PRE-FILED DIRECT TESTIMONY

OF JONATHAN R. SHAFER

ON BEHALF OF NORTHWESTERN ENERGY

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Witness Information

Q. Please provide your name, employer, and title.

A. My name is Jonathan R. Shafer. I am Manager of System Innovation for NorthWestern Energy's ("NorthWestern") Distribution Operations Innovation Department.

Q. **Please provide a description of your relevant employment experience and other professional qualifications.**

A. Management of the Montana Meter Upgrade Project ("Meter Project") has been one of my primary responsibilities for the last two years, including establishing contractual commitments, reviewing monthly budgets and forecasts, escalating project-related issues, assessing technical coverage commitments to ensure read rates were being met, and resolving challenges during project deployment. Prior to that, I managed the South Dakota Meter Upgrade Project for three years. My specific involvement included the development of the South Dakota meter upgrade Request for Proposals ("RFP") and performing the same duties as I currently perform related to the Montana Meter Project.

In addition to managing NorthWestern's meter upgrade projects, I have been a part of various NorthWestern project teams that include the LED Lighting Project, Bozeman Solar Pilot Project, Beck Hill Microgrid, and Yellowstone National Park Microgrids.

I have a Bachelor's degree in Electrical Engineering from Montana State University in addition to a Master's in Business Administration from the University of Montana, and I have been involved in renewable energy and utility technology for over 15 years.

Purpose and Summary of Testimony

Q. What is the purpose of your testimony in this docket?

A. My testimony provides the details regarding the Meter Project, including status updates, the solution selected, and why the project was necessary. I also present the associated cost information for the Meter Project during the 2021 test year and adjustments for projected 2022 capital investment.

Q. Please summarize your testimony.

A. With nearing end of asset life issues, NorthWestern has a unique opportunity to re-envision its metering infrastructure to enhance the customer experience initiative as indicated as a need by our customers and to lay the foundation for the digital transformation for the evolving challenges and expectations of the energy sector. When planning the Meter Project, NorthWestern considered the following primary objectives:

- Resolve asset life issues associated with existing metering and meter reading equipment;
- Meet increasing customer expectations;
- Enable the development of new energy products and services; and
- Advance NorthWestern's mission to provide a sustainable energy future.

As noted later in my testimony, NorthWestern has primarily read meters using Automated Meter Reading ("AMR") equipment over the last 25 years. I am often asked why NorthWestern did not stay with the AMR technology. AMR technology is not well-equipped to serve the evolving current needs and expectations of NorthWestern and its customers. In particular, the existing AMR equipment is: (1) underserving current customer expectations, (2) reaching the end of its intended service life, (3) causing NorthWestern to fall behind the industry standard of using Advanced Metering Infrastructure ("AMI") meters, and (4) lacking the foundational capabilities needed to deliver new services.

Synopsis of NorthWestern's Montana Meter Upgrade Project

Q. Please provide an overview of NorthWestern's Meter Project.

A. NorthWestern is currently in the process of upgrading its electric meters and natural gas modules[1] throughout its Montana service territory. This project began in 2021 and involves the installation of approximately 590,000 electric meters and natural gas modules over a five-year period. NorthWestern is upgrading its metering equipment from AMR technology, which The Montana Power Company largely installed between 1997 and 2000, to the current industry standard AMI.

[1] A gas module is a battery-operated device that is installed between the gas meter and the index that displays gas usage to record and transmit gas usage to a metering collection system.

Q. What is the current status of the Meter Project?

A. In 2021, NorthWestern completed 95,058 electric meter and natural gas modules (endpoints) installations, with 131,540 endpoint installations planned in 2022. Thus, by the end of 2022, NorthWestern estimates it will have installed approximately 226,598 of an estimated 590,000 natural gas and electric endpoints.

Q. What prompted NorthWestern to investigate and implement an upgrade of its meters?

A. More than half of the AMR meters and the Encoder Receiver Transmitters ("ERTs")[2] deployed in NorthWestern's Montana service territory are already at, over, or soon approaching the end of their designed service life. This means that a significant portion of NorthWestern's AMR metering infrastructure would have needed to be replaced in the near future.

NorthWestern customers have also been requesting more from us, including, but not limited to, outage communication and granular energy usage data. For NorthWestern to continue meeting the customers' changing expectations, a new platform needs to be implemented and that begins with metering capabilities.

