is a very cost-effective way to provide customers with a solar choice. Subscriber Solar participants will be able to subscribe in 200-kilowatt-hour blocks up to their total usage. The 20-megawatt solar farm will provide approximately 20,000 blocks.

Both commercial and residential customers can participate in this universal solar program. Many customers

can actually save money by switching to the Subscriber Solar program. Others will participate simply to support clean energy that's generated in the state, while reducing their use of non-renewable energy.

Another advantage of the program is its flexibility: Subscriber Solar customers, if they move, can take their solar with them and transfer their subscription blocks to any area served by Rocky Mountain Power in Utah, so customers can stay on the program effortlessly even when relocating. By contrast, customers who own their rooftop solar PV systems do not have this seamless flexibility if they change residences.

THE COSTS

The Subscriber Solar program is revenue-neutral; Rocky Mountain Power makes no profit from it. All program costs are paid by subscribers. As a result of our 20-year contract with the solar farm developer, we lock in the energy portion of subscribers' bills for the same 20 years. Assuming the program is 100-percent subscribed, which we fully expect, other customers are not impacted by the program.

Before launching the program, we took the necessary steps to meet with regulators, renewable energy advocates, and consumer watchdog agencies to help shape a program that addresses our customer needs and desires, as well as one we could work with. Dan

Chwastyk, utility strategy manager for the Smart Electric Power Alliance, called Subscriber Solar "an incredibly well-thought-out universal solar program."

THE FUTURE

The solar farm is under construction, and the program is expected to be fully subscribed before it goes online in January 2017. We expect to develop additional universal solar projects to meet future demands of our customers; our experience with Subscriber Solar is laying the groundwork for these future programs.

Our customers are thinking ahead, and Rocky Mountain Power wants to be the first place customers think about whenever energy questions cross their mind.

- How can I help reduce my carbon footprint?
- How can I protect myself from price hikes?
- How can I participate?

Rocky Mountain Power has the answers. We are happy to be actively engaging with our customers in developing even more innovative solutions for the future.

“Traditional demand response programs are missing an opportunity to delight customers, and can be transformed into something that works for all customers, all the time.”

-CHRIS BLACK

The Next Generation of Demand Management

CHRIS BLACK

COO and Chief Technology Officer, Tendril

Electricity is an essential service. There's no substitute for it, like the air we breathe. And like air, energy gets taken for granted. For more than a century now, energy providers have delivered the power customers need to run their homes. Customers expect the power to flow, no matter how much they need. Electricity customers need service that's seamless, universal, dependable, and simple. Traditional demand response (DR) programs are missing an opportunity to delight customers, and can be transformed from a potentially disruptive experience into something that works for all customers, all the time.

Embracing opportunities to delight customers is the key to an energy provider's success, especially as outside solutions that cater to individual customer needs (like solar and storage) become more available. The energy providers that approach demand management as a nuanced, automated communication between connected devices within the

home—and that fulfill customers' desires to contribute to generation through distributed energy resources (DERs)—not only will improve customer satisfaction, but will also open doors to more widespread use of effective DR initiatives.

RE-ENVISIONING DEMAND MANAGEMENT

Adopting a consumer-centric approach to DR starts with re-imagining demand management at the retail level. Today, retail DR programs compensate customers for the power they don't use to help reduce peak load. For example, an energy provider will pay for the right to cut off air-conditioning (A/C) for a period of time during a heat wave. Behavioral demand response uses social pressure and financial incentives to encourage customers to voluntarily turn down their A/Cs when they need cool air the most, among other uses. Similarly, time-of-use rates increase the price customers pay for electricity during periods of high usage.

In my view, these efforts to manage demand may compensate customers for inconvenience, but they don't delight customers. Netflix would never ask customers not to watch movies on Saturday nights to help them out with their network congestion issues, so why should energy providers ask customers to turn off their A/C during a heat wave, especially when that A/C is essential to health and well-being?

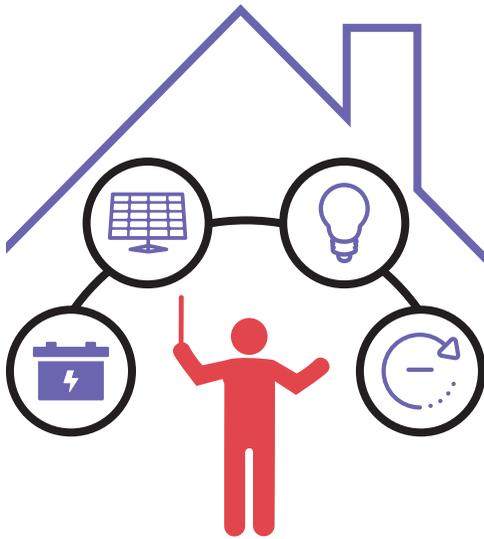
Here's how energy providers can do better with retail DR. They can migrate to a model that turns demand management from a blunt object that rations customers' energy, to a nimble tool that meets customers' needs at the lowest cost possible. With the right technology, the new model of DR can be simple and virtually invisible to customers, most of whom do not want to learn about kilowatt-hours or therms but want to stay comfortable in a way that is affordable.

Deployed in conjunction with smart thermostats, this approach to DR considers a multitude of data points, ranging from home characteristics to micro-weather patterns, to construct a virtual energy usage model of each individual home. By making high-precision predictions and optimizing the home cooling or heating system based on the customer's desired comfort, algorithms and controls can run

continuously rather than using today's existing approach that sets a handful of pricing events each year based on market conditions. The new retail DR approach instead puts the focus on the customer's desired outcomes—whether they revolve around cost, comfort, or performance. In fact, it is hard to call this new approach DR. This is next-generation demand management. If done right, a home's demand is shifted out of peak, thus not contributing to the overall peak demand problem.

EMBRACING DISTRIBUTED ENERGY RESOURCES

Better energy management doesn't stop with regulating demand on peak days. Energy providers can also integrate into their offerings the full range of DERs that customers are using—solar panels, electric vehicles, smart appliances, and batteries. Rather than being chaotic disruptions, these new devices can act as additional assets to the grid, making energy cheaper, cleaner, and more efficient. DERs become assets when energy providers have the technology in place to monitor their generation and use capacities in real time and make continuous adjustments to connected appliances within the home to ensure the home's balance of power stays in the pre-determined optimal range.



Utility As Conductor

Energy providers will need the sophisticated ability to orchestrate all of these distributed resources, rather than using the blunt tools of the past. Energy providers will delight their customers when they adopt the technology they need to manage DERs smoothly, to analyze the real-time fluctuations of demand within homes, and to transform DR into a resource that supports widespread use reductions without widespread disruptions. They'll build loyal customer bases that turn to them for all of their energy needs, knowing those needs will be met seamlessly, without depriving customers of the resources they need to survive and thrive.

