The Democratization of Energy

nationalgrid

Climate Change, Renewables and Advancing the American Dream

By Dean Seavers

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Table of Contents

2 **Flipping the Switch**
Building a New Energy Delivery Model, Democratizing Energy, and Advancing the American Dream

5 **The Transition Blueprint**
Designing the Future of Energy in New England

8 **Investing for Impact**
Energy-Driven Economic Development in Upstate New York

12 **The New Buffalo**
A Case Study in Energy Innovation

15 **No One Left in the Dark**
A Solar Solution for Every Community

18 **The Future of Storm Resiliency**
Building a Community Microgrid in New York State's North Country

21 **Customer Empowerment**
Smart Grid Programs in Worcester and Beyond

24 **An Efficiency Game Changer**
Saving Energy Atop the Poles

27 **How Big is the Bridge?**
Transitioning to a Decarbonized U.S. Energy Infrastructure

30 **Green Connections**
Electric Transmission and the Transition to a Clean Energy Future

33 **Clean Energy Economic Development**
Triple Win of Lower Bills, Less Carbon, More Jobs

35 ***About National Grid***

About the Author

Flipping the Switch

Building a New Energy Delivery Model, Democratizing Energy, and Advancing the American Dream

Many Americans who follow climate change – the great challenge of our time – have rallied around a target year of 2050 for a decarbonized energy infrastructure in the U.S. As the leader of one of the nation's largest electricity and natural gas utilities, you can count me in.

Getting the transition right, of course, will be no small feat. No one knows this better than I. My first year in the energy sector has made it clear that, while we've built extraordinary networks over the last century, it's no longer "business as usual." We need to accelerate the pace of change. Now.

I believe we can get from our current mix of renewable and hydro power – less than 30 percent of the energy in New York and New England – to a decarbonized energy network. But it will take the entire energy supply chain: system operators, generators, distributors, and customers; as well as policy makers, technology companies, and climate change activists – all collaborating at a level our nation has never seen before.

At National Grid, this desire for a decarbonized energy network isn't wishful thinking. It's been our motivation for years. We serve the energy needs of 20 million people across New York, Massachusetts, and Rhode Island, so we know that as we build a solution to navigate this transition over the next ten years (and beyond), our touchstone should always be customers, large and small.

Above all, our customers' energy must be affordable. Right now, electricity and gas customers are being whipsawed by monthly bill volatility in a number of regions. For instance, after years of low-cost electricity, New England saw prices surge in 2013 due to the interdependency between natural gas and electricity prices. Over the last three years, natural gas constraints cost electricity customers in the region an extra $7 billion.

In Upstate New York, from cities such as Buffalo, Syracuse, and Albany, to small communities like Fredonia, Watertown, and Saratoga Springs, 20 percent of our customers are more than 60 days behind on their electricity bills.

Again, the prerequisite of our transition solution must be affordability. If not, we will strand working middle-class families and capital-challenged communities. This, in turn, will risk crippling local economies in a downward spiral of high energy costs, increasing unemployment, and decreasing entrepreneurship and business investment. That means more community needs chasing fewer and fewer community revenue sources.

This concept of affordability combined with easy accessibility came to life in the U.S. in the 1930s and 1940s with FDR's Rural Electrification program and the Tennessee Valley Authority Act, among other policy efforts. The democratization of energy proved fundamental to the U.S. economy and, by extension, the American dream.

How do we transition to a decarbonized energy network by 2050 while growing local economies and ensuring our families' long-term economic and environmental health? How do we do this while building a solution that engages everyone with a stake in our energy future?

The remedy must start with our utility companies and our policymakers.

First, we must put customers in charge.

Consumers will make the right choices if they have the right tools and information. More web-based, big-data solutions will be transformational. Increasing the use of such smart technology will make choosing energy efficiency and productivity easier for all customers. (Today, 57 percent of our energy in the U.S. is wasted through heat loss, leaks, and inefficiencies.) We have seen a small number of smart grid installations scattered across the U.S. with technologies like wireless meters and web-based thermostats. In this eBook, you'll read about several smart grid pilots we have in the works, each with enormous potential for long-term energy savings and carbon reduction.

Second, we must embrace our technology partners.

The legacy of our electricity and gas networks is that utilities were incentivized to become generally reactive and risk-averse to innovation. That must stop. We need to open our networks to high-tech partners focused on efficiency, energy storage, and distributed generation such as solar, wind, and biogas.

Turn the grids into innovation playgrounds and we can propel the type of market-based advances that lifted the telecommunications and personal computing industries decades ago.

Last, yet most important, we must change how we regulate and finance the industry.

Our fragmented industry in the U.S. – 1,100 electric distribution companies plus 1,600 local natural gas delivery companies – answers to an array of state and local regulators.

While that regulatory relationship encourages a form of accountability, it hasn't traditionally prioritized aggressive investments in innovation and infrastructure. But there are signs of change. Recently in New York, for example, the Public Service Commission put energy innovators on notice with its 68-page call-to-action, "Reforming the Energy Vision."

They get it right, calling for a transformation of the regulator-utility-customer relationship. Instead of a narrow focus on just next month's bill, they've



The energy industry must become a sector of innovators.

widened the aperture to include solving for greater capital investing, increased energy efficiency programming, and facilitating connections to maturing renewable sources.

Perhaps the PSC's most significant paradigm-busting idea is redefining utilities as a kind of smartphone for energy distribution, with energy generators, service providers, and technology partners delivering a range of energy solution "apps."

At National Grid, we're aligning ourselves with this vision through what we call our Connect21 strategy, and our New Energy Solutions division: a team dedicated to driving our plan for the energy company of the future.

That includes community solar, microgrids, smart grids, offshore wind energy, green transmission, and many other opportunities that advance our electricity and natural gas networks so that our 21st century digital economy is sitting atop a truly 21st century energy infrastructure.

The chapters that follow tell that story and more: community solar for working families in Buffalo's Fruit Belt neighborhood; the Newtown Creek direct-to-grid biogas project; green transmission for large scale renewables across New York and New England.

These initiatives signal the transition to a decarbonized energy network. At the same time, they reinforce our fundamental approach to energy in the U.S.—we find ways to ensure our communities' long-term economic and environmental health. And we do this while building a solution that engages everyone with a stake in our energy future, including – and especially – our neighbors across the planet.

The Transition Blueprint

Designing the Future of Energy in New England

Whether you call it a "balanced approach," an "all-of-the-above strategy" or, as Massachusetts Governor Charlie Baker put it, an energy "combo platter," the bottom line is that New England needs everything: renewable energy, demand reduction, increased natural gas supplies, and electric transmission to connect us to remote resources.

The region is already a national leader in the first two; Massachusetts and Rhode Island are perennially ranked in the top five states in the country for energy efficiency. But New England is simultaneously facing issues with access to natural gas and some of the highest electricity prices in the country. Why? We've seen an increased reliance on natural gas due to a shift away from coal-fired electricity generation over the last 25 years. That's coupled with a surging demand in gas as a heating fuel and little change in the region's gas transmission infrastructure.

These natural gas shortages aren't the result of nationwide scarcity. Rather, they are caused by capacity constraints on the pipelines that tap into cheap gas sources just a few hundred miles away.

These shortages put New Englanders – including our customers – at risk of electricity price hikes, service disruptions, and even brownouts or rolling blackouts.

Some say the answer is to support only sources of renewable power despite their intermittent nature. Others believe liquefied natural gas will solve all of our problems. The way I see it, a balanced approach is in order.

We must advance renewable energy sources while also lowering demand through energy efficiency. We must invest in natural gas pipelines today to stabilize electricity prices and prepare for the electrification of transportation tomorrow.