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[2] ERTs communicate meter data over a short-range radio frequency so that a utility vehicle can collect data without entering the customers' premises.

Q. How did NorthWestern select its metering technology for the Meter Project?

A. Prior to the South Dakota Meter Upgrade Project, NorthWestern issued an RFP for AMI technology that would be evaluated according to the principles mentioned above. Five vendors submitted proposals. After NorthWestern evaluated the five proposals, we selected Itron OpenWay Riva because it:

1. provided the ability to extend coverage for both natural gas and electric;
2. proved to be one of the most affordable networks to deploy; and
3. established a strong foundation to manage future utility requirements.

With an AMI vendor selected in South Dakota and back office infrastructure in place to support it, the Meter Project selected the same AMI technology for its electric and combo (i.e., electric and natural gas) customers in Montana.

Q. Can you please explain how the available AMI metering technology works and NorthWestern's evaluation of that technology?

A. AMI deployments primarily use three options for communication technologies:

1. mesh network - A mesh network relies on its neighbor's meter to relay information back to the utility. Mesh networks have been proven to work well in rugged terrain and are easy to deploy.
2. point-to-point star network - Other AMI technologies, such as the point-to-point star network, require communication towers and are limited by line-of-sight obstructions.
3. power line carrier ("PLC") - PLC technology uses the power lines to communicate to electric meters. PLC requires additional infrastructure to be installed within the substation and has a higher cost per installed endpoint. This technology is not typically used to read natural gas modules.

NorthWestern selected a mesh-based system as its preferred AMI network technology for electric and combo areas[3] given the substantial costs of large towers and limited ability to service equipment on the towers necessary for point-to-point star networks and the costly deployment for PLC. In Montana, NorthWestern has limited deployment of PLC technology. PLC technology may be used in instances where very remote electric meters are needed when the mesh network will not reach these meters.

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[3] NorthWestern is still evaluating technology to be deployed in natural gas-only areas.

The AMI mesh technology software is deployed within NorthWestern's facilities in Montana and is not hosted in the cloud. Each electric and natural gas endpoint is manufactured with security keys that are unique to NorthWestern and must be registered and authenticated with NorthWestern's back-office AMI software to demonstrate proper security measures have been meet. Each message from our facilities to and from an endpoint is encrypted.

Once the meter is registered and authenticated on NorthWestern's network, NorthWestern interrogates the meter three times a day. During the interrogation, the meter responds with interval data, register read data, and events. The information sent and received is encrypted and only includes meter-related information. There is no customer information, including personally identifiable information, stored in our headend system.[4] Thus, no customer information is transmitted to and from the meter, nor does the meter currently communicate with any behind-the-meter devices such as electronic devices in the customer's home.

[4] AMI headend software, located in NorthWestern's facilities, is the software used to receive and collect information from the meters.

Benefits of the Montana Meter Upgrade Project

Q. What are the benefits of the Meter Project?

A. As NorthWestern invests in its system, it is crucial that it continues to invest in technologies that enhance the customer experience. AMI technology, for example, provides many immediate and future opportunities to improve the customer experience. In the near term, AMI will enable NorthWestern to: (1) have, and be able to communicate to customers, timely information regarding outages; (2) achieve more accurate estimated reads and more consistent meter reads; and (3) perform remote services, such as turning on power for new or relocating customers, remote meter reading for electric services even after hours, and investigating metering issues such as voltage problems remotely.

Apart from these more immediate improvements to the customer experience, AMI technology also enables NorthWestern to support the evolving expectations of its customers through many other future offerings and services including flexible rate structures, meter pre-pay, bill forecasting, and much more.

Q. How will outage awareness benefit NorthWestern's customers?

A. Outage awareness enables NorthWestern to accurately and quickly inform customers of outages. Today, unless an outage is associated with a distribution substation or feeder or a transmission outage, NorthWestern is unaware of a customer’s power outage until the customer calls and informs NorthWestern about it. In some instances, customers may not call in the outage until the following morning. Power Outage Notifications (PONs) provided by the AMI metering technology detect and report potential outages automatically. This allows the utility to be notified of an outage in near real time and communicate the outage to the customer shortly after. This, in turn, translates to a more transparent and satisfactory customer experience and it improves the response time of the utility – helping to reduce outage durations across the system.

