



414 Nicollet Mall  
Minneapolis, MN 55401

August 4, 2022

**—Via Electronic Filing—**

Will Seuffert  
Executive Secretary  
Minnesota Public Utilities Commission  
121 7<sup>th</sup> Place East, Suite 350  
St. Paul, Minnesota 55101

RE: AMI AND FAN TECHNICAL WORKSHOP SERIES – WORKSHOPS #1 AND #2  
RECORDINGS AND PRESENTATION  
TRANSMISSION COST RECOVERY RIDER  
DOCKET NOS. E002/M-21-814 AND E002/M-20-680

Dear Mr. Seuffert:

Northern States Power Company, doing business as Xcel Energy, submits to the Minnesota Public Utilities Commission this letter to provide the recordings and presentations from our first two Technical Workshops, which were part of the Procedural Agreement the Commission approved in its June 2, 2022 Order in the above-referenced dockets and outlined in our June 29, 2022 Letter. We also provide details on our third Technical Workshop.

Workshop 1 was held on July 19, 2022 and provided an overview of the industry landscape of grid modernization and technologies, along with a discussion of the specific technologies, selection process, and implementation of our Advanced Metering Infrastructure (AMI) and Field Area Network (FAN) investments. The Workshop 1 presentation is provided as Attachment A.

Workshop 2 was held on July 25, 2022 and focused on the advanced grid customer strategy, customer experience changes and enhancements, and how we intend to maximize the benefits of our AMI and FAN investments for our customers. We also discussed the advanced rate design roadmap and how data from AMI and FAN can benefit grid operations. The Workshop 2 presentation is provided as Attachment B.

Recordings of both workshops can be accessed at the link below.

<https://www.youtube.com/playlist?list=PLlogUk2DY9hGpf7n2ABk17uNYDJfnBXO>.

We will hold Workshop 3 on Wednesday, September 7 from 1:00 p.m. to 2:30 p.m. This final workshop in the series will explore the AMI and FAN costs requested in our Transmission Cost Recovery Rider Petition, the cost-benefit analysis for AMI and FAN, and the Company's proposed reporting. Additional details regarding the full Technical Workshop Series, including Workshop 3 are were submitted in the Company's June 29, 2022 Letter in the above-referenced dockets and available on eDockets at:

<https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={80EBB081-0000-C71E-BEB5-B02F2B25C9BF}&documentTitle=20226-186972-02>.

### **WORKSHOP 3: AMI AND FAN COST-BENEFIT ANALYSIS, FINANCIALS, AND REPORTING**

**Date:** September 7, 2022

**Time:** 1:00 – 2:30 p.m. CT

**Venue:** Microsoft Teams [Click here to join the meeting](#)

We appreciate the opportunity to host these technical workshops and provide stakeholders with information about the Company's AMI and FAN implementation as well as respond to stakeholder questions.

We have electronically filed this document with the Minnesota Public Utilities Commission and copies have been served on the parties on the attached service lists. Please contact me at [bria.e.shea@xcelenergy.com](mailto:bria.e.shea@xcelenergy.com) or Karin Haas at [karin.b.haas@xcelenergy.com](mailto:karin.b.haas@xcelenergy.com) if you have any questions regarding this filing.

Sincerely,

/s/

BRIA E. SHEA

REGIONAL VICE PRESIDENT, REGULATORY POLICY

c: Service Lists



# ADVANCED METERING INFRASTRUCTURE AND FIELD AREA NETWORK – TECHNICAL WORKSHOP SERIES

**Workshop 1: Industry Landscape and Technology Selection,  
Capabilities, and Implementation**

July 19, 2022

# AGENDA

## Industry Perspective

- AMI and FAN

## Xcel Energy Selected Technologies and Capabilities

- Technology selection process
- FAN capabilities
- AMI capabilities

## AMI and FAN Implementation

## SPEAKERS

**Wendall Reimer**, Director of OT Network

**Paul Davis**, Director of Metering and AMI Operations

**Mark Raak**, Manager, Capital Projects Sourcing

**Raymond Mauya**, Program Manager, AMI

**Karin Haas**, Regulatory Policy Specialist



# INDUSTRY OVERVIEW: FAN

## Wendall Reimer – Director of OT Network

# FIELD AREA NETWORK (FAN) INDUSTRY PERSPECTIVE

Typically refers to:

- The wireless field network used to provide connectivity to devices for communicating back to a central system.
- Providing two-way device connectivity to IoT devices (Internet of Things).

For utilities, it is primarily being used, or considered for use, in connecting devices such as meters, sensors, etc. that require low bandwidth consumption and do not require low latency.

Historically and presently, the FAN networks have been singularly purposed (i.e., just for AMI or just for Distribution Automation).

Increasingly, FAN networks are being considered and deployed as “converged” networks to handle multiple types of traffic, standardize on network solutions, reduce the cost of deployment, and minimize support costs.

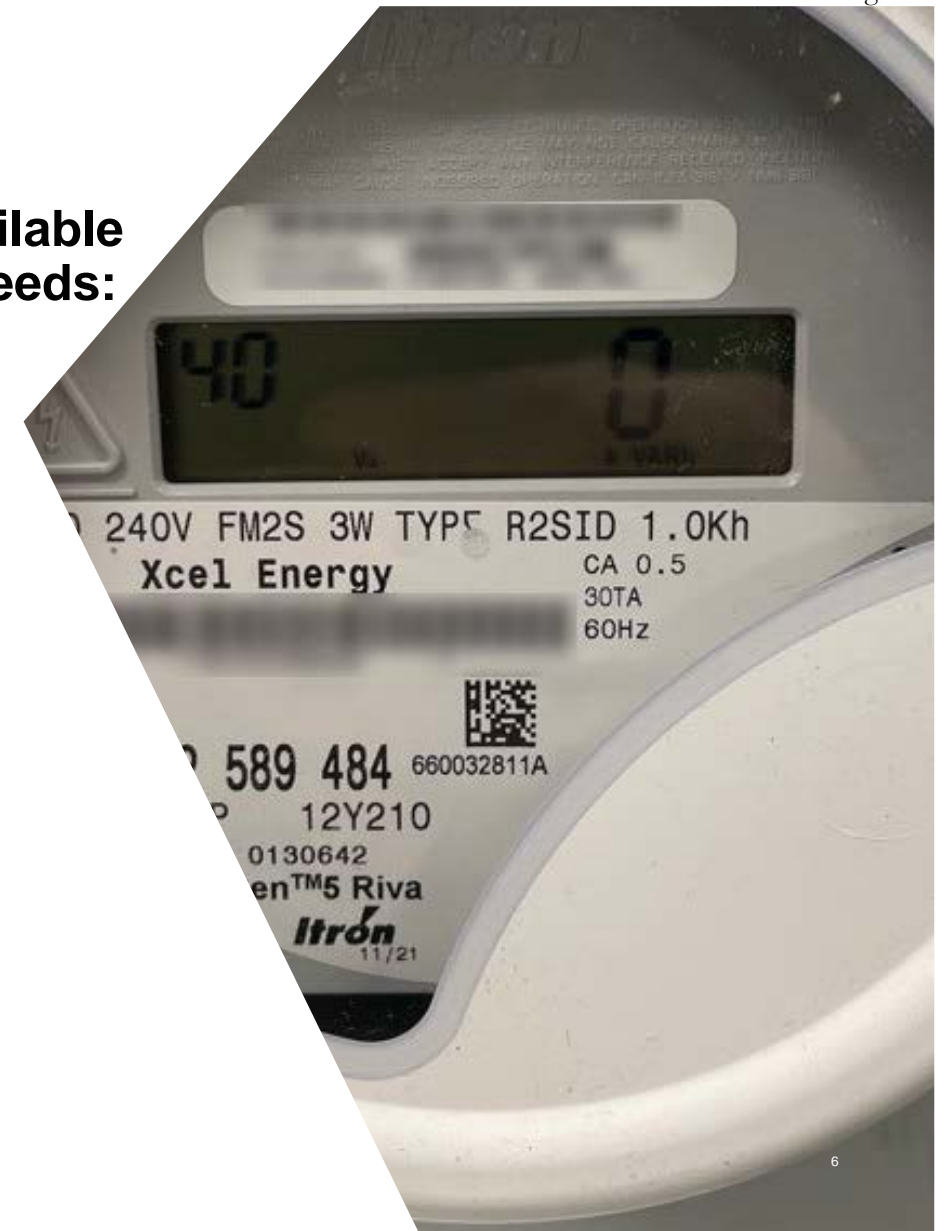
Many include the “backhaul” method that connects the FAN to the backend systems, usually in a data center.

- Usually this includes fiber, microwave, leased circuits, public cellular, and private LTE.
- Backhaul networks are usually considered BAU (Business As Usual) as they provide connectivity for many different purposes beyond grid management.

## FAN IN THE INDUSTRY

### Types of communications methods/systems available for AMI and other 2-way field communications needs:

- Point-to-Multipoint solutions (ex. WiMAX and LTE)
- Radio Frequency (RF) Mesh solutions
- RF mesh topology, widely used for AMI networks in the last mile.
- These topologies are gradually gaining a higher level of acceptance by utilities who are responding well to the technology's built-in resiliency.
- Determining which solution to implement varies based on critical requirements of utility:
  - Cost
  - Full scope of use (e.g., just meters vs. any field device)
  - Communication capabilities of end device chosen
  - Bandwidth requirements (i.e., How much data is being sent)
  - Latency requirements (how fast does that data need to be sent across the network – both to and from a host system)





# VARIOUS NETWORK USES ACROSS THE INDUSTRY

## Examples of multi-use networks



Electric Distribution (meters, cap banks, ENGO's, etc.)



Two-way switches



Streetlights



Gas (meters and SCADA)



Batteries



# INDUSTRY OVERVIEW: AMI

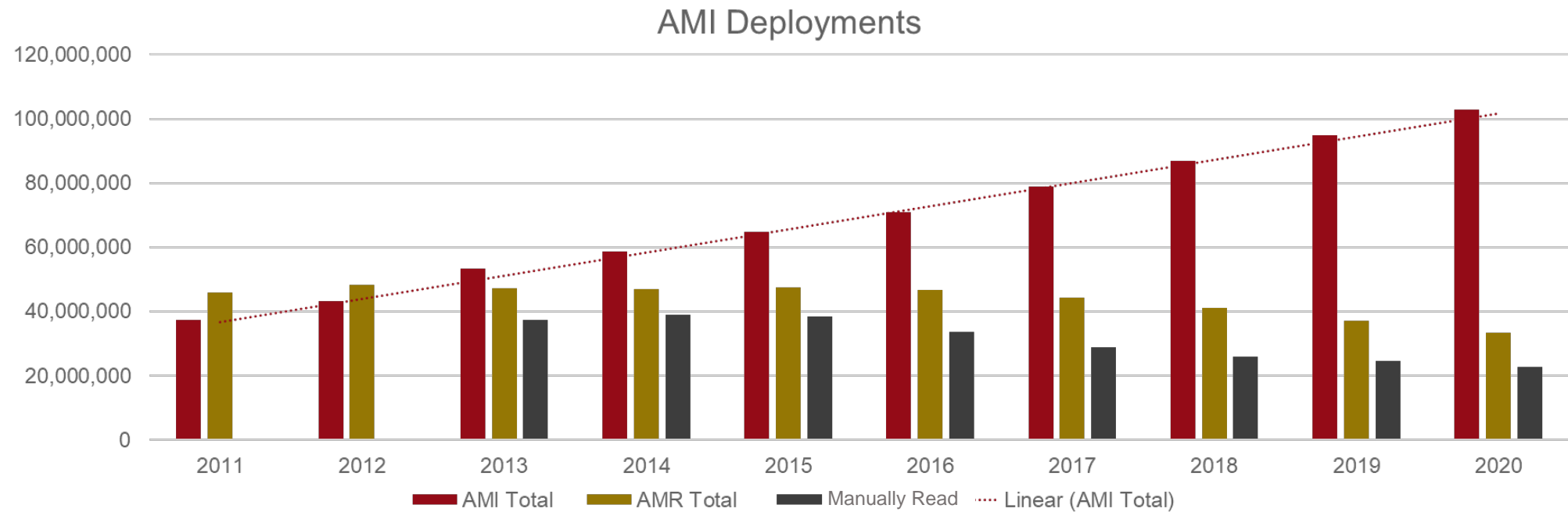
**Paul Davis – Director of Metering and AMI Operations**

## AMI IN THE INDUSTRY

**Various AMI technologies exist in the industry**

Wired	Wireless
Fiber optic	Radio Frequency (RF) - Mesh
Power Line Communications	RF-Point to multi-point
Telephone Dial-up modem	RF-Cellular
Digital subscriber line (DSL)	

