CITY OF CHARLEVOIX

Agenda
City of Charlevoix City Council Regular Meeting
Monday, September 18, 2023 - 5:15 PM
Council Chambers, 210 State Street, Charlevoix, MI

1. **Call to Order**
2. **Presentations**
   A. Technology Work Plan- Electric Department
      Kyle Kopczyk
3. **Public Comment**
4. **Adjourn**

Persons with disabilities who need an accommodation to fully participate in these meetings should contact the City Clerk's Office at 231-547-3250 or by email clerk@charlevoixmi.gov. A 24-hour notice may be needed for certain accommodations. An attempt will be made to grant all reasonable accommodations requests.

Charlevoix City Council

Presentations

Title: Technology Work Plan- Electric Department
Date: September 18, 2023

Presented By: Kyle Kopczyk

Background:
Power System Engineering was selected as the consultant for the City of Charlevoix's Automated Metering Infrastructure (AMI) project. Included in their proposal was the development of a Technology Work Plan (TWP). The plan started with an evaluation of Charlevoix's current technologies, systems, and assets. The following step determines the desired future state of Charlevoix and its use of technology. Step three was used to identify the gaps between the current state of technology and the desired future state. Finally, PSE has provided recommendations to address these gaps. PSE's recommendations address future and current investments, transition and integration strategies, interdepartmental agreements, an implementation schedule, and a five-year capital and maintenance budget.

Mr. Kyle Kopczyk will present the TWP on behalf of Power System Engineering. Kyle holds a Bachelor of Science degree in Electrical Engineering from Michigan Technological University, Houghton, Michigan. He also holds a Masters in Business Administration degree from the University of Minnesota, Minneapolis, Minnesota. He had ten years' of experience in the utility industry prior to joining Power System Engineering.

Recommendation:

Attachments:
1. Charlevoix TWP Final




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Technology Work Plan

Recommendations

CHARLEVOIX

Forward-Thinking Professionals
Helping Clients and Colleagues **ACHIEVE** Their **Goals.**

www.powersystem.org

Kyle Kopczyk

September 18th 2023

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Project Goals and Business Drivers

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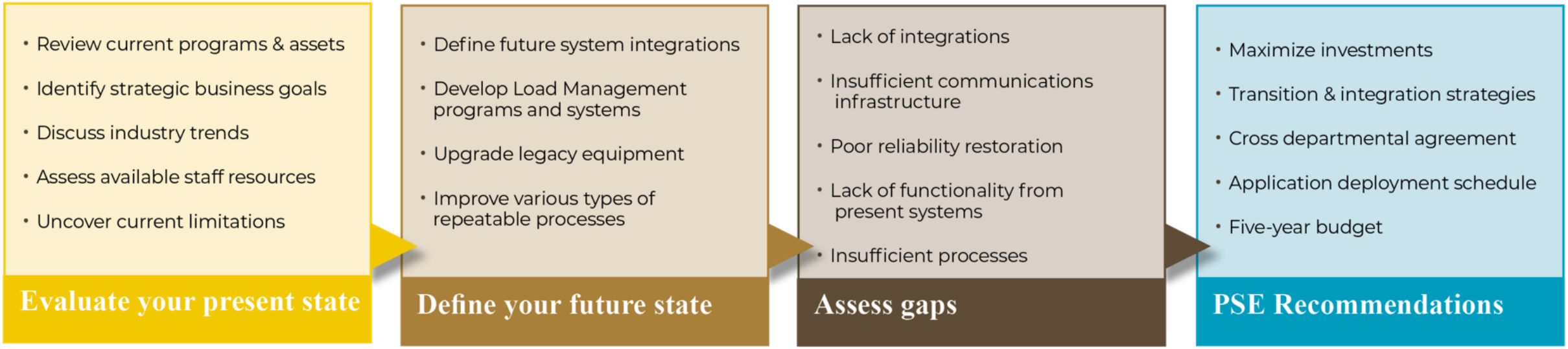
Developing a Technology Work Plan (TWP)

Below is the process that PSE follows for technology work plan development.



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Business Driver Comparison – Current Level of Performance

Poor / Low | Ok | Good / High

Category	Current Performance	Current Level of Importance
Reliability	Good	High
Consumer Services / Engagement	Ok - Good	High
Utility Costs and Impact	Ok	Medium
Utility Wide / IT	Ok	High
DER / EV	Ok - Good	Low - Medium
System Integrations	Ok	High
Data Analytics and Visualizations	Poor	Medium - High

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Desired Future State, Use Cases, and Gaps

The Desired Future State is defined by the ability to support use cases. We will work with you to define use cases that meet your future needs. Strength in using existing systems.

- Integration(s)
  - What is done today?
  - How and how often?
  - Systems not integrated?
- Outage Handling / OMS
  - Accurate prediction & dispatch
  - Fault location
  - OMS customer communications
- GIS
  - Utility Network
  - OMS through GIS?
- AMI
  - AMI Interval Reading (make adjustments?)
  - System reporting
  - Data extraction
- Billing and Customer Service
  - Rates and complaints
  - Visibility to data and being proactive
- Data Analytics and Business Intelligence
  - Summary and detailed data correlations
  - Actionable intelligence
  - Customized and relatable

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AMI

Reliability
Consumer Services
Utility Costs and Impact
Utility Wide
DER/EV
System Integrations
Data Analytics

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TWP Areas of Interest – AMI

PSE perceptions:

- More information is being requested from consumers which cannot be fulfilled by the current system
- There is less visibility into areas of concern
  - Water leaks
  - Frozen pipes and bursts in seasonal locations
  - Transformer loading and health
  - High bill complaints
  - Voltage and power quality requests
- Pursuing AMI is strongly recommended to close numerous data and process gaps
- Recommended maintenance of the AMI system will further increase the longevity (15+ years)

Level of Importance
High

Gap Size
High

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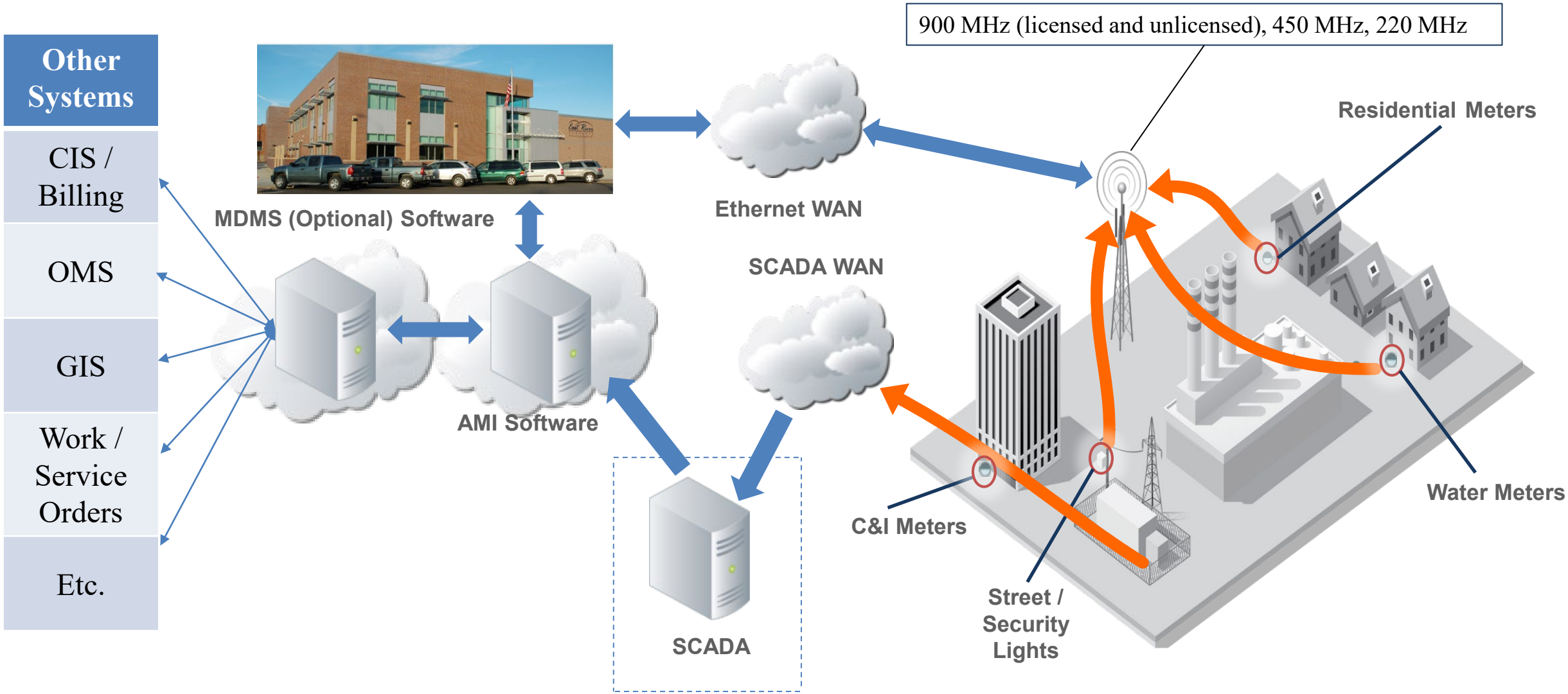
AMI – Generally Speaking



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Technology to Assess Situations

Using AMI will be key to Consumer and Utility maximizing its benefits

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Maintenance - Collectors

- Do you know where all your AMI assets are?
  - GIS is a good system of record
  - AMI also stores location information
  - Spreadsheet?
- Collectors typically have:
  - Battery back up
    - Lead-Acid vs. Lithium-Ion
  - Backhaul Communications
  - Antenna and Coax
  - Weather Resistant Enclosure
  - Mounting Hardware
  - Firmware

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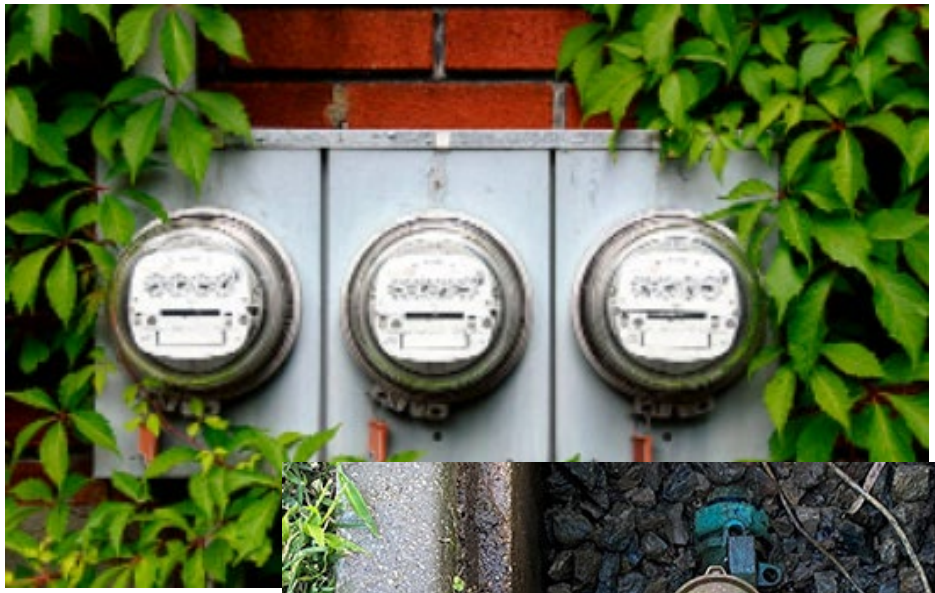
Maintenance - Endpoints

- Meters and Modules typically have:
  - A Super Cap (for electric)
    - Outages
  - Battery (for water)
    - Readings, events, etc.
  - Weather Resistant Enclosure
  - An AMI Communication Module
    - AMI or Cellular Network (or both)
  - Firmware for the Module
  - Firmware for the Meter
  - Also for Load Management, Street Lights, & DA



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Maintenance - Software

- Software will depend on the installation:
  - SaaS
    - Updates to OS, Hardware, Security – All Included (if not, we should talk)
    - Meter/Module Firmware
    - AMI Software Updates
  - On-Prem
    - Updates to OS, Hardware, Security – Utility Responsibility
    - Meter/Module Firmware – Maybe be Pushed from AMI, Sometimes the Utility
    - AMI Software Updates – Could be AMI, Could be Utility
      - Check your SLA and Support Agreement
  - Firmware is sometimes tied to software updates

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AMI Recommendations

- Deploy AMI system to enhance the data and education to consumers
  - Reporting, billing, outage & restoration, leaks, etc.
- Further support the Utility needs (engineering/operations, field crew, etc.)
  - Transformer loading and EV detection
  - Time of Use and other complex billing options
  - Reverse leak detect (which did not open taps during cold spell)
- AMI will be the field data collections and there will be a lot which can be done
  - Reporting
  - Integration
  - Maintanence and operation of the system

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Communications

Utility Wide

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TWP Areas of Interest – Communications

PSE perceptions:

- The city owned and maintained fiber is a strong asset to continue to use and leverage
- Having AMI collection points will be beneficial, but do not build miles and miles of new strands just for AMI. A cellular network will work well for the data requirements.
- 5G and LEO (Starlink) may become a market disruptor (5G more likely) for the City residents vs. the City's daily operations.
- Do **not** recommend a fiber to the home project unless considerably more thought, potential execution planning, and near & future financial assessment is done

Level of Importance
High

Gap Size
Low

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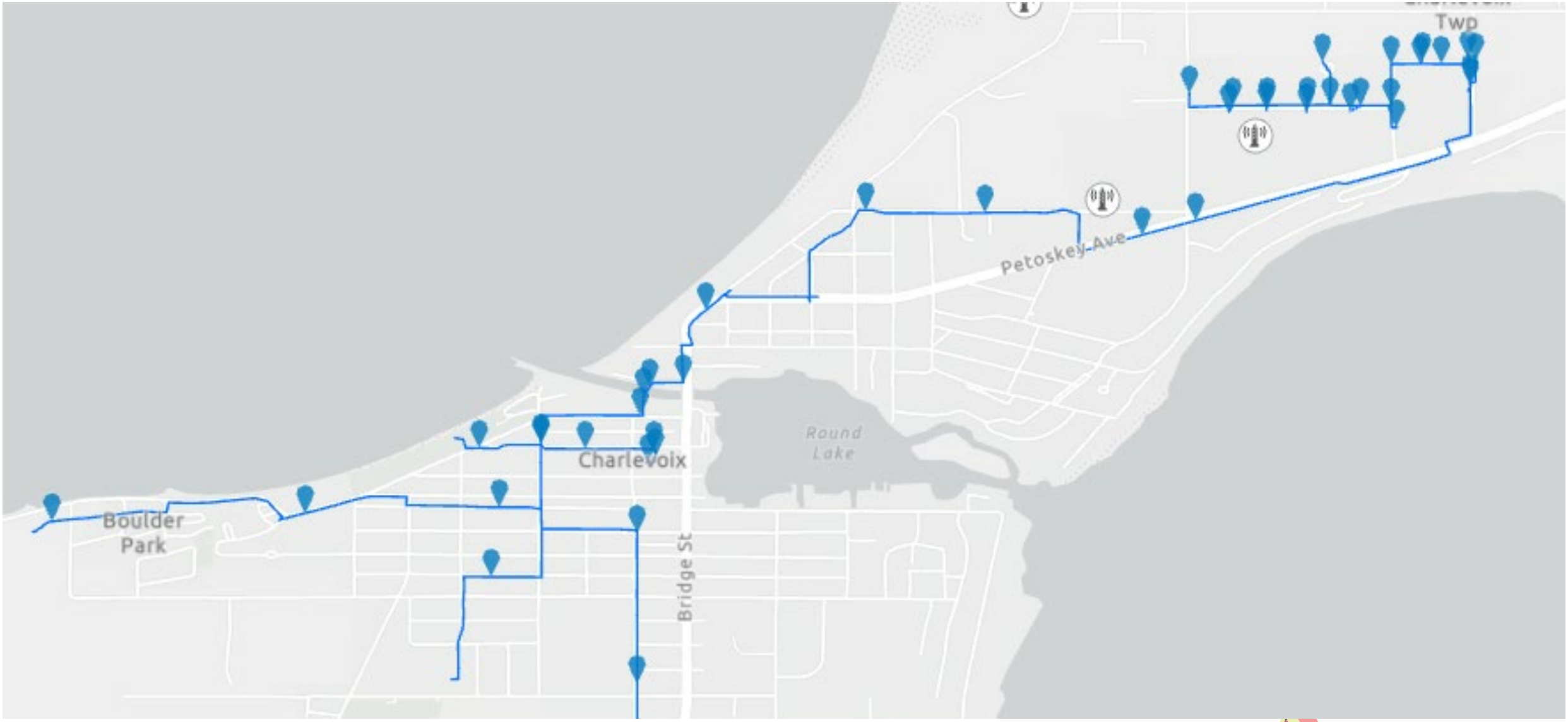
Fiber Connection



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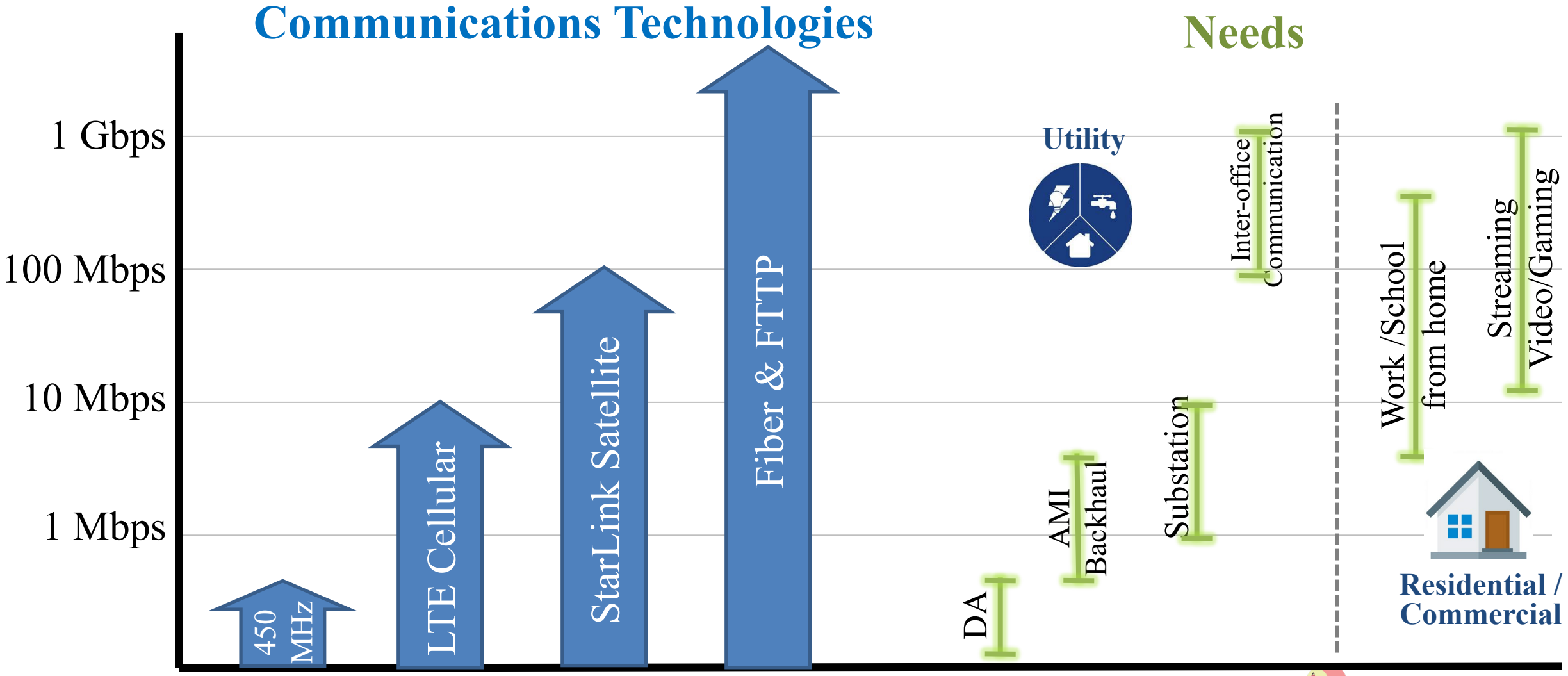
Communications Performance & Requirements

Aligning the technology with the need allows for smart investment.



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Fixed Assets Alternatives

- Fiber
- Leased circuits
- Microwave
- Point to multipoint radio (coop owned)
  - Licensed
  - Unlicensed
- Satellite
  - GEO
  - LEO (emerging)
- Cellular (3G, LTE, 4G, 5G)
- Point to multipoint radio (coop owned)
  - Licensed
  - Unlicensed
- Broadband
  - Wireless
  - Fixed

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Market Disrupters – 5G

- Wireless will have an impact on the use of fiber
  - Wireless carriers will require more attachments (equipment and poles)
  - Wireless carriers will require substantial fiber backhaul (5G deployment and 4G cell densification)
    - Potential to lease dark fiber or lease
    - Potential for joint builds
- Wireless carriers will better position themselves as and alternative to utility owned Field Area Networks (FAN)
  - Higher speed and higher capacity than traditional utility point-to-multipoint wireless options
  - May offer lower costs than utility owned and operated fiber
  - Reduces utility control of availability and performance

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Market Disrupters - LEO

- Wireless carriers are positioning themselves as an alternative for wired (fiber, coax, cooper) broadband services. Impact is not just with 5G, also includes
  - White space, 2.4 GHz, 5.8 GHz, other
  - 3.65 GHz CBRS (Citizens Band Radio Service)
  - Low Earth Orbiting (LEO) Satellite,10 announced initiatives including:
    - Eutelsat (IOT, M2M)
    - Iridium upgrade (maritime, aviation, government, IOT, M2M)
    - LeoSat (broadband)
    - Oneweb (5G backhaul, 5G cells for broadband)
    - SpaceX Starlink (broadband)
    - Telesat (maritime, aviation, government, cellular backhaul)

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AMI Recommendations

- Leverage fiber as a backhaul for AMI and Distribution Automation where available
  - If near a splice point and area where fiber is accessible
  - Make sure the AMI and DA traffic are separated from other City traffic (IT)
- We do not recommend a fiber to the home/premises currently
  - There are too many financial risks and unknowns to make a good recommendation
  - A full impact study would be needed to further assess the viability
- Cellular for AMI and DA are viable options where other communication is not available.
  - Long term cellular costs are likely less than the capital for new fiber layouts, unless there are additional supporting use cases

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Billing and Service

Consumer Services and Engagement
Utility Costs and Impacts
Utility Wide
System Integrations
Data Analytics

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TWP Areas of Interest – CIS and Billing

PSE perceptions:

- CIS is ok, but lack of integration work is a struggle
  - Billing township read water/sewer meters **was** a manual process
- As a new CIS is put in place:
  - Focus on the training and how AMI might complicate billing, meter exchange, processing billing, go-live dates, and historical records
  - Will the account numbers change and what about the meter(s) associated to the account?
  - AMI integration is still a flat file, but this likely is a scope change for integration work. We will need to address this with the new CIS, old CIS and Aclara
- Consumer portal would be ideal for future application
  - Wait until the AMI is nearer completion to target a portal
  - Consider payment processing through vendors and not through the City

Level of Importance
High

Gap Size
Medium

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TWP Areas of Interest – Member Engagement and Interactions

PSE perceptions:

- General outreach and social media messages all working well
  - Internal redundancy for posting and responding to messages
- Facebook and twitter are ok tools
  - Twitter for immediate responses
  - Facebook more generalized and informational
- As more consumers engage on Social Media, is the current setup sustainable?

Level of Importance
Low

Gap
Small

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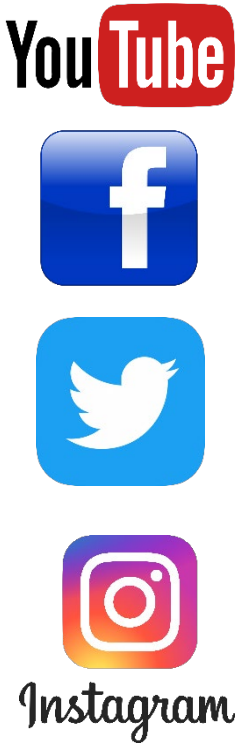
Member Services Communications

- What is your goal for using Social Media?
- What platforms are you currently using for member outreach?
  - New services and programs (new rate or appliance rebates)?
  - Outage and restore
  - New members vs. current/long-term
  - General updates and on-goings
- What platforms are your members using to interact with Charlevoix?
  - Social media?
  - Google/Yelp reviews?
  - Email?
  - Phone?
  - YouTube?



