

Completed Projects

1.1 Introduction

This section of the IRP contains a description of VEC's past power supply portfolio, T&D improvements, and capital investment.

1.2 Power Supply Completed Projects

1.2.1 Tier 1

Tier 1 Strategy

VEC's Tier 1 strategy is to monitor the price of all Tier-1-qualifying RECs and, when cost effective, sell as many Massachusetts Class-I and Connecticut Class-I-qualifying RECs as possible and meet any resulting shortfall in its Tier 1 requirement by purchasing lower priced RECs or making a payment to the Clean Energy Development Fund at the applicable Alternative Compliance Rate.

Tier 1 Action Plan

1. Participate in Public Service Board Docket #8550 regarding rules for Tier 1 resource qualification and other aspects addressing implementation of Vermont's RES.

Action Taken: This is an ongoing item. VEC has, and will continue, to participate in PUC proceedings regarding the implementation of Vermont's RES.

2. Monitor VEC's Tier 1 requirements, especially with respect to how needs may change as a result of Tier 3 implementation. This will require monitoring and updating:

- a. Load forecasts as more recent information becomes available;
- b. The pace of net metering installations, including size and technology, and the associated impacts on load;
- c. Load reduction impacts of efficiency measures actually installed and projected to be installed on the VEC system by Efficiency Vermont; and
- d. Load growth impacts of Tier 3 technologies implemented on the VEC system.

Action Taken: VEC has two planning tools (a Power Cost Projection spreadsheet and a Resource Projection spreadsheet) it uses to estimate its Tier I and Tier II requirements on a 20-year basis. The tools are based on VEC's most recent load forecast adjusted for load increases from Tier III programs and load reductions due to energy efficiency implemented by EVT and Net Metering projects installed in VEC's territory.

3. Monitor and update the annual projected output of all Tier 1 resources and REC purchase contracts in VEC's portfolio.

Action Taken: See response to item 2.

4. Develop a spreadsheet, or some other data tracking tool, to track VEC's projected requirements and resources to provide a simple, easy to update view of VEC's Tier 1 REC position.

Action Taken: See response to item 2.

5. Monitor current prices and projections for purchase and sale of all Tier-1-qualifying RECs and the Tier 1 Alternative Compliance Rate. This will likely include monitoring volumes of Tier 1 Resources in New England with respect to requirements in the various states.

Action Taken: VEC monitors the current and short-term costs of Tier I resources through information provided by brokers. VEC also has a subscription service with Sustainable Energy Advantage (SEA) through which it tracks factors in the New England renewable energy market place that impact the short-term and long-term value of RECs. The SEA subscription also provides short-term and long-term REC value projections for the most highly traded and valued REC classes in New England.

6. Sell more valuable Tier-1-qualifying RECs and replace by purchasing less-valuable Tier- 1-qualifying RECs as needed to fulfill Tier 1 REC requirements. Decisions regarding when to transact, how much to sell/buy and whether to pay the Alternative Compliance Rate will be based on:

- a. Short-term prices with respect to history;
- b. Long-term projections;
- c. The relationship of prices with respect to those assumed in financial plans; and
- d. The relationship of prices with respect to those already in VEC rates.

Action Taken: This is an on-going, continuous process through which VEC sells RECs from 1 to 3 years out into the future. Sales/purchase prices and volumes are based on information collected in items 1-5 above. Transactions are limited to 3 years because the REC market is often not very liquid beyond that time frame. However, VEC may enter contracts beyond 3 years if it can find counterparties at prices VEC believes are reasonable and in line with long-term budget assumptions.

