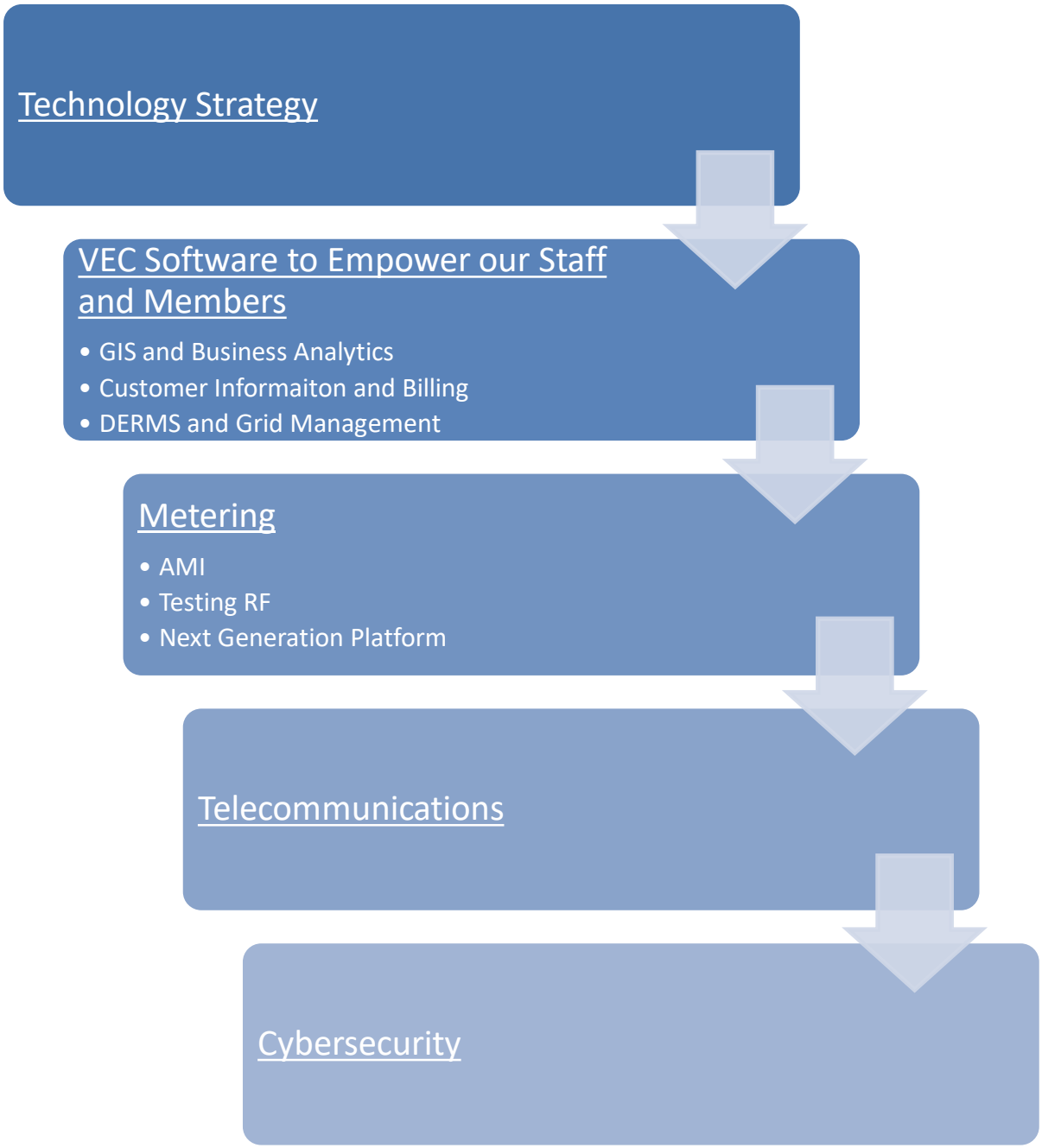
6 Data and Technology

6.1 Introduction

VEC's technology platforms and tools are fundamental to the operation of a safe, affordable and reliable electric grid. They enable us to be proactive with our members and investments as well as recover from major events. This section covers our technology strategy, the existing tools we use today, our metering platform, telecommunications and our processes for keeping our data and our members' data secure.



6.2 Technology Strategy

VEC's goal is to update its long-term Technology strategy in Q4 of 2022. This includes a review of several key focus areas:

- **Cybersecurity –** We will maintain and enhance security of the enterprise, to protect member and employee data. VEC continues to focus on our cybersecurity posture with a combination of training and new technology.
- **Business Software** – Through training and additional products we will enhance business performance and communications. We will work on methods to enhance data collection and leverage data from advanced technologies.
- **Next Generation Metering -** Our metering system is end of life and with increased grid complexity, we will need higher resolution data and offerings to our members.
- **Operational Technology (OT)** – We will implement tools that orchestrate DERs and integrate existing technology. In addition, we will maintain existing hardware and software.
- **GIS and Mapping –** We will focus on expanding internal abilities through new tools and providing external stakeholders with more capabilities through online access.
- **Business Equipment** – We will modernize the technology resources on which the new products and tools run. VEC continues to focus on mobile technologies and to identify ways to enhance remote work capabilities.

6.3 VEC Software to Empower Our Staff and Members

VEC has several key data sources and analytical tools critical to the day-to-day functions of the cooperative that us to understand the complex power system, VEC members' needs and usage, and enhancements to utility operations. Data and data analysis are increasingly important as the grid becomes more complex through the addition of distributed generation, battery storage and other load management devices.

These data and tools used by VEC are listed in further detail below.

6.3.1 National Information Solutions Cooperative (NISC)

VEC utilizes NISC's software company wide from HR time entry, to customer information, to GIS visualization, to lineman mobile tools and for accounting and billing. NISC develops and supports software and hardware solutions for our Member-Owners who are primarily utility cooperatives and broadband companies across the nation.

6.3.2 Geographic Information System (GIS)

VEC's Geographic Information System (GIS) is fundamental to VEC's analytics tools. GIS sits at the center of our Customer Information System (CIS/Service) and Accounting Business Solution (ABS/Financials) and is integrated with VEC's engineering model. The system runs on an ArcGIS server, which is an Environmental Systems Research Institute (ESRI) product.

GIS map editing allows new services, line relocations, and other changes to the VEC system to be added to the GIS as part of the normal workflow of VEC's engineering and design staff. In this way, all portions of the VEC electric system can be displayed in a series of mapping tools. The electric connectivity of the GIS is used to integrate with VEC's Outage Management System (OMS), also created by NISC. The GIS system is integrated with Clearion Vegetation Management software used to schedule and track the clearing of VEC rights-of-way.

NISC MapViewer

VEC's office staff rely on a web-based GIS tool (MapViewer) to view the system, protective devices, and many different background layers such as wetlands and parcels

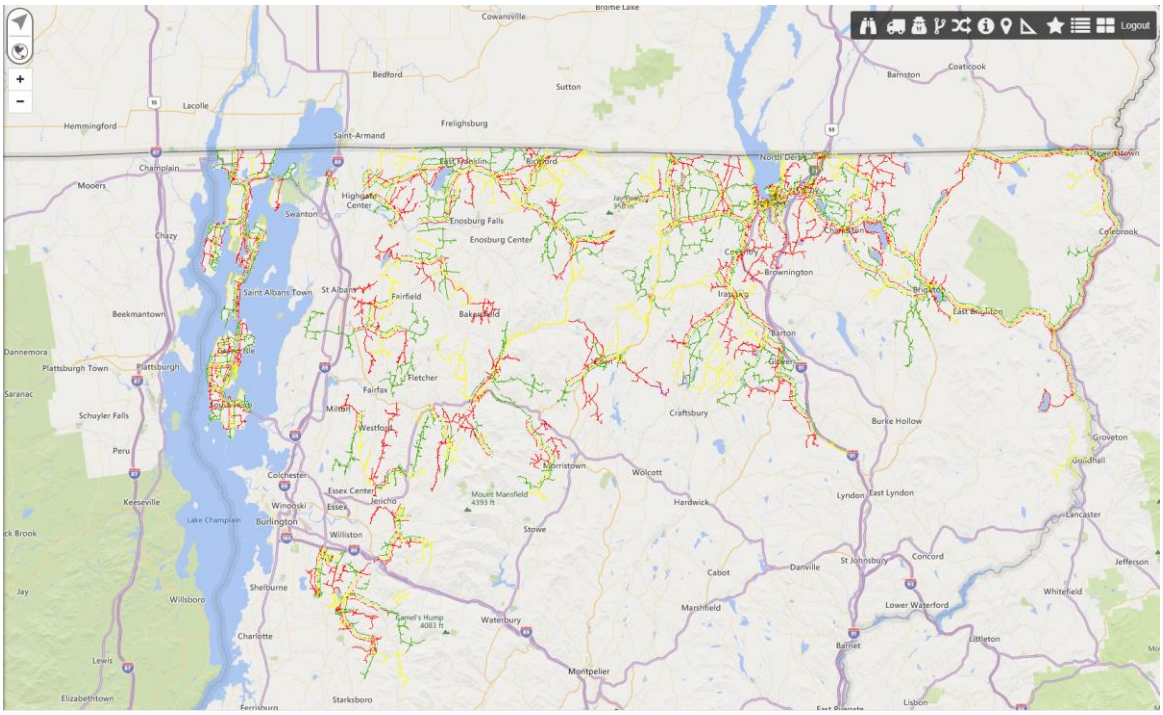


Figure 6.3.2.A NISC MapViewer

NISC AppSuite

Field staff can view the same information on their iPhones/iPads through a tool called AppSuite. They can also manage their task workflow, view outages, and perform paperless inspections.

Figure 6.3.2.B. NISC AppSuite

Clearion Vegetation Management Software

Clearion is VEC's Vegetation Management software. It is also based off ESRI's ArcGIS platform and allows VEC to plan, record, and visualize work related to Vegetation management.

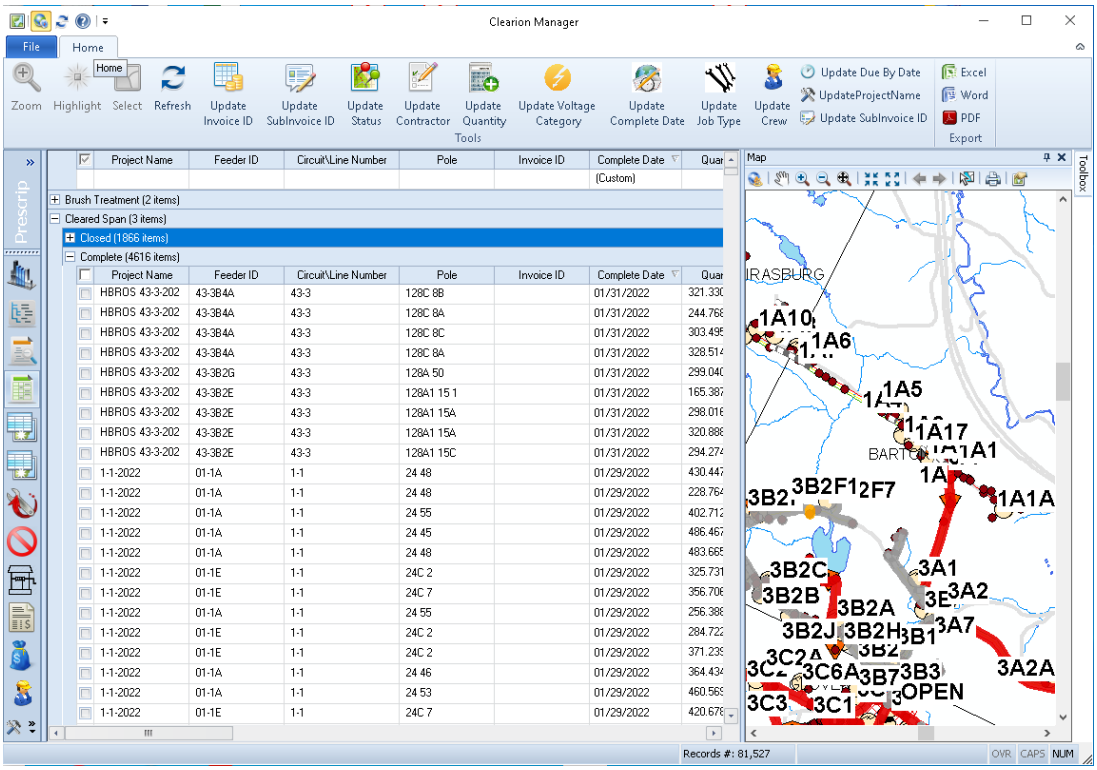


Figure 6.3.2.C. Clearion Manager software

In January of 2021, VEC and its contract crews began using a mobile platform, ClearionX, to manage work directly from the field.