“ Over the past year, we have undertaken more than 30 public-private partnerships focused on establishing new renewable energy and microgrid projects. The innovative relationships we forged have established the know-how that will last for decades. ”

-DENNIS MCGINN

A North Star for Energy Resilience

DENNIS MCGINN

Assistant Secretary of the Navy, Energy, Installations and Environment

In an earlier volume of this series, I contributed an article called “Choosing to Lead on Energy,” which described the Department of the Navy’s efforts to partner with communities and with private-sector stakeholders to focus on the planning and development of key energy infrastructure projects and capabilities. Projects like these create mutual support and assurance between the Navy and its neighbors.

Establishing resilient communities around Navy sites is not something we will achieve overnight. Rather, I think of community-level energy resilience as a “North Star” for the Navy’s infrastructure planning—including appropriate partnerships and security-driven separations along installation boundaries. Each step at installations, whether large or small, is undertaken with a shared vision and set of standards designed to improve energy resilience today and in the future.

The Department of the Navy has made significant strides forward on this front. Over the past year, we have undertaken more than 30 public-private partnerships, focused on establishing new renewable energy and microgrid projects, which will serve the needs of Navy and Marine Corps installations and of community partners. In total, the Department of the Navy will have played a key role in the development of more than one gigawatt of new electric generating capacity, all renewable.

Our first online project toward the 1-gigawatt goal is located on MCB Camp Lejeune in North Carolina. The Navy partnered with Duke Energy Progress to develop a solar facility on base that sends power to the grid for community consumption. The facility came online in December 2015 and is capable of producing 17 megawatts of direct current or 13 megawatts of alternating current energy. This project increases

energy security for the base while helping Duke Energy Progress to meet North Carolina's Renewable Energy and Energy Efficiency Portfolio Standards.

Another project at MCAS Yuma in Arizona further demonstrates the benefits of partnerships between utilities and the military. The Marine Corps and Arizona Public Service (APS) are building a 25-megawatt microgrid system on base that will automatically provide power to the base during commercial outages. The system will increase reliability for other customers as well, in that APS can utilize the generators during periods of peak demand. This partnership creates the first base in the U.S. to have 100-percent backup power.

Our partnerships also increase energy resilience for installations and the communities supporting them. In coordination with the State of Connecticut and Groton Utilities, the Navy has made significant progress toward establishing a microgrid to support the Atlantic submarine fleet at SUBASE New London. The microgrid will provide enhanced resilience to mission critical operations and support for community emergency services. Keeping the families of our Sailors safe during an outage allows them to focus on operating and maintaining vital national security assets. The project will be developed in a phased approach that leverages

state grants, third-party financing, and Navy energy resources that will achieve a fully functioning, resilient installation microgrid within two years.

With hard work and careful project management, our projects cited above, and many more, will come to fruition, to the benefit of all. However, there is more work to be done to attain the resilience that the Navy and Marine Corps and our nearby communities seek. I see the Navy's progress over the past year as an achievement in itself—but also as an important foundation for growth. That foundation is not only comprised of physical capital—it is very much human as well. Soon, the Navy Department's lands will host new physical infrastructure that generates electricity without requiring fuel. We are transforming our non-tactical vehicle fleet in order to incorporate zero-emission electric vehicles and provide the required charging infrastructure. Through these efforts, the Navy is initiating a program to rapidly transform its fleet configuration and energy use not only to preserve, but to increase our capabilities.

Our Navy and Marine Corps team of professionals and our private-sector partners have stretched themselves personally and professionally to make renewable energy projects a reality. The innovative relationships we have forged with utilities, developers, and

the financial community during this energy voyage have established the know-how for creating a mutually beneficial platform that will last for decades. The initial establishment of organizations, partnerships, and processes will prove even more valuable to future endeavors. Our horizon is broadening, and the course we are taking is clear and expanding.



A Clear Vision

As I wrote in my earlier essay, we expected that leading these changes would be challenging for the Department of the Navy and for all the stakeholders involved. I can say now with certainty that we were right. But this force is *designed* for meeting difficult challenges. We welcome more. We will continue to pursue our next initiatives with deliberate speed and a steady course. As long as we have a clear vision of the North Star, and a talented crew aboard, we will continue to move in the right direction, toward stronger communities and a stronger, more resilient Navy and Marine Corps.



SMART STORAGE, SMART CITIES, SMARTER GRID

Three forces are emerging to point electric utility companies in a new direction: society is demanding a clean, sustainable energy economy driven by electricity; storage is enabling greater use of renewable energy and efficiencies; and yesterday's smart grid is evolving into an even smarter Grid of Things™ consistent with the emerging Internet of Everything. The essays in this chapter describe some of the latest technologies and trends taking electric companies beyond their traditional roles.

AES Corporation President and CEO Andrés Gluski and Vice President and Chief Technology Officer Chris Shelton say that simply including energy storage as an option in planning and procurement processes will speed its adoption. Storage can improve the reliability of renewable resources, enhance generation performance, ease transmission constraints, and integrate distributed generation. Batteries can help achieve the clean power grid of the future.

John Carrington, CEO and Director of Stem, describes how the value of storage is maximized when located on the customer side of the meter, where customers, energy companies, and grid operators all can extract and share its benefits. When paired with intelligent software, storage can be completely automated and invisible, flexibly responding to prices and grid conditions.

Itron's Russell Vanos sees a role for electric companies as key leaders in the smart cities movement. Itron's 2016 Resourcefulness Index found that consumers are looking to electric companies to lead the way toward a smart city revolution, using data and smart technologies to engage with cities to drive efficiencies, increase sustainability, and improve community life.

Roger Woodworth, President of Avista Development, discusses the role of electric companies in delivering value in new and unexpected ways to the communities they serve. He sees the opportunity for them to do more than deliver electricity. He asks: How might electric companies provide new streams of value to communities—in improved water services, building operations, transportation modes, and more? Citing Amazon's transition into new diversified services, he encourages electric companies to think big, and bigger still.

“To speed greater adoption of energy storage, our industry simply needs to include storage in planning and procurement processes and remove unnecessary barriers to its deployment.”

–ANDRÉS GLUSKI & CHRIS SHELTON

After a 100-Year Hiatus, Batteries Are Helping the Grid Again

ANDRÉS GLUSKI

President and CEO, AES Corporation

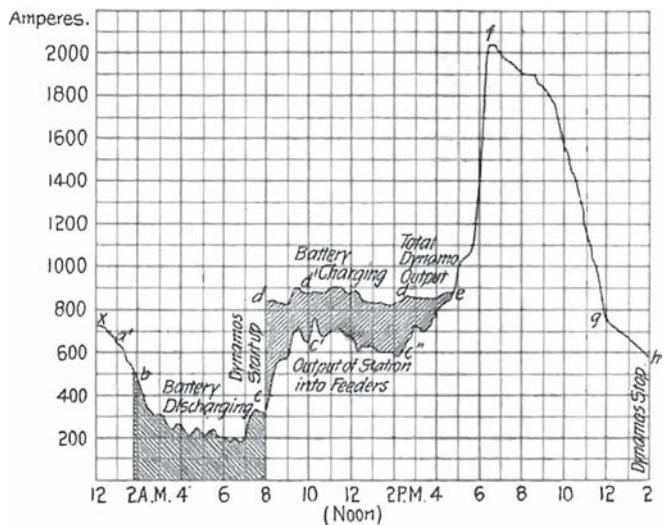
CHRIS SHELTON

Vice President and Chief Technology Officer, AES Corporation

Battery storage: it's back to the future. More than 120 years ago, batteries were commonplace on the power grid. Thanks to Thomas Edison's vision, many central station power plants and distribution networks utilized battery systems in the 1890s.

