THOUGHT LEADERS SPEAK OUT:

The Evolving Electric Power Industry

The Edison Foundation
INSTITUTE for ELECTRIC INNOVATION

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The Evolving Electric Power Industry

Edited by:

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Executive Director, Institute for Electric Innovation

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“Today the electric power industry—a fundamental industry that powers our economy and our lives—is in the midst of a profound transition. There are intense debates in almost every state about how this transition should evolve.”

–LISA WOOD

Introduction

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

It's easy to forget how much we depend on electricity. Yet, without it, we can't pump gas or water, turn-on our air conditioners, power our computers, charge our smart phones and tablets, or access our money from an ATM. Electricity is both a service and a commodity. In the US, electricity is a reliable, affordable, plug-and-play service that we all largely take for granted.

Today the electric power industry—a fundamental industry that powers our economy and our lives—is in the midst of a profound transition. Among those most involved—electric utility leaders, technology company executives, policy makers, consumer advocates, environmentalists, and other stakeholders—there are intense debates in almost every state about how this transition should evolve.

No longer an industry of one-way power flows from large generators to customers, the model is beginning to evolve to a much more distributed network with multiple sources of generation—both large and small—and multi-directional power and information flows. This is not a hypothetical future. It's already unfolding.

This book is a collection of essays by electric utility and technology company leaders, policy makers, and other stakeholders focused on three distinct and interrelated areas driving the evolution of the electric power industry today—the Evolving Grid; the Evolving Customer; and Evolving Regulation.

EVOLVING GRID

The distribution grid is an area where we are probing new opportunities for efficiency and facing new challenges. The distribution grid is becoming a platform to integrate a diverse set of energy resources, large and small—from traditional thermal generating plants, hydro plants, and large-scale wind and solar farms to generally smaller, more local resources such as combined heat and power plants, rooftop solar systems, community solar gardens, micro-grids, electric vehicles, storage,

demand response, and energy efficiency. This new vision will require and foster increased interaction among utilities, customers, and third parties. The grid edge—which lies between the distribution utility and the customer—holds opportunities and challenges for both utilities and customers.

Managing the integrated grid platform will require utilities to continue to maintain, upgrade, and modify their distribution systems; to invest in technology; and increasingly to collaborate with three key strategic groups: technology companies, whose innovative products and services plug into the grid; regulators, who define appropriate business models for the grid platform and determine "just and reasonable rates" for customers, while assuring that the utility remains a healthy and viable business that can meet customers' needs; and customers, who have specific needs and desires.

EVOLVING CUSTOMER

Electricity customers today expect service. They are used to it in their desktop and mobile communications, and require it in the electric service that drives their many devices. They expect the best service and the lowest prices, and they want maximum flexibility, maximum choice, and maximum value. But, they also expect, as they have for decades, high-quality and reliable service at an affordable price. Today, some customers want rooftop solar panels, but they also want reliable electricity around the clock. For customers, this is the beginning of a new era of choice and control over their energy supply and use that's unlike anything seen before. Increasingly, customers are gaining access to technology that gives them unprecedented ability to tailor their energy use to their personal needs and wants. The key issue that customers face is whether utilities, technology companies, and regulators can collaborate to help them take advantage of new service offerings and unlock the value in those services.

"The key questions for policy makers are whether the regulatory paradigm can be redesigned to best support the power industry transition that's underway and whether this can be done collaboratively."

EVOLVING REGULATION

The power grid is evolving. Customers are evolving. Utilities too are changing in response to competitive pressures, customer desires, and policy directives. But the regulatory model remains essentially unchanged.

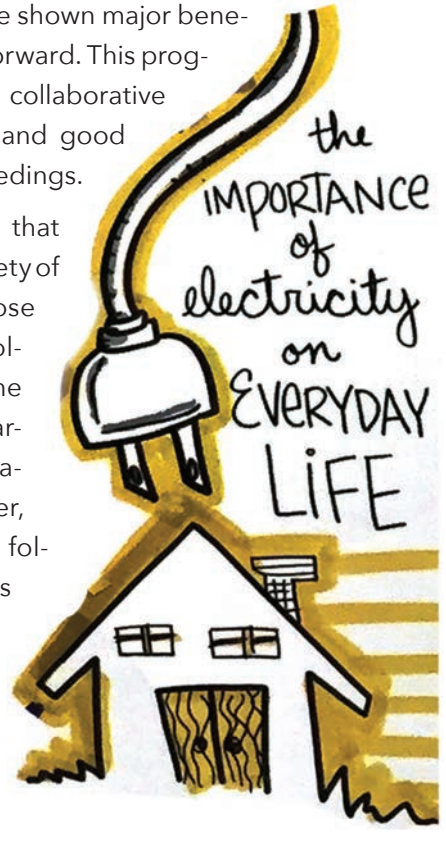
State regulators are dedicated, hard-working public servants, but do they have the tools to induce both efficient and innovative behavior by the power industry and its customers? Our regulatory statutes were written for an era that is largely past: plain vanilla, unidirectional service by the utility, quite different from the multi-directional grid model that we're moving toward today and from the requirements for vastly improved technology and the agility that it demands. Many programs utilities are asked to support–to promote energy efficiency, demand response, and distributed energy resources–are contrary to their motivation under the current regulatory structure, their ability to raise capital, and their responsibility to shareholders.

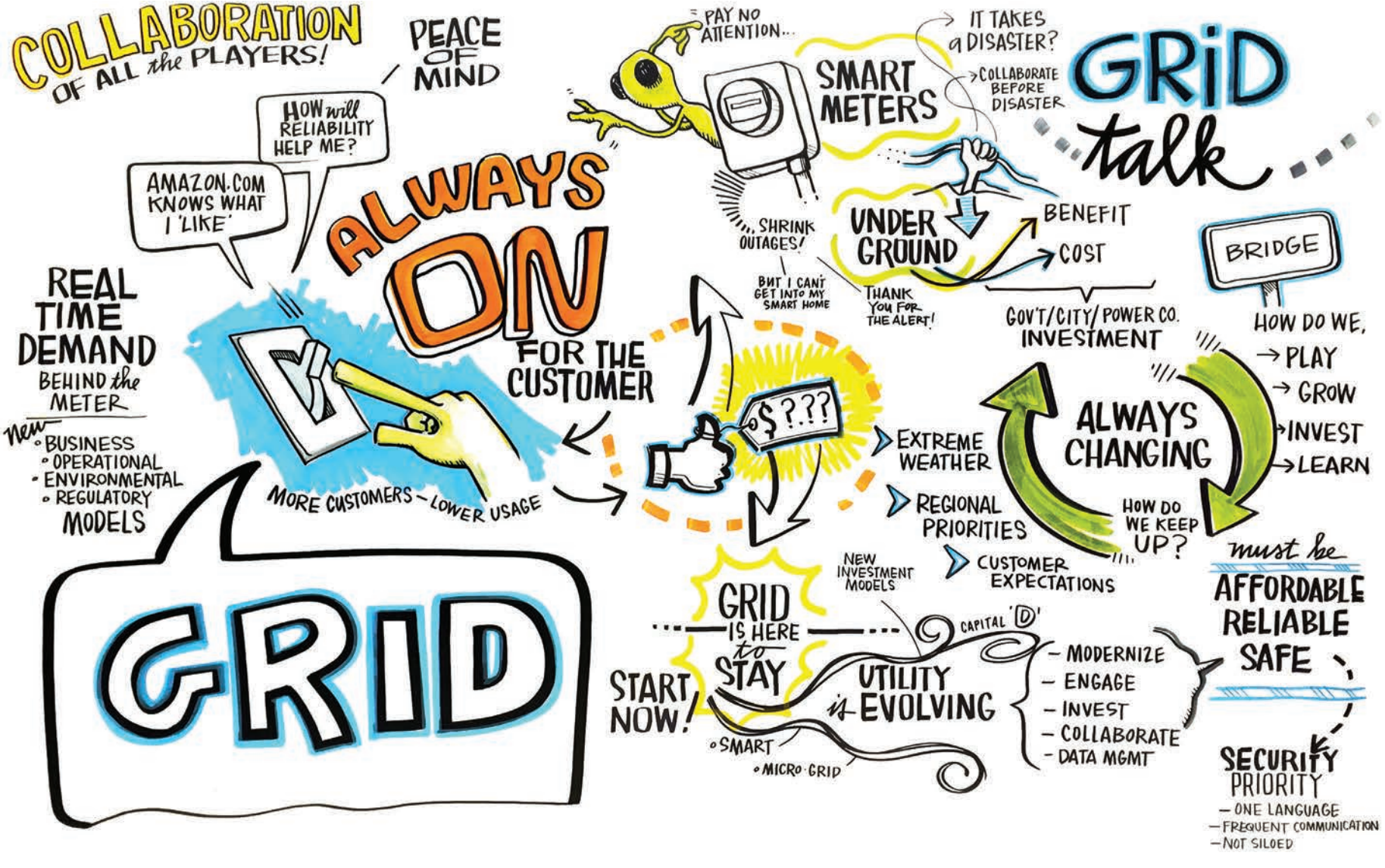
This paradox is widely recognized, but typically is addressed piecemeal and has not resulted in a redefinition of the regulatory paradigm in a fundamental way–one that could benefit not only electricity customers and utilities, but also the broader public interest.

Regulation is the essential link between the utility and the customer and carries within it the explicit duty to uphold the public interest. The key questions for policy makers are whether the regulatory paradigm can be redesigned to best support the power industry transition that's underway and whether this can be done collaboratively.

In a few states, informal meetings involving utilities, regulators, technology companies, consumer advocates, environmentalists, and other stakeholders have shown major benefits and may point the way forward. This progress has occurred through collaborative processes based on trust and good faith–not adversarial proceedings.

The authors of the essays that follow represent a wide variety of stakeholders not unlike those involved in these state collaboratives. Indeed, in some cases, they are active participants in those collaboratives. I invite you, the reader, to consider the essays that follow as an addition to this very necessary and timely discussion of the evolving electricity industry.




COLLABORATION
OF ALL the PLAYERS!
PEACE OF MIND
HOW will RELIABILITY HELP ME?
AMAZON.COM KNOWS WHAT I 'LIKE'
ALWAYS ON
FOR THE CUSTOMER
REAL TIME DEMAND
BEHIND the METER
new
• BUSINESS
• OPERATIONAL
• ENVIRONMENTAL
• REGULATORY
MODELS
MORE CUSTOMERS – LOWER USAGE
GRID
PAY NO ATTENTION...
SMART METERS
IT TAKES a DISASTER?
COLLABORATE BEFORE DISASTER
GRID talk
SHRINK OUTAGES!
BUT I CAN'T GET INTO MY SMART HOME
THANK YOU FOR THE ALERT!
UNDER GROUND
BENEFIT
COST
GOV'T/CITY/ POWER CO. INVESTMENT
BRIDGE
HOW DO WE,
→ PLAY
→ GROW
→ INVEST
→ LEARN
$???
EXTREME WEATHER
REGIONAL PRIORITIES
CUSTOMER EXPECTATIONS
ALWAYS CHANGING
HOW DO WE KEEP UP?
must be
AFFORDABLE
RELIABLE
SAFE
NEW INVESTMENT MODELS
GRID IS HERE to STAY
START NOW!
UTILITY is EVOLVING
capital 'D'
• SMART
• MICRO-GRID
– MODERNIZE
– ENGAGE
– INVEST
– COLLABORATE
– DATA MGMT
SECURITY PRIORITY
– ONE LANGUAGE
– FREQUENT COMMUNICATION
– NOT SILOED

EVOLVING GRID

Today's electric distribution grid is hurtling along in an evolution that often feels like a revolution. In addition to its traditional role—delivering electricity to customers reliably and affordably, around the clock—the grid is becoming more efficient and flexible: a platform for efficiently integrating new energy resources, new technologies, and new devices into the system. With an information technology overlay, as well as investment in more sophisticated operating technology, the grid also is becoming a more flexible network that will deliver energy multi-directionally, both from large generators on the transmission grid and from smaller, distributed energy resources throughout the distribution system.

As the essays that follow make clear, this evolving grid will improve reliability and resiliency. It will enable more interactive customer services, applications, and choice. It will remain affordable, while also being more resistant to external threats posed by extreme weather, sudden resource changes, or cyber attacks. It's becoming a smarter grid—active, dynamic, and able to respond to changing system conditions in real time. It's also becoming a more connected grid—a Grid of Things™—as more and more devices and technologies are plugging into the network.

The evolving grid also must be a catalyst for innovation, capable of automatic high-speed decision-making and seamless operations throughout the network to ensure that resource operations are efficient. From coast to coast, aided by platform-enabled programs like Con Edison's Brooklyn Queens demand management program and Southern California Edison's preferred resources pilot that focuses on next-generation energy efficiency, demand response, distributed generation, and storage, the grid is doing more and doing things differently.

For tomorrow's distribution network to operate efficiently and largely automatically will require investment in new tools—sophisticated information technology and operating systems—and a readiness to look outside the industry to partner with non-traditional players that are technology innovators. Increasingly, utilities must endeavor to "see around the corner" to identify breakthrough opportunities.

All of this will require thoughtful public policy and partnerships that recognize the value of the grid as a unifying network that delivers reliable, affordable, safe, and increasingly clean electricity.

“We have the opportunity now to enable an even better, smarter energy future for our kids and grandkids. And the path to that future runs through the 21st-century electric grid.”

–CHRIS JOHNS

Grid of Things™

Chris Johns
President, Pacific Gas & Electric Company

By 2020, 80 percent of the world's adults will have a super-computer in their pocket. That's a staggering projection from a recent article in *The Economist*.

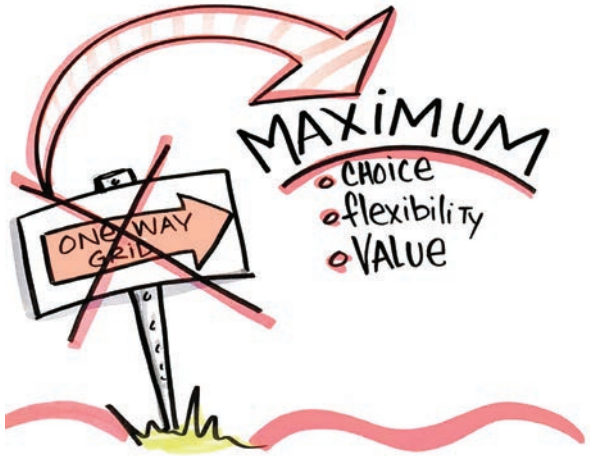
More than that, those super-computers will be super-connected. Cisco estimates the number of things connected to the Internet by 2020 will hit 50 billion. And when these predictions become reality, amazingly, we'll likely take them for granted.

All this is relevant as we think about how the energy business is evolving. Technology and innovation are moving so fast and becoming so hyper-connected that they're creating a whole new world of possibilities and reshaping our expectations as consumers.

Today we can get what we want, where and when we want it, and we expect it to be very personalized. Our customers have access to technology that offers them unprecedented visibility and control, allowing them to tailor their energy usage to their budget, schedule, and environmental goals.

It's an era of choice and control over our personal energy unlike anything we've seen before—and it has only just begun.

The question for our industry is: how do we help customers unlock value—from clean energy and efficiency goals, to improved reliability, resiliency, security, and power quality?



PG&E'S VISION

At PG&E, our vision is called the Grid of Things™.

Like "the Internet of Things," where seemingly everything in our lives is interconnected, the same thing is happening in our industry, where the technologies that our customers want to pursue are connected to an increasingly modernized and integrated grid.

Besides being able to put a solar panel on the rooftop, our customers may want a battery in their garage and to have these technologies work together. They may want to charge their electric vehicle anywhere and anytime and sell stored electricity back to the grid for demand response.

They may also want to plug in new devices and access new services from other providers, and expect seamless communication with the utility. They might even want to sell excess power from their rooftop to their neighbor at the push of a button, using their Smartmeter and Smartphone.

"Our customers expect us to develop and maintain a grid that gives them *maximum flexibility, maximum choice,* and ultimately, *maximum value*."

Our customers expect us to develop and maintain a grid that integrates all of this technology in a way that gives them *maximum flexibility*, *maximum choice* in how they use their energy, and ultimately, *maximum value*.

As we've learned from the mobile phone, its far more valuable when it's super connected. So, at the same time, the grid itself needs to get stronger and more flexible.

All this means the grid is going to be just as indispensable and valuable for the next 100 years as it has been for the last 100 years. If we're serious about fully realizing the potential of all of this innovation, about making renewables the go-to technology of the future, or reaping even bigger gains from energy productivity for our economy, I believe the Grid of Things™ is the paradigm we need to think about.

CHALLENGES

The challenge today is modernizing the grid to become that platform of integration. There are three key areas for us to focus on.

The first is investment. We must continue to invest in grid modernization, which means more than replacing wires and pipes. It also means putting in sophisticated information technology and operating technology, and data analytics capabilities that allow us to optimize that technology.

It means adding new voltage controls to allow the grid to handle power from multiple resources, and advanced sensors that give us visibility and flexibility in how we run the system. It means providing new grid services to our customers, like electric vehicle charging stations.

It also means greater automation. Over the past few years at PG&E, we've invested in smart switches that have helped us avoid millions of minutes of interruptions for our customers and moved us toward our goal of a self-healing grid.