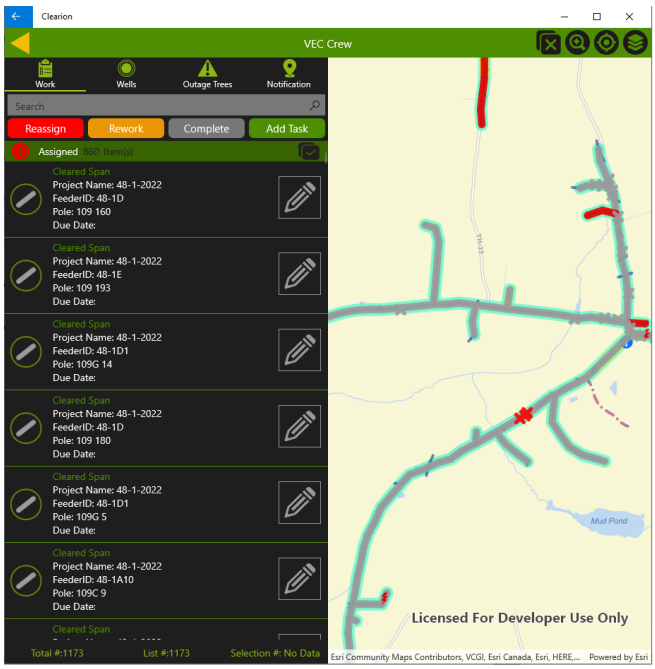


Figure 6.3.2.D. ClearionX Software

Public Access

VEC distributes shape files of the electric system to the Vermont Open Geodata Portal via VCGI (Vermont Center for Geographic Information). These shape files include pole locations, wire (overhead and underground), and number of phases. While this information is limited, VEC regularly distributes more detailed GIS data to several utilities, state entities, and supporting vendors for uses such as system planning, broadband deployment, or utility location services to support the DigSafe program.

VEC has recently begun work on an ArcGIS online portal that will enable stakeholders to pull live data such as poles, three phase lines, generation locations.

6.3.3 Customer Information and Billing

NISC Service and Financials

Our NISC Customer Information System (CIS/Service) and Accounting Business Solution (ABS/Financials) house our member databases for location, billing, and equipment. These platforms are fundamental to many of the tools we use at VEC.

SmartHub

In addition, we use iVUE for billing and for VEC's consumer interface application, SmartHub. As discussed in an earlier section, SmartHub is a mobile and web-based application that allows members and VEC to view usage information and set alerts. This tool empowers VEC members to make changes that help them reduce their energy usage and ultimately lower their energy bill. SmartHub also provides members with a method of notifying VEC of an outage or receiving notifications from VEC.

6.3.4 System Planning

VEC's GIS and AMI data are fundamental to system planning efforts. Automated systems feed data from both platforms into the Engineering Milsoft WindMil model.

Milsoft WindMil Model

At the heart of system planning is VEC's Milsoft Engineering model which allows VEC system engineers to perform specific studies and identify voltage or loading constraints on new loads, new generation, and system upgrades. In addition, the tool is also used to coordinate protective devices such as fuses and reclosers.

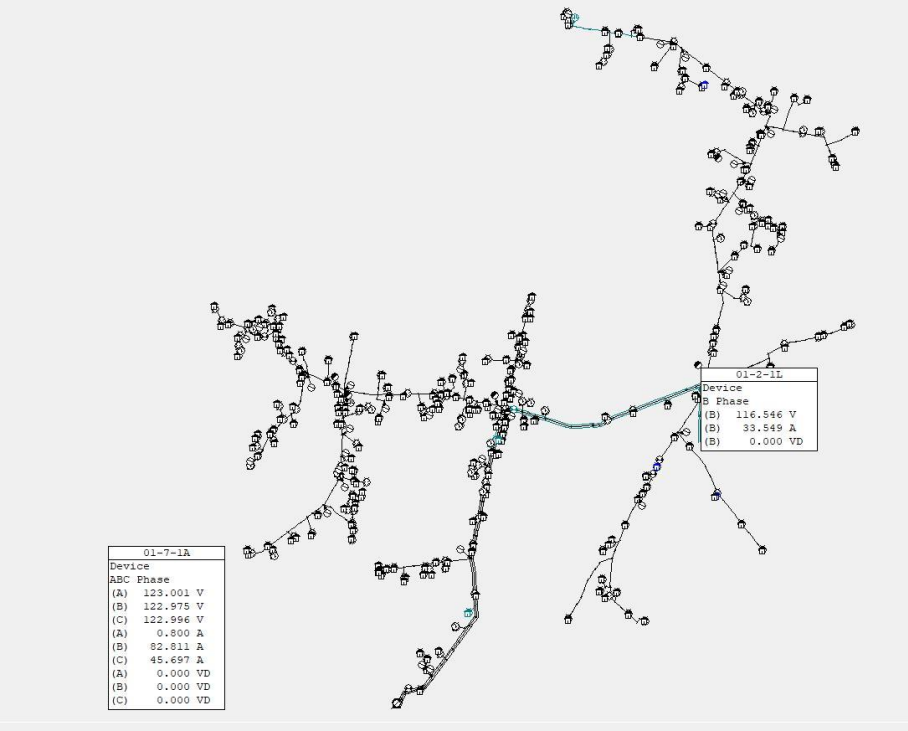


Figure 6.3.4.A VEC Fairfax 01-1A circuit engineering model

6.3.5 Business Analytics Tools

VEC currently uses a multitude of reporting tools and manual processes to analyze data internally. By automating some of these manual processes and empowering users to visualize the information we expect to gain new insights on our members and services. VEC is trying to consolidate the three business analytics tools currently in use:

- NISC Mosaic – Used to analyze work order financials and provide outage reports.
- iDashboards – Used to analyze member application and work management data.
- Workday Adaptive Planning – Currently in development but will be used for budgeting and forecasting.

6.3.6 Moving from a DNO to a DSO Through Data Orchestration

As intermittent generation becomes more localized and loads continue to electrify, VEC needs tools and software that provide visibility and enable us to manage both the load and intermittent generation so that we can continue to meet the reliability needs of our members. We are moving from a Distribution Network Operator (DNO) that was responsible for just poles and wires to a Distribution System Operator (DOS) who is managing may different kinds of devices.

The vast quantity of devices on the grid (distributed generation, electric heating and transportation) has increased complexity and made orchestration challenging. VEC utilizes and hopes to expand the following operational technology tools in this space.

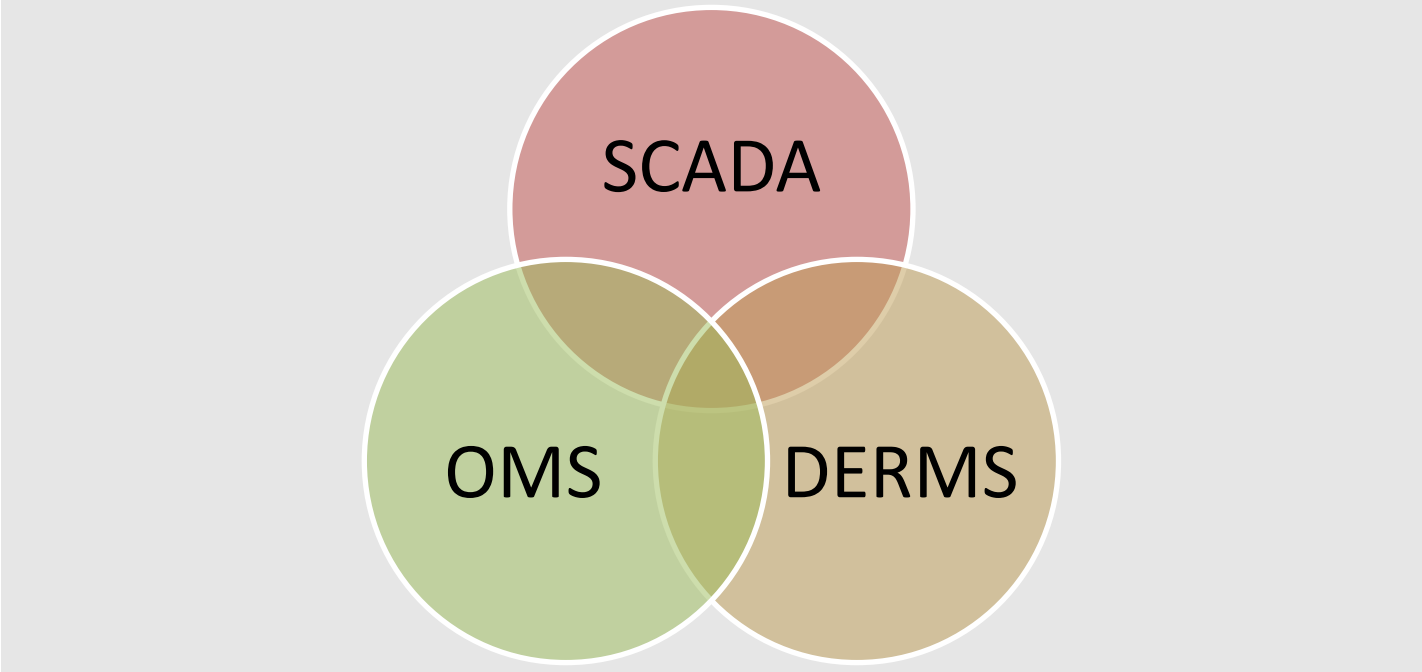


Figure 6.3.6.A. Overview of Grid Managmenet Tools

Supervisory Control and Data Acquisition (SCADA)

Existing System

SCADA enables VEC to view real time data as to the status of equipment and other assets (open vs. closed states on reclosers for instance) and their analog values (e.g., power, voltage, current, etc.). It also allows us to remotely operate assets such as reclosers and switches.

In 2011, VEC received a $5.7 million dollar grant from the Department of Energy that facilitated the modernization and upgrade of almost all VEC substation reclosers and regulators and implementation of SCADA to over 65 locations including at all VEC substations and metering points (roughly 11,000 data points). VEC supplies much of this information to VELCO for operational and planning purposes via an Inter-Control Center Communications Protocol (ICCP) connection. These investments took place over four years and VEC was able to complete almost $11.4 million worth of projects with a 50 percent cost share with the Department of Energy.

Remote or supervisory operation allows VEC to save labor hours and reduce outage times by allowing remote switching and tagging, reducing or eliminating travel time to the field or between devices. Travel and labor hours can be reduced by eliminating trips to the field to place monitoring devices, to perform switching and tagging for maintenance and outage restoration activities and to perform operational mandates such as voltage reductions tests or events. The overall result is shorter outages and lower costs.

Real-time data monitoring (2-second intervals) provides visibility for system operations to monitor and react to events on the power system. In addition, as VEC sees more multi-direction electric flows throughout its system, the real time data provides engineering and planning with a view into the system that can be used to review system irregularities (such as voltage drops or outages) and planning analysis (identification of substation transformer upgrades or load balancing). While this data is a great asset, one of the challenges VEC faces is data validation and accuracy. The devices and relays that provide data to the Remote Terminal Units (RTUs) are not revenue grade and generally have an accuracy rate between three to five percent. This level of accuracy is adequate for high level

planning but VEC continues to rely on revenue grade Electro Industries Nexus meters at its substations or Power Quality (PQ) recorders to review system events.

