Building a Community Energy Company for the Future

Discussion Guide 2015

mgoe®
your community energy company

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Madison Gas and Electric would like to thank Great Plains Institute for their collaboration and assistance in writing this discussion guide.

About GPI: The Great Plains Institute is a non-partisan non-profit organization that specializes in consensus based strategies to discover and implement durable solutions to society's most pressing energy challenges.

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GREAT PLAINS INSTITUTE Better Energy. Better World.

Dear Madison Gas and Electric Customer:

We at Madison Gas and Electric Company are grateful for the privilege of serving our customers' energy needs for over 150 years. As your community energy company, our shared values of safety, reliability, affordability, energy efficiency, and environmental and social responsibility shape our business and the services we offer.

It is a time of great change in our community and in the lives of our customers. The technology we have at our fingertips changes almost daily and affects everything we do - from the ways we work, play and live to the ways we communicate and connect. So too, the energy world is dramatically changing how energy can be generated, delivered and used. These changes bring great opportunities.

Because the utility industry is undergoing such dramatic changes, we need direction from you. We want to focus our community, our customers and our company to find a shared vision for:

- reliable and affordable energy services,
- innovative and responsive customer services,
- future sources and costs of energy,
- ways customers can impact our energy future and costs,
- MGE's role as your community energy company of the future.

Regardless of where we live or what we do, having reliable energy is important for daily life. Energy is a critical service upon which our community depends. At MGE, we take seriously our responsibility to provide energy to our customers 24 hours a day, seven days a week, 365 days a year.

We want to shape our collective energy future in ways that:

- provide clean, dependable, reliable and affordable energy to our customers,
- continue to meet the needs of our community and do so equitably,
- take advantage of new technology to benefit our entire community and for future generations,
- maintain the long-term health and vitality of our communities,
- balance and reflect our customers' values and preferences.

We need you – our customers and other stakeholders – to problem-solve with us. Working together, I am confident that we can strike a balance going forward to address the tradeoffs and challenges we face.

Help us understand how we can best serve you. Feedback from this extensive process will guide our next steps and our long-term energy plan. Most importantly, by participating with us in these conversations, you can help us build a community energy company for the future.

Thank you for your help and the opportunity to serve you.

Sincerely,

Gary J. Wolter

How MGE strives to serve the community

Notes:

Obligations as a public utility

Like all other regulated public utilities, we have certain obligations. We have an obligation **to provide reliable electricity and natural gas service** for all customers whenever, wherever and however they need it, 24 hours a day, seven days a week, and to do so safely. We take our responsibility to provide critical energy services for this community very seriously.

Providing reliable service requires:

- **An adequate and balanced mix of energy sources** to efficiently and cost-effectively meet customer needs whenever and however customers need energy, including sufficient and varied resources so that if one or more resources are not producing, others can supply the need.
- **Robust and safe electric and gas distribution systems** to deliver energy to homes and businesses. These systems are planned, constructed and maintained to minimize outages and interruptions.
- **Operating and control systems that can instantaneously manage fluctuations** in energy generation and customer use seamlessly and without interruption.

Because by law we have been given a franchise to serve all the public in our area, we are also required **to act in accordance with the decisions and rules established by our state and federal regulators,** primarily the Public Service Commission of Wisconsin, but also the Wisconsin Department of Natural Resources, the Environmental Protection Agency, and others.

And, as a publicly-traded utility, we have an obligation **to provide a return on investment to our shareholders,** who finance the investments - in power plants, pipelines, substations, other equipment and systems - we use to serve customers. This is similar to the way a bank provides a mortgage loan for a homeowner and requires a return on the loan in the form of interest payments.

Guiding values of service

But MGE is more than pipes and wires. In addition to **providing reliable energy**, as your community energy company, we are committed to improving the quality of life for all of us who live and work here and we strive to provide energy in ways that balance the needs and values of those we serve.

We work to provide value and serve as a community energy company in these ways:

Ensuring customer equity - We work to provide culturally competent, inclusive customer service and remove cultural and linguistic barriers to working with us, so that our programs and services are accessible and equitably serve all customers.

Working together in partnerships - We work closely with customers, stakeholders, organizations and businesses to extend and deepen our service to the community and to find ways to work together to achieve common goals.

Promoting energy efficiency and conservation - We have a long-standing commitment to help and encourage customers to use energy efficiently and wisely and to make energy efficiency products and services available to our customers. We count on conservation as an important part of our energy supply. We provide customers with information, assistance, tools and resources directly and through partnerships with others.

Enabling new technology - We continually evaluate new and emerging technologies. We want to understand how they can help meet customer needs and contribute to meeting our community's energy needs. Through our long-established technology demonstration projects, we test new technologies in public and accessible places throughout the community and then provide information on their performance so that together we can learn how to incorporate new technology for the benefit of all.

Keeping service affordable - We work to keep our service affordable by controlling costs in our day-to-day operations and long-term planning. We use a diverse mix of energy sources to provide a cost-effective supply of energy.

Creating a cleaner energy future - We are committed to transitioning to a cleaner energy supply while maintaining affordable, reliable service. Through use of resources like sun, wind, landfill gas and animal waste, we are increasing the percentage of our energy supply that is renewable energy and decreasing our greenhouse gas emissions over time. We also invest in state-of-the-art pollution control technology at our fossil fuel power plants to lower emissions.

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Harnessing local resources - We include local sources of energy in our energy supply mix. Today there are more than 350 local distributed energy sources that are connected to the electric distribution system and help meet the needs of all customers. These sources range from solar photovoltaics to landfill gas to cow manure.

Making our communities better - We work to support the day-to-day and long-term quality of life in our area. We work with non-profits, serve on committees, boards and task forces, and work side-by-side with many stakeholders, associations and organizations. We partner and collaborate to make this community a better place to live for everyone here. Both the company and its philanthropic arm, the MGE Foundation, provide financial support to a wide array of local non-profit and other organizations. For example, over the past five years, the Foundation has contributed $3.9M to over 380 different community organizations and events.