The second key is having the right policy approaches. We need policies that are smart about supporting and encouraging innovation in our industry while ensuring continued safety, reliability, and affordability.

The third key is to continue driving innovation. We also need to focus on partnerships. Innovation in our industry once came largely from within. Now much of it is driven by non-traditional players. We're going to see more of that. At PG&E, we are actively reaching out to these companies and looking for opportunities to work together.

PG&E is excited about this work. We're excited about building the Grid of Things™.

This is an incredible time in our industry. People are thinking about and engaging with energy like never before. We have the opportunity now to enable an even better, smarter energy future for our kids and grandkids. And the path to that future runs through the 21st-century electric grid.

We look forward to what the future holds for our company, our customers, and our country.

“It is time to lift our sights to think—and act—more boldly. We need to fundamentally rethink the way we deliver, manage, and use energy.”

–PHILIP MEZEY

Shifting from Smart to Active

Philip Mezey
President & CEO, Itron

A century ago, Thomas Edison could only dream of where his inventions and innovations would lead modern society. His brilliance brought electricity to homes, businesses, and factories over a grid—a pivotal development in the industrialized world. A key to his success was constantly challenging himself and those around him to think bigger and broader.

Fast forward to today. Where do we find ourselves on the path Edison trail-blazed? I think Edison would challenge us: "There's a way to do it better—find it."

Imagine what we could do if the modernized grid was more than just a connected grid. Or if the grid could evolve to be more dynamic and actively solve problems. We need to expand how we think about the grid and innovate for the changing utility landscape. The time to take the next step in optimizing how we manage and use energy and water is now.

THERE IS A BETTER WAY, AND TOGETHER WE CAN FIND IT

Our industry has a history of innovating that is too often overlooked. A mere 30 years ago, battalions of meter readers walked house-to-house to record readings. They would then pass their hand-written hard-to-read notebooks to armies of clerks who painstakingly calculated the bills. But then automated meter reading (AMR) was pioneered, changing the face of the industry at the time, improving the experience for our customers, and creating unheard of productivity and customer-service gains for utilities.

In fact, we perfected the current meter-to-cash model. By moving from manual reads to AMR, and finally to advanced metering infrastructure (AMI), we've saved the average consumer $23 per year in meter reading costs alone.

In that same period Bill Gates ignited a technology revolution at Microsoft with a bold vision that there should be a PC in every home and on every desk. Today, 35 years later, a recent cover story in *The Economist* predicts that by 2020, 80 percent of adults in the world will have a supercomputer in their pocket.

Bold visions and innovative technology are revolutionizing every sector. Yet, even with the advancement of AMI, it is easy to feel that our industry has plateaued. We talk smart. Smart

metering. Smart cities. Smart grids. Smart technologies all used to improve efficiency and reliability, while empowering consumers to better manage resources. But we stop short of the next major advancement. Trapped in old thinking while facing massive new resource challenges.

It is time to lift our sights to think—and act—more boldly. We need to fundamentally rethink the way we deliver, manage, and use energy and water.

Growing populations are hungry for more energy and water. A more complex mix of demands is taxing current systems. The challenges are real and require that, beyond innovation, we must *challenge the model*. We need a sea change in the way we think about and pursue innovation, and the way we implement technology.

Historically, our Western approach to resource challenges has centered on two simple strategies: produce more and, more recently, *use less*. While effective at times, such an approach fundamentally overlooks the profound reality that we are incredibly wasteful and inefficient.

In the US alone, an incredible amount of electricity, gas, and water is wasted every year because of aging infrastructure and inefficiencies.

- We lose $13 billion in water every year. That's an expensive leak.
- We lose $24 billion annually in electricity transmission and distribution.
- It costs the US $2 billion per year for natural gas that is unaccounted for and never used.

Add it all up and we lose nearly $40 billion every year simply wasting resources! We can no longer assume that our existing systems are good enough. We must address waste. When we do this right, we will be defining the utility of the future.

CREATING AN ACTIVE & DYNAMIC GRID

Today, our networks and devices simply move data around, and that's fine. It's worked for years. But it won't work much longer. Increasing demands will outpace our ability to produce or conserve. Electric vehicles, renewable energy, and distributed generation are forcing us to rethink the structure and operational suppleness of the grid. We're moving away from a centralized generation and delivery model toward a dynamic, distributed collection of micro-grids and two-way power flows that will need to be synchronized, monitored, and maintained in real time.

Today, we collect reams of data and make long-range plans looking backward. We need to envision and create a grid that is active, dynamic, and secure, with the ability to respond in real time. The *active grid* leverages data to make real-time changes, where and when they're needed.

The active grid harnesses the power of the Internet of Things (IoT) to reduce waste, improve efficiencies, and create value for both utilities and communities. Cisco, the world leader in networking, is betting its entire business on IoT and its projected $19 trillion payout. The power and promise of IoT applies across all industries, and it applies to us.

At Itron, we're expanding our global presence by creating IoT-compatible devices, software, and applications with the computing power not only to measure and communicate, but to solve problems on the grid in real time. These solutions, for example, determine where and when water leaks are occurring, detect leaks and other potential dangers in gas pipes before they do harm, and dynamically manage outage conditions through an intelligent, distributed, and self-aware network—improving safety, reliability, and, ultimately, profitability.

Billions of connected devices on the Internet are creating unprecedented amounts of data. Big data. But "Big Data" is overhyped, overrated, and overstated. All the data in the world is worthless if you don't know what to do with it. Utilities, businesses, and consumers don't need more data. They need the *right* data, and they need it at the *right* time.

We need information that allows us to interpret consumption patterns, quickly identify problems and opportunities, and more efficiently allocate resources. Collecting data in a central data store and running reactive analytical data modeling only gets us so far. Having dynamic analytical engines throughout the network that accelerate and improve our decision-making and shorten the time it takes to react to dynamic grid conditions—that's the next wave of transformation!

Data that moves us from managing delivery systems with forecasts and insights built on historical data, to real-time insights and the ability to take action on the health of that system will allow us to manage the resources we have today as we use them.

We've been looking at production and conservation as the two sides of the coin. In reality they're on the same side of the coin. It's time to flip the coin and understand that on the other side lies waste and resourcefulness. Can we be more resourceful? Yes, and we must.

In the last 30 years, we used automation to optimize the way we deliver energy and water. In the next 30 years, we'll transform automation. Let's attack the remaining waste in transmission and distribution by harnessing the power of the IoT. We'll deploy field devices and software with the processing power to make decisions and solve problems in real time.

Let's reduce waste. Let's use the tools we have and those we will develop to become more efficient in delivering, managing, and using energy and water. It's time to create a more resourceful world, together.

“We are modernizing our grid as a smart energy network that improves electric reliability and resilience while adapting to integrate new energy sources, products, and services.”

–KENNETH M. MERCADO

The Grid of the Future: Evolution or Revolution?

Kenneth M. Mercado
Senior Vice President, Electric Operations, CenterPoint Energy

Viewers of the short-lived TV show "Revolution" witnessed a world returned to the dark ages after the collapse of the electric grid. Although the show was fiction, real fears have been expressed about a so-called utility death spiral, in which customers will disconnect from the grid *en masse*. I do not share that fear. I believe that while the electric grid is undergoing a rapid evolution, the grid is here to stay!

In fact, the growth of distributed energy resources (DER) and demand for customer choice and energy reliability will make the grid *more* important than ever as it evolves from a one-way energy delivery system into an energy network. Today's always-connected consumers demand reliable, secure, affordable electricity to power their busy lives and businesses. They want more control over their energy choices. Around the country, stakeholders are debating the future of the electric grid as consumer demands and alternative energy sources grow.

In Texas, it's not a question of investing in either DER or in grid modernization. At CenterPoint Energy, we are modernizing our grid as a smart energy network that improves electric reliability and resilience while adapting to integrate new energy sources, products, and services. As it evolves, the grid of the future must, at minimum, do five things.

IMPROVE POWER RELIABILITY AND RESILIENCE

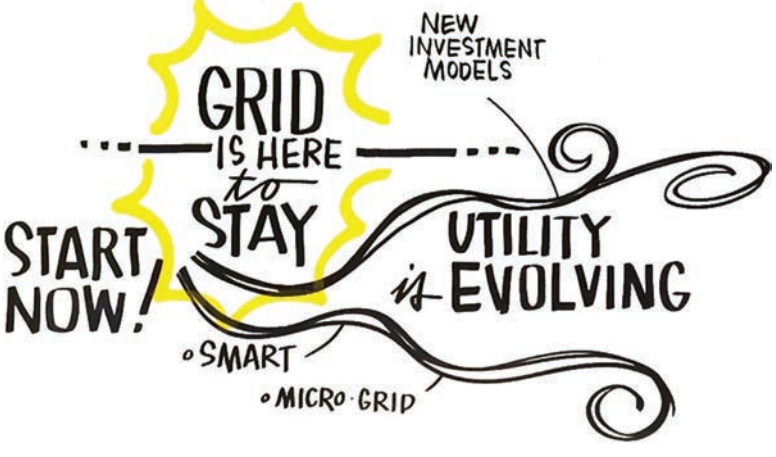
Customers want fewer and shorter outages—even during disasters. After Hurricane Ike hit Houston in 2008, calls arose for replacing wooden poles with steel or burying all the lines underground, which would be far too costly. Instead, the Mayor's Task Force concluded that Intelligent Grid technology offers the best investment to improve power reliability and resilience.

CenterPoint Energy agreed. We installed 2.3 million smart meters throughout Houston that automatically notify us of power outages. As a result, we have restored power to more than 1 million customers without a single phone call to report the outage. The meters, along with advanced data analytics, help us localize outages faster, which helps us restore power more quickly.

We have installed Intelligent Grid switches on circuits serving more than 417,000 customers, through which we can isolate outages and reroute power. This reduces outages for some customers from hours to minutes. Since 2011, we have saved customers more than 100 million outage minutes through grid automation. In 2014, we improved reliability by 28.5 percent using our intelligent grid, and most recently installed our Advanced Distribution Management System.

ENABLE CUSTOMER SERVICES, APPLICATIONS, AND CHOICE

Consumers expect the same kind of service from their utilities that they get from banks, phone companies, and others, including access to more information in real time. CenterPoint Energy's smart energy investments provide a platform for new electric products and services such as energy analysis tools, pre-paid service, time-of-use rates, peak-time rebates, and our new Power Alert Service.



Smart meters give consumers more frequent, detailed electricity usage data. Hundreds of thousands of Texans are taking control of their energy use with this information. According to ERCOT, more than 700,000 Texans are enrolled in time-of-use rates or peak-time rebates and they are compensated for reducing load during peak events.

CenterPoint Energy's Power Alert Service gives 400,000 enrolled consumers automatic notification of outages at or near their home or business by phone call, email, or text. This notification includes an outage cause, crew status, estimated restoration time, plus confirmation when power has been restored. Customers today expect such proactive, personalized service.

INTEGRATE DISTRIBUTED ENERGY RESOURCES

A growing number of customers want cleaner energy and/or the ability to generate their own solar or wind power, operate a micro-grid, or store energy via batteries or electric vehicles. Texas generates more wind power than any other state and is also a leader in energy storage development.

"Powerful data analytics give utilities better, real-time insight into the grid."

CenterPoint Energy's smart grid, with its two-way communication and multi-channel meters, provides a platform for integration of DER. We must integrate both utility-owned and customer-owned assets serving the grid. It's a collaboration. Just as some customers will relinquish control of their thermostat to support grid reliability, utilities must prepare to adapt and relinquish some control to consumers. However, as utilities, we must also understand how DER impacts the grid and prepare to manage a grid that is a multi-point network rather than a one-way transmission and distribution system.

REMAIN AFFORDABLE

Many things compete with energy for a share of consumers' wallets: food and shelter, computers, smart phones, entertainment, etc. These all depend on energy, so power demand will remain high, but consumers want energy prices to stay low.

Smart-grid-enabled products and services such as energy analysis tools, time-of-use rates, peak-time rebates, and pre-paid service can help consumers save energy and money. In fact, one-half to two-thirds of the consumers we've surveyed who use these tools say they are taking energy-saving measures as a result.

Generating their own power is another way for customers to manage their energy costs, after a significant up-front investment. However, I believe that if energy prices stay low, most consumers will be happy to leave power generation and delivery to the experts as long as they get a reliable supply of power and a choice of energy sources, products, and services.

BE SECURED FROM CYBER AND OTHER THREATS

CenterPoint Energy maintains a comprehensive cyber security program based on national standards followed by leading companies in the energy, defense, and financial industries. While actively monitoring the security of our systems, we also employ outside vendors to audit our security practices and test the protection of our systems.

We understand customer concerns about privacy. Under Texas law, energy usage data belongs to the customer and can only be shared when authorized. No personal customer information is stored on or transmitted by smart meters. The security of the grid, including essential telecommunications and computing systems, remains a top priority for our company, industry, and nation.

American's electric grid is evolving daily. Yesterday's one-way electricity delivery system has today become a two-way network, in which powerful data analytics give utilities better, real-time insight into grid health and give consumers real-time information to manage electricity use. The grid of tomorrow will revolutionize energy markets. The grid is here to stay!

“We have seen our system evolve with the modern world, from the age when the world’s first skyscrapers were being built, to today’s networked, information-driven environment.”

–ROBERT SCHIMMENTI

Roadmap of the Future Grid

Robert Schimmenti
Senior Vice President, Electric Operations, Consolidated Edison Company of New York

Con Edison is playing a central role in the evolution to a smarter and more resilient electric distribution grid. Our company delivers power to 3.4 million electric customers in New York City and its suburbs, where global centers of finance, commerce, and culture intersect in a city that truly never sleeps. We have seen our system evolve with the modern world, from the age when the world's first skyscrapers were being built, to today's networked, information-driven environment. The immense, dynamic LED displays that famously illuminate Times Square every night aptly signify the technology-powered era we operate in today.

New York's Public Service Commission (PSC) too is seeking regulatory transformation. Its Reforming the Energy Vision (REV) initiative is advancing new models for how our utility and others will operate the grid, offering an array of different products and services to our customers and defining a new role as a Distributed System Platform Provider (DSPP). REV ultimately envisions a less centralized, more distributed grid and is meant to foster greater deployment of less carbon-intensive energy sources. Under this paradigm, customers choosing to install distributed energy resources (DER) and micro-grids will likely participate as an integrated extension of the delivery grid. Utilities will be challenged to develop system design and operations to handle greater complexity than ever before, while continuing to meet customers' expectations for safety, reliability, quality, convenience, and cost.

Achieving this vision will requires a significant transition for Con Edison, but also a great opportunity. We see this as the roadmap of the future grid:

- We will continue to invest in grid infrastructure, the backbone for new distributed technology, while actively seeking targeted DER solutions to offset peak demand growth.
- We will accommodate greater penetration of DERs by integrating modern communications and data platforms for smart monitoring and control, and solve interconnection challenges through advanced network systems design.

- We will expand our ability to engage customers in managing their usage by harnessing more data and analytics, and develop incentive programs that will drive their responses.

In each of these areas, Con Edison has several ground-breaking initiatives in progress.

BROOKLYN QUEENS DEMAND MANAGEMENT (BQDM): MEETING PEAK DEMAND GROWTH

A thriving economy relies on reliable infrastructure systems to help sustain growth. In New York City, we are in the midst of a building boom, evidenced by the common sight of tower cranes in every borough. When Con Edison's planning studies forecasted a need to expand our infrastructure to meet rapidly growing electric demand in Brooklyn, the PSC asked us to study non-traditional approaches as part of the solution.

"Continued development of smart grid functionalities will be integral to managing a more advanced grid in which every customer meter and DER installation may become an active node interacting with the distribution system."

We launched the BQDM program to incentivize customers and developers to implement DERs in order to defer a $1.2 billion substation build. Through this program, we expect to add 52 MW of mostly customer-sited DER and energy efficiency solutions by the summer peak period of 2018. BQDM is designed to diversify energy sources and encourage emerging solutions like utility-scale battery energy storage. If successful, the concept may serve as a model for utilities and regulators advancing alternative earning opportunities to reduce reliance on traditional utility rate base expansion.

ADVANCED PV INTERCONNECTIONS: MANAGING A MORE COMPLEX GRID WITH SMART GRID SOLUTIONS

Con Edison's recent innovations in tariff design, interconnection practices, and communication technology have given customers more options for installing distributed generation. That has contributed to doubling the number of new solar installations each year and development of several customer microgrids of ambitious size and scope.

In 2013, we advanced a new smart grid solution enabling customers' large, exporting photovoltaic (PV) systems to interconnect to our network. Uniquely, most of our service territory is served by highly reliable networked distribution instead of more typical radial or loop configurations. Prior to this

innovation, excess PV-generated power flowing into sections of the networks had been restricted, since our system integrity relies on network protection equipment that's designed to open in response to reversed power flow.

To solve this issue, Con Edison engineers designed a smarter network protection scheme that would recognize and respond to faults, but allow power flow to and from the solar customer. The solution was integrated into our SCADA platform, allowing control room operators to communicate remotely with the network protector nodes as well as the customer's PV inverter. Two years later, almost 6 MW of new PV capacity are interconnected in this manner, making up 10 percent of all our interconnected PV.

Con Edison's advanced PV interconnection solution is a step toward more ubiquitous two-way power flow on the distribution system. Recent smart grid investments, enabled by federal stimulus funds, implemented active monitoring and control equipment on both our overhead and underground systems. Continued development of these types of smart grid functionalities will be integral to managing a more advanced grid in which every customer meter and DER installation may become an active node interacting with the distribution system.