Long Term Strategy

VEC does not expect to expand its SCADA system any further but rather focus on maintaining devices and security of its existing system. In addition, we hope to integrate our SCADA system with OMS to further speed up outage identification and restoration.

OSIsoft PI Historian

VEC utilizes an OSIsoft PI Historian, which archives SCADA data for use in post-mortem review of system events and anomalies as well as for system planning. VEC has built dashboards to enable mobile access to SCADA data for use by field personnel, which provides near real time visuals of the system during SCADA commissioning and during equipment maintenance. The snapshot below shows the one line for VEC's Fairfax #1 Substation with reclosers in the closed position for each main circuit (red) and no faults or trips (green) along with other vital information.

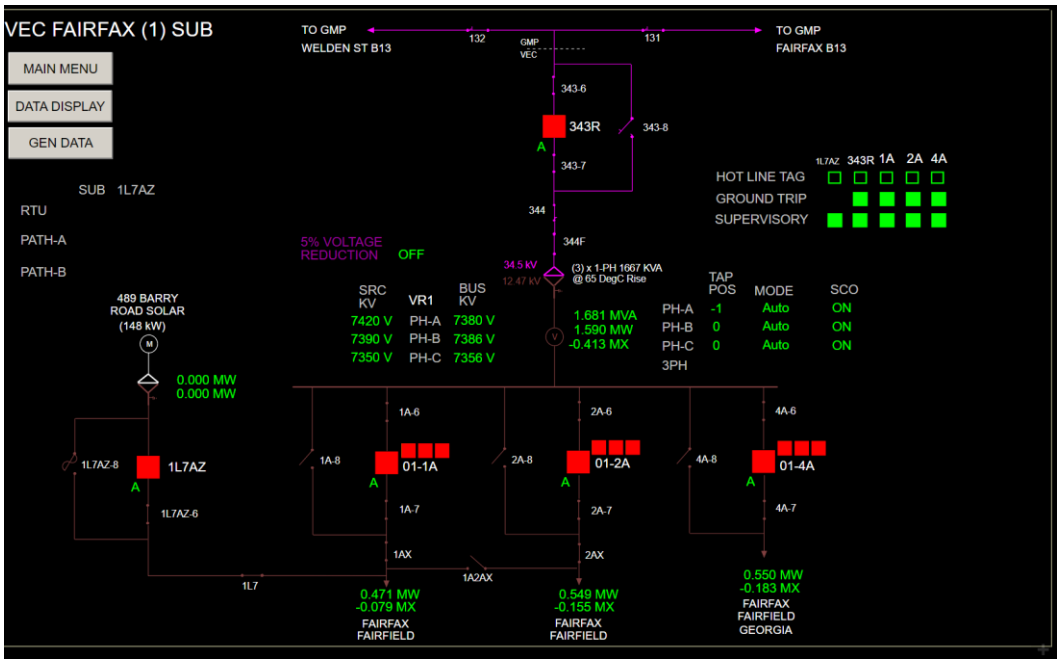


Figure 6.3.6.B. OSIsoft PI SCADA display (near real time data)

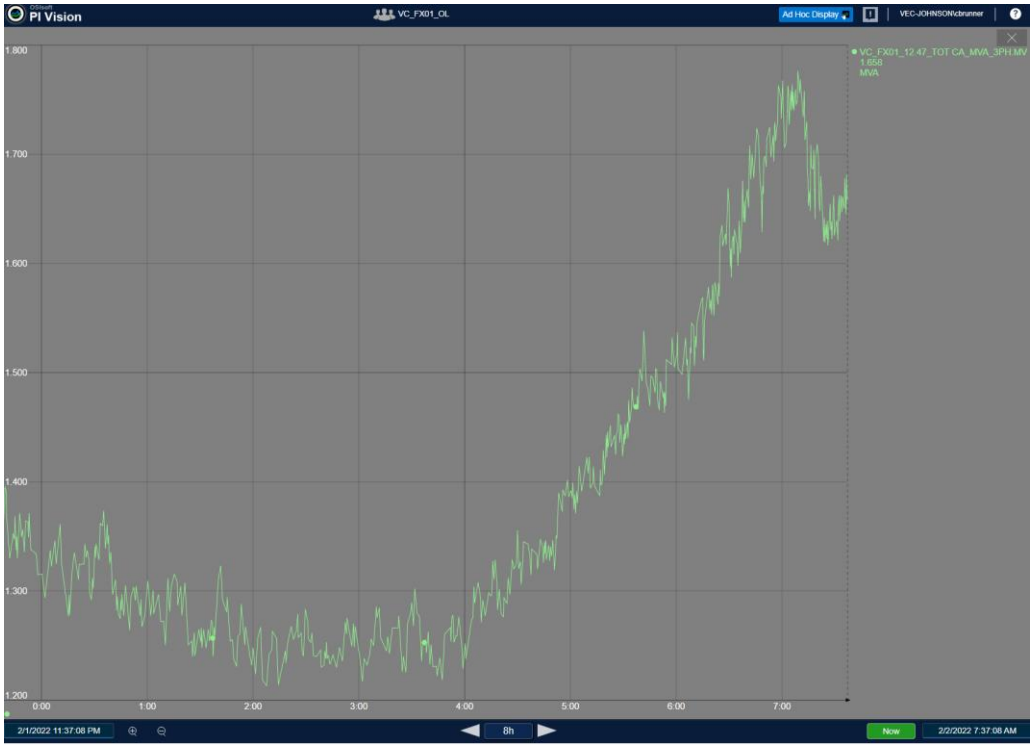


Figure 6.3.6.C. OSIsoft PI SCADA historical data

EnergyHub Gridsolver

In 2020, VEC began a yearlong project with a Burlington, Vermont based company, Packetized Energy (recently acquired by EnergyHub), to build a GIS based AMI analytics tool. The tool was initially designed to provide VEC employees with a visual graph showing peak loads by transformer with the ability to dive down into individual meter loads. VEC worked with Packetized to ensure that the AMI and GIS data were updated daily.

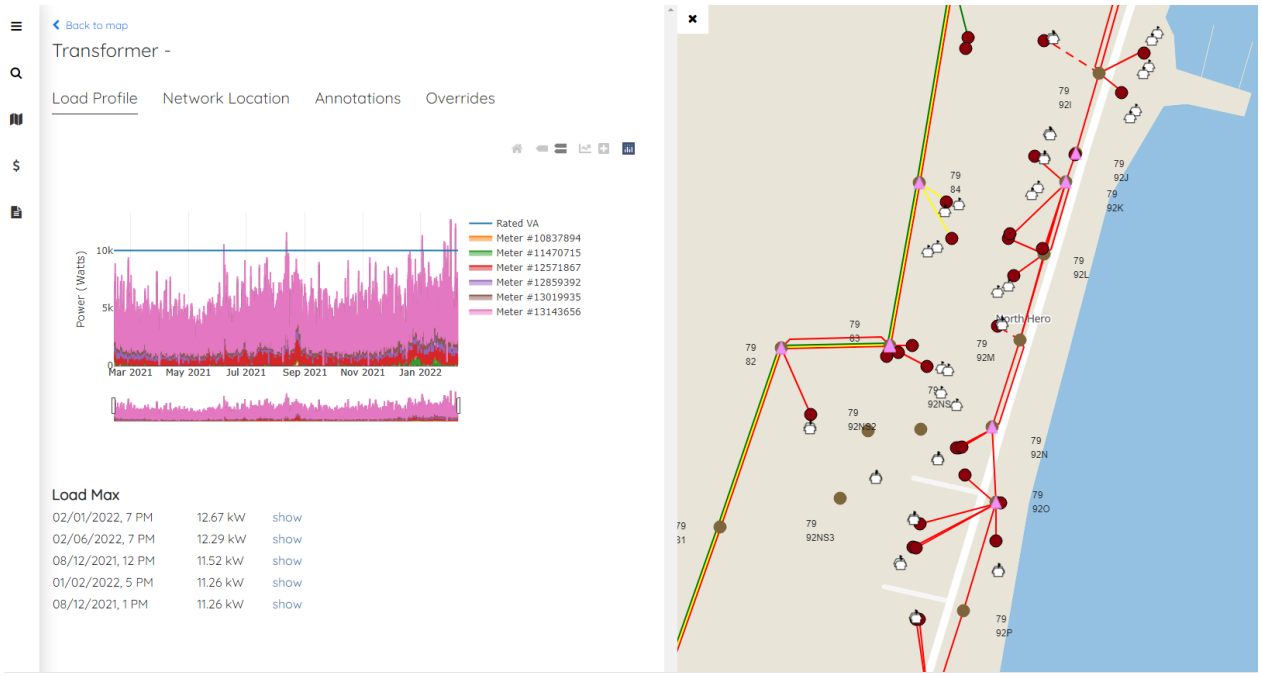
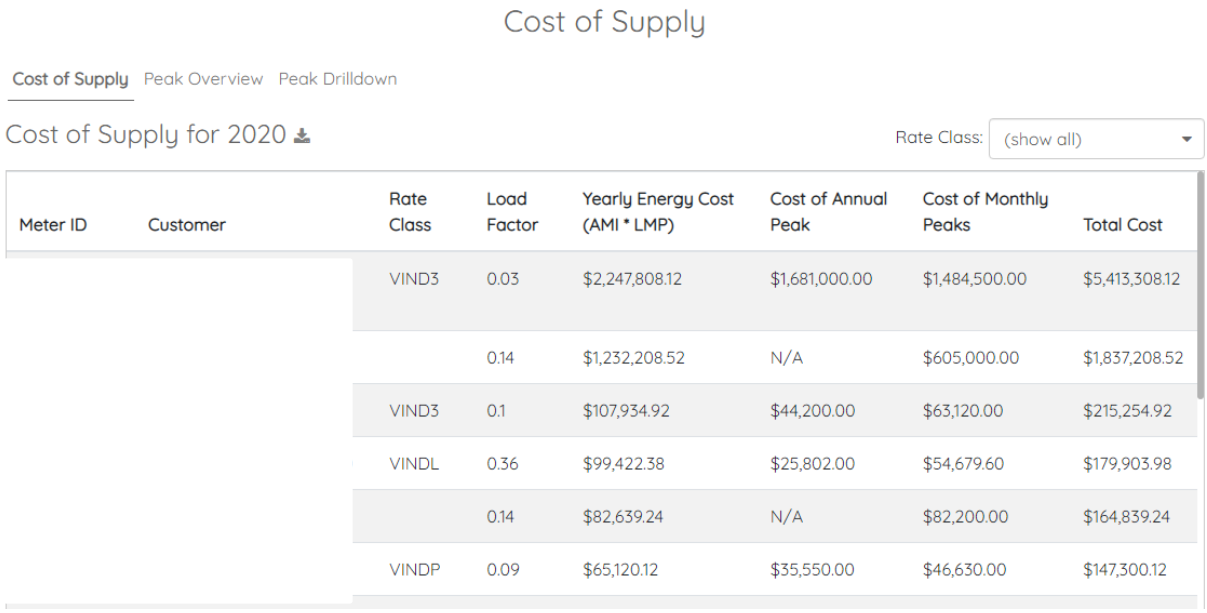


Figure 6.3.6.G. Packetized Gridsolver

In addition to the transformer load management tool, Packetized built a tool that allowed VEC to see which of its members were most impacting the annual ISONE peaks and the Vermont monthly peaks. This tool allows VEC to develop targeted load management programs to its members and is sortable by rate class.