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Member Services Communications

- What do you see the role of Social Media playing in:
  - Customer Outreach (new and old)
  - Charlevoix's "brand"
  - Strategic communications
- What Apps and Social Media platforms do you currently use?
  - Facebook? Instagram? WhatsApp?
  - NISC
  - Email?
  - Phone/Text
- Do you use any "bots" or automated responses?
- Do you confirm followers or members interacting on Social Media?
- How do you address negative posts or messages? (Is silence better than a response?)

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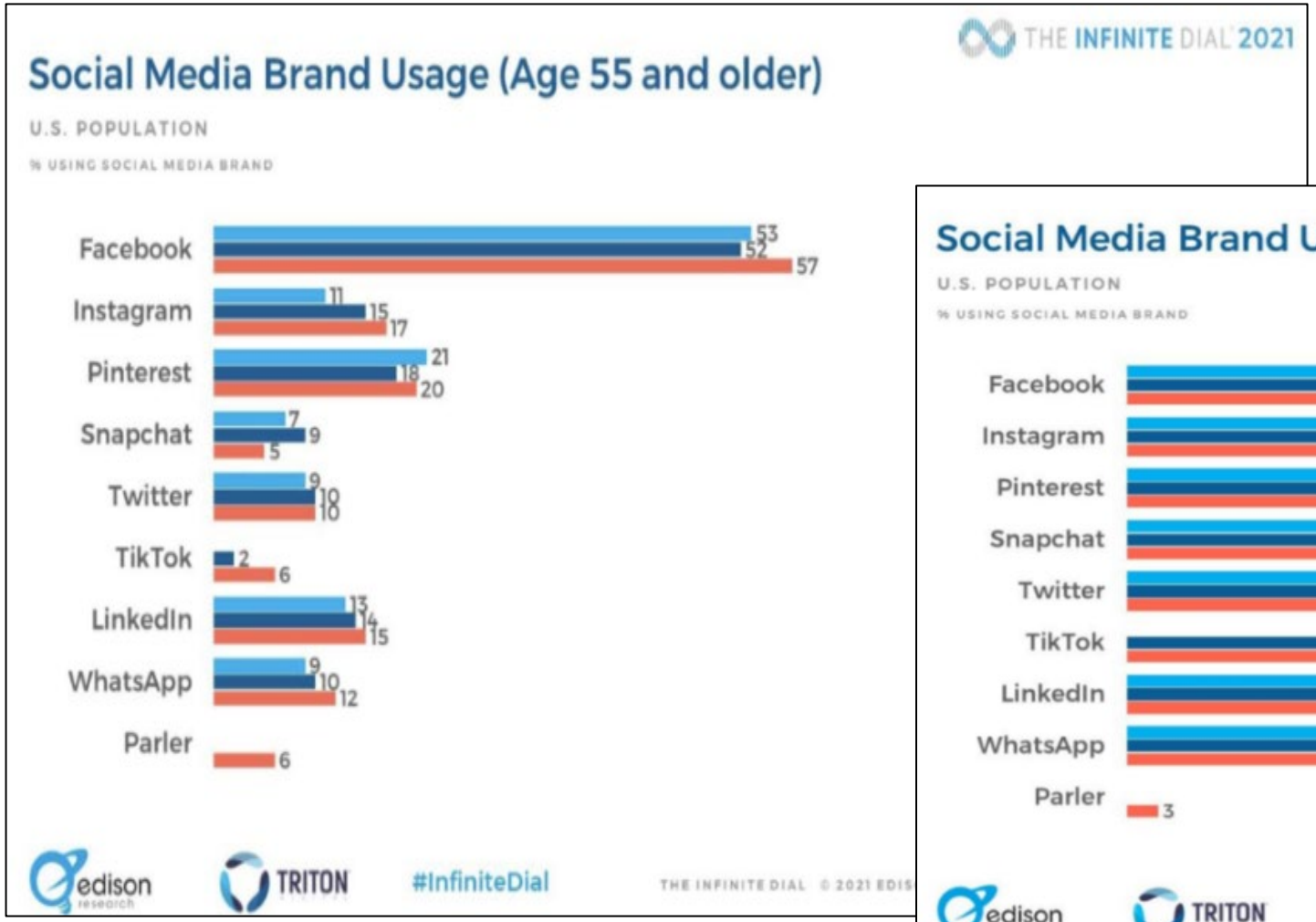
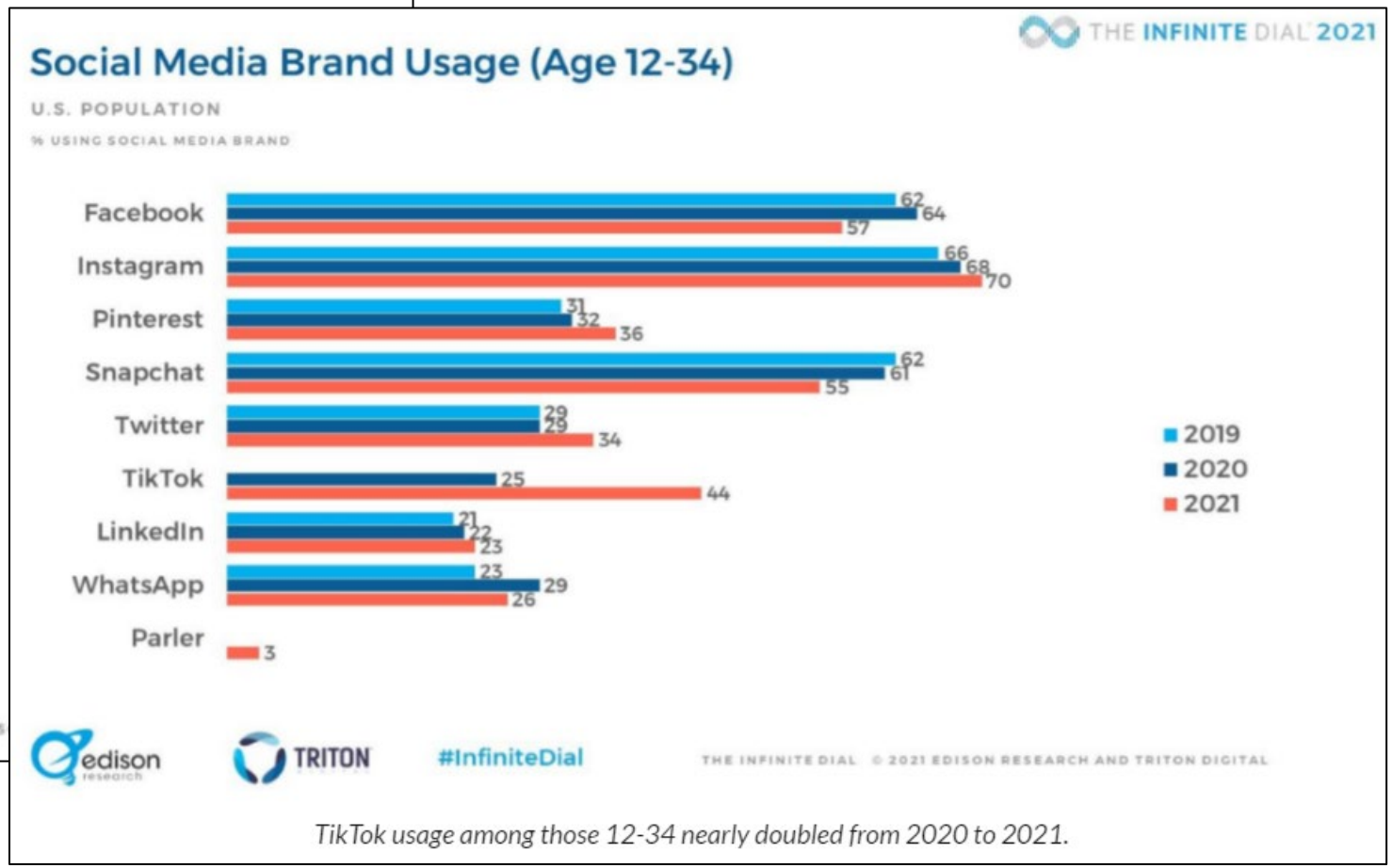
Using Technology





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Pre-paid Metering Overview

- Typical Components
  - AMI system
  - Prepayment system integrated with CIS
  - Means to notify customers of balance status (web site, phone, IVR)
  - Means for customers to pay remotely (web, IVR, kiosk)
  - Remote disconnect switch or demand limiting for habitual offenders

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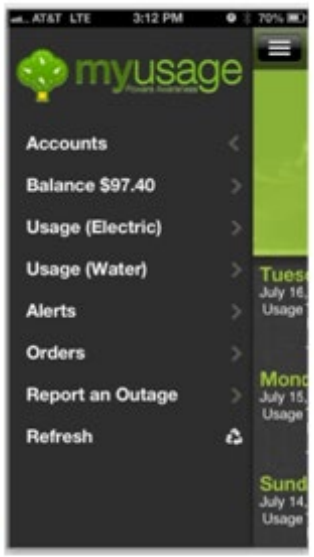
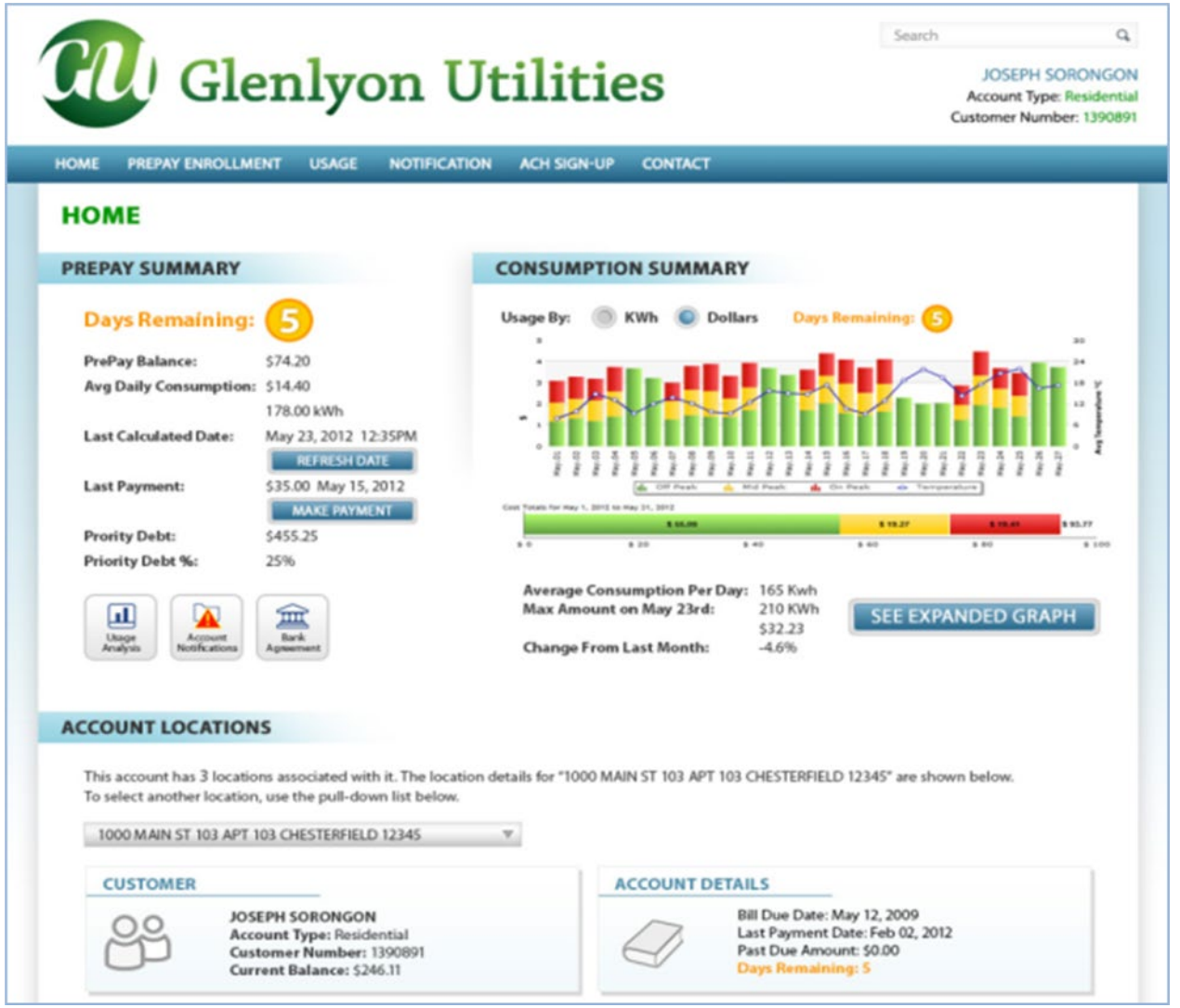
Pre-paid Metering Subscriber Screen Samples Example 1





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Hourly Meter Consumption (kWh) by Meter

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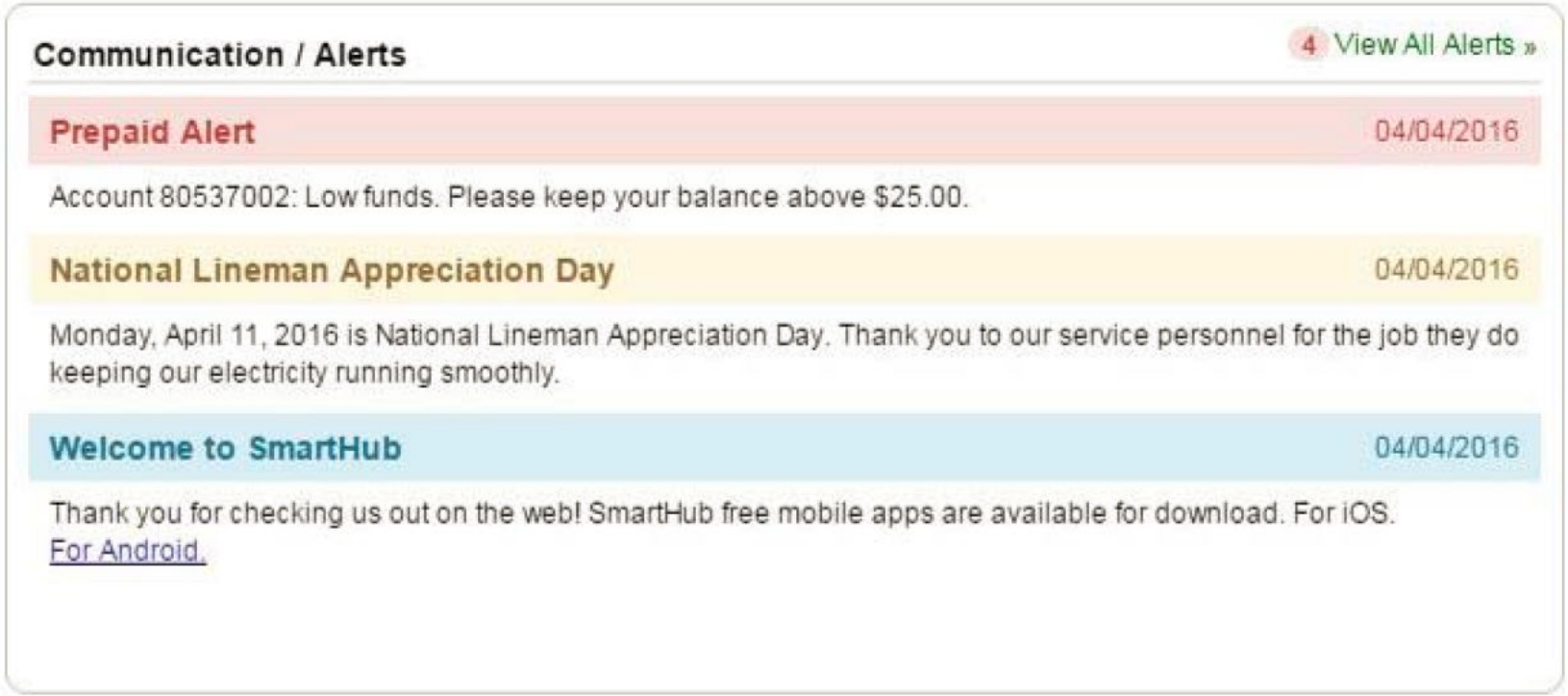
Reminders and Alerts



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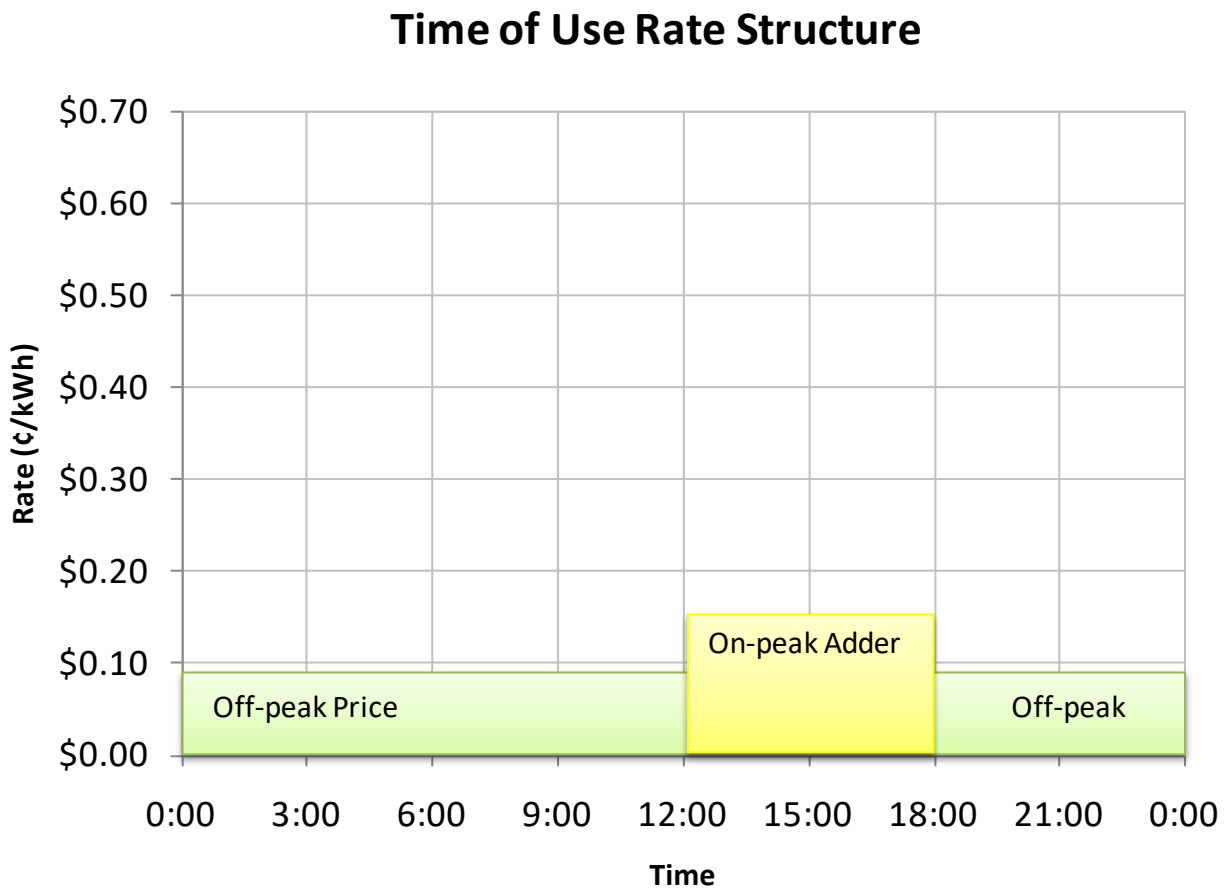
Support for Time of Use (TOU) Pricing

Differentiated prices at pre-set time of day.



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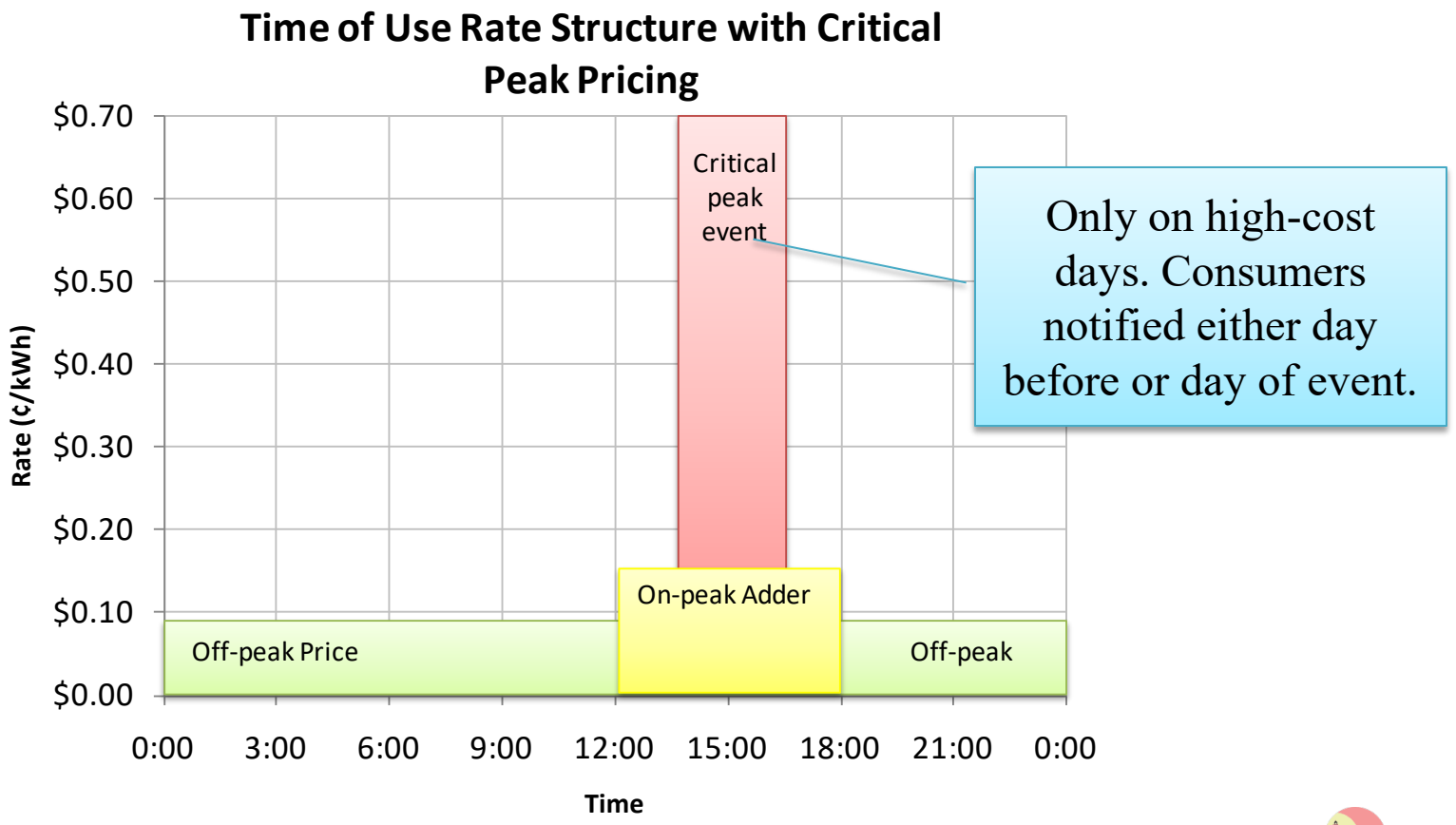
Critical Peak Pricing (CPP) Support

High price in a focused time period during select days.

- Ratio of CPP to off-peak prices can be as high as 10!