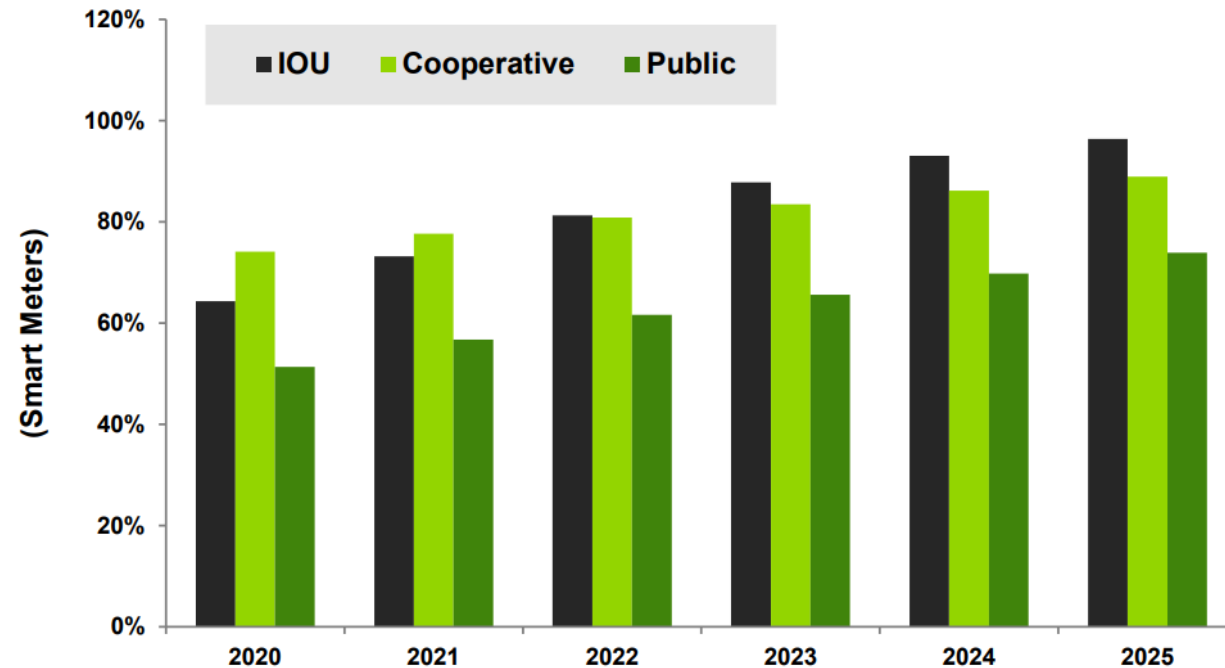
# HISTORICAL GROWTH IN U.S. AMI DEPLOYMENT



Data source: U.S. Energy Information Administration, Form EIA-861, "Annual Electric Power Industry Report." Form EIA-861S, "Annual Electric Power Industry Report (Short Form)."

## FUTURE GROWTH IN AMI DEPLOYMENT

AMI meters already serve nearly 65% of electric utility customers across the country as of 2020; penetration will approach 90% by 2028.



(Source: Guidehouse Insights)

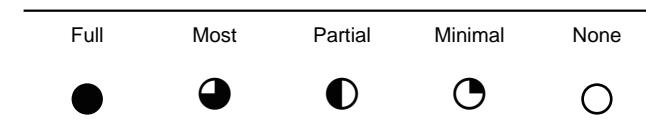
Source: Guidehouse Insights, *AI at the Grid Edge How Inside-the-Meter Analytics Drive Value at the Grid Edge*, available at <https://www.grid4c.com/hubfs/2021/AI-at-the-grid-edge.pdf>.

# AMI VS. NON-AMI TECHNOLOGIES

Feature/Capability	AMI	AMR (One-way System)	AMR (Limited two-way system)	AMR Drive-by System	Manual Read
Total cumulative consumption data	● Supports more complex rates	◐ System supports 2 tier rates.	◑ Support only two TOU rates and meters cannot be remotely programmed to capture TOU data.	◑ Limited capability. Some meters could support one TOU bin in addition to other metering quantities.	○ Not supported
Interval Data	● Capable of measuring and recording more complex interval data sets; supports more interval data lengths	◑ Can only be used for load research purposes and not for billing as data is not revenue grade quality; limited to traditional energy interval data	◐ Data can be used for billing; limited to traditional energy data; limited to 5- or 15-minute interval lengths	○ Not Supported	○ Not Supported
Real time notification of power outages	● Real-time availability of outage information	◐ Outage notification but not in real-time	◐ Outage notification but not in real-time	○ Not supported	○ Not supported
Fast response to customer inquires	● Real-time access to customer metering data Access to real-time meter diagnostic information	◑ Limited access to customers metering data Limited access to real-time meter diagnostic information	◑ Lack of real-time view of customer's metering data No access to meter real time diagnostic information.	○ Not supported	○ Not supported
<div> <div>Full</div> <div>Most</div> <div>Partial</div> <div>Minimal</div> <div>None</div> </div> <div> <div>●</div> <div>◑</div> <div>◐</div> <div>◑</div> <div>○</div> </div>					

# AMI VS. NON-AMI TECHNOLOGIES CONTINUED

Feature/Capability	AMI	AMR (One-way System)	AMR (Limited two-way system)	AMR Drive-by System	Manual Read
Support integrated systems that offer customers options for energy conservation and cost management programs	● Technology supports customer side technologies such as smart thermostats, load control devices, etc.	◐ Limited and uncoordinated technology that can allow for such customer facing solutions. Highly customized options for various customer bases required to offer such programs.	○ Not supported	○ Not supported	○ Not supported
Ability to remotely upgrade metering devices e.g., firmware upgrade, meter configuration changes	● AMI offers the platform to remotely perform such functions.	○ Not supported	○ Not supported	○ Not supported	○ Not supported
Availability of near real-time data e.g., voltage, current, power, etc. that are vital for distributed energy resource (DER) monitoring	● AMI offers the foundation that makes the availability of such data possible.	○ Not supported	○ Not supported	○ Not supported	○ Not supported
Remote availability of meter diagnostic data e.g., missing phase, CRC errors, etc. useful for remote troubleshooting	● Data available with full AMI systems.	◐ Feature supported to a limited extent.	◐ Feature supported to a limited extent.	◐ Feature supported to a limited extent.	○ Not supported
Detect unsafe field metering conditions	● Provides service condition information such as temperature and service quality that can be used to detect unsafe conditions such as hot sockets.	○ Not supported	○ Not supported	○ Not supported	○ Not supported



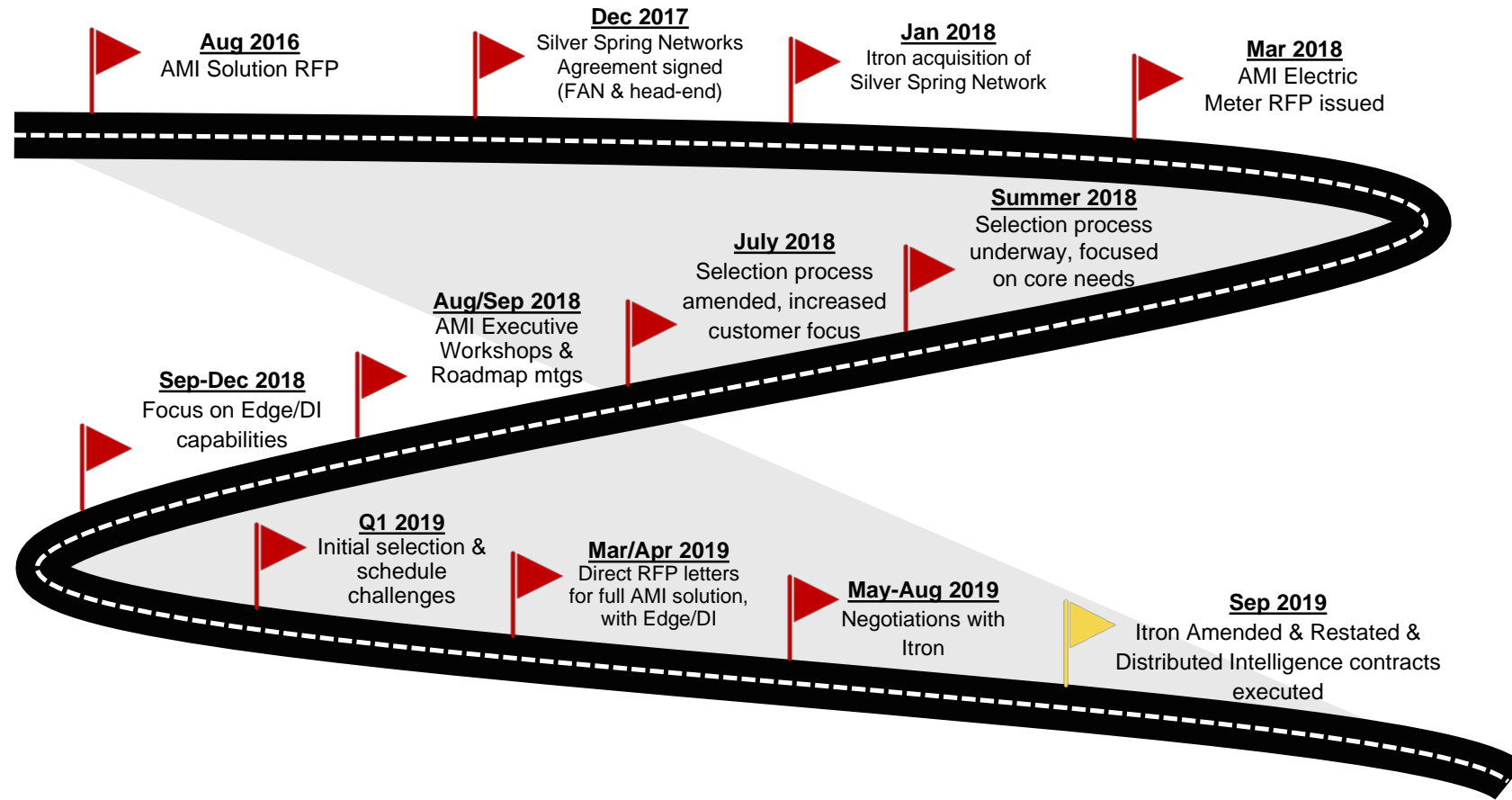


# SELECTION PROCESS

**Mark Raak – Manager, Capital Project Sourcing**



# AMI HISTORY PATHWAY



# EDGE TECHNOLOGY/DISTRIBUTED INTELLIGENCE CONSIDERATIONS

- Future proofing capabilities
- Enable computing at the edge of the grid
- New communication capabilities
- Provides open application environment
- Provides capabilities for an enhanced customer experience
- Operational benefits
- Grid optimization



# KEY CONSIDERATIONS

## Network

- Technological capabilities, robust, standards-based network
- Security & resilience
- Price & commercial considerations
- Meter agnostic

## Meter

- Compatibility with the selected network
- Core metrology
- Edge Technology/Distributed Intelligence/Customer
- Price & commercial considerations
- Enterprise schedule

# ITRON SELECTION

## Itron's INSI Gen5 Network & Riva 4.2 Meter

- Highest evaluated network performance, including security and resilience.
- Met or exceeded core metrology requirements with the next generation, Riva 4.2 meter.
- Distributed Intelligence capabilities at a price in the competitive range of non-DI meters.
- Comprehensive solution, including network, network communications (NIC), meter, and DI.
- Lowest risk, lowest cost for a comprehensive AMI solution that included DI capabilities.