1.2.2 Tier 2

Tier 2 Strategy

VEC's strategy is to enter long-term power purchase agreements with developers as opposed to developing generation projects on its own for the following reasons:

1. As a not-for-profit utility, VEC's core strengths are delivering electricity to its customers, negotiating favorable power supply contracts, and managing the financial risk associated with the resources in its energy and capacity portfolios.
2. VEC does not have expertise in the design, development and maintenance of renewable projects. To develop this expertise would take time and money, and will come at a cost, as mistakes would likely be made along the way. VEC believes it is in its members' best interests, at this point in time, to focus its labor resources on its core competencies and allow other entities to develop and own the projects.
3. Developing any generation project can require the expenditure of several hundreds of thousands of dollars in site selection, design and permitting. There are many hurdles along the way which can force the potential project to be abandoned before it becomes commercial. As a result a developer (whether VEC or a third party) can spend a significant amount of money with no project to show for it.

Some of these power purchase agreements will likely be at levelized prices (meaning the same price for each year of the term) in order to provide cost stability. Others may start at lower prices and escalate each year in order to provide lower rates in the earlier years of the contract.

Tier 2 Action Plan

1. Participate in Public Service Board Docket #8550 regarding rules for Tier 2 resource qualification and other aspects addressing implementation of the RES.

Action Taken: *This is an ongoing item. VEC has, and will continue, to participate in PUC proceedings regarding the implementation of Vermont's RES.*

2. Monitor VEC Tier 2 requirements especially with respect to how needs may change as a result of Tier 3 implementation. This will require monitoring and updating:

- a) Load forecasts as more recent information becomes available;
- b) The pace of net metering installation including size and technology, and the
- c) associated impacts on load;
- d) Load reduction impacts of efficiency measures actually installed and projected to
- e) be installed on the VEC system by Efficiency Vermont;
- f) Load growth impacts of Tier 3 technologies implemented on the VEC system.

Action Taken: *VEC has two planning tools (a Power Cost Projection spreadsheet and a Resource Projection spreadsheet) it uses to estimate its Tier I and Tier II requirements on a 20-year basis. The tools are based on VEC's most recent load forecast adjusted for load increases from Tier III programs and load reductions due to energy efficiency implemented by EVT and Net Metering projects installed in VEC's territory.*

3. Monitor output of resources compared to current projections and adjust future projections accordingly.

Action Taken: *See response to item 2.*

4. Establish a method for monitoring and updating the annual projected output of all Tier 2 Resources outside of VEC's control, including:

- Net metering projects installed by VEC members on or after January 1, 2017.
- Standard Offer projects whose commercial operation date is on or after July 1, 2015.

Action Taken: *See response to item 2.*

5. Monitor actual output, and accordingly update the projected output, of Tier 2 resources in VEC's portfolio that it has acquired.

Action Taken: *See response to item 2.*

6. Monitor the cost of new Tier 2 resources compared to the cost of non-renewable resources plus the Tier 2 Alternative Compliance Rate.

Action Taken: *VEC updates Tier 2 Alternative Compliance Rate projections on an annual basis and monitors the cost of Tier 2 RECs through broker data and other available market information. These data are available for comparing against the cost of new Tier 2 resources that VEC has the discretion to purchase.*

7. Work with developers or other potential suppliers of Tier-2 qualifying resources to optimize the deployment of new projects.

Action Taken: *VEC has only entered into 2 agreements with developers that were not already in progress at the time its 2016 IRP was completed. Because those agreements were in lieu of the developer building 500 kW Net Metering projects, VEC had only some discretion in the timing of the projects. Outside of these 2 projects, VEC has no projected need for additional Tier 2 resources in the next 8+ years, as a result it has not yet had the opportunity to optimize the timing of new projects, but will do so when needed.*

8. Develop a spreadsheet, or some other data tracking tool, to track VEC's projected requirements and resources to provide a simple, easy to update view of VEC's Tier 2 REC position.

Action Taken: *In addition to the spreadsheets mentioned in item 2, VEC also has made tracking the output of Tier 2 resources a Key Performance Indicator that is tracked on a quarterly basis and reported to VEC management and the Board of Directors.*

9. For each project, determine whether VEC will take an ownership position or continue with its current strategy of entering PPAs with solar developers.