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CIS/Billing Recommendations

- A new CIS to support complex billing rates will be valuable
  - Time of Use (heavy peak loads, EVs, C&I, residential, Etc.)
  - Critical peak pricing
  - Support of net and reverse meter readings for DG
- Explore a Customer Portal through the new CIS
  - Or we can provide additional options
- Consider the complexities to deploying AMI and CIS at the same time
  - Multiple integrations and Multiple systems or record
  - Meter exchange process
  - Billing processing and new system training
  - New file processing for Township read water meters

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Engagement Recommendations

- Use current platforms (Twitter, Mailers, Facebook) to provide updates
  - Younger and seasonal may look to social media before calling the office
- Engagement does not need to be a constant feed
  - Consistent messages
  - Supports and represents the Utility and City well
  - Important information
    - Outage and restore (“we know about it and addressing”
    - Potential water line freezing
    - Etc.

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GIS

Reliability
Consumer Services
Utility Wide
System Integrations
Data Analytics

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TWP Areas of Interest – GIS

PSE perceptions:

- GIS is getting much better in usability and field functionality
  - Continue using and building familiarity with the tools
- The ability to use GIS for outage and restore
  - Fed from AMI and their ‘real-time’ (needs to be defined) API
  - This can replace an OMS by giving visibility to outage and restored devices
- Potential future applications for Asset Management, System and Connectivity Model (Utility Network for Electric and Water), and other applications

Level of Importance
High

Gap Size
Low - Medium

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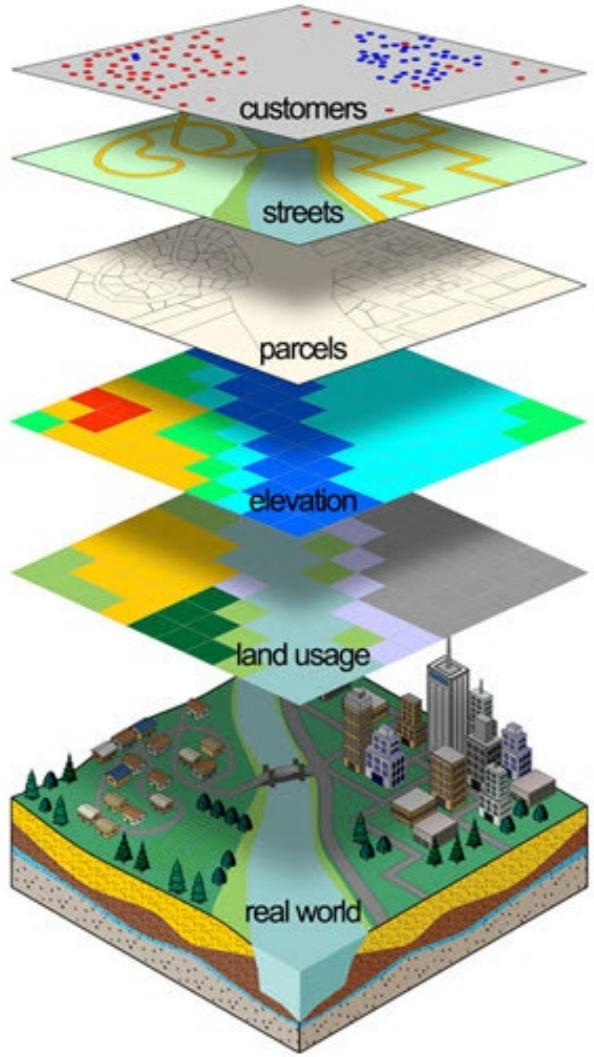
Aspects of GIS

- Visualizing Data:
  - Geographic data that is stored and then displayed
- Combining Data:
  - Layers are built and combined to form the visualization
- Extracting Information:
  - Search or query data in layers
- Integration:
  - Incorporating information from other data sources to build better visual layers

GIS is ideal for seeing the system(s); it is only as good as the information entered



Source: Westfield State University

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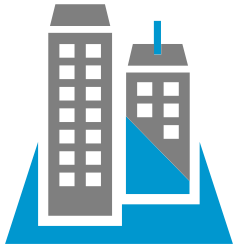
Use Case - General Visibility



Technology

- ArcGIS Enterprise
- ArcGIS Pro
- ArcGIS Portal
- ArcGIS Field Maps

Personnel

- GIS Analyst
  - Light loading for periodic updates.

Data Sources

- Electric Assets
- Water Assets
- Gas Assets
- Parcels & Easements
- Aerial Imagery

Deliverables

- Web Mapping App

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Use Case - Distribution Planning

New Route/Load Planning

Technology

- ArcGIS Enterprise
- ArcGIS Pro
- FME
  (for a WindMil export)

Personnel

GIS Analyst
- As needed for new data requests

Planning Engineer
- Moderate use for analysis

Data Sources

- Electric Assets
- Roads and Water
- Parcels & Easements
- Aerial Imagery & LiDAR
- Reliability Information

Deliverables

Web Mapping App & Pro
- Preliminary Route Analysis
- Reliability Analysis

WindMil model

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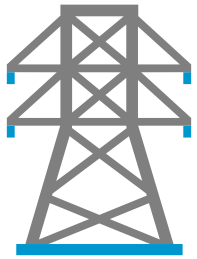
Use Case - Engineering Line Design



Preliminary Route Survey, Route Design, Construction & As-Built

Technology

- ArcGIS Enterprise
- ArcGIS Pro
- AutoCAD

Personnel

GIS Analyst
- As needed for new data requests

Design Engineer
- Moderate use for analysis. Not additional beyond

Data Sources

Primary
- Electric Assets
- Roads and Water
- Parcels & Easements
- Aerial Imagery & LiDAR

Deliverables

Direct access to GIS in CAD

Web Mapping App & Pro
- Preliminary Route Survey
- Route Design

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GIS Data to Feed Line Design

Technology Stack

PLS-CADD

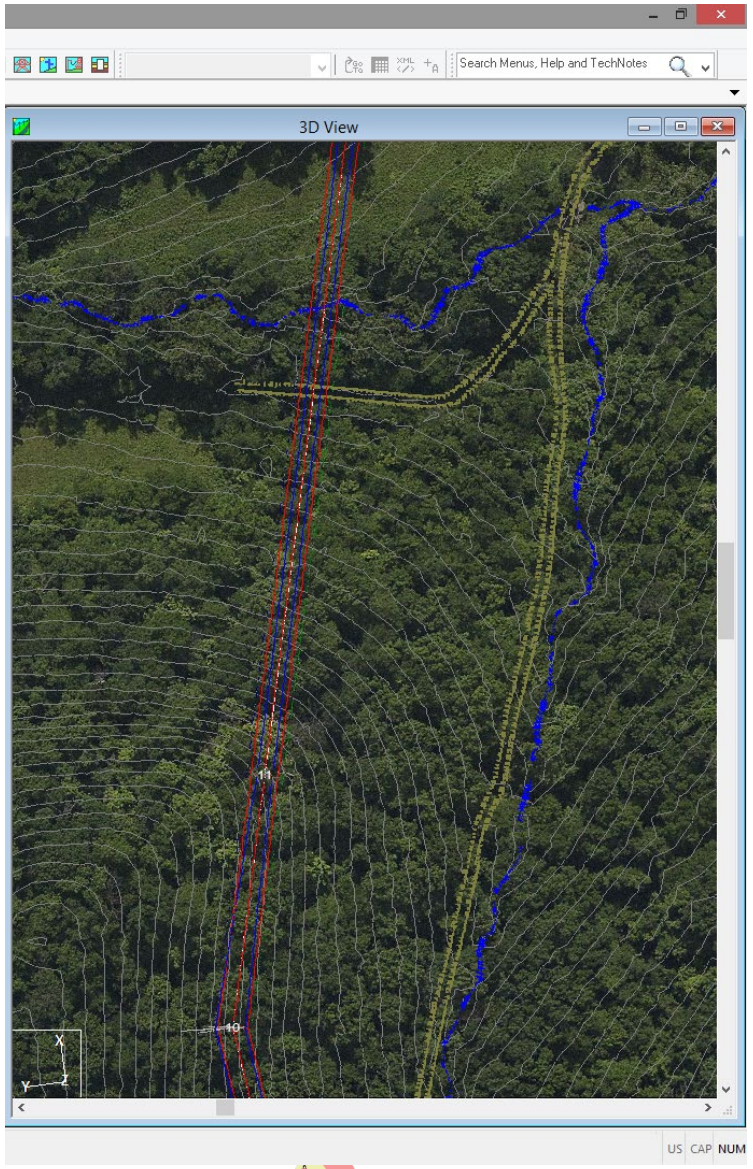
- Detailed Design
- Final Deliverables

ArcGIS Pro

- Data Review
- Pre-planning
- Mapping
- Spatial Adjustment

Data Sources

- Utility Line Data
- Easements & Right-of-way
- Statewide LiDAR
- County aerial imagery
- Original P&Ps and CAD



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Use Case - Operations

Guiding Crews Managing Events

Technology

- ArcGIS Enterprise
- Portal for ArcGIS
- ArcGIS Field Maps

Personnel

GIS Analyst
- Minimal need

Operations Staff
- Users with no additional tasks beyond today

Data Sources

- Electric Assets
- Water Assets
- Gas Assets
- Roads and Water
- Aerial Imagery

Deliverables

ArcGIS Field Maps
- UN tracing
- Construction unit identification
- Form-based data collection

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GIS Recommendations

- Continue to use and train on the ArcGIS Online GIS
  - Data collection
  - Field updates
  - Further adding layers of new endpoints (AMI)
- Maintenance mode is much better than clean up mode
  - Stay up to date on the database, administrative tasks and overall GIS health
- Utility Network maybe something to explore in the much longer term
  - Enables system modeling, outage management predictions, water zoning, etc.
  - Not possible with ArcGIS online and can be costly – we suggest proceeding with caution to weigh the options

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Outage Handling and Leak Detect

Reliability
Consumer Services
Utility Costs and Impact
Utility Wide
System Integrations

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TWP Areas of Interest – Outage and Restoration

PSE perceptions:

- First move to using the AMI system to report, visualize, and restore services
  - Manually inspect and assess issues (will always be the case)
- Separate into two areas
  - ‘Real-Time’ reporting, assessment, and restore
  - After the fact reporting – outage and reliability reporting
- Accuracy in reporting outages and time is important
  - Don’t get penalized for mis-managed data
- GIS and UN next step before finally looking towards an ‘out-of-the-box” solution

Level of Importance
High

Gap Size
Large

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TWP Areas of Interest – Water Leaks

PSE perceptions:

- First move to using the AMI system to report, visualize, and restore services
  - Manually inspect and assess issues (will always be the case)
- Separate into two areas
  - 'Real-Time' reporting, assessment, and addressing issue
  - After the fact reporting – time, duration, and impact reporting
- Accuracy in reporting leaks and time is important
  - Catch burst pipes and flooded premises more quickly
- Data reporting will alert to trends and recurring issues

Level of Importance
High

Gap Size
Large

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Outage Handling Goals

- Customers & Customer Service
  - Capture outages and leaks reported by phone calls
  - Outage visualization for customers
  - Notifications to customers of outage, water turn-off, restoral & estimated time
  - Internal visualization of outage and leak areas, customers
- Operations & Dispatch
  - Visualize outages and leaks from AMI and GIS (office and field)
  - Manually assess potential areas of failures
  - Assigning crews & Organizing repair efforts
  - Outage and leak tracking – # incidents, minutes out, residents out, gallons estimated lost, etc.
  - Estimated Fault Location or main breaks
- Crews and working outages and leaks
  - Crews assign themselves work based on outages or leaks reported
  - Crews get notified and have visibility to work assigned
  - Crews provide updates from the field on status / causes (GIS)
- Data
  - Better substantiation of reporting metrics and visualizations
  - Insight into true causes and how to improve reliability (comparisons)

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Customer Scenarios with an OMS

This introduction to customer capabilities will allow us to begin to discuss which are beneficial

Scenario	OMS Capabilities
Customer calls CSR	CSR is able to log the outage and provide valuable info to your customers, • Extent of the outage • Ping meter to verify • Repair Status • Estimated Repair Time • Outage History • Call History
Customer calls IVR	Phone system logs the outage call and provides feedback to the customer, • Part of an existing outage • Estimated Repair time
Customer reports outage with web portal.	Secure web portal can allow customer to report outage and provide feedback, • Part of an existing outage • Estimated Repair time
Publish outage info to utility web page.	Utility web page can display basic information about outages, • Extent of the outage • Number of customers affected • Viewable on mobile devices
Call back or SMS customers to notify ETR or restoral.	Customers requesting notification can get updates on the outage (call or SMS) • Restoration (with verification) • Repair Time (with caution) • Can also send out unsolicited notifications if customers sign up.
Customer disconnected for non-payment calls.	CSRs & IVR can be aware of customers who've had power disconnected, • Avoids unneeded confusion. • Allows issue to be addressed as quickly as possible.

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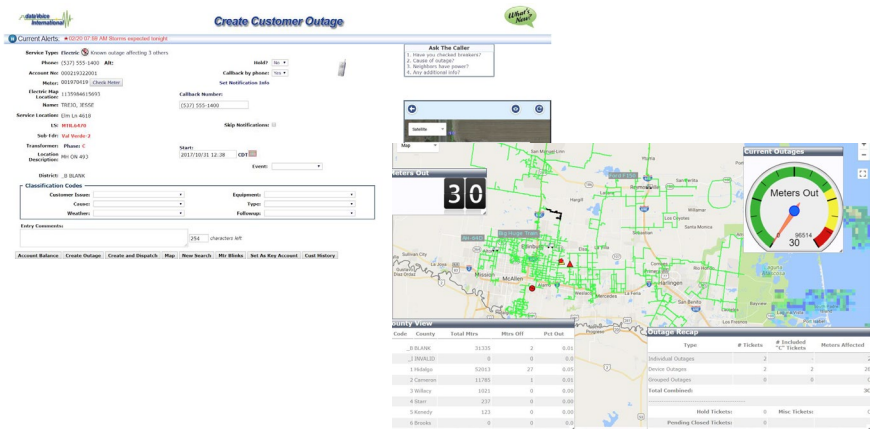
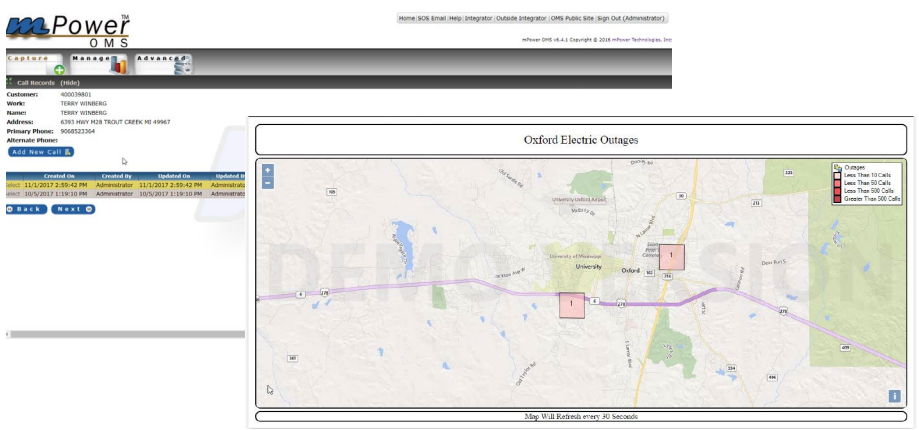
Customer Map & CSR Tools

Vendors differ in the sophistication of the tools they provide.

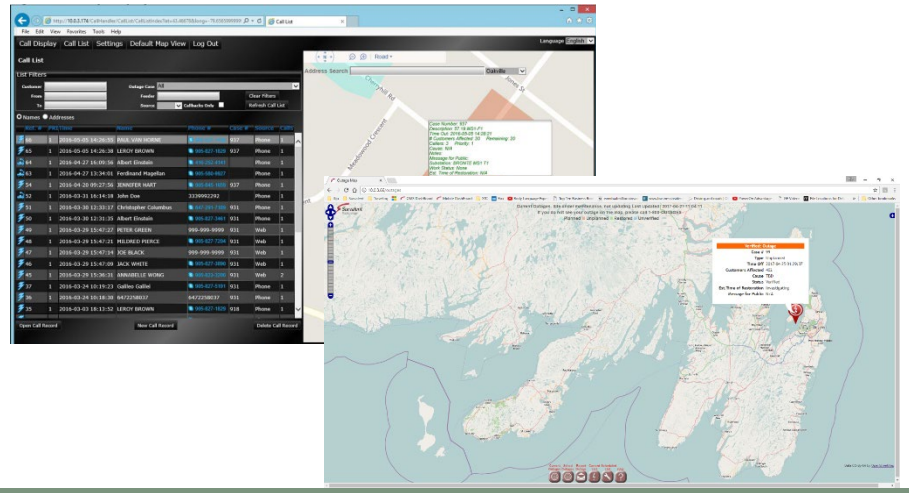
dataVoice



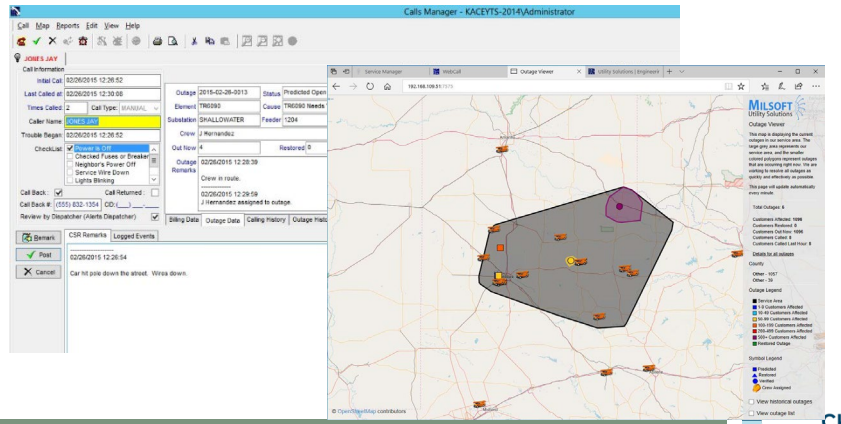
mPower



Survalent



Milsoft



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Crew Scenarios with an OMS

What roles are valuable for crews to have in using the OMS?

Scenario	OMS Capabilities
Crew receives assignment	Outage assignment contains • Protection Device predicted • Number of customers out (for each assignment / outage)
Adds / Removes Assignment	Crews can add themselves to work to assist or remove to work elsewhere
Views network map	The network view provides clear information about the distribution system. • Extent of outage & crews in area • Protection devices in the area • Customers (critical) affected • Possibilities for restoration
Updates status of outage	Crews can directly update the outage status from laptop, tablet • Confirmed, Repaired • Estimated Time for Restoration
Captures outage cause	The cause code is critical for learning how to reduce outages in the future • Select from cause categories
Capture new work needed	Allow crews to capture other work that is noticed when on site • Poles / transformers aged or in need of replacement

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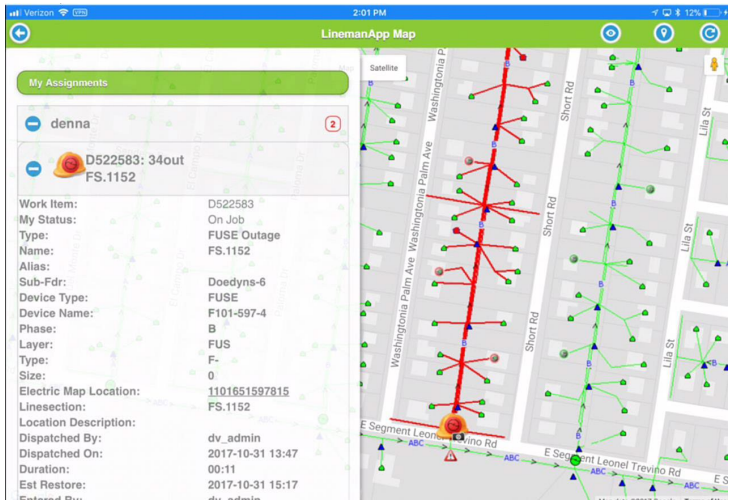
Crew Tools

dataVoice



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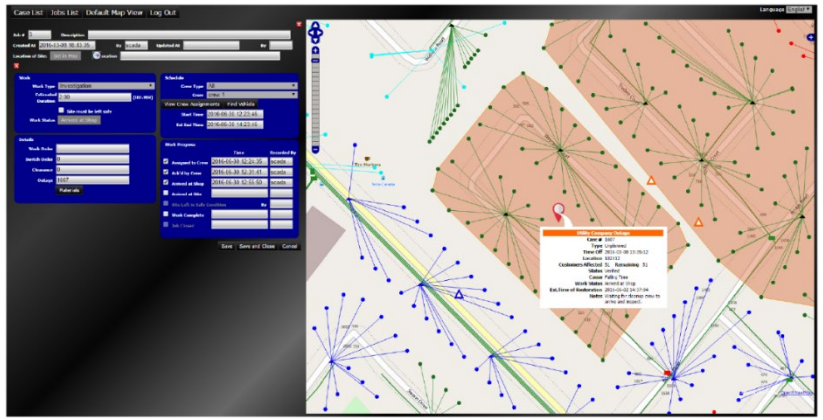
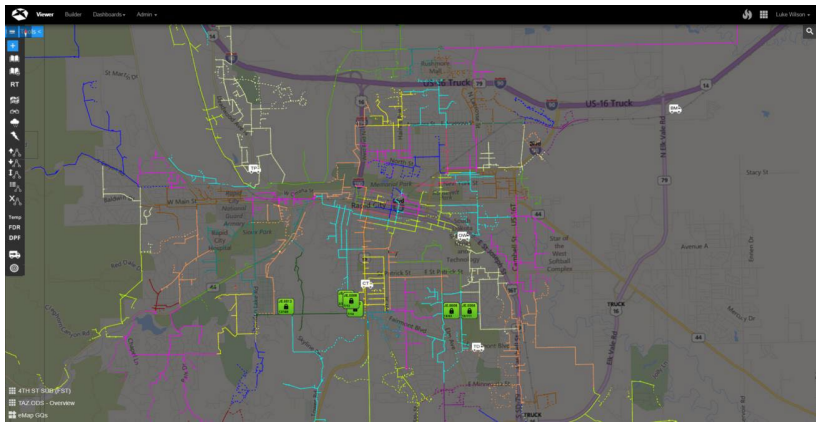


OSI



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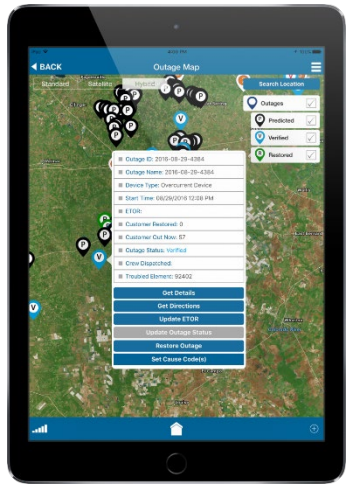

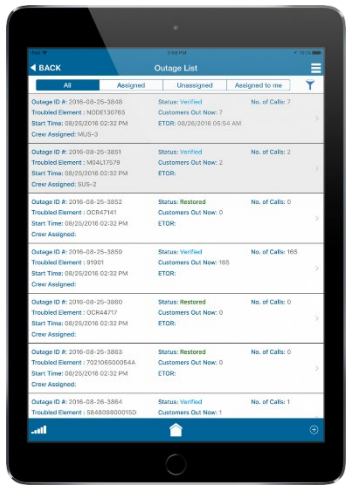

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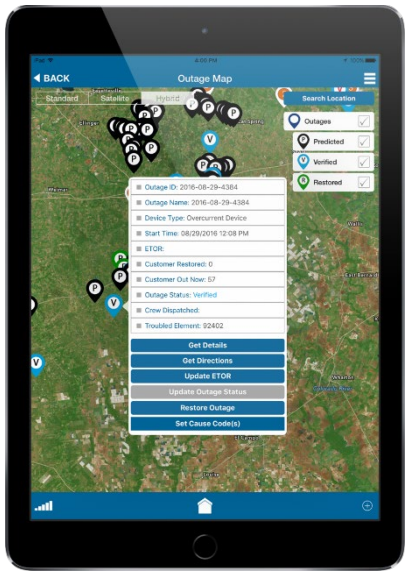
Mobile Outage

- Mobile tool expressly design for field crews
- Mobile Outage Network View
  - Up/Downline protection devices
  - Extent of outages
  - Crew locations
- Automatically Provides
  - Assigned Outages
  - Status Updates
  - Closure Codes
- Several questions arise,
  - What tool(s) do crews look at?
  - Does it work without cellular?



