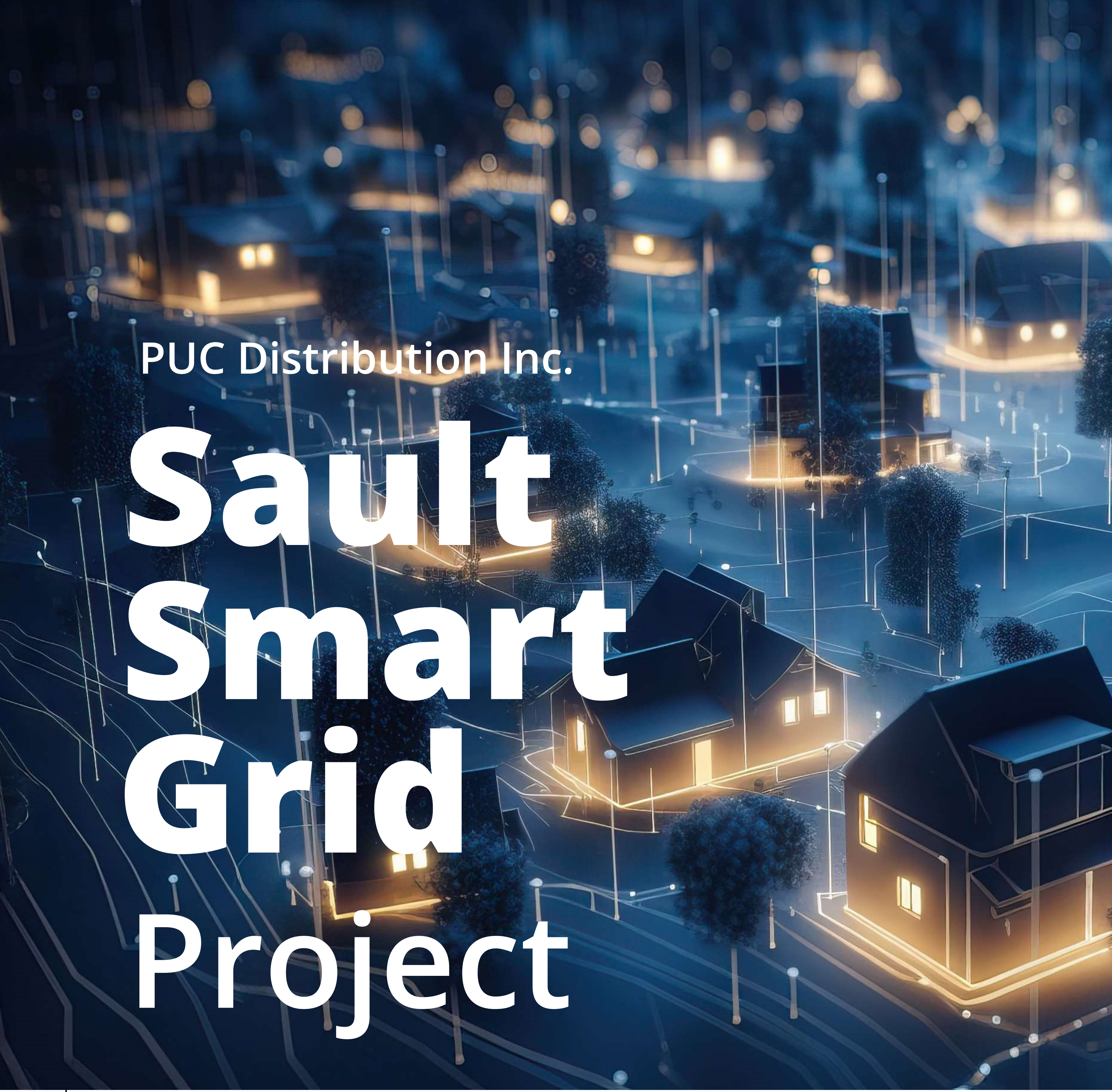


PUC Distribution Inc.

Sault Smart Grid Project

Final Public Report

Created by: PUC Distribution inc.

July 2023

PUC DISTRIBUTION

Contents

Introduction

Project Overview

The PUC Distribution Inc. (PUC) Sault Smart Grid (SSG) Project is a project to modernize its distribution energy infrastructure. The SSG will enhance reliability and resiliency, improve outage management, reduce energy consumption, and provide increased real-time operational awareness and control of the distribution system for improved operations and asset utilization efficiency without increasing the customer bill. Reduced energy consumption will directly result in reduced greenhouse gas emissions from reduced provincial grid generation requirements. The project included an upgrade to the legacy SCADA system to the Survalent Advanced Distribution Management System (ADMS) and integration of existing systems, including Automated Meter Information (AMI), Geographic Information System (GIS) and the Customer Information System (CIS).

The (ADMS) key applications include:

- FLISR (Fault Location, Isolation & Service Restoration) - distribution automation with SCADA-enabled stations and line distribution equipment such as breakers, reclosers, switches, and faulted circuit indicators (FCIs),
- VVO/DVR - (Volt-VAR/ Distribution Voltage Reduction) – SCADA-enabled equipment on substations and feeders for voltage management control, and
- OMS – (Outage Management System) - improved outage management functions for PUC and customer information.

The SSG project also required the application and development of communications technologies for required new equipment through PUC Services utility communication networks, including fibre and cellular technologies, for data access and control.

Collectively these technologies and applications comprise the SSG that will deliver the benefits outlined above and is positioning the PUC to better deploy and/or accommodate new distributed energy resources (DERs) such as photovoltaics, energy storage (batteries), cogeneration, and electric vehicles (EVs) as well as support smart city and other community growth initiatives.

Project Objectives

The Sault Smart Grid project (SSG) provides a community-scale smart grid enabling platform for the PUC electrical distribution service area. The project implements technologies to increase the efficiency of the distribution grid, reducing electrical energy delivery requirements from the transmission grid, thus reducing greenhouse gas emissions and reducing energy costs to the consumers. The project also improves reliability and resiliency with self-healing networks and integrated system data management systems for normal outage planning and especially addressing situational weather events with enhanced outage management capability. Operational efficiencies will be achieved by integrating AMI, GIS, and CIS systems with the ADMS. The project provides an enabling platform for renewable energy and technology integration and customer opportunities in energy services and solutions, supporting Federal and Provincial objectives and LDC license requirements.