Other utilities have already begun to utilize the capabilities of AMI technology to enhance the customer experience through increased outage awareness. For example, Ameren, which serves portions of Missouri and Illinois, was found in a recent report by E Source to have measurably improved the customer outage experience: “Ameren has delivered a variety of solutions, including the Potential Power Outage alert—a proactive notice to customers that Ameren is aware of an outage in their area. Almost 94% of Ameren’s customers find it valuable and 68% reported that receiving the notification increased their satisfaction with the utility—two indicators that Ameren is on the right path to increasing its overall J.D. Power customer satisfaction score.”[5]

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[5] https://www.esource.com/system/files/consultingcasestudy-amerenoutages-web.pdf.

Additionally, Ameren observed the following:

- "A 30% reduction in calls transferred from the interactive voice response system (IVR) to a customer service representative;"
- "A decrease in social media complaints related to changing restoration times;" and
- "Favorable feedback from customers—94% of customers in Illinois and 83% in Missouri who are part of the Potential Power Outage pilot find it valuable or highly valuable."[6]

Q. How will improved meter read rates benefit NorthWestern's customers?

A. Historically, with its AMR equipment, NorthWestern successfully acquired readings from approximately 96% to 98% of its meters during a typical month. With every 1% increase in actual read rates, we are assisting 5,790[7] customers in receiving an accurate bill. Customers, whose meters were not able to be read for a given billing cycle, are issued an "estimated" bill based on the average electrical and/or natural gas usage based on the previous month. Given many factors such as occupancy, pumps, and weather, this can be highly inaccurate. Once their actual usage could be determined, either through a successful read in a subsequent month or

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[6] https://www.esource.com/system/files/consultingcasestudy-amerenoutages-web.pdf.

[7] One percent of NorthWestern's Montana meter endpoints (579,000) is 5,790.

through a manual read, the discrepancy between the actual and estimated billed usage would be remedied. This uncertainty and variability is not ideal for the customer or NorthWestern because the customer may be required to pay more for that month or NorthWestern is required to provide a credit to customer. Fortunately, AMI metering equipment can reduce the need for, and challenges of, estimated bills in several ways.

First, NorthWestern's AMI equipment communicates via a wireless mesh network, as described above. This network is well-established, flexible, robust, and includes multiple communication paths for network devices such as electric and natural gas meters. As such, it is well-designed to handle changing conditions such as weather, interference, or network growth. The reliability of the AMI communication network means that AMI metering equipment can achieve read rates of greater than 99% – reducing the number of estimated bills.

Additionally, despite this improved reliability, if an AMI meter still fails to provide a read during a billing period, the resulting estimated bill is more accurate than previously possible with AMR meters. Estimated bills from AMI meters are based on the recent electrical or natural gas usage of that specific customer. Since meters are interrogated three times a day rather than monthly, the estimate uses highly relevant information to estimate bills. This improved accuracy in estimated bills results in a smaller "true-up" adjustment and a more consistent and predictable billing experience for the customer.

Lastly, problematic and failed AMI meters that are unable to provide reads can be identified and resolved much more quickly than is possible with AMR meters. Previously, due to the inherent variability of the one-way communications, non-communicating AMR meters typically required three consecutive months with missed reads before NorthWestern could conclusively determine that the meter had failed and required repair or replacement. This means that a customer would experience three consecutive estimated bills before NorthWestern could identify and resolve the issue. Conversely, communication issues with AMI meters can be identified almost immediately and are typically flagged and resolved via back-office troubleshooting after seven days. Or for more significant, unresolved, or recurring issues, AMI meters can be reliably identified for field repair or replacement after 30 days.

The technological abilities of AMI listed above make it a much more reliable meter-reading platform than AMR. In fact, NorthWestern has already begun to see substantial improvements in its read rates from its AMI meters. For areas where NorthWestern has deployed the meters in Montana, we have achieved greater than 99% read rates, which equates to between 5,790 and 17,390 customers receiving more accurate meter reads once fully deployed.

Q. How do remote services benefit NorthWestern's customers?

A. Remote services allow NorthWestern to be able to wirelessly support its customers through a range of real-time services that have traditionally required an employee to visit the customer's home or business. This includes the ability to perform remote meter reads in addition to troubleshooting issues such as power quality by performing real-time voltage measurements.