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Restoration Levels

It is critical to understand your end-goal for restoration before choosing an architecture to implement it.

- Level of operator intervention and automation
- Speed of restoration & available communications.

Category	Process	Time Frame
Operator Activated Restoration	Detect trips with SCADA alarm, determine switching steps, coordinate with line crews, perform isolation & restoration	5 minutes
Centralized Automated Restoration	Software determines most likely fault location, isolation & restoration strategy.	30 sec – 2 min
Decentralized High-Speed Restoration	Products such as Siemens 7SC80 & S&C IntelliTeam coordinate amongst themselves	1-2 seconds
Automatic Source Transfer	Localized critical load source switching	~100ms (6-10 cycles)
Direct Transfer Trip	Transmission Line protection between separate substations	~100ms (6 cycles)

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OMS Data Perspectives

Data is presented differently to provide value to each user.

Real Time
- Locations of outages
- Work order completion

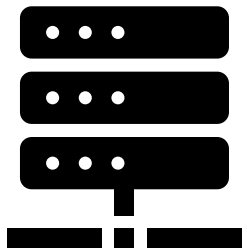
Post-event Analysis
- Repair time by cause
- Major Event / Typical
- Crew & Time of Day

Dispatch

Real Time
- Locations of outages
- Work order completion

Post-event Analysis
- Repair time by cause
- Major Event / Typical
- Crew & Time of Day

Crews



Real Time
- Major Events

Post-event Analysis
- Reliability by System Area
- Trends of performance
- Refine Estimated Repair Time
- Data for protection studies & work plans

Engineering

Real Time
- System Overview
- How many, where, when
- Key Accounts, Hospital, Police, BPUB facilities

Post-event Analysis
- Key accounts
- Districts & Neighborhoods
- Large Events

Senior Mgmt.

Cust. Svc. / Public Relations

Real Time
- System Overview
- How many, where, when
- Key Accounts, Hospital, Police, BPUB facilities

Post-event Analysis
- Key accounts
- Districts & Neighborhoods
- Large Events

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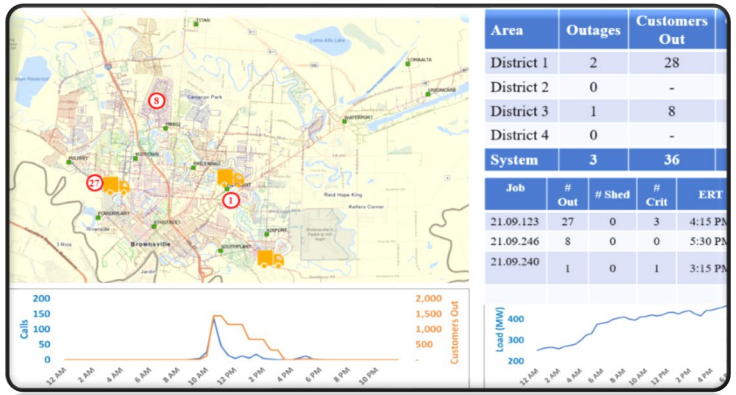
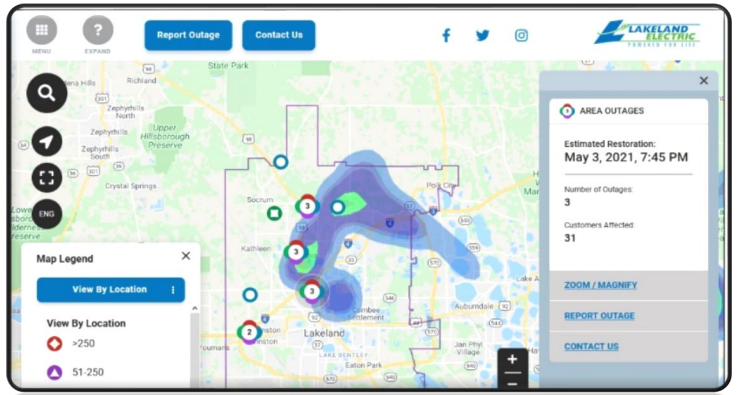
OMS Template Dashboards & Reports

Examples of a framework of best-practice reports

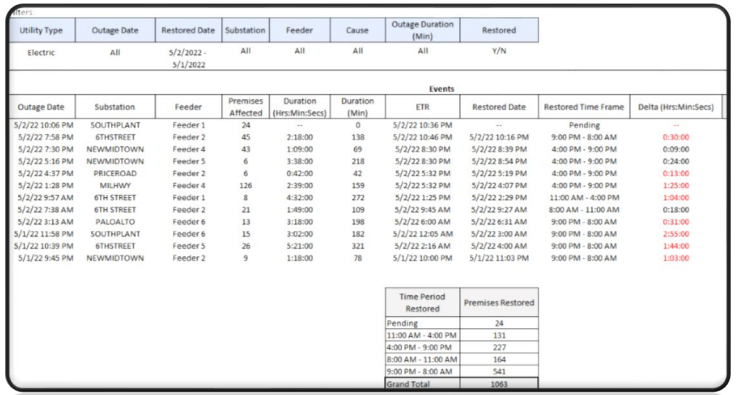
Internal Dashboard



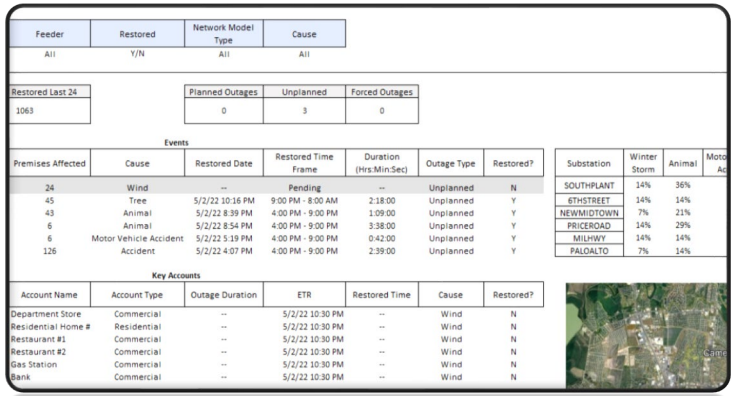
Customer Outage Maps



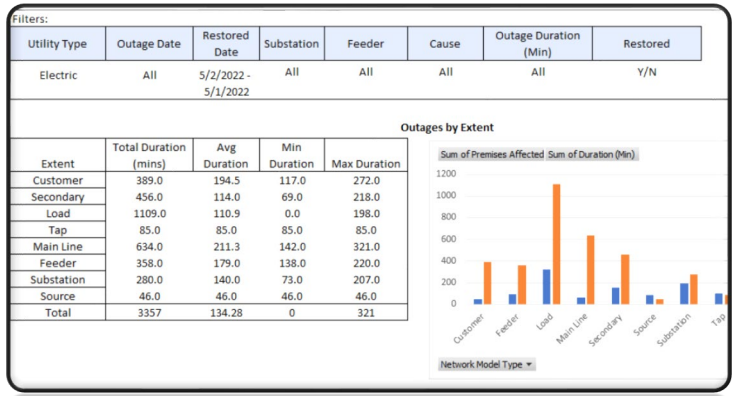
PUC Report



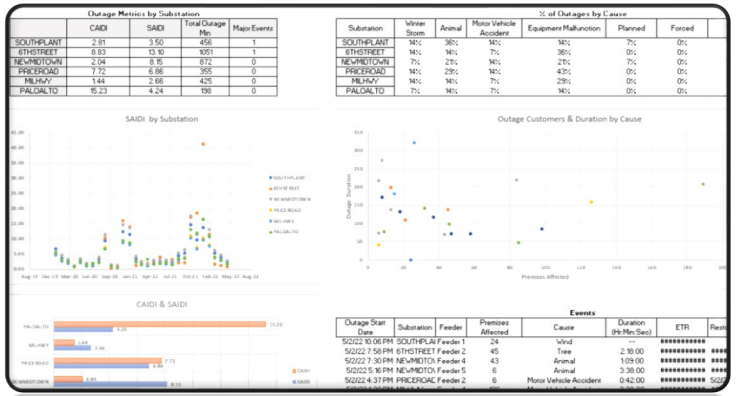
(Key) Customer Analysis



Extent & Time



Cause & Area Reliability



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SAIDI Impact – Outage Causes & Restoration Time

- Do you know the primary causes of outages & outage minutes?
  - Tree Trimming
  - Storms / Weather (Ice, …)
  - Animals
  - Car Accident
  - Equipment Failure
- Remediating / Reducing Outage Minutes
  - Fault Location
  - Partial Restoration

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Outage/Restore and Leak Recommendations

- Before getting an OMS, consider what the Utility Network can provide
  - Connectivity
  - API from AMI to GIS to display Outages (and clear restores) and leak events
- Reporting for time and duration coming from AMI and the endpoints
  - Formatted correctly
  - Combined with other data already (phone calls, crew time, etc.)
  - After the fact – not used as a ‘real-time’ interface
- Real need now is on visuals and reporting
  - Predictability is nice to have, but not needed
  - Knowing where, when, and how long a leak has occurred

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Asset Management

Reliability
Utility Costs and Impact
Utility Wide
Data Analytics

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TWP Areas of Interest – Asset Management

PSE perceptions:

- Asset management is all over the place and disconnected from each other
  - Lack of centralized data and information is contributing
- Fleet management
  - Number of manual processes here
- Asset maintenance and inspections somewhere, but not regularly reviewed
- Each department has been tracking, updating, and managing assets on their own
  - GIS is available and this is a good start.

Level of Importance
Low

Gap Size
Large

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Components of Asset Management, Work Management & Analytics

Distribution System Information

- Asset Visualization & Status

Distribution System Maintenance

- Inspections & regular maintenance
- Forms for Data Collection

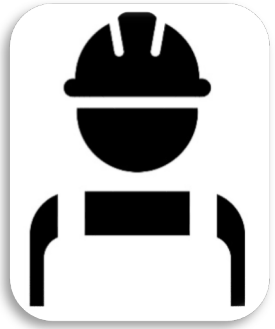
Fleet & Facilities Maintenance

- Fleet regular maintenance
- Facilities, substation inspections, …

Tracking what has been done and what needs to be done.

- Scheduled Maintenance
- History & Work Tracking

Work Management



- Work Assignments
- Cost Tracking
- New Construction
- Repair Work
- Service Order Assignment

Analytics & Prediction

- Device Loading
- Failure Prediction

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Aspects of Asset Management

- Record of Devices - Maintaining a record of assets:
  - Cost
  - Warranty
  - Remaining useful life
  - Physical condition
  - Repair and maintenance consistency
- Scheduling:
  - Automated scheduling for maintenance and inspection
  - Develop a defined program for maintaining systems, grids, and devices
- Historical Record and Integration:
  - Provides historical data for assets
  - Complements GIS to support reference points for visualizations

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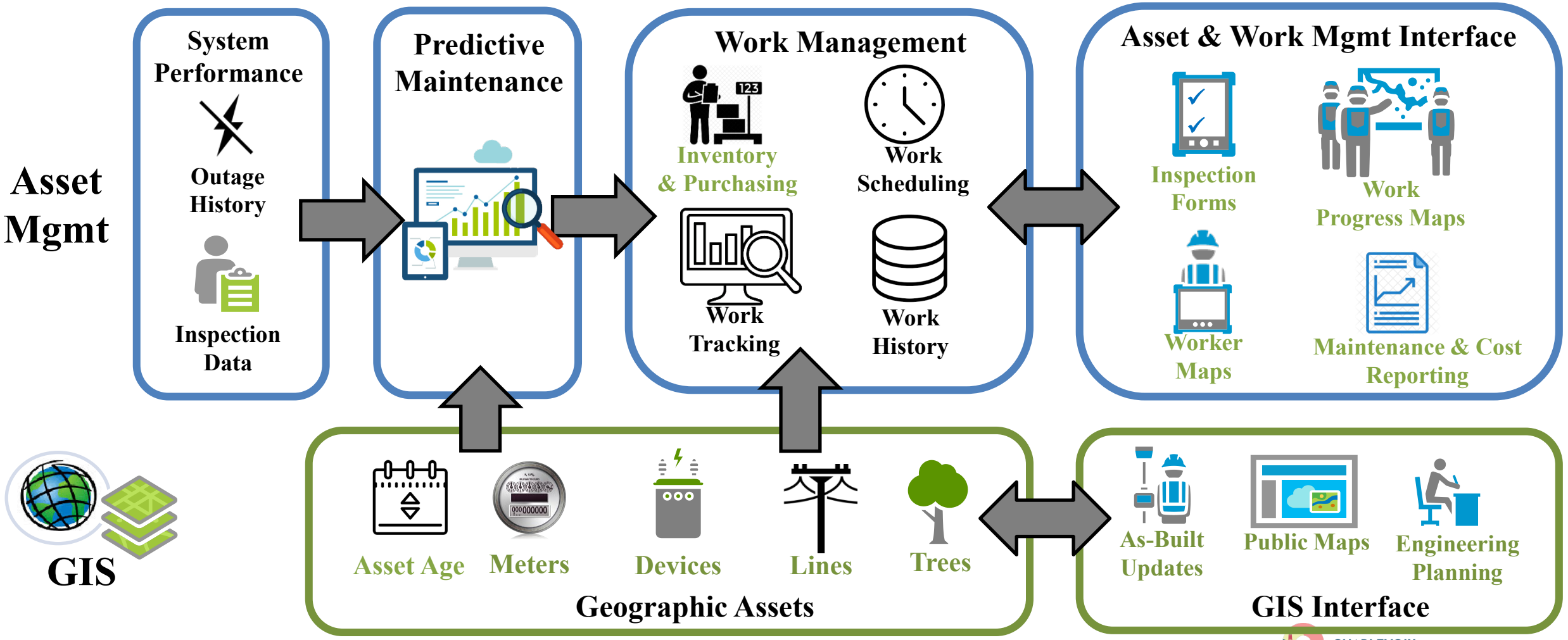
Roles of GIS & Asset Management

GIS and asset management complement each other well.



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Asset Management Recommendations

- Use existing options available today, do not buy an asset management system
  - Expense and time to manage likely out-weighs the benefits of using current resources
    - Spreadsheets / Scheduled Maintenance
    - AMI
    - GIS
    - Reporting tools (PowerBI, Tableau, Etc.)
- Adding AMI adds more equipment with Warranties
  - Install dates and equipment warranty
  - Water nodes and battery life
- Electronically tracking items is better than hand-written
  - Easier to report and follow trends
  - Less susceptible to being lost or destroyed

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DER and EV

Consumer Services
Utility Costs and Impact
Utility Wide
DER / EV
System Integrations
Data Analytics

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TWP Areas of Interest – Distributed Energy Resources

- Small number of applications for Solar
  - Trying to stay on top of educating
- Public EV charging not in high demand yet, but completed the first install recently
- Stay on top of this area
  - Consumer communications, applications, impact studies, billing, etc.
- Communications to inverters, batteries, charging stations, etc.
  - AMI, Private or otherwise - Wi-Fi, Etc.
- Large growth potential
- Could have Demand Response and Billing implications

Level of Importance
Low - Medium

Gap
Small (for now)

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Electric Vehicle Growth

- Overview: Electric vehicles can offer the **biggest load growth potential** for electric utilities at a time when load is shrinking for most utilities.
  - **10 states have adopted** California's Zero Emission Vehicle (ZEV) mandates requiring a percentage of zero emission vehicles by 2025.
    - The list is growing, and GM is becoming an all-electric manufacturer
  - Sacramento, CA is anticipating growth from 2,500 EVs currently to **140,000 by 2030**.
    - Approximate **4% increase in energy sales** annually.
    - Potential 500MW of additional demand on SMUD's system (or roughly **15% of peak demand**).
  - Average 250kWH per month: 250kWH * $0.10/kWh * 12 months = $300/yr../vehicle
    - A utility with 25,000 meters & 5% adoption = 3.75MWHr sales / $375,000 revenue annual
  - **Fast chargers can overload transformers**, especially in neighborhoods with multiple EVs
  - Beyond EVs, unexpected load growth can come from Marijuana grow houses too.
- Charging during peak hours is likely
  - TOU programs and member rates?
  - Direct EV control?

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Electric Vehicle Growth

- Average 250kWH per month: 250 kWh * $0.10/kWh * 12 months = $300/yr./vehicle
  - **Fast chargers can overload transformers**, especially in neighborhoods with multiple EVs
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Electric Vehicle Growth

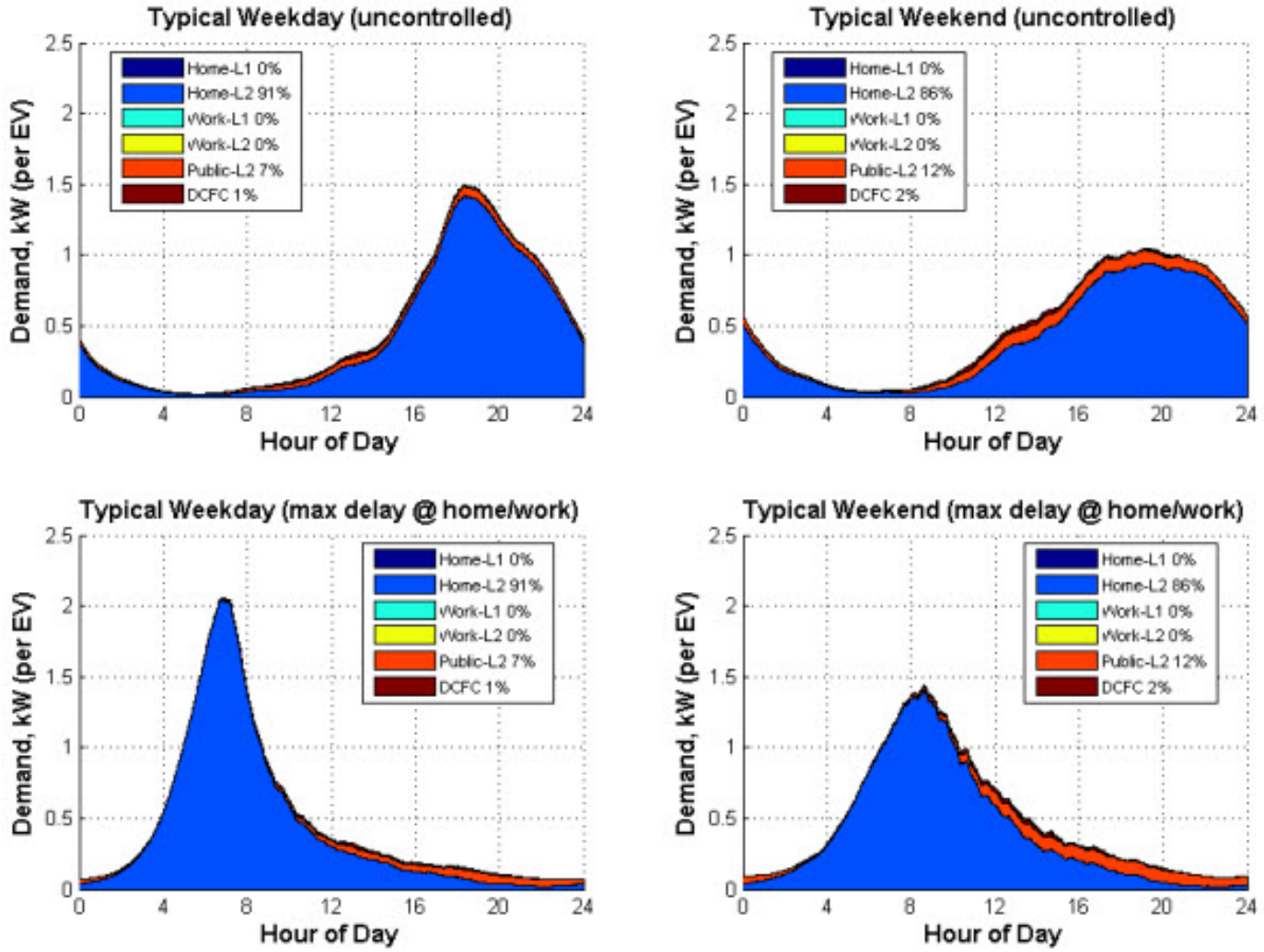

Figure 6 Aggregate demand profiles for 100,000 EVs under weekday and weekend uncontrolled and maximum delay charging conditions

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EV Charging Stations by State (Excluding California & Vermont)

per 100,000 residents

Stations | Outlets | Level 1 Chargers | Level 2 Chargers | DC Fast Chargers

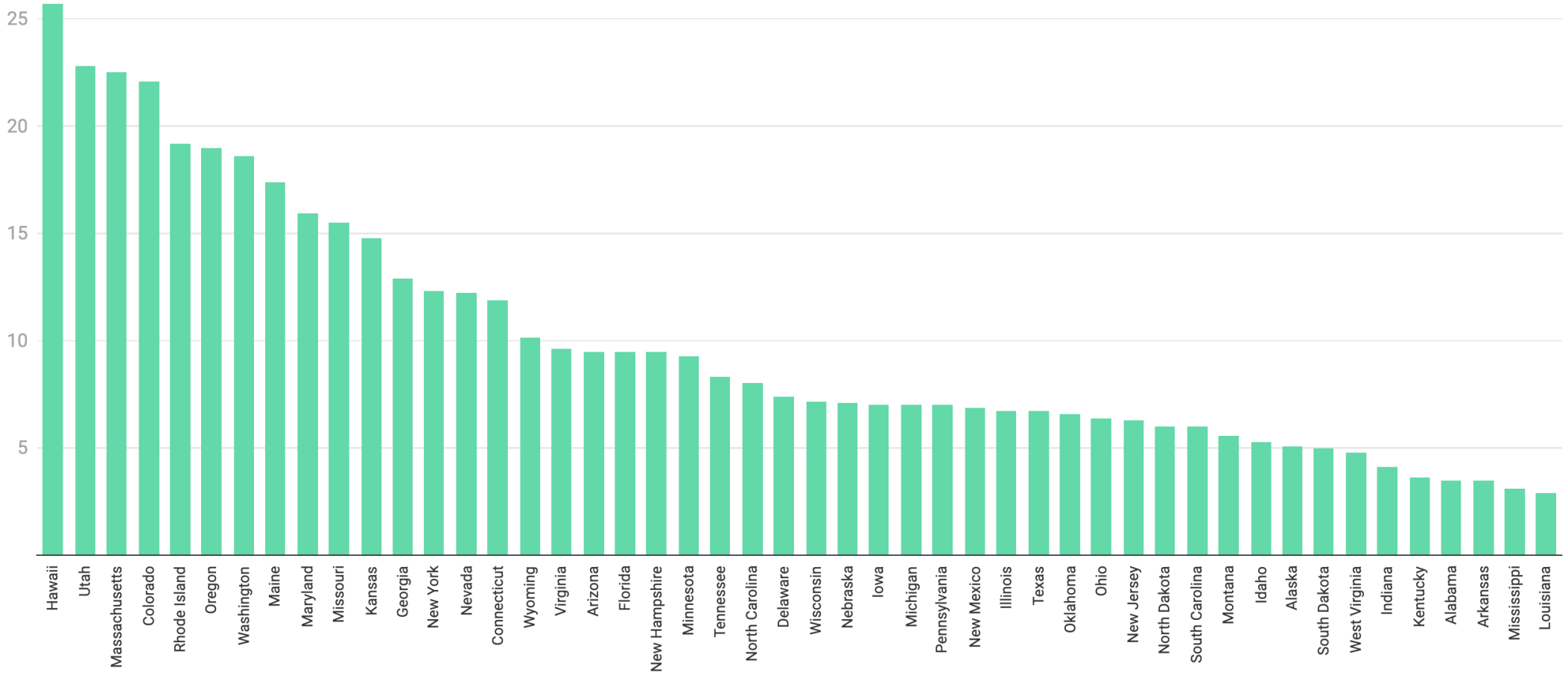

Chart: Zach Shahan, CleanTechnica • Source: U.S. DOE

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DER and EV Recommendations

- Consider processes in place for solar impacts and regulations
  - Billing rebates and buy back – work with UFS
  - Impact studies for large scale
  - AMI process for meter configurations tied to install application approvals
- Have special rates for off-peak charging
  - Suspect capacity is impacted more during the summer vs. the winter / off-season
- Monitor transformer loading
  - Analytics to find EVs on the system
  - Impact to current transformer ratings and recommendations
- Now this is a small gap, but could turn quickly