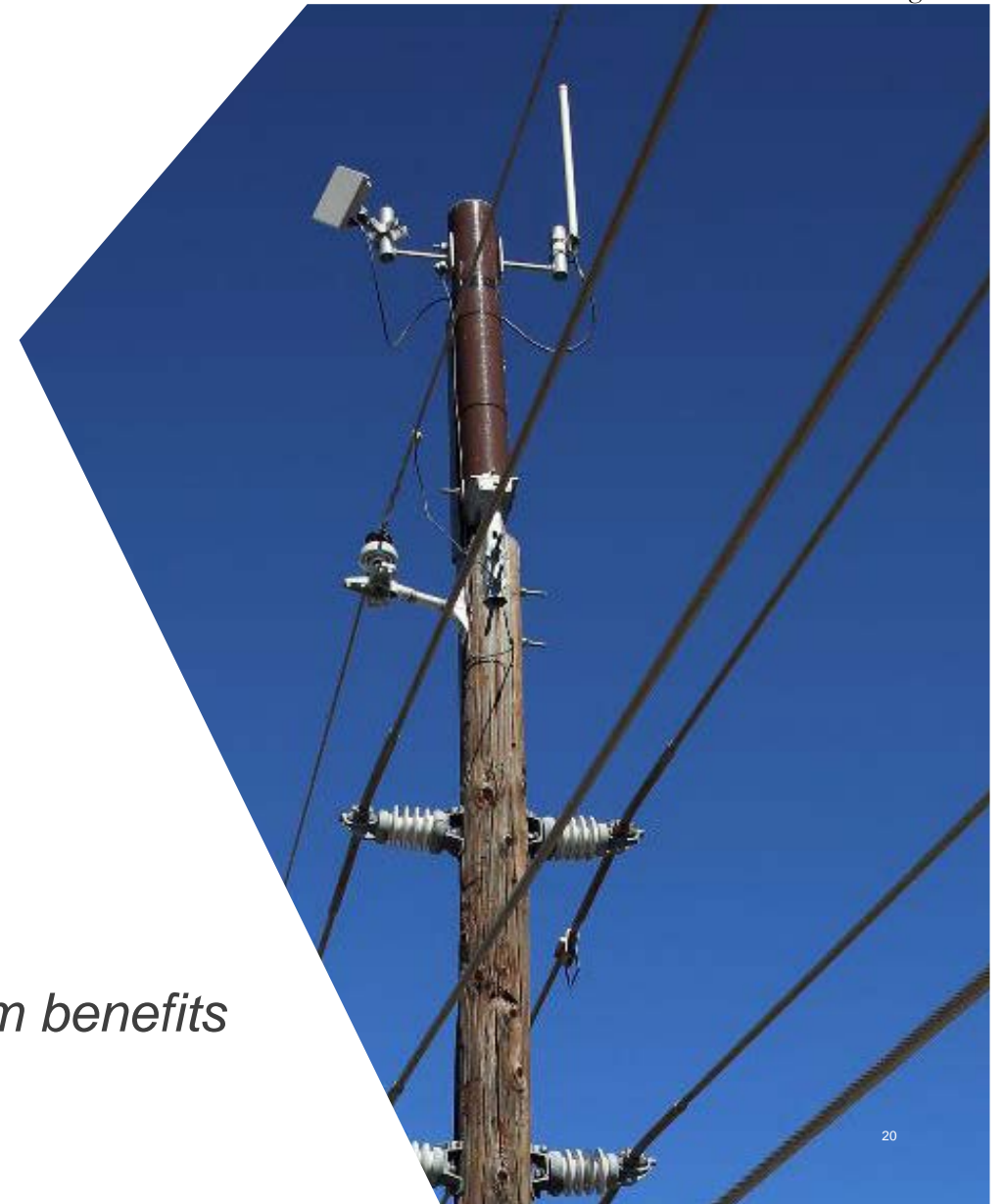
# CAPABILITIES – FIELD AREA NETWORK

## Wendall Reimer – Director of OT Network

## Field Area Network (FAN)

- Provides high speed connectivity to field devices
- High Speed Communications Network
- Wi-SUN (RF Mesh) technology
- Standards Based, seeking interoperability
- Envisioned as part of 2013 Network Strategy
- Tiered network to future proof
  - Multiple standards deployed
  - Interoperability critical
  - Multi-purpose network

**Foundational** – *Enabler of various program benefits*



# WI-SUN

## WIRELESS SMART UTILITY NETWORKING

### **Standards-based, interoperable wireless mesh network**

- Based on IEEE 802.15.4g
- Uses standard network protocols (IPv4/IPv6)
- 2-way communication to all devices
- Meters participate in mesh network
- Redundant paths for all nodes

### **Per hop bandwidth up to 1.2mbps, one-way latency less than 50ms**

- 200x more bandwidth and 5x improved latency of legacy technology

### **Each mesh cluster is approximately ½ mile radius**

- Avg. 2500 meters per cluster – capable of 5000 per cluster



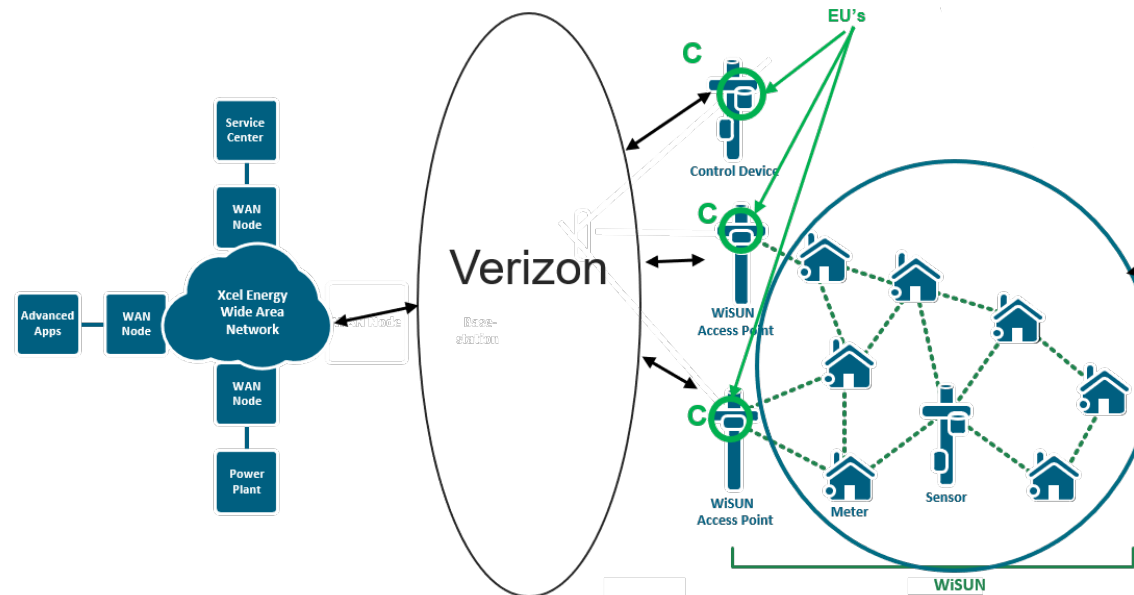
# FAN CORE PRINCIPLES

The Field Area Network will...





# Advanced Grid FAN Architecture





# CAPABILITIES – ADVANCED METERING INFRASTRUCTURE

**Raymond Mauya – Program Manager, AMI**

## Itron Gen5 RIVA (HW4.2) Meter

### Consumer Services and Grid Optimization through Open Platform Distributed Intelligence (DI) enabled Smart Meters

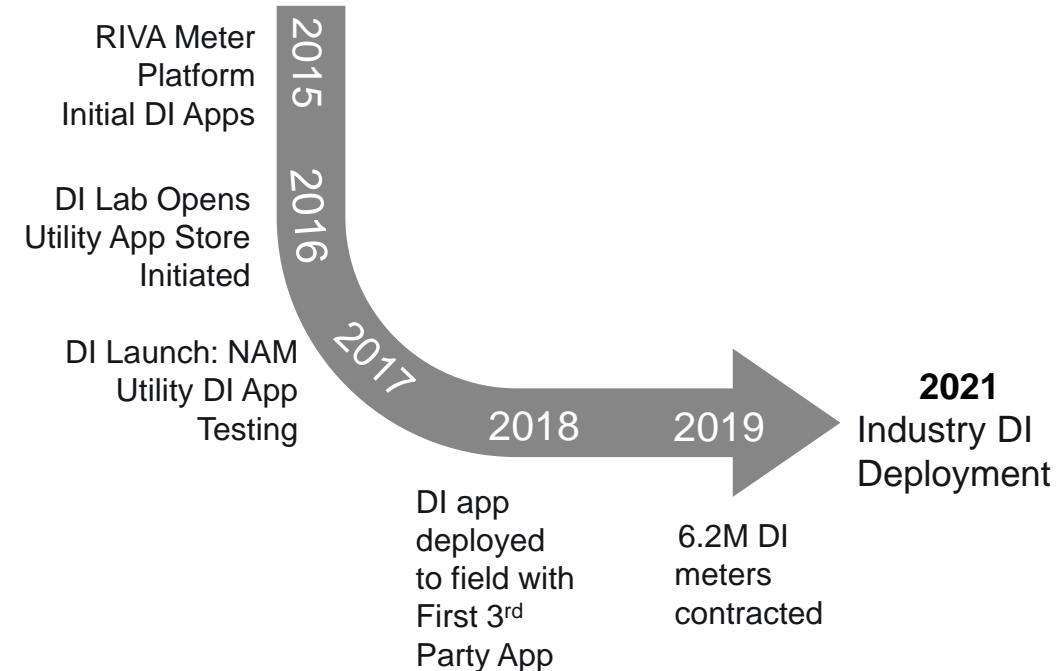
Third evolution of the RIVA meter

- High frequency sampling + processing power to run local analytics.
- 2.35M RIVA (HW4.1) Meters deployed since becoming Itron standard in 2015.
- Gen5 Riva (HW4.2) Meters included Xcel Energy collaborative design suggestion integrations and wireless protocol enhancements to operate on multiple networks.



## Itron Experience with the Gen5 RIVA (HW4.2) Meter

- Evolution of existing platform.
- Qualified in compliance with all American National Standards Institute (ANSI) C12 requirements.
- Rigorous Accelerated Life Cycle testing & >3.3M hours of “Meter Farm” operation.
- More than **4 million** Itron RIVA 4.1 and 4.2 meters shipped to date



# Meter Architecture

## Two main Integrated Circuit Boards:








### Register Board

- Arm Cortex A7, 256MB RAM, 512MB FLASH, 2GB Extended Flash
- Linus OS
- Billing Register
- DI
- Firmware
- Wi-Fi (HAN, DI, Local Access)
- Mesh Radio
- PLC (Enable Peer to peer for DI)

### Metrology Board

- Measure raw values (Voltage, current and power)
- Power Supply
- Arc Detection
- Load side voltage Detector

## Meter Functionalities

	Enhanced Outage Notification	Near-real time notification.
	Interval Data	Capable of capturing more complex data sets.
	TOU Data	Capable of capturing more TOU data.
	Remote Disconnect/Reconnect*	Faster service reconnection, lower reconnection fees.
	Temperature Monitoring	Enable hot socket detection.
	Tamper Detection	Reverse power flow, removal, inversion, etc.
	Distributed Intelligence	Supports “grid-edge” services and products.



# IMPLEMENTATION

## Raymond Mauya – Program Manager, AMI

# Meter Deployment Plan

- The plan is for all Minnesota customers to have an AMI meter by the end of 2024
  - 1.4 million meters planned in total
  - Deployment began late April 2022
- Supply chain issues impacting deliveries across the industry
  - Monitoring and managing closely

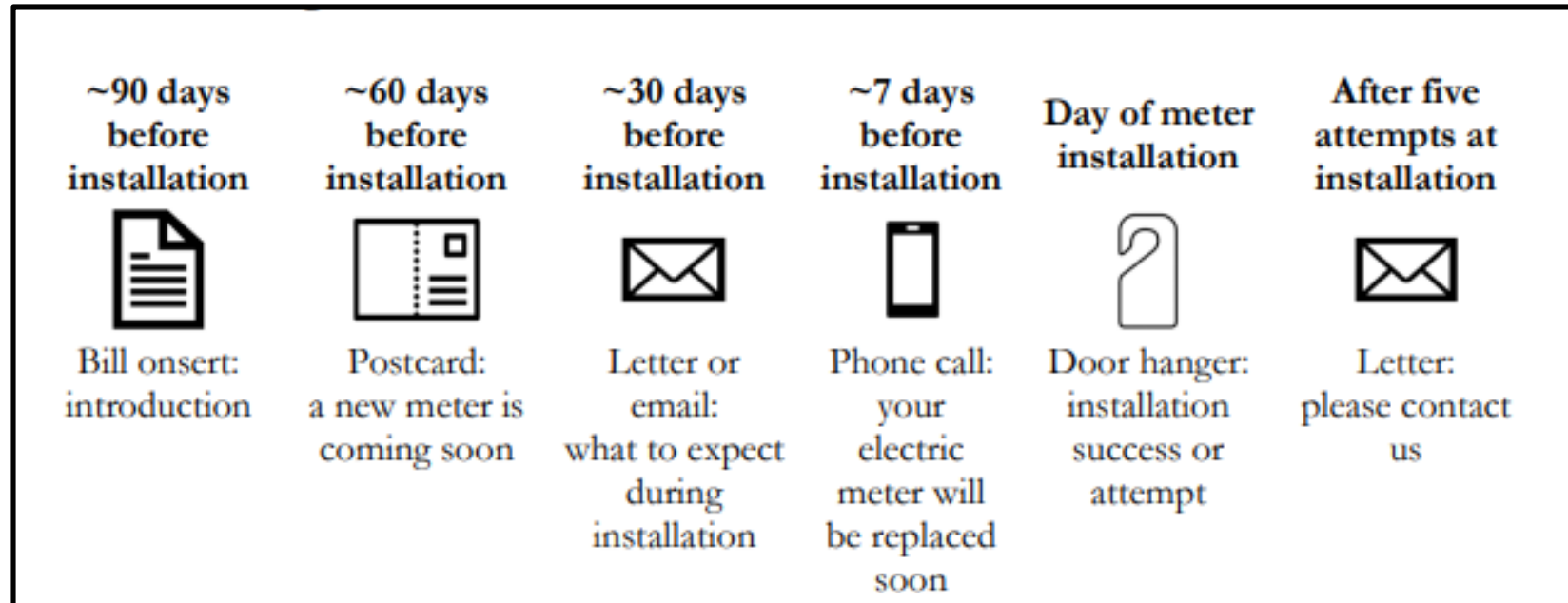




## OTHER IMPLEMENTATION-RELATED ITEMS

**Karin Haas – Regulatory Policy Specialist**

## Deployment – Customer Communications



## AMI Opt-Out Option

Residential and small business customers\* may choose to have a “non-communicating” meter installed instead of a standard AMI meter.