We must advance renewable energy sources while also lowering demand through **energy efficiency.**

And we must continue to build the resilient electricity transmission networks that underpin and enable the economic prosperity of our region.

So what's included in a balanced approach for New England? In Rhode Island, we're building undersea cables that connect customers to the nation's first offshore wind installation—Deepwater Wind's Block Island Wind Farm. We're also innovating to increase the value of renewable

A balanced approach includes large-scale renewables, energy efficiency, and natural gas infrastructure.

energy to all New Englanders. Initiatives include the Green Line Infrastructure Alliance, which backstops wind generation from Maine and New York with Canadian hydro power (ramping up hydro when the wind dies down and vice versa), and our large-scale solar program in Massachusetts, which strategically places photovoltaic farms near centers of demand.

These investments are a key part of our balanced approach, but let's be clear: alone they are not enough to provide New Englanders with the clean, affordable, reliable energy they need. No conceivable increases in renewable energy and efficiency programs could replace the lost generating capacity that would result from failing to ease constraints on gas transmission, especially now that other generating plants across the region, such as the Pilgrim Nuclear Power Station, are retiring.

Now is the time to **increase energy** innovation, not erase possibilities from the list. To protect New England's future, we need it all.

Two major natural gas projects are currently in the works that, together, can make up the difference and fill out the balanced approach New England needs. Kinder Morgan's Northeast Energy Direct would bring in a billion cubic feet of gas per day, and Access Northeast, a project proposed by Eversource, Spectra, and National Grid, would provide another 900 million cubic feet.

We're also accelerating the rate at which we replace older pipes in our distribution system, to ensure all of the gas we transport gets to our customers. National Grid will replace every one of the thousands of miles of cast iron and unprotected steel mains in our system within the next 20 years.

In many ways, the various parts of our balanced approach are interconnected. The expansion of natural gas, for instance, enables the increased use of wind and solar by providing a safety net of generation on calm or cloudy days. At the same time, natural gas is a fossil fuel that must be burned to create power, whereas renewables are emissions-free. And the cheapest, cleanest unit of energy you can find is the one you never use in the first place, thanks to energy efficiency.

Now is the time to *increase* energy innovation, not erase possibilities from the list. To protect New England's future, we need it all.

Investing for Impact

Energy-Driven Economic Development in Upstate New York

It's no secret that Upstate New York – once recognized nationwide as a manufacturing leader – has yet to fully stake its claim in a globalized economy. What might still be a secret to some is how close the region is getting to reclaiming that leadership position.

I won't pretend to be an expert in the emerging fields getting us there: nanotechnology, advanced manufacturing capabilities, or anaerobic digesters enabling process waste to be converted into electricity, to name a few. But I can tell you, from my travels throughout our service regions, our customers understand them. In fact, they'll tell anyone who'll listen.

At National Grid, we've made listening part of our mission. Across the 24,000 square miles of our diverse upstate New York footprint, we've listened – and beyond that, we've heard. We've heard about industrial parks making products in demand around the world. About abandoned brownfield properties burdening communities and taxpayers, yet teeming with potential. About untried startups that, with the right support, will have no limit to their reach. About established businesses – large and small, urban and rural – primed to innovate and grow. And about jobs – good jobs, lasting jobs. The key, of course, to real sustainability in these communities.

Decades of hearing about our customers' visions have made us visionaries too. We believe in our customers' goals, their workforces, and the communities and futures we all share. And we invest in them, in every way that matters.

Two of our programs supported Upstate New York projects generating over

$717 million

in new capital investment and creating almost

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One example of how we're partnering for progress? Take a look at the nanotechnology boom happening all the way from Albany to Buffalo. Running parallel with the New York State Thruway, and the Erie Canal before that, New York's growing Nano Corridor is poised to yet again transform business across – and beyond – our state.

Attracting the semiconductor industry to New York has been a 20-year process, and National Grid has been keenly involved from the start. Investing millions and providing critical engineering and planning support for the sophisticated electricity transmission infrastructure that today's intensely high tech firms demand. Sharing in the dramatic success of the SUNY Polytechnic Institute's Colleges of Nanoscale Science and Engineering Nanotech

Strength in Numbers: The Impact of National Grid Economic Development in FY 2014:

- In 2014, two of our programs supported Upstate New York projects generating over $717 million in new capital investment and creating almost 1,600 new jobs
- That same year, we approved nearly $11 million in new potential grants statewide, one of our largest-ever annual funding commitments
- Since 2003, $7.8 billion has been invested – and more than 35,000 jobs created or retained – in Upstate New York as a result of projects receiving National Grid funding

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Megaplex in Albany. Expanding on that success with the NANO Utica initiative in the Mohawk Valley, where the 450-acre Marcy site we helped launch is set to break ground in the spring of 2016 – and expected to add more than 4,000 new jobs over the next ten years. And that's just the beginning.

Food processing and agribusiness industries are among the fastest-growing sectors in the upstate economy, and National Grid grant programs play a major role in that growth – funding electric infrastructure upgrades for the new $40 million, 60-employee Agrana fruit processing facility in Onondaga County, enabling the Intergrow Greenhouses operation in Orleans County to undertake a $15 million expansion, and more. In the past year alone, our matching grants for lean manufacturing and other productivity and growth support provided funding for 35 small and medium-sized manufacturing businesses across 15 Upstate New York counties.

At the same time, family farms and other smaller rural customers are using our power incentive grants to realize expansion plans that depend on upgrading to three-phase electrical service – helping revitalize the region's economy even at hyper-local levels.

Across the region, our Upstate New York customers have much more success to share. While National Grid may not always make the headlines, we're often part of the story – and we're proud to have earned a place as our customers' strategic partner. It's our responsibility, our challenge, and our privilege.

My prediction? Businesses will continue to discover, or rediscover, upstate New York. Because we are ready.

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The New Buffalo

A Case Study in Energy Innovation

The Buffalo Niagara Medical Campus's gleaming new buildings require innovative energy solutions.

For many years, Buffalo, N.Y. was the symbol of Rust Belt economic decline in the northeast. A once-thriving industrial powerhouse, the city and region suffered through a decades-long slide that seemed to have no bottom.

Not anymore.

Today, construction cranes dot the skyline. Long vacant buildings are being repurposed. Old industries have stabilized, and new industries are taking root. Troubled neighborhoods are seeing new investment. The previously desolate waterfront area is a beehive of activity, even in the dead of Buffalo's infamous winters. In fact, since 2012, Western New York has seen more than $19 billion in development, more than half of it in the city of Buffalo.

I am proud to say that National Grid is quietly at the heart of it. We have an obligation to serve, of course, but through our Connect21 strategies, we're trying to lead and not just follow. Under the old utility paradigm, developers would have made their plans, come to us for service, and then been forced to wait while we proceeded with engineering and, if necessary, installed new infrastructure to meet their needs.

For today's Buffalo, that just won't work. We need to be quicker and more flexible. To do so, we've taken an approach that gathers customer intelligence before the shovel hits the ground, integrating our planning with that of our customers. No better example exists than the burgeoning Buffalo Niagara Medical Campus (BNMC).

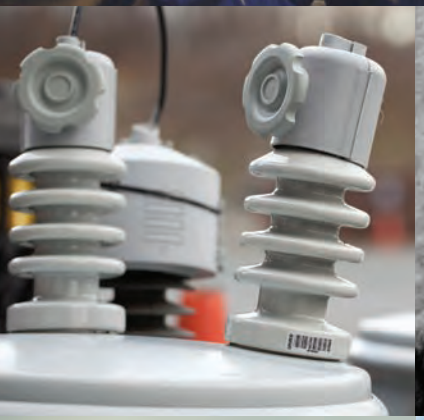
Since 2012, Western New York has seen more than **$19 billion** in development, more than half of it in the city of Buffalo.