Action Taken: *VEC continues to believe that the best course of action for its membership is PPAs as opposed to direct ownership. However, this question will be revisited whenever VEC has a need for additional resources.*

10. Continue to be an active participant in the National Rural Electric Cooperative Association Renewable and Distributed Energy Membership Advisory Group. This will allow VEC to learn from the experiences of other cooperatives regarding issues associated with implementation of distributed renewable resources. It will also allow VEC to share its knowledge with other cooperatives.

Action Taken: *VEC continues to be an active member in the NRECA Renewable and Distributed Energy Membership-Advisory Group. VEC attends semi-annual meetings of the group. Outside of the meetings VEC communicates with other Coops for ideas and insight on new concepts and technologies.*

11. Research and monitor developments in energy storage and develop a strategy for utility scale uses that will benefit VEC's membership.

Action Taken: *VEC has been actively following developments in battery storage prices and strategies.*

VEC has entered an Energy Storage Services Agreement (ESSA) in which a developer will build a battery storage facility on VEC's system and VEC will have the right to call on the battery to discharge and reduce its load as seen by ISO New England for 400 hours a year. The developer must provide 1 MWh for each of the 400 hours dispatched each year. VEC will use the battery to manage NEPOOL transmission costs by reducing its load in the one hour Vermont peaks each month, and reduce its costs in the ISO New England capacity market by reducing its load in the one hour New England peaks each calendar year.

VEC is also trying to develop a residential battery storage program, but is running into economies-of-scale issues. VEC is now working with other Coops to develop a joint program to eliminate the economies-of-scale issues. Whether or not this is successful has yet to be determined.

12. Establish a Purchase Power Agreement template(s) to be used between VEC and prospective renewable energy developers in order to streamline the contract negotiation and approval process at both the VEC Board of Director and Public Service Board (now Public Utility Commission) levels.

Action Taken: *VEC has established a solar Power Purchase Agreement and an Energy Storage Service Agreement template to streamline future contract negotiations.*

13. Assist Coronal Municipal Energy Services in finding locations on the VEC system for up to 4 MW of solar facilities.

Action Taken: *VEC had been working with Coronal until talks with Coronal regarding the Alburg solar project fell through. At that point VEC ended its relationship with Coronal.*

14. Complete negotiation of contract with Bullrock-Deutche ECO for a 4.99 MW solar facility in Grand Isle to come on line by the end of 2016. VEC will also monitor, and assist in, the 248 approval process required for the project to receive its Certificate of Public Good.

Action Taken: *The project received its CPG and began commercial operation in December 2017.*

15. Continue to monitor the REC market and VEC's Tier 2 REC position. To the extent necessary, balance the purchase of RECs from the new Tier 2 facilities with VEC's projected needs.

Action Taken: *VEC monitors the current and short-term costs of Tier 2 resources through information provided by brokers. VEC also has a subscription service with Sustainable Energy Advantage (SEA) through which it tracks factors in the New England renewable energy market place that impact the short-term and long-term value of RECs. The SEA subscription also provides short-term and long-term REC value projections for the most highly traded and valued REC classes in New England.*

VEC projects it will be excess Tier 2 REC for the next 8+ years. At this time it plans to sell all excess Tier 2 RECs to reduce rates for its members. However, on an annual basis it will monitor whether to sell all Tier 2 REC, use them to offset Tier 3 requirements or bank the REC for a future compliance year.

16. Continue to refine VEC's Survey Monkey tool used to solicit offers from developers and control the onslaught of inquiries from potential developers.

Action Taken: *VEC recently developed a Survey Monkey tool to solicit offers for residential storage products.*

1.2.3 Non-Renewable Strategy and Action Plan

Non-Renewable Strategy

For reasons similar to those discussed in the Tier 2 Strategy section, VEC will acquire non-renewable resources, at least for now, through purchase power agreements as opposed to direct ownership in newly developed resources.

VEC intends to meet its energy needs in the least expensive way possible while meeting the minimum required renewable portfolio standards. Therefore, as long as it will minimize costs, VEC will target using the maximum amount of non-renewable energy on an annual basis as the RES allows. Any allowable non-renewable energy added to the portfolio will be procured by balancing short-term and long-term costs net the sale of any excess RECs.