Meter ID	Customer	Rate Class	Load Factor	Yearly Energy Cost (AMI * LMP)	Cost of Annual Peak	Cost of Monthly Peaks	Total Cost
		VIND3	0.03	$2,247,808.12	$1,681,000.00	$1,484,500.00	$5,413,308.12
			0.14	$1,232,208.52	N/A	$605,000.00	$1,837,208.52
		VIND3	0.1	$107,934.92	$44,200.00	$63,120.00	$215,254.92
		VINDL	0.36	$99,422.38	$25,802.00	$54,679.60	$179,903.98
			0.14	$82,639.24	N/A	$82,200.00	$164,839.24
		VINDP	0.09	$65,120.12	$35,550.00	$46,630.00	$147,300.12

Figure 6.3.6.H. GridSolver Cost of Supply tool with Customer and Meter ID hidden

Current Load Management Platforms

VEC has contracted with "several software as a service" companies (SAAS) to enable the peak management activities discussed above. Each of those companies is briefly discussed below. However, one of the challenges that VEC faces in the load management space is that each SAAS provider assesses a fee for access to their software. Additionally, many manufacturers also assess a fee for access to the, often, proprietary application programming interface (API) that allows for communication to a manufacturer's device. The combination of these fees can make or break the economics of a load management program. Additionally, unless VEC enters a long-term contract, these fees can be subject to change. For example, after EnelX bought out Juicebox, they sunset the old API, which VEC was utilizing through Virtual Peaker to communicate with and manage several Juicebox chargers, and they assessed a fee for access to a new API. VEC determined that paying a significant fee was not viable as only a small number of Juicebox chargers were enrolled in the management program.

VEC utilizes Tesla's PowerHub software to manage Tesla Powerwalls that are enrolled in our Flexible Load – Home Battery Program. The snapshot below shows a 75-kW dispatch from 1700 to 1830.

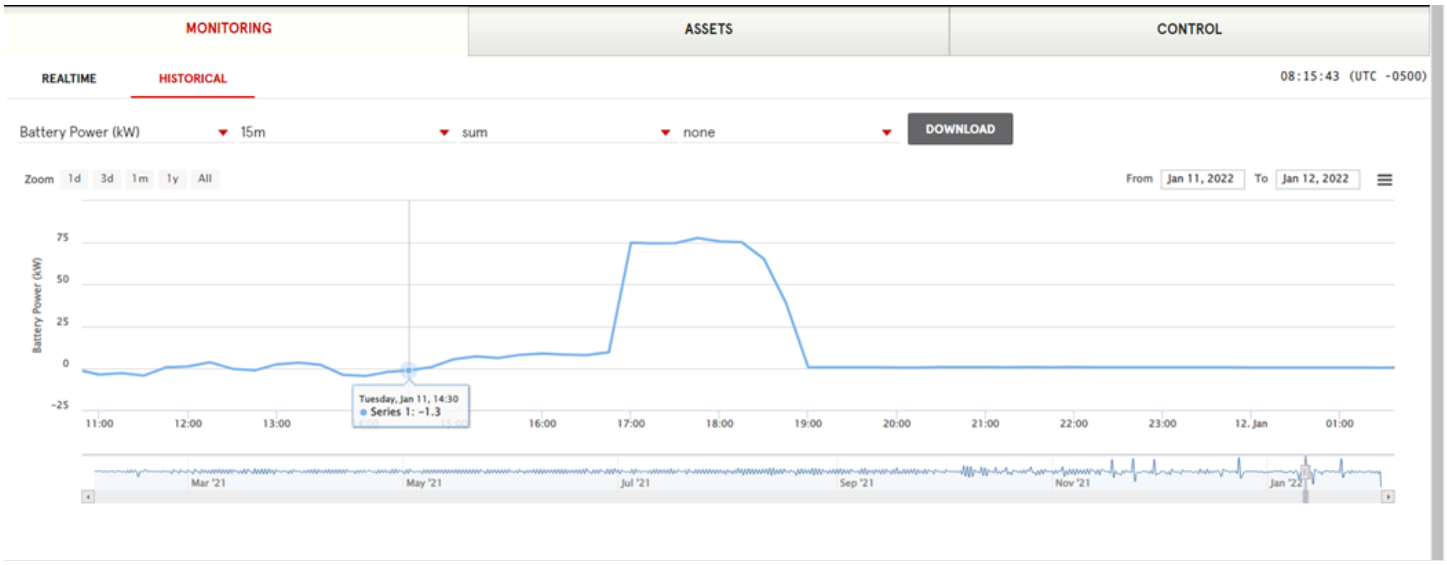


Figure 6.3.6.E. Telsa Grid Logic battery dispatch

VEC utilizes Virtual Peaker (VP) to manage both residential batteries as well as EV chargers. Current eligible devices include Sonnen batteries and ChargePoint and Flo EV chargers. Enrolled members receive a monthly bill credit in return for allowing VEC to manage their device for peak shaving an estimated 4-6 times per month. The snapshot below shows EV charging over a 24-hour period.

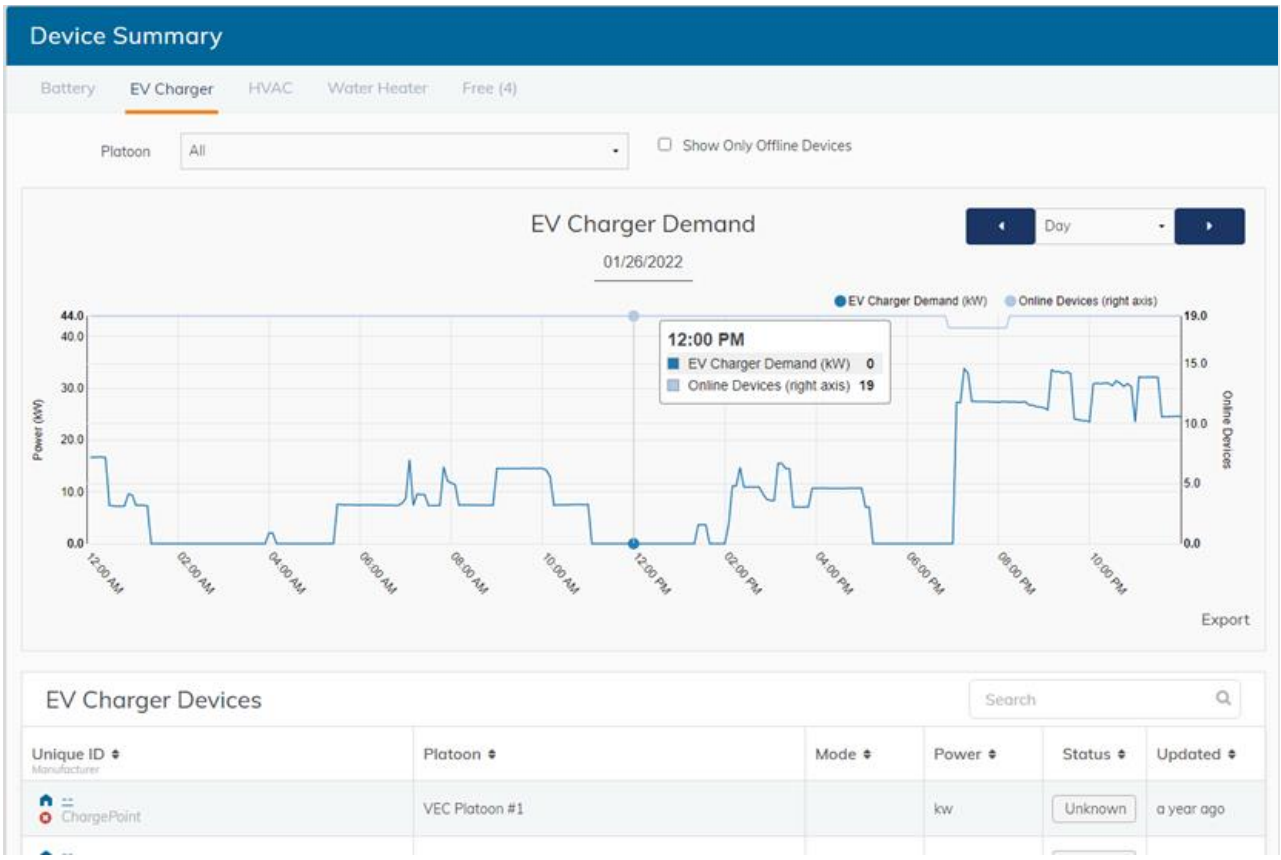


Figure 6.3.6.F. Virtual Peaker EV charger dispatch

VEC System Operations

In addition to great technology, VEC is fortunate to have highly trained System Operators who manage and respond to the power system. System Operators monitor the power system via SCADA and OMS and provide support to field personnel as required. Qualified System Operators staff VEC's control room twenty-four hours a day, seven days a week, 365 days per year. In addition to utilizing SCADA and OMS, System Operators also utilize a security system which provides real time video footage of all VEC's service facilities (Grand Isle, Richford, Newport, and Johnson headquarters), and over ten substations within VEC's system.

Figure 6.3.6.J VEC's main control room

As of early 2021, VEC also has a backup control room and computer server room in an undisclosed location close to VEC's telecommunications network and in an area that would not be affected by localized natural disasters (tornados, flooding, etc.) that could affect VEC's primary control room in Johnson.

The backup control room/server room houses a fully redundant, hot standby SCADA system. Operators can access operating documents through the VEC Intranet system that is also backed up at this location. VEC also maintains paper copies of all operating documents at this location.

All other systems including OMS, mapping, radio and other company network services are available at the backup control room. There are phone restrictions due to infrastructure limitations so in the event VEC needs to operate from the backup control room, VEC would rely heavily on an external call-center support provider to handle at least a portion of member calls.

VEC Operating Procedure OP-30 – Evacuation of Control Room, which VEC tests annually, guides all company actions if evacuation is required.

Distributed Energy Resource Management System (DERMS)

A distributed energy resource management system, or DERMS, is a software platform used to manage a group of distributed energy resource (DER) assets such as behind-the-meter batteries, or electric vehicles. Our existing tools and technology are lagging the quick growth of the energy transition. While we have invested in many foundational technologies over the years we see full data integration as a key building block in managing increased complexity.

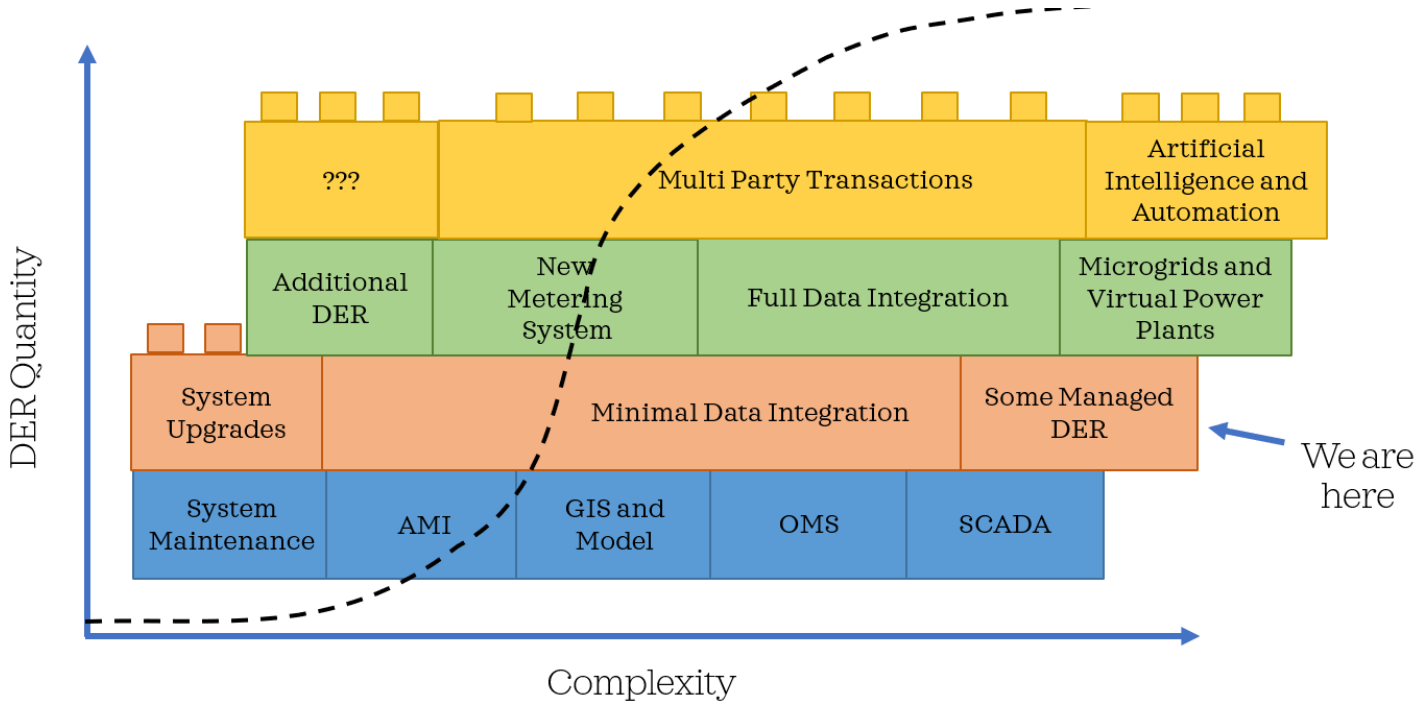


Figure 6.3.6.D DER adoption and tehcnology impacts

There are many unknowns in the speed at which DER's are deployed but our goal is to be proactive in managing these rouses. We currently manage DER's through a siloed approach with many human decisions.