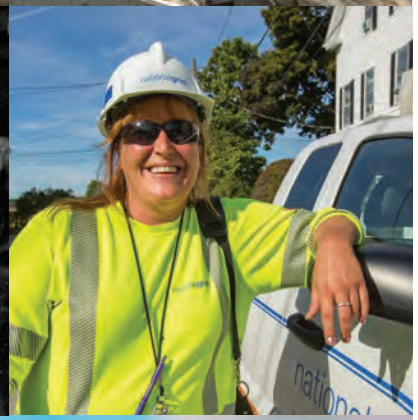
The BNMC is an economic engine unto itself. A collection of hospitals, life science research and educational facilities, medical offices, and even a hotel, it encompasses 120 acres just north of the downtown business district. It's currently home to 500 doctors and 200 PhDs. When the current round of $200 million in construction is complete, more than 12,000 people will be working and learning there. The pace of growth has been remarkable and so has the demand for energy.

For a time, we struggled to keep up. Every new building, every renovation, every new computer put a strain on aging energy infrastructure that was already near capacity. We were at risk of being a barrier to progress. So, we found a better way. We became a part of the BNMC's planning, giving us a view of where they were going, and where we needed to go to meet their needs.

The result? Together we developed a comprehensive energy strategy – energizeBNMC – that allows us to meet the campus energy needs today and tomorrow, and allows the campus to better manage its energy use and meet its goals of development and sustainability. We put money in the ground, adding electrical capacity in the Michigan Ave. corridor *before* it was actually needed. BNMC leadership, taking some risks, has invested in everything from electric vehicle charging stations to parking lot



lighting that is powered by both wind and solar, completely off-grid with its own battery storage.

I need to emphasize how critically special this is. Historically, utilities DO NOT do this. But it's a sign of change; we're transitioning to a new way of doing business.

National Grid and the BNMC are bringing energy innovation to the surrounding neighborhood, as well. This area, known as the "Fruit Belt" with its Lemon, Peach, and Grape Streets, is an underserved corner of the city immediately east of the campus. But it's on the cusp of a turn-around.

As part of New York's Reforming the Energy Vision (REV) proceeding, we've proposed to bring the benefits of community rooftop solar to the Fruit Belt. Unlike traditional solar installations, which generate electricity only for one resident or business who can afford it, we'll aggregate the power from 100 neighborhood solar installations and share the benefits with residents who otherwise might not be in a position to install on their own.

It's an exciting time in Buffalo and the region, and not just on the medical campus. You should hear about Larkinville, Canalside, Outerharbor – names being identified with the rebirth of a once and soon-to-be great city. Riverbend is the new site of the largest solar panel manufacturer in the Western Hemisphere, ground zero for the city's burgeoning clean energy industry. These are stories for another day, but we're excited to be a part of them all.

No One Left in the Dark

A Solar Solution for Every Community

Harnessing the sun to generate clean, homegrown electricity is brilliant. We know it is an important piece of a balanced energy portfolio. But after conversations with customers and other stakeholders, it has become clear to me that we mustn't be blinded by the benefits of solar energy – it must still be affordable and accessible to all.

A decade ago, the solar energy industry in the northeast was in its infancy. Building solar installations and getting them connected to a local utility was cost-prohibitive. In an effort to support this clean technology while achieving the goal of slashing greenhouse gas emissions, policymakers set out to implement incentives that would make solar economically feasible. From Massachusetts to New York, solar gained popularity quickly, creating jobs and giving birth to a robust industry. It worked.

We've connected hundreds of megawatts of customer-owned solar to our networks in the states we serve. In fact, National Grid in Massachusetts was named one of the top five utilities connecting the most megawatts of solar energy in the United States. And this is a state that's not exactly known for its reliable sunshine. To keep pace with increasing demand, we have more than doubled the size of our renewable energy team that is charged with getting these projects online.

National Grid in Massachusetts was named one of the top five utilities connecting the **most megawatts** of solar energy in the United States.

Here we are, years later, with a fairly mature solar industry. The actual costs of building an installation have drastically decreased, and more residents, businesses and communities are jumping at the opportunity. Despite this growth and maturation, in some states solar is still receiving those same lucrative subsidies. At the same time, solar owners and developers don't pay for the distribution system they use to sell power into the grid or get electricity back when it's dark or cloudy, leaving non-solar customers to pick up the whole bill.

To be clear, this state of affairs does not affect our bottom line as a utility – all the costs of purchasing electricity and maintaining the grid are, by law, collected through the rates customers pay on their bill.

But it does affect the bottom lines for the vast majority of our customers who do not or cannot own solar. In Massachusetts, for example, subsidies for solar energy, including net metering, renewable energy credits, and use of the grid, add up to millions of dollars in bill increases each year–totaling $3.5 billion by 2025.

Those numbers just won't work when the primary prerequisite of our energy transition is affordability. That's why we have encouraged policymakers across our U.S. footprint to adopt policies that are more fair and sustainable in the long term for all families and communities.

How do we ensure continued solar growth without further burdening our customers?

- Reduce subsidies to continue solar growth without overpaying for the benefits of solar
- Eliminate guaranteed floor prices for solar renewable energy credits and establish a competitively bid system to get the lowest prices possible
- Implement rate policies that ensure solar owners who use the distribution system help pay for that system

Focusing on energy costs does not mean losing sight of a decarbonized future that includes solar. Just the opposite: creating a sustainable system today will enable renewable energy to truly flourish tomorrow.

SolarCity's brand new factory in Buffalo will be the Western Hemisphere's largest solar panel manufacturer.

That's why we're also taking the lead on innovating ways to make interconnections easier and more affordable. To maximize the benefits to our customers, we are building large-scale solar, owned by National Grid and strategically located near centers of high demand. We have also positioned these solar installations southwest – rather than the traditional "due south" – to maximize the value of the sun's rays for customers later in the day, when the demand on the system is highest.

National Grid is committed to achieving the benefits of solar for the lowest possible cost. This journey to a clean, reliable and affordable energy future must be accessible for all of our customers.

To ignore the issues of affordability and accessibility would leave us with a future of renewable energy that divides customers between the haves and the have-nots. We refuse to leave so many customers behind in our pursuit of a clean energy future but instead continue to support a long-term sustainable solution for all.

The Future of Storm Resiliency

Building a Community Microgrid in New York State's North Country

The North Country of Upstate New York is home to some of the nation's most severe storms. As global climate change continues to increase the frequency and intensity of these storms, we must improve crisis preparedness and response. We need to ensure that emergency services have the power they so critically need and that companies like us can focus on getting customers and businesses back up and running as quickly as possible.

I am keenly aware that one of our biggest challenges while responding during these storms is mobilization. With trees down and power out, it is difficult – if not impossible – to move equipment into the area faster.

Some impacted areas must rely on generator backup systems to provide partial power until proper resources arrive. To address this critical delay we need to "harden" the electric grid to maintain a supply to essential services like hospitals and first responders.

That's why we're teaming up with Clarkson University, SUNY Potsdam, and the Village of Potsdam to create a system that we believe will maintain essential electric service for a safer, more efficient, and more timely restoration.

The initiative, one of our demonstration projects under New York's Reforming the Energy Vision (REV) is formally known as "The Design of a Resilient Underground Microgrid in Potsdam, N.Y."

