5. GMP Innovation

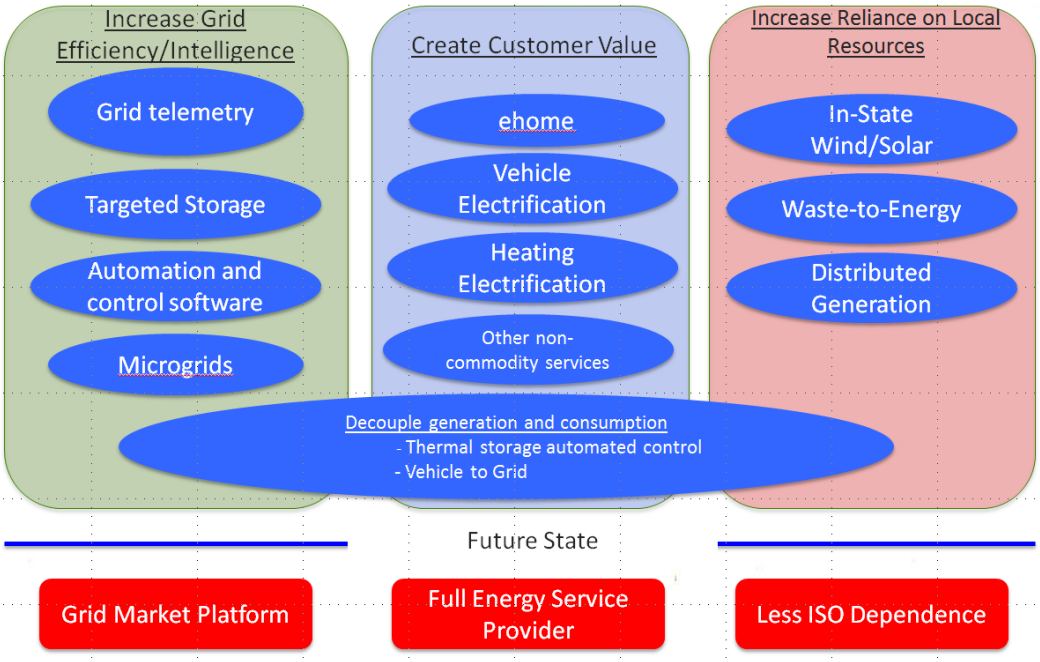
The electricity distribution business is in an unprecedented state of evolution. Where the grid operators of the past were primarily matching predictable demand with centralized and easily dispatched supply, today's grid operators are managing a growing penetration of intermittent distributed generation and increasing demand complexity.

An additional challenge for the electric utility industry is load growth that is at best level, and more likely to decline, as a result of the combined effects of energy efficiency and continued growth of customer-owned renewable generation. At the same time, cost pressures are increasing as a result of region-wide trends that point toward higher transmission, capacity and energy prices.

In the face of these challenges, GMP sees opportunity in embracing technology to advance a new business model. This requires strategic change as GMP's role as an integrated utility evolves into a role in which we offer a full range of energy services to our customers. GMP's three-part strategy consists of the following:

1) Create customer value
2) Increase grid efficiency and intelligence
3) Increase reliance on local grid resources

Figure 5.1: GMP's Innovation Strategy



Rutland – The Energy City of the Future

To realize its three-part strategy, GMP intends to make Rutland a demonstration workbench of energy innovation for other communities throughout Vermont and the United States. As a citywide lab focused on rapid deployment of renewable technologies, smart grid capabilities including grid resiliency, energy storage, and thermal and electric efficiency, energy innovation can help Rutland foster and support a rapid and meaningful socio-economic turnaround. We envision that Rutland will be the regional leader in reliance on and development of these technologies and programs, and a key component of an electric vehicle (EV) program focused on the Route 7 corridor, and, as such, will demonstrate the value of locally produced renewable energy to the grid. As we work through a variety of pilot programs in Rutland, we expect to take those that are most successful forward to the benefit of all of our customers in our service territory.