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Demand Management

Reliability
Consumer Services
Utility Costs and Impact
Utility Wide
DER / EV
System Integrations
Data Analytics

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TWP Areas of Interest – Demand Response

PSE perceptions:

- For now, there is not a need for demand response
  - Stay on-top of trends for EV charging and MPPA's plans
  - See Data Analytics section
- EV charging at homes and hotels
- New AMI system can support traditional load management
  - There are alternatives as well

Level of Importance
Low (for now)

Gap
Small (for now)

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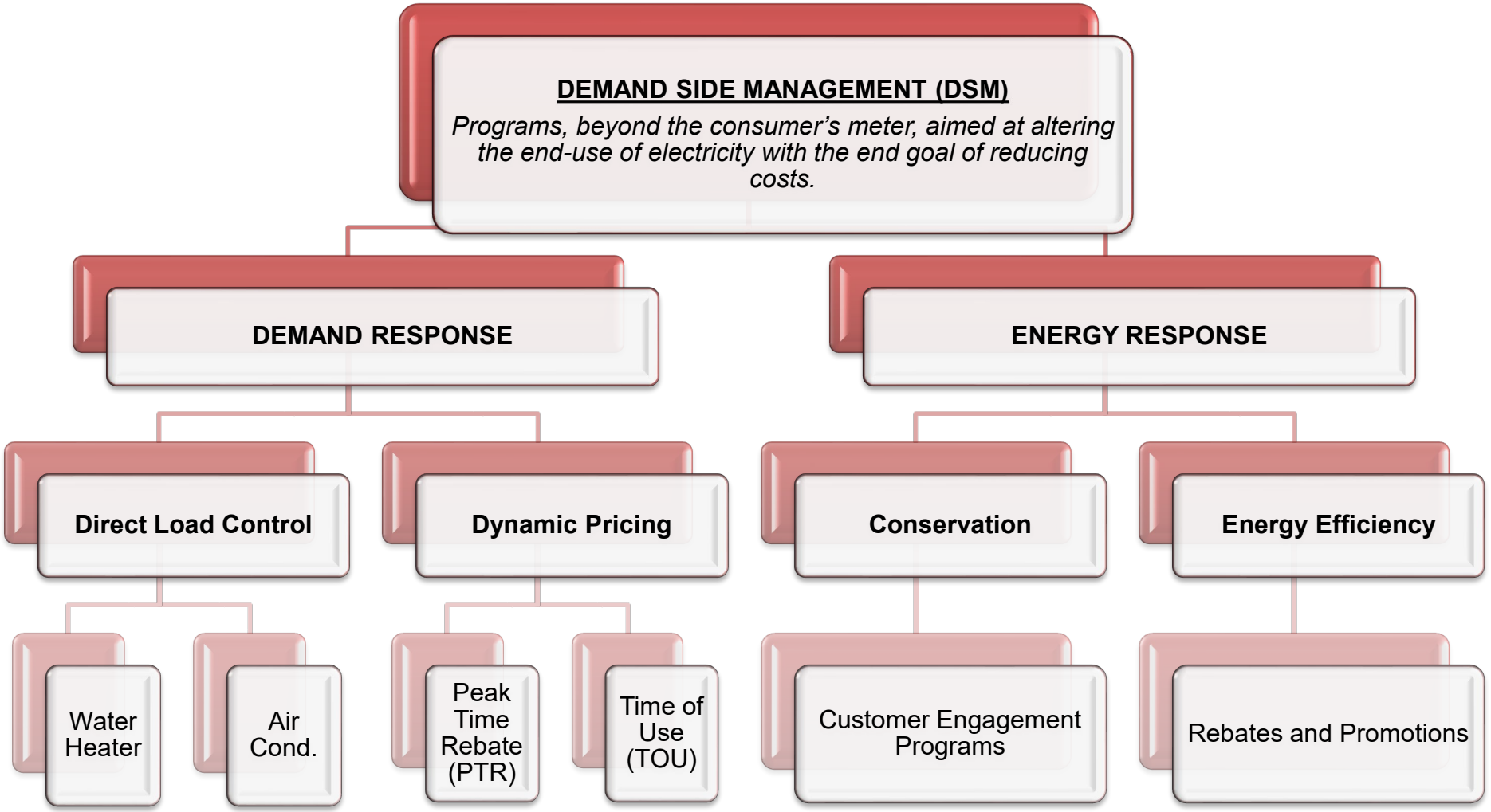
Demand Side Management Overview



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Other Devices

Figure 1: Illustration of CTA-2045 Port on a Water Heater, and a CTA-2045 AC Form Factor Communications Module. *Figure modified from EPRI*

Figure 2: Photo of SkyCentrics AC Communications Module Connected to an A.O. Smith Water Heater. *Photo courtesy of SkyCentrics*

Figure 3: DC Form Factor Communications Module. *Photo courtesy of SkyCentrics*

Figure 4: DC Communications Module Plugged into the Upper Left Corner of an Emerson Smart Thermostat. *Photo courtesy of EPRI*

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Demand Response Recommendations

- As supply and market pricing changes, demand response may become relevant
  - EVs and electrification are changing load curves
    - But is generation keeping up?
- Have special rates for off-peak charging (see DER/EV)
- The new AMI system supports DR
  - Alternative areas are available too:
    - Pricing signals and incentives
    - Interoperable / cloud enabled sources
    - Battery storage
- This is a small gap, but could turn quickly
  - Continue to stay up on changing market pressures

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Data Analytics

Consumer Services
Utility Costs and Impact
Utility Wide
DER / EV
System Integrations
Data Analytics

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TWP Areas of Interest – Data Analytics and Integration

PSE perceptions:

- AclaraOne has some "MDMS functionality", but better features are needed and would be an add-on cost
- Right now, reporting is limited in several ways:
  - Lack of data sources
  - Lack of simple and existing tool usage
  - Integration and system dependencies

Level of Importance
Medium - High

Gap Size
Large

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Overview of "Data Analytics"

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(Generalized) Levels of Analytics

Levels of analytics vary significantly depending on perspective and desired output

Level	Description	Tools
Level 1	• Data reporting from various sources • Manually processing data sets • Consuming data into another form/report • Manually generated graphs and charts	• Word • Excel • PDF • MS Access • PPT
Level 2	• Automated most steps from level 1 • Access to data sources / systems of record • Data warehousing and storage organization • Visualization/graphics of single and multi source data sets	• SharePoint / Network Folders • Direct integration to DB • PowerBI, Tableau, Etc.
Level 3	• Culmination of Level 2 • Large data warehousing / data lakes • Automated pre-processing of data • “Machine Learning” and data correlations	• Data storage and monitoring • Scripting tools and resources • Output tools (CSV, Graphs, etc.) • Business processes

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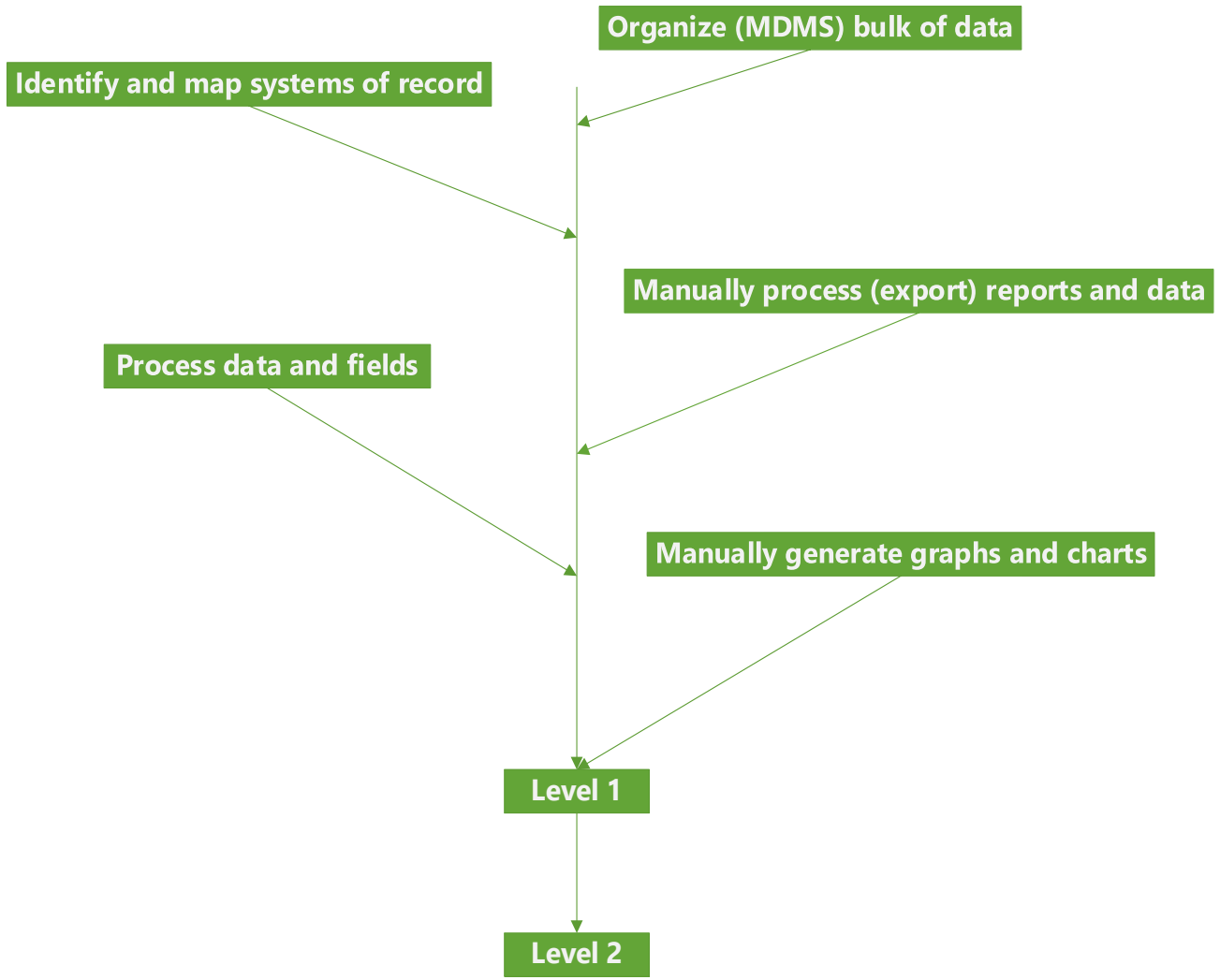
Path for Level 1 Analytics



- Some tasks are being completed in some capacity
- AMI will help in extracting better data from endpoints
- Identify use cases and data reporting needs (what are we needing?)
- Manually generate outputs/extracts:
  - Excel (tabular)
  - PowerBI / Tableau (graphical)
  - AMI, CIS, GIS, Etc.

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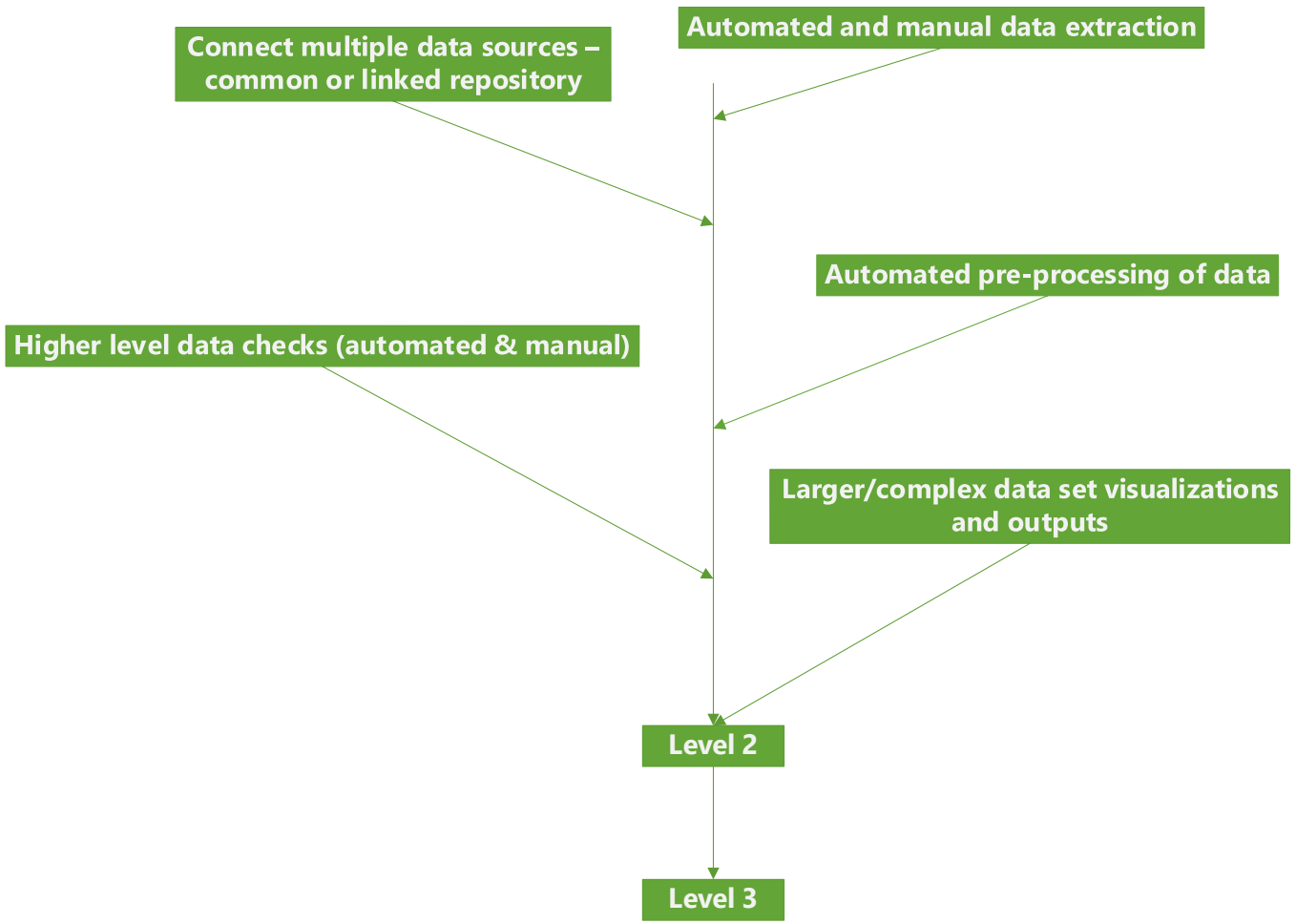
Path for Level 2 Analytics



- Connecting multiple data sources
- Automation of the pre-processing of data (from raw to useable)
- Maintain level 1 outputs
- Generate new goals and use cases
- Manually manipulate data and conscience of data size:
  - PowerBI
  - Excel or CSV
  - Scikit (python) and ELK or other
    - Start of more sophisticated algorithms and machine learning

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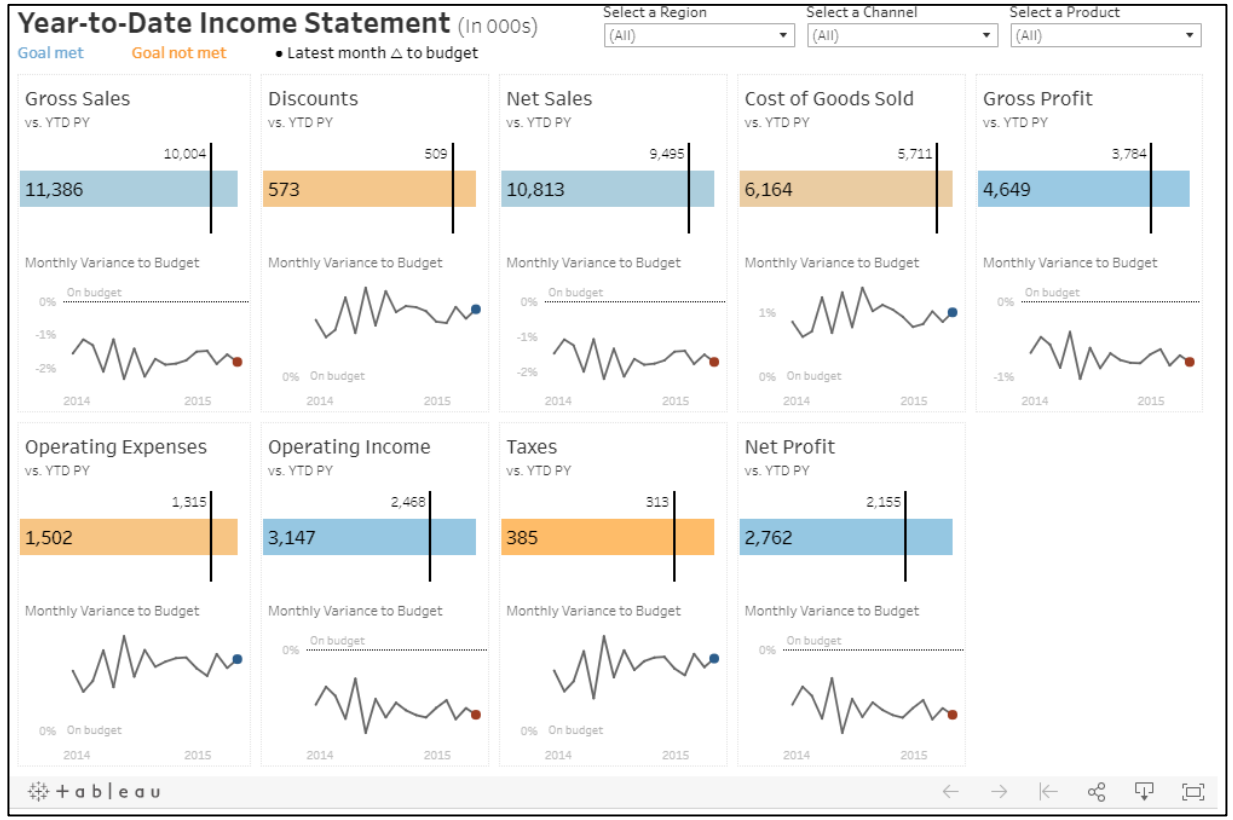
Presenting Data

- Current tools and processes working well now
- Improvements may be realized through existing reporting tools
  - Tableau & PowerBI can provide decent visualizations
    - Board reporting
    - Internal financial impact, year-over-year tracking, etc.
  - Exploring options in reporting may unlock unrealized potential



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Example Use Cases

- Historical Outage & Restoration
  - Data refresh year-over-year
  - Heat maps for quick identification
- System Line Loss Analysis
  - System vs. Substation vs. Feeder
- Rate Impacts
  - Are members in the right or best rate class?
  - Coincident Peak Billing
- High Bill
  - Preemptive trending and potential high bills
- Load Management
  - Measurement and Verification
  - Rebates vs. participation
- Estimates vs. As-Builts
  - Project cost tracking
  - Are estimates within range?
- Voltage
  - High and low voltage detection
  - End of line vs. mid-line

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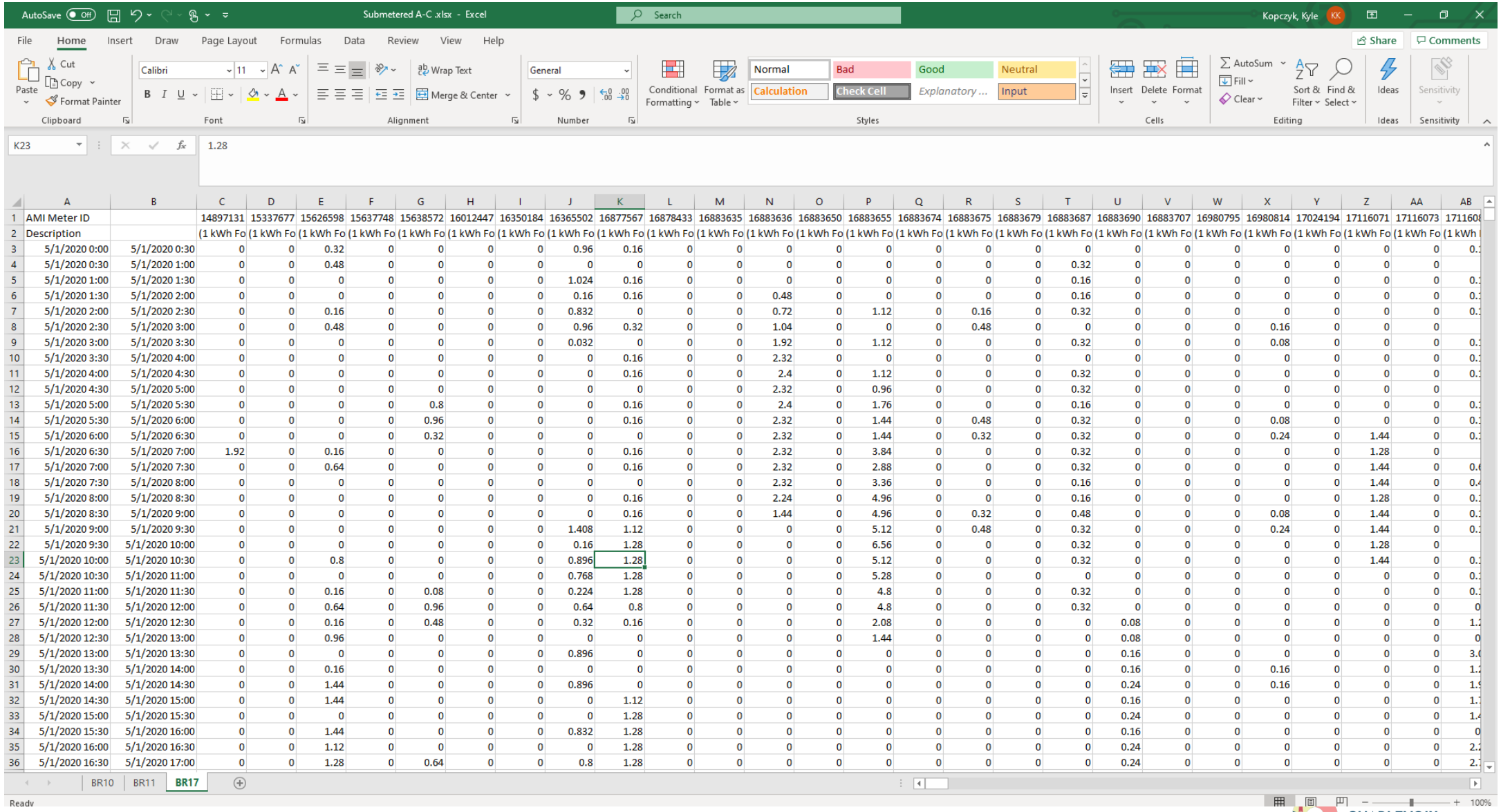
Raw Data