Partners and Stakeholders

PUC Group of Companies:

- PUC Distribution Inc. (PUC) - as the local distributor PUC distributes electricity to over 33,600 customers within the boundaries of the City of Sault Ste. Marie, as well as parts of Prince Township, Dennis Township and the Batchewana First Nation Rankin Reserve. PUC is a private company registered under the Ontario Business Corporations Act and is wholly owned by the Corporation of the City of Sault Ste. Marie through the city PUC Inc. (HoldCo). PUC is a provincially regulated Local Distribution Company (LDC) and must comply with requirements issued by the Ontario Energy Board (OEB) with respect to the provision of services. As a participant in the Ontario electricity market, PUC must comply with the rules of the Independent Electricity System Operator (IESO). As an LDC, the company must adhere to Regulation 22/04 of the Electricity Act.
- PUC Services Inc., a utility municipal services company in the electric, water and wastewater sectors, operates as a wholly owned municipal corporation of the Corporation of the City of Sault Ste. Marie. PUC Services Inc. provided lead project management services for the SSG project on behalf of PUC Distribution.

  PUC Services Inc. manages the assets and business of PUC Distribution Inc., manages the Sault Ste. Marie Public Utilities Commission water treatment and water distribution system and also operates the City's two wastewater treatment plants under multi-year contracts. Water and wastewater services are also provided to several communities and organizations in the Algoma District.

Black & Veatch is the engineering, procurement and construction contractor for the project and is responsible for system design, construction, integration and testing. It is a 100-percent employee-owned global engineering, procurement, consulting and construction company with a more than 100-year track record of innovation in sustainable infrastructure. Since 1915, Black & Veatch has helped its clients improve the lives of people around the world by addressing the resilience and reliability of critical infrastructure assets. Its 2022 revenues were US$4.3 billion.

Survalent has been in business for over 50 years, supplying substation automation and ADMS systems to electric, water, transit, renewable energy, and gas utilities since 1964. With headquarters in Brampton, Canada and offices in USA,-the Middle East, Asia, South America, and Mexico, they are a leading supplier of ADMS-SCADA systems with an installed base of more than 800 systems worldwide. Survalent has successfully deployed a total 34 Outage Management Systems for electric utilities, of which 13 are in Canada and nine are in Ontario.-Survalent is providing the new ADMS system including modules for VVO/DVR and FLISR along with the new OMS.

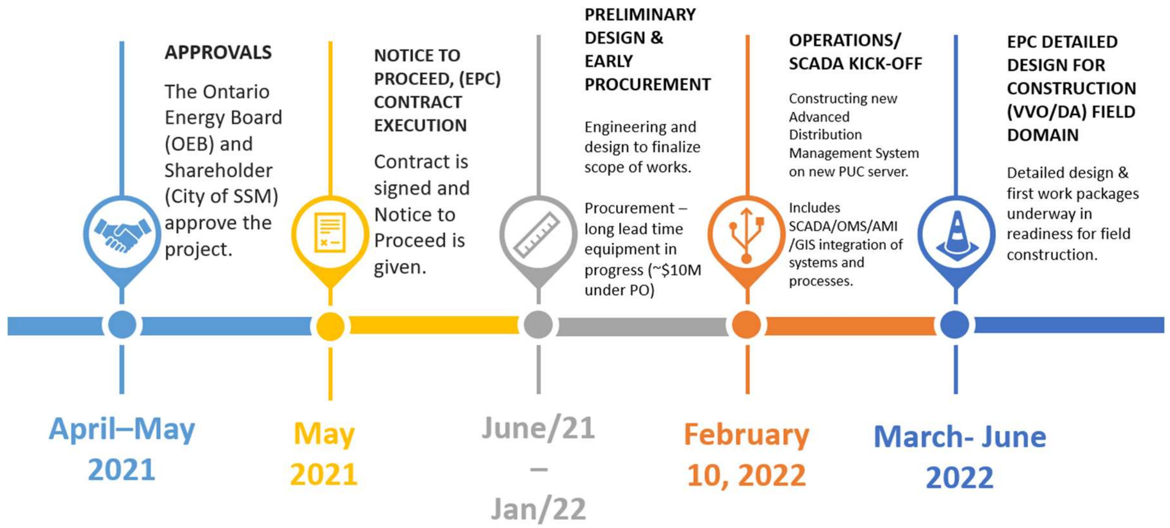
PowerTel Utilities Contractors Limited, a Cormorant Utility Services' company, originated in Fort William, Ontario in 1968. The company has grown to become one of Canada's leading high voltage contractors offering services in transmission lines, substations and distribution systems including all phases from development to commissioning. PowerTel is the lead field contractor for B&V for the station construction work on the project.

Project Timeline

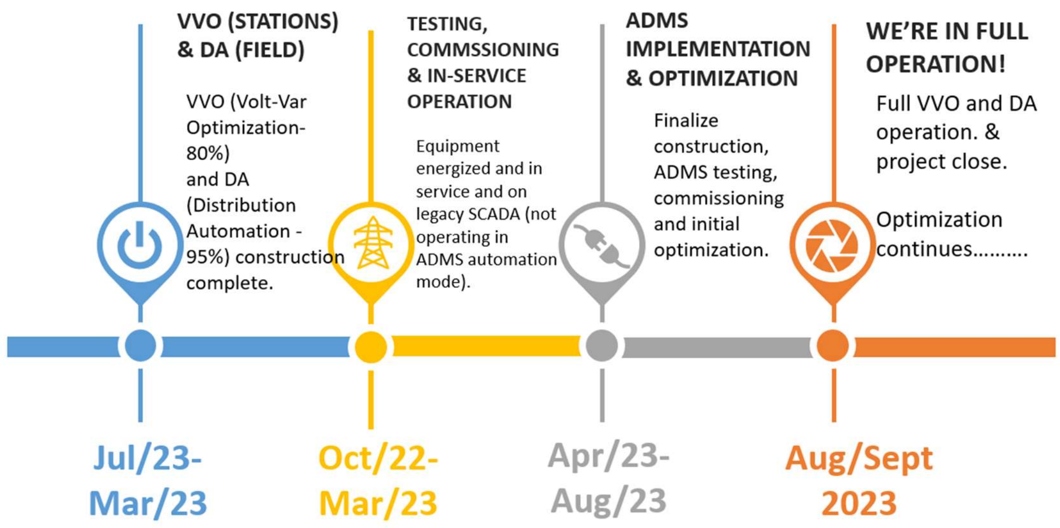
Project Development, Planning & Approvals	2018 through Apr 2021
EPC Notice to Proceed, Engineering & Early Procurement	May 2021 through Jan 2022
Detailed Engineering, Procurement and Construction	Feb 2022 through Mar 2023[1]
Testing, Commissioning & In-Service Operation	Oct 2022 through Mar 2023 [1]
System Implementation and initial Optimization	Expected: Apr 2023 through Sept 2023
Project Close	Expected: Oct/Nov 2023