Today, battery-based energy storage is again becoming vital to our power system. Storage is needed for load balancing and a great deal more. Batteries can help achieve the reliable, affordable, and clean power grid of the future, in the U.S. and around the world.

This chart shows a 19th century "duck curve" for New York City, and demonstrates the key role that batteries played in smoothing the peaks and valleys of electricity demand throughout the day and night in Edison's time.¹



**Load Diagram of 33rd St. Station,
Edison Illuminating Co., of New York City,
Sept. 30, 1893**

A SECTOR IN TRANSFORMATION

Electric companies have a reputation for being steady and unexciting enterprises, providing a service that is silent, invisible, and noticed only when it fails to deliver the energy that's so essential to our personal lives and the entire economy. But the electric power industry is moving into a dynamic period of operating challenges and structural change, driven by innovations in technology, commodity markets, regulation, and security needs. Batteries can assist power system operations in this transformation in a variety of ways:

Improving the reliability of renewables. Renewables are critical to the future of power generation. In the U.S., more than half of new capacity additions came from renewables last year.² Globally, two-thirds of new power investments through 2040 are projected to be wind and solar.³ Greater renewable energy generation reduces the carbon intensity of our electric system. But, renewables are highly variable; small disruptions from clouds or wind bursts can create major challenges for the grid. Batteries can help balance supply and demand when the sun isn't shining and the wind isn't blowing. In fact, California utilities are already choosing to use battery-based storage as a competitive complement to their generation services and electric network investments to deal with

the massive adoption of solar energy in the state, exceeding targets set by their regulators for energy storage.

Enhancing performance of traditional power generation. By adding batteries to the existing generation fleet, we can hold less generation in reserve and produce more energy. Greater use of batteries can also facilitate more efficient operation of thermal units, reducing wear and tear and maintenance costs in the long run. These benefits have been realized in the northern region of Chile, where AES worked with the system operator to improve power plant output by four percent using batteries while simultaneously eliminating load-shedding and reducing the overall system cost by more than \$30 million per year.

Easing transmission constraints and integrating distributed generation. Our transmission system is only 50 percent utilized in the U.S. because of significant grid constraints during peak periods. Batteries can help match energy production with the times and places where it is needed most, no matter where the energy is generated. Better use of existing infrastructure reduces the need for near-term investment in transmission upgrades. Batteries can also provide a variety of ancillary services that grid operators increasingly need in today's more complex power markets.

AES ENERGY STORAGE

AES is the world leader in lithium ion-based energy storage. AES has now released its fourth-generation battery energy storage system, Advancion®, which is available globally through alliance partners such as Eaton and Mitsubishi Corporation. Advancion combines eight years of designing, developing, and operating energy storage in one complete product that's ready to serve for the long-term. There are more than 384 megawatts (MW) of Advancion in operation, under construction, or in advanced development in seven countries: the United States, United Kingdom, Netherlands, Chile, India, the Philippines, and the Dominican Republic.

A SIMPLE PATH TO THE GRID OF THE FUTURE

To speed greater adoption of energy storage, our industry simply needs to include storage in planning and procurement processes and remove unnecessary barriers to its deployment. When utility systems are planned, when markets are designed, and—most important—when a procurement process is initiated, it makes sense to consider and include storage for the operational and economic advantages it offers.

In procurement processes, AES and our storage customers have shown that energy storage is competitive without

special incentives. We have seen this with the Advancion fleet in PJM (one of the world's largest wholesale power markets), a similar storage fleet in Chile, and, more recently, in California, where a competitive all-source procurement for capacity by Southern California Edison resulted in selection of more than five times the amount of energy storage that was expected, including a 100 MW Advancion energy storage array.

As more renewables are developed in the U.S. and globally, and as system operators seek the increased flexibility that batteries afford, it appears that Thomas Edison's vision for an efficient battery-enabled power system will be achieved many times over in the 21st century.

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1. Engineering News, Vol. 30, p 358, Nov. 2, 1893.
 2. <https://www.snl.com/InteractiveX/Article.aspx?cdid=A-34950800-13103>.
 3. Bloomberg New Energy Finance, "2015 New Energy Outlook."

“ Intelligent energy storage has emerged as a critical bridge between the traditional electric power system and a more dynamic power grid—clean, efficient, and distributed. ”

– JOHN CARRINGTON

Transforming Our Energy Future with Intelligent Batteries

JOHN CARRINGTON

CEO and Director, Stem

More than 130 years ago, on Pearl Street in lower Manhattan, Thomas Edison opened America's first power plant. Edison's Pearl Street Station—a central-station, direct current system—was developed to provide safe, reliable lighting across a neighborhood network, while offering electricity rates that were affordable for its 508 customers.

Over time, technology providers, resource developers, and policymakers made improvements to the energy infrastructure, discovering that wider networks could be better supported by an alternating current system, and that larger unit sizes yielded more efficient, lower-cost generation. Higher-voltage lines increasingly linked smaller city or area networks efficiently into a larger, more reliable power grid.

Still, in many ways, today's interconnected power grid looks shockingly similar to its early design—despite a tripling of the U.S. population, a much-

increased demand for electricity, and, most recently, a growing desire to shift electricity sources away from traditional generation sources to cleaner sources.

Over the past few years, as this transformation has unfolded, intelligent energy storage has emerged as a critical bridge between the traditional electric power system, powered by centralized fossil fuel generators and sized to accommodate levels of demand only encountered a handful of times each year, and a more dynamic power grid—clean, efficient, and distributed—that can meet the needs of tomorrow.

UNLOCKING THE VALUE OF THE GRID WITH CUSTOMER-SITED STORAGE

Power grid operations are governed by the physics of electricity. In each grid, supply must match demand as precisely as possible, instantaneously, at all times. The most popular forms of renewable energy—solar and wind power—are variable resources that are

difficult to shape and control. Unlike conventional generation, they cannot easily follow load, ramping up or down to match the demand on the power grid. This means that other resources must perform that function.

The variability associated with renewable resources *could* be a cause for great concern. Managing this concern requires operations management skills and new tools to meet the challenge. Intelligent energy storage is a tool that can allow excess power to be easily absorbed for use during later periods of constrained supply, helping to maintain balance on the power grid. In regions with a high penetration of renewables, such as California and Hawaii, this is critical.

But not all storage is created equal! The value of energy storage is maximized when it is fully utilized, and one way to increase utilization is by locating storage on the customer side of the meter, where customers, energy companies, and grid operators can all extract and share its greater benefits.