These pilot programs, some of which have already begun, will include a la carte offerings as well as holistic energy services. These will likely include trials for air-source mini-split heat pumps; air-source hot water heat pumps; expansive installation of Level 2 and Level 3 EV charging stations; home automation and security offerings; micro-power; a range of consumer-focused solar projects; portable energy; a variety of grid resiliency efforts; and other new home energy services and programs.

5.1 Create Customer Value

GMP is focused intensely on identifying and delivering value for our customers. Our ultimate goal is to provide one-stop shopping for all of our customers' energy needs. The services that we envision range from traditional electric services that are needed for powering homes and businesses to the delivery of new, innovative services and products such as EV charging, cutting-edge home-heating and cooling equipment that can reduce costs and environmental impacts, and new products and services that give customers personal, real-time information and remote control of their energy use. In the coming years, GMP will pilot and bring to market a range of new energy products, tools and consumer options that will move GMP beyond the role of the traditional utility. These include renewable energy choices and opportunities that will give customers direct control of the environmental and pocketbook impacts of their energy consumption.

Most essential and critical to GMP's future strategy as a full services energy provider is how well it can create and expand value, while increasing comfort, for our customers. There are fundamentally two components to this value.

The first component of value is directed at the customer in terms of savings on their own energy bill and ability to reduce their emissions profile. The air-to-air heat pump and the EV have both brought new capability for customers to decrease (and in some cases, completely remove) their dependence on oil and other fossil-fuel sources. Depending on customer suitability, these technologies can create substantial energy cost savings and reduce emissions.

Through GMP's eHome service, the company plans to develop what we believe will be the nation's first utility-delivered holistic energy program. Through this program, customers will be able to address all of their home energy needs, from simple electrification to self-generation, home heating and cooling to automobile transportation. We are in the infancy of this effort; over the next one to two years, we plan to take the concept and first-home effort through a 100-home proving ground in Rutland County to determine how best to provide these services in the most efficient, understandable and cost-effective way to all of our customers. Starting with one home in Rutland, GMP has begun a pilot program to do three key things: provide customers with an unprecedented opportunity to lower their costs, increase their comfort, and improve the efficiency of their energy consumption.

The second component of value is the services that customer devices can provide to the grid. Technological advances now allow for much greater involvement of customer devices with energy markets. Industry discussion of energy storage technology over the past few years has been focused heavily on batteries. While GMP regards this technology as very important, latent energy storage available on the customer side of the meter is as well. Existing hot water heaters, building envelope, commercial ice-based chilling and electric thermal storage are examples of this latent storage. To the extent GMP can grow and harvest this value, it can provide system benefits that can be shared with the participant customer and potentially others. By example, an electric thermal storage system can be used to reduce on-peak electricity consumption, and with modern controls, to provide reserves and frequency regulation services to ISO-New England.

What is frequency regulation?

The power grid relies on a number of "ancillary services" to keep supply and demand in balance. Frequency regulation is one of those services. It refers to adjustments in power generation or demand on a time scale of seconds or less that are needed to keep the grid at 60 hertz. At any given moment, if generation and demand are slightly out of phase, the frequency will deviate from 60 hertz. Devices such as batteries, generation, hot water heaters and electric thermal storage can be turned on and off rapidly to help bring frequency back to 60 hertz.

5.2 Increase Grid Efficiency and Intelligence

At the heart of GMP's vision is an ever-smarter electric grid and an intense focus on our customers' needs. For decades, the traditional distribution utility model has been pretty simple: build and maintain a system to deliver centrally generated electricity over wires and poles to every corner of the service territory, as cost-effectively and reliably as possible. Today, this historical model is becoming antiquated.