REV DEMONSTRATIONS: ENGAGING CUSTOMERS THROUGH NEW PRODUCTS AND SERVICES

Most recently, the PSC has asked us to devise REV demonstration projects with the aim of exploring novel product and service offerings to customers. Underlying this initiative is the idea that utility earnings should depend more on creating value for customers than on investment. We have the opportunity within this demonstration setting to be entrepreneurial and create new business models. Our success will require that we better harness data and use analytics to inform our practices. This will, in turn, require that we develop new skill sets in our work force, and new tools to run our business.

The REV demonstrations, along with smart grid solutions and targeted demand management programs, are all part of an evolution of the grid that will better serve our customers. It is an extraordinary time for the utility industry. With all the technological and regulatory change, however, what remains constant is the grid's essential role in our lives.

> The business and technology decisions our sector makes today will influence grid operations for future generations.

–KEVIN C. FITZGERALD

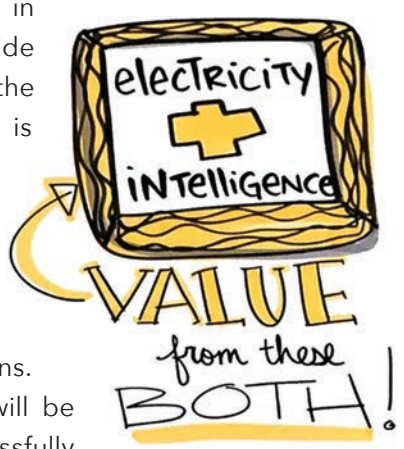
The 21st Century Plug-and-Play Delivery System

Kevin C. Fitzgerald
Executive Vice President and General Counsel, Pepco Holdings, Inc.

The National Academy of Sciences found the electric grid to be the single most important engineering achievement of the 20th century. The network of transmission and distribution wires delivered electricity to all, driving economic, social, and public health benefits. The 21st century has also brought the advent of the Internet and its network of information sharing, data management, and communications, similarly transforming many businesses and industries in the process. The growing connection between the Internet and the nation's energy delivery system holds the promise of unprecedented transformation for the electric industry. Information technology sensors, microprocessors, software and the like ("smart devices") are fast becoming integral parts of the electricity network. Stacking smart devices and the Internet on top of the energy delivery system will allow for greater monitoring, control, and optimization, ultimately leading to a self-healing grid.

Connected products are proliferating in our customers' homes and distributed generation options are becoming more mainstream. Some of these—such as rooftop solar, electric vehicles, and smart thermostats—are already interfacing with our utility systems in ways that challenge us to think about how the grid will need to evolve continually to support new assets.

More than ever before, utilities must focus on their core job, which is to ensure reliability, affordability, environmental leadership, and power quality in the energy services we provide to our customers. Viewing the market through this filter, it is clear that we are at an inflection point. The business and technology decisions our sector makes today will influence grid operations for future generations. Tremendous opportunities will be unleashed as utilities successfully



evolve the grid to serve as a platform for delivering and supporting new energy services. To enable this, we need to focus on two critical areas: (a) optimizing the grid platform, and (b) creating a culture for proactive deployment of connected products and data analytics.

GRID PLATFORM OPTIMIZATION

Microsensors, low cost computer processing, and wireless communications, as well as data management/analytics provide the utility operator with a remarkable set of new tools to drive efficiency in the energy supply chain. For example, smart devices connected to the electric grid can assist in lighting control, room heating and cooling control, and other efficiency measures that reduce consumption. Further, heating sensors, voltage and load monitors, and smart meter data can address predictive maintenance, grid resilience, and electricity theft matters.

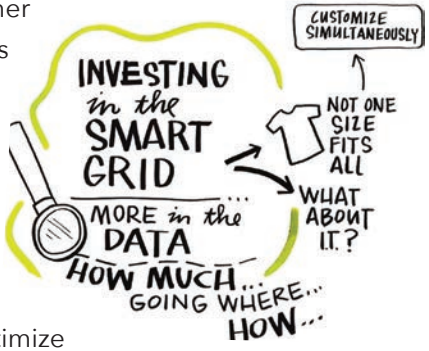
"Stacking smart devices and the Internet on top of the energy delivery system will allow for greater monitoring, control, and optimization, ultimately leading to a self-healing grid."

In addition, those smart devices also serve as the facilitator for new consumer products. Distributed energy resources that reside on the customer side of the meter comprise a significant share of new connected assets. Utilities are the enablers and facilitators of distributed energy resources and storage. This is a natural extension of our role. Where we need to do more, however, is in building out our sensor and control networks to facilitate interconnection as well as appropriate monitoring and control of the constantly evolving grid. This will help ensure that the grid platform is truly a two-way plug-and-play platform for a growing number of customer desires, including distributed energy resources.

DEPLOYMENT OF CONNECTED PRODUCTS AND DATA ANALYTICS

In conjunction with building out and developing the grid platform, we must utilize data in new ways. The reason for this is twofold. First, the useful data available now is abundant! For example, smart devices today can meter their own energy use, and many have machine learning and automatic controls built in, so we can know ahead of time when and how much energy will be used. Second, system oversight is essential! As more things become connected to the grid, the system becomes more complex, and the importance of ensuring that the system

components work together rather than at cross-purposes increases. Fortunately, the new sensor and communication technologies can be used to provide system operators with the information they need to monitor, control, and optimize system resources. By proactively analyzing and drawing insights from available data, we can not only optimize energy development and delivery, but also support more distributed resources and connected technologies on the grid. This transformation of the grid will require utilities to break down historic silos between operations technology (OT) engineers and information technology (IT) professionals.



Ultimately, deployment of smart devices and data analytics will lead to a more reliable, resilient, and efficient grid. Optimizing the grid platform and proactive data analytics will require utilities to work closely with technology companies, regulators, and customers. In doing so, we will encounter new issues related to privacy and security. For example, with more connected devices, access to data and how things are networked becomes a core question for all stakeholders. On one hand, most people will agree that customer data should be as private as possible. However, that same data, when aggregated over circuits, neighborhoods, etc. and networked, will help the grid operate more efficiently. Further, smart devices and data collection/analytics will require enhanced cyber security measures.

By collaboratively working through these challenges with customers and other stakeholders, utilities will unlock the benefits of the evolving grid platform and unleash opportunities that benefit both our customers and the economy.

“As leaders in the industry, we embrace the energy challenges of today and play offense to best create tomorrow’s solutions.”

–MARK S. LANTRIP

Delivering Customer-Focused Energy Solutions

Mark S. Lantrip
Chairman, President and Chief Executive Officer, Southern Company Services, Inc.

The Southern Company system's approach to the grid stems from how we operate our business overall: every decision is focused on providing the best service to the customer. Our ongoing effort to maintain and improve the grid is part of a broader strategy to ensure clean, safe, reliable, and affordable energy for the families, businesses, and communities we are privileged to serve.

Modernizing the grid begins with ensuring that it continues to deliver the electricity customers need safely and reliably. In addition to more than $500 million per year of transmission asset investment, we have already invested more than $1 billion in smart devices, communication systems, and applications. Over the next few years, we plan to invest even more to maintain and expand our grid, making it smarter and more robust.

GRID DEVICES AND OPTIMIZATION

Increasing the number and capability of smart field devices on the grid provides opportunities for improved optimization, resiliency, and reliability. In concert with grid investments, we recognize that IT system architecture must be secure and durable, so our combined smart grid and IT investments are always focused on improving reliability and maximizing the efficiency of operations.

Two particular areas where we have advanced our grid are the Smart Grid Investment Grant (SGIG), in partnership with the US Department of Energy; and Advanced Metering Infrastructure (AMI), also known as "smart meters." The significant benefits for customers from the efforts funded through the SGIG include our faster recognition of outage locations, improved reliability from quicker service restoration, reduced maintenance costs and equipment failures, optimized grid operations, and enhanced situational awareness and visualization of the system for faster and better decision-making.

Perhaps the greatest benefit of AMI, beyond the cost savings and reduced vehicle emissions from remotely reading the meters, is the operational information the meters provide. Using data transmitted from the meters, we are able to identify

voltage issues on the grid, respond more quickly and efficiently to outages, and take both proactive and reactive corrective action. We have deployed approximately 4.4 million smart meters across our service territory in Alabama, Georgia, and the Florida panhandle.

These are critical steps, as we determinedly pursue ways to better manage and optimize the grid. We are already seeing results: we have experienced a 12-year trend of improved performance in terms of the frequency and duration of outages.

Our vast, 120,000-square-mile service territory makes reliability and resiliency a central focus for Southern Company's utilities. Our investments to harden the grid in the event of adverse and abnormal conditions and events are the foundation that enables us to meet the needs of our customers. With outage communication technology, online outage maps, and drawing on our prior experience with severe weather events, we have the resources and technology to provide real-time information to our customers about our service restoration efforts.

Several years ago, a series of tornadoes caused significant damage across much of Alabama. Our restoration team drew on data from newly-installed smart meters, real-time systems, and aerial imagery to quickly identify the hardest-hit areas and create staging sites and material distribution facilities to support 10,000 restoration personnel from 20 states. IT employees joined field crews, creating a responsive environment for developing and deploying immediate solutions. Under extraordinarily difficult circumstances, our outstanding workforce was able to safely and efficiently restore power.

EMBRACING ENERGY CHALLENGES

As leaders in the industry, we embrace the energy challenges of today and play offense to best create tomorrow's solutions. That's why the Southern Company system is investing in the full portfolio of energy resources—nuclear, 21st-century coal, natural gas, renewables, and energy efficiency. System-wide, Southern Company has added or announced more than 3,100 MW of renewable energy projects since January 2012. We remain committed to robust, proprietary research and development, having managed some $800 million in environmental research and development over the past decade.

"We believe in inventing our energy future. Our bottom line: we must keep the lights on and costs affordable."

In April, we announced the creation of our Energy Innovation Center—a facility dedicated to developing solutions customers need today and will need tomorrow—through collaborative partnerships. We believe in inventing our energy future.

The more than 4.5 million customers across our system value the service we provide. To maintain their trust, we need to safely integrate new technologies while ensuring high reliability. Our bottom line: we must keep the lights on and costs affordable. To harness the velocity of change, we always remember that the customer is our North Star.

Over the past four decades, the consumption of electricity has grown five times as fast as other energy sources in America. Electricity is becoming ever more important to our economy and to improving our standard of living. Our commitment to growth, service, and innovation—setting the trend for the industry—focuses on making the communities we serve better off because we are there.

> The real value of big data comes when we're able to tie it back to our core business processes.

–BRADLEY WILLIAMS

Technology & the Evolving Grid: Top Three Myths

Bradley Williams
Vice President, Industry Strategy, Oracle Utilities

The electricity grid is changing, and changing very quickly. As a former utility engineer, I spent 20 years interconnecting large renewables into transmission and distribution systems in Southern California and in the Pacific Northwest. To do this we had to innovate our approaches to modeling and managing the impacts of renewables on the system in real time, and we had to create forward-looking forecasts that included distribution and substation automation technologies.

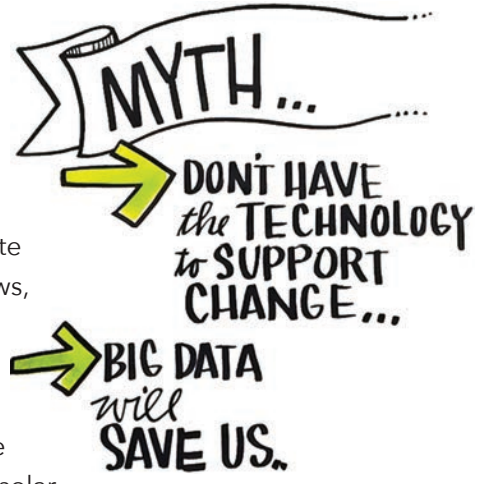
We soon learned that information is critical in order to build a model that will support integrating intermittent renewables into the grid, and to do it safely, reliably, and affordably. It's too easy to say, "Our grid wasn't designed for that." In fact, there are a number of myths that affect our ability to really see where our grid is going. Here are three I want to dispel:

- Myth #1: We don't have the technology to support this vision of the smart grid.
- Myth #2: Big Data will solve all of our problems.
- Myth #3: We can leverage existing operational solutions, expanding them to enable the grid of the future.

MYTH #1: WE DON'T HAVE THE TECHNOLOGY TO SUPPORT THIS VISION OF THE SMART GRID

Myth #1 says we don't have the technology to support where we need to go with the grid, particularly the grid edge, where we see growth in consumer energy technologies. We have lots of data from sensors, home energy management systems, and rooftop photovoltaic, all causing a lot of disruption for distribution operators.

In fact, we're seeing the distribution grid becoming more of a platform. The New York Public Service Commission's "Reforming the Energy Vision" proceeding anticipates the utility becoming a distribution system platform provider with an interoperable plug-and-play platform. That will require changing the way we think about the distribution system.



The distribution system will no longer simply distribute bulk power from transmission lines to end-use customers. It will also need to accommodate two-way electricity flows, and to manage those flows. We will still need central generation resources to provide service, especially when solar or wind are not available, and to respond to other intermittency. We will still need the grid.

But if this new platform is going to be an interconnected environment, as utility engineers we need to ask: how can we provide a platform that can integrate these plug-and-play tools? These technologies exist now. It all starts with modeling the system and being able to integrate large volumes of data to provide real-time simulation, as well as proactive, predictive performance of the distribution grid.

MYTH #2: BIG DATA CAN SOLVE ALL OUR PROBLEMS

Yes, "big data" is a great tool. Of course, I work for a data company, so obviously we embrace big data and analytics. But the real value of big data comes when we're able to tie it back to our core business processes: when we tie analytics back into the real-time processing systems that optimize the grid, or dispatch crews, or tell customers about outages. To do that, we need to be able to integrate with other systems, and to take big data beyond producing cool reports and into very prescriptive automated processes.

MYTH #3: WE CAN USE EXISTING SYSTEMS TO ENABLE THE GRID OF THE FUTURE

For decades, we have used energy management systems (EMS) scaled down to Distribution Management Systems (DMS) to run our distribution systems and scan our more traditional end points and devices. But considering the many transactions we expect at the grid edge, there are limits to what traditional

"We need to be able to integrate with other systems and take big data beyond producing cool reports and into very prescriptive automated processes."

utility EMS and DMS can do. We don't have continuous reporting capabilities from these grid edge devices and there's no visibility beyond the substations with these traditional solutions. In fact, we need a more real-time, model-based approach—one that represents all loads and all resources, and can aggregate that data to connection points on the grid in a much more advanced way than we have ever done in this industry before.

I believe innovation is the only way to break through some of these myths. And innovation requires leadership.

Times of immense change like these challenge us to move beyond traditional thinking, and to provide leadership to pursue technologies that enable us to create a vision of where we want the grid to go.

> As the grid continues to evolve and change, it is important that customers, utilities, technology providers, and policy makers join forces to drive its innovation intelligently and strategically.

–THOMAS R. KUHN

Connecting the Dots

Thomas R. Kuhn
President, Edison Electric Institute

More than any time in recent memory, the US electric power industry is in the midst of a major, long-term transformation. While it is difficult to predict what our industry will look like 20–30 years from now, I firmly believe that our success is contingent upon the strategic partnerships and collaborative efforts that we are charting today.

In today's energy industry, it is critical that customers, utilities, technology providers, and policy makers are all connected through ongoing dialogue and partnerships. This year's *Powering the People* event—and the essays in this book—really drive home the importance of "connected conversations," which are critical to ensuring tomorrow's energy success.

Looking at the bigger picture and how we connect the dots, the starting and end points will always be customers. Utilities have established relationships with customers, and are focused on providing safe, reliable, affordable, and increasingly clean electricity to them.

CUSTOMERS AND TECHNOLOGIES

Customers today expect to be connected all the time and everywhere, and they want to be able to plug in all of their devices and access new services. At the same time, they expect utilities to continue to sustain a power grid that supports their needs, while also giving them flexibility and choice in how they use energy.

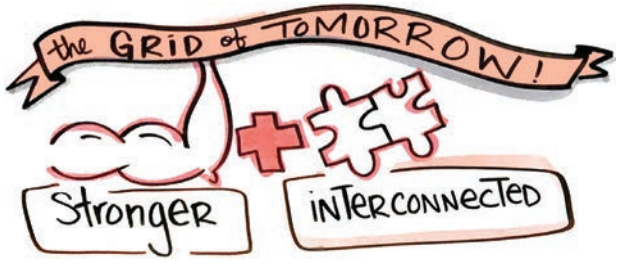
The smart meters and smart rates being deployed nationwide give customers more options and provide new services—bill management tools, energy use notifications, energy efficiency, and smart pricing programs. And the data collected by smart meters allows utilities and customers to better analyze electricity usage to see if it can be tightened or made more productive.

Our technology partners play a significant role in our industry's ongoing transformation, and utilities are working at breakneck speed to integrate new innovations as they come on the market.

Electric utilities are developing and leveraging new technologies to transform how they generate and deliver electricity as they transition to a low-carbon and digital future. We are investing more than $90 billion each year, on average, to transition to a cleaner generating fleet and to enhance the electric grid. Utilities are increasingly integrating more renewable energy resources, particularly solar and wind, in their generation portfolios.