Non-Renewable Action Plan

1. Participate in Public Service Board Docket #8550 to be aware of any rules or implementation issues for Vermont's RES that may affect VEC's non-renewable portfolio.

Action Taken: *This is an ongoing item. VEC has, and will continue, to participate in PUC proceedings regarding the implementation of Vermont's RES.*

2. Monitor VEC's maximum allowable non-renewable resources. This will require monitoring and updating:
a. Load forecasts as more recent information becomes available;

- b. The pace of net metering installations including size and technology, and the
- c. associated impacts on load;
- d. Load reduction impacts of efficiency measures actually installed, and projected to
- e. be installed, on the VEC system by Efficiency Vermont;
- f. Load growth impacts of Tier 3 technologies implemented on the VEC system.

Action Taken: *VEC has two planning tools (a Power Cost Projection spreadsheet and a Resource Projection spreadsheet) it uses to estimate its Tier I and Tier II requirements on a 20-year basis. The tools are based on VEC's most recent load forecast adjusted for load increases from Tier III programs and load reductions due to energy efficiency implemented by EVT and Net Metering projects installed in VEC's territory.*

3. Monitor expected non-renewable portfolio as a percentage of total load compared to maximum allowable percentage, especially with respect to how needs may change as a result of Tier 3 implementation.

Action Taken: *See response to item 2.*

4. Monitor output of Tier 1 and Tier 2 resources compared to current projections and adjust future projections accordingly.

Action Taken: *See response to item 2.*

5. Analyze needs, on a monthly basis, taking into account VEC system-wide load shapes the output and rate of implementation of Tier 2 resources, many of which may produce more energy in the summer than in the winter and the impact of Tier 3 implementation.

Action Taken: *VEC reviews its needs and sets a strategy for the next 5 years each March when it develops its 5 year projection. In addition, each year is reviewed more in depth in the fall of each year during VEC's annual budgeting process. More refinements are considered while developing VEC's Annual Resource Report required under Rule 5.200 submitted each January.*

6. Analyze needs, on an hourly basis in each month of the year, taking into account VEC system-wide load shapes the output and rate of implementation of Tier 2 resources, many of which may generate more energy in the summer than in the winter and the impact of Tier 3 implementation.

Action Taken: *See response to item 5.*

7. Monitor the cost-effectiveness of including additional non-renewable resources into VEC's mix on a long-term basis compared to:

- a. Additional Tier 1 resources
- b. Additional Tier 2 resources net the sale of the associated RECs
- c. Purchasing on the spot market.

Action Taken: *See response to item 5.*

8. Create a tool that will model the emissions impact of VEC's non-renewable portfolio based on the same assumptions used by EVT and the DPS in screening energy efficiency projects.

Action Taken: *VEC has developed a tool as part of its long-term planning process to estimate the emissions impact of its portfolio based on the emissions characteristics of the NEPOOL Residual Mix as posted on the NEPOOL Generation Information System (GIS).*

9. Negotiate short-term purchase power contracts with suppliers that take into account VEC's system-wide load shape, the output and rate of implementation of Tier 2 resources and the impact of Tier 3 implementation. Various structures will need to be analyzed on a contract-specific basis including:

- d. Load following
- e. Fixed shape
- f. Daily options
- g. Blocks of on-peak and off-peak energy

Action Taken: See response to item 5.

1.2.4 Forward Capacity Market Strategy and Action Plan

Forward Capacity Market Strategy

For reasons similar to those discussed in the Tier 2 and non-renewable strategy sections, VEC will acquire capacity resources, at least for now, through purchase power agreements as opposed to direct ownership in newly developed resources.

VEC intends to add resources to the portfolio through negotiated purchase agreements with suppliers of existing capacity resources. Most contracts will be short-term in nature (less than 5-years) because of the continually changing market rules and the potential volatility in the market.

To hedge against the possibility of Vermont becoming its own capacity zone, VEC will investigate costs associated with procuring capacity delivered to the Vermont load zone and a contract with a developer for a long-term purchase of up to 20 MW from a facility located in Vermont.