Supporting a vital economy - We work to support and encourage business and economic development through programs, projects and partnerships, such as business incubators, to help generate jobs and nurture the growth of local businesses. We work together with our communities to promote this area to expanding or re-locating businesses, and we work to provide the infrastructure needed for long-term, healthy and sustainable economic growth.

Building environmental sustainability - We recognize our responsibility to aggressively prevent pollution, minimize waste and improve the environment. We use continuous improvement to reduce our environmental footprint and impacts. We go beyond industry and regulatory compliance in our day-to-day operations where science and cost-effective technologies permit.

Helping customers manage and shape their energy use - We work to provide information and tools to help customers understand and manage their energy use and costs. We consult with customers as they make decisions related to their energy use and connect them with other resources and assistance.

Engaging with customers - We engage in open and honest dialogue, partnership and collaboration to best serve our customers and the broader community. We listen, learn and adjust what we do so that we can meet customer needs and provide better service. Working one-on-one and in groups, individually and collectively, we work to engage with customers at a personal level to help shape the way we do business.

Why hold energy conversations

MGE has a responsibility to plan for and provide electricity and natural gas to all of our customers.

We want your help in planning how we meet essential community energy needs in the future, as well as provide other products and services, over the next ten to fifteen years.

More than ten years ago, we held our first series of community energy conversations. What customers told us about their needs and preferences informed our Energy 2015 Plan. Through that plan, we significantly increased the amount of energy we get from the wind, substantially grew our green pricing program through which customers can purchase renewable energy and discontinued coal use at our downtown power plant.

Now it's time to create our next long-term plan. We do so in a world where the technologies used to generate, deliver and use energy are changing dramatically. This discussion guide and these conversations are designed to help you **help us:**

- **do the things you think** your community energy company should do,
- **think about the future** and the opportunities and challenges it brings,
- **better understand the needs and values** of all of our customers so we can strike the right mix of energy supply and customer services as we plan for the future.

We don't expect our customers to be energy experts, but the issues are complicated. So we have prepared this brief discussion guide to give you some information about how the electric system works[1] and how it's likely to change. It will help you better understand both the opportunities and challenges we all face. We'd like you to "walk in our shoes." That is, imagine you run MGE and are responsible for delivering affordable, increasingly clean electricity to everyone in the community.

We want to hear **what you would do, what things are important to you and how you think we should move forward** in serving this community in a changing world.

If we are going to successfully transition, together, to a cleaner, more dynamic energy system that's not just based on selling more electricity and building power plants, but rather on MGE delivering – and getting paid for – different products and services, then we need to know what products and services you think MGE should offer, and frankly, what you would be willing to pay for them.

At the end of this conversation process, later this year, we would like to have:

- an energy plan that sets direction for the next ten to fifteen years in terms of our energy supply mix and customer services,
- a set of "next steps" programs, projects and opportunities to work together with customers that will help us move in the direction stated in our plan.

[1] There are **six elements that make up the grid**—four physical components (**generation, transmission, distribution, and storage**); an **information infrastructure** that allows grid operators to monitor and coordinate the production and delivery of power and operate the grid; and finally **electricity demand**—you, our customers drive how the system operates and what investments in it get made (*Quadrennial Energy Review*) http://www.energy.gov/sites/prod/files/2015/04/f22/QER_Ch3.pdf

Pretend you are the CEO

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Perhaps the most important product you may never think of

Most of us don't give much thought to how or from where we get our electricity until it goes out. Then many of us use a cell phone as a flashlight to find the candles and matches. Yet, the National Academy of Engineering has named "electrification"—the vast network of power plants and power lines that delivers electricity around the clock—the top engineering achievement of the 20th century, making everything from lights and motors to refrigerators, elevators and computers possible.

Electricity has become a victim of its own success. It is so commonplace and generally available and affordable that **we typically take it for granted.** Until fairly recently, with the growth of more visible solar and wind power, the production and delivery of electricity has been mostly out of sight. It has been easy to ignore everything that needs to happen to make flipping that switch possible.

A balancing challenge

Unlike most other products customers purchase, **the generation and consumption of electricity must be balanced in real time.** Utilities need to make sure that there is neither too much nor too little electricity on the system at every minute of every day, and ensure that the voltage and frequency are just right for customer use.

Most would agree that the modern electricity system is vital to virtually every aspect of our lives. It is precisely because MGE takes its responsibility to provide this indispensable product very seriously that we want your help in updating how we go about it.

Pretend that you are the CEO of MGE

Imagine that you are now in charge of running MGE, the electric utility for your community. Your two main sources of electric revenue as a company come from selling more electricity and revenue that regulators allow you to collect on building capital-intensive assets (like a power plant or a transformer). You recover your costs through electric rates that include a fair rate of return for your shareholders, many of whom depend on that income to help fund their retirement.

Now imagine that the customers you serve are becoming more energy efficient (e.g., LED lights, efficient appliances) and thereby using less of your product. Plus a growing number are choosing to produce their own electricity from renewable sources, such as solar, which means less need for you to build new power plants—and remember, building more and selling more are your two main sources of revenue.

So while you know intellectually that both **energy efficiency and more customer-owned renewable energy are good for the environment** and for society, **they may reduce revenue for your company** under today's regulatory framework.

At the same time you face this steady erosion of your traditional sources of revenue,

- ➔ You are still legally obligated to provide safe, reliable and affordable electric service to all.
- ➔ Your prices have to be approved by a governmental agency.
- ➔ You are expected to replace and repair old and obsolete portions of your electric system.
- ➔ You need to make large new investments to make your system cleaner, more automated and intelligent, efficient, real-time controlled, open to more participants, more flexible (able to ramp up and down quickly), and more secure and resilient against attack and natural disasters.
- ➔ You must also empower customers to sell excess electricity and other services back to the grid and enable them to manage and reduce their energy costs.[2]

You can begin to see the conundrum you face as the head of MGE. One of the main reasons we are holding these Community Energy Conversations is to get advice from you—our customers—in helping us to make this transition toward a more efficient and cleaner energy system while staying financially healthy as a company so we can continue to provide customers with reliable service and meet the expectations of our investors. If we are unable to do that, then everyone loses.