Our industry is also focused on expanding electrification of the transportation sector. From electric vehicles to utility fleets to charging stations to seaports and airports, electric transportation enables utilities to support environmental goals, build customer satisfaction, reduce operating costs, and enhance national security by using more of our domestic resources.

As we continue to incorporate innovation and technology into the power system, it must be done in an evolutionary, not revolutionary, way. It is important that large-scale systems work hand-in-hand with distributed generation technologies; that micro-grids and storage batteries are in balance with traditional transmission towers and lines—complementing one another, instead of competing against each other. Like connecting the dots in a puzzle, thoughtful planning and strategy will be needed to construct a balanced, aligned system. This is where partnerships will be critical.



ROLE OF PUBLIC POLICY

While new technologies and customer expectations play significant roles in our industry's ongoing transformation, public policy is also a major driver of change. When many of us think of infrastructure, we generally think of poles and wires and all of the other assets that are part of the electric power system. But the policy and regulatory framework governing our industry is just as important in determining the value of service, and not simply the cost of service.

It is critical that policies continue to recognize the value that the grid provides, both as a platform for diverse, reliable, and affordable electricity, and as a facilitator for new technologies that give customers more choices and more control over their energy use.

"Since utilities already plan, build, and operate the grid, it makes sense that utilities continue to be the planners, builders, and operators of the grid working in partnership with third-party technology providers and customers."

Since utilities already plan, build, and operate the grid, it makes sense that utilities continue to be the planners, builders, and operators of the grid—provided they do it seamlessly—working in partnership with third-party technology providers and customers. Not only is this the most cost-effective solution, it will also ensure that the reliability and resiliency of the system are maintained. Finally, utilities should be able to go "behind the meter" to offer full service and a range of options to their customers. Often, it is only utilities that offer options to *all* customers.

As the grid continues to evolve and change, it is important that customers, utilities, technology providers, and policy makers join forces to drive its innovation intelligently and strategically. Through conversations, collaboration, and partnerships, we will define a successful energy future together.

“We must also remember to think big and to assess the value of what we do by what we enable others to do through the services we provide.”

–KEITH TRENT

Transforming the Grid of the Future

Keith Trent
Executive Vice President, Grid Solutions & President, Midwest and Florida Regions, Duke Energy

Duke Energy and power utilities everywhere face a rapidly changing future. Emerging mega-trends are already transforming the landscape in which we operate, presenting both great promise and exciting challenges. As we look ahead at how to adapt to create new and added value for customers, it is useful to begin by assessing the legacy grid.

The grid has been a powerful instrument for broad social change and economic development. The National Academy of Engineering recognized the electric grid as the "greatest engineering achievement of the 20th century," ranking it ahead of the computer, automobile, the Internet, and the airplane.

The grid has been the foundation of the many innovative applications that operate on its platform, including nearly all modern technologies. The grid has been an engine of economic development and a catalyst for innovations that continue to enhance our quality of life.

Many people define the electricity industry by its product, but the Academy looked beyond what we produce to all the innovation it enables. The grid, the world's largest integrated machine, allowed independent entities all across the continent to build and integrate their distinct pieces of the system, melding them into a single machine that functions seamlessly with 99.99 percent-reliable power delivery. It is important to connect with these roots. As we look at the challenges ahead, these roots remind us to think big and with the right perspective as we assess new needs and capabilities.

POSITIONING FOR THE PROMISE OF THE FUTURE

Many say that Thomas Edison would recognize the grid of today, but I think it would also surprise him in many ways. Moore's law has enabled significant uplift in capability of the original grid. It's no longer Grid 1.0, but more like Grid 1.99.

The power of advanced computing, data analytics and models, sensors, and telecommunications continue to drive automation, increasing grid efficiency and system optimization. At the same time, many technologies are growing rapidly, including distributed energy resources (DER), renewable energy, and energy storage. All these changes point toward a transformation to the grid of the future, or Grid 2.0.

"Investing in advanced grid capabilities, and integrating new technologies will position us to unlock the full potential of the energy value chain and the grid."

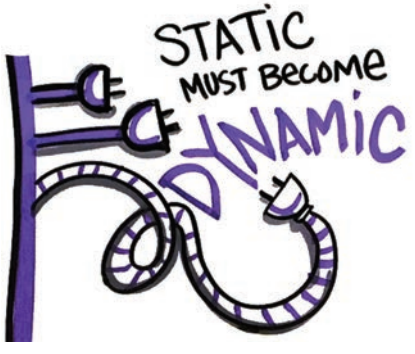
UNLOCKING THE POWER OF GRID 2.0

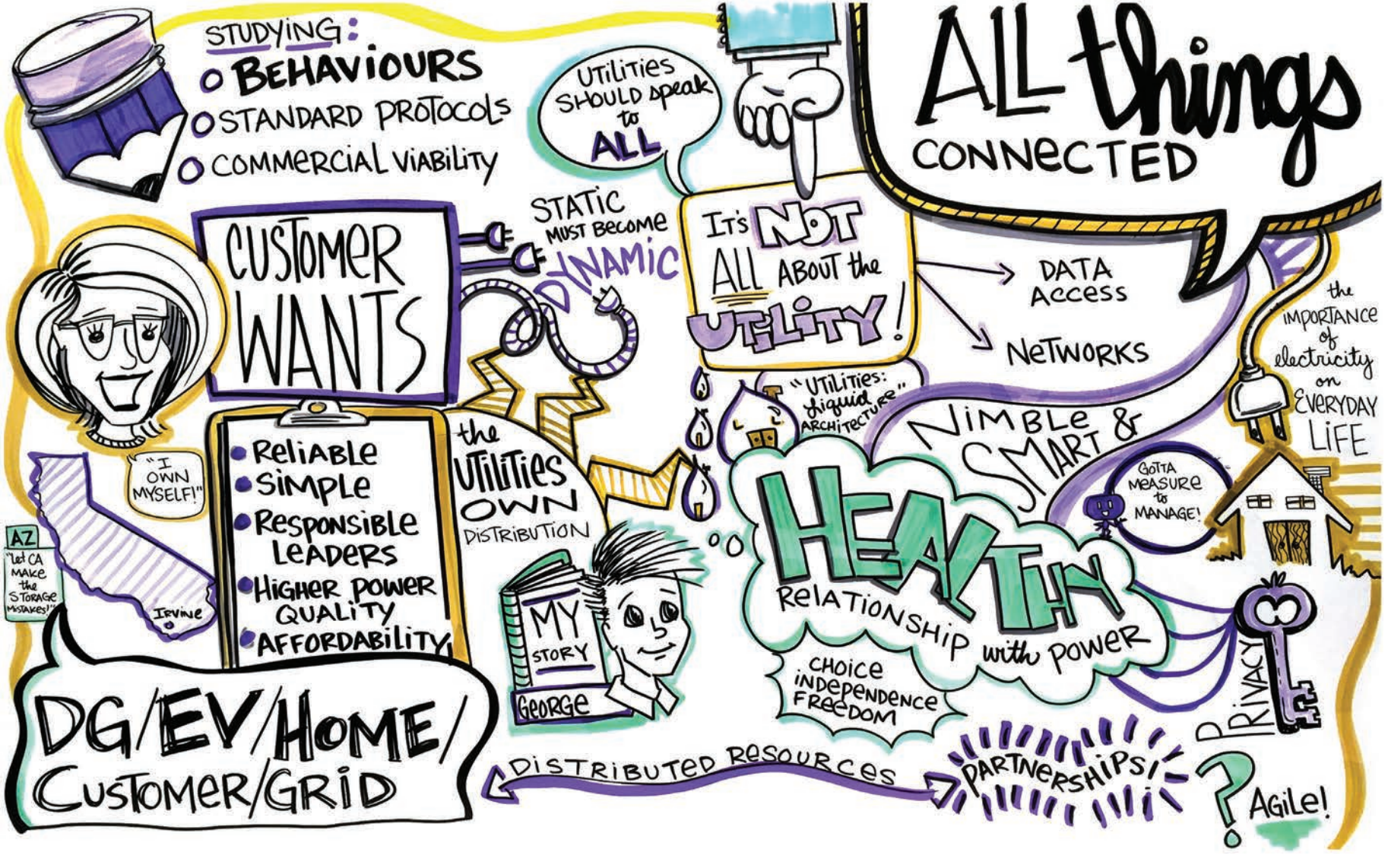
One example of Grid 2.0's capabilities is management and coordination of distributed energy resources to optimize benefits. The dynamic nature of the future grid, with one-way flows replaced by two-way flows, means more high-speed decision making at the grid edges to ensure that resource participation is complementary and not disruptive.

Complementary participation maximizes the value of all resources—those connected to the transmission system, those on the distribution system, and those behind the customers' meters—by mitigating possible negative outcomes, such as localized over-voltage and other adverse system impacts, through high-speed localized decision making. It enhances the customer experience while also maximizing the value to the grid. Duke Energy is currently leading efforts in a collaborative engagement project across the vendor community to enable this capability.

Embracing this potential, investing in advanced grid capabilities, and integrating new technologies will position us to unlock the full potential of the energy value chain and the grid. In so doing, we reconnect with the 20th century grid as an engine of innovation and integration.

We must also remember to think big and to assess the value of what we do by what we enable others to do through the services we provide, for our customers and for the communities we serve.




STUDYING:
BEHAVIOURS
STANDARD PROTOCOLS
COMMERCIAL VIABILITY
UTILITIES SHOULD speak to ALL
ALL things CONNECTED
CUSTOMER WANTS
STATIC MUST become DYNAMIC
It's NOT ALL ABOUT the UTILITY!
DATA Access
NETWORKS
the IMPORTANCE of electricity on EVERYDAY LIFE
"I OWN MYSELF!"
Reliable
Simple
Responsible
Leaders
Higher Power Quality
Affordability
the UTILITIES OWN DISTRIBUTION
"UTILITIES: liquid ARCHITECTURE"
NIMBLE SMART & HEALTHY
GOTTA MEASURE to MANAGE!
AZ "Let CA make the STORAGE MISTAKES!"
IRVINE
MY STORY
GEORGE
RELATIONSHIP with POWER
CHOICE INDEPENDENCE FREEDOM
PRIVACY
DG/EV/HOME/ CUSTOMER/GRID
DISTRIBUTED RESOURCES
PARTNERSHIPS!
AGILE!

EVOLVING **CUSTOMER**

The electric utility customer is changing—and driving change.

Residential customers have more devices connected to the grid than ever. Many commercial and industrial customers have systems that require "clean" power, without voltage spikes and frequency deviations. Accustomed to a high degree of service from leading companies like Amazon, FedEx, and Apple, customers expect excellent service from electric utilities as well, along with plans tailored to meet their needs.

Customers expect utilities to provide reliable, affordable electricity 24/7, while at the same time enhancing the grid; replacing aging infrastructure; providing cleaner electricity; and connecting customer-sited resources and ever more devices. This requires investment—costs that customers will pay—so we also must talk about the price tag that goes along with it. Electricity is an essential service, but the grid also must remain affordable. What do we want and how much will it cost? An informed discussion of these questions involving all stakeholders in a search for mutual understanding is timely and essential.

The essays in this section straddle the gap between utilities' and customers' perspectives on the electricity service that is so central to our lives. If we are to be successful in developing this modern Grid of Things™, that gap must be narrowed.

Here are some customer questions that need to be answered honestly and completely:

- What is a modern grid and why do we need one?
- Why do I need a smart meter and what does it do?
- How are the grid costs reflected in my electricity bill today?
- Should solar energy be developed by solar companies, or utilities, or both?
- Can rooftop solar panels work for customers without a grid connection?

Utilities must take the initiative to educate the public on how the grid works and why it is taken for granted. (Children love to educate their parents, so perhaps this education begins in the schools.) When utilities initiate discussions in their communities—not just when facing a crisis—the services the grid provides and the part that utilities play are better understood.

In the evolving energy landscape, utilities are moving toward operating the distribution grid as a platform for the varied energy resources and services that customers want and need—in other words, to be the trusted service providers for electricity customers. But for utilities to retain that central customer relationship, they must earn and be "seen" in that role. That will require both education and understanding. As George B. Green discovers, in the essay by Commissioner Bob Stump, "Our nation's utilities are uniquely equipped to preserve and improve our energy future by combining reliability with innovative customer-sited resources as few other entities can."

> As a former regulator, I know how essential electricity service is today. For many it's literally the difference between life and death. And, electricity access means affordability.

–MONICA MARTINEZ

Share the Machinations, Mystery, and Magic of the Grid

Monica Martinez
Principal, Ruben Strategy Group

Customers expect access to a safe, resilient, and reliable grid. When they wake up in the morning and look at the alarm clock the first thing that comes to mind probably isn't "Yeah, I love that grid! Great job, utility for keeping the power on!" Believe it or not, the grid is often taken for granted. Now customers are demanding even more of it, and from it. And, why shouldn't they? Technology is constantly evolving in every facet of their lives. Every day, there are new mobile apps to meet their needs and entertainment expectations. So, really, why can't the grid keep pace?

When we talk to our customers, we hear about their expectations of the grid:

- What do you mean you don't know when my house specifically lost power? You operate the grid don't you?
- Why can't you tell me when my power will be restored?
- Why can't you bury my power lines?
- Can I use this cool new app I got with my smart meter?

Then we talk with another set of customers who also have questions and concerns.

- Why do I need a "smart meter"? Isn't my old one smart enough?
- Why do you want to know about my power usage? Are you sharing my information with the government?
- How will these reliability improvements help me?

Customers have different expectations and different needs.

Whether it's the state public utilities commission or the utility, we are all in changing times. For years, we applauded quarterly and annual benchmarks when regulators received fewer contacts from their constituents and utilities from their customers. The system worked. People flicked the switch and the lights came on. We were happy to be in the background and not on the front page or dealing with a crowd of protesters at a public meeting.

Today, regulators can no longer sit idly by, waiting for constituents to contact them—or not. No, they need to engage with the public—maybe even share with them the machinations, mystery, and magic of the grid. And we must confront our biggest challenge head on: the price tag that goes along with reliability and resiliency. Together, we need to explain why these investments need to be made. We need to be willing to engage in cost/benefit discussions—and not just in a filing as part of a rate case. Utilities—that means you too!

Of course, customers expect access. As a former regulator, I know how essential electricity service is today. For many it's literally the difference between life and death. And, in my opinion, access means affordability; service from the grid has to be affordable. This means we must have a cost/benefit discussion with constituencies. We must discuss how we can make investments more affordable. This might mean that the regulatory construct for incorporating costs into rates needs to be revised.

Perhaps we need to consider new business and operational models as well. Whatever the solution, I believe the discussion needs to begin under a collaborative effort with key constituencies and stakeholders—utilities, regulators, policy makers, community leaders, and parties in typical cases. The whole purpose of such a collaborative effort would be to initiate engagement and start a discussion before a crisis.

All too often, action is spurred by tragedy or a severe weather event. When this occurs, there may be a knee-jerk response that is ill-considered. Even the best intentioned efforts can be stymied by misinformation in the public space. Let's not forget the need to invest in general education on these issues.

In an ideal world, customers and constituencies would have that "good feeling" about the grid—like the sentiment in those infamous MasterCard commercials. Imagine: the grid would no longer be taken for granted but, rather viewed as … "priceless."

Until that day, however, our focus needs to be on getting our constituencies talking about grid reliability and resiliency—what we want and what it will cost. When we engage in this discussion we could be surprised by the feedback we get. But we also might learn a thing or two about customer expectations and how we can work cost-effectively to meet them.

"In an ideal world, customers and constituencies would have that 'good feeling' about the grid. Imagine: the grid would no longer be taken for granted but, rather viewed as … 'priceless.'"

You never know—we might even find ourselves in broad agreement and understanding. Agreement and understanding: now that *would* be priceless!

“Our nation’s utilities are uniquely equipped to preserve and improve our energy future by combining reliability with innovative customer-sited resources as few other entities can.”

–BOB STUMP

George B. Green Re-Discovers Self-Reliance and Independent Thought

Bob Stump
Commissioner, Arizona Corporation Commission

Imagine, if you will, a man who wishes to do right–for himself, for the planet, for the community. His name is George B. Green. George lives considerately. When asked to describe himself in three words, he says, "Respectful, mindful, responsible."

George knows the sun is the giver of life and that any effort to impede its energy is morally suspect. George believes he will soon be self-reliant–this great American dream, articulated by Emerson, will soon be a reality. George is seeking "energy independence," "choice," and "freedom."

He's heard Barry Goldwater Jr., Chairman of *Tell Utilities Solar Won't Be Killed* (TUSK), trumpet these virtues. Utilities and other profiteers wish to prevent George from living out the meaning of the American dream. How could they have the audacity to "tax sunshine?"

Renowned energy ratemaking expert Rachel Maddow says that charging solar customers for their use of the grid is "a fine for the crime of using solar." Tom Morrissey, former Arizona Republican Party chair, says, "If we can keep one dollar from going to people who are killing our kids in Afghanistan, it's a good thing–and I feel that's what solar energy does."

George believes something world-changing is upon us. Electric vehicles will let him sing a song of himself, free on the open road, hurtling through a new frontier. He will become a "prosumer," producing as well as consuming energy.

He already uses Uber and his phone is loaded with apps. He feels empowered and individuated, but also more interconnected than ever before. George values independence of mind and genuine self-reliance. Yet because electricity is the most political of commodities, George will have to cut through sloganeering to discern reality.