Customer-sited storage can automatically time-shift consumption to manage costs, making customers more active and price-responsive grid participants.

For utilities, distributed storage assets serve the same purpose as a centralized generation asset. They can act as a fast-responding resource that provides capacity as well as the ability to absorb energy when renewable generation exceeds demand. In order to manage multiple objectives, batteries must be paired with sophisticated software that can automatically predict and quickly respond to changing prices and patterns of demand.

AUTOMATING CUSTOMER RESPONSE

Historically, controlling costs on the demand side of the power grid has required active customer participation and behavior change. Demand response programs pay customers (both large and small) to reduce consumption when notified by the system operator. They have grown over the past decade and voluntary participants



enjoy the additional revenue, but participation can be burdensome, interfering with business operations and comfort.

Energy storage, on the other hand, can shift demand with no change or disruption in customers' daily routines. It can be completely automated and invisible, flexibly responding to price and other power grid conditions. This is especially critical in commercial and industrial facilities that cannot simply turn off machines, processes, or lights when fully engaged in commercial tasks. Thus, aggregated energy storage can be a more reliable asset with a larger potential market than even conventional demand response.

With the increased proliferation of renewables and the Internet of Things, from onsite generation to smart thermostats, customers expect more choices and control than ever before. When paired with intelligent software, energy storage allows customers to integrate their service, energy resources, and energy-using devices into one self-optimizing platform that responds to price signals, cutting energy costs and making these energy resources available to the power grid when they are most valuable.

PROPELLING THE ENERGY INDUSTRY FORWARD

Today, the electric power system and the business models that support it are truly in flux. Intelligent energy

storage is demonstrating its power to transform our energy future in an unprecedented way, while maintaining a strong and reliable grid. In regions where energy companies, grid operators, and policy makers have nurtured adoption of customer-sited storage, energy customers have responded in growing numbers.

- More than 1,000 customer-sited energy storage systems are in operation today, primarily in California, Hawaii, and New York.¹
- According to Stem analysts, an estimated 30 percent of Fortune 500 companies have adopted or are actively evaluating intelligent energy storage technology.
- According to GTM Research, more than 700 megawatts of distributed energy storage will be deployed in the U.S. between 2014 and 2020 alone.²

It is time for all industry stakeholders—policy makers, technology providers, energy companies, and customers—to respond by supporting energy storage. It is a tool that will modernize the power grid, making it more efficient, while controlling costs, empowering customers, and accelerating the transition to a clean energy future.

1. GTM Research (2016). GTM Research CDEF Keynote: California and the Distributed Energy Transformation.

2. GTM Research (2016). U.S. Energy Storage Monitor: 2015 Year in Review Full Report.

“ A smart city uses data and technology to help drive efficiencies, create sustainable initiatives and actions, and engage citizens to improve community life. ”

-RUSSELL VANOS

How Utilities Can Lead the Smart City Revolution

RUSSELL VANOS

Vice President, Sales and Marketing, Global Software, Services and Smart Cities, Itron

As the global population continues to grow, the imperative to manage and sustain our vital energy and water resources has never been stronger. Though electric utilities have always been a key pillar of the economy, the 2016 Itron Resourcefulness Index, a global benchmark for energy and water resources management, found that consumers are now looking to utilities to lead the way toward the smart city revolution. We agree. A smart city uses data and technology to help drive efficiencies, create sustainable initiatives and actions, and engage citizens to improve community life.

To grasp this opportunity to lead and to grow, electric utilities must go beyond today's evolving smart grid—with its improved grid sensors, smart meters, and improved utility-customer interactions. To help lead the smart city movement, electric utilities need to be principal players in implementing what we might call the next generation

power grid, an active and intuitive grid that responds to system changes and makes decisions in real-time at the edges of the distribution network. This enhanced power grid will facilitate more efficient transactions with minimal transaction costs, will apply smart technology to Internet of Things (IoT)-ready networks, and will allow electric utilities to achieve efficiencies and reduced carbon emissions, while also providing a platform to make communities more livable and smooth functioning.

Electric utilities are a key driver to economic prosperity. Today, they have a unique opportunity to lead the smart city revolution. Consider the following functions necessary for every smart city:

1. Empower Sustainability. A smart city is a sustainable city. By investing in smart technologies, electric utilities can play a key role in providing customers detailed information about their energy and water usage, along with other programs to incent conservation.

2. Drive Economic Growth. Electric utilities can provide cities with a competitive edge by driving city-wide efficiencies and, according to IDC research, support socio-economic initiatives to reduce economic divides, grow domestic industries, and attract skilled workers.¹

3. Deliver Safe and Reliable Resources. In many U.S. cities today, electric and water infrastructure is more than 100 years old. By upgrading infrastructure with smart grid technologies, electric utilities can better align supply with demand, improve service delivery and reliability, and support the use of clean energy sources.

4. Adopt Industry Best Practices. While development of a strong vision and roadmap is important, cities can learn from other stakeholders that have pioneered the smart cities path. One example is Envision America, a program of Envision Charlotte, established to share best practices and challenge America's cities to utilize smarter resource conservation technology, build cross-sector collaboration, and commit to developing innovation to improve quality of life.

5. Encourage Collaboration. A truly smart city involves not only multiple departments within a city, but goes outside its walls and convenes city leaders, electric and water utilities, universities, businesses, technology partners, and

citizens. An integrated approach with open communication and cross-sector collaboration is essential for a smart city to thrive. Demonstrating true collaboration, Spokane, Washington's Smart City Accelerator is run by a group of partners that lead in their respective fields, including the local electric company, Avista; Washington State University; and Itron. This initiative will create a living laboratory in the 770-acre University District to advance urban innovation and emphasize the critical interactions among health, water, energy, food, and buildings.

6. Prioritize Open Standards Network Infrastructure. Investing in a smart grid network with open standards can provide a foundation for a smart city. Open standards provide the mechanism for effective two-way communications. With sensors and intelligence embedded in every device, the network provides the backbone for all city connections and the capability to use real-time data to reduce energy and water waste.

7. Create an Open Pathway for Innovation. By committing to an open network, electric utilities open the door to innovation—new technologies and applications that can accelerate the development of an ecosystem of IoT apps, such as resource management, building energy management, smart-street lighting, and solar monitoring.

8. Leverage the Power of Data. Data is instrumental to the success of a smart city, whether to reduce water and energy losses or to enhance lighting controls, building efficiencies, safety measures, or other applications. Smart devices, including sensors and smart meters, provide real-time data that can be turned into actionable insights. For example, using energy, water, waste, and air quality data, Envision Charlotte, the smart city initiative in Charlotte, N.C., is connecting people with information to drive sustainability goals and reduce waste in office buildings. Since 2011, the initiative has achieved a 16.4-percent reduction in energy usage, which is about \$17 million in savings.

9. Engage Participation. Successful smart cities create the foundation to engage, inform, and empower citizens. Leveraging actionable insights from data and real-time reporting, utilities can engage with consumers around energy and water usage and conservation, not only helping them to make decisions about their impact on energy, water, and waste, but also notifying them when to take quick action.