[2] The Edison Electric Institute has estimated that by 2030, the U.S. electric utility industry will need to make a total infrastructure investment of $1.5 trillion to $2.0 trillion.

Technology is changing the energy landscape

If you aren't already amazed by how a steady stream of electricity flows every second of the day to where you live and work, consider that the 21st century electric system is becoming even more complex as we fundamentally change the ways we use, generate and deliver electricity.

Electric system feature	Yesterday
The customer's role	**Mostly passive** recipients of electricity, produced however utilities thought best (i.e., from coal, natural gas, nuclear, wind, solar, hydropower, etc.). **No real-time information** telling you how much energy you're using or what it costs.
Electricity prices and how you are billed	**Simple meters** **Billed monthly, based on accumulated usage**, don't really see the price per unit until the bill comes. **Emphasis on low *rates*** (price paid per unit of electricity, measured in kilowatt hours, kWh). **Everyone pays a "fixed charge"** (regardless of how much electricity you use) to help maintain the electric system and invest in its maintenance. MGE's costs are averaged and recovered through variable rates that apply the same to everyone because everyone uses electricity the same way.
The role of energy efficiency	Has **avoided expensive new power plants**. Has **meant fewer energy sales** by utilities. Has **required active intervention by consumers** (installing insulation, energy audits, better windows, etc.).
Electricity production	**Centralized** at a relatively small number of power plants. Mainly based on **fossil fuels** (coal, natural gas and some diesel/oil), plus nuclear and hydro.
The bulk transmission grid	Similar to Interstate highways, high-voltage transmission lines **transport power long distances** from centralized power plants, to distribution networks and customers. This system allows utilities to share resources to improve reliability.
The distribution network	Transforms high voltage electricity to a safer lower voltage; **sends electricity one direction to customers.**
Distributed generation technologies	Also referred to as "DG," distributed generation is small-scale, on-site power generation located at a customer's home or business. A limited number of customers have on-site generation, mostly used for emergency backup power when system power is not available during an extended outage.
Reliability of the system	**Reliability is important,** and one of the core goals of the system, alongside safety and affordability.

The shift we are experiencing in the electricity sector is somewhat similar to the shift from large, centralized "mainframe" computers, to the highly distributed system of laptops and cell phones that have now put computers quite literally in nearly everyone's hands. The electricity sector is going through much the same transformation. The table below gives you a glimpse of how some of the main aspects of the electric system are changing:

The status quo is not a viable option, either for our customers or for MGE as a business. Home Depot is selling solar panels. Google is selling energy management devices and services. There are new energy efficiency "apps" for your phone. The market is already challenging the old electric system.

Electric system feature	Tomorrow
The customer's role	Everyone still wants electricity to be available and affordable... But **a growing number want more options and active control** over how their electricity is produced, how to pay for it, and how to control when and how they use it, some becoming net energy producers. New technologies, from **smart thermostats and appliances to electric vehicles**, are opening up new ways for customers to benefit from and interact with the electric grid.
Electricity prices and how you are billed	**Advanced meters** **Your electricity use is measured in real-time** (more like filling up your car at the gas station), and you are able to see easily what the prices are at any given time. **Emphasis on low *bills* rather than focusing just on rates.** Meaning that even if the cost per unit of electricity goes up (as the cost of most things do), both utilities and consumers have incentives to keep people's *bills* affordable. Everyone pays some "fixed charge" for upkeep and system improvement, but **customers still have incentives to conserve energy**; different customers pay different rates based on how they use electricity, and utilities have other options for raising the revenue needed to maintain & improve the system.
The role of energy efficiency	Greater efficiency frees up money to **help pay for modernizing the aging electric system**. **Both utilities and consumers have financial incentives to save energy.** **Automation of the electric grid**—the ability of things connected to the grid to communicate with each other—**makes it possible to optimize the efficiency of the entire system.**
Electricity production	**Decentralized**, with thousands of actors on the system producing their own electricity and selling remainder to the grid, plugging in vehicles, etc. **Growing emphasis on energy efficiency and renewable sources** of electricity (e.g., solar, wind, bioenergy).
The bulk transmission grid	New transmission lines "knit together" regional grids to facilitate broad regional energy markets and **enable reliance on renewable energy from a larger geography**.
The distribution network	**Automated two-way flow of both electricity and information**, so that customers can sell energy and other useful services back to the grid; and grid operators manage a much more complex system.
Distributed generation technologies	Costs of some DG installations, such as solar panels, have declined, contributing to their more widespread use. DG requires two-way power flows on the grid so customers who produce their own power may also send electricity to the grid, creating a more complex community energy grid.
Reliability of the system	**Growing demand for even greater reliability** as more critical services and day-to-day recreational and economic activities become digital. Of course safety and affordability remain important.

MGE's objectives about changing technology

This more complex system will require a "conductor" to ensure that the system remains safe and reliable, and to ensure that it develops in a coherent way that **keeps electricity affordable for everyone.** MGE wants to be that conductor. **We want to take advantage of new technology and respond to our customers' evolving needs and preferences.**

Toward that end, we have identified the following objectives that, taken together, reflect the kind of energy company we want to be in the future, to best serve our community with respect to rapidly changing technology.

MGE'S OBJECTIVES ABOUT CHANGING TECHNOLOGY

1. Provide our customers with options they want today and in the future.

2. Help our customers control their energy use and costs, which in turn will minimize the need for costly new electric generation and distribution systems.