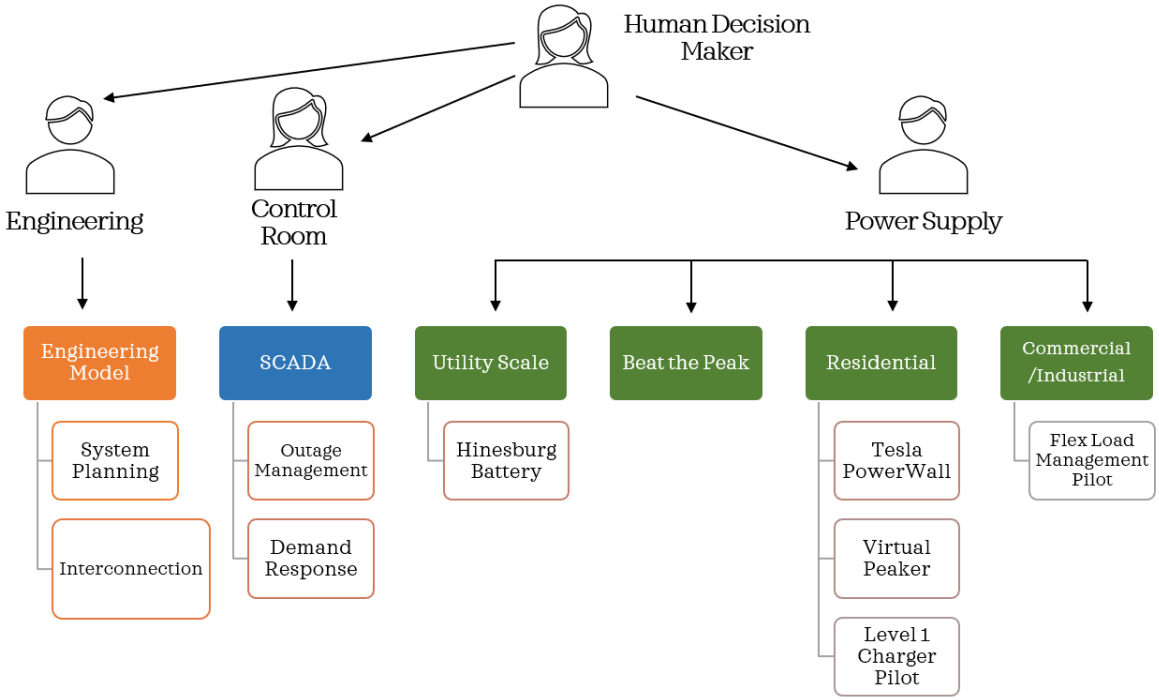


Figure 6.3.6.D Current DSO functionality (Source: GMP)

We need to break down these silos and operate through the same platforms. Additionally, we are already experiencing complexity in when and how we dispatch our resources. Through automation we believe we can proactively identify reliability concerns and most economically dispatch resources. The DERMS platform will integrate

and orchestrate our existing data sources and tools such as SCADA, GIS, and Engineering/Planning tools in hopes of developing new analysis and subsequent actions on the distribution system.

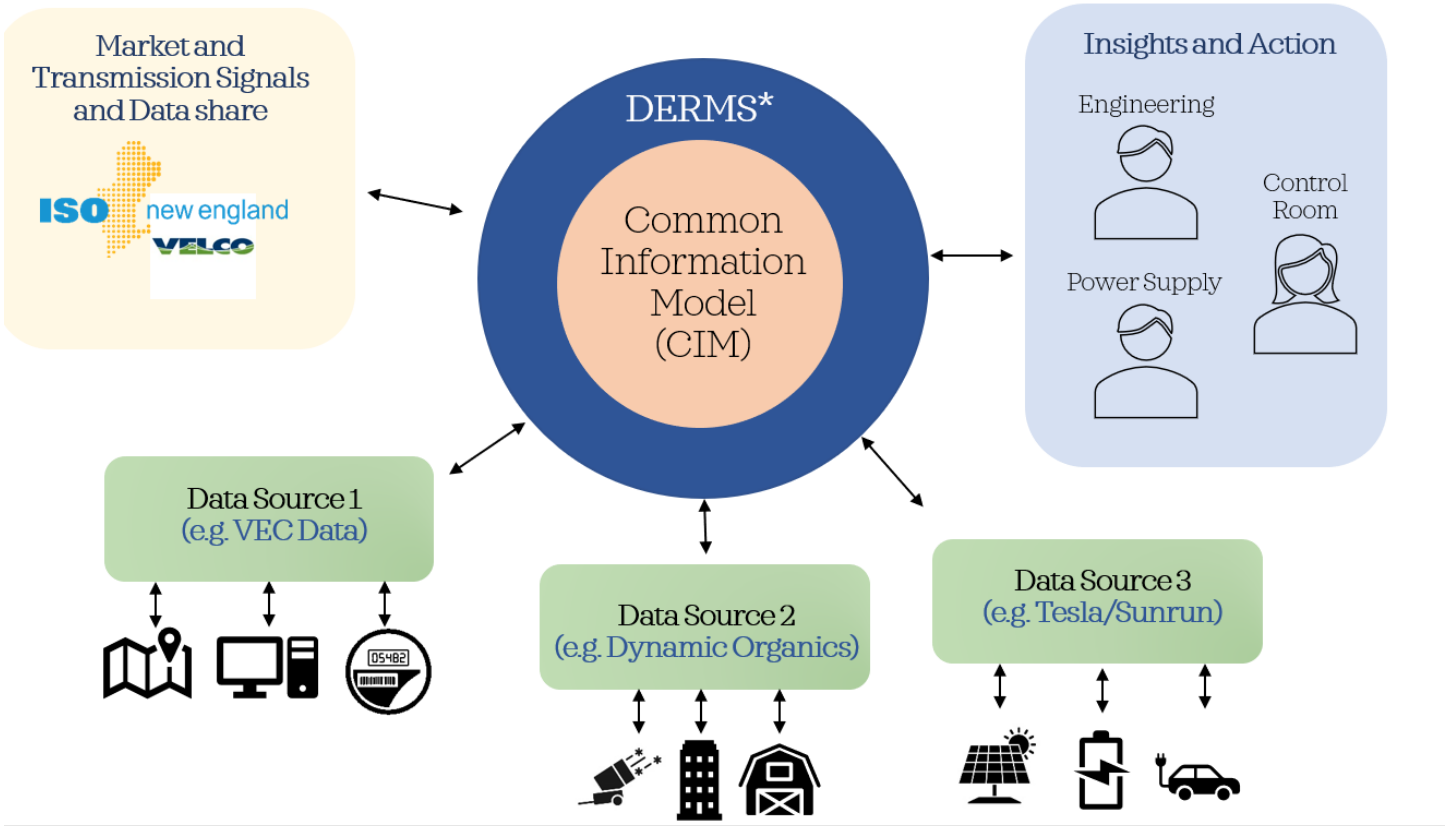


Figure 6.3.6.E Where DERMS fits

A DERMS in this role must be able to monitor and orchestrate distributed devices and local grid conditions. Many existing DERMS only focus on the device monitoring and orchestration, not grid awareness.

Common Information Model (CIM)

Key to implementation of any DERMS tool is a common information model (CIM) that integrates several components:

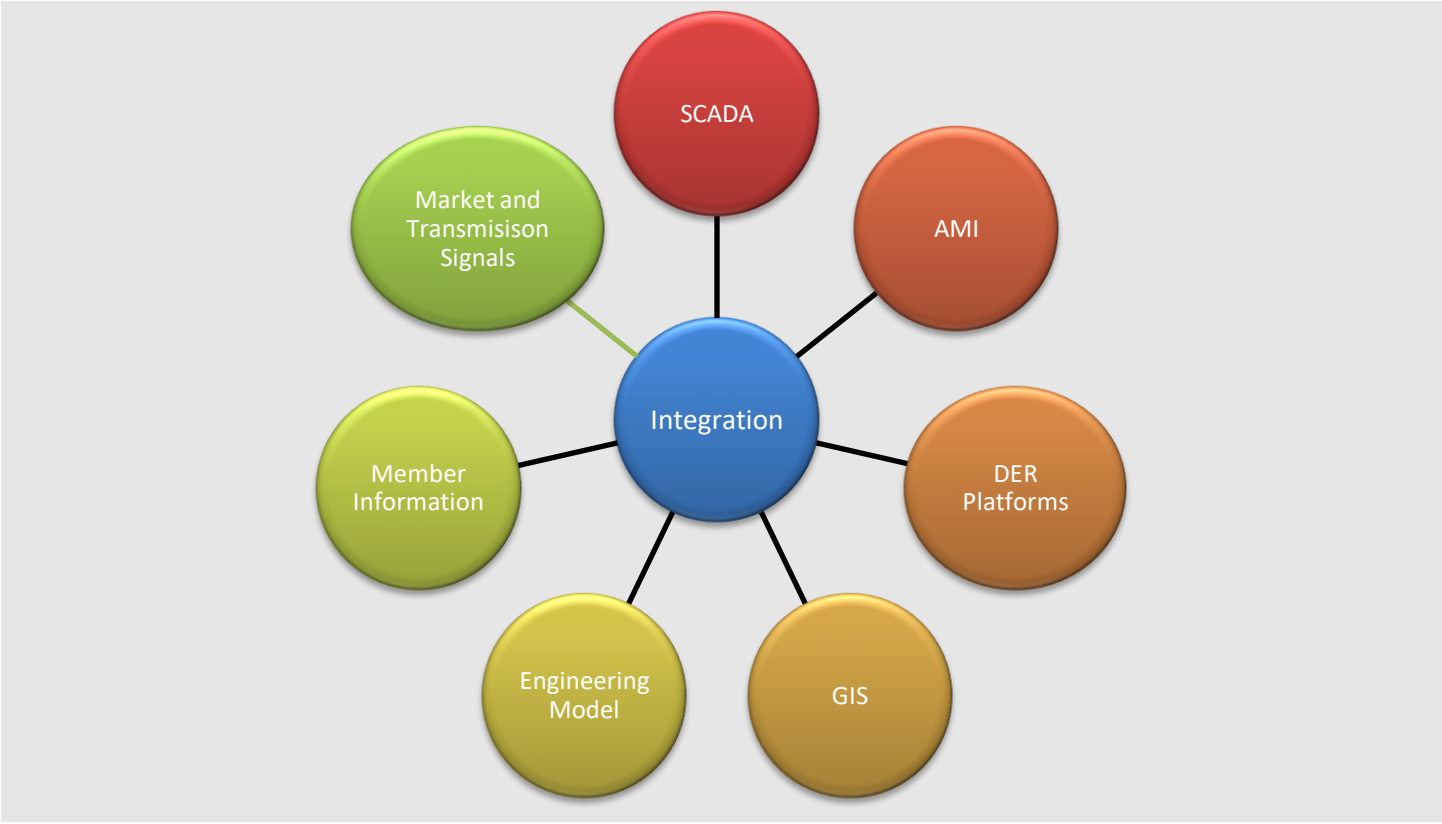


Figure 6.3.6.F Common Data Platform

- SCADA –*While the DERMS platform will not directly control SCADA devices it will need near real time visibility of devices and the data associated with them.*
- AMI– *Providing data on members usage and impacts to voltage are necessary to ensure that transformer assets are not overloaded. In addition, the AMI data feeds engineering models and allows detection of EV's and other DER's*
- DER Platforms - *Visibility into the status and usage of DERs such as EVs and solar inverters is critical to maintaining reliability and affordability. Operational control can have benefits such as enabling VEC to change inverter settings or adjusting voltage regulator taps during the middle of the day to provide voltage support. This is often referred to as an ADMS (Advanced Distribution Management System). However, this is not an area VEC anticipates focusing on first.*
- GIS- *Geographical locality of existing resources (poles, wire, equipment) and DERs paired with asset nameplate data feed the operational visibility, engineering and planning functions.*
- Engineering Model – *Real world data is always best but often not available in all locations. To fill those gaps and perform "what if" scenarios an 8760-hour engineering model is needed. Our current modeling efforts focus on peak hours and other hour increments.*
- Member Information – *Data from our CIS provides details on equipment, service locations, and account details that help feed planning and operational analysis.*
- Market and Transmission Signals – *Signals from power supply markets and transmission owners will play a key role in how we manage DERs.*

Pacific Northwest National Laboratory (PNNL)/VELCO Demonstration Project

Vermont utilities continue to see new operational challenges associated with an increasingly complex T&D system. To help us manage this effort VELCO, along with GMP, BED and VEC has a initiated a new demonstration project. VEC is

co-chairing the subcommittee, and the Vermont utilities have been provided the opportunity to advance a billable R&D project with the Department of Energy (DOE) and PNNL.

The project funds issued by Senator Leahy's Office were directed to execute "sensor demonstration" activities in partnership with PNNL and VELCO. The 3-year project will develop a standards-based model can help utilities use sensor data to collaboratively coordinate and make more informed decisions. The goals of the project are to:

- Integrate data sources between the Vermont distribution utilities and VELCO into a common information model (CIM)
- Enable greater visibility of DERs during Under Frequency Load Shedding (UFLS) events. Our current challenge is that we do not have visibility over all the generation on feeder circuits and as such it is difficult for us to guarantee we are shedding the correct amount of load.
- Demonstrate that with data conveyed over VELCO's fiber optic system, utility operators can better pre-position and prepare the system for a UFLS event differently given DER at the time of an event

In the future these efforts will be critical to enabling more situational awareness, informed decisions and new grid architectures.

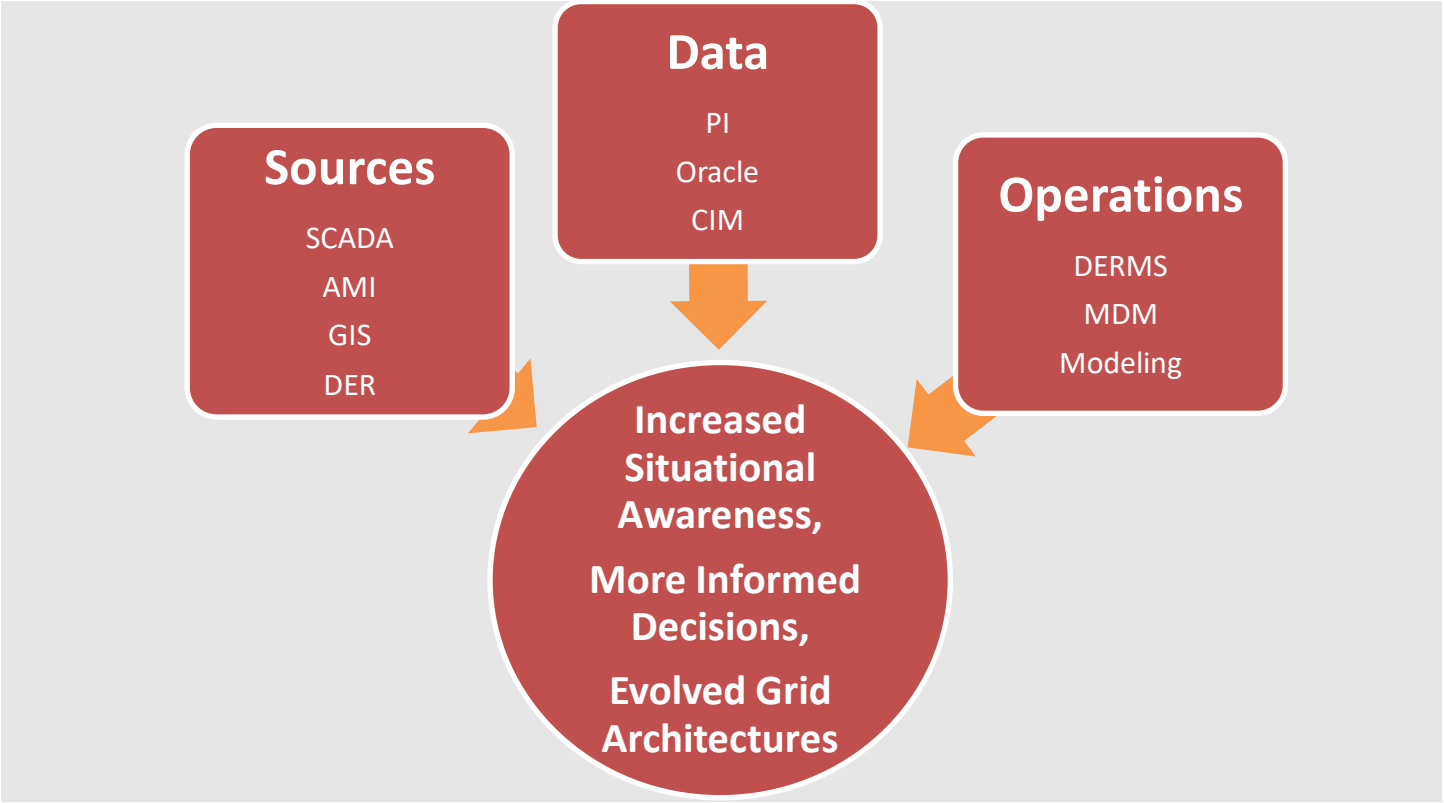


Figure 6.3.6.I Future opportunities through demonstration project

6.3.7 Outage Management

VEC uses several tools to plan for and respond to outages as quickly and effectively as possible.

Outage Management System (OMS)

VEC has used an Outage Management System (OMS) supplied by the National Information Solutions Cooperative (NISC) since February 2008. The system relies on four inputs:

1. AMI meter information provided by Aclara.
2. Integrated Voice Response (IVR) automated phone system data.
3. Member service inputs from the VEC Member Service Department.
4. Inputs from VEC's external overflow call center (CRC - Cooperative Response Center).

The system is initiated by an outage call from a member or by the VEC Control Center. The OMS system then begins to "ping" surrounding AMI meters from that member until power is detected. The process for identifying the location of an outage normally takes between 30 seconds and two to three minutes depending on the size of the outage.

VEC publishes these outages to vtoutages.com and posts every outage on its website (https://www.vermontelectric.coop/outage) with an estimated time of restoration (ETR). VEC updates the outage information every five minutes, which balances the needs of members to be informed with the stress on the OMS system of more frequent updates.

In addition to the online member facing information, VEC employees can view and update outages on their mobile devices through NISC's AppSuite.

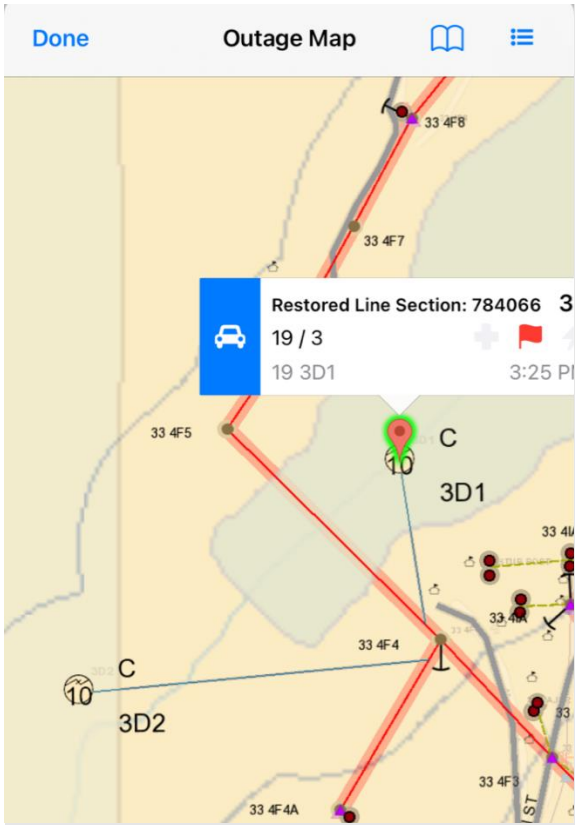


Figure 6.3.7.A VEC AppSuite Outage Response

NorthView Weather Outage Forecasting

In 2017, VEC began working with Northern Vermont University - Lyndon and its subsequent startup, Northview Weather LLC, focused on enhanced approaches to utility forecasting. Northview Weather LLC continuously updates

their development of these forecasting tools to provide electric utility operators with reliable and actionable forecast information in meaningful formats without the need to assimilate large quantities of numeric data typically processed by a meteorologist.

These tools will significantly reduce the time that utility personnel will spend to analyze the weather forecast, and they will also allow for more efficient and effective response planning. Highly accurate temporal and spatial forecasts allow utility management to plan for the appropriate personnel and to deploy those personnel to targeted locations prior to the event. In addition, Northview Weather LLC is also developing systematic verification to understand storm performance metrics such as the accuracy of the forecast and the resilience of grid. An example of one of these forecasts is shown below:

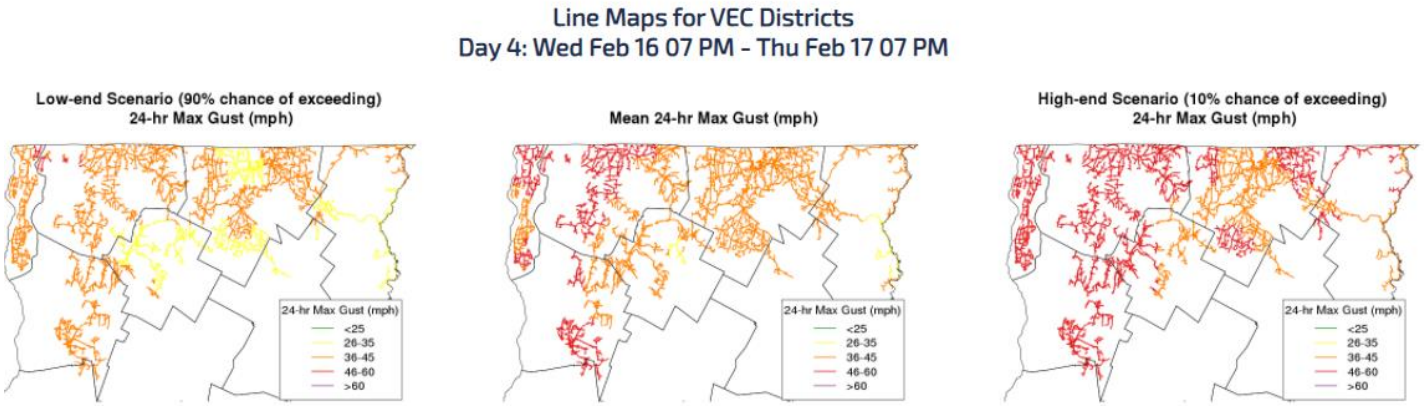


Figure 6.3.7.B NorthView Weather online portal forecast.