[1] NRCan Project Completion Date

Timeline: Where the project started and milestone steps:



Timeline: finalize construction and ADMS full operation

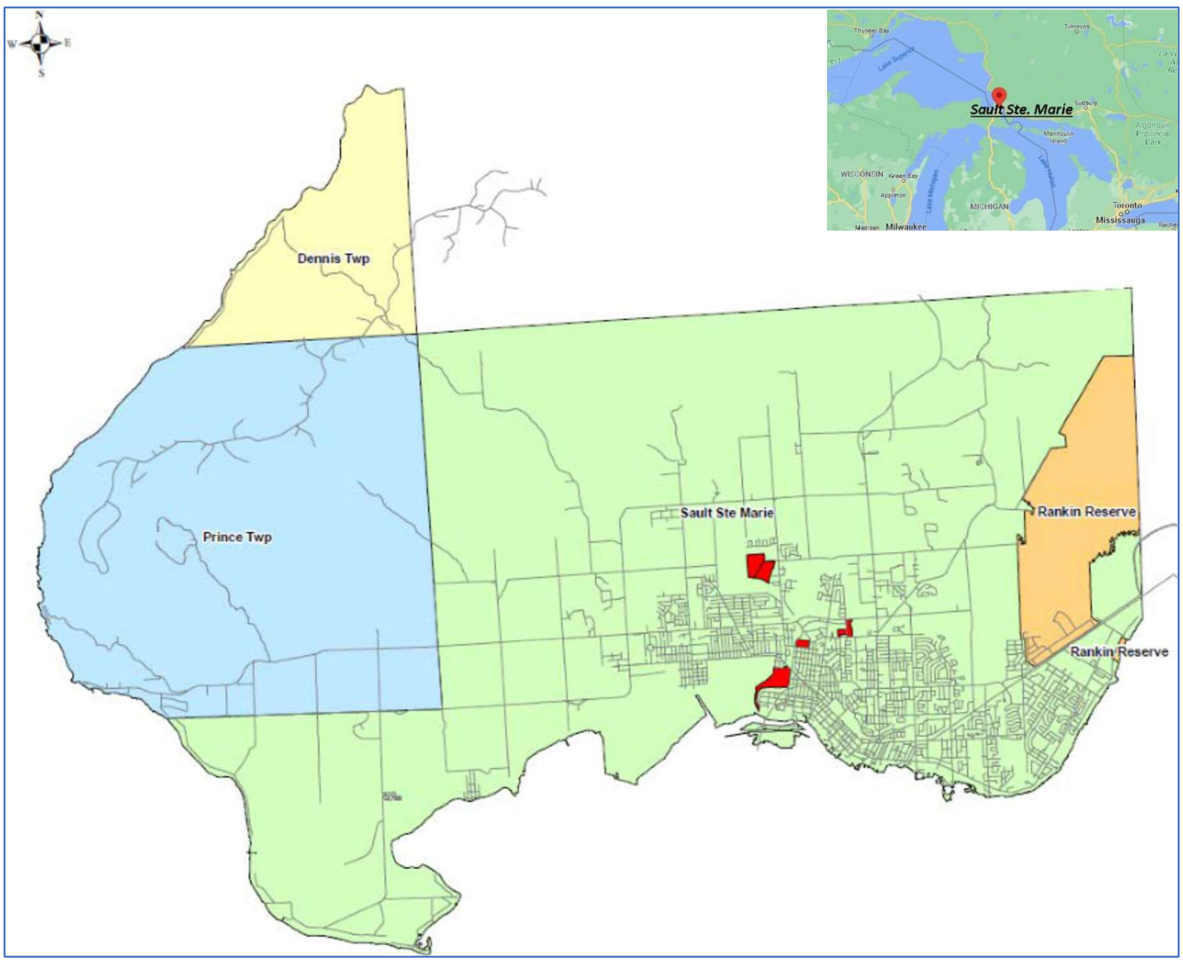


Location

PUC Head Office in Sault Ste. Marie, Ontario

The SSG project encompasses the PUC service territory, which includes most of the City of Sault Ste. Marie, Batchewana First Nation (Rankin Reserve), Prince Township and parts of Dennis Township. Its service territory covers a service area of approximately 342 square kilometers, with a combined population of approximately 75,300. The service territory includes approximately 29,700 residential customers and approximately 3,800 general customer services for a total of approximately 33,500 customers.

PUC owns and operates two transformer stations - TS1 and TS2, which step down power received from the provincial transmission grid at 115 kV to 34.5 kV. The 34.5 kV feeders supply a total of 14 distribution stations, which step down power from 34.5 kV to local distribution networks at 12.5kV (10 stations) and 4.2kV (2 stations).



Distribution Service Territory Map

Project Design

The outline of the design and construction specifications are summarized below:

Voltage Control Scope – VVO/DVR scope includes designing, procuring, installing, and commissioning a Volt/VAR control scheme on PUC Distribution's 12.5 kV distribution system.

A centralized model based VVO software from Survalent will be installed at the PUC Distribution system control room. The interfaces with AMI and system models will be built so that the VVO system can exchange data with these systems. Each field device will be installed with a controller to enable data exchange. A cellular-based communication system will be implemented by the EPC contractor to provide communication between field devices and the central software system. Field integration of all equipment will be accomplished. LTC controller and regulator settings will be determined and applied to the associated equipment. SCADA points list will be developed, and a data acquisition system of these points will be established.

Distribution Automation Scope - DA scope includes designing, procuring, installing, and commissioning a distribution automation system that will improve reliability on PUC Distribution's 12.5 and 34.5 kV distribution and sub-transmission systems.