3. Transition MGE to a more environmentally sustainable energy supply.

4. Provide a dynamic, integrated electric grid that supports a range of distributed and centralized energy technologies and reliable service to MGE customers at a reasonable cost.

5. Ensure that changing technology serves all customers equitably.

Notes:

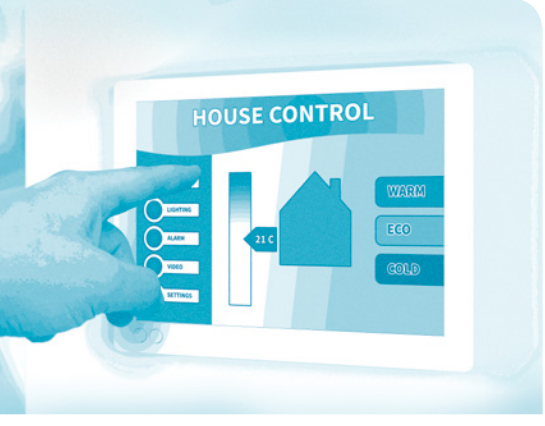
OBJECTIVE 1

Provide our customers with options they want today and in the future.

Despite all of the complexity behind the scenes, getting electricity service has been pretty simple in the past. Your utility connected you to the distribution network, activated your service and the electricity kept coming.

MGE sees the changing energy technology landscape as an opportunity to offer our customers more customized products and services based on individual preferences. Some customers will be happy with the electricity we deliver, produced with an evolving mix of fuels—including coal, power purchased on the open market, renewables, etc.—and other customers will want to invest in producing their own power from solar, for example, either directly on their roof or through shares in a community solar project.

We recognize that many, maybe **most people will want their electricity service to remain simple and effortless in the future**. But we also see that new energy, communications and digital technologies are making it possible for people and institutions to engage in the energy system as never before, as both users and producers of energy and other "ancillary services[3]." For example, people who have their own electricity generation may need additional power to start large electric equipment such as their central air conditioner. This momentary boost of power from the grid provides support to run their air conditioning along with other major appliances. That will mean that **some customers will want new kinds of information, services and technologies from us**.



For example, there are now technologies that can help customers manage their energy use and provide automated control and convenience. You might replace your existing thermostat with something that looks more like a "tablet" that connects to and communicates with the digital devices throughout your home—from your AC and other appliances, to lights and the heating system—to optimize their efficient use.

[3] **Ancillary services** include "ramping" (responding quickly to balance supply and demand of electricity), and maintaining the right voltage and frequency so the system remains reliable at all times. As the power system continues to change, a wide range of technologies can provide these services, from electric vehicles, solar installations and batteries, to larger "balancing areas" made possible by a more robust transmission network.

Your energy control panel would automatically know the cheapest time to charge your electric vehicle, or cycle your refrigerator or air conditioner off and on to reduce peak demand on the electric system and thereby reduce costs for everyone (more on this later). It could even know when to sell excess energy from the solar panels on your roof, if you have them, earning you money for contributing energy or other benefits to the system. Not everyone will want or be able to afford these features, but they are fast becoming possible.

If you are living on a fixed income, these technologies could help you be sure that you are using energy at the most affordable times and operating your home as efficiently as possible.

New technology can also incorporate (and respond to) what's happening on the regional electric system as a whole. Smart meters can communicate with a customer's automation and control systems at their home or business, giving you more information about the costs of providing electric service to you at any given time. Each device can gather data and communicate with the utility's network operations center, allowing the utility to adjust and control each individual device or thousands of devices from a central location for those who have chosen this option. This may sound intrusive, but could dramatically improve the efficiency of the entire system and thereby reduce costs for everyone, and can be done while respecting privacy.

We want to learn from you—what kinds of products and services you are most interested in.

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OBJECTIVE 2

Help our customers control their energy use and costs, which in turn will minimize the need for costly new electric generation and distribution systems.

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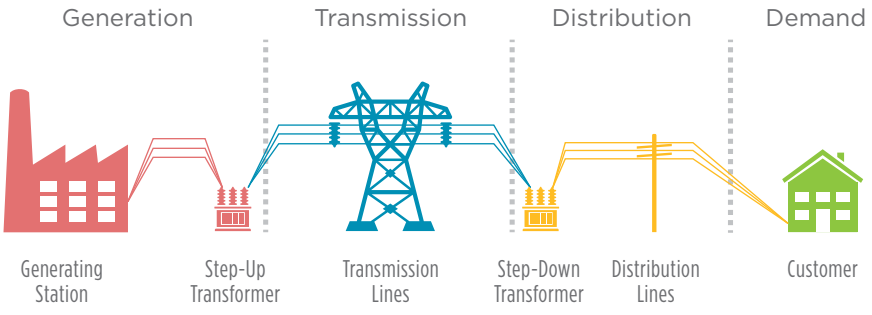
You can help us build and maintain an electricity system that is only as big as we really need

The basic design of the electric grid has remained largely the same since the first commercial power plant in the U.S. went into service in 1882. Electricity is generated remotely at large central stations, transmitted long distances with high voltage lines, and then reduced in voltage for local distribution and delivery to customers. Over the years, this system has worked remarkably well.



We are required to plan and operate the system to meet the peak demand in any given year, and to handle the instantaneous demand of customers—plus build the system with a little extra cushion (called a "reserve margin".) **Because reliable power is critical to our safety, security, economy and quality of life, we make sure there is always enough electricity available,** including when there are unexpected power plant and/or transmission line outages.

Put another way, we have intentionally—and by necessity—over-built the electric system just to accommodate short periods of peak demand—a bit like a local fire department that has an extra fire truck that stays in the station most of the time. It is used only for really big fires or if another fire truck cannot respond. **Today's grid is designed to meet a peak demand that is nearly twice the average demand for electricity.** This means that most of the time **there is a lot of excess electricity generating capacity.**

To use another analogy, it's like building a bigger factory than you need—most of which sits idle for long periods of time—just so you can meet a burst of demand for your product that happens once or twice a year. Other industries that do not provide such critical, life-sustaining services would not do this, because building and maintaining that extra capacity means higher costs for everyone. We are required to provide power, and leaving people in the dark for a while because the system has a high demand is not an option for us.