The modern grid is becoming more and more complex and dynamic. Thousands of customers are adopting their own intermittent solar generation. The introduction of EVs creates new demand profiles as well. The new and emerging model requires integration of all of these supply/demand dynamics through newer grid technologies and most importantly, inherent capacity and storage capability behind the customer meter. Our goal is to move to a grid model that is flexible, adaptable and interactive, as opposed to a one-way delivery mechanism. The first piece of this effort was GMP's advanced-metering effort.

Advanced-Metering Initiative ("AMI")

The successful completion in early 2013 of GMP's smart grid investment project known as GMP SmartPower[1] marked a key milestone in the ongoing evolution of Vermont's electric grid. The deployment of new technologies is bringing a smarter grid to life for GMP customers. These technologies include:

- The deployment of new advanced meters;
- Installation of additional substation and grid automation equipment;
- Creation of a two-way communications network that allows grid devices to be monitored and operated remotely; and
- Integration of these new technologies to state-of-the-art IT systems.

By using smart grid data, GMP is better able to understand the frequency and duration of outages and can use this data to improve reliability, optimize power flows and control costs. GMP's smart grid investment grant project has established a solid foundation for its new business model.

[1] GMPConnects was the name of the legacy GMP smart grid program. Concurrent with the merger with CVPS, GMP adopted the name of GMP SmartPower.

Improved System Feedback

With the new AMI system now in place, GMP estimates there are 9.5 billion data points received from the AMI system annually. Fifteen-minute customer usage data will allow a better understanding of how the grid is operating, by improving the accuracy of the modeling of the system and having better transparency into system performance, including system efficiency and reliability.

GMP is currently working on integrating AMI data into its enterprise data warehouse and analytical tools so that this huge data set can be transformed into useful information. Starting in 2015, GMP operations staff will have a much more accurate and comprehensive view of system load customer-by-customer, circuit-by-circuit, and in aggregation. This broader information set will provide a much richer picture of when and where peak loads are occurring and when and where power congestion or bottlenecks may adversely affect customer service.

In the future, equipment that is being overloaded as a result of load growth can be identified and replaced, or load can be reduced, before a failure occurs. Costs can be reduced, as equipment is right sized and equipment ratings are better aligned based on improved information about actual system load.

Faster Service Restoration

GMP is in the final stages of testing the integration of outage information transmitted by advanced meters with GMP's outage management system. When the power goes out, an advanced meter sends a "last gasp" signal. This signal is fed into the outage management system (OMS), notifying GMP of a customer outage. These notifications will allow GMP to respond to potential service interruptions more quickly, especially in the middle of a business day or in the middle of the night when customers often do not report issues. In addition, the signals will provide a better sense of the location of the outage and the number of customers affected, so that appropriate resources can be dispatched to restore power as quickly as possible.

Beyond Advanced Metering

The AMI system was a critical first step in establishing the grid of the future. However, more innovation is required as the industry continues to evolve. The proliferation of intermittent renewable generation on the grid and new technologies on the customer side of the meter are creating a system that requires increasingly sophisticated monitoring and control capabilities. New tools and information are needed to efficiently and effectively manage a grid that is made up of a mix of traditional and intermittent renewable generation, energy storage devices and

customer-owned technology, such as thermal storage devices and thermostats. GMP is also evaluating the use of a new distribution management system and customer-focused microgrid software to interface with the existing SCADA system.

The future grid that GMP is working toward leaves behind the century-old uni-directional delivery model to favor a multi-directional marketplace where customers can in some instances be providers of services (energy, capacity, ancillary services) to the wholesale electricity market. The historic model has always taken customer demand as a given and constructed appropriate grid capacity to meet this demand, plus a margin of error.

GMP has reimagined the grid structure so we can more deeply engage the customer and drive inefficiencies out of the system. Technology is evolving to a state where devices can now act on customers' behalf to optimize energy usage patterns with no discernible impact to customer comfort. Smart thermostats, controllable water heaters, thermal storage, smart appliances and smart PV solar inverters are examples of technologies that can offer significant benefits to the grid and create value for the customer if the right grid model is in place.