- Non-communicating meter does not send/receive data through the FAN, but still measures interval usage
- Non-communicating meters must be read manually each month

The Manual Meter Reading Tariff<sup>^</sup> outlines the applicable terms, conditions, and customer costs:

- Manual meter reading: \$15/month
- Installing and/or removing non-AMI meter
  - \$40 if customer has already had an AMI meter installed
  - \$40 when customer vacates premise or chooses an AMI meter

\*Residential Service, Residential Time of Day, Small General Service and Small General Time of Day Service customers are eligible.

<sup>^</sup>Approved by the Minnesota Public Utilities Commission on July 21, 2021 (Docket No. E002/M-20-592).

## Minnesota Customer Billing Form Change

- With current/AMR meters, current and previous readings were used.
- With AMI meters, bills based on sum of interval billing data over billing period (month).
- Commission approved change to customer bill in Docket No. E002/M-20-592.

### Current/Previous Usage Example

METER READING INFORMATION			
<b>METER NUMBER:</b> 0000000000		Read Dates: MM/DD/YY – MM/DD/YY (00 Days)	
DESCRIPTION	CURRENT READING	PREVIOUS READING	USAGE
Total Energy	00000 Actual	00000 Actual	000 kWh

### Interval Usage Example

METER READING INFORMATION		
<b>METER</b>		Read Dates: 04/05/20 - 05/04/20 (29 Days)
DESCRIPTION	USAGE TYPE	USAGE
Total Energy	Actual	267 kWh

## Remote Connect/Disconnect

**AMI meters have the capability to reconnect and disconnect service remotely.**

- Benefits include faster reconnection of service, lower reconnection fees, reduction of “truck rolls,” mitigation of possible safety risks.
- We make every effort to proactively support customers and contact through multiple methods; disconnection is always a last resort.
- Fully remote disconnection proposed in Docket No. E002/M-22-233 in May 2022 after consultation with stakeholders and consumer advocates.
- Under proposed process, “door knock” replaced by an additional phone call to the customer prior to disconnection.
- Can use remote reconnect capabilities now, enabling faster service restoration and negating the need for a second field visit.



QUESTIONS?



## FAN – AVAILABLE TWO-WAY COMMUNICATIONS METHODS

### Point-to-Multipoint solutions (ex. LTE)

#### Technical Specifications

- Long-Term Evolution (LTE) is a standard for wireless broadband communication for mobile devices and data terminals
- Based on the GSM/EDGE and UMTS/HSPA standards. It improves on those standards' capacity and speed by using a different radio interface and core network improvements
- The standard is developed by the 3GPP (3rd Generation Partnership Project) and is specified in its Release 8 document series
- LTE is also called 3.95G and has been marketed as "4G LTE" and "Advanced 4G"
- The LTE Advanced standard formally satisfies the ITU-R requirements for being considered "IMT-Advanced"

### RF Mesh solutions

#### Technical Specifications

- Based on IEEE standard 802.15.4
- Low-Rate Wireless Personal Area Networks" – 802.15.4g
- "PHY Amendment for Smart Utility Networking (SUN)" – Wi-SUN Alliance
- Enables device-to-device and device-to-headend communication
- Operates in ISM 900 MHz Band
- IPv6 Addressed Nodes
- Mesh Cluster is approximately ½ mile radius – up to 5,000 devices per cluster
- Network is easily expandable



# **ADVANCED METERING INFRASTRUCTURE AND FIELD AREA NETWORK – TECHNICAL WORKSHOP SERIES**

**Workshop #2 – Customer Strategy and  
Products & Services Roadmap**

July 25, 2022



# AGENDA

Customer Strategy Overview

Customer Research

Meter Install Experience

AMI-Enabled Products and Services

Distributed Intelligence

Rate Roadmap

Leveraging AMI Data for Grid Operations

## **SPEAKERS**

**Drew Quirk**, Manager, Advanced Grid Customer Solutions

**Nikki Caicedo**, Advanced Grid Customer Experience Manager

**Nick Paluck**, Rate Consultant

**Raymond Mauya**, Program Manager, AMI





# CUSTOMER STRATEGY OVERVIEW

***Drew Quirk, Manager, Advanced Grid  
Customer Solutions***

# **XCEL ENERGY**

## **Strategic Priorities**

### **Lead the Clean Energy Transition**

- 100% carbon-free electricity by 2050
- Estimated >80% carbon-free electricity by 2030
- Reduce carbon >80% by 2030

### **Enhance the Customer Experience**

- Know our customers' needs and interests
- Make it easy to do business with us
- Deliver meaningful products, services and experiences

### **Keep Bills Low**

- Bills below national average
- Low-cost renewables
- Extensive customer efficiency programs

# CUSTOMER FOCUSED STRATEGY

**With smart meters, customers want to...**

**Save Money**

**Help the Environment**

**Gain better insight and control  
over usage**



## **New Services Categories**

### **Usage Feedback**



Alerts, notifications, and tips regarding usage habits and patterns, enabling real-time and asynchronous feedback

### **Time-varying Pricing**



Applying different price-points based on time of day, enabling TOU, DM (CPP, PTR, BDR), and, eventually smart rates

### **Data Disaggregation**



Ability to detect and quantify distinct customer loads by end use, equipment type, and, eventually, specific device

### **Behind-the-Meter Connectivity**



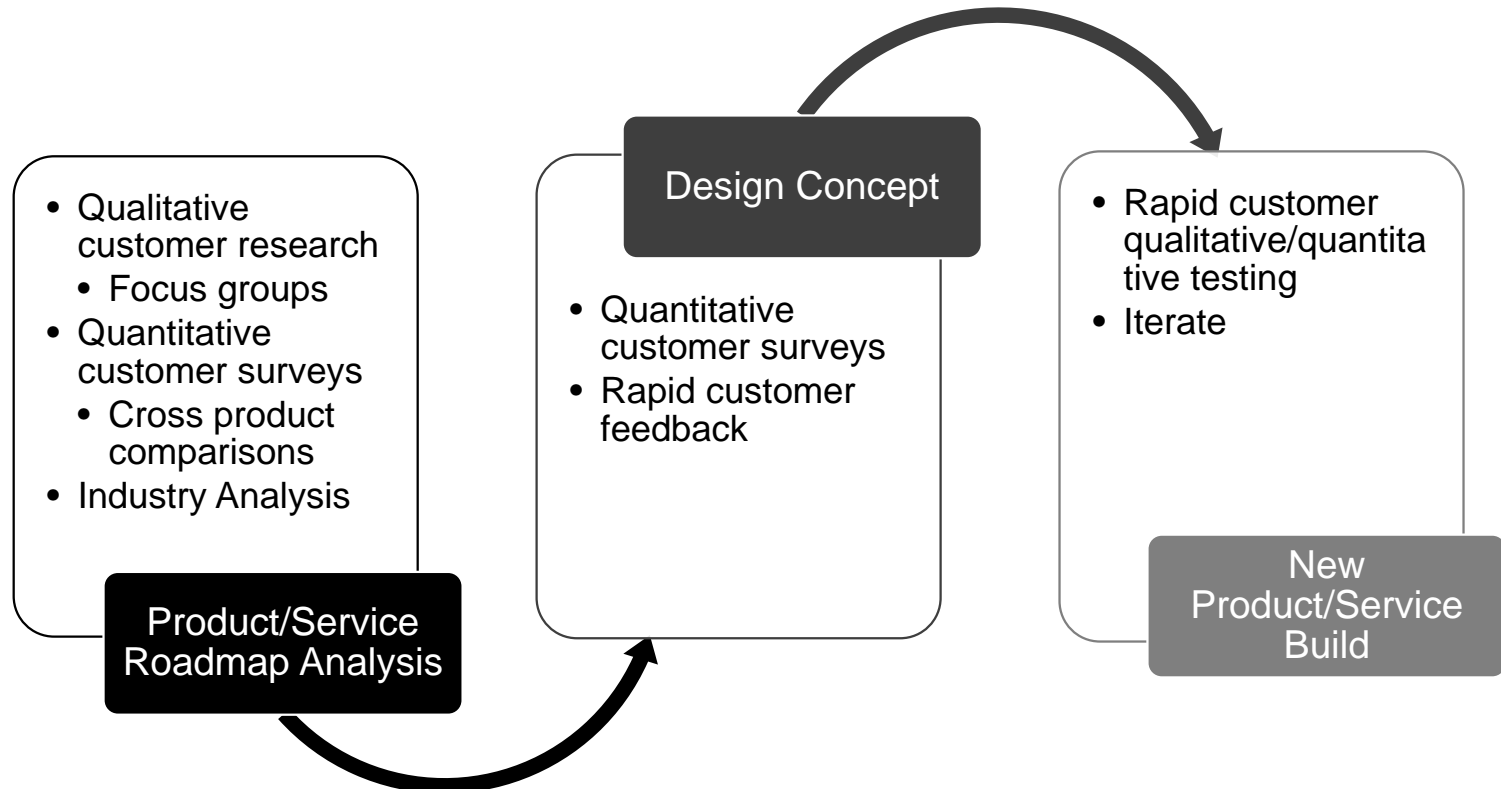
Ability to communicate directly with customer-sited systems, enabling deeper insights and, eventually, direct control



# CUSTOMER RESEARCH

***Nikki Caicedo***, *Advanced Grid Customer  
Experience Manager*

# VOICE OF THE CUSTOMER INFORMS STRATEGY





## WHICH PRODUCTS WILL CUSTOMERS PREFER?

- Measuring customer interest from the outset to prioritize a road map.
- How do customers see the “utility of the future”?
- Methodologies include surveys, focus groups, interviews, etc.



# PRODUCT DESIGN: CO-CREATE WITH CUSTOMERS

- New product ideation and design based on and informed by the **customer**.
- Rapidly solicit feedback about a product ***from the people who will use it throughout the design process.***
- Ability to adjust the design in response to feedback.
- Done through surveys, interviews, and other methodologies.



# RELEVANT RESEARCH

## Focus Groups

- Grid Modernization & Smart Meters
- TOU Rates
- New Products/Services

## Customer Surveys

- Understanding
- Preferences
- Characteristics

## Product Surveys

- Value Propositions
- Preferences

## Industry

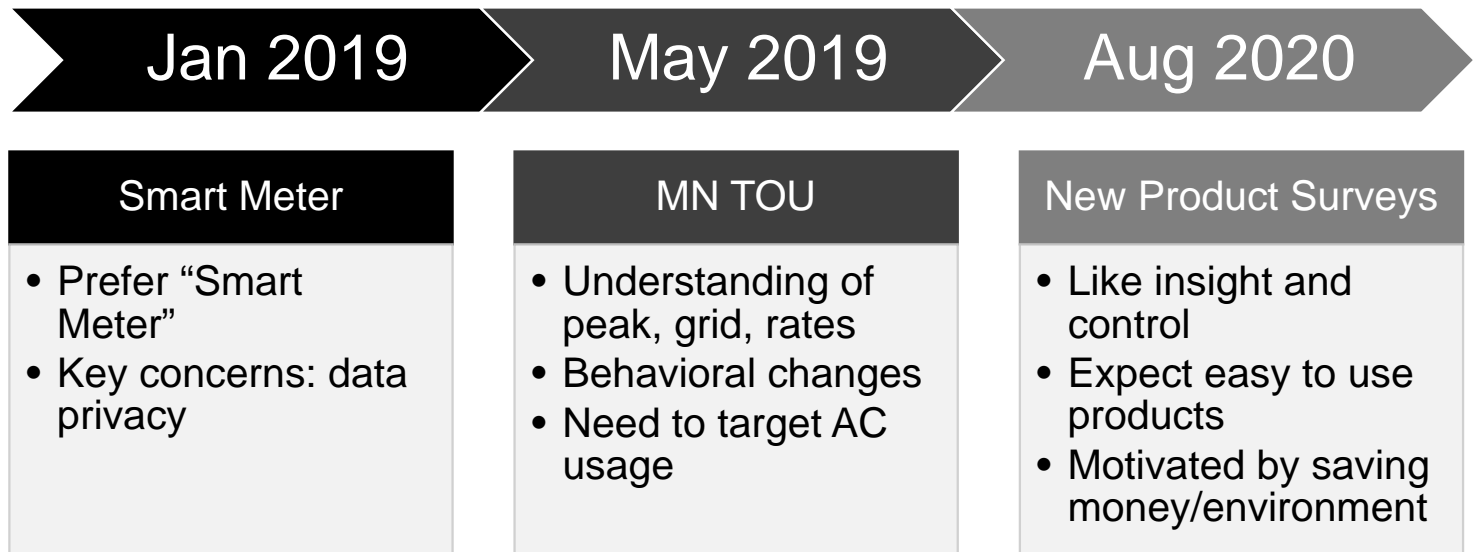
- Trends
- Peer examples

## RELEVANT RESEARCH\*

Survey	Type	Respondents
MN Time of Use (TOU) M&V	Pre-Pilot Launch Surveys	1,610
CO TOU M&V	Post-Pilot TOU survey	1,252
HAN	Product Concept test	1,992
Virtual Energy Audit	Product Concept test	370
Rate Advisor	Product Concept test	397
Focus Groups	TOU/Advanced Grid	69
Home Appliance Monitoring	Product Concept test	543
Total		<b>6,233</b>

*\*Additional research includes but is not limited to industry research, benchmarking, customer surveys, message testing*

# FOCUS GROUPS



## KEY FOCUS GROUP FINDINGS



Customers expect to receive detailed information from their utility. They expect this information to be personal and frequent.