Submetered A-C .xlsx - Excel

K23 | 1.28

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1	AMI Meter ID		14897131	15337677	15626598	15637748	15638572	16012447	16350184	16365502	16877567	16878433	16883635	16883636	16883650	16883655	16883674	16883675	16883679	16883687	16883690	16883707	16980795	16980814	17024194	17116071	17116073	171160
2	Description		(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh Fo	(1 kWh
3	5/1/2020 0:00	5/1/2020 0:30	0	0	0.32	0	0	0	0	0.96	0.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
4	5/1/2020 0:30	5/1/2020 1:00	0	0	0.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.32	0	0	0	0	0	0	0	0	
5	5/1/2020 1:00	5/1/2020 1:30	0	0	0	0	0	0	0	1.024	0.16	0	0	0	0	0	0	0	0	0.16	0	0	0	0	0	0	0	0	0.1
6	5/1/2020 1:30	5/1/2020 2:00	0	0	0	0	0	0	0	0.16	0.16	0	0	0.48	0	0	0	0	0	0.16	0	0	0	0	0	0	0	0	0.1
7	5/1/2020 2:00	5/1/2020 2:30	0	0	0.16	0	0	0	0	0.832	0	0	0	0.72	0	1.12	0	0.16	0	0.32	0	0	0	0	0	0	0	0	0.1
8	5/1/2020 2:30	5/1/2020 3:00	0	0	0.48	0	0	0	0	0.96	0.32	0	0	1.04	0	0	0	0.48	0	0	0	0	0	0	0.16	0	0	0	
9	5/1/2020 3:00	5/1/2020 3:30	0	0	0	0	0	0	0	0.032	0	0	0	1.92	0	1.12	0	0	0	0.32	0	0	0	0	0.08	0	0	0	0.1
10	5/1/2020 3:30	5/1/2020 4:00	0	0	0	0	0	0	0	0	0.16	0	0	2.32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
11	5/1/2020 4:00	5/1/2020 4:30	0	0	0	0	0	0	0	0	0.16	0	0	2.4	0	1.12	0	0	0	0.32	0	0	0	0	0	0	0	0	0.1
12	5/1/2020 4:30	5/1/2020 5:00	0	0	0	0	0	0	0	0	0	0	0	2.32	0	0.96	0	0	0	0.32	0	0	0	0	0	0	0	0	
13	5/1/2020 5:00	5/1/2020 5:30	0	0	0	0	0.8	0	0	0	0.16	0	0	2.4	0	1.76	0	0	0	0.16	0	0	0	0	0	0	0	0	0.1
14	5/1/2020 5:30	5/1/2020 6:00	0	0	0	0	0.96	0	0	0	0.16	0	0	2.32	0	1.44	0	0.48	0	0.32	0	0	0	0	0.08	0	0	0	0.1
15	5/1/2020 6:00	5/1/2020 6:30	0	0	0	0	0.32	0	0	0	0	0	0	2.32	0	1.44	0	0.32	0	0.32	0	0	0	0	0.24	0	1.44	0	0.1
16	5/1/2020 6:30	5/1/2020 7:00	1.92	0	0.16	0	0	0	0	0	0.16	0	0	2.32	0	3.84	0	0	0	0.32	0	0	0	0	0	0	1.28	0	
17	5/1/2020 7:00	5/1/2020 7:30	0	0	0.64	0	0	0	0	0	0.16	0	0	2.32	0	2.88	0	0	0	0.32	0	0	0	0	0	0	1.44	0	0.6
18	5/1/2020 7:30	5/1/2020 8:00	0	0	0	0	0	0	0	0	0	0	0	2.32	0	3.36	0	0	0	0.16	0	0	0	0	0	0	1.44	0	0.4
19	5/1/2020 8:00	5/1/2020 8:30	0	0	0	0	0	0	0	0	0.16	0	0	2.24	0	4.96	0	0	0	0.16	0	0	0	0	0	0	1.28	0	0.1
20	5/1/2020 8:30	5/1/2020 9:00	0	0	0	0	0	0	0	0	0.16	0	0	1.44	0	4.96	0	0.32	0	0.48	0	0	0	0	0.08	0	1.44	0	0.1
21	5/1/2020 9:00	5/1/2020 9:30	0	0	0	0	0	0	0	1.408	1.12	0	0	0	0	5.12	0	0.48	0	0.32	0	0	0	0	0.24	0	1.44	0	0.1
22	5/1/2020 9:30	5/1/2020 10:00	0	0	0	0	0	0	0	0.16	1.28	0	0	0	0	6.56	0	0	0	0.32	0	0	0	0	0	0	1.28	0	
23	5/1/2020 10:00	5/1/2020 10:30	0	0	0.8	0	0	0	0	0.896	1.28	0	0	0	0	5.12	0	0	0	0.32	0	0	0	0	0	0	1.44	0	0.1
24	5/1/2020 10:30	5/1/2020 11:00	0	0	0	0	0	0	0	0.768	1.28	0	0	0	0	5.28	0	0	0	0	0	0	0	0	0	0	0	0	0.1
25	5/1/2020 11:00	5/1/2020 11:30	0	0	0.16	0	0.08	0	0	0.224	1.28	0	0	0	0	4.8	0	0	0	0.32	0	0	0	0	0	0	0	0	0.1
26	5/1/2020 11:30	5/1/2020 12:00	0	0	0.64	0	0.96	0	0	0.64	0.8	0	0	0	0	4.8	0	0	0	0.32	0	0	0	0	0	0	0	0	0
27	5/1/2020 12:00	5/1/2020 12:30	0	0	0.16	0	0.48	0	0	0.32	0.16	0	0	0	0	2.08	0	0	0	0	0.08	0	0	0	0	0	0	0	1.2
28	5/1/2020 12:30	5/1/2020 13:00	0	0	0.96	0	0	0	0	0	0	0	0	0	0	1.44	0	0	0	0	0.08	0	0	0	0	0	0	0	0
29	5/1/2020 13:00	5/1/2020 13:30	0	0	0	0	0	0	0	0.896	0	0	0	0	0	0	0	0	0	0	0.16	0	0	0	0	0	0	0	3.0
30	5/1/2020 13:30	5/1/2020 14:00	0	0	0.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16	0	0	0	0.16	0	0	0	1.2
31	5/1/2020 14:00	5/1/2020 14:30	0	0	1.44	0	0	0	0	0.896	0	0	0	0	0	0	0	0	0	0	0.24	0	0	0	0.16	0	0	0	1.9
32	5/1/2020 14:30	5/1/2020 15:00	0	0	1.44	0	0	0	0	0	1.12	0	0	0	0	0	0	0	0	0	0.16	0	0	0	0	0	0	0	1.7
33	5/1/2020 15:00	5/1/2020 15:30	0	0	0	0	0	0	0	0	1.28	0	0	0	0	0	0	0	0	0	0.24	0	0	0	0	0	0	0	1.4
34	5/1/2020 15:30	5/1/2020 16:00	0	0	1.44	0	0	0	0	0.832	1.28	0	0	0	0	0	0	0	0	0	0.16	0	0	0	0	0	0	0	0
35	5/1/2020 16:00	5/1/2020 16:30	0	0	1.12	0	0	0	0	0	1.28	0	0	0	0	0	0	0	0	0	0.24	0	0	0	0	0	0	0	2.2
36	5/1/2020 16:30	5/1/2020 17:00	0	0	1.28	0	0.64	0	0	0.8	1.28	0	0	0	0	0	0	0	0	0	0.24	0	0	0	0	0	0	0	2.1

BR10 | BR11 | BR17

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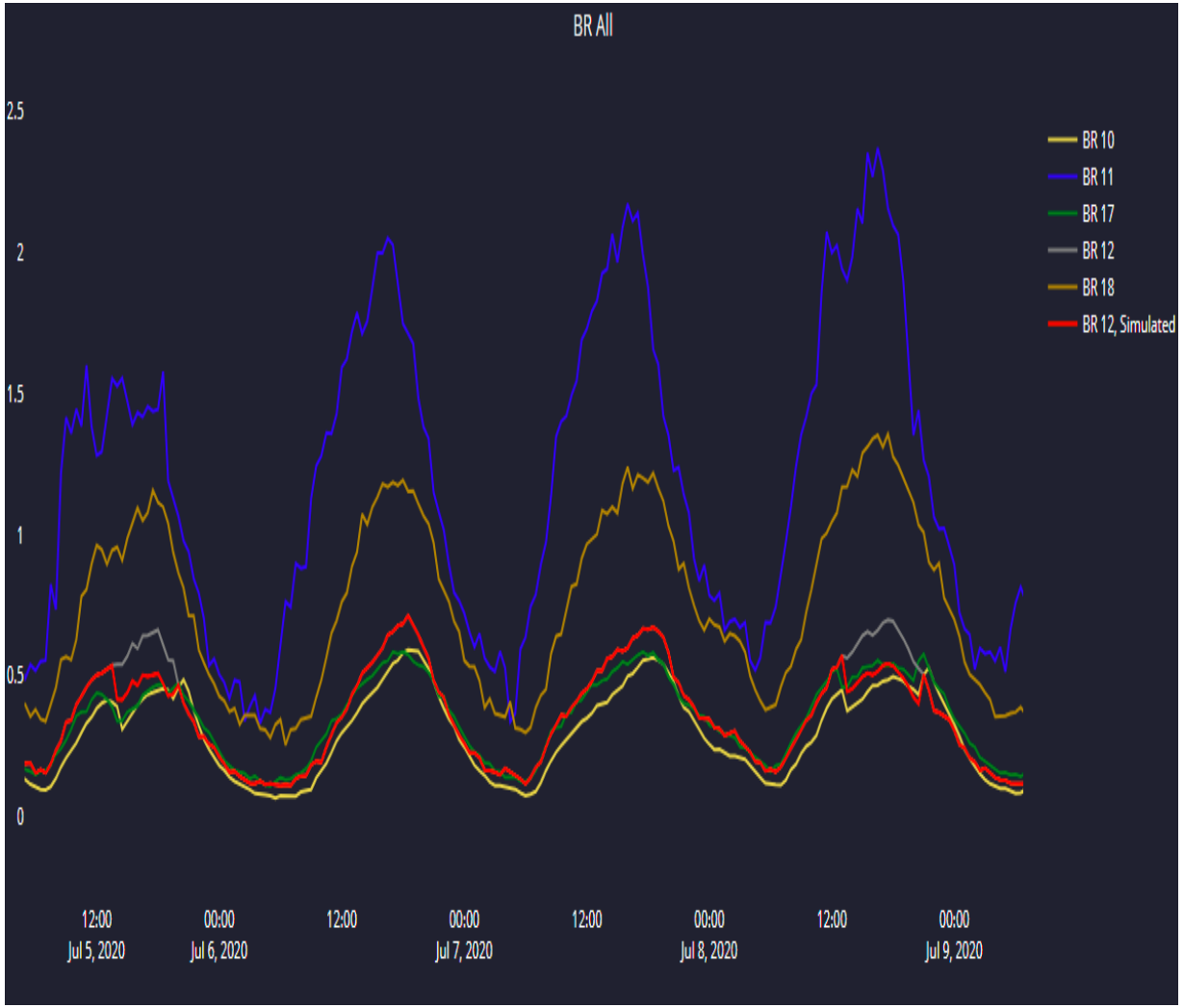
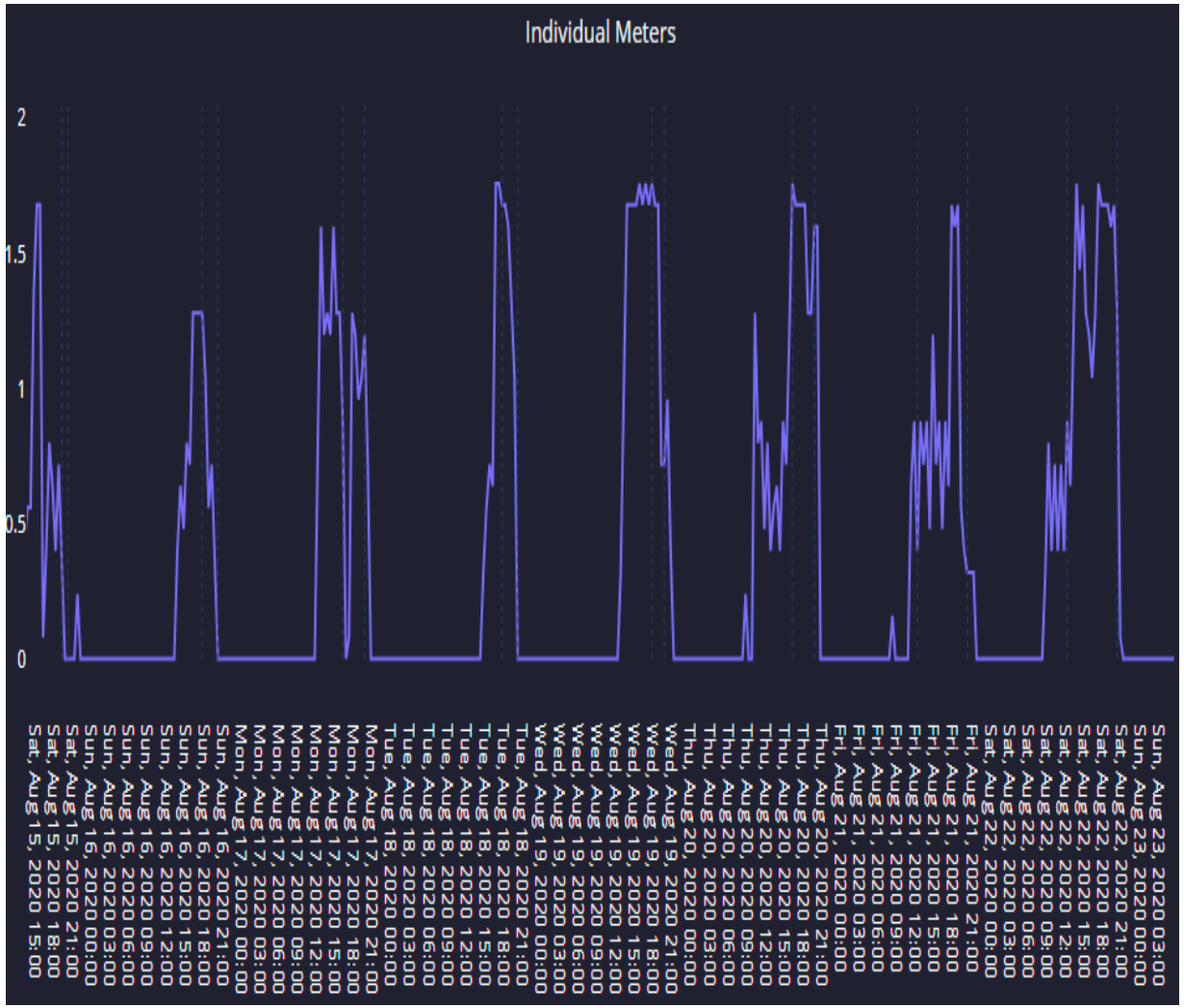
Raw Data vs. Visualization





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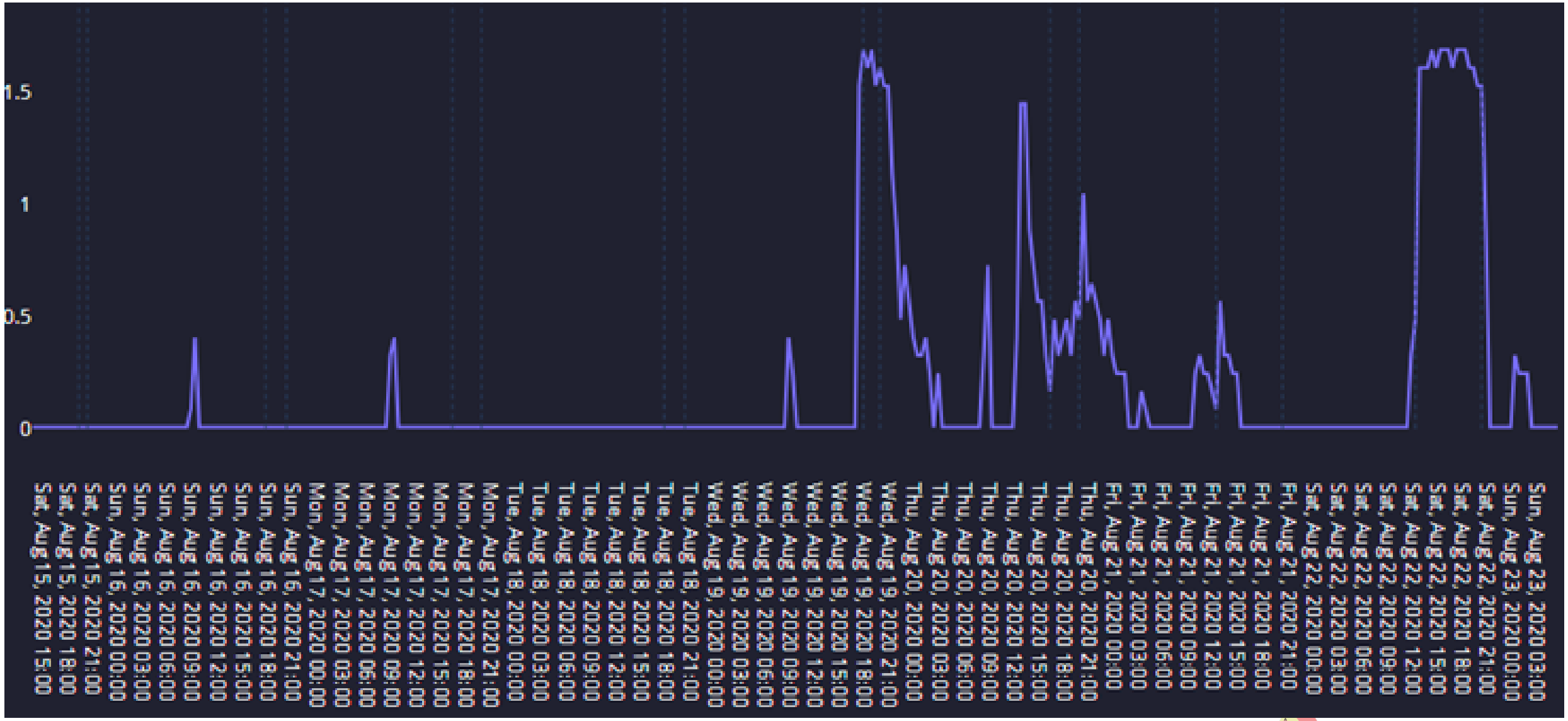
Next Steps Data Analytics – Load Management M&V



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Line Loss Historical Progression

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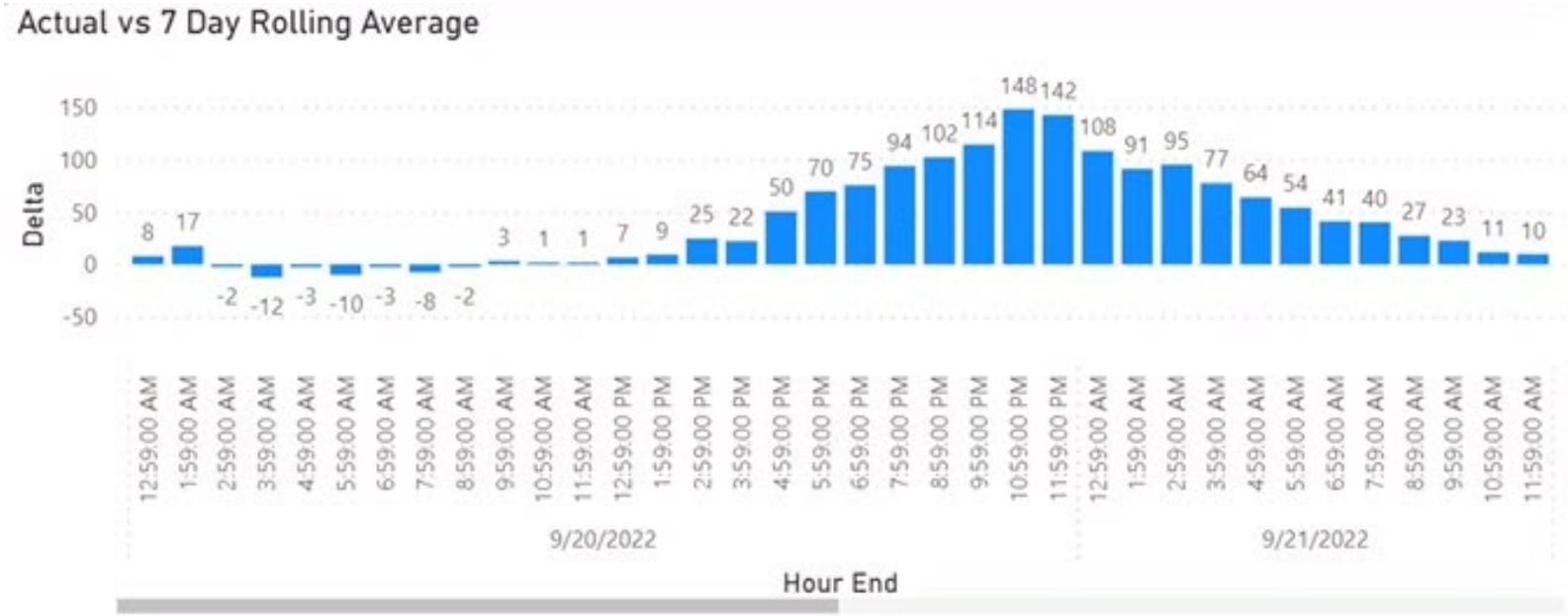
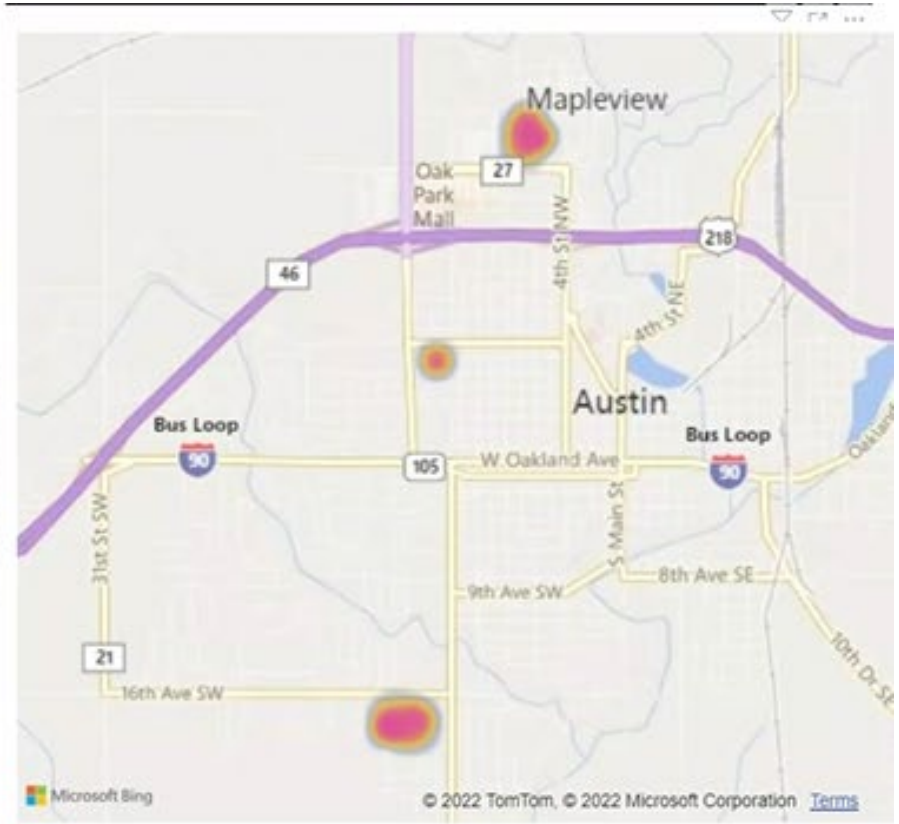
Peak Day - System Load Analysis





Date	Hour End	kW value by hour	kW demand 7 day rolling average	Delta
9/20/2022	12:59:00 AM	203.72	196.00	8
9/20/2022	1:59:00 AM	205.56	188.19	17
9/20/2022	2:59:00 AM	170.64	173.09	-2