So, George begins to ask questions. Energy independence? From what? From Middle Eastern oil, perhaps? This isn't yet possible. From the utility? That's not possible, either. Freedom to do what? Perhaps to become energy independent and engage in choice? George feels these are circular arguments.

George learns that the National Academy of Engineering recognized the electric grid as the top engineering achievement of the 20th century, more momentous even than the automobile, the airplane, and the computer.

"George understands that a healthy utility and electric system enables him to achieve precisely the modicum of energy choice and independence he is seeking."

Thus it begins to dawn on George that even using Uber requires public infrastructure, that apps require a network that we all use, and that using distributed generation still means being connected to the grid from which he longs to be liberated.

George begins to see that nearly everyone needs the grid to have reliable electric service. He starts to feel that perhaps we *are* all in this together—his environmental awareness taught him that.

George doesn't quite understand how solar companies are competitors with utilities. They provide intermittent energy. Solar customers are still connected to the grid and need the utility to keep the lights on and to balance their energy needs. Mustn't one be a potential equal to be a competitor?

In the final analysis, even though George admires and wishes to emulate Henry David Thoreau by living off the grid, he realizes that he values the contents of his freezer too much. Utility reliability, he recognizes, is the *foundation* for choice in his life. It provides a freedom and independence that he would miss, should it disappear. He now understands that a healthy utility and electric system—with or without solar—enables him to achieve precisely the modicum of energy choice and independence he is seeking.

And so George begins to embrace a degree of energy independence and choice by employing smart devices. He installs *utility-owned* rooftop solar to make his life easier—thereby living up to what Goldwater called "true conservative principles" by not embracing a net energy metering subsidy George thinks is unfair.

Goldwater had, after all, spoken of equality of opportunity for energy resources in a competitive marketplace. But this is exactly what *foregoing* a net metering subsidy means to George. George also recognizes that taking advantage of the subsidy means a "tax" on the 98 percent of Arizonans in APS territory who choose not to "go solar."

George begins to develop an appreciation for irony: He knows the sun isn't free, that "killing solar" just makes it stronger, that solar is impractical without the utility connection that some pro-solar folks claim to despise. The utility can survive without rooftop solar, but rooftop solar cannot survive without the utility.

Ultimately, George learns that the utility grid is here to stay. Indeed, the solar energy he wants would not power his home without a grid connection. In fact, the grid connection provides a continuous, reliable supply of energy.

For George, Thoreau's Walden Pond would remain a dream. He recalls that even Thoreau had his mother fix him meals during his sojourn in the wilderness.

George finally understands Edmund Burke's maxim: A disposition to preserve, and an ability to improve, is the standard for good public policy. Self-reliance, independence, and freedom—using all the tools at our disposal to manage our energy future—may be achieved by both preserving and improving the electric system and strengthening the regulatory compact between utilities and regulators, while allowing solar to play its part.

Our nation's utilities are uniquely equipped to preserve and improve our energy future by combining reliability with innovative customer-sited resources as few other entities can.

George feels that Emerson would approve of his self-reliance—especially self-reliance manifesting itself as independence of thought, which is such a challenge in today's environment.

“What everyone wants is an affordable solution that treats all parties fairly, leverages the best of technology, applies it locally, and with sustainable values.”

–STEPHEN CALLAHAN

The Times They Are A-Changin'

Stephen Callahan
Vice President, Global Strategies and Solutions, Energy and Utilities, IBM

…you better start swimmin'
Or you'll sink like a stone
For the times they are a-changin'

–The Times They Are A-Changin', by Bob Dylan

Change is coming. No, actually, change is here, looking us right in the eye. Defined by words like smart, disruptive, and hard, change in the electricity industry is in the air, everywhere, palpable in virtually every industry forum. And here are a few of the questions we ponder in this change:

- Can we have smart technology synched with smart regulation?
- Have we really figured out the IT challenges of Smart Grid?
- Are we incentivized to invest in innovation?

These questions are aimed at trying to figure out if it's the regulatory/business model, the technology, or just the underlying DNA of the industry that may impede a smooth transition to what future historians may call the "post-industrial" electricity industry.

Three core drivers have the industry in a maelstrom of uncertainty.

The first is the rise of viable substitutes to the traditional mode of energy supply. These substitutes are more distributed and more uncertain in their operation than the traditional model, but they are also more sustainable and nearing cost parity with grid-provided energy. Their prevalence in the electric energy world is only going to increase.

The second is a fundamentally changed customer–one who uses less energy to obtain the same outcome (think: LED lights vs. incandescent–i.e., lumens per watt), a customer who uses less energy from centralized sources (think: net zero homes and buildings) and a 21st century customer (think: propensity to interact with the world through mobile devices). This customer

"Change is coming. No, actually, change is here, looking us right in the eye."

is different from a familiar one whose interaction is via a monthly bill, the mail, or an occasional unhappy call reporting an outage.

The third is that no matter how disruptive to the current business model substitutes might be, or the complexity of the new customer interaction, the norms of the industry persist. The requirements for safe, reliable, affordable, and increasingly sustainable energy endures. No regulator or customer expects a reduced quality of service or a less resilient energy supply. Expectations are rising, not diminishing!

Given these drivers, it is easy to see why the change dialogue is so prevalent, but identifying the situation is easier than predicting its outcome. Still, the dialogue does seem to present some clear patterns. Among them:

TECHNOLOGY-DRIVEN

The change is technology-driven. That is saying a lot in an industry that uses a lot of technology but is so regulatory-driven. The technology—its economy, its reach, and its richness is making the entire discussion of change plausible. It is not lost on industry veterans that nearly every innovation being discussed (e.g., roof top solar, demand response, and storage) is decades—sometimes many decades—old.

DIVERSITY OF VIEWS

The diversity of the dialogue is rich and there is no single or simple answer. Depending on where you work and live, the economics, the politics, and the physics of the issue suggest that varied approaches and time scales for the change are possible.

CHANGE IS HARD—AND IT SHOULD BE

Perhaps the clearest item that all can agree on is that the change is and will be challenging. The industry is besieged by Johnny-come-lately "innovators" pronouncing the industry decades behind in its technology, its thinking, and its economics. Industry incumbents can learn and be inspired by uncomfortable prodding from outside. But supplying electricity to the world safely, reliably, and affordably is not an arbitrary or a whimsical undertaking and not for the faint of heart.

What is this "post-industrial" electricity industry? It will undoubtedly be more electric, more distributed, and more uncertain—both economically and physically. It is also ever more essential to our economy and our future. It is perhaps this contrast of uncertainty and essentiality that defines the core problem to be solved.

The core problem: What everyone wants is an affordable solution that treats all parties fairly, leverages the best of technology, applies it locally, and with sustainable values. Now that would be change!

“Some people see all this change as a 'disruptive' threat to the utility business. On balance, I see it as an opportunity to make our nation’s power grid more flexible and ultimately better serve our customers.”

–TED CRAVER

A One-Stop-Shop for Customers

Ted Craver
Chairman, President and CEO, Edison International

The needs of our customers are changing. They want more choices, clean and more reliable power, and affordable power.

In our increasingly digital, networked world, reliable service is more important to customers than ever. Power outages, even brief fluctuations, can disrupt a wide variety of microprocessor-based devices, from computers running the Internet to life support systems.

For homeowners, if the power goes out even for a couple of seconds, customers have to reboot all their digital devices. That's not high on their satisfaction list.

Outages are even more damaging for businesses. More and more of our business customers have their processes computerized, so even a momentary outage can knock out computerized controls, requiring them to reboot their systems. The down time can be expensive.

Customers' demands for power quality are only going up. Today our industry averages 99.99 percent availability—less than an hour of downtime per year. That sounds good, but it won't be good enough going forward.

Business customers represent about two-thirds of Southern California Edison's load. They all have different requirements for power quality. Some just need back-up systems; others, like those with digital control devices used in manufacturing and high-tech industries, have very high power-quality needs.

Business customers are also very sensitive to price and competitiveness. The power system is a key part of their cost picture, so electricity service must remain affordable. Affordability is important for economic development generally, so that business customers can compete on cost, and for our region's competitive position.

In one initiative, for example, SCE and the Electric Power Research Institute partnered with aerospace company Space X to reduce power anomalies and improve energy efficiency for Space X. This resulted in overall power quality improvement and significant production and cost savings.

We also see opportunities to partner with commercial real estate owners to enable on-site services, like electric vehicle chargers and solar power, to help make their properties more attractive.

All electric utilities have essentially the same mission: to provide safe, reliable, and affordable electricity to its customers. More recently, an important fourth element has been added: to do this in an environmentally responsible way.

California, probably more than any state, has made greenhouse gas reduction a central feature of its public policy. Our challenge is to figure out how to provide electricity with as little environmental impact as possible without choking off growth and job creation.

Distributed energy, especially rooftop solar, is here to stay. In California, which has more than one-quarter of the nation's distributed generation, our customers are being actively recruited by companies offering to install rooftop solar systems.

Some people see all this change as a "disruptive" threat to the utility business. On balance, I see it as an opportunity to make our nation's power grid more flexible and ultimately better serve our customers.

Distributed energy has the potential to offer customers cleaner power, more choices, and more control over their energy bills. It can also provide a number of benefits to utilities, including increased engagement with customers in how their energy is sourced, delivered, and used.

"We see our role as the trusted energy advisor, a one-stop-shop for customers who want to take advantage of new energy technologies. As the utility, we'll be there 24/7—helpful, credible, and easy to deal with."

That's why we are building a more flexible, resilient, and low-carbon electricity distribution grid for the 21st century and beyond. We call it the "plug-and-play" backbone system—a power network that customers can plug any device into and have it work seamlessly, whether it's an electric vehicle, solar panels, batteries, or "smart home" technologies we haven't even thought of yet.

Such a network also allows us to partner with clean-energy technology and service providers, facilitating the adoption of new products. For example, at SCE we have a 3,000-home pilot with NEST that offers a potentially less costly way to manage demand response: Instead of the utility installing demand response devices on customers' HVAC units, we can access the customer's home network via the NEST thermostat.

The key benefits in all this are customer choice and ease of use. For major energy-consuming devices, customers can "set it and forget it." It also helps us meet our energy efficiency and demand response goals.

We see our role as the trusted energy advisor, a one-stop-shop for customers who want to take advantage of new energy technologies from suppliers.

The home energy market today includes many service providers: home security companies like ADT, and cable/telecomm companies like AT&T, Comcast, and Time Warner. It also includes retailers selling devices for the do-it-yourself market, like Lowes, Sears, and Home Depot. The explosion of new players and new services available may seem overwhelming to some customers.

As the utility, we'll be there 24/7—helpful, credible, and easy to deal with.

> The new energy world is one of partnerships, smart data analysis and application, and pervasive consumer participation. It has customers at its center and, with the necessary developments, it will have utilities at the helm.

–ADRIAN TUCK

Utilities as Orchestra Conductors

Adrian Tuck
CEO, Tendril

Technological advances, regulatory changes, consumer-centric communication practices—they're all reshaping the energy industry at faster rates than we've experienced in the past century.

With these shifts must come changes in the ways utilities deliver electricity. Traditionally, utilities owned and managed the entire energy value chain, from generation to the service drop at the customer's meter. Now, many other players have a stake, from solar and storage companies to traditional service providers. Consumers are buying different energy-related products and services on their own, changing the nature of their dependence on utilities. This may all seem strange and new, but appearances can be false.

In the new energy landscape utilities can still own the central customer relationship and manage all of the assets customers use, even if the assets come from other providers. Because of their history, utilities understand customers' energy practices better than anyone else, and that understanding makes them the most likely energy advisors and service providers, now and for years to come.

Utilities do, however, need to evolve as the grid evolves. They need to find ways to quickly cooperate with new players and insert themselves into the role as the orchestra conductor of suppliers, regulators, and customers. Utilities can most effectively fulfill this new role if they operate as bundled service providers, similar to, for example, the way that cable companies provide television, phone, and Internet services, and bundle content. In their bundled service provider roles, utilities will be the primary entity to which consumers turn for all their energy needs.

ACQUIRE, ENGAGE, AND ACTIVATE CONSUMERS

While this transition to the role of orchestra conductor creates opportunity for utilities, it also brings challenges. It requires a reconceptualization of business practices and customer relationships. The utilities that move beyond compliance and cost-driven motives, while treating every customer interaction as a chance to build a relationship, stand to profit and succeed. Focusing on three guiding principles—the ability to acquire, engage, and activate consumers—can set utilities on the right path.

"Focus on three guiding principles—the ability to acquire, engage, and activate consumers."

Acquire. Utilities will prosper if they prioritize the customer relationship by offering an enhanced set of products and services. Setting customer retention and acquisition as a priority means using the wealth of consumer data utilities possess to determine what consumers need and want and then tailoring communications to these individuals. Utilities will gather, aggregate, and act on data most efficiently and effectively if they approach acquisition as an organization-wide mission. A broad focus on developing attractive service packages could include, for instance, access to community solar for people living in rentals or fixed-rate pricing for those on fixed incomes. Strong energy services management technology can perform the necessary consumer segmentation and targeting to enable utilities to get the word out about their bundled services to the most likely program participants.

Engage. Utilities will succeed if they keep their customers satisfied. Engagement requires a company-wide focus on personalized interaction with customers. Utilities can get to know their customers individually through data aggregation and holistic analysis of statistics in combination with information from occasional home visits and in-person interviews. With this data in hand, utilities can communicate information in ways that are helpful, not intrusive. Information needs to be relevant, for example, helping customers keep their costs and consumption at an appropriate level. Engagement will also allow utilities to offer additional products and services that data and analysis suggests will appeal to the customer.

Activate. Finally, utilities will thrive when they embrace their roles as orchestrators of all of the players and services in the energy market. Activation demands that utilities look at new dimensions of the industry—like solar, storage, and distributed energy—as opportunities, not threats. Partnerships with providers of these services, as well as with other companies that refine the customer experience, can strengthen utilities' relationships

with customers, who can still turn to utilities as the trusted advisors and sources for their energy needs. Utilities can build the institutional capacity to integrate the energy services consumers may want, then distribute them through personalized, tailored communication and delivery.

Conductors of multi-piece, nuanced, intricate orchestras do not have easy jobs. Utilities face comprehensive, complex transformations as they position themselves to lead in the new energy market. Changing their business models into those of bundled service providers and adopting strong technology to help with data-driven, multi-channel, proactive communication will set utilities on the path to success.

The new energy world is one of partnerships, smart data analysis and application, and pervasive consumer participation. It has customers at its center and, with the necessary developments, it will have utilities at the helm.

> Today's customers compare their utility experience to every other service experience, and they expect their service providers to accommodate their preferences and choices.

–JOHN DISTASIO

Managing the Transition

John DiStasio
President, Large Public Power Council

The Large Public Power Council (LPPC) represents the 25 largest public power systems in the United States and the island of Puerto Rico. While not all LPPC members directly serve retail consumers, they all have a keen interest in the evolving power grid.

The evolution of the grid is the result of many things, but particularly developed from the convergence of three factors: Technology, Consumerism, and Policy. These factors have precipitated a robust debate—about the future of electricity generation and delivery, customer choice, utility resource planning, big data and privacy, cyber security, and environmental policy. While all of these areas are important in their own right, it's the best balance and the sensible interrelationship of all of them that will yield an optimal result.

For utilities, finding the appropriate mix of reliability, affordability, and environmental stewardship, while paying close attention to how customers weigh each of those values is critical to the transition underway.

RELIABILITY, AFFORDABILITY, AND THE ENVIRONMENT

Reliability is expected and rightly so. Pressures on reliability have grown in our increasingly digital world. The loss of electricity, even for short durations, has serious and adverse effects on our communities and our economy.

Affordability comes from sound resource decisions and scale. Since the central station utility model is quite capital intensive, scale has mattered. Large, long-lived investments can be financed and their costs recovered over time, keeping customer bills as low as possible. Today, interest is growing in the economic and operational benefits from distributed resources on the grid.

Finally, *environmental stewardship* is important to our customers and to the quality of life in the communities we serve. Given the long-lived nature of past investments, the transition to a new resource mix, informed by a better understanding of associated environmental impacts, needs to be anchored to outcomes that ensure both reliability and affordability.

How will the grid evolve, given these dynamics? Through technology, the grid has become smarter and that will continue. The grid has driven the American economy for 100 years and was smart enough to manage the generation sources, end uses, and customers' expectations of our pre-digital society.

Many agree that the grid that's evolving will have the capability to manage myriad new resources, technologies, and customer end-uses, and the ability to reduce and aggregate demand in increments. The overlay of digital communication networks makes this possible, allowing for the two-way flow of information and energy transactions.

"Customer service today is about enabling the customer through technology and communications capabilities, while keeping the back office in the back office."

TECHNOLOGY AND CUSTOMERS' EXPECTATIONS

The evolution of electric power, communications, and information technology is well underway and many utilities have embraced these technologies—initially, to understand how to integrate them into the existing grid, while maintaining reliability, and to reduce costs. Many utilities are now offering new technologies as part of their base business offerings.

The grid is growing into a technology platform that will allow customers to choose their relationship with their utility. Given other demands, many customers may want to maintain a full requirements, full service relationship. Many may want a greater hand in managing their energy use and to self-supply a portion of their energy needs. A few may seek independence from the grid altogether.