What is a microgrid? In essence, it's a localized grouping of electric sources that normally connect to the traditional centralized power network (macrogrid), but can disconnect and function autonomously like an island of energy during storms.

The key element of the microgrid will be a new underground distribution loop that interconnects critical energy supply and generation in the village with National Grid's overhead primary distribution system. In the event of an outage, the underground system will separate from the overhead system, becoming the islanded microgrid that will deliver power to connected emergency service providers. This microgrid can provide power to essential services for up to two weeks following an extreme weather event, servicing not only the immediate area but also enabling the town to act as a regional hub for restoration activities.

Since the Potsdam Microgrid is a demonstration, we're also looking at it as an opportunity to advance technology by involving multiple interconnected electric power customers and a variety of generation systems that promote resiliency for our customers and communities. Potential sources include a hydroelectric facility on the Raquette River, a two-megawatt solar installation at the Potsdam Municipal

These generation sources could supply

5 to 10 megawatts

of power to the microgrid during extreme weather events.

Airport and a combined heat-and-power (CHP) generation system at the State University of New York at Potsdam.

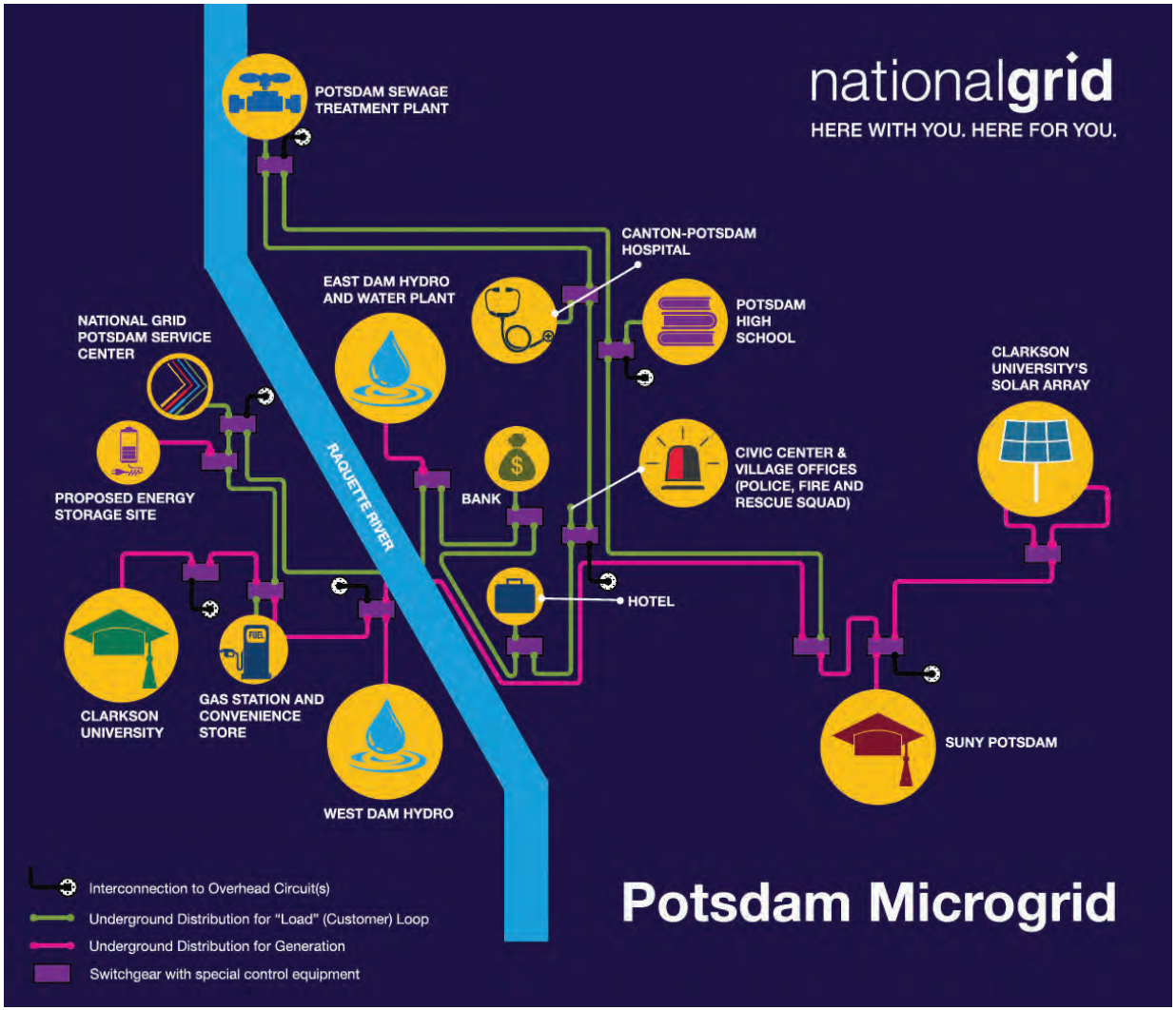
Additional generation needed by the town may be sourced through other innovative resources, including battery storage and hybrid fuel cells, technologies that have never been deployed in this kind of system before.

All combined, these generation sources could supply five to ten megawatts of power to the microgrid during extreme weather events.

This program is a chance for National Grid, the communities we serve, and the energy industry as a whole to envision the future. Do microgrids belong in every municipality? What's the right mix of generation sources to protect against a wide range of extreme weather events? How should the microgrid be controlled and financed?

These key questions about the transition to the electric grid of the 21st century remain unclear, but with the Potsdam Microgrid, we intend to begin answering them.

And in the meantime, we're addressing a significant need for our customers in the North Country of Upstate New York.



The microgrid is an opportunity to try new technologies while creating a regional storm restoration hub.

Customer Empowerment

Smart Grid Programs in Worcester and Beyond

Let's be honest. Most of our customers believe energy prices are too volatile and too expensive. Reliability might have been a differentiator for high-performing utilities in years past, but today, keeping the lights on is table stakes. Advancing technologies, the need to stay constantly connected, and personal choice in all areas of their lives are driving our customers to want more control over how and when they use energy.

And I couldn't be more proud of the communities we serve for embracing this trend. Why? Because in the end, it will drive a more sustainable long-term model.

In Massachusetts, we rolled out Smart Energy Solutions, a program designed to provide customers the information they need through an integrated package of smart electric meters, in-home technology and new variable delivery rates. After a successful first year, we're now exploring opportunities to apply our learnings and develop this "Smart Grid" concept further with additional pilot programs.

In real time, customers can now closely examine how much energy they use and at what cost.

Leveraging the power of advanced smart meters, nearly 15,000 customers in the city of Worcester, Mass., were given access to their own personal usage information through in-home technologies that communicate directly with the meters on their houses. In real-time, customers can now closely examine how much energy they use and at what cost.

They also have the opportunity to get a more comprehensive look at an entire day's usage by visiting our "Worcester Smart" website. With access to this information, the customer's bill evolves from a confusing set of numbers and rates and becomes a transparent, easy-to-follow document that connects the dots by showing what electricity costs at various times of the day. Making that connection empowers customers to use power more strategically or lower their usage overall.