In the world of electricity, this underutilization of the electric system is called having a low "load factor" (whereas a high load factor would mean that power usage is relatively constant all the time). Unlike many other parts of Wisconsin and the country, the Madison area has very few factories or other energy-intensive businesses that run 24/7. And unfortunately, **MGE's load factor is actually getting worse (lower) rather than better because peak demand for electricity on our system is growing faster than overall sales.**

If customers reduce their peak demand, our load factor will improve and we could reduce costs for everyone in the long-run.

If we could reduce that peak demand—when everyone is flipping on their air conditioning in the late afternoon in the summer—it would save both MGE and our customers money because we could avoid the expense of having additional generating capacity to meet that peak demand (in effect, we could eliminate the extra fire truck and reduce the size of the factory mentioned above).

One way that some utilities are trying to motivate customers to reduce the peak demand and thereby avoid the construction of expensive new power plants is something called "demand response." Demand response programs encourage electricity customers to reduce their energy use during the most expensive times of peak demand by providing a financial incentive. Demand response programs not only benefit customers financially but if enough customers sign up, they can reduce the amount of energy being demanded from the system. Then MGE could avoid using the fossil-fuel-fired peaking plants that we would otherwise have to turn on. This reduces greenhouse gas emissions and minimizes the costs of the system for everyone.

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Reducing peak demand also helps us "right size" the distribution system to reduce overall costs.

This same concept is true for our electric distribution system. The distribution system is a little bit like our highway system, delivering power to customers all over our network. Unlike the highway system, however, we need to build enough capacity and controls to easily handle rush hour traffic, even if that rush hour occurs during system maintenance or lasts only a few minutes a day. Because our service is critical, we can't just let traffic slow down or stall.

If we can right-size our electric distribution system, we can avoid costly system upgrades and reduce system losses (generating and moving electricity inevitably means some losses at each transition step, given the laws of physics). **Building only as much distribution infrastructure as necessary, and in the right places, will save everyone money and make the system work most reliably.**

To develop the distribution system cost-effectively will require "locational value mapping." This means understanding where on our distribution system things like new solar installations, energy storage and "demand response[4]" can do the most good for the system as a whole—either by reducing congestion or avoiding overloaded transformers and substations—as electricity flows to and from customers.

Paired with pricing that varies with time, new technology can help control customers' costs.

The local electric grid of the future will require a much more automated "smart" system that can manage thousands of transactions among utilities, grid operators and customers seamlessly. This means advanced metering technology and a transition to time-varying electricity rates so that customers get accurate price signals that tell them when electricity is most and least expensive.

[4] All these and more are often lumped together and called "Distributed Energy Resources."

Some customers may worry that if prices for electricity vary by the time of day that there won't be much they can do to avoid paying those higher prices. But that's precisely why we'll need the help of more sophisticated electricity meters and smarter appliances that can "talk" to the electric grid and control your costs for you, based on your preferences ("smart" thermostats and appliances that can accept and send price signals to and from the grid are increasingly available, though not yet on the MGE system).

Time-varying rates paired with smarter electricity meters can alert customers to opportunities for lowering their current cost of power or signal when is the best time to run a dishwasher, plug-in an electric vehicle or sell electricity or other "ancillary services[5]" back to the grid to fetch the best price.

Applied fairly and with some advance notice, time-of-use rates can significantly reduce the system's peak demand for electricity, leading to more efficient use of the system's existing capacity and avoiding the need for new power plants. Not having to build additional gas-fired, traditional "peaking plants" will simultaneously save customers money and reduce emissions.

To give customers options, MGE could explore making time-varying rates available to customers who want to use new technology, such as an automated signal to the thermostat to adjust itself. Meanwhile we could preserve simpler rate options for customers who use little electricity or have limited options for changing their electricity use and may want to manually turn off their AC for a couple of hours at peak times.

Advanced meters will make it possible for MGE to offer tailored electricity rate options based on the common characteristics of different groups of customers.

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[5] Services that maintain the reliability and smooth functioning of the grid, such as maintaining proper voltage and frequency

OBJECTIVE 3

Notes:

Transition MGE to a more environmentally sustainable energy supply

Like most other utilities around the Midwest, MGE has traditionally relied heavily on burning coal and natural gas to make electricity. These fossil fuel energy sources have been relatively cheap and abundant and have helped keep rates affordable. As a regulated utility, we are required to pursue least-cost options for our customers and must justify the costs to the Public Service Commission of Wisconsin that approves our investments and the rates we can charge customers.

Over the years as we have learned about the negative side-effects of burning fossil fuels, MGE has begun to address them. Hundreds of millions of dollars of pollution control equipment have been installed to reduce mercury emissions and control sulfur dioxide and nitrogen oxide emissions that contribute to the formation of acid rain and damage to the ozone layer. As climate change is becoming more of a concern, we are examining the next steps to a more environmentally sustainable energy supply.

MGE has steadily diversified the mix of fuels of the generation assets we own. For 2014, 48% of our electricity generation was coal fueled, 13% came from renewable energy sources (wind, solar, biogas) and 3% came from natural gas. The remaining 36% came from electricity we purchased on the open market (made from a variety of fuels). MGE is a part of a regional organization called the Midcontinent Independent System Operator (MISO), which covers portions of 15 states, including Wisconsin and other Midwest states. MISO directs the power plants in that region when to produce electricity and then buys and sells the power to the members based on the economic market price. As a result, about 70% of the energy produced in the Midwest is coal-generated energy.