10. Lean on Partners and Experts. The pathway to developing and implementing a smart city is far more complex than any one company or entity. For example, once an electric utility implements smart technology, investing in managed services to administer the back office

technology and software can help a city more quickly realize smart city benefits. In the South Pacific, Tonga Power Limited (TPL) is installing smart grid technology, which features open standards and enables distributed intelligence, to help meet its goal of becoming a smart island. TPL will use managed services for overall system management and maintenance of Itron's cloud-based services for data collection.



Utilities have a unique opportunity to lead the smart city revolution through the adoption of smart technologies and by engaging with cities in these 10 key areas.²

1. IDC FutureScape: Worldwide Smart City 2016 Predictions, November 2015.
2. Visit www.itron.com/10tenets to learn more.

“ So, what’s next?
Anyone can stand in
the defense of what
is. But who’ll stand
as champions for the
potential of what can
be? Utilities are an
obvious candidate. ”

– ROGER WOODWORTH

Utilities as Champions, Again

ROGER WOODWORTH

Vice President, Avista Corp. and President, Avista Development

Reliable. Safe. Affordable. Who could argue with such standards for the delivery of electricity? By and large, electric utilities have championed and kept this promise for more than a century. The industry has performed so well, in fact, that some see operation of electric infrastructure as utilities' only relevant role today. But beyond infrastructure, utilities are part of the very fabric of each community they serve and are well-positioned to enable their customers to achieve so much more. And not just with energy.

The rapid advance of technologies and the digitization of information fundamentally change what's possible—even with something as conventional as the power grid. Proof of such change abounds in the many new market entrants that are combining sensing, analytic, and communication technologies with alternative business models to offer customers new options for energy and related services. Indeed, much more is possible.

In the face of such trends, the U.S. electric power industry is on a foreseeable path to invest billions of dollars to modernize aging utility infrastructure, enable the system to integrate and optimize distributed energy, and deliver new, sophisticated services. The result of this investment will certainly be a smarter, more resilient grid—one that's even more reliable, safe, and affordable. But this begs a question: "Is that all?"

What if utilities layered new technologies into the electric system to do more than deliver electricity and optimize control of the grid in smarter ways? How might utilities add to *what they plan to do anyway* to deliver value in new, unexpected ways and, in so doing, strengthen their relevance to the communities they serve?

THE MOST EMPOWERING INVENTION

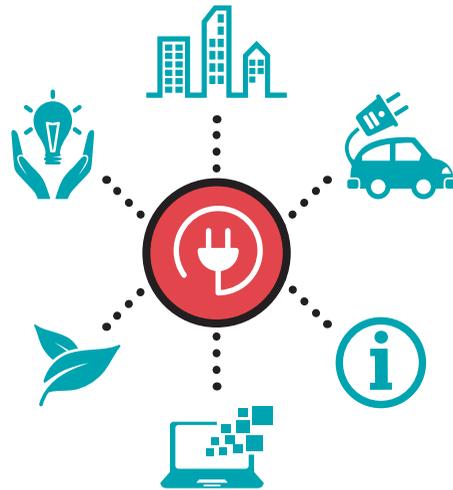
Imagine utilities as champions for improving the quality of life. This role dates to a time when electricity was

new, a technology unlike anything before. Utilities enabled the hot in your shower, the cold in your beer, and lights at the flip of a switch. To this day, whether you live in a small house or the White House, electricity relieves the burden of work; powers productivity; enables entertainment; and connects consumers in ways never before possible. Little wonder then that electrification was voted the greatest engineering achievement of the 20th century by the National Academy of Engineering.

Electricity truly is the most empowering invention, and yet... . Recently, in response to this declaration, a seasoned utility executive's impulsive retort was, "No, it's the Internet!" He quickly recanted, of course, because without electricity there is no Internet. Even those closest to the complexities of delivering this highly valued service can lose sight of power's pervasive influence on every aspect of our personal and professional lives.

So, what's next? Anyone can stand in defense of what is. But who'll stand as champions for the potential of what can be? Utilities are an obvious candidate. They are already trusted operators of a ubiquitous system that empowers society. So, in addition to a cleaner, more resilient electric system, how might utilities leverage their assets, capabilities

and other resources to improve the built environment and serve society in new ways?



Expanding the Grid's Role

A MODEL TO MIMIC

As the above story of the executive suggests, whether utilities expand and strengthen their role and relevance depends first on the mindset of leaders. Champions of anything must first understand and embrace the higher purpose they serve. Then, a combination of wisdom and innocence helps open eyes to see fresh opportunities. Finally, the courage to act and adapt separates value-builders from the pack.

As a point of reference, consider the transitional experience of Amazon. In simple terms, new technology enabled an alternative model for the

distribution of books—the real kind, printed on paper. Once built, the same distribution system could then be leveraged for delivery of other products of all kinds, driving a new wave of growth.

Along the way, Amazon faced the potential disruption of e-books as an alternative to print. By integrating e-books into the delivery system—coupled with another new enabling technology, the Kindle—Amazon again expanded its role and relevance to consumers. Of course, all of this Internet-enabled distribution requires a system of computer servers so robust that excess capacity could be shared, even with competitors. That led to Amazon Web Services.

Reflect for a moment on Amazon's experience. What if Mr. Bezos had defined Amazon as strictly a distributor of printed books and printed books only? What if e-books were kept apart from, rather than made a part of, the distribution system? What if he'd refused to leverage Amazon's assets in to new, diversified services? What if he'd fought to protect only that which he'd first created rather than stand as a champion for something more, something greater? To the good fortune of many, he did none of these things.

Amazon's transitions offer potent lessons for utilities paying attention and

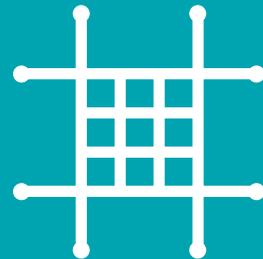
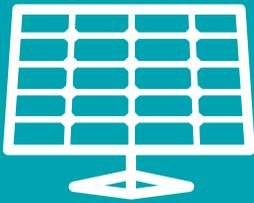
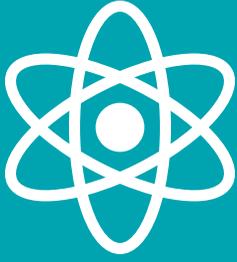
willing to step-up: don't be hidebound by past success. Embrace enabling technology. Integrate the new to optimize the whole. Leverage what is into what can be.

THE SMARTER CITIES OPTION

Utilities must continue to honor the promise of reliable, safe, and affordable electricity. As the grid is modernized, new technology will enable a smarter, more resilient electric system. But more is possible. With technology, the ability to sense anything, anywhere, at any time is on the rise, as is the capacity to store and to analyze digitized data.

How might utilities—as trusted purveyors of electricity—combine and integrate these new capabilities into new streams of value in service to communities? What role might electric utilities play toward improving water services, building operations, transportation modes, and more?