In the scope of work, centralized control software and FLISR will be installed in the PUC Distribution control room. The interfaces with AMI and GIS will be built so that the DA system can acquire data from these systems. The conceptual scope of work identified during the previous preliminary engineering had equipment proposed to be deployed to ~70% of the system. The current scope includes a complete system review and an adjustment to quantities and locations as a balancing mechanism to the total project budget. Each field device will be installed with a controller to enable data exchange. A cellular-based communication system will be implemented by the EPC contractor to provide communication between field devices and the central software system. Field integration of all equipment will be accomplished. Controllers and protective relay settings will be determined and applied to the associated equipment. SCADA points list will be developed, and a data acquisition system of these points will be established.

Outage Management & Systems Integration (Survalent) Scope – The systems integration scope includes designing, procuring, installing, and commissioning a new Outage Management System (OMS) along with the integration of existing systems for Advanced Metering Infrastructure (AMI), Geographic

Information System (GIS), and Customer Information System (CIS) along with the overall Survalent ADMS in conjunction with the Voltage Control and Distribution Automation above.

The new upgraded Survalent system encompasses multiple environments that are further described below.

1. ADMS SCADA/DMS/OMS Production System: The ADMS SCADA/DMS/OMS System is the production environment used for the real-time monitoring and control of the power grid. It performs its function by using real-time data and produces information immediately applicable to real-time operations and represents a “best” estimate of the current “as-operated” real-time state of the power system. The new VVO/DVR (voltage control) and FLISR (self-healing) systems reside in this environment.
2. Project Development System: The Project Development System is an offline environment used for the generation, maintenance and testing of SCADA, DMS, and OMS databases, network model, displays, and reports. Once tested and validated, the updated databases, displays, and reports are published to the production environment for use in real-time operations.
3. Operator Training System: The Training System is an offline environment used for training users in the operation of the system. In this environment, real-time and/or saved data is replaced by equivalent data derived from a “simulation” of the real-time data. A dynamic model of the power system is used to produce the simulation data as the network model responds to hypothetical scenarios consisting of time-dependent loads and contrived system events such as feeder faults.
4. Quality Assurance System: The Quality Assurance System is an offline environment used for testing hardware firmware updates, operating system patches, software upgrades, updates, and hotfixes. The staging environment is a replication of the production environment, and full regression tests are performed in the staging environment prior to updating the production, development, and training environments to ensure all implementation steps and procedures are accurate.
5. Corporate Access System: The Corporate Access System is a collection of servers providing web-based access to ADMS functionality to corporate users and external applications connected to the Corporate WAN. They also provide a long-term archive for historical data and reporting. The Corporate Access System is implemented as a demilitarized zone (DMZ); this architecture

isolates corporate users and external applications from the ADMS real-time database, minimizing performance issues and data and cyber security concerns.

6. Outage Management System: The project also included the installation of a new OMS system with the ADMS.

Project Technical Scope and Work Completed

The EPC overall technical scope can be summarized at a high level in three areas, VVO, DA and OMS. Each of these areas is further described below including status for project completion reporting purposes as of March 31, 2023.

Voltage Control Scope Completed

This includes designing, procuring, installing, and commissioning a Volt/VAR control scheme on PUC Distribution's 12.5 kV distribution system.

A centralized model based VVO software from Survalent has been installed on PUC servers for use in the system control room. The interfaces with AMI and system models are built so that the VVO system can exchange data with these systems. All twelve 12.5kV distribution stations are included in the voltage control design. This includes one existing station with LTC transformers, three stations using new LTC transformers, seven stations using new bus voltage regulators and one station with feeder overhead regulators. Each field device is equipped with a controller to enable data exchange. The existing SCADA communications system is supplemented by additional cellular-based communications to provide communication between field devices and the central software system. Field integration of all installed equipment is complete. LTC controller and regulator settings are determined and applied to the associated equipment. SCADA points lists are developed, and the data acquisition system of these points established. As of March 31, 2023, about 80% of the VVO construction work was complete with equipment live and in service at a non-automated status.

Distribution Automation Scope Completed

This includes designing, procuring, installing and commissioning a distribution automation system that will improve reliability on PUC Distribution's 12.5 and 34.5 kV distribution and sub-transmission systems.

Base configuration of the centralized control software and FLISR is installed on PUC servers for use in the system control room. The interfaces with AMI and GIS are built so that DA system can acquire data from these systems. Each field device is installed with a controller to enable data exchange. A cellular-based communication system is being used to provide communication between field devices and the central software system. Field integration of all installed equipment is complete. Controllers and protective relays settings are determined and applied to the associated equipment. SCADA points lists are developed, and a data acquisition system of these points established.

Within the original project concept, the quantities and locations were reviewed as part of managing the overall project budget. Changes made in quantity and locations are confirmed and the adjusted scope of work defined implementation on approximately 40% of the subtransmission and distribution feeders. The FLISR system areas deployed on the subtransmission network to initiate automated switching will impact the reliability to all PUC customers. The FLISR system areas deployed on the 12.5 kV distribution feeders were prioritized from analysis of historical outage data with factors such as customer mix, circuit construction and feeder performance included. As of March 31, 2023, about 95% of the DA work was complete with equipment live and in service in a non-automated status.

Outage Management & Systems Integration Scope Completed

This includes designing, procuring, installing, and commissioning a new Outage Management System (OMS) along with the integration of existing systems for Advanced Metering Infrastructure (AMI), Geographic Information System (GIS), and Customer Information System (CIS) along with the overall Survalent ADMS in conjunction with the Voltage Control and Distribution Automation above.