We see this fuel mix continuing to change over time driven largely by changes in consumer preferences for cleaner energy, improvements in clean energy technology and sharp declines in their cost. For example, the wholesale cost of solar photovoltaic panels has dropped by 99% since 1977 and 83% since 2007, making it more attractive for households and institutions to produce their own power[6].

[6] According to GTM Research, by 2016, there will be a new distributed solar PV installation every 83 seconds in the United States. More distributed solar has been deployed in the past 2.5 years than in the 50 years prior, and GTM Research is forecasting another doubling over the next 2.5 years.

The historically higher capital costs of solar has made it harder to justify its inclusion in the energy supply mix, but as you can see, this is changing—and fast[7].

We expect renewable sources of electricity (like solar and wind) to continue to fall in costs and want to further diversify our energy supply, which will reduce air pollution and lower carbon dioxide emissions, the principal greenhouse gas contributing to climate change. To date from 2005 to 2015, we've been able to reduce our carbon emissions by about 20%.

The challenge for us is to figure out how we transition to cleaner energy going forward and in what time frame.

One important function that coal-fired power plants play is to provide electricity that is available 24/7 (for example, during the bitter cold "polar vortex" of 2014 when natural gas was being diverted for space heating, we relied on our coal-fired plants to meet the demand for electricity). A second important function that these coal plants provide is that the large rotating mass of their turbines creates inertia in the system that helps maintain the grid's frequency and thus its reliability. This "inertial stability" can be accomplished in other ways, but it's something we would need to plan for in advance.

Over time and with changes in technology, there may be ways to replicate the 24/7 stability that our gas and coal-fired power plants provide – with some combination of energy efficiency, wind, solar, demand response, energy storage, electricity purchases from a more interconnected regional electricity market, etc. – but doing so would require significant and careful analysis in advance to **ensure that we have a reliable system in the future and can replace the functions of those coal plants at a reasonable cost.**

In addition, our coal-fired power plants are still used and useful assets and therefore not fully paid for (like owing a mortgage on your home, or having a car payment). Abandoning those plants early would mean that the cost of the remaining life of those assets, plus the costs of replacing the functions those coal plants provide on our system, would somehow need to be recovered.

Notes:

[7] Solar energy produced has grown over 400% since 2010, and in 2013 was the second-largest source of new U.S. electricity generating capacity (right behind natural gas.) – Fall 2014 Solar Energy Statistics, U.S. DOE.

Notes:

An electric system powered by more renewable energy will need to operate differently

Electricity demand can be different at any time of day and on any day of the year. We need to have a mix of electric generating capacity that can be used to meet that demand whenever it occurs. Because wind and solar generators are intermittent (i.e., the sun doesn't always shine and the wind doesn't always blow), the system will need to operate differently and draw on a range of resources to meet the demand when the sun and wind aren't there.

We used to think that we needed some way to "back up" wind and solar when they weren't available, often with "peaking" plants running for brief periods on diesel or natural gas. Our whole approach was to plan for how much electricity demand there might be at any given time in the year, then build enough electric generating capacity to meet that demand through "dispatchable baseload," "intermediate," and "peaking" power plants ("baseload" plants being those that essentially run all the time, and "intermediate and peaking" plants being those that we call upon for shorter periods when electricity demand is higher).

Today's large, "liquid" electricity markets are able to re-match net demand with net supply every five minutes across the entire region and do so using a variety of supply and demand-side resources to meet the net demand for electricity.[8] Having a good mix of options for meeting the demands being placed on the system at any given moment is what makes this more flexible, dynamic and responsive electric grid possible.

[8] The U.S. has ten "Independent System Operators" (ISO) that balance supply and demand in real time and coordinate the electricity market within their footprint. The one in our region is the Midcontinent ISO (or MISO.)

KEY FEATURES OF THE EVOLVING ELECTRICITY GRID

- Demand-side customer participation in energy efficiency and "demand response" programs;
- Robust interconnections across the physical grid itself to enable balancing of supply and demand;
- Energy storage at key places on the grid;
- A sufficiently large electricity market that can draw on resources across a large footprint;
- Steady improvements in forecasting and scheduling when wind and solar will be available;
- The speed with which operators can dispatch a given energy resource (either reducing demand through "demand response" programs or adding power from somewhere on the system);
- Market rules that fairly reward new technologies financially for what they can deliver to the system's power needs and reliability.

If this sounds a bit more complex than just when to dispatch the right size power plant, it is, and it's already happening.

Notes:

OBJECTIVE 4

Provide a dynamic, integrated electric grid that supports a range of distributed and centralized energy technologies and reliable service to MGE customers at a reasonable cost.

The 100+ year-old electricity system has made modern life possible. But as with so many things, what worked in the past is not necessarily well-suited for the future. We know that we need to transition from a relatively simple system that moved electricity in one direction from central power plants to homes and businesses, to a much more complex system that operates more like the internet, where there are thousands of energy producers and users on the system, and virtually all elements can "talk" to each other in real time. MGE is not alone in seeing this new energy system emerging.

According to the U.S. Department of Energy's recently released *Quadrennial Energy Review,*

> A revolution in information and communication technology is changing the nature of the power system. The smart grid[9] is designed to monitor, protect, and automatically optimize the operation of its interconnected elements, including central and distributed generation; transmission and distribution systems; commercial and industrial users; buildings; energy storage; electric vehicles; and thermostats, appliances, and consumer devices.

THE MODERNIZED GRID

As noted earlier, we are headed for a more "networked grid" that is able to respond and adapt to rapidly changing technologies and can function in new and untraditional ways. In particular, the modernized grid needs to be able to:

- **Integrate a high level of distributed energy sources, such as solar**, while managing the fluctuations in voltage and frequency that those sources of power can cause;

- **Automatically manage two-way flows of electricity and data in real time** from thousands of actors, while maintaining the reliability of the system as a whole;

- **Enable new uses for electricity**, such as electric vehicles (EVs);

- **Provide seamless integration of all resources connected to the grid**, allowing customer technologies to "talk" with utility technologies, including "smart" connected buildings;

- **Optimize efficiency to keep overall costs down when paired with prices that encourage people and institutions to manage their power use** (such as charging EVs when there's excess electricity).