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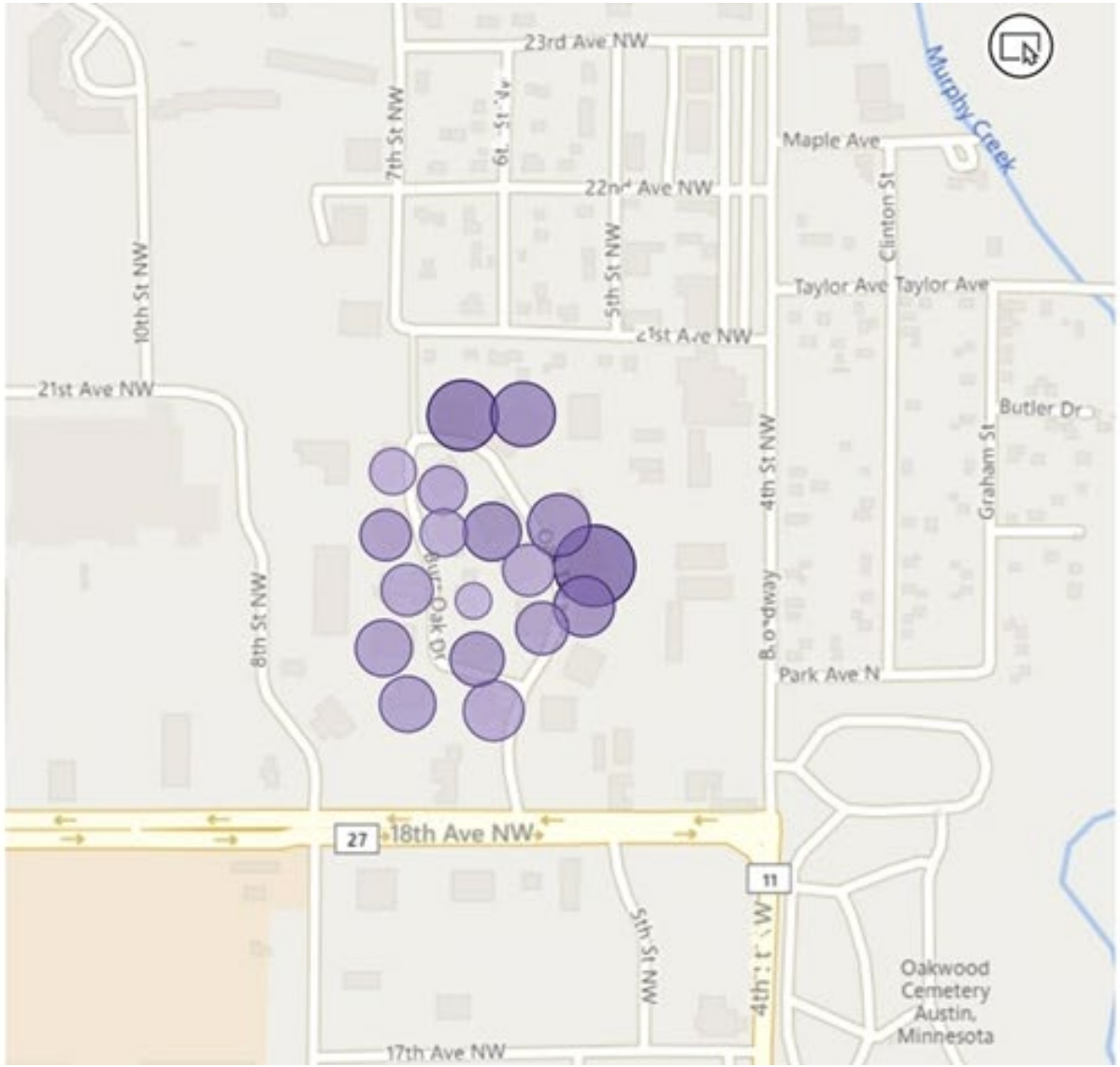
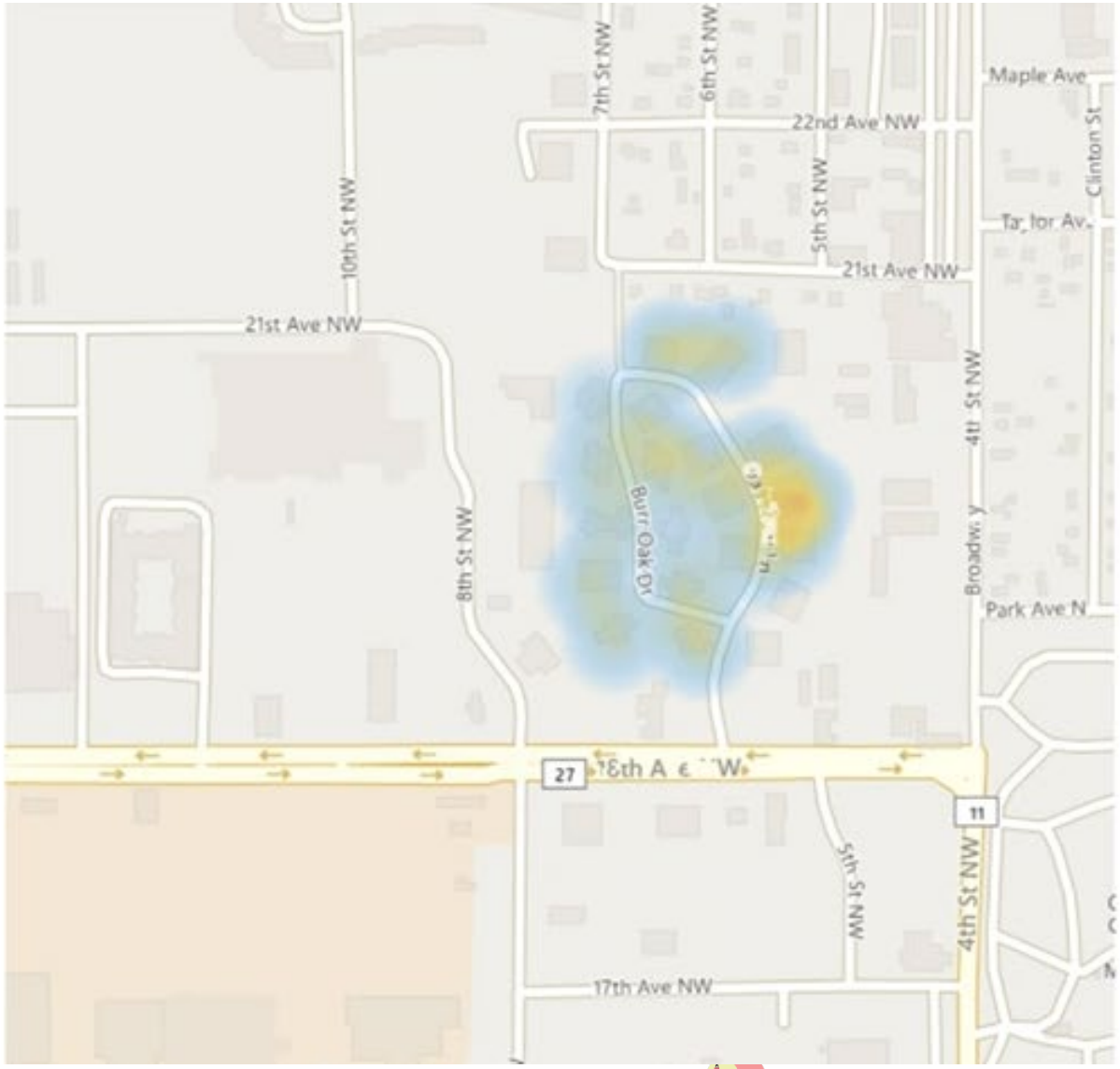
Peak Day - System Load Analysis





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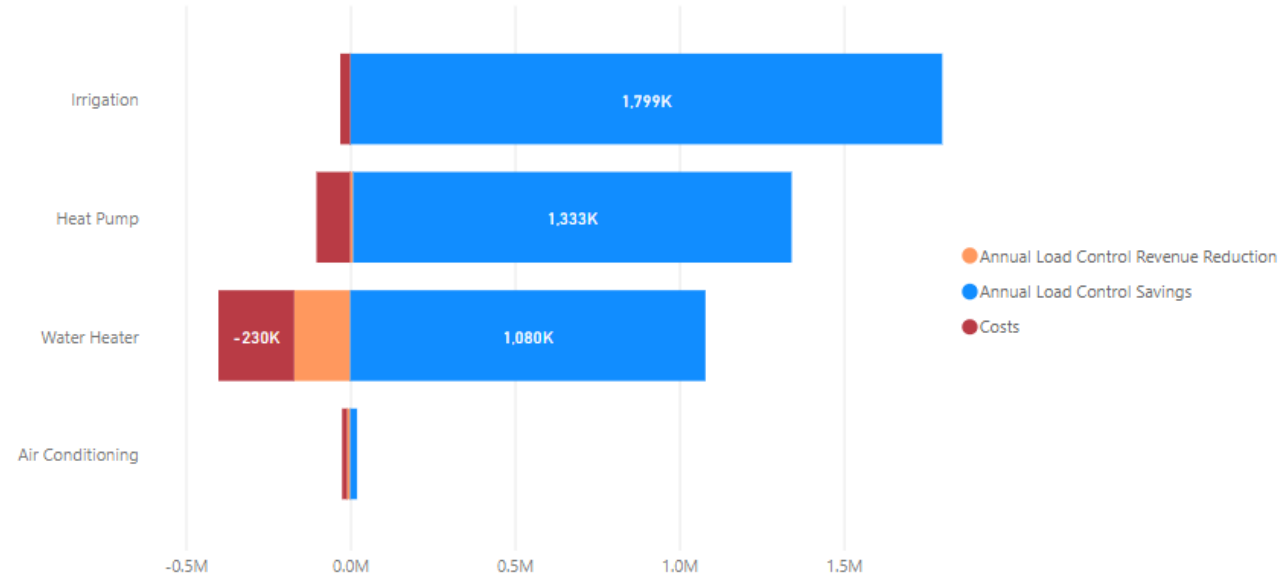
Load Management Analysis

Load Control Program Summary (10 years)

Load Control Benefits by Type



Cost Details

Summary Category	Load Control Category	Load Control Value
Costs	LM Hardware Support Fee Increase - Already Included	0
Costs	LM Software (One-Time Fee) - Already Included	0
Costs	Installation Cost of Switches	-156,760
Costs	Cost of Switches	-221,640
Total		**-378,400**

Control Type	Annual Load Control Revenue Reduction	Annual Load Control Savings	Costs	Total
Irrigation	0	1,799,476	-30,240	**1,769,236**
Heat Pump	8,713	1,332,945	-102,400	**1,239,258**
Water Heater	-170,100	1,079,685	-230,400	**679,185**
Air Conditioning	-9,164	20,845	-15,360	**-3,679**
Total	**-170,551**	**4,232,951**	**-378,400**	**3,684,000**

Total Benefits (10 years)

Year	Air Conditioning	Heat Pump	Irrigation	Water Heater	Total
2023	-14,492	5,915	61,425	-77,373	**-24,525**
2024	960	69,195	146,293	-34,552	**181,896**
2025	1,095	129,350	173,502	87,901	**391,848**
2026	1,095	129,350	173,502	87,901	**391,848**
2027	1,095	129,350	173,502	87,901	**391,848**
2028	1,095	129,350	173,502	87,901	**391,848**
2029	1,095	129,350	173,502	87,901	**391,848**
2030	1,095	129,350	173,502	87,901	**391,848**
2031	1,095	129,350	173,502	87,901	**391,848**
2032	1,095	129,350	173,502	87,901	**391,848**
2033	1,095	129,350	173,502	87,901	**391,848**
Total	**-3,679**	**1,239,258**	**1,769,236**	**679,185**	**3,684,000**

100% Success Controlling Peak

75% Success Controlling Peak

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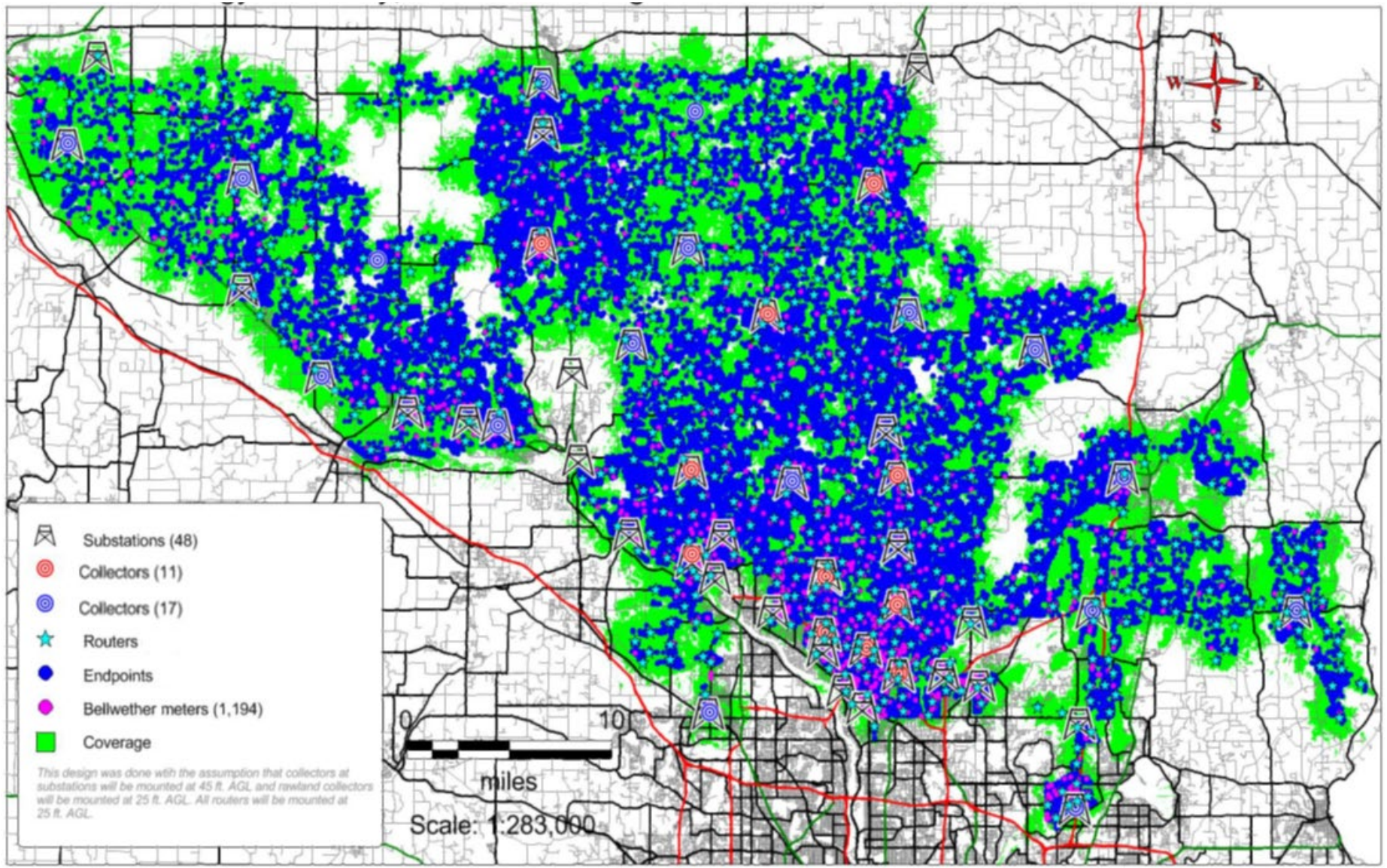
AMI Network Health



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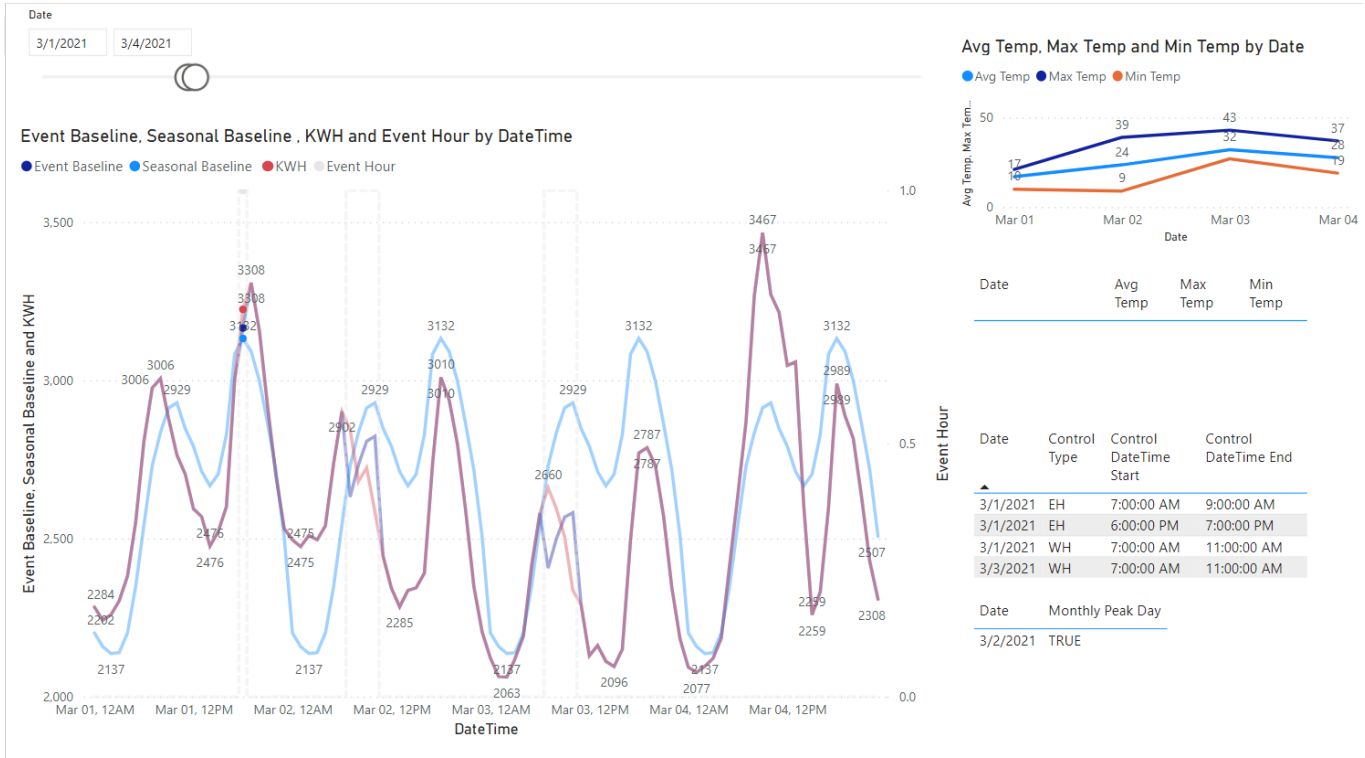
Presenting Data – Load Management

Load Management

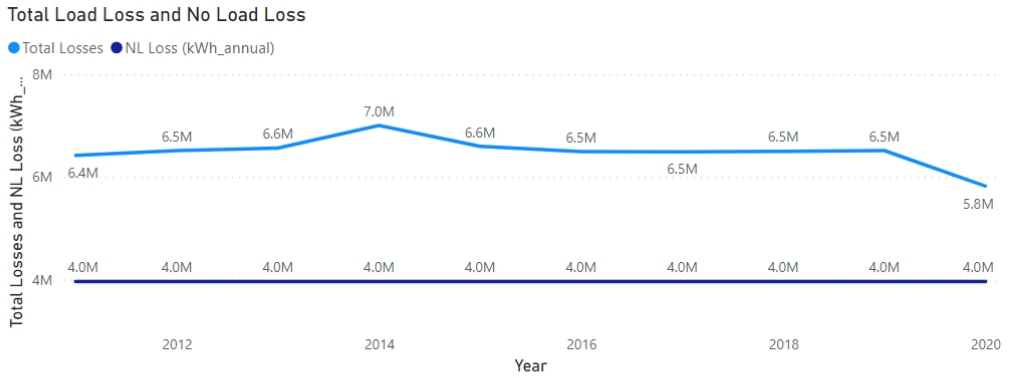


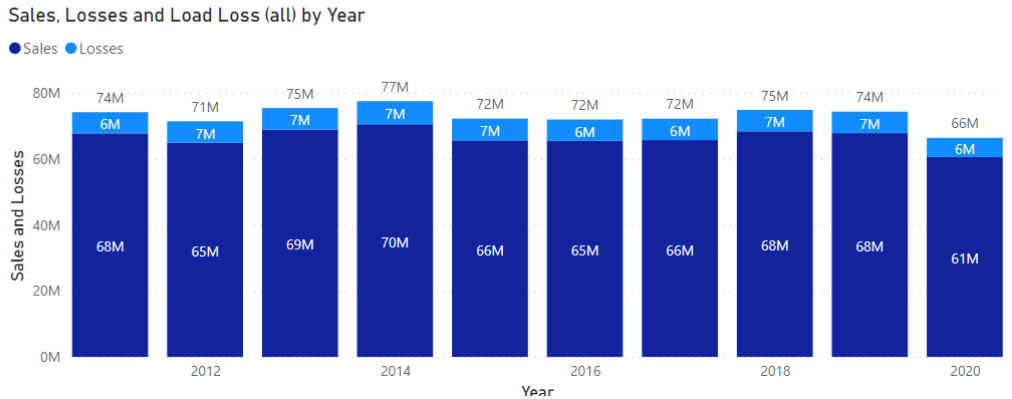
Date	Avg Temp	Max Temp	Min Temp

Date	Control Type	Control DateTime Start	Control DateTime End
3/1/2021	EH	7:00:00 AM	9:00:00 AM
3/1/2021	EH	6:00:00 PM	7:00:00 PM
3/1/2021	WH	7:00:00 AM	11:00:00 AM
3/3/2021	WH	7:00:00 AM	11:00:00 AM

Date	Monthly Peak Day
3/2/2021	TRUE

Transformer Load Loss / No Load Loss





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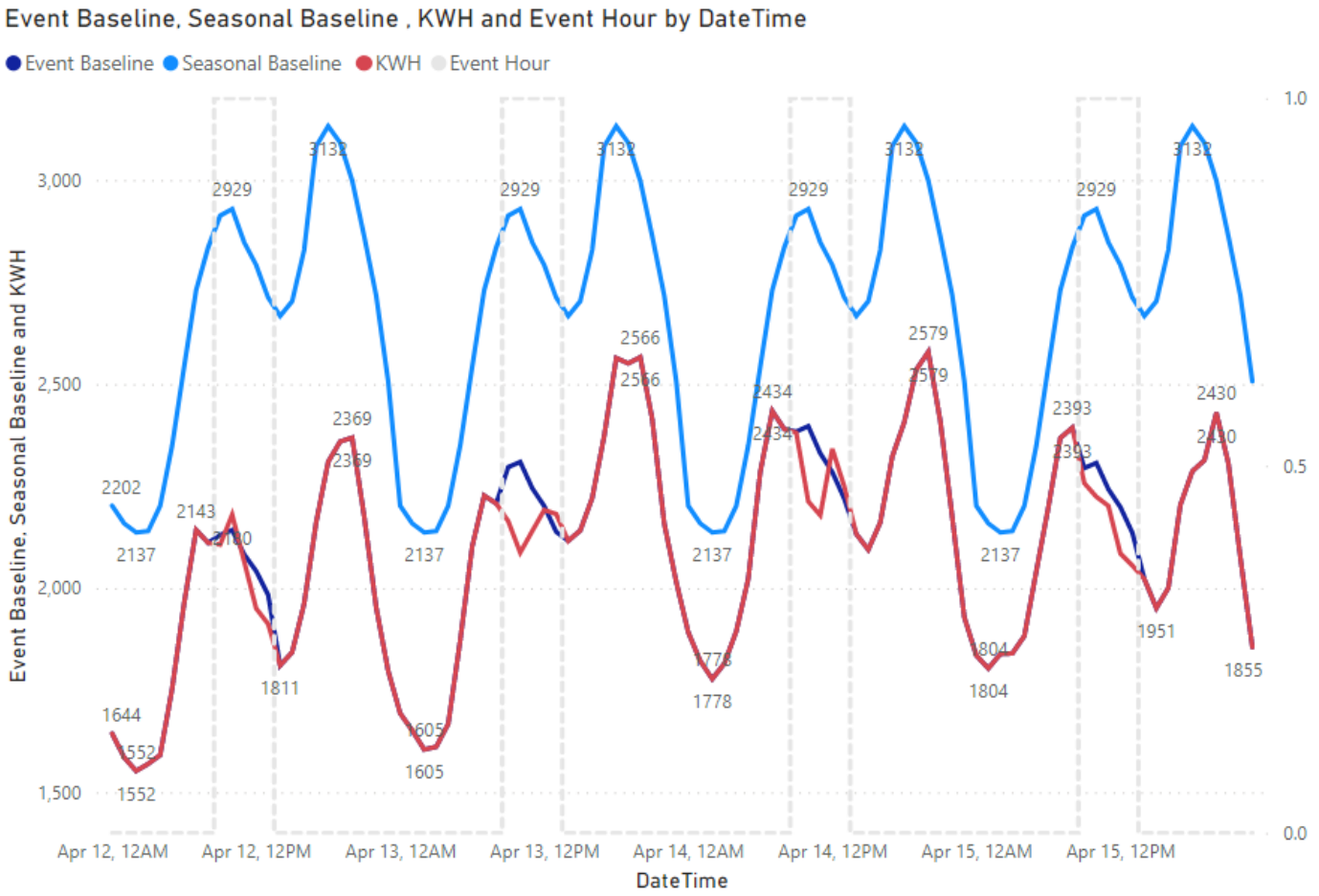
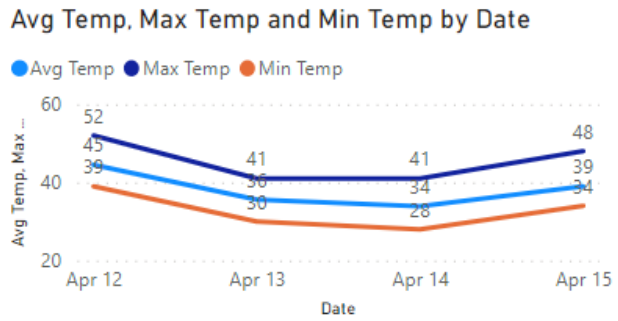
Load Management Analysis