Remote services also includes the ability to remotely connect and disconnect electrical service for remote switch capable meters[8] for new customers, customers who are moving or canceling service, or for customers who wish to enable and disable service seasonally. As seen in Table 1 below, AMI reduces the time it takes to reconnect a customer from an hour or more to as little as five minutes. This would allow NorthWestern

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[8] The project excludes standalone remote shutoff valves for natural gas meters. These shutoff valves require a trained installer to turn off the building's natural gas supply to retrofit the shutoff valve into the existing piping and then re-light all customers' natural gas appliances. Due to the complexity and additional labor costs, natural gas shutoff valves are out of scope for the Meter Project. Additionally, AMI meters that use current transformers (CTs) do not include remote reconnect/disconnect functionality. Large residences, commercial and industrial buildings, hospitals and schools are all examples of where you may find a CT meter installed.

to reconnect a customer while on the phone with the customer on nights, weekends, or during normal business hours.

Table 1: Average Customer Wait Time for Reconnection of Electrical Service

	Order Creation	Dispatch Time	Avg. Work Order Completion	Order Closure	Total Estimated Time
AMR (Traditional Truck Roll)	~2 min	10 min to 72 hours[9]	43.32 min	~2 min	58 min to 73 hours
AMI (meter with remote switch)	~2 min	N/A	<1 min	~2 min	<5 min

Not only do these remote services benefit customers by providing more timely and comprehensive assistance including after-hours remote services, but they also benefit NorthWestern by drastically reducing the workload of its field employees – freeing them up to support the other needs of NorthWestern's electrical and natural gas systems.

NorthWestern has also already begun to realize the benefits of the remote service offerings of AMI technology in its South Dakota service territory. More specifically, Table 2 shows the reductions in the number of service orders for issues or services that NorthWestern can now complete

[9] NorthWestern does not currently dispatch disconnect or reconnect orders after business hours or on weekends.

remotely in South Dakota due to the AMI upgrade project. The percent reduction is the estimated average number of work orders between 2017 and 2018 compared to the total work orders completed by the field[10] in 2021. The reduction to "Meter Maintenance and Repair" is attributed to installing new meters – reducing the overall maintenance requirements for meters.

Table 2: Reduction in Field Service Orders in South Dakota Due to AMI

Field Service Orders	% Reduction
Electric Connect/Disconnect	75%
Electric Customer Investigation	75%
Electric Meter Operations & Inspection	82%
Electric Meter Maintenance & Repair	77%
Gas Meter Maintenance & Repair	62%
Gas Customer Investigation	92%
Gas Meter Operations & Inspection	37%

Even though there is a significant reduction in expected truck rolls and associated field work orders due to AMI, the reduction also frees up employees' time to work on other projects or perform other field service orders.

[10] To capture true truck roll savings, only work completed by the field is analyzed. For example, electric connects/disconnect service orders can be completed in the back office, so work order volume is not addressed.

Montana Meter Upgrade Project Investment

Q. Can you please describe the investment made by NorthWestern in the Meter Project through 2021?

A. The total capital investment in AMI through December 31, 2021 was $25,536,761, broken down as follows:

Materials	$15,101,179
Installation Contractor	$7,997,769
Internal Labor	$1,807,131
Project AFUDC	$416,817
Software, Postage, Office Supplies, Shipping, Travel	$213,865
Total	**$25,536,761**

The materials amount includes electric meters, gas modules, and networking equipment. The installation contractor portion reflects labor costs associated with installing the meters, including installation technicians, warehouse staffing, and management by the independent contractor hired by NorthWestern to install the AMI meters. The internal labor category consists of the project management, installation of networking equipment, software installation and configuration, and union labor to complete electric meter and natural gas module installations that the contractor was not able to finish. The postage, office supplies, and shipping includes the cost of mailing customer notifications. Notification to customers consists of the costs for a brochure sent at least 60 days before deployment and postcards delivered days to weeks before a customer's meter and/or natural gas module installation. The software cost item includes the capitalized meter reading and programming software.