6.4 Metering

6.4.1 AMI (Automated Metering Infrastructure)

VEC has been operating its present Aclara based AMI system since 2005. VEC utilizes this system for 99 percent of demand usage metering and outage monitoring on residential, small commercial and industrial consumers. By the

end of 2022, AMI will be available to all VEC members, although some members still choose to opt out.

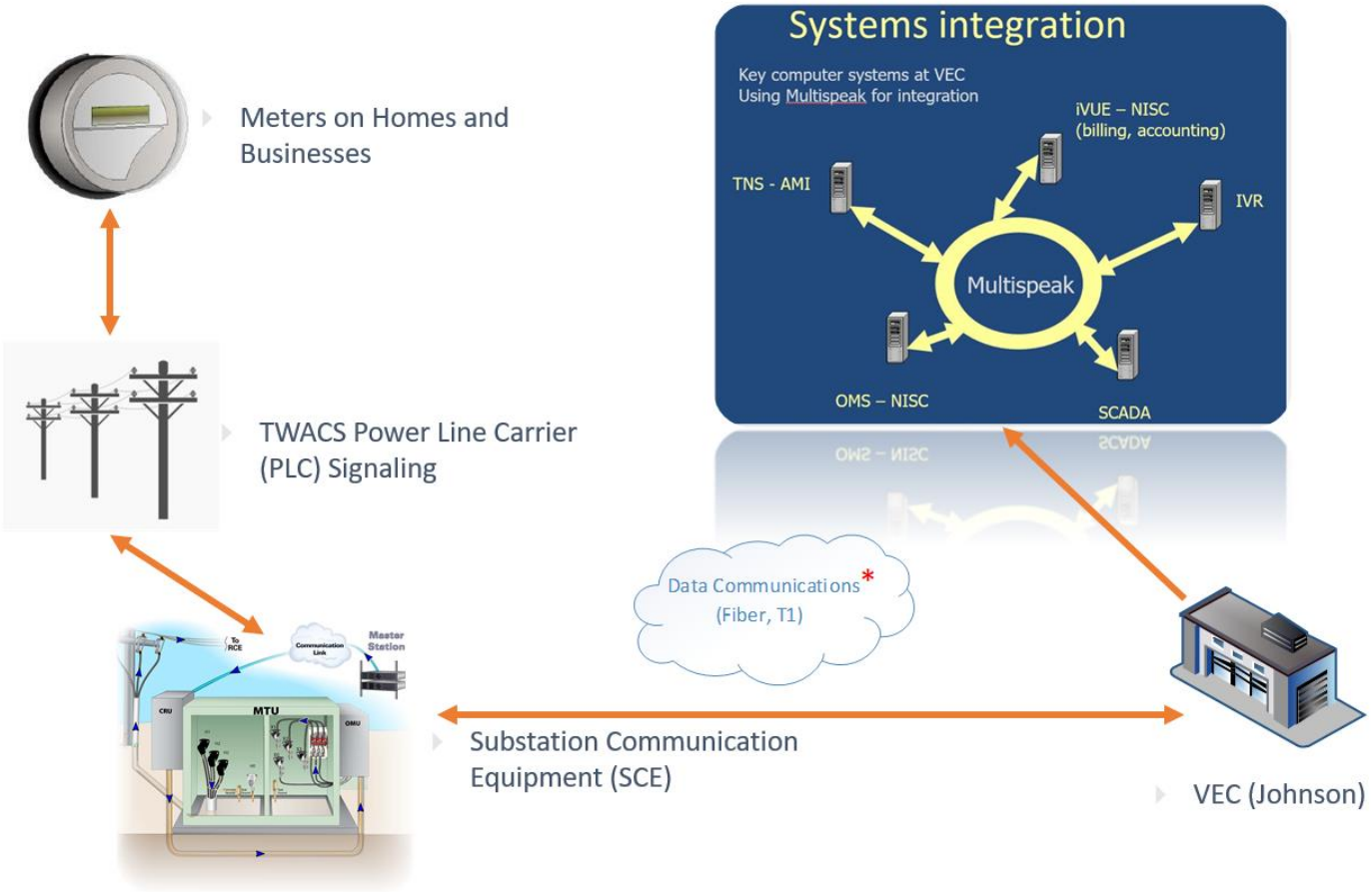


Figure 6.4.1.A. Communicaiton pathway for AMI data

VEC's AMI system is integrated to several other tools through Multipeak. VEC uses the National Information Solutions Cooperative (NISC) "iVUE" system to house meter data in its Meter Data Management (MDM) system.

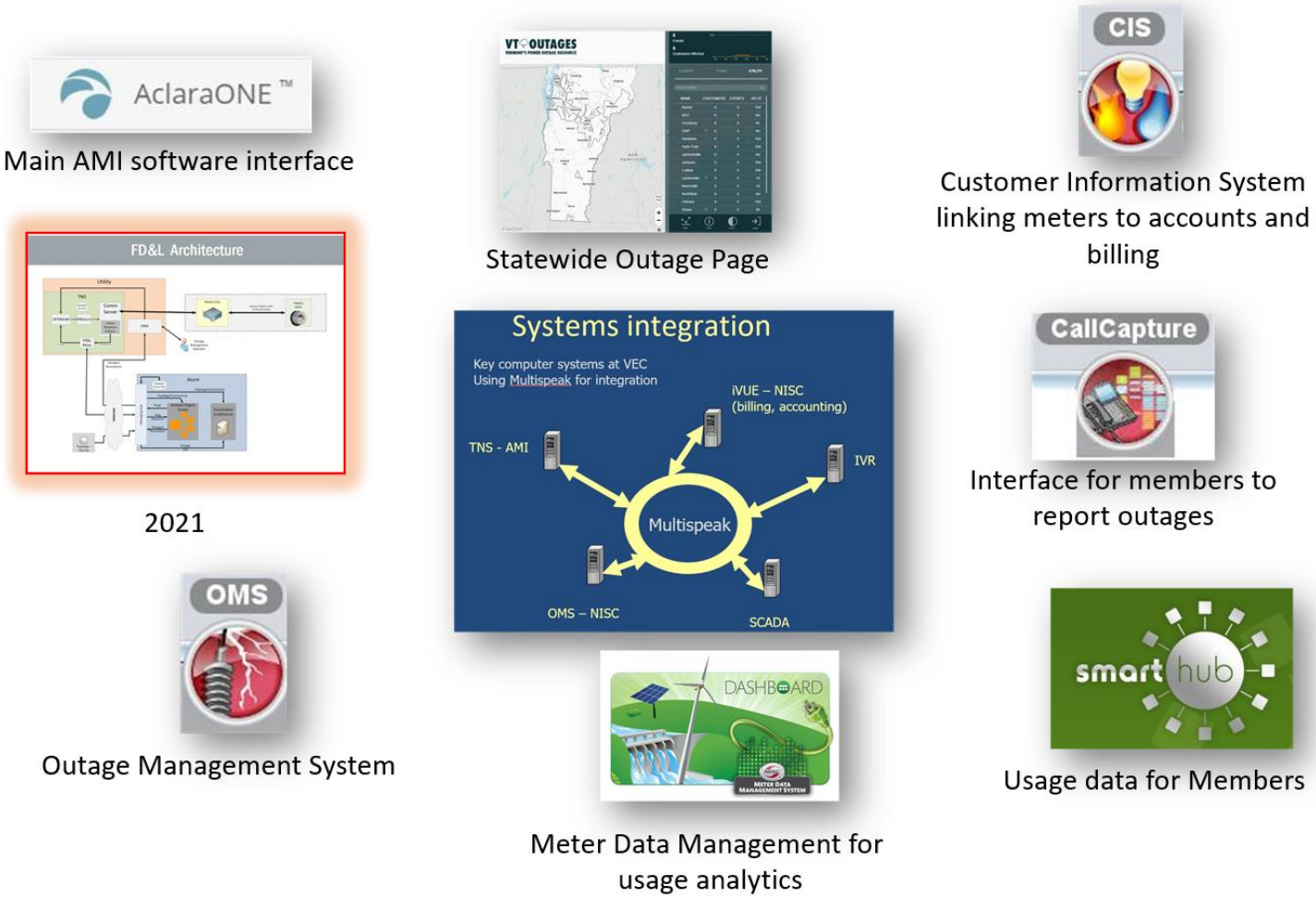


Figure 6.4.1.B. AMI integration with other products.

While the cost of a residential 2S AMI meter is higher than a non-AMI meter (~$120 versus $20) the benefits of fewer manual meter reads (and associated management and administrative support), increased meter reading accuracy, and outage management significantly outweigh the costs.

VEC replaces meters on a 10-year cycle or as failures occur. The advertised life expectancy is 15 years and is based on one read per day. VEC currently does three reads per day or once every 8 hours. Therefore, there is a lower life expectancy on its meters. The AMI meter communication involves a high-current pulse generated by the meter, which puts a level of stress on the AMI meters, hence, shortening their life span/expectancy.

6.4.2 Radio Frequency (RF) Pilot

VEC is exploring the use of an Aclara RF system as a solution to get to 100 percent AMI on its system. The only substation without AMI on VEC's system is French Hill which has around 90 meters. Unfortunately, the costs associated with a PLC based AMI package were not cost justified with such a small number of meters.

In addition, a recent system constraint provided VEC with an opportunity to pilot this RF system. In 2020, VEC modeled the Fairfax 01-4A circuit as part of our annual system planning and found that the voltage at the end of the line was below 114V. Our goal is to meet ANSI standards which require us to meet +/- 5% voltage (120V is nominal, so that is between 114V and 126V). The standard solution would be to add two conductors (6.43 miles) from FT 1 to

35 78X to the circuit and split the load to resolve this issue. This is certainly feasible but a high-level estimate puts the total construction cost at more than $1.2 million.

When looking at the area, VEC noticed that are several long sections of cross-country lines with no members on them and that there are GMP facilities present throughout the line. As an alternative to the distribution line upgrade, VEC is currently working with GMP to install three new metering points allowing us to retire 3.17 miles of line saving us around $16,000 annually in maintenance costs (~3.17 miles at $5,071 cost per mile) and forgoing the capital expenditure of $1.2 M.

The initial constraint of the metering points was that VEC needed to maintain AMI services to its members and the PLC system would not work through GMP's electrical lines. VEC would have needed three AMI packages (at a cost of around $85,000 each), one of each meter point, to make the project work. One of our new employees at the time suggested we investigate using a RF system.

The Aclara RF system is used by many other utilities and in this scenario was a cost-effective solution for VEC. In addition, the metering point project paved the way for us to get AMI to the 90 French Hill members since we could also use the RF infrastructure for this area. This pilot will involve around 260 meters (those off French Hill and those served by the three proposed GMP primary metering points), is faster than our legacy PLC system, and provides us with additional data points such as voltage. The meters also provide a "last gasp" capability which allows the meter to send out an outage message just before the power goes out. VEC expects to complete this project by the end of 2022.

6.4.3 Substation, C&I, Generation Metering

VEC utilizes EIG (Electro Industries GaugeTech) Nexus and Shark meters for generation, substations and tie-points. VEC has 72 of these meters installed currently, with roughly 12 on our largest accounts. All the Standard Offer projects are equipped with this style meter as are large generation/storage facilities like Kingdom Community Wind and our Hinesburg Utility Scale battery.

We use the EIG Meter Manager to allow our data to be archived and tied to our CIS system. The log data from the meters is pulled in to our MDM database on a scheduled routine (every 4 hours). Another tool, CommunicatorPQA, allows us to access real-time data such as current, voltage, real power, reactive power, and apparent power, quality, vector diagrams, harmonics, etc.