Forward Capacity Market Action Plan

1. Monitor Forward Capacity Market rules and potential changes through participation in NEPOOL Participant Committee meetings and reviewing notes from NEPOOL Markets Committee and Reliability Committee meetings.

VEC is an active, voting member of the NEPOOL Participants Committee, which votes on potential NEPOOL and ISO New England rule changes.

Action Taken: VEC monitors potential developments at the NEPOOL Markets and Reliability Committees through meeting minutes and reports from VELCO staff.

2. Attempt to understand how rule changes may impact capacity prices in Vermont.

Action Taken: Based on the information from the discussions at the NEPOOL committees regarding potential rule changes, VEC attempts to assess which direction capacity prices should go.

3. Maintain model projecting VEC Capacity Load Obligations and Capacity Supply Obligations on a 20-year forward-looking basis.

Action Taken: VEC continues to maintain a tool to project its Capacity Load and Supply Obligations on a monthly basis. The model is periodically updated.

4. Target Tier 2 resources for development in locations in VEC's territory that will have the most beneficial impact on VEC's Capacity Load Obligation with ISO-NE.

Action Taken: To the extent possible we are trying to steer developers away from the SHEI until solutions to increase sufficient transfer capability out of the region have been implemented. To do this, VEC has/will not enter Power Purchase Agreements for facilities in the SHEI and has intervened in cases at the PUC regarding applications for Certificates of Public Good for any generators (including Net Metering) with installed capacity of greater than 150 kW AC.

In addition, distributed generation is less valuable to VEC if it is located in VEC's Block Load area. As a result, VEC has/will focus on PPAs for generation outside of the Block Load.

5. Maintain capacity resources sufficient to cover at least 50% of VEC's projected Capacity Supply Obligation going into the Forward Capacity Auction for any given commitment period.

Action Taken: VEC is currently hedged at a minimum of 75% through the June 2023 - May 2024 Commitment Period, and at a minimum of 50% through May 2035.

6. Investigate developing an interruptible rate for customers on the VEC system that will allow VEC to reduce the customers' load at times of New England and Vermont peaks in order to minimize VEC's capacity costs.

Action Taken: VEC has an interruptible rate that is available to industrial members which is being used by multiple members. VEC is currently in discussions with an industrial member that has the capability to reduce its load on the VEC system at critical peak hours. VEC and the member are working to identify the estimated load that could be reduced and develop an agreement structure that would allow VEC to call on the member to reduce load at specific times targeting transmission and capacity market savings. If successful with this particular member, the program could be expanded and offered to additional members with similar load reduction capabilities.

7. Investigate the acquisition of a long-term capacity resource in Vermont through a long-term capacity purchase agreement.

Action Taken: VEC has entered a 10-year ESSA agreement for a battery storage project that will be used to manage VEC's load at the time of the New England peak.

VEC is also currently seeking proposals for other 1 MW/4 MWh batteries and investigating the feasibility of a residential battery storage program to help manage its load at the time of the New England annual peak and the Vermont monthly peak.

As part of the Action Plan for the 2019 Integrated Resource Plan VEC anticipates investigating the feasibility of offering a PPA program with member who currently own their own generation through which VEC would pay the member a monthly fee in exchange for the right to dispatch the generation a certain number of hours a year to reduce VEC's load as recognized by ISO New England at the time of the Vermont monthly peaks and the New England annual peak.

1.3 Transmission and Distribution

1.3.1 Prior T&D Capital Projects (2008-2018)

The following section includes all projects that VEC completed from 2008 to 2018 and/or are proposed in VEC's 2015 IRP filing. The delayed projects are discussed in [E&O Capital Expenditure](#).