Customers expect that there will be a cost associated with the advanced meter but that the meter will also provide benefits over time.



Addressing service interruptions are important to all customer classes. Improved reliability will allow the Company to focus more on other customer priorities.



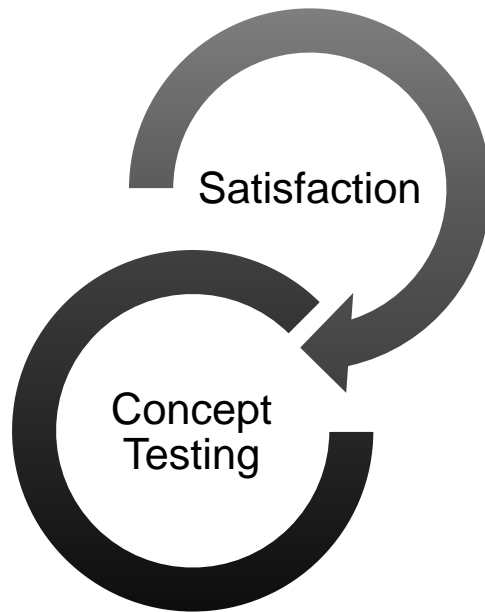
Customers expect that service interruptions will be less frequent in scope and duration.



Customers expect more tools and information for them to make decisions about their energy usage. Customers indicated more information allowed them to better identify opportunities and strategies to save energy and reduce their costs.

# PRODUCT SURVEYS

## Ongoing Research



- Measure satisfaction with product and usage of product.
- Information used to make product improvement.
- Measure customer value propositions and likely engagement.
- Information used influence product design.

# PRODUCT SURVEY EXAMPLE: DISTRIBUTED INTELLIGENCE

**Concept testing and customer interviews informed and validated prioritization and design.**

## **Concept Testing | Sample Takeaways**

- 80% of customers say they are interested in an app to understand their energy usage
- Top desired features: Usage by appliance and savings visualization
- The largest percentage of customers say they would use the app weekly
- Customers would want control over and insight into who has access to their data

## **Prototype Research | Sample Takeaways**

- Customers related to the “cost” graphs vs. usage-based ones
- Real-time data is important for EV drivers and customers in TOU programs.

## KEY TAKEAWAYS



### Motivations

Save money, manage environmental impact, more insights and control.



### Knowledge

Basic grid knowledge, some awareness of home energy use and how to manage bill.



### Behavior

More willing to make changes that don't inconvenience them.

Indicate they will engage more with products that give them more insight.





# METER INSTALL EXPERIENCE

***Nikki Caicedo, Advanced Grid Customer  
Experience Manager***

## METER INSTALLATION SO FAR

**26,763**  
TOTAL METERS  
INSTALLED  
(OF 1.4 MILLION)

**173**  
TOTAL OPT-  
OUTS

**0.22%**  
OPT-OUT  
RATE

**170**  
TOTAL  
INQUIRIES

**10**  
TOTAL  
COMPLAINTS

**84%**  
CUSTOMER  
COMMUNICATIONS  
SATISFACTION

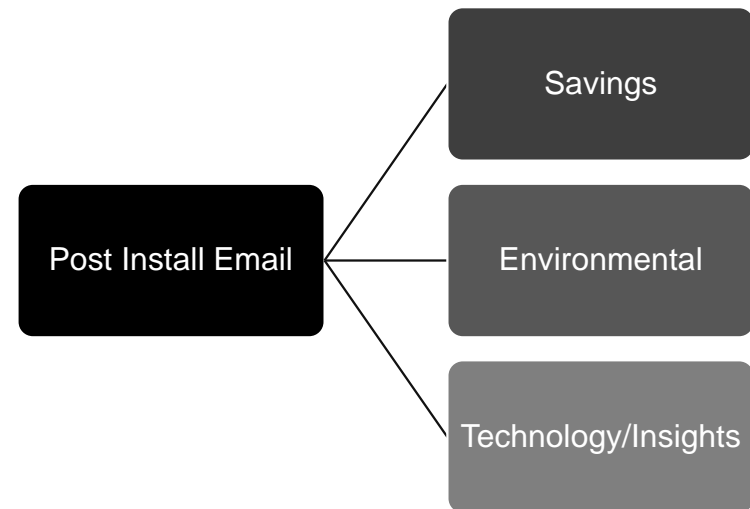
## PRE- INSTALLATION COMMUNICATION TIMELINE

Customer communications are based on the date of a customer's planned meter installation. The goal of these communications is to explain smart meter benefits, equip customers for a smooth installation, and direct customers to the website for more information.

90 days prior	<ul style="list-style-type: none"><li>• Bill Onsert</li><li>• Mass Media</li><li>• Community Playbook</li><li>• Website</li></ul>
60 days prior	<ul style="list-style-type: none"><li>• Postcard</li></ul>
30 days prior	<ul style="list-style-type: none"><li>• Letter</li><li>• Email</li></ul>
One Week Prior	<ul style="list-style-type: none"><li>• Phone Call</li><li>• Bill Message</li></ul>
Day of Install	<ul style="list-style-type: none"><li>• Door Hanger</li></ul>
2 Days After	<ul style="list-style-type: none"><li>• Email</li></ul>
One Week After	<ul style="list-style-type: none"><li>• Follow Up Email</li><li>• Postcard</li></ul>

## POST-INSTALLATION EMAIL JOURNEY

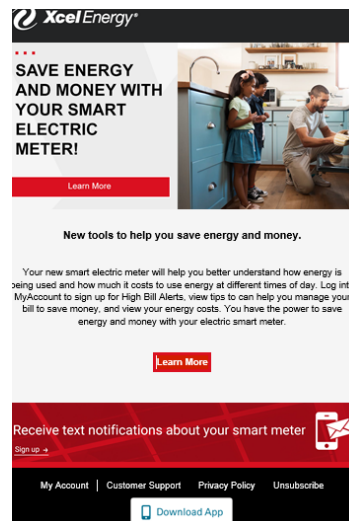
- Sent immediately after Xcel Energy receives installation file from meter installation vendor.
- Customers receive email within two days.
- Has coded content blocks that send a follow up email seven days later based on what customers click on.



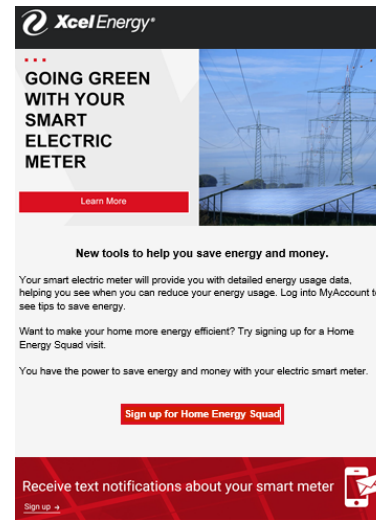
# POST-INSTALLATION EMAIL EXAMPLES



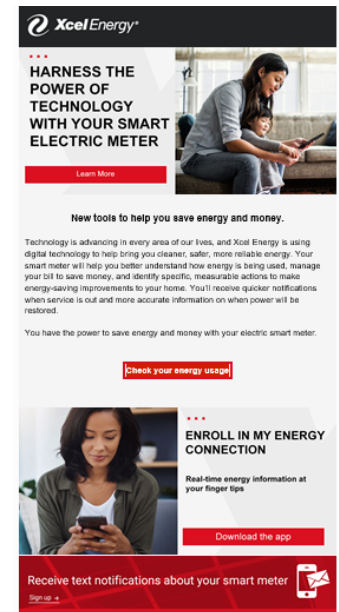
## Savings



## Environmental

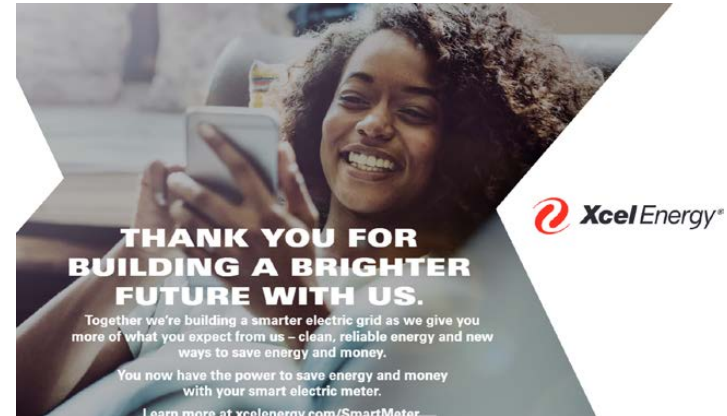


## Tech/Insights



## POST-INSTALLATION POSTCARD

- Sent within one month of install to customers without an email on file.
- CTA to sign up for My Account, complete My Energy assessment in order to earn rewards points.
- Conversion rate: 4.05%



### HARNESS THE POWER OF YOUR SMART METER AND GET REWARDED!



1800 Larimer St.  
Denver, CO 80202

POSTAGE  
FPO

When you enter My Energy through My Account for the first time and complete a home assessment, you'll earn points redeemable for a \$5 gift card! Simply click the red 'My Energy' button to get started.

Visit [xcelenergy.com](https://xcelenergy.com), log into My Account and click on My Energy.

With My Energy, you can:

- view your energy usage by the month, day, and hour
- get energy conservation tips
- earn points for completing simple energy-related tasks



Put yourself on your back and collect those energy saving points. You made a smart move with Xcel Energy!

FIRSTNAME LASTNAME  
ADDRESS LINE 1  
ADDRESS LINE 2  
CITY, STATE ZIP

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# AMI-ENABLED PRODUCT AND SERVICE ROADMAP

***Drew Quirk, Manager, Advanced Grid  
Customer Solutions***

# PRODUCT AND SERVICE GENERAL STRATEGY

- **Product concepts map driven by key value propositions identified for each customer segment**
- **Prioritization along roadmap depends on**
  - Customer and Societal Benefit
  - Technology Readiness
  - Market Adoption Characteristics
- **Initial offerings will grow, evolve, and differentiate over time**



# PRODUCT AND SERVICE ROADMAP

	DAY ONE (2022)	NEAR TERM (2022-2025)	FUTURE (2025+)
<b>ENHANCE THE EXPERIENCE</b>	<ul style="list-style-type: none"> <li>• Energy Usage Dashboard</li> <li>• Enhanced Web and Mobile Apps</li> <li>• Energy Usage Alerts and Notifications</li> <li>• Green Button Connect My Data</li> </ul>	<ul style="list-style-type: none"> <li>• Enhanced Outage Notifications</li> <li>• Emergency and Safety Notifications</li> <li>• Personalized Notifications</li> <li>• Power Quality Analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Artificial Intelligence Enabled Notifications</li> <li>• Smart Premise Restoration</li> <li>• Enhanced Microgrid Integration</li> <li>• Smart Safety Disconnect</li> </ul>
<b>KEEP BILLS LOW</b>	<ul style="list-style-type: none"> <li>• Enhanced Communication Options with Behind the Meter Systems (HAN)</li> </ul>	<ul style="list-style-type: none"> <li>• Whole Facility Monitoring</li> <li>• Rate Advisor</li> <li>• Time Varying Rates</li> <li>• Virtual Energy Audits</li> </ul>	<ul style="list-style-type: none"> <li>• Smart Rates</li> <li>• Enhanced Automated Demand Response</li> </ul>
<b>CLEAN ENERGY</b>		<ul style="list-style-type: none"> <li>• Demand management optimization</li> <li>• Enhanced access to battery storage and electric vehicles</li> <li>• Green notifications and controls</li> <li>• Enhanced DER detection and enablement</li> </ul>	



# DISTRIBUTED INTELLIGENCE

***Drew Quirk, Manager, Advanced Grid  
Customer Solutions***


# DISTRIBUTED INTELLIGENCE

## Overview

Current generation of AMI meters includes “grid edge” computing capability.



Enables local processing of real-time meter information to enhance customer services and grid operations.