We are experimenting with some additional control & monitoring features, such as alerts outside of preset levels and signals to relays. We are hopeful that with these monitoring features we can get notified if we lost a current transformer (CT) or loads shifted significantly.

6.4.4 Next Generation Metering

Our current PLC AMI network has limitations which will hinder efforts to keep current with advancements in the electric utility industry.

Existing System Limitations

During conversations with our current vendor and other utilities, VEC has been advised that little or no new functionality is anticipated to the current PLC product. The limitations of our existing system are as follows:

- *End of life* – Many cooperatives, municipalities, and IOUs are moving away from PLC to an RF based metering platform or do not use PLC. Vendors in many cases are no longer offering new PLC installations.

- *Limited new functionality* – In our last IRP we discussed the implementation of Fault Detection and Location software (FD&L) which would speed up our outage identification and response. Unfortunately, this product has been put on hold with no timeframe for re-engagement. In addition, our existing vendor has stated their meters have no Zigbee capability nor do they have options for 3rd party devices. Other vendors provide open platforms for app development to enhance the member and utility experience.

- *Grid of the future* – Member expectations are increasing as it relates to data visibility. Many other vendors are providing data disaggregation options which enable greater insight into usage. Moving from a centralized to a decentralized grid requires more real time data and our existing PLC system is limited to hourly interval reads on kWH and periodic (twice per month on the system) voltage reads. Our current platform does not allow integration for smart fault finders and other SCADA assets. Additionally, limited third party integration keeps us from using meter communications to send/manage DER's.

- *Substation communication equipment intensive* - PLC requires substation equipment (upwards of $85,000) that is only accessible by qualified personnel. A major benefit created by moving away from a PLC network will be the separation of metering communications from the distribution system. This separation will simplify the management and administration of the network.

Strategy

We are actively researching and evaluating a replacement metering platform and expect to follow this timeframe:

- During the research and evaluation process VEC will focus primarily on Radio Frequency (RF) metering networks. However, the potential of other methodologies, such as fiber or 5G wireless will not be disregarded.
- Q4 of 2022 - VEC will have formulated a "needs and wants" list to provide to interested vendors in the AMI metering space.
- Q2 of 2023 – Choose a new vendor
- Q1 of 2024 – Begin implementation of new system. Vendor resources and equipment availability will drive the implementation of a new system. A key challenge, due to restraints on micro-chip manufacturing, will be managing lead times on meter orders which can be up to 12 months.

6.5 Telecommunications Options

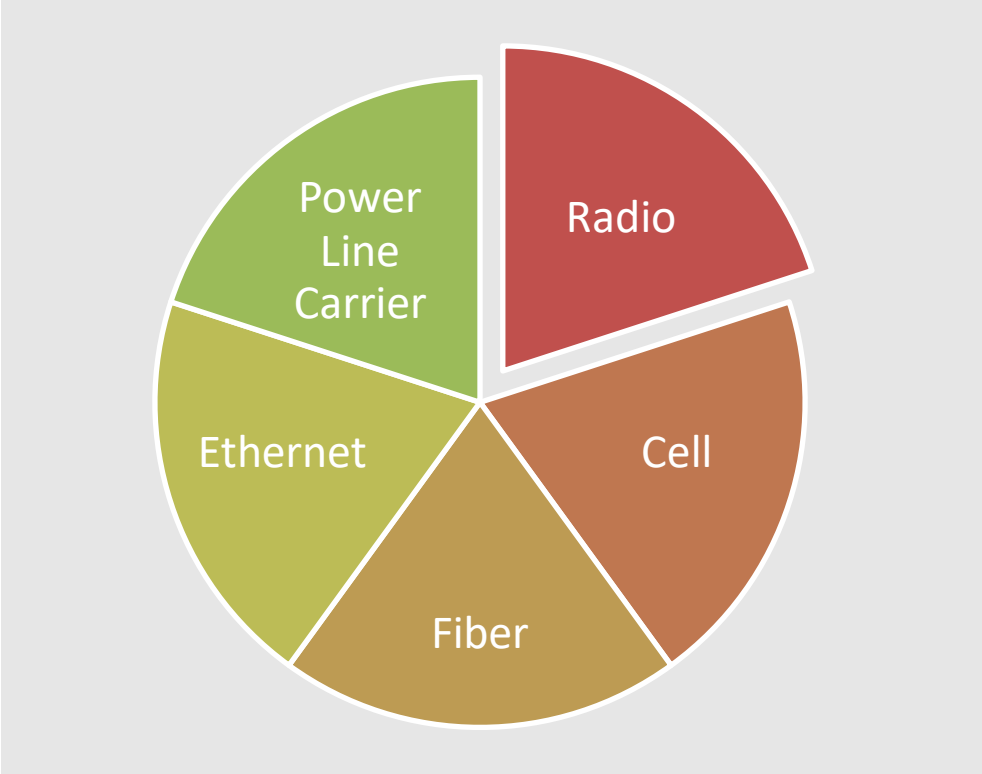


Figure 6.4.4.A VEC Telecommunication options

6.5.1 Fiber

Vermont Electric Coop relies heavily on our private fiber network to enable fast and effective communication the Equipment at Substations, District Offices and other Field Devices. To insure the infrastructure continues to meet our current needs and to enable new and innovative technology VEC will be upgrading our existing SONET network to a Multi-Protocol Label Switching - Transport Profile (MPLS-TP) network. Our existing network lacks stability and speed both of which will be resolved with the new network.

The schedule and rollout of this upgrade will be driven by cost of equipment, priority of new services/applications and the experience of other utilities using this currently. The switch to MPLS-TP will enable enhanced physical security at substations, new metering technologies and the growth of distribution automation, plus position us to adapt better to the unknown.

6.5.2 Power Line Carrier

VEC's metering system relies on powerline carrier (PLC). The system leverages VEC's distribution network for two-way communication to any meter or other endpoint device connected to the network without the need for additional repeaters or line conditioning equipment. In addition to revenue-critical meter data, the system also monitors line conditions, detects faults or outages and monitors power restoration. Data backhaul from the substation is currently provided using a mix of fiber optic cable, private carrier Ethernet, or cellular.

6.5.3 Radio

We use Point to Point or Point to Multi-Point radio for our distribution SCADA devices. In general, these are reclosers out on the line or generation sites. As part of our Radio Frequency (RF) metering pilot we have also begun using radio to communicate with some of our meters.

6.5.4 Cell

We use both a public and private cell network to communicate with various devices. For sensitive controls and monitoring we use a private network to connect to some our SCADA enabled switches and reclosers as well as distributed generation. Our public cell network is used to communicate with our C&I meters and some larger generation meters. We also use cell to communicate to any metering that requires 3rd party access.

6.5.5 Ethernet

VEC utilizes a mix of carrier ethernet through Consolidated Communications and ethernet provided by VELCO. This is used for equipment at substations, field devices, and for AMI/Metering backhaul.

6.5.6 Industrial metering

VEC uses a variety of methods to communicate with large member or generation metering. These include Public/Private cell networks, Carrere Ethernet services and VEC's own fiber network. The communications method is informed by the reliably and security needs of the connection, available communications technologies and the access needs of partner organizations. Metering data is stored at VEC's data centers in its raw form and processed by our MDM to for billing and engineering/planning applications.

6.6 Cyber-Security

VEC believes a strong cyber-security culture is essential to ensure the reliability of the electric grid now and in the future. The most significant risk is human behavior. Social engineered attacks, those designed to exploit the weaknesses of people rather than systems, are the most common and dangerous. Furthermore, with the increased use of technologies such as SCADA and AMI, VEC's various business and operations systems have become better able to communicate with each other. These integrated, autonomous, and complex systems have accelerated evolution of more sophisticated threats and attacks.

6.6.1 Program Management

VEC recognizes and meets these evolutions with a commensurate level of cyber-security. VEC utilizes a layered, "Defense in Depth" approach to cyber security to safeguard member information and business systems. Defense in Depth is an approach to cybersecurity, layering a series of defensive mechanisms to protect valuable data and information. If one mechanism fails, other steps up immediately to thwart an attack. Additionally, VEC follows the Department of Energy Electric Sector Cybersecurity Capability Maturity Model (DOE ES-C2M2) to evaluate, prioritize, and improve cybersecurity capabilities. Using the ES-C2M2 framework, VEC has increased its cyber capabilities to address a wide-ranging array of both technical and socially engineered attacks.

Each year VEC looks to improve one Maturity Indicator Level (MIL) in at least two domains as outlined by the C2M2 model. VEC measures success by working toward achieving an overall Maturity Indicator Level (MIL) score of 3 in

each domain. Annually, we develop specific key performance indicators approved by the Board of Directors that hold the company and specific personnel accountable to improving one MIL score in each of two domains.

6.6.2 Threat Identification

We rely on several organizations and various software tools to keep us informed of threats. The organizations include the Vermont Intelligence Center, the Department of Energy Electricity Information Sharing and Analysis Center (E-ISAC), NERC, Department of Homeland Security (DHS), and VELCO. VEC has a dedicated cybersecurity steering committee that puts together an annual plan for improvement and mitigates and cyber threats. The North American Electric Reliability Corporation (NERC) has identified the greatest cyber-security risks facing the North American electric grid today (in order):

- Human error
- Access control management
- Insider access
- Insufficient training
- Lack of vigilance by all stakeholders

VEC also performs annual penetration tests to identify any weak spots on its systems.

6.6.3 Threat Management

Internally, VEC uses separate domains for its Information Technology (IT) (e.g., regular corporate network, computers, firewalls, etc.) and its Operations Technology (OT) (e.g., SCADA, Control Center connectivity, firewalls, etc.), each domain treating the other as if it is an outside entity. Each domain has procedures in place for isolating from each other and islanding from any external or public connections. Where possible and appropriate, each group uses different sources and equipment for the various functions of cybersecurity including network devices, network segmentation, network isolation, intrusion detection, endpoint protection, and system event and information monitoring. This model includes continual improvement on both systems (e.g., upgrades, updates, patches) and personnel (e.g., training).

Externally, VEC collaborates with partners and professionals such as the Department of Homeland Security (DHS) and the National Guard to develop and exercise its cyber-security skills to identify areas for improvement. VEC participates in cyber-exercises annually with the DHS and National Guard (Vigilant Guard, Cyber Yankee). VEC monitors and participates in the following forums to identify and share emerging threats and best practices:

- Multi-Sector Information Sharing and Analysis Center (MS-ISAC)
- Electrical Sector Information Sharing and Analysis Center (E-ISAC)
- United State Computer Emergency Readiness Team (US-CERT)
- Industrial Control Systems Emergency Readiness Team (ICS-CERT)
- SANS Institute and Internet Storm Center
- VT Fusion Center

6.6.4 Training our Staff

VEC trains, tests, and develops its employees in the areas of cyber-security awareness and good cyber-hygiene. VEC's cyber-security team conducts training for, and testing on, all VEC employees bi-annually. All new employees are given an overview of cybersecurity topics and the importance of keeping themselves, and VEC, safe from a variety of

threats. Completion of cybersecurity awareness training is required prior to being given access to network resources. Employees discuss cyber-security awareness topics as part of a "Safety/Cyber Minute" before the start of most meetings. Additionally, VEC's cyber-security team provides an in-depth review of threats weekly for members of Engineering and Operations (E&O), especially field personnel. E&O shares this information with the entire company via the corporate internet.

Email security also continues to be a focus through ongoing training, awareness, and bi-annual testing to help protect VEC resources from one of most common malware attack vectors. The single weakest links in the information security chain are people who may be uneducated or negligent, vulnerable to attacks both inside and outside an organization.

We also focus on password security and increased use of two-factor authentication, specifically related to the accounts used to administer network resources. VEC plan to implement a new password server in conjunction with YubiKey two-factor authentication. This will allow flexibility and will end reliance on shared credentials.