Distribution

Reconductoring

VEC completed the following projects prior to the filing of this IRP:

- North Hero Route 2 project (2017-2019)

VEC delayed the following projects due to budgetary constraints and will complete them in the next IRP cycle (before 2021):

- Providence Island Reconductoring
- Irasburg 42-3A Reconductoring
- West Charleston 48-1A Reconductoring
- North Hero/Alburgh RT2 Reconductoring

Voltage Conversion

VEC completed the following projects prior to the filing of this IRP:

- Derby 45 - Beebe Road (2019)
- Newport 44-4D - North Derby Rd (2018-2019)
- Irasburg 124 134 - Lake Road (2019)

VEC cancelled the following projects due to a lack of justification for the project. In many cases this was due to load growth that did not materialize.

- Newport 44-4C - Darling Hill Rd
- North Troy 41-3H - Armstrong Rd
- West Charleston 48-3E - East Echo Lake Road
- Newport 44-4B1 - Missionary Acres
- Derby 45-4CA - Bates Hill Road

New Tie Lines

VEC delayed the following projects due to budgetary constraints but will review them as part of the 2019-2020

[System Contingency Analysis](#):

- Berkshire 16-2A to East Berkshire 30-1A
- North Troy 41-1A to Newport/Irasburg
- North Troy 41-3A to Newport/Irasburg
- Irasburg 42-1A to Newport 44-5A
- Irasburg 42-3A to Newport 44-5A
- Burton Hill 43-1A to Irasburg 42-3A
- Burton Hill 43-3A to Irasburg 42-3A
- Island Pond 47-4A to West Charleston 48-2A
- West Charleston 48-1A to Derby/Island Pond
- West Charleston 48-2A to Derby/Island Pond
- West Charleston 48-3A to Derby/Island Pond

- West Charleston 48-4A to Derby/Island Pond
- West Charleston 48-4A to Derby/Island Pond
- Guildhall 53-2A to Island Pond 46-2A

New Construction

- **New Sectionalizing (2008-2010)** - In an effort to reduce outages and improve reliability VEC performed a system sectionalizing study. VEC identified unfused side taps as well as locations where protection miscoordination had occurred. In addition, VEC installed new recloser and fuses across the system.
- **42-3A Reroute Irasburg (2014)** - Almost 2.3 miles of three-phase line was relocated from the off-road right of way to the road along Route 14 to Irasburg Village. This allowed a VEC to tie the Burton Hill 43-1A circuit to the Irasburg 42-3A circuit that greatly improved reliability in the area.
- **Derby Line Express (2014-2015)** - The Derby Line express feeder was intended to serve the Derby Line load starting in the fall of 2015, which facilitated the retirement of the Derby Line #25 substation. VEC has also identified this project as the Derby/Derby Line Consolidation. The new feeder improved reliability for the Derby Line area and completed the integration of the Citizens and VEC systems in this area.
- **Warren's Gore (2014-2015)** - This project was to provide a 12.47 kV three phase extension to 5 locations along Route 114 in Warren's Gore, VT as part of Sweet Tree's expansion. The line was fed off VEC's Island Pond Sub #47 substation and continued along existing FairPoint communications poles up to Norton Pond.
- **NEK Connector (2014-2015)** - In Mid-August of 2015 VEC completed a 23-mile 34.5kV distribution line upgrade to support future economic development and improve reliability in the Northeast Kingdom (NEK). The \$14.5 million NEK Connector Project began in 2010 with a grant from the Economic Development Administration (EDA). VEC contracted out project design and engineering in 2013, and construction began in early 2015 to replace 23 miles of aged 34.5kV distribution line and the substation infrastructure (transformer and voltage regulators) required to support it. In addition, contractors installed approximately 37 miles of new fiber optic cable. VEC relocated many sections of the existing line alongside the highway and installed a 1-mile section of new line in Lemington to allow for feeder backup of VEC's Island Pond #46 and Canaan #51 substations.

Substations

VEC completed the following projects prior to the filing of this IRP:

Eden #2 Transformer Replacements (2008)

This project replaced the transformers, reconfigured the copper bus, and replaced the high side switch, LA's, high side fuses to overhaul the existing substation to improve overall worker safety and system reliability. The three transformers were from different manufacturers and one or two were not substation class. VEC had past experience with transformer failures at other substations with similar transformer configurations.