[9] Smart grid technologies include: distribution system management systems, energy efficiency, combined heat and power, fuel cells, gas turbines, rooftop PV solar, distributed wind, plug-in hybrid and all-electric vehicles, distributed storage, demand response, and transactive building controls.

BENEFITS OF A MORE "NETWORKED" GRID

FOR THE UTILITY AND GRID OPERATORS		FOR CONSUMERS
Pinpoint outages rapidly, sometimes in advance and enabling the grid to "heal itself"[10] after a disturbance (e.g., from storms)	→	Means **fewer outages** and **outages of shorter duration**
Repair and replace equipment that's actually failing rather than doing it on a set schedule	→	Means **more controlled costs** over time for all customers
Optimize use of the electric system's assets (and their efficient interaction), so we aren't forced to build a larger system than is really necessary	→	Means **more controlled costs** over time for all customers
Giving people the price information they need to shift their energy use to off-peak times can **reduce peak power needs** on the system during high-use periods	→	Enables consumers to participate in "Demand Response" programs (where **you get paid *not* to use electricity at specific time intervals**) Reducing peak can mean **lower costs** for all customers
Enable more distributed, **clean energy technologies** paired with energy storage devices	→	Means a **cleaner environment** for all customers
Give customers more information about their energy use	→	Means customers **can make more informed choices and control their costs**

[10] This requires a system of sensors, automated controls, and advanced software that relies on real-time data to detect and isolate faults and to reconfigure the distribution network to minimize affected customers.

Transitioning to this modern grid will require investments. On top of maintaining the current electric system and replacing old and outdated infrastructure, we will need to make significant investments in new physical hardware (e.g., smart meters, sensors for every key node on the system, and smart inverters that can manage two-way electricity flows). We will need distribution management systems, grid-edge analytics, and the communications and control technologies necessary to enable the grid to function in these new ways and make all of the elements work together harmoniously.

Notes:

While two-way flows of electricity sounds simple enough, engineers will need to design and install components on the grid, such as safety interlocks, because without them, sending power back onto the grid (when it wasn't designed to accommodate that) may pose a serious danger to line workers and the public. The grid will require additional investment to ensure that it can bounce back from increasingly frequent severe weather[11] and remain secure from cyber and physical attacks.

The electric grid still matters—even in a world of widely-distributed renewable energy

Some people may choose to disconnect from the grid (literally go "off the grid") and become self-sufficient in producing all of their own power. We think most people, however, will want to stay connected to the electric grid to ensure that: 1) they always have electricity, 2) someone else will troubleshoot and fix the problem when an outage occurs, and 3) they will be able to sell electricity back to the grid when they produce more than they can use.

The **grid** not only **provides reliable back-up power** should the customer's own system fail, but it can also act as a kind of shock absorber, **smoothing out the voltage and frequency disturbances** that might otherwise be caused by hundreds or thousands of participants taking and delivering electricity at any given time.

Thus, for the foreseeable future, **the grid will continue to be the backbone of our electric system.** It will provide the means through which we optimize the use of distributed resources like solar for our whole community. The electric grid can act like a big battery that can absorb excess power from a solar PV customer and deliver it to someone else who needs it. It is a **common asset that everyone benefits from and enables the greatest amount of renewable energy at the lowest cost.**

So how close are we to this modern, internet-like electricity grid?

The answer is different in various parts of the country and world. Some features you can already see emerging, such as the rise in solar and smarter meters being installed, but a truly modernized system like the one described above still faces a number of challenges.

[11] More frequent severe weather has become the leading source of electric grid disturbances in the United States: According to the *2015 Quadrennial Energy Review*, between 2003 and 2012, an estimated 679 widespread power outages occurred due to severe weather, costing the U.S. economy $18 to $33 billion each year during that time.

According to the U.S. Department of Energy's *Quadrennial Energy Review*, these include:

- **Comprehensive communication and data standards are not yet developed.** Competing, proprietary systems inhibit the adoption of technologies and control strategies and drive up the cost of deployment.
- **There are no uniform standards for "grid services" that end-use devices can provide** (things like frequency regulation and keeping voltage on the system at the right level).
- **The existing communication and control devices—**those that interface between the customer as a distributed generator and the distribution system—limit the types of services that the distributed generator can provide. In general, the lack of regulatory structures and standards are impeding the full utilization of information technology to enhance the efficiency and reliability of the grid.
- **The current system is not set up to compensate system participants for the full range of benefits they offer** (energy, capacity, voltage support, etc.) **or charge them for the legitimate cost of the grid services they use.** Without this "two-way street" being established, utilities will find it difficult to maintain the system and remain financially healthy. Today's "net metering" programs (in 34 states) credit customers for the electricity they export, often at retail rates. Supporters believe that net metering makes the financial proposition of distributed electricity generation more attractive since customers are guaranteed to sell any excess electricity at the going retail rate. Others have argued that net metering raises a fairness question about whether (and how much) producers of their own electricity are paying to maintain the existing electric grid that benefits everyone.
- **The stable frequency now provided by large, centralized power plants will need to be replaced.** Large fossil-fueled power plants, with their massive, spinning turbines help maintain the grid's frequency and thus its reliability. As we retire and replace those plants the system will lose the inertia they provided. This problem is solvable since distributed generation or storage can provide those same "frequency regulation" services to the grid if they are paired with the right communications technologies and smart inverters. It's another example of how modernizing our grid is more complex than it first sounds.

Of course there are other challenges too, but these are some of the main ones. MGE is obviously not in a position to resolve all of these by itself, but **with the help of our customers we hope to prepare for the day when we can offer all that a modern grid promises.**

Notes:

OBJECTIVE 5

Notes:

Ensure that changing technology serves all customers equitably.