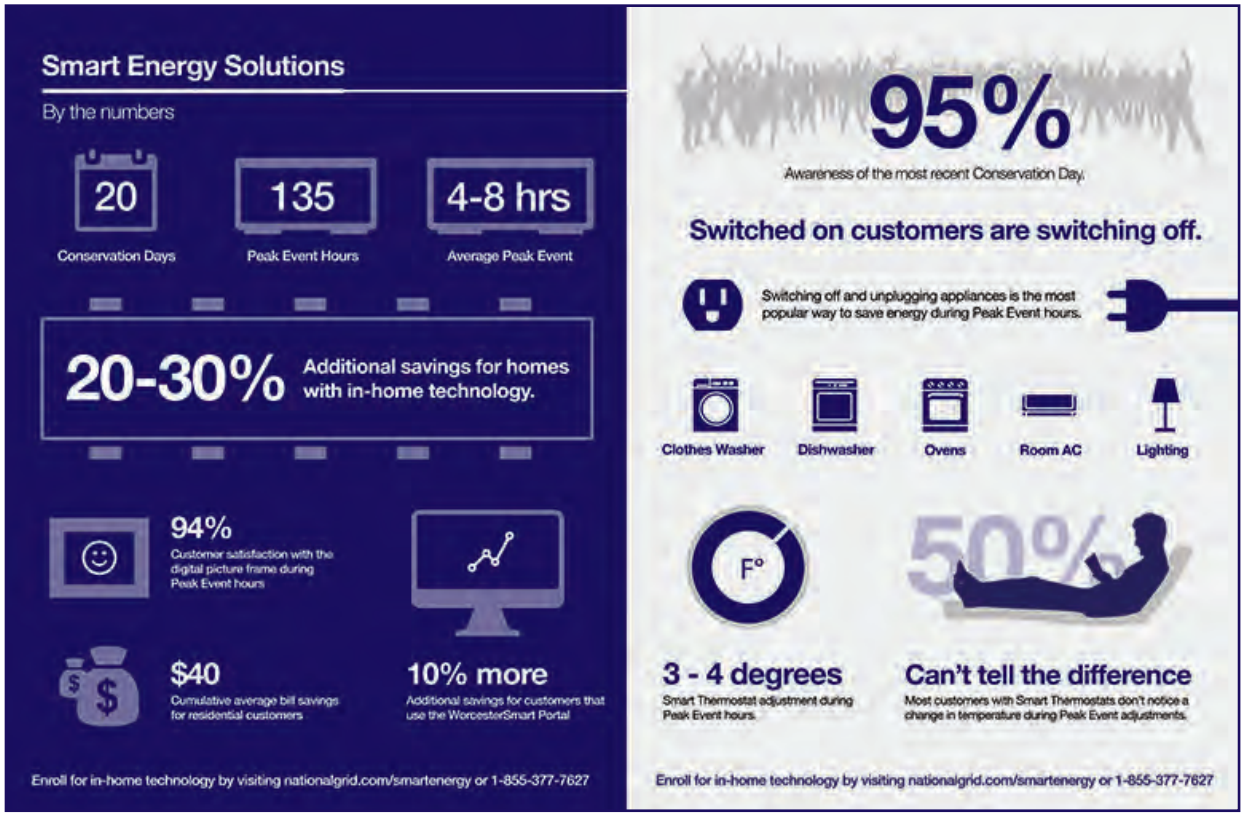
Smart Energy Solutions also enables us to communicate directly with customers during critical periods when the demand on the electric grid is high, called "peak events."

Peak Events & Home Appliances

Peak Event hours on Conservation Days are most common during the summer, but can be called any time throughout the year when demand on the electric grid is high.

Plan ahead! Which of these energy-gobbling appliances can you leave off, turn down or wait to use to save energy and money during the next Peak Event?

Visit **www.worcestersmart.com** for information and tips to help you save!



Before these events, customers receive automatic alerts (via email, text, or phone) and can pre-set smart thermostats to save both energy and money. They can also access "load control" devices that prevent water heaters and pool pumps from operating during peak events.

The summer of 2015 saw our first peak events in Worcester. What did we learn? Customers are taking action and feel that the technology is helpful for both understanding and controlling their usage.

Using Worcester as the blueprint, we're now looking at new opportunities to enhance the customer experience by taking the pieces that worked (smart meters, in-home technology, and new rates) and eliminating issues that our customers identified as participation hurdles.

Future pilot programs may help tackle other customer issues such as weather-related bill fluctuations or high upfront costs for investments such as solar panels.

With New York's regulatory leadership through REV, the Empire State will be our next stop for a smart grid pilot. The communities that we're exploring provide us with the opportunity to test new smart grid features such as combined electricity and gas "simple bills," that stay at one flat rate for the entire year.

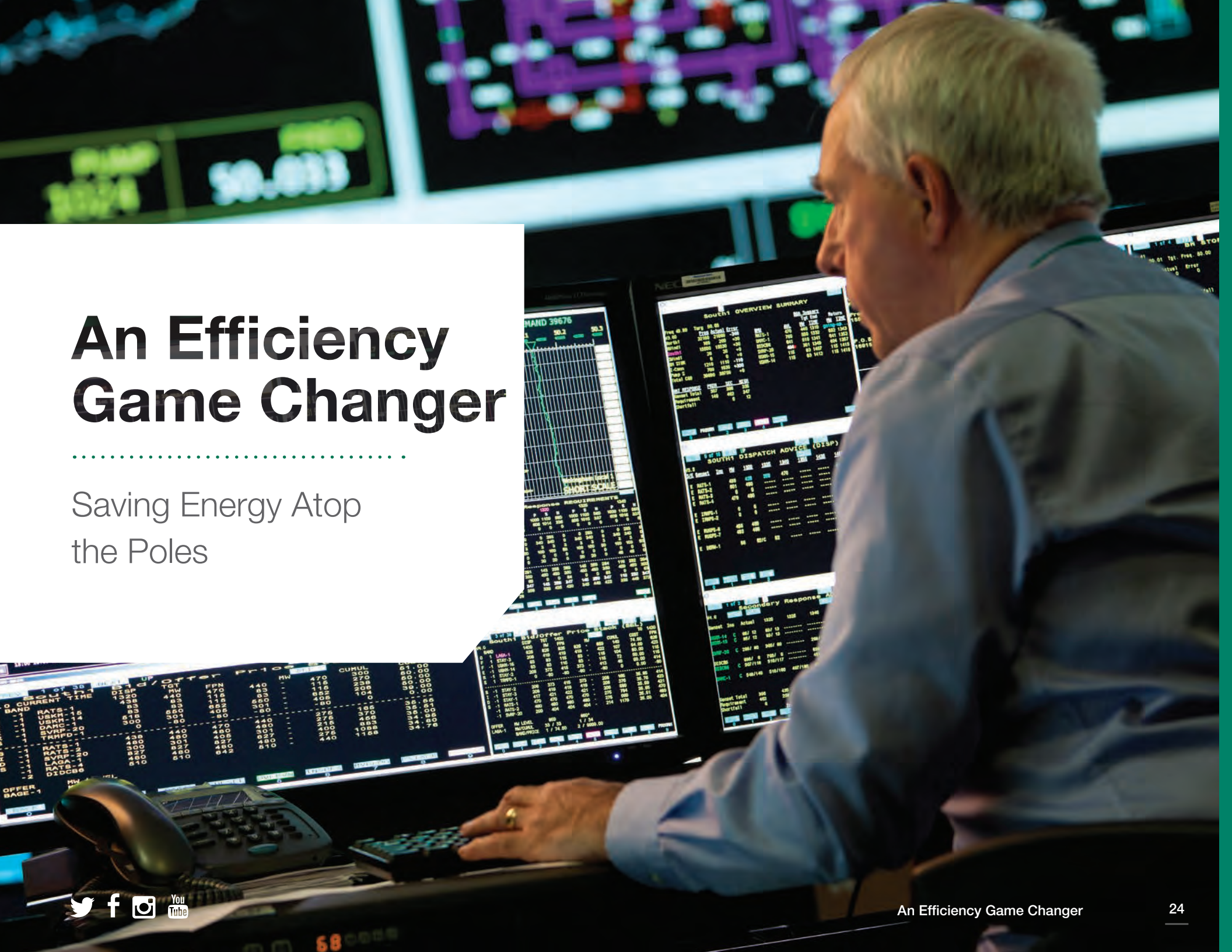
They allow us to consider an enhanced portfolio of customer-owned generation opportunities, such as new solar and wind, and new strategic partnerships with technology and appliance partners. Enhanced street lighting that reduces energy consumption and provides better lighting quality, as well as Volt/VAR Optimization, which you can read more about in our chapter titled "An Efficiency Game Changer", are also being considered for new pilots.