The time to experiment with such options is now, while the bulk of modernizing investments lies ahead. Along the way, we're certain to discover new value that utilities can deliver—as curators of prosperity. As champions, again.



ENERGY FUTURE

The future can be a hazardous place, so we best not forget Yogi Berra's admonition, "You've got to be careful if you don't know where you're going, because you might not get there." The authors of the essays in this chapter have their feet on terra firma and a good sense of what lies ahead. But, ultimately, the path to the future is never quite clear.

Ralph Izzo, Chairman, President and CEO of PSEG, reflects on a call he fielded in the aftermath of Superstorm Sandy with President Obama. The President wanted to know when Newark Airport would be operational again and when the northern New Jersey petroleum refineries would be back online. PSEG's 2.2 million electricity customers all had similar questions. Electricity powers nearly everything we do, so reliability and resilience are vital.

Our society and our economy are more dependent than ever on electricity, and customers want safe, reliable, clean—and affordable—energy. Energy efficiency, our most cost-effective resource, is critical to the future. But, the future also means we will need more collaboration with technology firms, Izzo says, to innovate and bring customers the services they want. In the future, he believes, we will value the power grid even more. It's the best battery on Earth!

Arizona Corporation Commissioner Bob Stump cleverly peers into the future through the lyrics of a Gershwin song, "Our love is here to stay." Central station power plants and the power grid are here to stay, he says, as is a new partner—distributed energy resources.

Stump observes that electric companies and distributed generation advocates often act like an unhappy couple, attached for life, with quirky co-dependencies. For example: renewable energy has price stability, which natural gas lacks. But a steady and stable supply of natural gas can moderate the variability of renewables. In the end, Stump notes, all of us in the energy arena are in this together, and together we will "go a long, long way" if we simply recognize it.

Robert Marritz, Editor and Publisher of *Electricity Daily* and *ElectricityPolicy.com*, concedes that the electric power industry is navigating rough seas and a profound transition. But, he believes that electric companies are also facing four great opportunities, which he describes.

“ With our eyes on the future, we believe energy companies need to go beyond reliability by providing greater resiliency, produce electricity in concert with the environment, and offer tools and innovations to customers. ”

-RALPH IZZO

A Clean, Efficient, Affordable, and Resilient Energy Future

RALPH IZZO

Chairman, President and CEO, PSEG

On October 28, 2012, I was standing in PSEG's control room with our operations team watching as a big storm moved up the East Coast. We were grateful that the U.S. forecasting service that tracks weather said we would miss the worst of the storm. But the European computer model didn't agree. It said we would get slammed, and indeed we did. New Jersey was hit with the most destructive storm in its history: Superstorm Sandy. Devastation was widespread—massive flooding and tens of thousands of downed trees everywhere. Ninety percent of our customers were without electricity. The storm impacted everyone.

The next day, Edison Electric Institute President Tom Kuhn facilitated a conversation with energy company CEOs and the President of the United States. The President asked a lot of questions, including: When would we have Newark Airport back online? When would the oil refinery industry in northern

New Jersey again be able to produce gasoline so people could drive?

We also received calls from many customers. One was from a heart surgeon, who asked: "I have two open heart surgeries scheduled for today. Can you get us back?" Somehow, we did.

Two million of our New Jersey customers discovered that 10 days without electricity are 10 days without computers, lights, TVs, hot water, hairdryers—even cell phones and iPads, once their batteries died.

Their feelings at that time were perhaps best summed up in an email from a parent. She wrote, "I know you have a lot of customers to restore. But if you don't get my electricity back on today, I am sending my teenager to live with you!"

The moral of the story is simple: From the President of the United States to that heart surgeon to that parent—our society is more dependent than ever on electricity.

For our customers, reliability is no longer enough. They want resiliency and expect that we will get their power back on quickly when it is lost, even if due to a major storm. And they want the system to be better prepared for those storms so they don't lose power in the first place.

Customers also want clean energy. For the last roughly 40 years, this nation has implemented stronger environmental protection, and this will continue well into the future.

Especially since Sandy, people are increasingly aware of and concerned about the environment. They know something different is happening with the weather. And, whether they believe in climate change or not, they want to breathe cleaner air and want us to reduce emissions.

There are a variety of ways to reduce emissions: Carbon-free nuclear generation produces about 20 percent of our nation's electricity. Renewables clearly have a growing role. At PSEG, we've invested more than \$1 billion in solar on our network, and our customers have spent millions more on private rooftop solar systems. We recently completed our 28th grid-connected solar facility and the eighth to be built on a landfill or brownfield site, feeding clean energy to all of our New Jersey customers.

Clearly, these customer expectations—for greater resiliency and greater environmental protection—come with a price tag.

But when do people even think about electricity? When they don't have it.

Supplying an essential service that your customers take for granted is a challenge, whether it's a business, or that surgeon, or that stay-at-home parent. How do you get people to pay for something when they only recognize its value when it's gone?

The solution requires innovative thinking about how energy companies are regulated and how all of us use technology.

The vision I have for our company is for our customers to use less electricity and natural gas to achieve the same level of comfort or economic output. Energy efficiency can be a critical part of the solution. After all, the cheapest and cleanest kilowatt is the one you don't use. This is where we need to get policy makers to think first. And, indeed, in many states across the U.S., many policy makers have taken steps to support energy efficiency, which is attracting more investment but has enormous untapped potential.

The second area is technology. Energy companies need to partner with technology companies and innovators to

develop and apply technology that can help customers use energy more efficiently, while also making sure that it's more cost-effective, clean, and reliable. It's the only way to keep bills affordable while delivering cleaner and more resilient energy.

This does not mean, as some might suggest, that customers should become islands unto themselves. Most everyone wants the service we provide because it's there at their fingertips and they don't even have to think about it. It seems magical, but it's real. That's why the network is important.

There must be recognition of the value of networks. Increasingly, we may choose not to own our cars; we can share via Lyft and Uber. We don't necessarily need to own a bicycle; we can share one via Citi Bike. And, we don't even need to own a second home. We can borrow one through Airbnb.

Increasingly, what we are seeing today is people recognizing the value of networks. And what is one of the most amazing shared networks? The energy grid. Even owners of the most decentralized resources, such as private solar on the rooftop, recognize the value of the energy grid to export their occasional oversupply and to make sure they are connected 24/7, when their own private solar may not be producing exactly the

amount of energy they are consuming. I see no reason why our industry should now do the opposite of what the rest of the economy is doing.



The electric power industry has a proud past. With our eyes on the future, we believe energy companies need to:

- Go beyond reliability—by providing greater resiliency.
- Produce electricity in ways that are increasingly in concert with the environment.
- Offer universal access not just to natural gas and electricity, but to tools and innovations that allow customers to lower their bills.
- And accomplish all of the above while working to keep electricity affordable.

It's no small challenge. But if we get it right, we have the opportunity to create a robust energy sustainability model for our nation's future.

“ All of us in the energy arena are in this together—trying to secure an affordable, reliable, and sustainable energy future—and we’ll go ‘a long, long way’ if we recognize this key fact. ”

—BOB STUMP

What's Here to Stay?