By engaging customer assets as energy capacity and storage assets, we hope to create new efficiencies in the system through the use of responsive demand to meet variable supply. Doing so will inevitably create load factor efficiencies and reduce line losses through voltage regulation.

Absolutely critical to this effort will be proper software to "choreograph" this supply-demand dance. Portfolios of aggregated customer assets will need to be synchronized in their activity with signals from the distribution grid management system, wholesale power prices and even weather and electric demand forecasts. Imagine, for example, if controlled heat pumps or water heaters on a circuit could be used to ramp down demand in the event of a predicted cloud cover event for solar PV on that circuit. Alternatively, these same devices could pre-cool or pre-heat a building in advance of a predicted system peak so that they could be shut down during the peak events, thus reducing ISO capacity or transmission charges that are based on system peak demand.

Automation of this system is a key goal. This type of complex interaction likely cannot be done manually, at least on a broad scale. As an eventual evolution beyond automation, GMP hopes that these grid-equipment interactions will eventually be driven by a dense nodal market for energy products. In that world, a liquid market determines time and geographically-differentiated pricing for energy, capacity and other ancillary services at thousands of points on the system. Customer devices and grid equipment would then choose to respond based on the price signal at any given time. Such a system would allow the market to determine where a utility needs to invest capital in its network. By monitoring market responses, or the lack

thereof, the utility could point its capital at those constraint points where the markets have chosen not, or are unable, to respond.

None of this will be easy, as it represents a dramatic change from the system that exists today. GMP expects that this transition will take years because technological advances, system integration, and cultural and societal interactions with energy will have to evolve.

Pricing Innovation

These technology advances also inform how we think about electricity price innovation. The past few years have brought an evolution of thinking on customer rates and customer connectivity at a pace we have not seen before. Like all things related to smart grid, we are seeing an unprecedented acceleration of technology, operational and customer service opportunities. When GMP began its smart meter program back in 2010, the thinking was that the technology would create customer demand for dynamic or time-differentiated rate structures that would link grid power prices to the price of power accessible to customers.

The envisioned rate structures ranged from simple time-of-use (TOU) structures to TOUs with additional incentives ranging from peak-time rebates and critical-peak prices to real-time prices where the price changes every hour or even every 15 minutes. In the latter case, prices presented to customers are the same as wholesale power prices. At this same time, the belief was that the smart meter would serve as the central energy control gateway into the home or business through the Zigbee capabilities within the meters, which can connect with devices such as in-home displays and other smart devices and appliances. Over the past several years, our outlook on rates and customer connectivity has evolved quite a bit. Through pilots we have run and by leveraging the experiences of other utilities, we have come to see that some of our beliefs back in 2010 need to be updated or replaced with more contemporary thinking.

Our thinking on dynamic rates has evolved as a result of watching how customers respond to signals, incentives and other stimulus intended to engage them in opportunities to lower their costs. As a product of our critical peak pricing pilot, we saw relatively limited engagement and some confusion at times on the part of customers surrounding the stimuli and mechanisms that require them to pay attention or take action in order to attain the value from dynamic rates. Although dynamic rates and other customer feedback programs may continue to play a part in incentivizing efficient customer behavior(s), our thinking is now focused more on rates or programs that include the option for GMP to control elements of customers' electric load in some way, consistent with customer preferences and instructions. We expect that as long as we keep customer metrics (home indoor temperature, for example) between certain upper and lower thresholds (thereby delivering comfort) the consumption associated with some electricity

end uses can be controlled to a sufficient degree to create value when we aggregate that load control capability across enough customers. Such load control has the potential to allow GMP to save substantial grid operating and maintenance costs, and pass those savings on to our customers.