As we continue to evolve the range of choices we're offering customers using Worcester's Smart Energy Solutions as a model, future programs will increase the adoption of smart home appliances through education, ease the impact on the upfront investments, and improve customers' understanding of how energy markets work.

All of these solutions optimize the customer experience, increase savings for the community, and protect the environment. Equally important, they enable the demand for energy to keep pace with local economic growth.

An Efficiency Game Changer

Saving Energy Atop the Poles



When I talk to our customers, it's clear that many of them share the same top priority about electricity: when they flip the switch, the lights go on. Yet, I've learned that what happens behind the scenes – and what affects the service those customers see every day – is much more complex.

The electricity industry is one of the few to master "just-in-time" manufacturing. Electricity is produced as it's needed. Unlike many products we use every day, electricity cannot be stored, put on a shelf and delivered at a later date. Instead, there is a comprehensive 24/7 effort nationwide to monitor and generate electricity on-demand. There are many challenges to delivering electricity in real-time and meeting fluctuating energy needs.

Now, consider the fact that the electric grid dates back more than a century. This combination of a complex industry, supported by an aging infrastructure, has resulted in some real challenges, including wasted energy as it's transported from one location to another over miles of cable.

The U.S. is dead last among developed nations when it comes to energy productivity. Shockingly, as a nation, we waste more energy than we use. A whopping 57 percent of the energy flowing into our economy is lost as heat, noise or leaks.

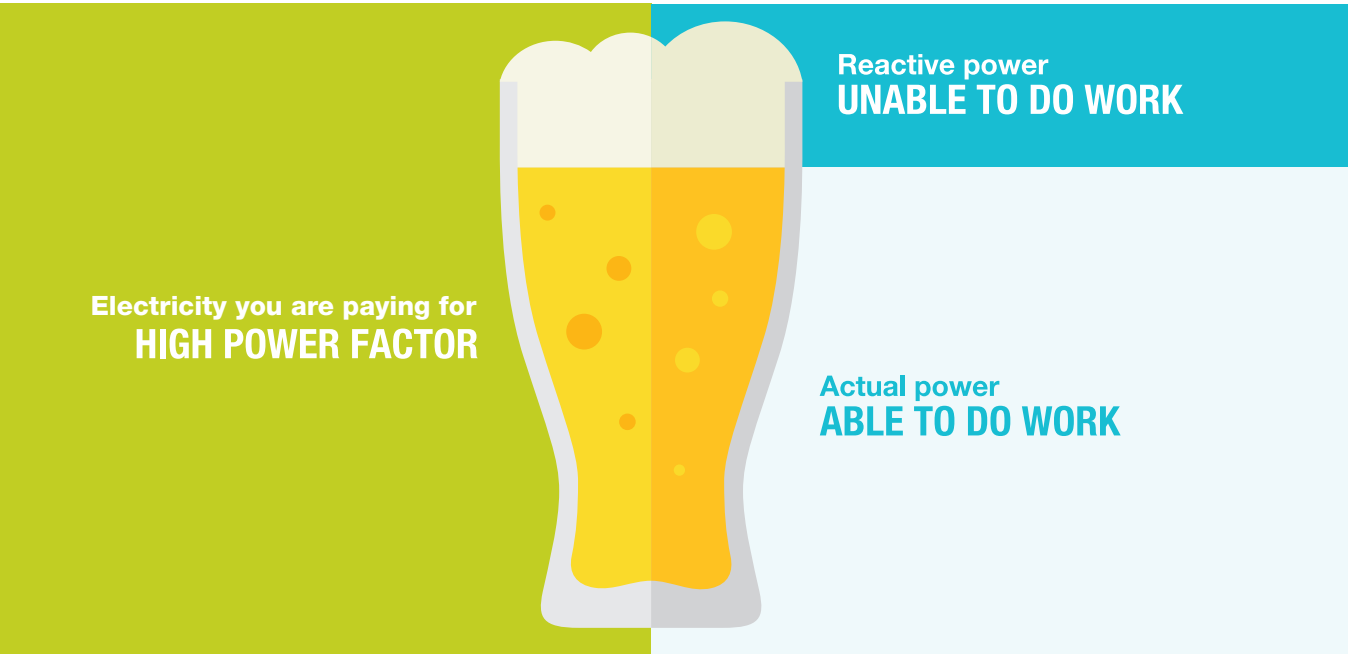
However, it doesn't need to be that way. Understanding where, why, and how energy waste occurs is now possible thanks to advanced technology. In Rhode Island, we are deploying Volt/VAR optimization equipment as a cost-effective way to limit energy loss on our distribution network.

Volt/VAR helps to reduce losses as electricity travels from generating plants, through the transmission network, into substations, and ultimately to homes and businesses by monitoring what we call "power factor." Think of a draft beer. Some would tell you there is an art and science to pouring it. It's all about getting the right ratio between the head and the actual beer.

Now imagine the beer is the electricity that powers our appliances, charges our phones, and meets our energy needs. It is the power that does all of the work.

Our electricity also contains something called "reactive power" (the head of the beer), which takes up space. If the head of beer in this example had been double in size, it would leave less room in the glass for the real power that does all of the work.

So what does all of this mean? Customers pay for both reactive and actual power. The goal is to limit the wasted reactive power and create the right ratio of power factor for the grid to operate most efficiently and affordably.



If your electricity is a draft beer, "reactive power" would be the head – Volt/VAR gives you a perfect pour.

We're investing
$6.2 million in
Volt/VAR technology in Rhode Island to benefit
16,000 customers.

Volt/VAR is a smart technology that monitors the power factor in real-time, helps to regulate it, and thus limits line losses. Volt/VAR also helps our customers' devices – from TVs and electric stoves to industrial machinery – function more effectively, reducing their monthly bills. In short, it is a high-tech energy efficiency tool.

For starters, we're investing $6.2 million in Volt/VAR technology in Rhode Island to benefit 16,000 customers. As a result of this investment, we are expecting a three percent reduction in energy demand.

While many of our customers might never know (or care) about Volt/VAR technology, they will see the impact of it at the end of the day: more reliable power, less expensive power, and a cleaner, more efficient electric grid. Imagine that three percent savings multiplied by the 20 million people we serve. Now we're talking about real money, a real impact on the environment, and a real 21st century electric grid.

How Big is the Bridge?

Transitioning to a Decarbonized U.S. Energy Infrastructure

A future without carbon emissions – one that would have seemed impossible just a few decades ago – is now visible on the horizon. In this future, climate change has been slowed to a standstill and we've succeeded in preserving the planet for future generations. And our global society no longer needs to release carbon into the atmosphere to generate all of the affordable, reliable energy we need.

At the start of this eBook, I told you that I believe in this future. National Grid employees live, work, and play in the communities we serve. What better way to protect our communities than to take the lead in creating decarbonized energy networks that keep them healthy while also delivering smart, sustainable economic development?

Looking out to 2050, many frame the future in terms of renewable resources. When will all of our energy needs be met by wind and solar? These renewables will be vital to creating a sustainable economy, but it's more useful to examine what we actually want that future to look like – a world with significantly decreased carbon emissions.