BOB STUMP

Commissioner, Arizona Corporation Commission

The other day, as I was going about my business, a jazz standard popped into my head. The song was George and Ira Gershwin's "Our Love is Here to Stay." You may remember the lyrics:

*The radio and the telephone,
And the movies that we know
May just be passing fancies
And in time may go
But oh my dear
Our love is here to stay
Together we're going a long, long way.*

Believe it or not, the song sheds light on today's energy dramas, which have become as intense as any telenovela or Puccini opera.

When pondering our energy future, it's critical to consider what is, or isn't, a passing fancy, and what is "here to stay." It is safe to say that central station power plants, and the grid, are here to stay—even though some wish that they "in time may go."

Distributed resources are also here to stay. Sweeping environmental regulations, lower clean energy costs, smart

devices, greater customer empowerment—these also appear here to stay. Yet few predicted the shale revolution, the death of coal, flat demand for electricity, widespread penetration of renewables, and so on. Trying to provide a snapshot of the future is a daunting task, but I will do my best, with a nod to the Gershwins.



Electric Utilities + **DG Advocates**

First. The shale revolution has inarguably been one of the most important energy events of our lives. Solar, wind, and natural gas constitute most of the new build in the U.S. today. Market forces, together with state renewable portfolio standards, are all driving

decarbonization. With coal on death watch, and little or no new nuclear in the U.S., natural gas will likely replace an enormous amount of today's base-load power. Indeed, worldwide, over the next decade, more natural gas will likely be installed than any other power source.

Second. It's important to achieve efficiencies from old technologies, such as extending the lives of nuclear plants. Upgrading an old plant brings benefits, but data analytics to maximize its output can bring even greater benefits.

Third. Resource diversity matters. Thankfully, the nation has gone from one diverse mix to another over the past 10 years: From about 50 percent coal; 19 percent natural gas; 19 percent nuclear; and 9 percent hydro and other renewables to about 33 percent coal; 33 percent natural gas; 20 percent nuclear; and 14 percent hydro and other renewables. As such, it appears that the U.S. is not abandoning the tried-and-true for the next hot thing.

Fourth. Arguably, no other nation affects our energy future more than China. Going forward, new capacity in China will include hydro, renewables, and nuclear at the expense of coal. China's economic slowdown has reduced demand for oil, contributing mightily to the historic collapse in its price. China's

solar photovoltaic (PV) manufacturing sector drove down PV costs dramatically, and now China is installing solar at a record pace. In 2014, China added more solar and wind than Europe and the United States combined.

Fifth. It often feels as though electric utilities and distributed generation advocates are subjects in an arranged marriage in which one party or the other is suing for divorce. Yet they recognize, in their heart-of-hearts, that they're attached for life and must learn to live together. Other forms of technology are also co-dependent. For example, renewable energy has price stability, which natural gas usually lacks. Gas, in turn, helps solve renewables' intermittency issues.

Will the natural gas and electric industries work more closely to align their interests, as legacy assets retire and renewable energy resources continue to grow? How will the interrelationship between central station and distributed resources play out? Energy efficiency, energy-management systems, electric vehicles—innovation is everywhere, and everything is interconnected. Decentralized and centralized, disruptive and traditional technologies, markets here and abroad—none is isolated from the other.

Together, as the Gershwins say, solar and energy storage can indeed “go a long, long way.” But will the water and energy sectors work together more closely, as they should?

The utility must redefine its mission as it interacts with consumers and third-party providers. How will it adapt to a customer-driven model? Allegedly, the average customer spends just a few minutes a year pondering his electric utility. Will new customer choices change this?

Will we regulators develop rates that support grid upgrades and allow seamless integration of new technologies without impairing reliability? What will the utility’s core services be? Will it be a power grid manager and aggregator? As more points of entry proliferate, with more points of entry for hackers and evildoers, mustn’t utilities pursue more sophisticated data analytics and cybersecurity? Will the utility remain a vital anchor in an increasingly dispersed system?

Sixth. When it comes to packing the biggest punch against carbon dioxide (CO₂) reductions and keeping costs down, many argue that big beats small. A greater emphasis on customer empowerment can lead to inefficiencies. Can customers feel empowered via distributed resources without our

investing too heavily in less efficient means of production? Will customer-produced power come to seem over-rated, if it means higher energy costs and lower reductions in CO₂?

It’s been said that in terms of relationships, we have a choice in life—to be lonely, or to be irritated until death do we part. All of us in the energy arena are in this together—trying to secure an affordable, reliable, and sustainable energy future—and we’ll go “a long, long way” if we recognize this key fact. We may irritate more than love one another as we travel the road ahead, but the brighter energy future we all seek will be well worth it.

“The electric utility’s role as the power grid manager, operator, and planner to coordinate and integrate resources into the grid has never been clearer.”

—ROBERT MARRITZ

Electricity Today and Tomorrow: Clean, Consumer-Oriented, Collaborative

ROBERT MARRITZ

Editor and Publisher, Electricity Daily and ElectricityPolicy.com

The electric power industry today faces the greatest collection of opportunities it has seen in more than 50 years, perhaps since the advent of Thomas Edison's Pearl Street Station in lower New York, where it all began.

Yes, the problems electric utility companies face are immense and challenging: meeting competitive threats; satisfying hard-nosed analysts and restless shareholders; pleasing customers who take electricity for granted; and navigating a complex and largely outdated regulatory system that breeds its own pressures.

But consider these four opportunities.

America and the world are committed to a clean energy future—something the electric power industry can, in part, provide. It matters little

whether we go 100-percent renewable, or just move toward that goal. The energy that electric utilities provide is increasingly clean.

America depends on the power grid.

The grid is an amazing technology that efficiently delivers reliable and safe energy so customers always get the power they need. It is the cheapest, best battery there is.

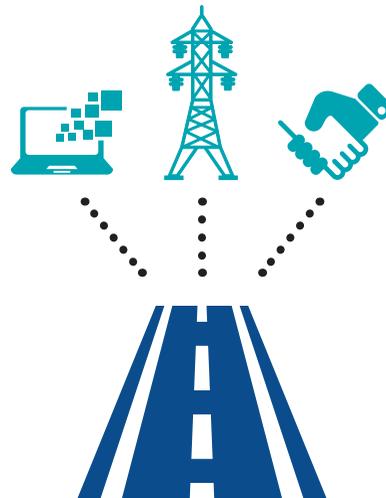
A huge growth opportunity exists for electric utility companies, as the transportation and buildings sectors move toward clean energy. Both sectors are carbon-intensive and would benefit from greater electrification. The move toward electric transportation, in particular, could significantly reduce carbon emissions.

Technology is opening channels to customers and communities that electric utility companies should be part of. As Avista Corp.'s Roger Woodworth told attendees at the Institute for Electric Innovation's (IEI's) Powering the People event in March 2016, there is growing interest in smart cities. Communities worldwide are wrestling with how they can function better—for transportation, safety, water, power, and education. "How might utilities combine and integrate new [digital and distributed grid] capabilities into new streams of value in service to communities?" he asked. Shouldn't utilities have a seat at the smart cities' table?