However, controlled rates will not appeal to all customers. Therefore, we believe there may be two sets of rates or rate programs. The first set would be designed for customers who just want a transactional relationship with GMP with no control involved. This kind of rate would have clear pricing rules to follow; customers who choose these rates would manage their electricity consumption behaviors based on the extent to which they have the ability and interest in responding to the pricing rules. An example of this is GMP's new large commercial customer demand response tariff. In this program, large customers who can commit to a significant load reduction will get a share of the demand savings for their participation.

The second kind of rates would look more like programs than rates, and would be for customers who want a more interactive relationship with GMP. This may include access to different load-controllable devices and technologies, and has the potential to deliver greater savings. An excellent example of this is GMP's water heater load-management program.

Currently, more than 16,000 GMP customers are enrolled in this program. Residential customers enrolled in this program pay a reduced rate for the electricity that they use to heat their water. In exchange, customers agree to allow their water heater to be turned off at certain times during the day, reducing load during periods when the demand for electricity is typically high. The water heaters that are used as part of this program are well insulated so customers continue to receive hot water and are typically unaware that their water-heating units are being cycled on and off during the day.

As a result of the success of this program, GMP is investigating the feasibility of offering additional load management and energy management choices that can help customers further save on their energy costs while maintaining comfort. In the current electricity market environment of rising capacity market prices and regional transmission charges and potential for more volatile energy market prices, the value proposition for controlled water heating and similar programs appears to be improving.

We have also changed our view on the role the smart meter will play in providing information and controls inside a customer's home. As stated earlier, our view as recently as 2010 was that the Zigbee feature in the smart meters would allow the meter to serve as the control gateway to the home. We have seen tremendous advancements to home automation technologies and offerings in the past few years, with companies such as Apple, MicroSoft, Comcast, AT&T and

ADT all introducing some type of home automation gateway service that can manage home security, energy and surveillance.

In these types of comprehensive home automation offerings, the utility meter is an actor in the home automation environment, but not the central gateway. We believe our meters may perform control functions in limited scenarios, but will more likely provide data and signal to a home gateway that intelligently coordinates the automation. We believe the benefits of in-home displays have been surpassed by smart phones and home automation gateways, which we now view as the primary customer interfaces.

5.3 Increase Reliance on Local Grid Resources

The third and final focus of GMP's grid strategy is to decrease dependence on the bulk grid by leveraging more local grid resources. As discussed in Chapter 6, the New England region is facing an electricity supply situation that is becoming tighter from a capacity standpoint and more reliant on natural gas, which has its own supply constraints. At the same time, costs for use of the regional grid are increasing. The result is a forward view of rising transmission, capacity and energy costs. Accordingly, GMP intends to pursue all reasonable and cost-effective sources of local, in-system supply. This may include but will not be limited to solar, wind, hydroelectric, combined heat and power, waste-to-energy and perhaps peaking plants fueled by natural gas and/or oil.

As discussed in Chapter 7, GMP will seek a significant degree of diversity in its distributed generation portfolio. Policy and technology gains have driven an increasing penetration of solar in Vermont over the past several years and this has created a cost-competitive resource, although considerations of intermittence and diversity will need to be managed as the scale of solar in Vermont is growing rapidly. Waste to energy projects could be an area for growth in supply in Vermont. GMP is evaluating projects now that could utilize manure, liquid waste from municipal water treatment facilities, wood and food garbage. These types of facilities have typically been difficult to render cost effective given their small size. GMP will seek to overcome this by achieving scale and recognizing value from ancillary products from the processing in the facility. An example of such a project would a large-scale community digester that could accept waste from multiple feed-stocks (manure, food waste, etc), in a region to reach a scale where generation of electricity from the project would be cost effective. By-products from such facilities can also include livestock bedding that can be sold for additional revenue.