Typically, as technology advances, there is the risk that some customers will have more ability to take advantage of new technology than others, especially in the early stages of an emerging technology when new products tend to be more expensive than they may eventually become. Think about the first personal computers or cell phones. We already see a "digital divide" in parts of our society where some people have access to the internet while others have no or limited access.

As the ways we generate, deliver and use electricity change, we want to make sure that we **consider the benefits, costs and impacts across all of our customers** of any new technology, product or service we offer. We must **equitably assign the costs of the system to all customers who are using it** – based upon how they are using it. We are committed to deploying new energy technologies in ways that **provide broad benefits** even as we develop new products and services that are more tailored to the preferences of different kinds of customers.

As noted earlier in the table on page 9, we are moving away from a relatively simple electric system of centralized power plants sending electricity in one direction, toward a much more complex system with potentially thousands of small producers of power and other grid support services (such as voltage and frequency) sending electricity and data in all directions.

This more "internet-like" grid – done right – can help optimize the use of all types of distributed energy resources, seamlessly deciding when to draw on solar or wind, stored energy, or demand response; and automatically charging electric vehicles when power is cheapest and most abundant. Through a highly networked grid, **MGE can own and operate new renewable installations on behalf of all customers.** In addition, for customers who want to own and operate their own distributed resources and sell excess electricity back to the system for all to benefit, a highly networked grid will make that possible.

IMPORTANT QUESTIONS TO ANSWER

While this new, more dynamic electric system opens up exciting new possibilities, it also raises new and important equity questions. These include:

- **How do we fairly compensate our customers** who may want to sell excess electricity (or other "ancillary services" such as frequency or voltage support) back to the grid? Determining the fair market value of these services is made more complicated by the fact that their value depends on several factors, including time of day, location on the grid and the ability to deliver those services in a predictable way.
- **How do we determine the value and cost of the grid** itself **and** then **charge appropriately** for those "grid services," so that everyone is paying their fair share of operating, upgrading and maintaining the system as a whole?
- **How do we determine the value of having energy available** so that if customer-owned resources are unable to provide energy when those customers need it, they are able to use energy from the grid to meet their needs?
- And finally, as some of our customers ask for more differentiated services (e.g. extra reliability or an all-renewables option), **how do we make sure that those services aren't unduly shifting costs onto other customers?**

These are all important questions to sort out as we work to take advantage of the exciting new opportunities new technologies provide.

Notes:

Principles by which MGE must operate

Notes:

Whatever products and services MGE provides in the future, we must:

- Provide universal service for all customers in a safe, reliable, and affordable manner;
- Maintain and sustain the infrastructure necessary to provide that universal service;
- Meet our customers' demands for energy, whenever and however they occur;
- Consider the needs of everyone;
- As required by law and regulation in WI, charge prices that are "just and reasonable;"
- Avoid "stranding" assets (such as a power plant that still has useful life left) unless there is a compelling reason to retire them early;
- As required by law and regulation in WI, ensure the investments we make on behalf of customers and shareholders are deemed prudent.

We want your input

We know your time is valuable. We appreciate you spending time thinking about the issues in our changing energy world.

- Tell us what is important to you.
- Tell us what you expect from "your community energy company" in the future.
- Tell us what products and services you think MGE should offer.
- Please share your thoughts. We look forward to hearing from you.

Thank you for your participation.

Appendix

Principles for Modernizing the U.S. Electric Grid

Quadrennial Energy Review

1. **The future grid should encourage and enable energy efficiency and demand response to cost effectively displace new and existing electric supply infrastructure, whether centralized or distributed.** The policies, financial tools, and pricing signals that enable customers to save money and energy while enhancing economic growth should be preserved and strengthened as business models evolve.

2. **The future grid should provide balanced support for both decentralized power sources and the central grid.** As the costs of decentralized power sources and storage continue to fall, there will be increased opportunities for end users to partially or completely supply their own electricity. At the same time, the vast majority of American homes and businesses will continue to rely on the power grid for some or all of their electricity. It is essential, then, that investment in both centralized and decentralized systems occur in a balanced manner, preserving high-quality service for all Americans while simultaneously enabling new options and services that may reduce energy costs or climate impacts. Similarly, access to renewable energy, energy efficiency improvements, and new energy-related services should not be limited to isolated customer groups, but rather become an integral part of the universal service that both decentralized and centralized grid customers enjoy.

3. **In the future grid, new business and regulatory models must respect the great regional diversity in power systems across the United States, as well as the critical roles played by state, local, tribal, and regional authorities, including state public service commissions and regional grid operators.** The drivers of change in the power system cut across the traditional boundaries of state and Federal regulation and thereby introduce new challenges in designing and overseeing new business and regulatory models. An unprecedented amount of consultation and collaboration will be necessary to ensure that national objectives are met alongside complementary state policies in power systems that are inherently regional in their scope and technology.

4. **Planning for the future grid must recognize the importance of the transmission and distribution systems in linking central station generation—which will remain an essential part of the U.S. energy supply for many years to come—to electricity consumers.** Transmission and generation both benefit from joint, coordinated planning. Transmission can allow distant generation—where there may be excess capacity—to supplement local supply and avoid the need to build new plants. New generation sometimes requires new transmission, especially remotely sited renewables or new nuclear plants. Utility and Regional Transmission Organization planning processes and tools should continue to evolve to evaluate transmission, generation (both central and distributed), and demand-side resources holistically.

5. **Finally, the careful combination of markets, pricing, and regulation will undoubtedly be necessary in all business and regulatory models of the future grid.** While the precise nature and scope of the market structures in the future grid may vary considerably, there is little doubt that markets in one form or another will be an important means of providing access to new technologies and services. Even in settings where prices are regulated, novel approaches can allow beneficial new pricing and service structures. Moreover, both new and traditional financing options provided by capital markets will be an important element in the future industry landscape.

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