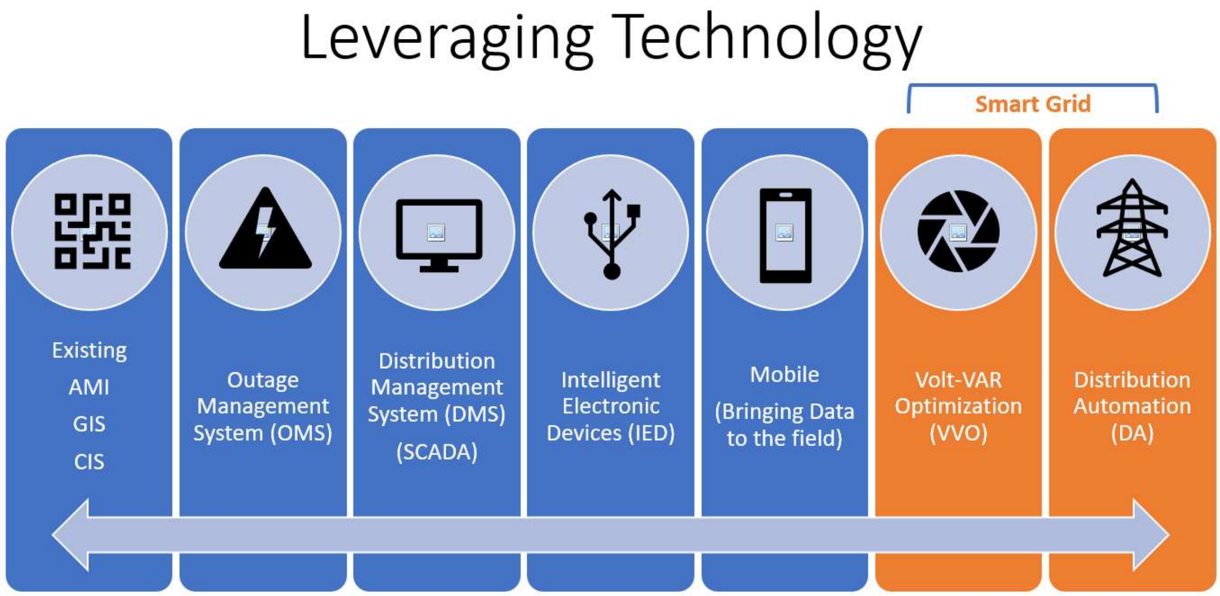
Base configuration of the software is installed on PUC servers for use by the system control operation, other internal users and integration to customer communication applications. The OMS interfaces with the new ADMS and existing PUC systems including Advanced Meter Information (AMI), Geographic Information System (GIS) and the Customer Information System (CIS). This allows "one source of truth" for the OMS system to acquire and display data from these systems. The OMS is a key initiative to improve outage management response, data management, reporting and provide improved communication to customers. As of March 31, 2023, about 25% of the OMS work was complete with base configuration complete and process review and change management plans developed for further implementation and testing.

Operational Challenges

A rolling and overlapping schedule of design and construction in multiple locations was implemented for the project. Multiple work packages in various stages of IFR (issue for review) and IFC (issue for construction) kept the engineering and construction teams in constant contact. Project planning and scheduling for critical path adjustments to maintain the flow of full design construction packages and efficient field construction activity was an ongoing effort throughout construction. Significant challenges were encountered in many areas, including materials availability and supply chain delays. At the beginning, the intended spring 2022 construction start was delayed to early July. This was in part related to the EPC contractor's design team to meet the challenging Ontario electric utility regulatory design approval requirements but also supply chain delays on some materials and equipment. Throughout construction, supply chain challenges, as well as timing and availability of specialty skill resources and local subcontractor trades constraints, continued to impact engineering and construction teams' ability to maintain the schedule. With each station requiring a full scheduled station outage, planning and coordination was a continuous effort as a delay on a station return to service plan had a domino effect on the ability for the next station outage schedule. This construction schedule continued through 2022 and right up to the Contribution Agreement deadline on March 31, 2023. At that point in time, approximately 80% of the VVO and stations work, and 95% of the DA and line construction field work was complete and in service tied into System Operations on the legacy SCADA system. Implementation and construction are anticipated to continue for about six months to complete the overall project.

Technology Overview

The PUC SSG Project is a project to not only modernize its distribution energy infrastructure but also leverage existing technologies deployed in the utility. The new systems will advance the level of grid intelligence to increase capabilities to manage the distribution system in near real-time. Adding and integrating these systems provides enhanced insight and analytics into the distribution system for Engineering, Operations and Customers.



New equipment installations included monitoring and control equipment that communicates with the control room ADMS. This included Eaton's Cooper Power series CL-7 voltage regulator control for new regulators, Beckwith - Model M-2001D - Digital Tap changer Control for new load tap changer transformers, Schweitzer SEL-2414 transformer monitoring and SEL-651R recloser control.

The Survalent ADMS is comprised of a number of specific systems. Some of the main components are described below.

1. **Production System**

   ADMS Servers - The ADMS servers process all incoming information from the stations and field data links and execute real-time supervisory control functions of the system. The ADMS servers are also responsible for executing distribution management (DMS) applications and outage management (OMS) applications such as network topology processing, distribution power flow, outage analysis, FLISR, and VVO.

Operator Workstations - Operator workstations were also upgraded for the project. Each workstation is equipped with the SmartVU operator interface. SmartVU provides users quick access to a large number of views of their map, alarms, operation logs and graphs. Operator actions, such as control and alarm acknowledgement, are forwarded to the ADMS server for execution.

2. Corporate Access System (DMZ)

The Corporate Access System is a collection of application servers and web servers that are configured in a demilitarized zone. To support the web servers, the Corporate Access System maintains a near-real-time copy of the ADMS database in a relational database (RDBMS). This isolates corporate users and external applications from the real-time database, thereby minimizing performance issues and data cyber security concerns.

ADMS Relational Database (RDBM) Servers - The RDBMS Servers are responsible for replicating near-real-time SCADA/OMS/DMS data to a relational database in the Corporate Access System demilitarized zone.

SCADA Web Servers - The SCADA web servers host the web applications that provide real-time SCADA information to users via a web browser without the need for custom installation or maintenance. Desktop and mobile web applications allow corporate users to call up and view any SmartVU graphical display, substation one-line, or tabular display.

OMS Call Handler Web Servers - The OMS Call Handler web servers host the web application that allows Customer Service Representatives and Call Centre staff to record customer trouble calls and make the data immediately available to the Survalent ADMS for analysis, dispatch and resolution.

OMS Dashboard Web Servers - The OMS Dashboard web servers provide access to the OMS Dashboard web application that integrates outage data from multiple sources into a single consolidated view with real-time visualization. The OMS Dashboard provides increased awareness of important outage information for utility staff, and detailed outage data is easier to understand and more actionable through visualization and customized views. The OMS Dashboard web application is accessible in two modes:

1) **Lobby Mode**: Provides an interactive dashboard that allows utility employees and other stakeholders to view the locations and the extent of known outage cases and OMS key performance indicators (KPI) such as the number of customers affected, SAIDI and CAIDI. Intended to run on large screen displays within a utility, the lobby mode dashboard is an important communication tool for utility employees and other stakeholders.