Another distributed supply strategy that GMP is exploring is to expand the use of micro-grids featuring a combination of solar and storage, similar to its Stafford Hill project in Rutland. The

Stafford Hill project will be used to island an emergency shelter. Other future microgrid projects could be designed for grid resiliency in other relatively urban locations, or to defer distribution upgrades or island remote radial lines during outages. GMP is working with partners to design modular solar + battery installations that would be optimized for economics and could be easily replicated for different locations. Solar + battery has not historically represented a cost-effective solution but has worked where there are distribution off-sets included and/or government grants are available, as was the case at Stafford Hill. GMP will be actively seeking both in the near term. We expect that the costs of both solar and battery storage will decline further over time and at some point, such installations may be cost effective as a source of incremental supply without subsidy.

Beyond the solutions highlighted above, GMP will be actively seeking incremental opportunities to develop or acquire other forms of distributed generation. Combined heat and power, new small-scale hydro and new wind facilities are prime examples used by other load serving entities but have proven difficult in the Vermont market for a variety of reasons. That said, each of these brings value as a diversified resource and we intend to pursue them where possible.

It is difficult to imagine a scenario where GMP could become completely reliant on in-state generation. Furthermore, Vermont is not an energy rich state and development of new generation will be difficult in such a large scale. As a result, we will likely rely on external sources for some percentage of electricity supply. However, cost-effective generation sited in our system will act as a hedge against regional supply risk. Local generation also has the potential to reduce energy losses on the transmission and distribution system, although this benefit tends to be quite location-specific and local generation in some sites can increase system losses.

Partnering to Serve Our Customers

Partnering with other providers and stakeholders is a mainstay of our approach to serving our customers. The latest example is GMP's partnership with NRG Energy, which will offer a series of new clean-energy products and services to help our customers manage their energy use and save money. This partnership is part of our efforts to establish Rutland as the Energy City of the Future, and helps position the state as a leader in the movement toward cost-effective, sustainable energy solutions.

In 2014, GMP has established numerous other partnerships, and we will continue to develop new ones as new technology and new partnership opportunities emerge. In addition to NRG

Energy, some of the key partnerships that were formed or developed in 2014 are summarized in the following bullets.

- Stafford Hill: To build the Stafford Hill Solar Farm, we partnered with the Shumlin Administration, Mayor Louras and city leaders, GMP's Energy Innovation Center, Stafford Technical Center, groSolar, the Vermont Clean Energy Development Fund, the Vermont Energy Investment Corporation (VEIC), and the Vermont Department of Public Service.

- On-Bill Energy Improvement Loan: In partnership with NeighborWorks of Western Vermont, all GMP customers have access to a home energy improvement loan that can be repaid through a line item on the customer's electric bill.

- Residential Peak Energy Savings Pilot Program: In partnership with VEIC/Efficiency Vermont and OPower, 35,000 GMP customers participated in this innovative pilot program this past summer to use less energy during peak hours of the four hottest days of the summer.

- Partnering with the Vermont Energy Investment Corporation: GMP will continue to collaborate with VEIC, a nationally recognized leader in energy-related activities, who operates Efficiency Vermont, to advance the energy policy of the state of Vermont in a way that maximizes benefits for Vermont energy customers and minimizes the negative environmental impacts of energy use. GMP and VEIC have recently entered into a Memorandum of Understanding that outlines a flexible framework for the relationship, roles and activities in which GMP and VEIC will partner together going forward.

5.4 Conclusions for Integrated T&D and Resource Planning

Using the City of Rutland as a test-bed for rapid deployment of innovative energy services, GMP's Energy Innovation Center will work with partners to pilot promising new products and services. After these pilots have demonstrated their cost-effectiveness, environmental benefits and commercial readiness, we will scale up the programs to the entire service territory, and use the experience gained from the pilot phase to embed the programs in future T&D and resource planning. In practice, this will take the form of incrementally greater system integration across the company. We expect a continual evolution of products and services will be integrated into utility systems, utility planning, and into our customers' behavior – with the goal of reducing costs, improving grid reliability and home comfort, and adding value for participants and non-participants alike.