The explosion in technologies and personal computing capabilities that has occurred over the past two decades has empowered consumers and raised their expectations for both the quality of service and service options in *every* aspect of their lives.

Gone are the days when utilities compared themselves solely to other utilities as a measure of meeting their customers' expectations. Today's customers compare their utility experience to every other service experience, and they expect their service providers to accommodate their preferences and choices.

Customer service today is about enabling the customer through technology and communications capabilities, while keeping the back office in the back office. The path to maintaining a successful customer relationship is still high quality service—but that service must be transparent and flexible, while enabling customers to make their own decisions.

OUTCOMES MATTER MOST

Finally, good public policy focuses on outcomes like reduced emissions, energy productivity, supply diversity, and energy security.

The evolution of the grid has been hindered by a lack of such broad policy objectives, too much prescription such as specific resource mandates, arbitrary renewable definitions, compound subsidies, pricing requirements that don't reflect cost, and a lack of technology neutrality. This has resulted in uncertainty, unnecessary complexity, and increased cost and a focus on compliance instead of innovation.

Policy makers have the authority and responsibility to set broad policy goals, but they should avoid setting the means to achieve those goals. This is especially true in a time of transition when creativity and innovation, both within the industry and by new market entrants, is critical to achieving the optimal balance of reliability, affordability, and environmental quality.

“Energy supply flexibility undoubtedly makes the Navy a better war fighter and a better community member. We see leveraging micro-grid technology as the key to making our energy systems more flexible.”

–HON. DENNIS MCGINN

Choosing to Lead on Energy

Hon. Dennis McGinn
Assistant Secretary of the Navy, Energy, Installations & Environment

The Department of the Navy has a long and successful history of energy innovation, from steam engines to nuclear engines on our ships, and connecting diesel back-up generators to critical buildings for our shore bases to ensure mission continuity and operational capability. Like the rest of the energy industry, we're looking to modernize our energy operations to ensure we are capable of achieving our highly specialized missions around the world.

Most people think of the Navy as a Sea Service, but the Navy also owns 3.5 million acres of land and 117,000 buildings. With all of this property, the Navy is absolutely interested in taking advantage of new technology that reduces our energy footprint and increases our abilities.

For the most part, the infrastructure that has supplied electricity to our shore bases has been reliable for more than a century. However, newer, cheaper, and more reliable energy technology now available has created an opportunity for the Department of the Navy and our sister services to pursue more resilient and flexible energy services. Micro-grids, which allow power users to demand a new level of control and reliability from their power sources, are of great interest to the Navy.

Micro-grids are not a new technology. To the Navy, a micro-grid is a network that allows us to be connected to the larger grid—or not, as circumstances dictate. A micro-grid allows us to have more energy resiliency if there are problems with the larger grid. It also allows us, in some cases, to lower our total electric bill by giving us a choice in terms of what is the best-value, least-cost electricity supply, whether that energy is coming from the grid or from some set of distributed generation assets located on Navy or Marine Corps installations.

In order to fully integrate new technology which we believe will provide cleaner, cheaper, and more flexible energy, our culture inside the Department of the Navy has to change. We need to understand in depth what the options are and what they offer.

Niccolo Machiavelli made an observation which still holds water today, "It ought to be remembered that there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success than to take the lead in the introduction of a new order of things. Because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders among those who may do well under the new."

In addition to addressing its culture and technology, it is essential that the Navy form meaningful partnerships to better meet our changing energy needs at home and abroad. We want to have partnerships within the Department of Defense and throughout the Federal Government, with every agency that impacts how we get and use energy. We also want to build partnerships with states, municipalities, towns, and cities where our installations are located.

Most important, the Navy needs to build more and stronger working partnerships with the private sector, so that we can utilize new technology and effectively integrate it into our culture.

Energy supply flexibility undoubtedly makes the Navy a better war fighter and a better community member. We see leveraging micro-grid technology as the key to making our energy systems more flexible, so we are poised to always support our missions and stand ready to support the communities that surround our bases.

For example, the Naval SUBASE New London; the City of Groton, Connecticut; Groton Utilities; the Connecticut Municipal Electric Energy Cooperative; and the local energy service providers are developing a hybrid distribution project for approximately 8 MW. The project will support multiple types of generation, including renewables, a baseload energy source like

natural gas, and backup generation. This template meets our desire to be cleaner and cheaper. And, by connecting these resources together on a micro-grid system, the Navy can have the flexibility to better support the installation's mission.

We recognize that our Sailors, Marines, their families, our Civilian employees, and our contractors don't just live, breathe, and work on-base all the time. We recognize that there's a community outside our walls. We want to partner with communities to provide strategic and emergency services when they are needed. Thus, we are experimenting with the partnership for the project at SUBASE New London to extend the micro-grid to first responders, medical treatment facilities, and even to a commercial corridor in Groton, so that if the grid is down, our community partners can have confidence that they too will have essential services. The Navy believes this ability will provide regional resiliency. We do not want to become islands of Navy or Marine Corps installations in the face of some sort of a widespread grid crisis. We want to ensure that our neighboring region is protected as well as our bases.

"Some will resist the change, as Machiavelli noted more than 500 years ago, but the potential benefits of embracing change in the energy sector are too great."

New technology is making power cheaper and cleaner so the Navy can integrate new energy systems that make our installations flexible. We believe flexibility will enable ultimate operational capability and mission continuity, and eventually will be able to stabilize and provide regional resiliency to our communities. Some will resist the change, as Machiavelli noted over 500 years ago, but the potential benefits of embracing change in the energy sector are too great.

The Navy is choosing to lead on energy.

> For much of our history, utilities have been a big black box to customers who had little reason to think about the actual complexities of how we delivered electricity. Now, customers are entering into new relationships with us.

–KAREN LEFKOWITZ

Opening the Black Box

Karen Lefkowitz
Vice President, Business Transformation & Chief Information Security Officer, Pepco Holdings, Inc.

Taking advantage of new and emerging technology is the new normal for utilities. That means re-examining how we approach our work.

Utilities, with our obligation for universal service, have historically spoken with one voice to our customers. Today, a deeper understanding of our customers is essential, and data analytics provide insight into customer needs and expectations as well as providing us a means to optimize and customize messages to our customers. For example:

- An energy efficiency program may be attractive to one customer because it provides an opportunity to save money, but it may only be attractive to another because it improves the environment.
- When a customer calls with a power quality problem, we have data and tools to evaluate what is happening at that location. And that call now can serve as an alert and trigger, where with little additional expense, an assessment of power quality for other customers served by that circuit or the substation can be conducted.
- Some customers want paper billing and paper bill inserts with generalized energy savings tips, while another customer may be more accustomed to interactive web sites containing information that is (or can be) tailored to that customer's specific circumstances.

Improvements in data analytics lead to improvements in grid management, which in turn lead to improved customer experiences and levels of service satisfaction. At Pepco Holdings, we are encouraging employees to think more expansively; collaborative employee teams developed about 50 use cases for data analytics, and organized them into categories: grid, reliability, asset management, enterprise, customer, load, voltage, and work.

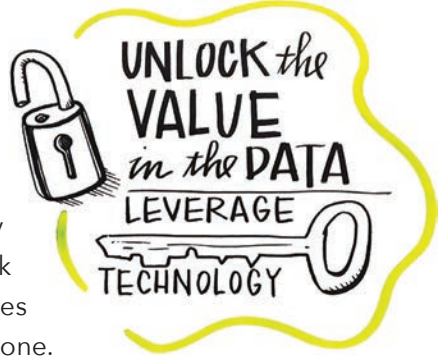
To prioritize the work, we asked ourselves some fundamental questions focused on what analytics will produce information that is most important to our customers. For example:

- Should we focus on analyzing the impacts of high penetration of renewable energy at specific locations? That is useful where we see fast growth of customer-sited renewables.

- Should we focus on customer segmentation and use it to better deliver messages to customers about energy efficiency programs and peak time rebate programs?

Some customers and regulators are concerned about data privacy. We have adopted tough data privacy standards into our policies. On the other hand, many customers are willing to share large amounts of their personal data to get something they value. And we know that entrepreneurs are developing products that require access to customer data. We have mixed messages to decode and understand and recognize that we sit at the crossroad of a new and exciting analytics-based energy value chain. While it would be easy to fall back on regulations, we owe it to our customers to collaborate with them, our regulators, and other policy makers and stakeholders in understanding, protecting, and managing the data.

For much of our history, utilities have been a big black box to customers—we delivered electricity from big power stations to our customers and they had little reason to think about the actual complexities of how those things were done.

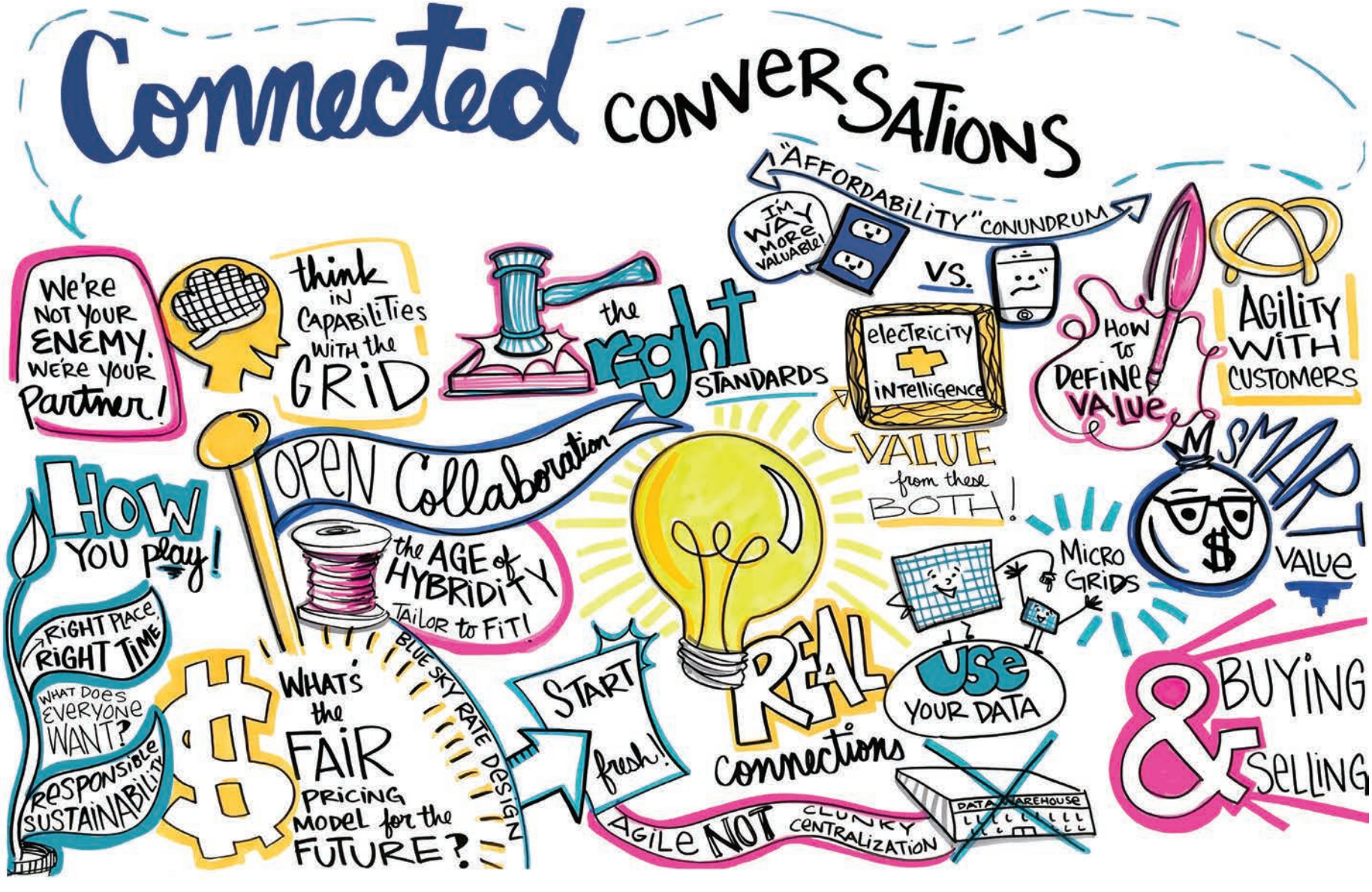


"Now we have the opportunity and the imperative to educate policy makers and customers—and ourselves—on what's really inside that black box."

Now, customers are entering into new relationships with us. Increasingly, they are self-generating and selling back excess energy to the grid or buying electric vehicles and substantially changing their electricity usage patterns.

The complexities of grid operation grow significantly with these new uses, yet the black box operational model that utilities grew used to, and even encouraged, today works against us as customers are left to wonder why the grid cannot always allow a certain use.

Now we have the opportunity and the imperative to educate policy makers and customers—and ourselves—on what's really inside that black box and its capacity to accommodate the exciting new uses that are being developed. We have to adapt by staying in front of the choices customers are making and develop ways to evolve the grid in order to meet their expectations. Otherwise, we will have failed our customers.


Connected conversations
"Affordability" conundrum
I'm way more valuable!
vs.
We're not your enemy. We're your Partner!
think in capabilities with the GRID
the right standards
electricity + intelligence
How to Define Value
Agility with customers
Open Collaboration
the AGE of HYBRIDITY
Tailor to Fit!
VALUE from these BOTH!
SMART
Value
How you play!
Right place Right Time
What does everyone WANT?
Responsible Sustainability
Micro Grids
Use your data
What's the FAIR pricing model for the FUTURE?
Blue sky rate design
Start fresh!
REAL connections
Agile NOT clunky centralization
Data warehouse
& Buying & Selling

EVOLVING **REGULATION**

Traditional electric utility regulation was designed for the electric grid that evolved from the work of Edison, Tesla, and Westinghouse to a natural monopoly structure covering much of the US. In 1978, the first opening to competition was introduced with enactment of the Public Utility Regulatory Policies Act (PURPA). PURPA was the leading edge of what became a competitive era that, over the next several decades, transformed a wholly monopolistic industry structure into one with elements of competition at each level.

Though the electric power industry is now much transformed by competitive forces, the same state regulatory laws meant to govern its original structure remain in effect. Today's state regulators are handicapped by the dissonance between the statutes they administer, artifacts of an earlier time, and today's era of immense innovation and change—in technology, customers, and competition that's driving the industry.

Today, competition has largely transformed energy generation, transmission is open to competition in much of the US, and at the distribution level, electric utilities remain largely a monopoly.

What's needed today, as the essays in this chapter make clear, is a new regulatory paradigm—one that's beginning to be discussed but is still far from defined. Below are some principles for evolving regulation that you will find in these essays.

- Regulation should be more forward looking, less burdened by lengthy rate proceedings, and more reliant on long-term rate plans that provide utilities flexibility and give customers rate predictability.
- Regulation should signal prices to customers in relation to the costs that customers cause and the value they provide to the grid.
- Regulation should allocate the cost of grid services equitably to all customers.
- Regulation should encourage innovation and collaboration among stakeholders.
- Regulation should foster competition and development of value-added and performance-based services.
- Regulation should give customers the opportunity to interconnect distributed resources to the grid, while assuring utilities recovery of their grid services costs.

Minnesota's e21 Initiative and similar activities in a few states address many of these issues. These initiatives involve all stakeholder groups in a good faith, collaborative effort to define a vision for the future grid and a path forward for state electric utility regulation. That path leads to a performance-based regulatory paradigm that acknowledges the value of the grid as the unifying network. It offers greater flexibility to utilities in meeting customer needs, while rewarding or penalizing them based on their ability to achieve agreed upon outcomes.

> The key question before us is how to adapt regulation to align with the changing role of utilities, accelerating technology, and increasing customer expectations, while also stabilizing rates, minimizing costs, and ensuring equity among customers.

–MARVIN E. MCDANIEL, JR.

Shaping the 21st Century Energy System

Marvin E. McDaniel, Jr.
Executive Vice President; Group President–Utilities and Chief Administrative Officer, Xcel Energy

Signs of change are all around us.

Years of successful conservation programs and efficiency improvements have slowed and in some cases reversed the electricity sales growth trends characteristic of the past century. Likewise, declines in the cost of distributed generation technologies, growing customer interest in expanded energy options, and supportive public policies have prompted a surge in the adoption of distributed resources and heightened demand for new products and services.

These trends are spurring innovation and entrance of new market participants into an evolving energy market. This evolution will not be without challenges for utilities, but it also represents an unprecedented opportunity to reshape what the energy system looks like, what it is able to do, and how people use it.

As a result of this wave of innovation, Xcel Energy is participating in an initiative to shape the energy system of the 21st century called the e21 Initiative. The e21 Initiative comprises a diverse group of stakeholders in Minnesota that came together on a voluntary and proactive basis to discuss how the regulatory model needs to evolve to embrace technological innovation, support customer choice, and transition to a lower carbon future.

THE GRID AS BACKBONE

An early point of consensus in Minnesota's e21 Initiative was that the current regulatory framework is increasingly incompatible with the state's energy policy goals and with industry trends. While stakeholders differed on exactly what needed to change and why, there was general agreement that a strong, reliable, and resilient grid is at the center of this energy future. Far from becoming obsolete, the grid will serve as the backbone and platform for new technologies, products, and services and be accessible to customers. It will grow in value as more devices are connected to it. Xcel Energy's long history and experience in developing and managing the grid, with all its complexities and requirements, makes us uniquely suited to continue providing grid services and to participate in its evolution.