2) **Mobile/Desktop Mode**: Provides an interactive dashboard that allows internal stakeholders to view the locations and the extent of known outage cases, OMS KPI data, outage causes, list of customers affected, estimated time of restoration and outage messages, and view a list of all planned outages. The mobile/desktop mode is intended to run on mobile devices or desktop computers for use by Managers, Supervisors, and other utility staff; user login is required.

OMS Mobile Crew Web Servers - The OMS Mobile Crew web server host the web application that allows dispatchers, schedulers, field workers and supervisors to access the same real-time information on outage conditions and field service operations. Using a tablet or laptop, field workers log in to the Mobile Crew web application tool to gain instant access to their assigned work, including new work assigned throughout the day. The Mobile Crew web application provides seamless operation even in areas without wireless coverage, allowing users to access the application when they are offline. When back online, user devices automatically synchronize with Survalent ADMS to update control room staff with the latest information.

OMS Customer Outage Portal Web Servers - The OMS Customer Outage Portal (COP) web server allows utility customers to view the location of existing outages and send new outage information. If utility customers are authorized to send outage information to the Survalent ADMS, the Customer Outage Portal web application uses CAPTCHA technology to limit the risk of a Denial of Service (DOS) attacks.

3. **Project Development System (PDS)**

   The Project Development System (PDS) provides an offline environment for generating and testing display and database changes without affecting the online system. The PDS provides tools to import distribution network data residing in a corporate GIS system or offline analysis tools into the ADMS. The PDS provides a full set of ADMS functionality in an offline environment. An off-line copy of the memory-resident databases is available on the ADMS Server for development and test purposes. Once the modifications have been tested and approved, they can be installed on the online system quickly and easily.

4. **Quality Assurance System (QAS)**

   The QAS provides an environment to install, monitor, and evaluate software patches and updates including, but are not limited to, operating system patches, third-party software patches, and Survalent software updates. Regression tests, including redundancy tests, can be performed and confirmed prior to installing the updates to the online system and hence minimizing considerably the risk to the online system. To support this functionality, the QAS can be configured to receive near-real-time data from the online system.

5. **Operator Training Simulator (OTS)**

   The Operator Training Simulator (OTS) provides an offline environment for distribution system operators to receive regular training in power system operations under normal operating conditions as well as emergency conditions. The Operator Training Simulator uses the same database and displays that are used in the real-time system. This allows operators to train in the exact environment used for real-time operations and eliminates the need to maintain a separate set of databases and display for the simulator.

6. **Advanced Historian**

The advanced SCADA historian provides continuous data collection for any analogue or status value upon detection of its value change or quality code change. The capture of the data values will preserve the time of change reported by the data source using the full capabilities of the SCADA protocol, including millisecond timestamps. The historical data is available for trending, reports, playback, and other SCADA functions. The advanced SCADA historian uses a proprietary, real-time database for optimal performance and supports an ODBC interface for integration with Microsoft Access, Microsoft Excel, and other third-party applications and report packages.

Other Project Achievements

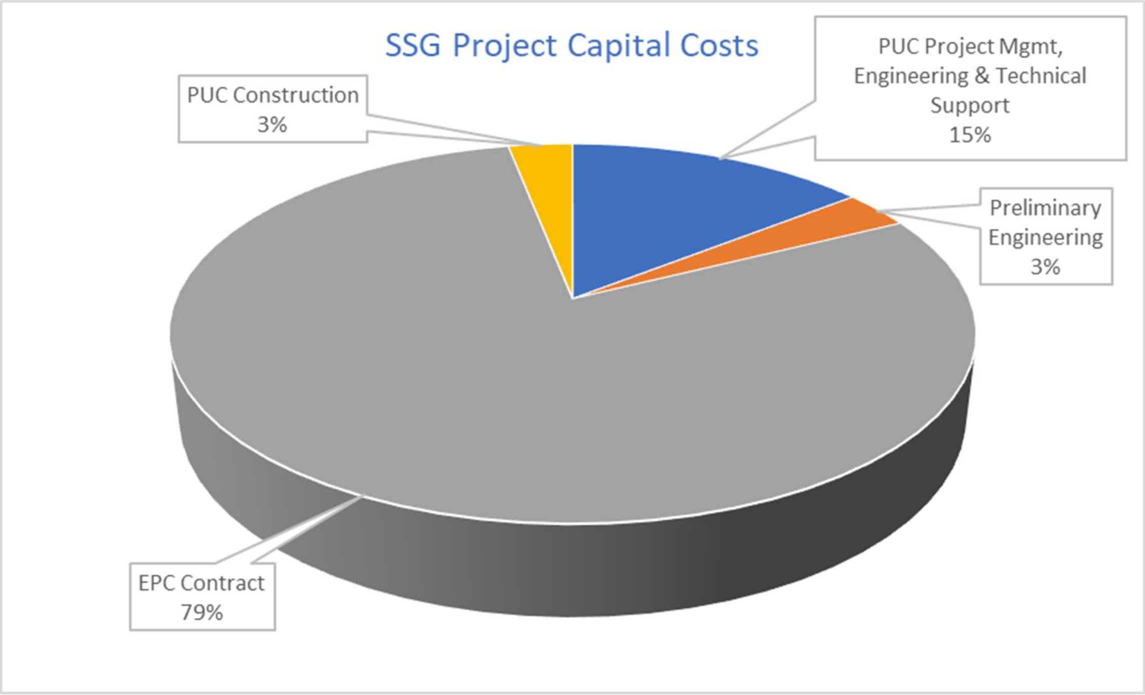
Some of the key highlights and project achievements are described in this section of the report.