Q. What projected investment does NorthWestern anticipate in 2022?

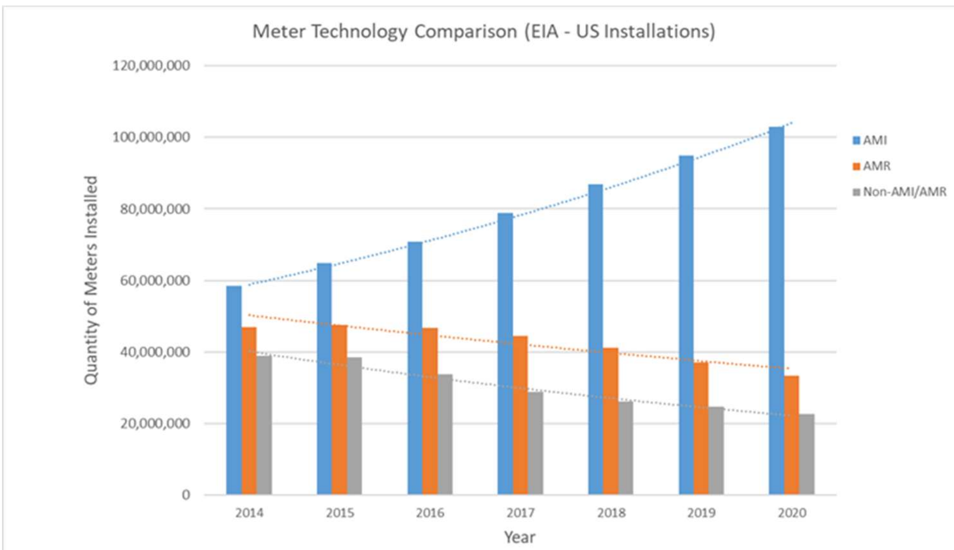
A. The anticipated projected capital investment for 2022 is $27.08 million. This includes the installation of an additional 131,540 endpoints in 2022. NorthWestern estimates that the costs of the project through 2022 will total $52.6 million of an estimated $125 million total project costs. However, it should be noted that only the 2021 and 2022 project costs ($52.6 million) are within the scope of this rate review.

Industry Standard Technology

Q. How has the use of AMI evolved in the utility industry?

A. Current AMR metering equipment no longer represents the standard technology across the utility industry. Accordingly, AMR does not offer the benefits and services that utility customers have come to expect. As mentioned previously and illustrated by the increased adoption rate shown in Figure 1 below, AMI technology has now become the standard in metering equipment. This shift is due, in part, to the broad range of capabilities, immediate benefits, and future opportunities provided by AMI that AMR does not offer or other metering technologies (see Table 3 below). Given that NorthWestern is already upon end-of-asset-life considerations with its existing AMR metering, it is prudent that NorthWestern continue to enhance its metering technology so that its customers can also realize the benefits and services provided by other utilities who have already deployed AMI technology.

Figure 1: Comparison of Metering Technologies Used in the U.S. Since 2014[11]



[11] Data is from the Energy Information Administration: https://www.eia.gov/electricity/annual/html/epa_10_05.html

Table 3: Meter Capability Comparison

Functionality	NWE's Existing AMR	AMI
Communications	One-Way	Two-Way
RF Spectrum	910-920 MHz	902-928MHz & PLC
Reading Frequency	Monthly & Out of Cycle Reads	3 Times per Day & On-Demand
Interval Data and load profiling	None	Hourly to 15 minutes
On-Demand Reading	None	Within Seconds
Voltage Information	None	Near Real Time[4]
Demand Reset	None (Manual)	Automated[4]
Outage Information	None	Near Real Time[4]
Power Restoration Information	None	Near Real Time[4]
Remote Disconnect/Reconnects	No	Near Real Time[4]
Utility Events	No	Near Real Time
Net Metering	Requires meter change-out	Capable for all customers without meter change-out. Timely captures both delivered & received energy, including interval data. [4]
Remote Configuration	Limited & requires nearby vehicle	Over the network
Flexible Rate Options[1]	No	Capable
Prepaid Metering[1]	No	Capable
Home Area Network/Behind the meter services[1,2,3]	No	Not available today, but is road mapped to be available. [4]
Demand Response[1,2,3]	No	Not available today, but is road mapped to be available. [4]
Streetlights Controls[1,2]	No	Not available today, but is road mapped to be available. [4]
Grid Edge Computing[1,2,3]	No	Limited capabilities today and not widely deployed. [4]

1. Functionality is out of scope for the current Meter Project, and would require Commission discussion and approval.
2. Much of the technology is still being developed by the metering vendor and will require system and endpoint upgrades. Specifically, Demand Controls, Home Areas Network, Street Lighting Controls are not currently available today from the metering vendor but are road mapped to work with our existing system. Grid edge computing has limited use cases by the metering vendor and has not been industry proven.
3. The meters are not currently capable of estimating and/or recording electrical energy usage by type of appliances within the home or business or programmed to communicate with any home device.
4. Not available for AMI gas ERTs.