Potential solution categories:

Reliability

Safety and  
Security

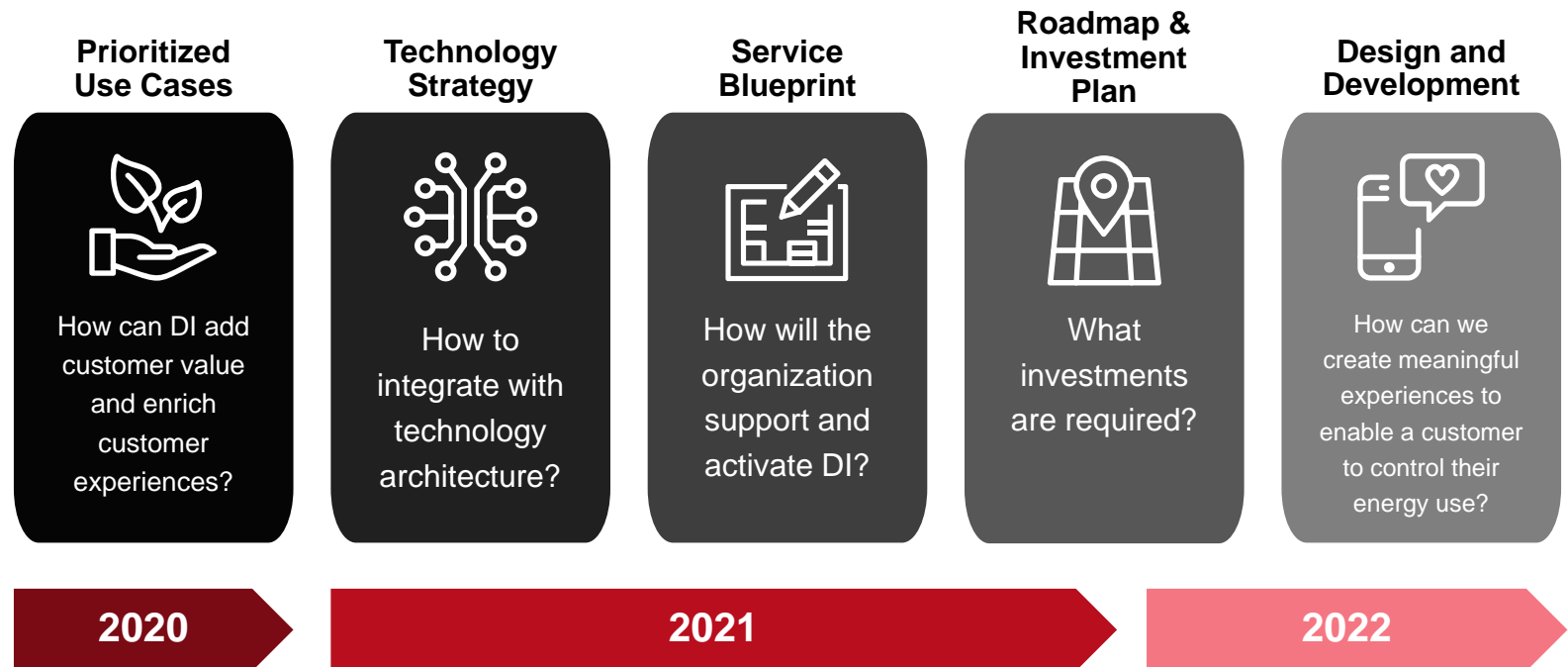
Energy Insights

Controls and  
Demand  
Management

Electric Vehicles  
and DERs




Grid Optimization

# DISTRIBUTED INTELLIGENCE ROADMAP PROCESS



# DISTRIBUTED INTELLIGENCE

## Value to stakeholders

<i>Value Category</i>	<i>Typical Value Levers</i>
 <b>Customer Value</b>	<ul style="list-style-type: none"><li>• <b>Enhance customer affordability</b> from operational improvements</li><li>• Improved <b>customer engagement</b> and experience</li><li>• <b>Energy cost savings</b> from incentives and TOU programs</li></ul>
 <b>Utility Operational Value</b>	<ul style="list-style-type: none"><li>• <b>Avoidance of peak generation</b> by shifting energy usage to off-peak</li><li>• <b>Optimization of energy supply and demand</b> through DR programs</li><li>• <b>Improved grid planning and operations</b> with safety and cost benefits</li><li>• <b>Reduction in customer service costs</b> through on-demand insights</li></ul>
 <b>Societal Value</b>	<ul style="list-style-type: none"><li>• Local <b>economic development</b> benefits</li><li>• <b>Lower carbon emissions</b> and <b>improved local air quality</b></li><li>• Potential to develop <b>programs to address community and customer needs</b></li></ul>

# DISTRIBUTED INTELLIGENCE

## Applicability to product and service roadmap

	DAY ONE (2022)	NEAR TERM (2022-2025)	FUTURE (2025+)
ENHANCE THE EXPERIENCE	<ul style="list-style-type: none"> <li>• <u>Energy Usage Dashboard</u></li> <li>• <u>Enhanced Web and Mobile Apps</u></li> <li>• <u>Energy Usage Alerts and Notifications</u></li> <li>• Green Button Connect My Data</li> </ul>	<ul style="list-style-type: none"> <li>• <u>Enhanced Outage Notifications</u></li> <li>• <u>Emergency and Safety Notifications</u></li> <li>• <u>Personalized Notifications</u></li> <li>• <u>Power Quality Analysis</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Artificial Intelligence Enabled Notifications</u></li> <li>• <u>Smart Premise Restoration</u></li> <li>• Enhanced Microgrid Integration</li> <li>• <u>Smart Safety Disconnect</u></li> </ul>
KEEP BILLS LOW	<ul style="list-style-type: none"> <li>• <u>Enhanced Communication Options with Behind the Meter Systems (HAN)</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Whole Facility Monitoring</u></li> <li>• <u>Rate Advisor</u></li> <li>• Time Varying Rates</li> <li>• <u>Virtual Energy Audits</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Smart Rates</u></li> <li>• <u>Enhanced Automated Demand Response</u></li> </ul>
CLEAN ENERGY		<ul style="list-style-type: none"> <li>• <u>Demand management optimization</u></li> <li>• <u>Enhanced access to battery storage and electric vehicles</u></li> <li>• Green notifications and controls</li> <li>• <u>Enhanced DER detection and enablement</u></li> </ul>	

Enabled or enhanced by Distributed Intelligence

## DI ENABLES DATA DISAGGREGATION

**Disaggregation allows us to take a whole building (aggregate) energy signal, and separate it into appliance specific data (i.e., plug or end use data).**

	AMI without DI	AMI with DI
Data Sampling Frequency	15 minute	< 1 Second
Data Used by Algorithms	Visually observable patterns; duration and time of use if consistent	Medium order harmonics to identify type of electrical circuitry in appliance
Appliances Identified	General categories of base load & variable load, and low accuracy of some large peak loads like AC	20-40 appliance types – toasters, computers, etc. along with loads identified by 1min-1sec algorithms

## AN ILLUSTRATIVE AMI vs. DI USE CASE



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### Experience with AMI

Later in the evening...

Your laundry use was high during on-peak hours today. Consider changing your laundry time in the future and you could save money.

**vs.**

### Experience with AMI with DI






Within minutes of washer starting...

“Hold the load!” You recently started a load of laundry. If you wait until later, you could save \$1.50 every load



# DISTRIBUTED INTELLIGENCE

## Scaled Development Approach (Customer-Facing)

	Disaggregation	Collection and breakdown of granular device-level data
	Insights	Energy analysis presented to the customer providing usage pattern insights
	Personalized Suggestions	Provide customers with choices to manage consumption
	Predictive Insights	Advanced insights that enable customers to adjust behaviors informed by value outcomes
	Automation & Control	Personalized decision-making providing customers significant control over outcomes

# DISTRIBUTED INTELLIGENCE

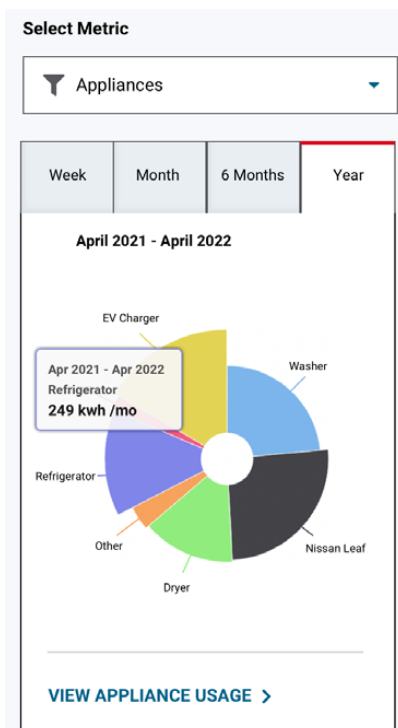
## Near-Term Customer Facing Solution Development Detail

<b>Home Area Network</b>	<ul style="list-style-type: none"><li>• Enable customers to securely connect their smart devices directly to the meter to receive real-time usage data.</li></ul>
<b>Electric Vehicle Detection</b>	<ul style="list-style-type: none"><li>• Engage EV customers in complementary programs and services.</li></ul>
<b>Energy Insights</b>	<ul style="list-style-type: none"><li>• Empower customers with detailed information about energy usage in the home.</li></ul>
<b>Anomaly Alerts</b>	<ul style="list-style-type: none"><li>• Alert customers through push notification when unusual usage patterns are detected.</li></ul>
<b>Customer Feedback</b>	<ul style="list-style-type: none"><li>• Users validate appliance information detected by smart meter and personalize &amp; edit appliance attributes.</li></ul>
<b>Program Recommendation</b>	<ul style="list-style-type: none"><li>• Personalized suggestions for programs to participate in based on user's smart meter data.</li></ul>

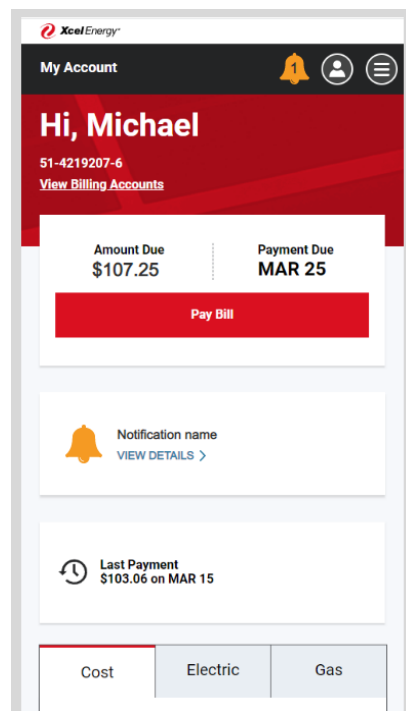
# DISTRIBUTED INTELLIGENCE

## Customer-Facing Solution Examples

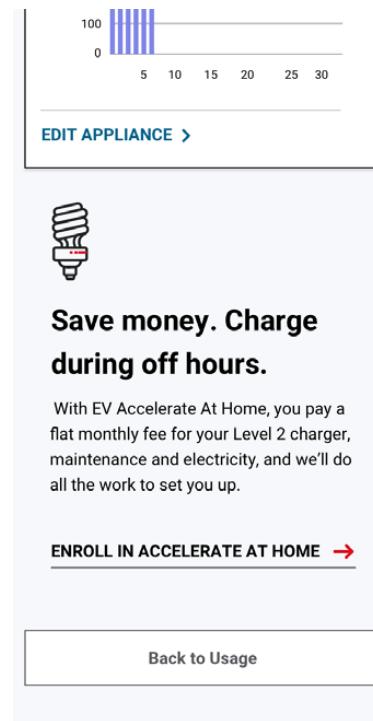
### ENERGY INSIGHTS



### ANOMALY ALERTS



### PROGRAM RECOMMENDATION





# RATE ROADMAP

*Nick Paluck, Rate Consultant*

# RATE DESIGN PRINCIPLES



Produce annual revenues that total the allowed revenue requirement.



Accurately reflect the resource costs of providing service.



Balance precision and complexity with practical considerations such as rate continuity, customer understanding and administrative practicality.

# PRICING OBJECTIVES



Empower customers with information, tools and options.



Increase access to electricity as a transportation fuel.



Encourage efficient use of the power grid.



Support clean energy transition.



Maintain reliability and customer experience.



Create design flexibility for changing technology landscape.



Provide benefits to all customers.

## RELEVANT INDUSTRY BEST PRACTICES



Rates should be designed based on fundamental principles.



Modified to consider current policy with stakeholder input.



Piloted and evaluated to gather learnings and solid data.



Customer education provided prior to mass rollout.



Structure should be adjustable to meet goals.

# CURRENT RATES

Residential	Commercial & Industrial	Voluntary
Seasonal rates (before 1980)	Seasonal demand rates	Windsor (2003) and Renewable*Connect (2017)
Electric space heating (before 1980)	Demand and energy rates differentiated by voltage	TOU rates optional (if under 1 MW )
Two-period Time of Use (TOU) rate (before 1980)	Interruptible rates (before 1980)	C&I Interruptible rates
EV Pay-As-You-Go EV Subscription Service	Mandatory TOU rates for all C&I above 1 MW (since 2007)	Saver's Switch
Multi-Dwelling Unit EV Pilot	Energy Charge Credit and Demand Limiter provisions	Solar*Rewards
Rates to serve income-qualified customers	Light Rail rate	Community Solar Gardens (bill credit)
	PV Demand Credit Rider	EV Public Charging Pilot
	Standby rates	EV Fleet Pilot
	Economic development rates (Business Incentive and Sustainability, Competitive Response)	



## HOW DOES AMI CHANGE RATE DESIGN?



Allows greater visibility into customer usage.