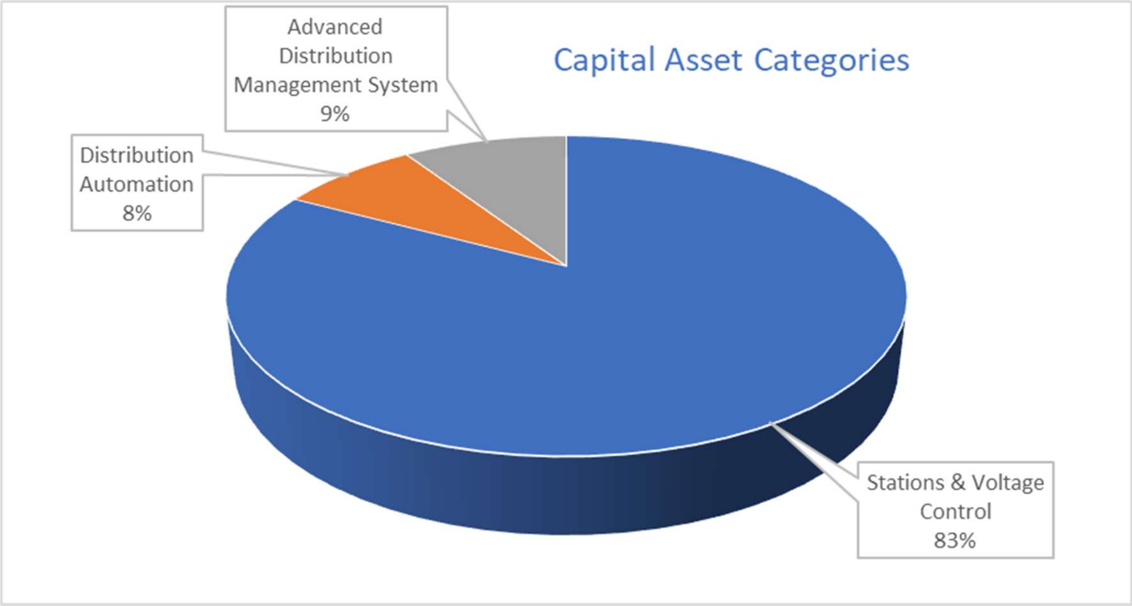
The first achievement is the overall project safety performance. The project plan included a comprehensive Health & Safety Management Plan from both PUC and from the EPC contractor. Their combined plans included dedicated H&S staff in both full-time and part-time roles on the project. Ongoing monitoring and control and reporting of leading indicators were a key focus. From project commencement in 2018 to project completion on March 31, 2023, a total of 53 full-time equivalent positions, 65% in field construction, have worked on this project without any lost time or serious injury incidents.

A second achievement for the project team has been meeting the challenges of the project schedule and NRCan program funding deadline, especially in relation to the project budget and capital spending. Regulatory approval delays, a pandemic, materials and supply chain delays, and key resource constraints at both local and broader levels were overcome to deliver a successful project. As of March 31, 2023, the project is about 85% complete. With the project delays full completion is expected to require approximately an additional six months.

Project Financials

The SSG Project capital spending includes costs defined over the NRCan Contribution Agreement Eligible Expenditure Period starting September 5, 2018, to March 31, 2023. Total costs were $31,698,647.62 on the project as of March 31, 2023. The project received a total contribution of $7,658,222 from the federal Smart Grid Program towards the project. The figures below provide different views of interest from perspective of project capital costs activities and asset categories.





Project Benefits

Overview

The SSG project benefits include not only to PUC customers, but also broader stakeholders supplied by the local and provincial transmission grid from the demand and energy savings to be achieved. Purchased energy reductions by PUC from the provincial grid will in turn reduce GHG emissions from the reduced marginal generation dispatched by the provincial Independent Electricity System Operator. GHG emission reductions from source emitters in Ontario benefit many Canadians beyond Ontario's boarders with a cleaner environment. Distribution Automation and Grid Monitoring will deliver improved resiliency and reliability to PUC customers and with the new Advanced Distribution Management System, an enabling platform for assessing and facilitating integration of Distributed Energy Resources such as energy storage and electric vehicles.

Benefits and Key Performance Indicators

In terms of Project Completion Reporting (as of the end of the Contribution Agreement), with the SSG project not being fully in service as of March 31, 2023, the benefits to be achieved are still ahead as the project continues towards final completion. The remaining scope of work for System Operations and Field construction will continue through to the end of summer. The tables below describe the key performance indicators and some of the project metrics being developed and finalized for the project. With key performance indicator measurement systems being finalized ongoing benefit measurement will be reported annually.

1. **GHG Emission Reduction**

Area	Metric	Description	Target
GHG emissions reductions	Reduction in GHG Emissions	GHG emissions reduction from provincial generation sources achieved through the SSG VVO reduction in kWh energy use/purchase.	785 (tCO2e) (revised)
	Reduced energy losses from GHG emitting supply (kWh) (but not calculated directly)	Energy reduction of lower power purchase/supply by PUC applied to average provincial transmission grid loss factor means less energy production from provincial generation sources and additional GHG reduction.	Is Included in above GHG calculation

The NRCan GHG Reporting Template report that was filed earlier this year for the SSG Project provided PUC projection of anticipated emission savings to be achieved from the voltage control systems. The NRCan GHG audit consultant reviewed PUC original submitted forecast methodology and annual estimate of ~2860 TCO2e based on a marginal generation dispatch of GHG emitting supply approach and concluded that for purposes of NRCan reporting to maintain uniformity in the overall NRCan Smart Grid Program they preferred a more conservative approach using an average emission factor for Ontario generation delivered through the Independent Electric System Operator controlled transmission grid. The estimated GHG emissions savings using the average approach reduces the annual savings estimate to 785 TCO2e. PUC does not dispute this approach by the NRCan auditor but does feel that this is a very conservative assumption and that the marginal approach would be realistic given the nature of the marginal generation dispatch in Ontario. PUC will be reporting annual estimates for GHG emission savings going forward using the NRCan methodology although for 2023 only a partial year of operational savings will be realized.

In addition to the emission savings from non-dispatched generation there would be some savings associated from reduced energy losses in the provincial transmission grid from less energy delivered to PUC as well although these were not quantified individually.