With new energy choices increasingly available, utilities are engaging with customers to help meet their objectives. Meeting customer needs is what utilities do, which is why companies like Dominion Virginia Power, Duke Energy, and NV Energy, among others, are helping large corporate customers like Apple, Google, and Microsoft meet their clean energy and sustainability goals. The utilities take pains to assure that the arrangement is not only revenue neutral for its other customers, but possibly beneficial. The World Resources Institute, World Wildlife Fund, and Rocky Mountain Institute recently formed a Renewable Energy

Buyers Alliance to support the dozens of companies that want to invest in clean energy. Some utilities are already active in this area and others can be too if they are nimble and customer-centric.

Many smaller customers also want to go solar, and they want choices too. In states where regulation allows, utilities can offer their smaller customers an easy option to access solar, as a Utah company is doing. Cindy Crane, President and CEO of Rocky Mountain Power said her company is sponsoring a novel approach—a form of community solar they call Subscriber Solar—that makes solar available to customers who want its benefits but prefer to avoid the investment and other issues associated with installing private rooftop solar panels themselves.

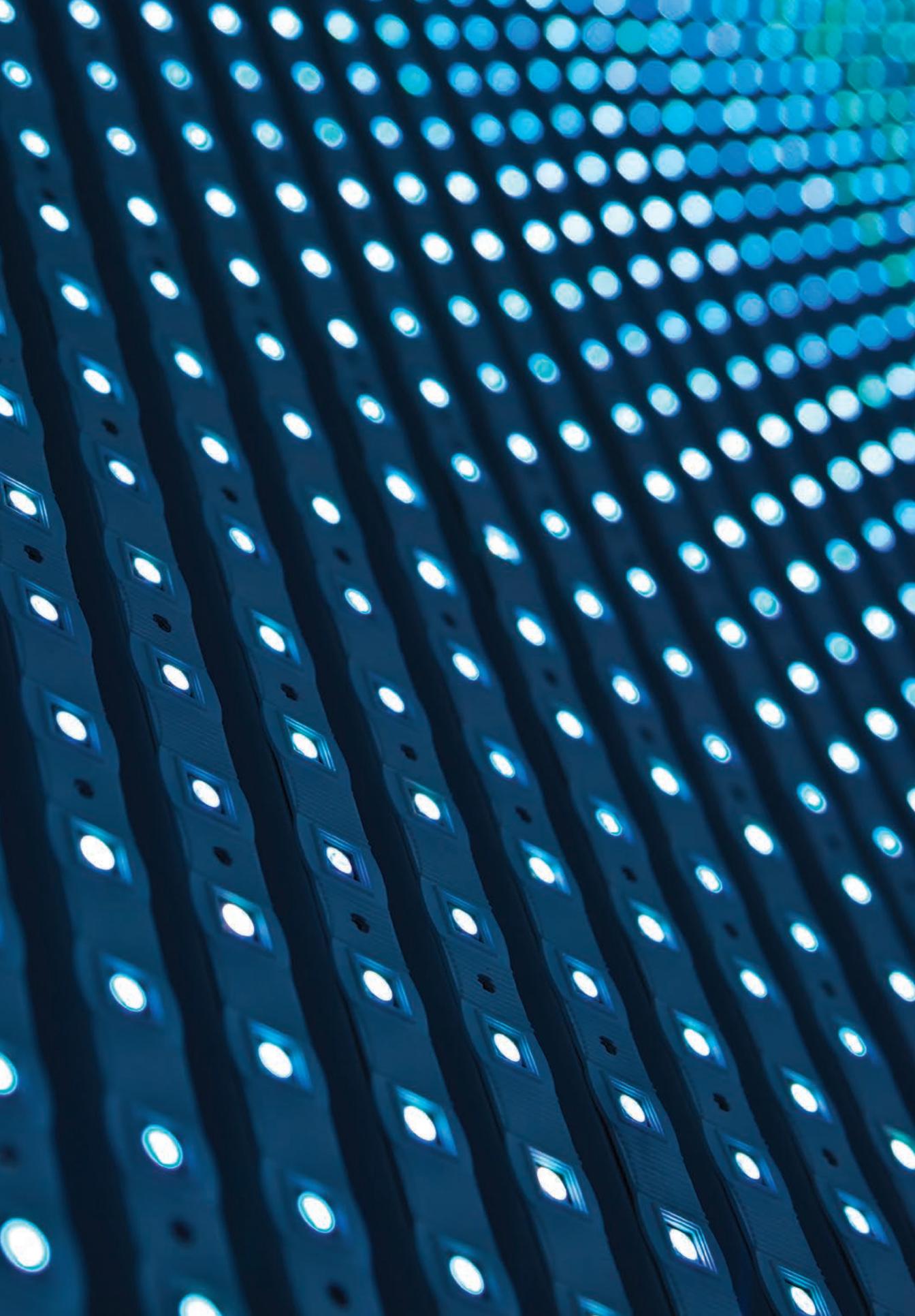


Collaborative Future

Collaboration with technology companies and close relationships with customers will be key for utilities in the future. As NorthWestern Energy CEO Bob Rowe noted at IEL's Powering the People event in March, "We're good at projects, we're good at networks, we're good at the community level working with people. But we're not going to have the magic application," so it behooves energy and technology companies to work together. And, in fact, many are doing just that.

It's certain that clean energy and distributed resources are here to stay, and that technological innovation will be driving industry change. While there will be growing numbers of participants active in the energy space, the electric utility's role as the power grid manager, operator, and planner to coordinate and integrate resources, large and small and ever more complex, into the grid has never been clearer.

The four opportunities noted at the beginning of this essay should be opening enough for the alert, nimble, and customer-centric electric utility company.



About the Institute for Electric Innovation

The Institute for Electric Innovation focuses on advancing the adoption and application of new technologies that will strengthen and transform the power grid. IEI's members are the investor-owned electric companies that represent about 70 percent of the U.S. electric power industry. The membership is committed to an affordable, reliable, secure, and clean energy future.

IEI promotes the sharing of information, ideas, and experiences among regulators, policy makers, technology companies, thought leaders, and the electric power industry. IEI also identifies policies that support the business case for the adoption of cost-effective technologies.

IEI is governed by a Management Committee of electric industry Chief Executive Officers. In addition, IEI has a Strategy Committee made up of senior electric industry executives and a select group of technology companies on its Technology Partner Roundtable.

About the Edison Foundation

The Edison Foundation is a 501(c)(3) charitable organization dedicated to bringing the benefits of electricity to families, businesses, and industries worldwide. Furthering Thomas Alva Edison's spirit of invention, the Foundation works to encourage a greater understanding of the production, delivery, and use of electric power to foster economic progress; to ensure a safe and clean environment; and to improve the quality of life for all people. The Edison Foundation provides knowledge, insight, and leadership to achieve its goals through research, conferences, grants, and other outreach activities.



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