Replaces load research samples with actual data for the class cost allocations.



Provides measurement capability to increase rate options, and to target price signals and customer segments.



Provides opportunity to lower future system costs by incentivizing customers to change energy usage.

## CURRENT ADVANCED RATE DESIGN

### Flex Pricing Pilot (Residential TOU Pilot)

- Focus on residential customer response and acceptance of 3-period TOU rates

### General Service 3-period TOU rate

- Design rate prior to data availability to speed up process

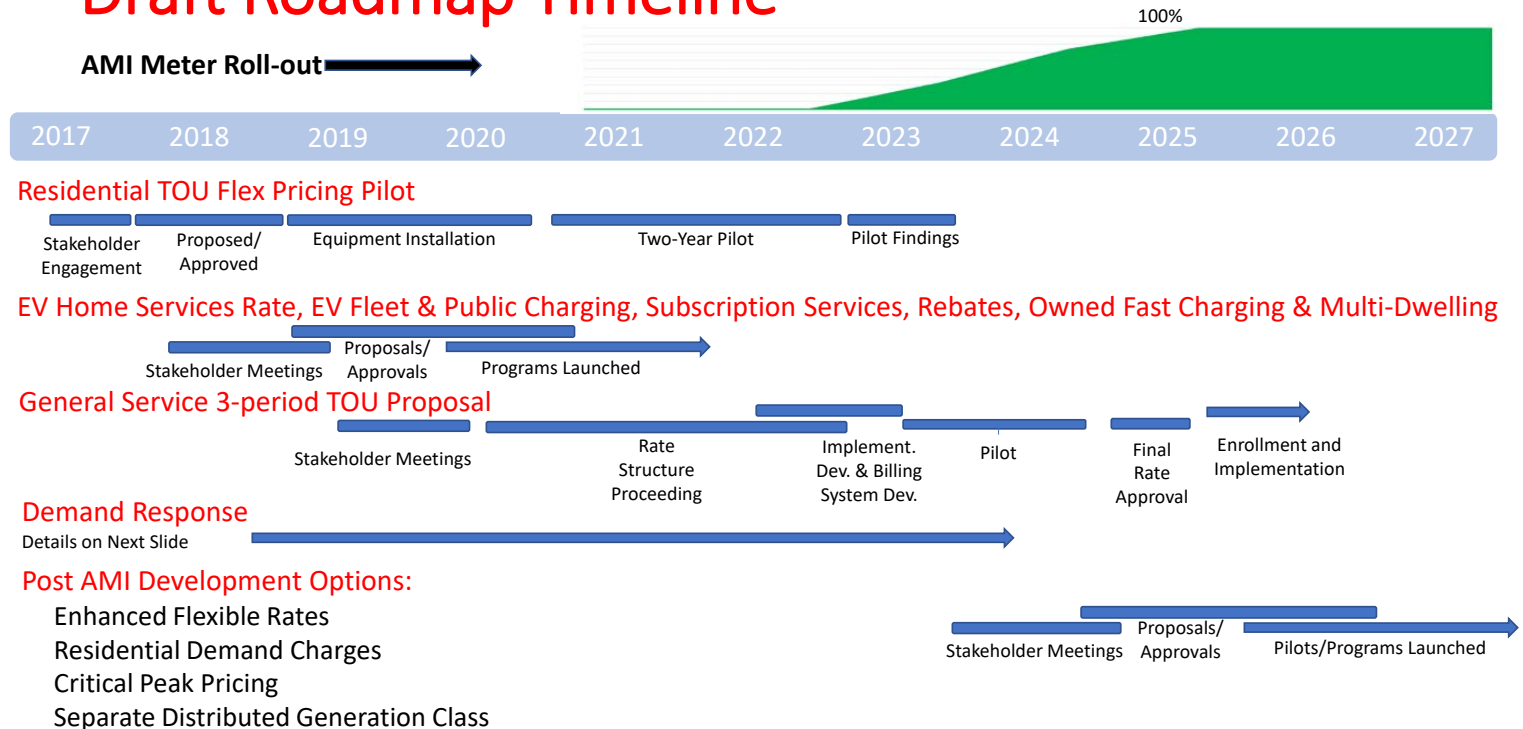
### Renewable\*Connect

- Design renewable product that doesn't impose costs on non-participants

### Electric Vehicle Charging Options

- Create suite of pilots to advance learnings and provide transportation electrification options

# Draft Roadmap Timeline



*From October 1, 2020 Compliance Filing in Docket No. E002/M-19-666 (Draft Rate Design Roadmap)*

# RESIDENTIAL FLEX PRICING TOU PILOT

**WAYS TO SAVE ON FLEX PRICING\***



Save \$3.50 per month:  
**Start your dishwasher before you go to bed, instead of right after dinner.**



Save \$6 per month:  
**Use small cooking appliances during weekday evening meal prep instead of your electric stove or oven.**




Save \$4 per month:  
**Do laundry on the weekends instead of weekdays right after work.**

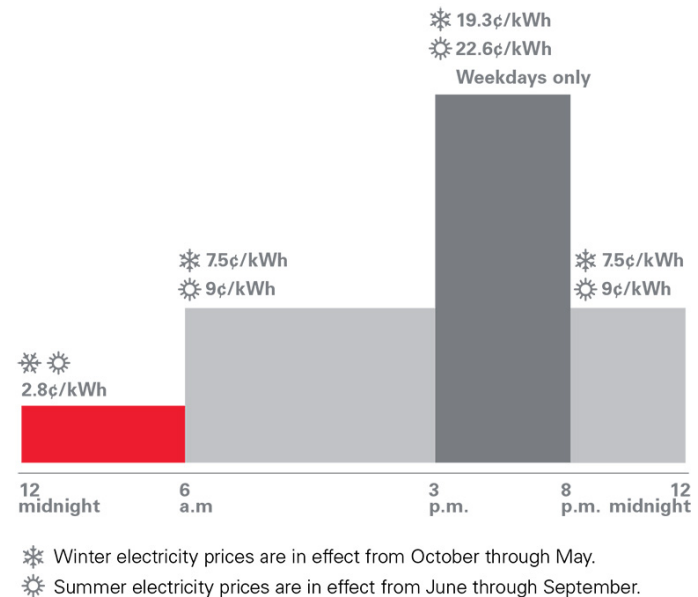
Already do these things? Keep it up and you could save money on your energy bill with Flex Pricing.

Want more ways to save?  
 Check out [xcelenergy.com/FlexPricing](https://xcelenergy.com/FlexPricing)

\*Costs and savings may vary depending on appliance mode, fuel, weather, behavior, etc. Laundry savings assume use of an electric dryer. These examples are for illustrative purposes and are not intended for estimating or calculating energy bill impacts.

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*Pilot reporting ongoing in Docket No. E002/M-17-775.*

# GENERAL SERVICE TOU PILOT Xcel Energy Proposal



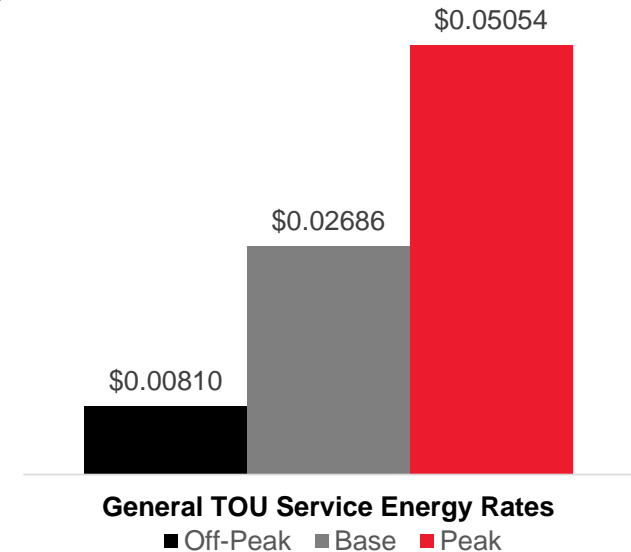
**Peak period:** 3:00pm - 8:00pm (*non-holiday weekdays*)



**Off-Peak Period:** 12:00am to 6:00am every day



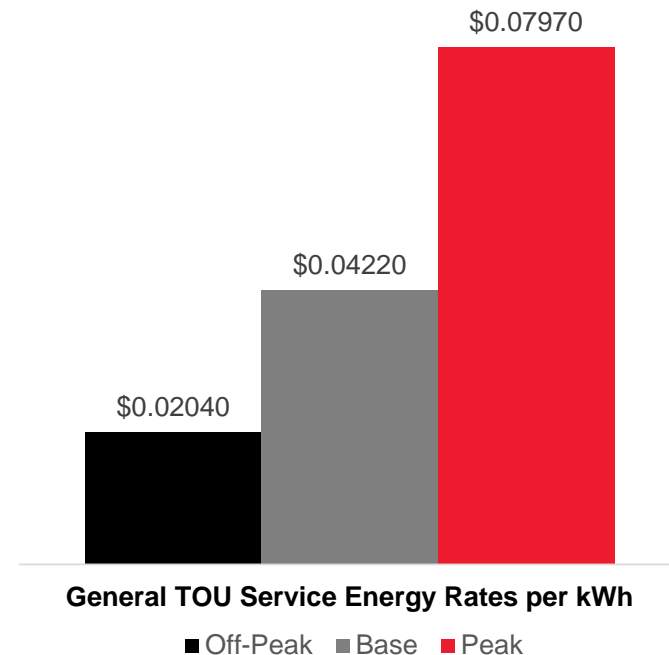
**Base Period:** All other hours



- Seasonal Base and On-peak period demand charges apply

# GENERAL SERVICE TOU PILOT Clean Energy Organizations' Proposal

- 3 Time Periods
- Energy Charges Only
- Critical Peak Pricing Rate of \$0.5588 / kWh
- CPP to be run through Demand-Side Management



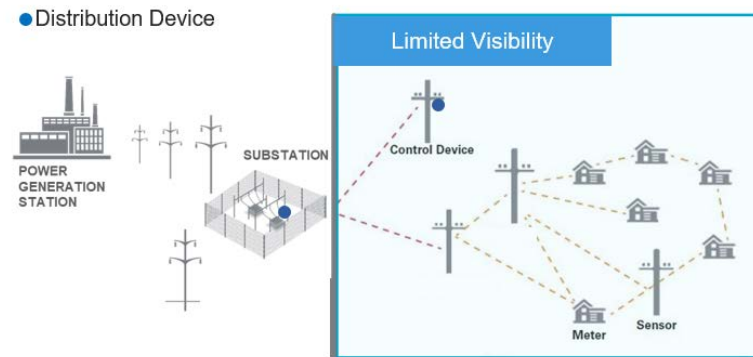


# LEVERAGING AMI FOR GRID OPERATIONS

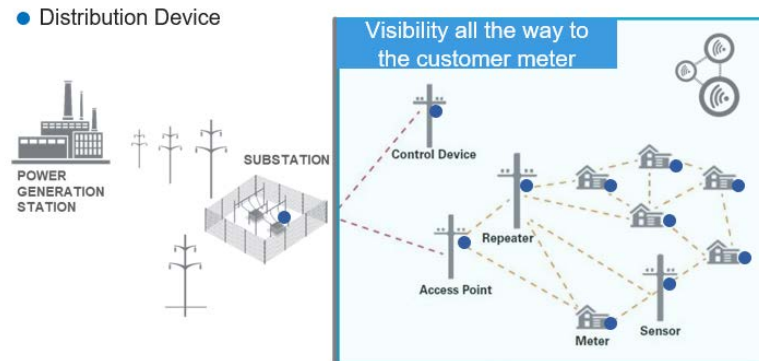
***Raymond Mauya, Program Manager, AMI***