Evolving the grid and keeping it safe, resilient, and secure will require ongoing investment and commitment. Our ability to make these investments and manage the cost of this transition will depend on having a constructive regulatory framework, particularly in the face of uncertain public policy, little if any sales growth, and increased competition. As the grid needs to evolve, regulatory models and rate structures also need to evolve, and demonstrate to those who provide capital that there is reasonable assurance that costs will be recovered and that utilities will have the opportunity to earn their authorized returns.

"Far from becoming obsolete, the grid will serve as the backbone and platform for new technologies, products, and services and be accessible to customers. It will grow in value as more devices are connected to it."

Utilities subject to the traditional cost-of-service regulatory model often struggle to meet today's business challenges. Cycles of frequent rate cases, such as we have experienced in Minnesota, have revealed a misalignment between an industry that requires continued investment and a relatively rigid and increasingly outdated regulatory framework. Thus, the key question before us and at the heart of the e21 Initiative is how to adapt regulation to align with the changing role of utilities, accelerating technology, and increasing customer expectations, while also stabilizing rates, minimizing costs, and ensuring equity among customers.

EVOLVING THE REGULATORY PARADIGM

Xcel Energy is not alone in exploring alternatives and modifications to the existing regulatory model. We recognize that important differences may exist across states, so we are not pursuing the same solutions in each of the eight states we serve. Each state we serve is addressing these issues in different ways, and at a different scope and pace. We try to consider each

situation and develop a spectrum of solutions that ranges from incremental to more comprehensive and transformational.

While there will not be a single solution that suits all states and utilities, we do believe there are some trends and common approaches.

- *First,* we believe the regulatory model must become more anticipatory and forward-looking, with greater reliance on tools such as longer-term rate plans that provide utilities with greater flexibility and customers with greater rate predictability. These rate plans could be part of filings that address a range of planning issues and look more like a business plan than a test year snapshot.
- *Second,* it is hard to overstate the importance of pricing and rate design. We must find better methods of assigning costs that send the right price signals to customers and appropriately assign system costs to those that cause those costs. Similarly, we must fairly compensate customers for the value of energy they provide.
- *Third,* many states may explore the role of incentives in driving utility performance in areas that are important to customers.
- *Finally,* we believe there will be a greater role for collaboration among stakeholders. Through broader collaboration and partnership, we can start to move away from the adversarial posturing inherent in the traditional regulatory environment and toward win-win solutions that appropriately balance interests and maximize value.

E21 INITIATIVE ADVANCES DISCUSSION

Stakeholders in Minnesota's e21 Initiative are advancing the discussion of how to adapt our regulatory model for the future. This initiative began organically as an idea for stakeholders to come together as part of a voluntary and consensus-based effort outside of the formal regulatory process to proactively respond to industry changes. The group published its Phase 1 report in December 2014, which included a number of recommendations related to regulatory reform. At the heart of the recommendations is a shift to a more customer-centric, performance-based regulatory model that uses multi-year rate plans and performance incentives to drive outcomes. For Minnesota, we believe e21 is a useful model for how stakeholders can work together to find areas of mutual benefit.

Utilities and the services we provide will remain critical well into the future. Our greatest challenges in evolving the grid will not be so much technological, but in designing a system that facilitates adoption of technologies and responds to customer interests while also stabilizing rates, treating all customers fairly, and ensuring that utilities have the financial health necessary to continue investing in the system.

> Regulation 2.0 must foster competition; incorporate the hybrid nature of the grid; and provide mechanisms that maintain balance and fairness for consumers, utilities, and investors.

–DR. LAWRENCE E. JONES

Toward a Modernized Regulatory Compact

Dr. Lawrence E. Jones
Vice President, Utility Innovations and Infrastructure Resilience, Alstom

Today, deployment of new technologies is creating a more dynamic grid with greater controllability and observability. The power grid must now be operated in an environment of increasing variability, uncertainty, and complexity. Demand is becoming more elastic and distributed generation from renewables and other sources is surging. System intelligence and transactive capabilities are being embedded in devices along the entire value chain, on a scale that will upend the way we produce, deliver, and consume energy going forward.

At the same time, electric utilities around the world are expected to continue to make capital investments in a grid infrastructure that provides high quality, reliable electricity service and societal benefits, while seeing declining sales growth. While utilities can adapt by adjusting their current operational practices to improve the type and quality of services they deliver to customers, and adopting decoupling mechanisms (as many jurisdictions have)—these approaches do not address the fundamental issue.

The regulatory compact in the US was designed more than 100 years ago with the goal of attracting private capital to help develop facilities to provide electricity services to society. In return, the providers of such services were granted franchise monopoly rights to sell electricity at rates that are considered just and reasonable. The assumption that underlies this business model is that the price consumers pay for electricity times the volume of electricity sold will allow utilities to collect the revenues they require to recover their operating costs while providing a fair return to their investors. The compact between utilities and their investors on the one hand, and between utilities and customers on the other, has served the US well, as electricity has driven the engines of the world's leading economy.

Today, however, the industry is facing several disruptive forces, especially at the grid edge, that fundamentally challenge the long-held assumption that growth in sales of electricity will provide utilities the revenue needed to continue financing and making capital investments in the grid. In light of the confluence

of these disruptive forces—high penetration of renewable energy and a surge in distributed energy resources (DERs) such as solar PV, energy storage, demand response, and micro-grids—there are intense discussions within the US electric industry and elsewhere about the future of the utilities. In most instances, the focus is whether utilities can adapt and remain successful, or will they retreat to a business-as-usual approach and fall into a so-called death spiral? But, is this really the question?

There is no lack of vision of the future grid or utility, and there are multiple potential pathways to achieve new utility models and satisfactory end-states. But any visions of the utility of the future will require adaptation of the current regulatory model to take account of exogenous forces that are stressing the existing model.

One cannot build and operate a utility of the future with regulation of the past. It is high time, therefore, to revise and update the traditional regulatory compact. It is time for Regulation 2.0. Already in a number of US states (e.g., Arizona, California, Colorado, Maryland, Massachusetts, and New York) regulators and policy makers are exploring alternative regulatory models. Regulation 2.0 should not, however, insulate utilities or any other market player for that matter from competitive forces. Instead, at the minimum, it must:

- Foster competition by allowing utilities to offer new value-added and performance-based services along the value chain (e.g. micro-grid as a service, energy storage as a service);
- Incorporate the hybrid nature of the grid with old and new assets having different economic life spans; and
- Provide mechanisms that maintain balance and fairness for consumers, utilities, and investors for services and cost-recovery.

"One cannot build and operate a utility of the future with regulation of the past. It is time to update the traditional regulatory compact."

Regulation 2.0 should spur innovation by utilities in how they leverage the important triad that defines their competitive advantages, including brand and name recognition, their reputation as a reliable service provider, and customers' trust. Understanding and meeting the diverse needs and preferences of the customers of the future (e.g., baby boomers, generation X and Y, and Millennials) will distinguish the successful utility.

Innovative, forward-looking utilities will harness advanced technologies to actively engage their customers. In the future, customers may want more value-added bundled services, not just timely and reliably delivered electrons.

There are excellent examples from other networked industries that show the benefits of bundled services. For example, Comcast bundled cable and Internet services and saw an increase in revenues, in spite of a reduction in the number of its subscribers. Similarly, in West Africa, some energy entrepreneurs are offering bundled energy services like refrigeration and lighting in lieu of selling electricity to villagers who prefer to pay a higher price for the bundled service than for kWh. How can electricity systems with legacy regulatory models transition to models in which bundled energy services are valued and monetized?

The US electricity industry is constantly evolving. How it will look in the next 5, 10, 50, or 100 years is difficult, if not impossible, to predict. What is certain is that the change is inevitable. As future consumers' needs, expectations, and values change, so too must utilities adapt to new competitive landscapes. In tandem, new regulatory and business models must be implemented sooner rather than later.

More than 100 years ago, faced with a similar need for capital to support economic development, an innovative regulatory compact was put in place that allowed electricity to fuel America's economic prosperity. Today, we are at a similar inflection point, as we consider the current transition.

Our electricity grid will continue to undergo modernization while we simultaneously implement measures in response to climate change. This will require trillions of dollars of investments. What modernized regulatory compact will attract investors, foster competition, and meet the needs of customers and the planet? How will it balance the allocation of costs, risks, and rewards?

> Investor-owned utilities' earnings opportunities should include performance-based incentives tied to benefits delivered to their customers by cost-effective initiatives to improve energy efficiency, integrate clean energy generation, and improve grids.

—RALPH CAVANAGH

The Death Spiral Fallacy: Robust Prospects for Cleaner Electricity Grids

Ralph Cavanagh
Energy Program Co-Director, NRDC

The San Francisco Earthquake struck me as a reasonable metaphor for the kind of changes the energy utilities have experienced in this country in the last several years, in effect turning their world upside down … The basic proposition of this symposium is that the dramatic underlying changes in the economics of energy in the United States occasion a corresponding examination of the role of our energy utilities.[1]

Neighborhood electric cooperatives; … rooftop systems integrated into a community storage and backup system; utilities as mere dispatching agents, or maintenance crews, or financing mechanisms; … these are a few of the visions of the urban future … Overnight we have witnessed a dramatic change in the assumptions underlying our electric generation technologies and regulatory procedures.[2]

The electricity industry is a classic example of a market ripe for breakout disruptive technologies.[3]

Although these three statements sound like contemporary discourse, their actual publication dates were 1980, 1983, and 2003, respectively. The quotations are a reminder that fervent rhetorical challenges to the utility business model have a long history, along with formulaic claims that technology innovation will shortly relieve people of any need for further reliance on their hometown utility's generation, transmission, and/or distribution systems, with dire consequences for everyone connected to these imminently obsolete ventures.[4]

I remember sitting in a hearing room packed with utility managers when a regulator in the nation's most populous state declared electricity distribution monopolies obsolete and admonished them to prepare for mass defections. That was twenty years ago. The regulator is now a widely respected chairman of a major electricity distribution monopoly.[5]

The resilience of the utility model reflects durable economies of scale in grid management, reliability assurance, and the procurement and integration (but not ownership) of electricity resources. Grid bypass remains unappealing to almost everyone with the option to connect or stay connected, notwithstanding every advance in the composition and management of rooftops and batteries. As E.F. Lindsey observed 30 years ago, "Until you've walked into a totally dark generator room with a flashlight in one hand and a toolbox in the other, you haven't had a firsthand experience with onsite power."[6] Inventors and venture capitalists have learned that it is far more productive to treat utilities as partners than adversaries. For those committed to a clean energy future, utilities remain the most important investors. Technological progress in the electricity sector has been and remains much more about opportunities for grid enhancement than grid evasion.

"For those committed to a clean energy future, utilities remain the most important investors."

This is not to say that regulatory models don't need to change. US electricity sales are not collapsing, but since 2000 the rate of growth has lagged well behind that of the population. Linking utilities' financial health to increasing commodity sales won't work any longer.

This yields two crucial questions: given declining growth in those sales, how do utilities secure the reasonable revenue certainty required to make investment decisions that will allow them to continue to provide reliable and affordable services? And how can regulators allocate the costs of those services equitably among all who use them? The simple but entirely wrong answer to both questions would be to stop charging for electricity service based on electricity use, and to make all or most of an electricity bill independent of consumption. The "all you can eat" pricing model may work well for some businesses, but none have environmental and equity dimensions comparable to electricity generation.

The most promising solutions emerge from collaborative discussions in open settings among regulators, their utilities, and diverse groups of stakeholders. The list begins with revenue decoupling, which makes utilities indifferent to retail energy sales without abandoning the tradition of volumetric pricing and its incentives for customers to use energy efficiently. More than half the states have now adopted this approach for at least one electric or natural gas utility, and a comprehensive order by the Washington Utilities and Transportation Commission is

a primer on how to do it effectively, using modest annual true-ups in rates that few if any customers even notice.[7]

We need also to address additional aspects of utility business model reform and rate design that are critical to a clean energy transition, and they form the heart of joint efforts by NRDC and the Edison Electric Institute.[8] The two institutions agree that "net metering programs in wide use across the United States have helped valuable 'distributed' technologies such as solar power gain traction and improve performance, but we believe that additional approaches are needed now." Although distributed generation (DG) can reduce a grid's needs for central station generation and other infrastructure, while providing clean and carbon-free electricity, DG typically does not eliminate the installer's need for grid services. Both utilities and distributed generators should get fair compensation for grid services received and provided.

Customers deserve the opportunity to interconnect distributed generation to the grid quickly and easily. For their part, utilities deserve assurances that recovery of their authorized nonfuel fixed costs will not vary with fluctuations in electricity use. This does not require rate designs that reduce rewards to all or most customers for using less electricity. Alternatives include minimum bills that convert to volumetric charges if the customer exceeds a monthly consumption threshold, and well-designed variable demand charges that take advantage of digital meter capabilities.[9]

Finally, investor-owned utilities' earnings opportunities should include performance-based incentives tied to benefits delivered to their customers by cost-effective initiatives to improve energy efficiency, integrate clean energy generation, and improve grids.

In general, business models should include profit opportunities linked to utilities' performance in delivering safe, reliable, and affordable energy services. This would mark a decisive and overdue break with the regulatory tradition of tying utilities' earnings opportunities to tonnages of capital invested in their own physical assets.

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1. California PUC, *Energy Efficiency and the Utilities: New Directions*, p. 1 (July 1980).
2. David Morris, *The Pendulum Swings Again: A Century of Urban Electric Systems*, in Howard J. Brown (ed.), *Decentralizing Electric Power Production*, p. 55 (1983).
3. Steve Silverman, *Taming the Electricity Beast*, Wired, November 2003, p. 036.
4. I explored these themes previously in the Preface to F. Sioshansi (ed.), *Distributed Generation and its Implications for the Utility Industry* (2014).
5. The regulator was then California PUC Commissioner Jessie Knight. He can be found today at the San Diego Gas and Electric Company, adroitly navigating what has proved to be stubbornly persistent utility regulation.
6. E.F. Lindsley, *Planning Practically for a Decentralized Electrical System*, in Howard J. Brown (ed.), note 2, p. 245.
7. Washington Utilities and Transportation Commission, In the Matter of the Petition of Puget Sound Energy and the Northwest Energy Coalition, Dockets UE 121697 and UG 121705 (June 25, 2013).
8. See http://switchboard.nrdc.org/blogs/rcavanagh/disparate_voices_joining_in_su.html.
9. An excellent resource on the "minimum bill" concept is http://www.raponline.org/document/download/id/7361. For a discussion of variable demand charges, see http://www.brattle.com/news-and-knowledge/news/778

> Utilities must be proactive in defining the grid's evolution; this is happening through innovative product design, new rules, and expanded partnerships with customers, regulators, and other key stakeholders.

–PHILIP J. DION

Adapting to Change, While Serving Many Masters

Philip J. Dion
Senior Vice President, Public Policy and Customer Solutions, Tucson Electric Power

The key question as we enter the framework of Utility 2.0 is: how do utilities adapt their established legacy grid systems and traditional regulatory and public policy frameworks to respond to new technologies and customers' evolving wants and needs?

We must begin with a reassessment of the grid and its operating protocols. Today's system, particularly the location of supply assets, traditionally has been determined and planned by utility engineers. As the grid becomes more distributed, the placement of many new assets will be driven by customer choices. Those same customers will demand that the quality of their electric service be equivalent to or better than the service they receive today. As a result, the grid itself is emerging as the focus of the most significant innovation, as it has to incorporate new assets, the location and operation of which the utility may or may not control, while still operating as if those assets are part of a designed system.

To succeed, utilities must embrace these evolving relationships with customers, regulators, and other stakeholders. Customers will look to utilities to provide new products and services. This means utilities will need better insight into what their customers want. In addition to providing safe, affordable, and reliable electric service,

utilities will be asked to provide additional value through flexibility, convenience, and other benefits. Utilities also must make distinctions between services customers say they want and services for which they are actually *willing to pay*.

REGULATORY ENTREPRENEURS

This evolution challenges utilities to become "regulatory entrepreneurs." In this role, they will have to engage with customers, identify their wants and needs, then execute a strategy that balances the needs of stakeholders, including regulators, while maximizing value to the customer. Success means providing increased customer and other stakeholder satisfaction while contributing to the sustainability of an evolving grid.

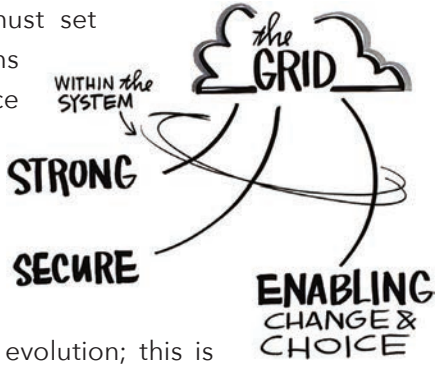
"This evolution challenges utilities to become 'regulatory entrepreneurs.' Success means providing increased customer and other stakeholder satisfaction while contributing to the sustainability of an evolving grid."

Of course, the effectiveness of a regulatory entrepreneur depends upon the willingness of the regulator to adopt flexible policies and pricing structures. Thus, it is not only the utilities' infrastructure that needs to adapt; the regulatory infrastructure must evolve as well.