2. Improved Asset Utilization and Grid Efficiency

Area	Metric	Description	Target
Improved Asset Utilization and increased energy efficiency	Reduction in peak demand on utility assets (kW)	Demand reduction (kW on station assets) will be measured as part of the VVO performance measurements.	Trending KPI's (kW and %)
	Reduction in energy losses (% of PP kWh)	The energy reduction achieved with the SSG VVO solution will reduce system losses in relation to the reduced energy delivery.	2.7% of system losses
	$ savings from deferred system upgrades	This measure requires further research on methodology and data collection and will be part of future asset management programs. The measure and associated target will be evaluated with asset management planning systems over the 2023-2027 DSP period.	Trending KPI TBD
	$ energy savings to customers (& kWh)	The VVO energy savings (kWh) and a total system average energy price (P_{AVG}) calculation.	2.7% kWh and $'s (calc)

This set of metrics are also related to the SSG voltage control systems. Through voltage control the reduced kWh energy requirements will also be measurable in kW demand reduction on transformation assets. Reduced demand over a long period will contribute to extending the equipment's life cycle. The requirement for less energy used by customers also results in lower distribution system losses as less energy is being delivered through the distribution system.

The SSG project has included some asset renewal with improved asset monitoring and control capabilities.

The improved system operation and asset performance data will support long-term system planning and asset management programs which are expected to support timely asset renewal and upgrade decisions. Some of the new assets deployed for the SSG project will deliver specific net present value savings with expected adjustments to new long-term asset investment plans. The historical data analytics and specific project design efforts for the project have maintained an estimated potential energy savings to be achieved of 2.7% for customers supplied on all the 12.5kV distribution circuits. Based on normalized PUC annual energy purchase requirements, this savings is estimated as ~$2.3M annually.

3. Increased Reliability and Resiliency

Area	Metric	Description	Target
Increased reliability and resiliency	# events Fault Location, Isolation and Restoration (FLISR) responded to	Utilize data captured in the Outage Management System (OMS) combined with data from SCADA to report an event count and trending KPI.	FLISR Event Trending KPI
	$ revenue loss avoided from outages avoided	Calculation/estimate from the customer minute reliability improvement metric multiplied by an average customer revenue value.	Calculated $'s
	NEW Reduced customer minutes of interruption (CMI)	Utilize the new OMS and SCADA system to calculate the difference in customer minutes of interruption (CMI) on feeders with DA deployed and an estimate of CMI that would have occurred without DA.	~10% CMI

The FLISR system is being deployed on about 40% of the distribution system supplying customers. Reporting the customer minutes of interruption (CMI) savings metric from the FLISR operation will require outage events making this a multi-year performance measure. The customer minutes of interruption (CMI) savings and $ revenue savings are expected to take a number of years before "typical" values can be determined.

In addition to the benefit metrics described above from the Contribution Agreement, there were three additional metrics identified in the original project proposal, 4) Increased system flexibility and renewable energy, 5) cyber security, and 6) Economic and Social Benefits that are further described below.

4. Increased system flexibility and renewable energy.

The SSG project included a complete upgrade of the legacy SCADA system to the new ADMS. This included the addition of advanced modules to support the voltage management and optimization controls on all 12.5kV distribution circuits. By implementing the system across all circuits, PUC has ensured that the full system is prepared to be ready for the expected growth in renewal energy type connection requests. With the base level software and platform in place the monitoring and control now available will support the safe and reliable operation of the present system and support requests for new connection of distributed energy resources (DER's). As the level of penetration of DER's grows new options for more task specific modules to be integrated in to the ADMS can be initiated to continue to connect and maintain the required level of system performance for all customers on the network.

5. Cyber Security

Cyber security is one of the highest risks to manage in the electric utility industry. The SSG project included expansion of IT network and communications hardware and software technology applications. Cyber security review was integrated throughout the design process and multiple zones and levels of protection were implemented. The new ADMS and associated systems have been integrated into PUC cyber security real-time monitoring and action protocols.

6. Economic and Social Benefits

One of the primary benefits in this area is the impact on new jobs and employment. Since the project commenced in 2018 to the NRCan Contribution Agreement end on March 31, 2023, there has been an estimated 53 full time equivalent positions employed on the project. In addition, PUC has added two new full-time positions in our System Operations area to support the operation of the new system.

System Operations staff in dedicated and relief roles have had or will have about 1.5 weeks of technical training on the new ADMS and equipment as well as some with direct project involvement in configuration and testing efforts. PUC technical staff in Stations, Lines and Engineering, will also be receiving training on new equipment post the current NRCan project completion date of March 31, 2023.

Lessons Learned

There were many lessons learned throughout the SSG Project from the approval stage and then design and procurement through installation, testing, and commissioning. The time for communication and building good understanding early in the project and throughout the various stages across all parties involved is time well spent.

Take the time needed to discuss and ensure understanding with external engineering resources of the Electrical Distribution Utility regulatory requirements related to utility construction arising from O. Reg. 22/04, which include material approval, design approval and construction verification approval. Getting this right from the first step can help to reduce efforts at re-work delays and revisions.

Document management protocols and structure should be set up early with clear guidelines and then adjusted or expanded as needed throughout the project life cycle. Consideration of a “document control” role for posting, sharing, comments, and retention can be a valuable addition.

Early procurement assessments for the material and equipment needs of the project are invaluable (especially in a pandemic). This should include not only major equipment items but also consideration of a full material list review, as some small components can have a large impact on execution.

Don’t miss the need and potential timeline for third-party approvals and permits. Some agencies can have multiple weeks or longer to respond to such requests.

Project schedules and clear communication on critical path and parallel path areas are very important for multi-site work and task management. Having options available to pivot and make the best use of resources when delays occur is invaluable in maintaining the overall schedule and milestones. Different levels of schedule presentation should also be defined for reporting purposes.

Next Steps

Completion of the final stages of the SSG project will be the focus for about the remainder of 2023 for the project team. Wrapping up field construction and final configuration, testing, commissioning, and rollout of the ADMS advanced systems for voltage control and FLISR distribution automation will be included. Project close activities will follow. A project update report will be prepared early in 2024.

With the need for reporting on progress metrics for five years with NRCan and for at least ten years for OEB regulatory requirements, on-going reporting support systems for the SSG project will need to be reviewed and potentially adjusted. Internal metric reporting is expected to expand as performance data is collected over time, which will also help in operations and efficiency continuous improvement initiatives over future years of operation.

With the capability and data expected to be available, the beginning of a future optimization stage for voltage optimization and expanding FLISR areas will be assessed. Some ideas have emerged as the project has been executed, and business cases will need to be explored for consideration and priority as well as integrated into longer-term Distribution System Plans.

Sault Smart Grid Project
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