Q. Can you describe the independent research you reviewed regarding the benefits other utilities experienced after upgrading their metering network?

A. There is extensive research already completed on AMI benefits and impacts. The U.S. Department of Energy has compiled a comprehensive report that addresses the opportunities of AMI. A few sample opportunities are listed below.[12]

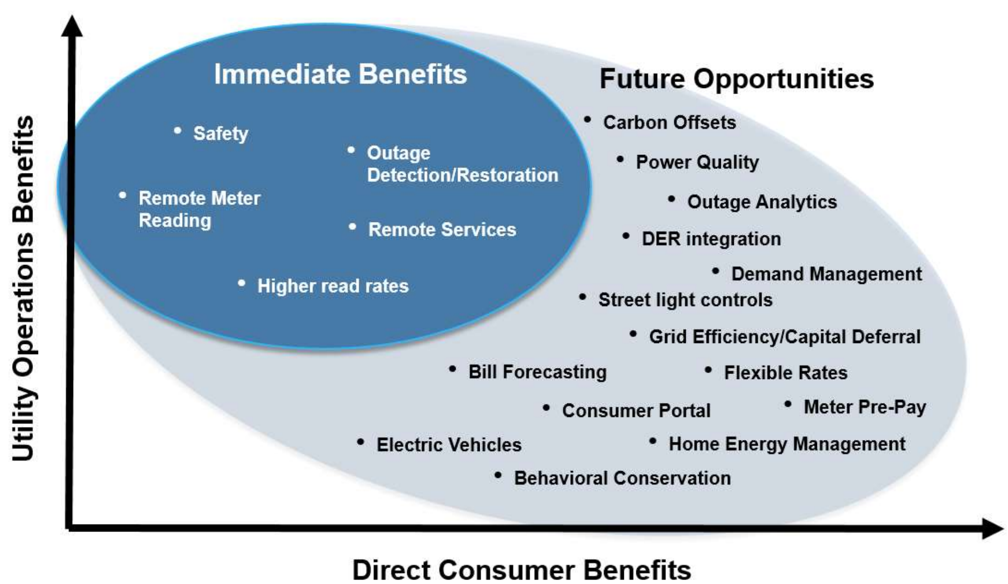
- AMI-enabled bill generation leads to fewer customer complaints about incorrect bills and allows utilities to resolve billing disputes more quickly than before. (Case Study with Oklahoma Gas and Electric).
- AMI enables utilities to proactively address customer billing issues (Case Study Burbank Power and Water).
- Utilities using AMI can now complete remote service connection and disconnection requests in hours rather than days. (Case Study Electric Power Board of Chattanooga).

[12] A copy of this report can be found at https://www.energy.gov/sites/prod/files/2016/12/f34/AMI%20Summary%20Report_09-26-16.pdf.

Q. What are the future opportunities that an AMI foundation enables?

A. In addition to the immediate benefits AMI technology enables such as remote services, higher read rates, safety, and outage awareness, AMI also serves as the platform necessary to unlock a wide variety of potential new products and services. AMI provides the necessary data and functionality to not only understand future grid needs, but enable the empowerment of customers. More specifically, utilities can use AMI data to provide flexible rate options, perform energy analysis on electric vehicle and Distributed Energy Resource (DER) opportunities, track demand management programs, and develop additional innovative and customer-focused programs as identified in Figure 2 below.

Figure 2: AMI Benefits and Opportunities



It should be noted that future opportunities require additional system investment; however, they cannot be realized without the AMI foundational equipment and network.

Q. Does this conclude your testimony?

A. Yes, it does.

VERIFICATION

This Pre-filed Direct Testimony of Jonathan R. Shafer is true and accurate to the best of my knowledge, information, and belief.

/s/ Jonathan R. Shafer
Jonathan R. Shafer