# DISTRIBUTION GRID VISIBILITY

BEFORE

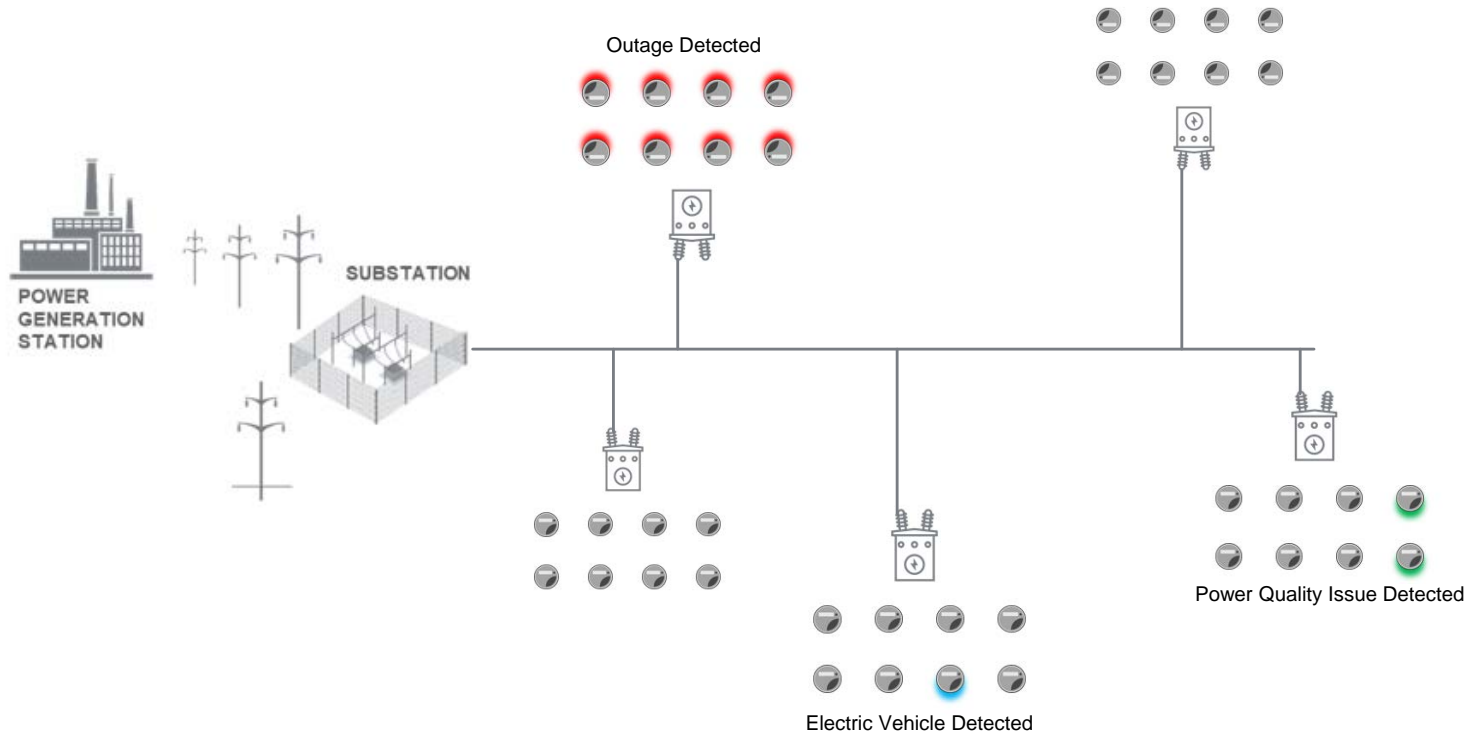


AFTER





# DISTRIBUTION GRID VISIBILITY



## AMI USE CASE OPTIONS

	AMI without DI	AMI with DI
Data Sampling Frequency	15 minute	< 1 Second
Data Analytics	Deployment of back-office analytics on 15-minute data	Deployment of DI applications that perform on the meter analytics and processing of sub one second data
Use Cases	Supports use cases that do not require sub-second data and/or lower accuracy results	Supports use cases that require sub-second data and/or more accurate results

## AMI USE CASE EXAMPLES

Outage Notifications

Transformer Load Management

Power Quality Improvements

Momentary Outages

High Impedance Detection (DI)

Location Awareness (DI)

EV Detection (DI)

# OUTAGE NOTIFICATIONS

## Outage Notification

- Last gasp, power restoration, and ping capabilities
- Integration with outage management system

## Result

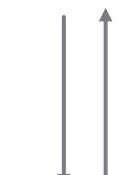
- Improved outage awareness and response

## Benefit

- Improved reliability for customers
- Cost savings during storm events

## Outage Management System

The screenshot shows the 'Outage Management System' interface. It includes a header with 'Trouble Info' and navigation tabs. Below the header, there are search filters for 'Event #', 'Region', 'Event Date', 'Event Device', 'Device Type', and 'On/Off'. A 'Filter All' button is also present. The main section is a table titled 'Customers' with columns: 'Cust #', 'Device', 'Name', 'Address', 'Account #', 'Life Support', 'Meter #', 'Primary #', 'Phase', and 'Group'. The table lists several customers affected by an outage, including 'JAMES R CAMP' and 'JAMES R CAMP'.



AMI Meters

# TRANSFORMER LOAD MANAGEMENT

## Transformer Load Management

- Aggregation of AMI interval data

## Result

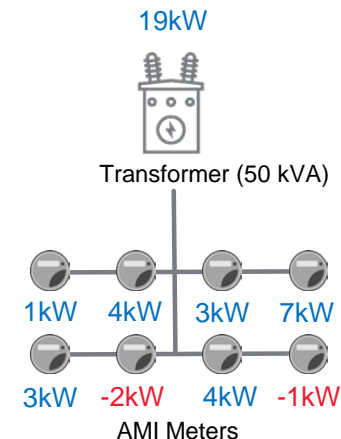
- Interval power usage on transformers (and other assets)

## Outcome

- Accurate power usage on transformers
- Proactive replacement of assets that are at or above capacity

## Benefits

- Improved infrastructure planning
- Proactively prevent outages and enhance service quality for customers



# POWER QUALITY IMPROVEMENTS

## Power Quality Improvements

- Interval voltage data
- Power quality data

## Result

- Improved service quality awareness

## Benefit

- Proactively enhance service quality for customers



# MOMENTARY OUTAGES

## Momentary Outages

- AMI meters send notification when voltage is below voltage threshold
- Additional analytics to filter voltage sags

## Result

- Improved momentary outage awareness

## Benefit

- Enhanced momentary outage reporting
- Proactively prevent outages and enhance service quality for customers



# HIGH IMPEDANCE DETECTION (DI)

## High Impedance Detection Application

- Detects deteriorating or loose connections
- Not possible with non-DI AMI solutions

## Result

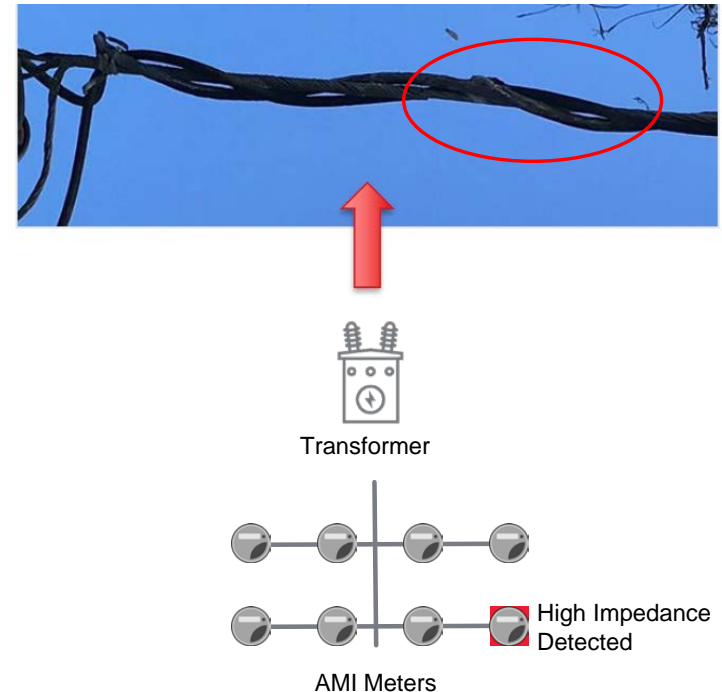
- Event notification of a High Impedance event

## Outcome

- Dispatch field crews to location and address issue

## Benefits

- Proactively prevent outages and enhance service quality for customers





# LOCATION AWARENESS (DI)

## DI Location Awareness Application

- Detects meters connected to a transformer based on a sub-second data
- Requires significant less back-office infrastructure and data science expertise than non-DI AMI solutions

## Result

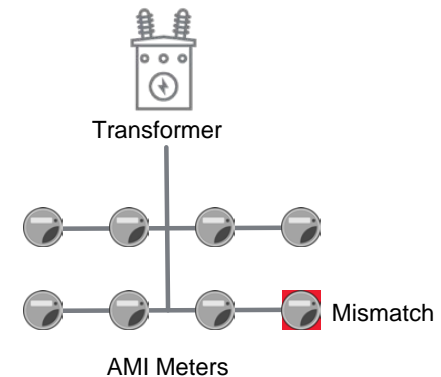
- Comparison to asset information in GIS

## Outcome

- Update GIS with correct asset information (for mismatches)

## Benefits

- Improved planning, operations, and customer outage communication



# EV DETECTION (DI)

## DI EV Detection Application

- Detects electric vehicles based on sub-second data
- Requires significant less back-office infrastructure and data science expertise than non-DI AMI solutions

## Result

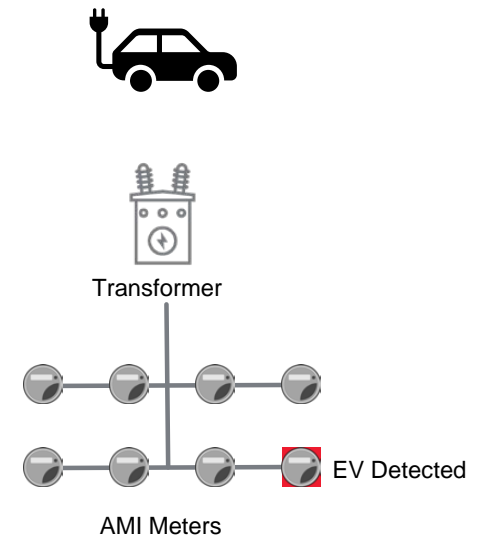
- Event notification of electric vehicle

## Outcome

- Accurate records and power consumption for electric vehicles

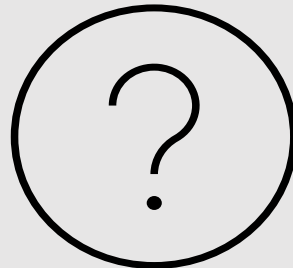
## Benefits

- Improved infrastructure planning for electric vehicles





QUESTIONS?





## CERTIFICATE OF SERVICE

I, Christine Schwartz, hereby certify that I have this day served copies of the foregoing document on the attached list of persons.

xx by depositing a true and correct copy thereof, properly enveloped  
with postage paid in the United States mail at Minneapolis, Minnesota

xx electronic filing

**Docket Nos.        E002/M-20-680**  
**E002/M-21-694**

Dated this 4th day of August 2022

/s/

---

Christine Schwartz

[illegible]

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Kenneth A.	Colburn	kcolburn@symbioticstrategies.com	Symbiotic Strategies, LLC	26 Winton Road  Meredith, NH 32535413	Electronic Service	No	OFF_SL_20-680_Official
Generic Notice	Commerce Attorneys	commerce.attorneys@ag.state.mn.us	Office of the Attorney General-DOC	445 Minnesota Street Suite 1400  St. Paul, MN 55101	Electronic Service	Yes	OFF_SL_20-680_Official
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Brooke	Cooper	bcooper@allete.com	Minnesota Power	30 W Superior St  Duluth, MN 558022191	Electronic Service	No	OFF_SL_20-680_Official
George	Crocker	gwillc@nawo.org	North American Water Office	PO Box 174  Lake Elmo, MN 55042	Electronic Service	No	OFF_SL_20-680_Official



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Curt	Dieren	curt.dieren@dgr.com	L&O Power Cooperative	1302 S Union St  Rock Rapids, IA 51246	Electronic Service	No	OFF_SL_20-680_Official
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Generic Notice	Commerce Attorneys	commerce.attorneys@ag.state.mn.us	Office of the Attorney General-DOC	445 Minnesota Street Suite 1400  St. Paul, MN 55101	Electronic Service	Yes	OFF_SL_21-814_M-21-814
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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David	Dahlberg	davedahlberg@nweco.com	Northwestern Wisconsin Electric Company	P.O. Box 9 104 South Pine Street Grantsburg, WI 548400009	Electronic Service	No	OFF_SL_21-814_M-21-814
James	Denniston	james.r.denniston@xcenergy.com	Xcel Energy Services, Inc.	414 Nicollet Mall, 401-8  Minneapolis, MN 55401	Electronic Service	No	OFF_SL_21-814_M-21-814
Curt	Dieren	curt.dieren@dgr.com	L&O Power Cooperative	1302 S Union St  Rock Rapids, IA 51246	Electronic Service	No	OFF_SL_21-814_M-21-814
Carlton	Doyle Fontaine	carlton.doyle.fontaine@senate.mn	MN Senate	75 Rev Dr Martin Luther King Jr Blvd Room G-17 St Paul, MN 55155	Electronic Service	No	OFF_SL_21-814_M-21-814
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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Generic Notice	Residential Utilities Division	residential.utilities@ag.state.mn.us	Office of the Attorney General-RUD	1400 BRM Tower 445 Minnesota St St. Paul, MN 551012131	Electronic Service	Yes	OFF_SL_21-814_M-21-814
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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