Date

4/12/2021 4/15/2021





Date	Avg Temp	Max Temp	Min Temp
4/12/2021	45	52	39
4/13/2021	36	41	30
4/14/2021	34	41	28
Total	**38**	**46**	**33**

Date	Control Type	Control DateTime Start	Control DateTime End
4/12/2021	WH	9:00:00 AM	2:00:00 PM
4/13/2021	WH	9:00:00 AM	2:00:00 PM
4/14/2021	WH	9:00:00 AM	2:00:00 PM
4/14/2021	EH	10:00:00 AM	12:00:00 PM

Date	Monthly Peak Day
4/14/2021	TRUE

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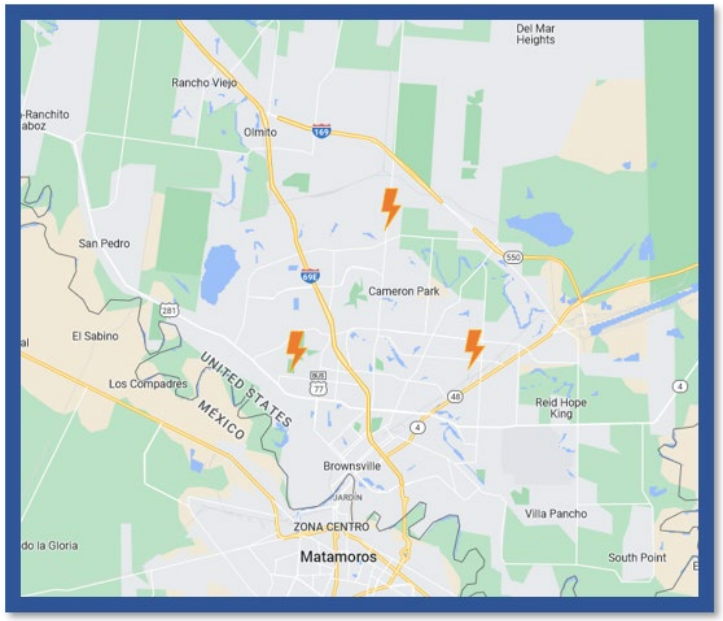
Presenting Data – Outage Management



Current Premises Affected	Premises Restored Last 24 Hours
24	1063

Planned Outages	Unplanned Outages	Forced Outages
0	3	0

Events

Outage Start Date	Substation	Feeder	Premises Affected	Cause	Restored Date	Restored Time Frame	Duration (Hrs:Min:Sec)	Outage Type	Restored?
##########	SOUTHPLANT	Feeder 1	24	Wind	--	Pending	--	Unplanned	N
5/2/22 7:58 PM	6THSTREET	Feeder 2	45	Tree	5/2/22 10:16 PM	9:00 PM - 8:00 AM	2:18:00	Unplanned	Y
5/2/22 7:30 PM	NEWMIDTOWN	Feeder 4	43	Animal	5/2/22 8:39 PM	4:00 PM - 9:00 PM	1:09:00	Unplanned	Y
5/2/22 5:16 PM	NEWMIDTOWN	Feeder 5	6	Animal	5/2/22 8:54 PM	4:00 PM - 9:00 PM	3:38:00	Unplanned	Y
5/2/22 4:37 PM	PRICEROAD	Feeder 2	6	Motor Vehicle Accident	5/2/22 5:19 PM	4:00 PM - 9:00 PM	0:42:00	Unplanned	Y
5/2/22 1:28 PM	MILHWY	Feeder 4	126	Accident	5/2/22 4:07 PM	4:00 PM - 9:00 PM	2:39:00	Unplanned	Y

Key Accounts

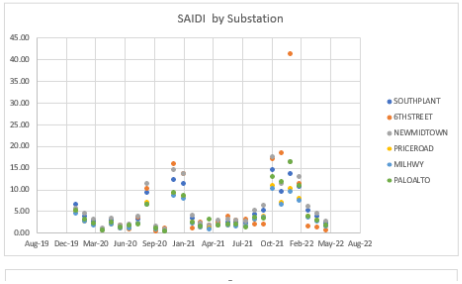
Outage Start Date	Substation	Feeder	Account Name	Account Type	Outage Duration	ETR	Restored Time	Cause	Restored?
##########	SOUTHPLANT	Feeder 1	Department Store	Commercial	--	5/2/22 10:30 PM	--	Wind	N
##########	SOUTHPLANT	Feeder 2	Residential Home #1	Residential	--	5/2/22 10:30 PM	--	Wind	N
##########	SOUTHPLANT	Feeder 4	Restaurant #1	Commercial	--	5/2/22 10:30 PM	--	Wind	N
##########	SOUTHPLANT	Feeder 5	Restaurant #2	Commercial	--	5/2/22 10:30 PM	--	Wind	N
##########	SOUTHPLANT	Feeder 2	Gas Station	Commercial	--	5/2/22 10:30 PM	--	Wind	N
##########	SOUTHPLANT	Feeder 4	Bank	Commercial	--	5/2/22 10:30 PM	--	Wind	N

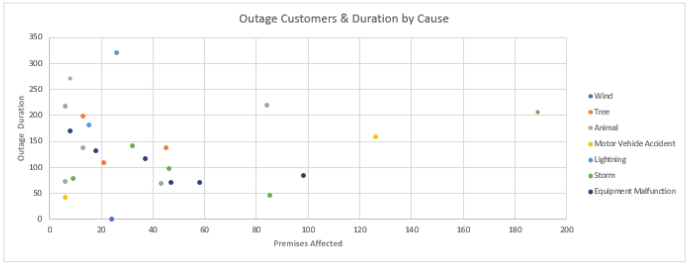
Outage Metrics by Substation

	CAIDI	SAIDI	Total Outage Min.	Major Events
SOUTHPLANT	2.81	3.50	456	1
6THSTREET	8.83	13.10	1051	1
NEWMIDTOWN	2.04	8.15	872	0
PRICEROAD	7.72	6.86	355	0
MILHWY	1.44	2.66	425	0
PALOALTO	15.23	4.24	198	0

% of Outages by Cause

Substation	Winter Storm	Animal	Motor Vehicle Accident	Equipment Malfunction	Planned	Forced	Tree	Total
SOUTHPLANT	14%	36%	14%	14%	7%	0%	14%	100%
6THSTREET	14%	14%	7%	36%	0%	0%	7%	100%
NEWMIDTOWN	7%	21%	14%	21%	7%	0%	64%	100%
PRICEROAD	14%	29%	14%	43%	0%	0%	7%	100%
MILHWY	14%	14%	7%	29%	0%	0%	14%	100%
PALOALTO	7%	14%	7%	14%	0%	0%	0%	100%





Events

Outage Date	Substation	Feeder	Premises Affected	Duration (Hrs:Min:Secs)	Duration (Min)	ETR	Restored Date	Restored Time Frame	Delta (Hrs:Min:Secs)	Cause	Restored?
5/2/22 10:06 PM	SOUTHPLANT	Feeder 1	24	--	0	5/2/22 10:36 PM	--	Pending	--	Wind	N
5/2/22 7:58 PM	6THSTREET	Feeder 2	45	2:18:00	138	5/2/22 10:46 PM	5/2/22 10:16 PM	9:00 PM - 8:00 AM	0:30:00	Tree	Y
5/2/22 7:30 PM	NEWMIDTOWN	Feeder 4	43	1:09:00	69	5/2/22 8:30 PM	5/2/22 8:39 PM	4:00 PM - 9:00 PM	0:09:00	Animal	Y
5/2/22 5:16 PM	NEWMIDTOWN	Feeder 5	6	3:38:00	218	5/2/22 8:30 PM	5/2/22 8:54 PM	4:00 PM - 9:00 PM	0:24:00	Animal	Y
5/2/22 4:37 PM	PRICEROAD	Feeder 2	6	0:42:00	42	5/2/22 5:32 PM	5/2/22 5:19 PM	4:00 PM - 9:00 PM	0:13:00	Motor Vehicle Accident	Y
5/2/22 1:28 PM	MILHWY	Feeder 4	126	2:39:00	159	5/2/22 5:32 PM	5/2/22 4:07 PM	4:00 PM - 9:00 PM	1:25:00	Motor Vehicle Accident	Y
5/2/22 9:57 AM	6TH STREET	Feeder 1	8	4:32:00	272	5/2/22 1:25 PM	5/2/22 2:29 PM	11:00 AM - 4:00 PM	1:04:00	Animal	Y
5/2/22 7:38 AM	6TH STREET	Feeder 2	21	1:49:00	109	5/2/22 9:45 AM	5/2/22 9:27 AM	8:00 AM - 11:00 AM	0:18:00	Tree	Y
5/2/22 3:13 AM	PALOALTO	Feeder 6	13	3:18:00	198	5/2/22 6:00 AM	5/2/22 6:31 AM	9:00 PM - 8:00 AM	0:31:00	Tree	Y
5/1/22 11:58 PM	SOUTHPLANT	Feeder 6	15	3:02:00	182	5/2/22 12:05 AM	5/2/22 3:00 AM	9:00 PM - 8:00 AM	2:55:00	Lightning	Y
5/1/22 10:39 PM	6THSTREET	Feeder 5	26	5:21:00	321	5/2/22 2:16 AM	5/2/22 4:00 AM	9:00 PM - 8:00 AM	1:44:00	Lightning	Y
5/1/22 9:45 PM	NEWMIDTOWN	Feeder 2	9	1:18:00	78	5/1/22 10:00 PM	5/1/22 11:03 PM	9:00 PM - 8:00 AM	1:03:00	Storm	Y

Time Period Restored	Premises Restored
Pending	24
11:00 AM - 4:00 PM	131
4:00 PM - 9:00 PM	227
8:00 AM - 11:00 AM	164
9:00 PM - 8:00 AM	541
Grand Total	1063

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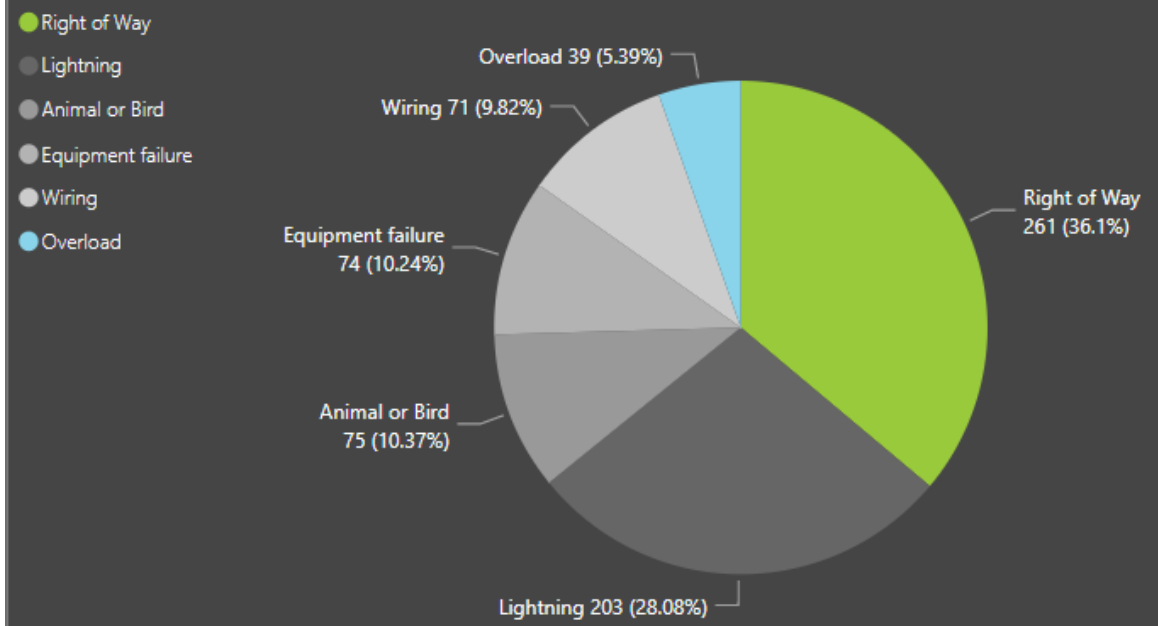
Outage Summary

Count of Outages by Cause



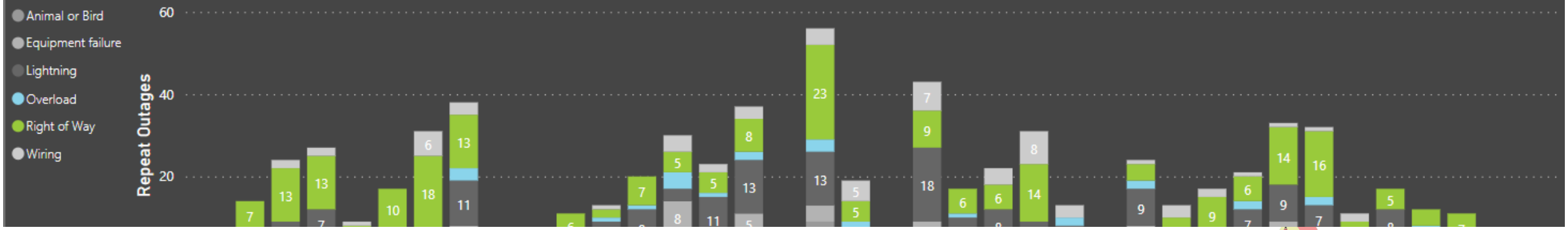
Exclude Cause Code

- Select all
- Animal or Bird
- Equipment failure
- Lightning
- Overload
- Right of Way
- Wiring

Duration (in Mins.)	Affected Customers	Total Customers
4.13M	41591	84608

SAIDI	CAIDI	SAIFI
48.86633	99.40807	8.14406

Repeat Outages by Sub and Cause



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Data Analytics Recommendations

- Start with analyzing the small data available to build processes
  - Once AMI is in place, feed in the additional data into the visualizations
- Connect and share information across platforms
  - GIS
  - Reporting engines
- Start processing reports and data based on desired outcome and audience
  - Operations (transformer loading, peak days, outage/restore etc.)
  - Water (leaks, pressure, flow, etc.)
  - AMI (read rates, alarms/events, maintenance)
  - Council reporting and updates (financial, project status, outages, etc.)

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Next Steps and Budget

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Next Steps Towards Future State

1. **Deploy and implement AMI and CIS**
   - Take care in coordination, deployment, and integrations
   - Manage the meter configurations to support data and future rate updates/changes
2. **Continue to the work on GIS**
   - Use the updated tools to maintain the current system, add in the AMI locations too
3. **Leverage AMI to further Consumer engagement on alerts and notifications**
   - Water leak and potential frozen pipe notifications
   - Billing posted and available
   - Etc.
4. **Use GIS, AMI, and Visualizations to further initiatives**
   - Implement a visualization tool (PowerBI or the like)
   - Reporting needs (outage, transformers, leaks, read rates, etc.)
   - Stay up on level 2 in-home chargers and DG installations
   - Stay up on load management changes and possible implementation
5. **After AMI and CIS is complete**
   - Focus on asset management and move to AMI “maintenance” mode
   - Explore a Customer Portal and new CIS ability to process payments

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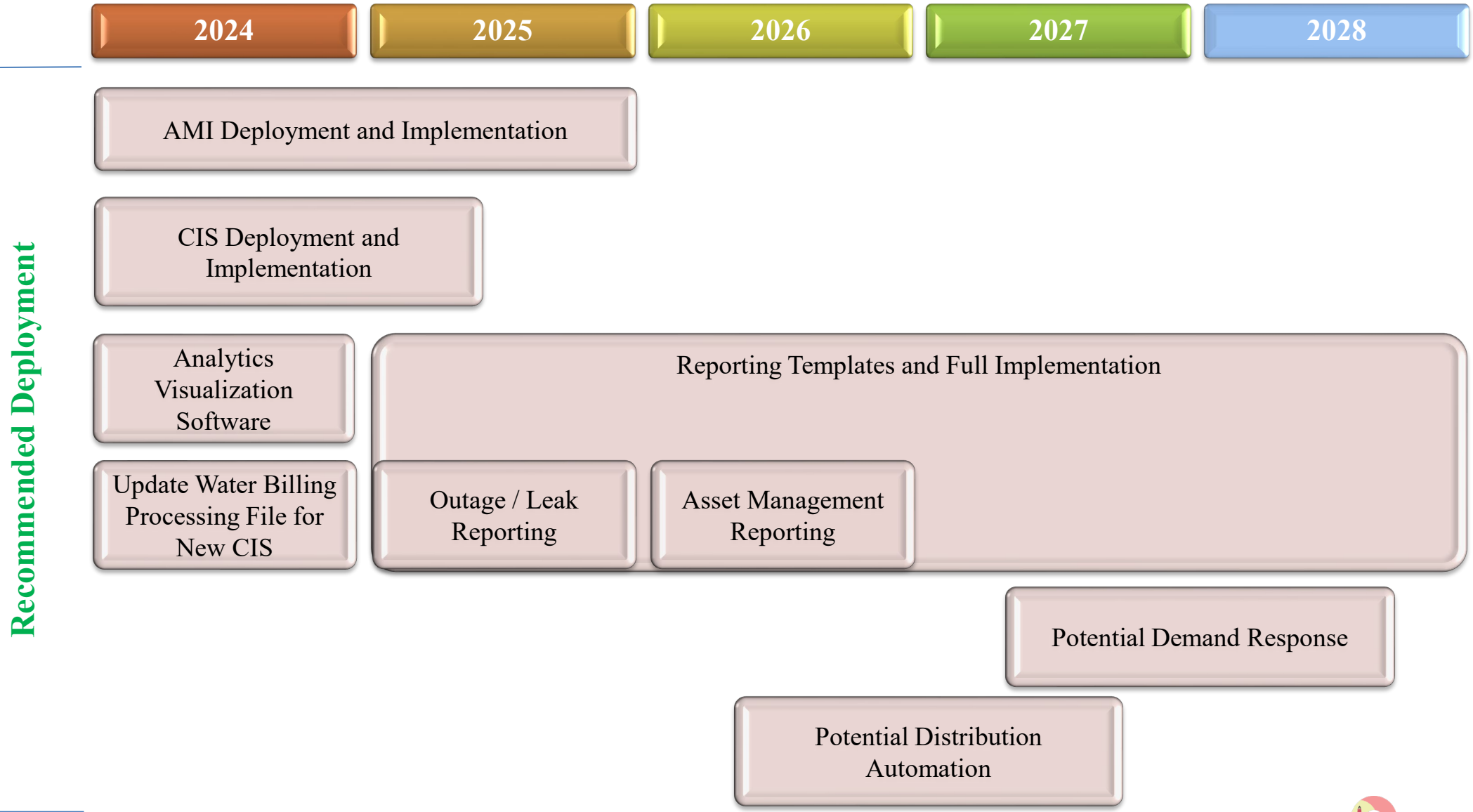
Recommended Implementation Sequence



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Deployment Costs

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Capital & Implementation Cost Timeline Summary Total

The table below summarizes the estimated capital costs for deployment.

- Major cost driver is the AMI
- Most programs are incremental enhancements to maximize existing system or small costs for higher impact.

Programs	2024	2025	2026	2027	2028	Total
GIS Updates, Outages, and Utility Network Upgrades	$0	$0	$25,000	$0	$200,000	**$225,000**
AMI Deployment and Implementation Support	$485,000	$1,875,000	$0	$0	$225,000	**$2,585,000**
Township Billing Import File Update	$6,500	$0	$0	$0	$0	**$6,500**
Reporting Tools and Visualizations	$15,000	$5,000	$10,000	$0	$0	**$30,000**
Total	**$506,500**	**$1,880,000**	**$35,000**	**$0**	**$425,000**	**$2,850,000**

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Capital Cost Timeline Summary

Programs	Capital & Engineering Costs				
	2024	2025	2026	2027	2028
GIS and Outages					
DER / EV					
See Demand Response	$0	$0	$0	$0	$0
GIS for OMS					
GIS Integration to AMI and Visualization of Outages	$0	$0	$25,000	$0	$0
Upgrade to Utility Network					$200,000
Ongoing Support for City and Utility Department					
PSE Services - maintenance and Updates	$0	$0	$0	$0	$0
Charlevoix FTE ($55k/year Fully Loaded)	$0	$0	$0	$0	$0
AclaraONE AMI					
AMI Deployment	$360,000	$1,800,000	$0	$0	$0
AMI and CIS Implementation Support	$125,000	$75,000	$0	$0	$0
Future Distribution Automation	$0	$0	$0	$0	$0
Future Demand Response Program	$0	$0	$0	$0	$225,000
Township Billing (Water)					
Update to Billing Imprort File Caselle to New CIS	$6,500	$0	$0	$0	$0
Reporting Tools and Visualizations					
Power BI Pro Licenses per year	$0	$0	$0	$0	$0
Build Reporting from Data Sources	$15,000	$0	$0	$0	$0
Asset Management Reporting	$0	$0	$10,000	$0	$0
Outage, Leaks, and other Templates	$0	$5,000	$0	$0	$0
Total	$528,500	$1,880,000	$35,000	$0	$425,000

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Operational and Maintenance (O&M) Cost Timeline Summary Total

The table below summarizes estimated O&M costs for deployment.

Programs	2024	2025	2026	2027	2028	Total
GIS Updates, Outages, and Utility Network Upgrades	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
AMI AclaraONE On-Going Fees	$5,000	$27,000	$27,000	$27,000	$28,400	**$115,000**
Township Billing Import File Update	$0	$0	$0	$0	$0	**$0**
Reporting Tools and Visualizations	$13,000	$13,000	$13,000	$13,000	$13,000	**$65,000**
Total	**$68,000**	**$90,000**	**$90,000**	**$90,000**	**$92,000**	**$430,000**

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O&M Timeline Summary

Programs	O&M Costs 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
GIS and Outages										
DER / EV										
See Demand Response	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
GIS for OMS										
GIS Integration to AMI and Visualization of Outages	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Upgrade to Utility Network	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ongoing Support for City and Utility Department										
PSE Services - maintenance and Updates	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
Charlevoix FTE ($55k/year Fully Loaded)	$0	$76,000	$76,000	$76,000	$76,000	$76,000	$76,000	$76,000	$76,000	$76,000
AclaraONE AMI										
AMI Deployment	$5,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000	$27,000
AMI and CIS Implementation Support	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Future Distribution Automation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Future Demand Response Program	$0	$0	$0	$0	$1,400	$1,400	$1,400	$1,400	$1,400	$1,400
Township Billing (Water)										
Update to Billing Imprort File Caselle to New CIS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reporting Tools and Visualizations										
Power BI Pro Licenses per year	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600
Build Reporting from Data Sources	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500
Asset Management Reporting	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Outage, Leaks, and other Templates	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$68,100	$90,100	$90,100	$90,100	$91,500	$91,500	$91,500	$91,500	$91,500	$91,500

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Next Steps Towards Future State

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Thank You

We look forward to helping you achieve your goals.

Power System Engineering, Inc.

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