While traditional cost-of-service regulation of poles, wires, and generators will likely continue, regulators should be encouraged to embrace more entrepreneurial models for new products and services. This would encourage utilities to innovate, searching for new ways to serve customers' needs while enhancing the versatility and value of the grid. These products and services could include the design and construction of micro-grids, effective integration of distributed generation and technology, and behind-the-meter offerings. These new products and services will require utilities to forge new partnerships with third-party developers or other organizations that heretofore were difficult to establish due to more traditional views and rules of the regulatory regime.

To transition to such a regime, regulators, utilities, and stakeholders will have to engage in a dialogue regarding pricing methodologies for products and services that fall outside the traditional regulated sphere.

Ultimately, the industry must set aside outdated conceptions of traditional utility service and adopt new business models and structures appropriate to the changing energy marketplace.



Utilities must be proactive in defining the grid's evolution; this is happening through innovative product design, new rules, and expanded partnerships with customers, regulators, and other key stakeholders. By embracing change, utilities can continue to be the trusted provider of safe, reliable, affordable—and sustainable—energy and services for the communities they serve.

> To enable the goal of a modern electric transmission and distribution system, advanced cloud-based IT offerings are necessary. Regulators need to respond by removing barriers and providing incentives to deploy cost-saving, high-performance 21st century software systems.

–PETER MCCARTHY

Regulation for IT Investments

Peter McCarthy
Senior Vice President, North America, C3 Energy

The National Academy of Engineering identified electrification of the grid as the most important engineering achievement of the 20th century. That infrastructure is now being substantially upgraded, and the resulting smart grid will be one of the largest and most complex machines ever conceived. Like its forebear, the evolving smart grid will likely prove to be one of the most significant achievements of the 21st century.

It is estimated that as much as $2 trillion is being invested this decade in upgrading electricity infrastructure globally to make devices in the power grid remotely machine addressable. The most common example is the smart meter that allows the grid operator to remotely sense the electric or gas meter's state in near real time. As the grid becomes increasingly monitored by sensors, it becomes a fully connected sensor network (think of it as the Internet of Energy), from which unprecedented volumes of data are produced. These data can be integrated, processed, and analyzed using state-of-the-art information technology to optimize the generation, transmission, and distribution value chain.

C3 Energy is a private sector response to this challenge and opportunity, harnessing the power of big data, social networking, cloud computing, human-computer interaction models, and machine learning to make advances in safety, reliability, cost efficiency, and security of power generation and delivery, unlocking up to $300 per meter per year in annual economic benefit for US utilities, retailers, and their energy customers.

The rapid growth of sensor investments in the smart grid opens a new opportunity for utilities to take advantage of next-generation information technology to fully unlock the insights and value that a modern grid has to offer. Today's state utility regulation, however, has not kept pace with and actually impedes the ability of utilities and their customers to benefit from new IT models that will substantially improve system performance, reduce capital and operating costs, and produce substantial economic value for utility customers and shareholders.

Under current guidelines, a utility may generally classify investments in legacy hardware and supporting on-premises software as a capital expense and investments in state-of-the-art cloud-based technologies as an operating expense for which it does not receive a rate of return.

Utilities are investing billions of dollars to make the devices in the power grid remotely IP-addressable, including the nearly 1.1 billion smart meters that will be installed worldwide by 2022.[1] While representing only a fraction of the sensor devices on the grid, the number of smart meters provides a good indication of the growth rate of the smart grid.

McKinsey & Company has estimated that widespread use of big data analytics solutions could cut more than $50 billion per year from electricity bills in the US. Globally, the opportunity amounts to $300 billion annually.[2] Smart grid analytics solutions across the entire power value chain can deliver $1.5 billion in recurring annual economic benefit to a typical integrated, five-million meter US utility and its customers. That is a very real private sector stimulus for the economy.

Because smart grid analytics produce far greater savings than they cost, it requires no financial assistance or incentive from the federal government to succeed. But success will be achieved and benefits realized more rapidly if regulatory obstacles are removed. For example, by updating rate regulations to recognize Software-as-a-Service (SaaS) products as the equivalent of a capital expense, and by updating accounting rules and guidance to encourage utilities to add analytics solutions to their planned budgets for grid modernization, progress will accelerate.

IT offerings have rapidly evolved to leverage innovative cloud computing models, including SaaS, Platform as a Service, and Infrastructure as a Service. With these models come opportunities to leverage the capabilities essential to fulfilling the promise of the smart grid, including continuous access to increased processing speeds and power, more flexibility and mobility, elasticity/on-demand surge capacity, and lower costs through scale.

The majority of IT innovation and development in the 21st century is focused upon these next-generation, cloud-based computing models. The acceleration of this trend is breathtaking, with examples appearing in the news every day from leading

companies, including Google, Facebook, Amazon Web Services, and Apple. Cisco recently predicted that by 2018, more than three-quarters of all corporate information will be processed in the cloud rather than on internally-hosted computer servers.[3] In February, Ginni Rometty, CEO of IBM, announced an additional $4 billion investment in cloud-based technology development, predicting that 40 percent of IBM's expected total revenues will accrue from cloud computing by 2018.[4]

"Today's state utility regulation has not kept pace with and actually impedes the ability of utilities and their customers to benefit from new IT models."

To enable the goal of a modern electric transmission and distribution system, advanced cloud-based IT offerings are necessary. Regulators need to respond by removing barriers and providing incentives to deploy cost-saving, high-performance 21st century software systems similar to those that a utility receives for investing in other capital infrastructure, including IT systems.

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> Hawaii is keenly focused on creating a sustainable, market-based structure that provides customers choice and enables rooftop solar and other distributed energy resources to offer the greatest value to the grid, while assuring that non-participating customers are not adversely affected.

–MICHAEL E. CHAMPLEY

Rooftop Solar Deployment: Lessons from Hawaii

Michael E. Champley
Commissioner, Hawaii Public Utilities Commission

It's been said that Hawaii's experience with rooftop solar PV and net energy metering is a postcard from the future.

Hawaii has experienced exponential growth in rooftop solar PV systems over the last few years. Many customers have installed distributed solar PV, responding to the island utility's high prices and relatively attractive solar panel prices. As a result, Hawaii leads the nation in penetration of rooftop solar PV systems as a percentage of the overall power system. More than 50,000 customers have rooftop solar—that's 13 percent of all residential customers, and perhaps 40 percent of customers with roofs that could accommodate solar panels.

Average residential customer electricity usage has declined by 30 percent over the last decade, due primarily to energy efficiency programs and price-responsive behavior and from distributed rooftop solar PV installations. But, grid investment did not decline by 30 percent during this period; in fact, it increased, due in part to growth in rooftop solar.

OPERATIONAL CHALLENGES POSED BY DISTRIBUTED ROOFTOP SOLAR PV

Distributed solar on Oahu, Hawaii's most populous island by far, amounts to about 25 percent of the evening system peak. The solar units are connected to the utility distribution system, yet their output and operation can't be controlled by the utility grid operator. As a consequence, unscheduled and uncontrolled excess solar energy is exported to the grid, whether or not the utility can physically or economically use that energy.

The aggregated distributed solar capacity would be the equivalent—in Hawaii's small system—of several nuclear units for a typical mainland electric utility system. Imagine if that capacity was not under operator control.

Hawaii's distribution systems have generally been more robust in the amount of solar PV they can host than originally envisioned. More than half of our distribution circuits have installed solar PV capacity greater than 75 percent of gross daytime

minimum load, so there is little or no net load during the "solar noon" period. Bulk power reliability and operational challenges, not distribution system issues, are the binding constraint on Hawaii's electrical grid.

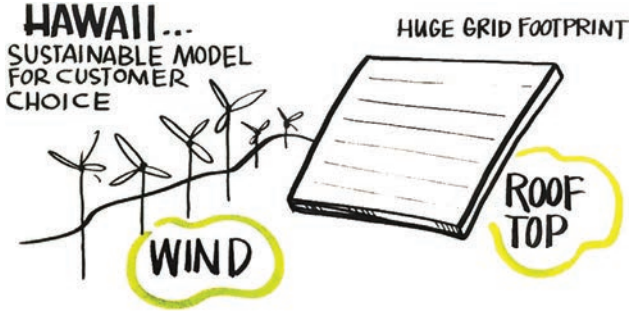
Regrettably, the rapid growth of rooftop solar PV in Hawaii occurred without stakeholders fully understanding its technical and economic consequences, both for the utility and its customers. As a result, Hawaii now faces a number of significant economic, policy, and technical challenges associated with distributed rooftop solar PV penetration.

THE NEED TO TREAT CUSTOMERS FAIRLY

The lessons to be learned from Hawaii's experience can be useful elsewhere. The Hawaii Public Utilities Commission recently observed that–

> *"… it is unrealistic to expect that the high growth in distributed solar PV capacity additions experienced in the 2010–2013 time period can be sustained, in the same technical, economic, and policy manner in which it occurred, particularly when electric energy usage is declining, distribution circuit penetration levels are increasing, system level challenges are emerging, and grid fixed costs are increasingly being shifted to non-solar PV customers."*

The rapid growth of rooftop solar PV systems is creating two broad, distinct groups of utility customers–rooftop solar PV customers and customers who do not have rooftop solar. They present quite different power supply and service requirements. These requirements must be harmonized if the utility is to fulfill its obligation to serve non-solar customers at reasonable cost and in parallel, also enable customers to adopt distributed energy technologies.



THE RULES OF THE GAME MUST CHANGE

Hawaii's net energy metering (NEM) policy was designed to incent early adoption of solar PV in an administratively simple manner. NEM's retail rate pricing is not flexible to adapt to changes over time in the economic value of exported solar energy. At higher levels of distributed solar PV penetration, lower solar grid benefits and higher solar integration costs are inevitable outcomes.

Notwithstanding this, NEM customers continue to receive full retail rate compensation for exported energy regardless of the solar PV penetration level. The consequences may be insignificant at low levels of penetration, but at high levels of solar penetration, they can be significant and adversely affect non-solar customers.

Recognizing this situation, the Hawaii Commission stated that –

> *"the distributed solar PV industry in Hawaii will, out of necessity due to their accomplishments thus far, have to migrate to a new business model, not unlike what is expected for [electric utilities] as a result of disruptive technologies."*

Hawaii is keenly focused on creating a sustainable, market-based structure that provides customers choice and enables rooftop solar and other distributed energy resources (DERs) to offer the greatest value to the grid, while assuring that non-participating customers are not adversely affected.

MARKET-BASED PATHWAYS UNDER CONSIDERATION

Sound technical, economic, and regulatory principles should guide the development of a sustainable, market-based DER customer choice model. The Hawaii Commission is currently considering two market-based development pathways—customer self-supply (retail centric, non-export model) and customer grid-supply (wholesale centric, export model)—among the alternatives to the current NEM model.

"Electric utilities, their customers, and the solar industry will need to adapt to new business models in which customers are fairly compensated for the value they provide to the system and fairly charged for the grid services they use."

As the Hawaii Commission recognized—

> *"Current electric utility rate structures in Hawaii are not well suited for a future environment where there are significant quantities of variable renewable energy, customer-sited distributed energy resources, and increasingly smart grid technologies. … By establishing pricing that more accurately reflects the economic costs of grid operations, the electric utilities can recover the costs of grid investments that benefit all customers, third party energy service providers could develop new offerings to meet customer energy needs and support grid operations, and customers would have a growing array of options better suited to the changing demands of their homes and businesses."*

Electric utilities, their customers, and the solar industry will need to adapt to new business models in which customers are fairly compensated for the value they provide to the system and fairly charged for the grid services they use.

“The papers that fill this book recognize the electricity grid as the most essential of all our essential infrastructures. It is the one infrastructure that enables all others.”

–BOB ROWE

Conclusion

Bob Rowe
President and CEO, NorthWestern Energy

The three sections in this book—the Evolving Grid, the Evolving Customer, and Evolving Regulation—are both independent and interdependent. The elements they represent are discrete and distinct, but interrelated. None makes sense without the others. Like a three-legged stool, function and stability require balance.

EVOLVING GRID

The grid that's evolved to become the heartbeat of America's economy is entering a transformation that will see it become more interactive and useful than ever before, not only producing and delivering electricity from generators, but also integrating and dispatching customer resources. The grid requires at least two things to thrive: *regulation,* both state and federal, because it provides essential services and is deeply "affected with the public interest"; and the *customers* it's meant to serve.

Like an organism, the grid evolves. Customers want it to be smarter, sturdier, and more flexible. Regulators want it to be self-healing and interactive—not only with steel in the ground, but also the intelligence and resilience to adapt to changing conditions, whether from violent weather, an adverse grid event, or sudden changes in resource availability.

There is an accelerating shift from passive to active grid management, as information technology pushes deeper into the network, creating opportunities to improve the efficiency of power flows and the reliability of the distribution system.

The increasing digitization of the network also means that ever more data are generated. How can that data be used to enhance efficiency, improve quality, and build and operate a more flexible and—especially—a more resilient grid? Data from the grid will enable it to do much of what's needed, but data alone is useless without the analytics to make sense of it. The grid will need a bigger brain than ever before.

Both customers and regulators want the grid and the services it enables to remain affordable. It's regulation's job to ensure that the grid does all of those things it needs to do, while earning enough to attract investment necessary to support renewal and modernization.

Service from the grid will evolve differently in a dense city than in rural and rugged areas with differently-configured infrastructure. It will evolve differently based on the array and cost of alternatives. It will evolve differently based on the processes and decisions of policy makers and regulators. It will evolve differently based on the perceived risks, opportunities, and alternatives available to debt and equity investors, upon whom grid investment depends.

EVOLVING CUSTOMER

Electricity is driving the revolution in systems and processes that American businesses need to be competitive. Meanwhile, residential customers are using more plug-and-play devices for home safety, comfort, and entertainment. Amazing things are happening inside homes and offices, as wireless routers support sophisticated home and energy management systems. Our most engaged customers are interested in exercising choices about both energy production and consumption.

The public is excited about the prospect of non-polluting renewable generation providing a major share of tomorrow's energy, just as increasing efficiency in our devices and systems helps manage consumption. Efficiency is itself a killer app.

While some of us long for energy independence—not only from other countries' resources but also from utilities and the grid—most leading thinkers believe the grid remains central to all our energy goals.

Here's what UC Berkeley professor Severin Borenstein wrote recently about the question, "Is residential solar really the future of electricity generation?"[1]

> *"Count me among the people who get no special thrill from making our own shoes, roasting our own coffee, or generating our own electricity. I don't think my house should be energy independent any more than it should be food independent or clothing independent. Advanced economies around the world have gotten to be advanced economies by taking advantage of economies of scale, not by encouraging every household to be self-sufficient."*

> *"That's not to say that distributed generation couldn't be the best way for some people at some locations to adopt renewables, but simply that DG should not be the goal in itself. We desperately need to reduce greenhouse gases from the electricity sector, not just in the US, but around the world, including some very poor countries where affordability is a real barrier and electricity access is life-changing. If DG is the least costly way to get that done, I'm in, but the choice should be driven by real cost-benefit analysis, not slogans about energy freedom."*

EVOLVING REGULATION

Regulators today have the toughest job. Gone are the good old days when steady load growth required new generating plants, each one more efficient than the last. Keeping costs and rates low was easy. Customers and utilities were happy. Today—not so much!

Regulators today are asked to make decisions about an essential industry that's in a rapid transition, its future shape is unclear. Here are some questions they—and all of us—must consider:

- What will technology enable us to do?
- What will policy require and allow us to do?
- What will the financial sector support us doing?
- What do citizens and customers want us to do—or be enabled to do themselves?

Regulators are expected to see the broad public interest, ensuring that customers have the services they need—today, and in the future—and that the prices they pay cover the cost of operation and provide a sufficient return to attract capital. Regulators have the ability to ensure that policy goals, utility requirements, and customer needs are aligned over the long term.

There is a growing view, including among many regulators, that regulation should move away from the backward-looking, accounting-based, contested case approaches, and toward more forward-looking, business- and planning-based approaches that are more collaborative and less adversarial. Utilities should have greater flexibility to meet diverse customer needs (and with increased flexibility should be expected to do so), with their performance measured against success in achieving societal outcomes.

Regulators in many states are beginning to shape a vision of a new kind of regulation that will support development of this future grid. Modernizing regulation should be a major public concern, one that public-spirited consumer and business groups both support.

I'll close by circling back to the grid and the values it helps our customers and the economy achieve. The great papers that fill this timely book recognize the electricity grid as the most essential of all our essential infrastructures. It is the one infrastructure that enables all others. As thought leaders, their goals for that infrastructure are diverse, lofty, and inspiring. Here are just a few:

- Reliability
- Resiliency
- Ubiquity
- Affordability
- Efficiency
- Diversity
- Sustainability
- Interoperability
- Environmental Compatibility
- Creativity
- Stability

Our three-legged stool—the evolving grid, the evolving customer, and evolving regulation—can build a better understanding of the links between technology, policy, and finance, while meeting societal goals and customer expectations. If the legs can be maintained in balance, we will better be able to deliver the bright future toward which we are all working.

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1. Severin Borenstein, "Is residential solar really the future of electricity generation?" *The Berkeley Blog,* May 8, 2015 <http://blogs.berkeley.edu/2015/05/08/is-residential-solar-the-future-of-electricity-generation/>

About the Institute for Electric Innovation

The Edison Foundation 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 utilities that represent about 70 percent of the US 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 more than 30 smart grid technology company partners.

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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