All three of the states National Grid serves, Massachusetts, New York and Rhode Island, have established 2050 goals of 80 percent reductions in emissions versus 1990 levels. These states have already made significant progress toward these targets. Since 1990, the amount of electricity generated from coal has fallen by 82 percent in New York and 66 percent in New England, leading to declines in carbon emissions of 52 percent and 35 percent, respectively.

So where is this new electricity coming from? While renewable energy sources grew, they still make up less than five percent of the electricity generation in the region. The real game changer was natural gas, which went from less than a quarter of the power generation in the 1990s to about half today.

There's still a long way to go. Almost all of the emissions reductions in the Northeast to date have come from cleaning up power generation. Meanwhile, the region's largest polluter, transportation – emissions from the tailpipes of trucks, trains, planes and all of our cars – hasn't budged since 1990.

Our next step toward creating a decarbonized energy network should be to broaden our reach, using the same model that cleaned up power generation – a balanced approach of renewables, energy efficiency, and natural gas – to enable an all-electric transportation sector.

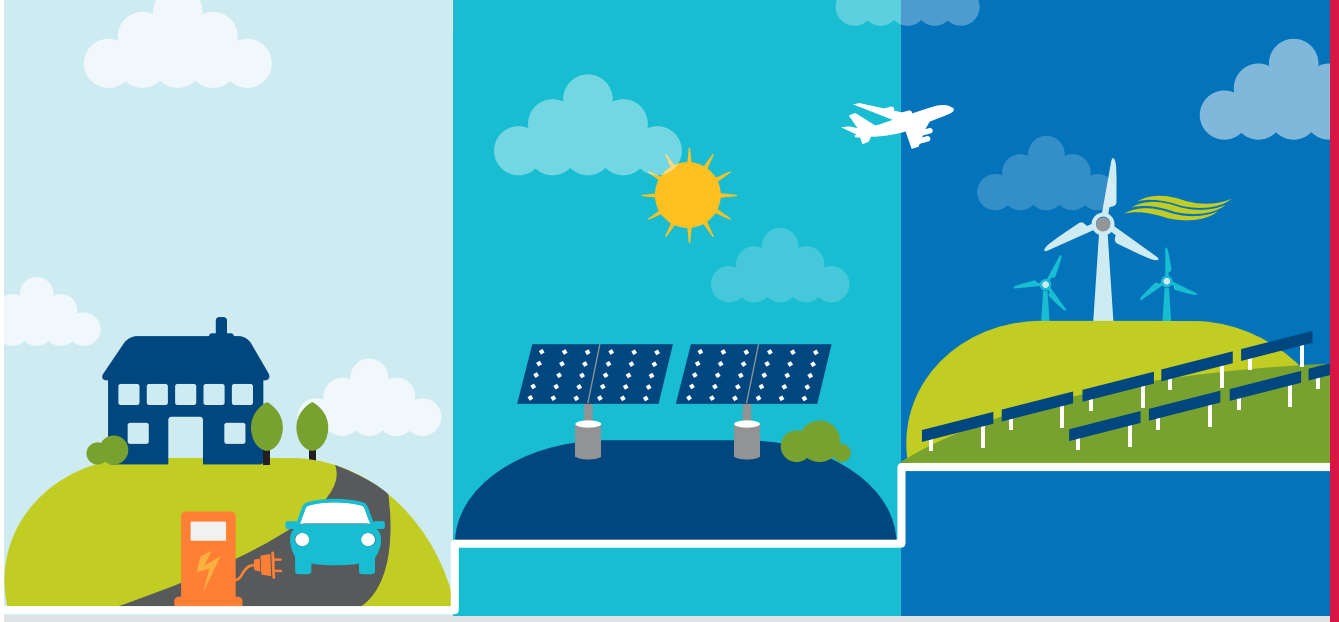
Since 1990, the amount of electricity generated from coal has fallen by

82% in New York and 66% in New England

At the same time, we will continue to decrease heating emissions for homes and businesses by converting from oil to natural gas, just as the Veterans Affairs Medical Center in Northport, N.Y. did. The Northport VA's conversion prevents 5,000 tons of carbon from escaping into the atmosphere every year, the equivalent of taking 3,500 cars off the road. And the medical center's $2.5 million in savings can be invested back into programs that directly benefit veterans.

We've teamed up with the White House, Google and the Environmental Defense Fund, state regulators, and others on efforts to reduce methane emissions and make natural gas and even cleaner transition fuel. National Grid is also part of One Future, a seven-member coalition with the goal of achieving a methane leak rate of no more than one percent across the natural gas supply chain.

You can imagine how natural gas forms a bridge that helps take us to a decarbonized future. It serves as a backstop to bring on more intermittent renewable energy generation until large-scale energy storage technologies become available. And we're already coming up with new and fascinating ways to make that bridge even cleaner. Take Newtown Creek, where National Grid teamed up with the largest water treatment facility in New York City to produce renewable biogas from the waste stream and inject it directly into the local gas network. By converting a potentially harmful byproduct into a valuable source of cleaner heat, we're scoring an economic and environmental victory.



HOW WE GET THERE

The Near Term:
investing in natural gas infrastructure, green transmission, and energy efficiency today to prepare us for the electrification of transportation and cleaner home heating tomorrow.

The Mid Term:
achieving an 80 percent reduction in emissions in all three of the states we serve by 2050, driven primarily by cleaning up the transportation and heating sectors (and once again fueled by renewables, efficiency and natural gas).

And the Long Term:
a future economy that is powered by an integrated decarbonized energy system.

While aggressive, our strategy sets the table for eliminating significant emissions from the energy supply chain without triggering economic disruption in local communities. Frankly, we can't wait.

Green Connections

Electric Transmission and the Transition to a Clean Energy Future

National Grid customers will soon receive energy from Deepwater Wind's Block Island Wind Farm, the first offshore wind installation in the U.S.

By now it's clear that I'm an ardent supporter of developing significant new clean energy resources, and doing it in a way that's affordable for all customers.

At National Grid, we are very fortunate to operate in states that share the desire to green our energy portfolio in a major way, and our policymakers have enacted ambitious and commendable energy policies to do so. These policies require utilities to purchase ever-increasing amounts of clean energy to deliver to customers.

But here's the challenge – there isn't anywhere near enough supply to meet these requirements today, never mind down the road, when they will increase exponentially. And it's next to impossible to build large-scale solar facilities or wind farms – let alone hydroelectric dams – near the highly-populated areas where the renewable power is needed.

To fill the gap, utilities may purchase renewable energy credits or certificates, commonly called RECs. A REC represents the property rights to the environmental, social, and other non-power qualities of renewable electricity generation. And they can be purchased separately from the physical electricity produced by a renewable generator.

While the REC option works on paper, at least for now, it does nothing to encourage the development of new clean generation resources. What we need is a paradigm shift in our thinking about the transmission grid.

> What we need is a paradigm shift in our thinking about the **transmission grid.**

Our power grid is widely considered to be a marvel of the 20th century. It was initially built to deliver electricity from power plants to local communities. Later, as the industry evolved, it was modified and expanded to accommodate interstate and interregional electricity transmission.

Now, it needs to evolve again to meet the needs of our growing 21st century digital economy, in particular to deliver remote large-scale clean energy resources to population centers where demand is high – and to do so in a way that is affordable for customers.

National Grid has fully embraced this undertaking.

In 1990, we flipped the switch on a nearly 1,000-mile high-voltage direct-current, or HVDC, transmission system that runs from northern Quebec to central Massachusetts. This project has delivered many thousands of megawatts of carbon-free Canadian hydropower to New England over the past 25 years. When it came online, it was the first project of its kind, and to this day remains one of only a handful worldwide.

National Grid is also a key investor in Clean Line Energy Partners, a developer of long-haul transmission lines to connect wind energy resources in the Midwest to cities and communities that lack access to new, low-cost renewable power.

Closer to home, we have joined forces with Anbaric Transmission to form the Green Line Infrastructure Alliance (GLIA), which also aims to develop long-haul HVDC transmission projects to deliver a combination of abundant, cost-effective onshore wind and hydropower from northern New York, Maine, and Canada to population centers in New England. This clean energy "two-fer" solves the intermittency issues often associated with renewable energy by combining the cost-effectiveness of onshore wind with the reliability of hydropower, which can serve as a backstop when the wind isn't blowing. We have initially proposed two projects: the Maine Green Line and the Vermont Green Line, both of which are hybrid land and submarine HVDC cable systems.

National Grid, through another green transmission project called "sea2shore," is also facilitating the development of Deepwater Wind's Block Island Wind Farm. This is a monumental breakthrough. Our Rhode Island customers will receive energy generated by the first offshore wind farm in the entire United States.

Our customers will receive energy generated by the **first offshore** wind farm in the entire United States.

We're building the transmission cable that will connect Deepwater Wind's turbines to mainland Rhode Island. In addition to connecting the wind farm, sea2shore also will enable Block Island to wean itself from the diesel generators that, to date, have provided its electricity, and instead take power from the wind farm and the regional power grid.

The Block Island Wind Farm under construction

It will take time for these and other clean transmission projects to complete the various siting processes and required regulatory reviews that precede their construction, so it's imperative that we keep forging ahead so they can be completed as quickly as possible. Clean transmission is a critical component of the balanced portfolio of solutions that are needed to secure our long-term, decarbonized energy future.

Clean Energy Economic Development

Triple Win of Lower Bills, Less Carbon, More Jobs

As this book comes to a close, you've seen the enormous challenges the energy industry must overcome to decarbonize the supply chain. Affordability, innovative regulation, advances in technology, unprecedented partnerships, the natural gas bridge – all must be implemented on a large scale and at the local level. What does that mean? How, exactly, does that macro vision translate to micro stories in the communities we serve?

There's a lot of economic benefit that comes with having a large utility in your backyard. For one, we bring billions to bear in local investment – $12.5 billion over the next five years, in fact. And that's just in infrastructure upgrades. This

number does not take into account the state and local taxes we pay, the jobs we provide, and the capital we invest to move our systems into the 21st century – with the proper regulatory support, of course.

Remember, we're not selling widgets. We're transporting energy – a volatile commodity whose needs must be met with 24/7 oversight. I can only speak for National Grid, but as a multinational energy delivery company with a hyper-local customer focus, there are a number of examples of clean energy leadership I'm proud to lean on.

Our new approach to large-scale solar in Massachusetts is one of them. By strategically targeting installations – more than 20 megawatts of solar panels in projects across the state – National Grid is looking to provide additional energy to communities that need it *when* they need it, vastly improving the value of solar projects to customers. And the local economic benefit? In addition to the powerful impact these installations will have on the energy grid, the projects will create jobs for the community and, in some locations, help to transform marginal existing space into something far more beneficial. Further, the solar projects will also provide information to help us determine if infrastructure can be retired and removed in certain locations. There's that triple win again—lower bills, cleaner energy, and more jobs.

We are also innovating how we bring clean energy to customers through on and offshore wind projects. Our Green Line transmission projects tackle the issue of intermittent energy from wind power by linking wind farms with hydro generation. When wind generation slows, we ramp up hydro – and vice versa – to create a stable stream of electricity that will be delivered from New York, Maine, and Canada via efficient HVDC transmission lines to population centers in southern New England.

And if that doesn't get you excited, consider this: the first offshore wind installation in the U.S. is rising out of the waves here in Rhode Island. Deepwater Wind's Block Island Wind Farm will connect Rhode Islanders with clean electricity, and I'm proud to say that National Grid is building the undersea cable that will connect Deepwater Wind to mainland electric consumers. Again: the triple win.

There is no silver bullet when it comes to a decarbonized energy future – that's why we believe in a balanced approach to getting us there. Enter the natural gas-to-renewables transition story – the one that few talk about. The facts remain: yes, natural gas is a fossil fuel. But it's the cleanest, most abundant and affordable option we have that can supply reliable energy over the next several decades in the way we have come to expect. No other resource can deliver on that promise. It is the bridge that will allow us all to make the best decisions for our communities. No customer or community can be left behind, so the solutions must be the right ones the first time.

Climate change threatens nearly every aspect of our society. From health, food supply, businesses, the environment—all the way up to national economies and security. Our industry, and the U.S. as a whole, must continue to advance renewable energy sources while also lowering demand through energy efficiency.

Given the region's growing electric-gas interdependency, we must invest in natural gas pipelines today to stabilize electricity prices and prepare for the electrification of transportation and home heating tomorrow. And we must continue to build the resilient electricity transmission networks that underpin and enable the economic prosperity of our communities.

There's no denying what our customers already know: tomorrow's power grid and energy supply chain must look much different than today's.

I admit that we don't have all the answers yet, but I can guarantee we are committed to finding them. We *do* know we must put customers in charge, embrace technology partners, and see real change in how the industry is financed and regulated. It's time for all utility companies—and our policy and tech partners—to bring the full weight of our power to bear, killing our 20th century infrastructure paradigm in order to have one that works for the 21st century, and beyond.

About National Grid

FTSE 350 Climate Change Disclosure

Leadership Index Member

—Carbon Disclosure Project

All three states we serve:

Top 10 for Energy Efficiency

—ACEEE

Top Green Utility in the World

—Newsweek

People we serve: More than

20 million in the US

US Investment: $12.5 billion
over the next 5 years

About the Author

Dean Seavers joined National Grid in December 2014 as President of National Grid in the U.S.

Dean's long career has included leadership roles at GE, United Technologies, and Tyco. He led GE Security, a $2 billion product and technology group, and he also led a $4 billion global services portfolio for United Technologies.

At Red Hawk Fire & Security, Dean's most recent venture, he was a founder and served as President and CEO. Red Hawk quickly became the second largest independent fire and security platform in the U.S., providing integrated security solutions to large and mid-sized commercial customers.

Dean has a strong background in financial strategy, performance improvement, and operational leadership. At National Grid, his focus is on continuing the performance progress that underpins the company's U.S. business while driving its Connect21 agenda of building the advanced natural gas and electricity networks that are the foundation of our 21st century digital economy.

A native of Sandusky, Ohio, Dean graduated summa cum laude with a bachelor's degree in business from Kent State University and earned an MBA from Stanford University's Graduate School of Business.

Dean and his family have a home in Boston.

nationalgrid

About National Grid

National Grid (LSE: NG; NYSE: NGG) is an electricity and natural gas delivery company that connects more than 20 million people to energy sources through its networks in New York, Massachusetts, and Rhode Island. It is the largest distributor of natural gas in the Northeast. National Grid also operates the systems that deliver gas and electricity across Great Britain.

Through its U.S. Connect21 strategy, National Grid is transforming its electricity and natural gas networks to support our 21st century digital economy with smarter, cleaner, and more resilient energy solutions. Connect21 is vital to our communities' long-term economic and environmental health and aligns with regulatory initiatives in Massachusetts (Grid Modernization), New York (REV: Reforming the Energy Vision), and Rhode Island (Infrastructure, Safety, & Reliability).

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