Highgate Springs Substation #27 (2008)

This project upgraded the voltage at the existing Highgate Springs Substation #27 from 2400 V to 7200 V that included the replacement of the existing substation transformer. This was a continuation of a project to eliminate three step-down transformers and convert the entire feeder to 12.47/7.2kV. This project lowered the feeder's power losses when operated previously at 4.16/2.4kV. VEC rebuilt the primary metering platform at the same time to address a safety hazard.

Tafts Corners #9 Substation (2009)

Due to projected load growth in the Williston area, and aged distribution equipment, VELCO, Green Mountain Power (GMP) and VEC jointly undertook a project that increased the capacity of their distribution systems and replace aged equipment. This included adding a transformer and related equipment within the existing fenced-in area of the VELCO Tafts Corners substation, and related improvements to the distribution system. The existing substation was fed from one transmission line while the new joint substation has two transmission feeds and a bus tie breaker which greatly increased reliability.

Eden #2 Substation (2009)

The East Hill Substation was a wood structure substation with a 14.4kV step down to serve Craftsbury with a single phase. It also contained the three 12.47/7.2kV Eden feeder reclosers. It was a safety hazard. VEC expanded the Eden Substation to include the three feeders and eliminated the 14.4kV feeder along with the wooden station.

Spare 34.5 kV Transformer (2009)

Three spare 34.5/12 kV 833 KVA Power Transformers were purchased as backups for Fairfax #1, Eden #2, Cambridge #3, Underhill #4, Lowell #5, Montgomery #7, Westford #11, Fairfax #12, Pleasant Valley #13, and Johnson #14 substations.

Spare 12.47 kV Transformer (2009)

A spare 46/12.47 kV 7/9 MVA power transformer was purchased as the eventual replacement for Island Pond 47 12.47 transformer

Enosburg #35 Transmission Substation (2009)

The existing structure was a three-way switch that included primary metering package for the Town of Enosburg. The location was prone to lightning strikes, and the metering package had failed several times. The new substation included three circuit breakers to better sectionalize the transmission lines and improve reliability.

Richford #31 Substation Transmission Switches (2009)

After an incident involving a VEC employee, VEC removed the existing transmission switches and installed new automated switches at the Richford #31 substation. In addition, the project rebuilt the entire switching structure.

Replaced East Berkshire #30 Transformer (2010)

The existing transformer did not have enough capacity to back-up the Richford distribution system. VEC installed a larger capacity transformer allowing for full feeder back up of the Richford 31-1A circuit.

Johnson #14 Substation Upgrades (2011)

This project replaced the transformers, reconfigured the copper bus, and replaced the high side switch, lightning arrestors, and high side fuses; overhauling the existing substation to improve overall worker safety and system

reliability. The three transformers were from different manufacturers, and one or two were not substation class. VEC had past experience with transformer failures at other substations with similar transformer configurations.

Jay Tap #39 (2010)

In 2010, VEC commissioned a new Jay Tap 39 switching station to improve reliability for several thousand VEC members in the northern part of our service territory. VEC owns and operates the Jay Peak Tap located approximately 300 feet west of the Leavitt Circle in the town of Jay. It is part of VEC's Highgate to Newport 46 kV transmission line. The "Tap" is a terminal that originates at this facility and delivers electricity to our Jay Peak Resort Substation.

The existing Jay Peak Tap consisted of pole-mounted switches that were over 50 years old and conditionally inadequate. The deteriorated physical condition of these switches had resulted in delays in outage recovery for as many as 8,000 members. These conditions also required unnecessary outages to sectionalize the line for planned maintenance. The improved facility has five circuit breakers, four capacitor banks, bypass switches to permit breaker maintenance without load interruption, metering for Jay Peak Substation, remote capability from VEC Johnson System Operations Center, and security lights.

Kingdom Community Wind (KCW) (2011-2012)

The Kingdom Community Wind Project located in Lowell, Vermont consisted of the installation of 21 Vestas 3.0 MW wind Turbines. In addition to the interconnection facilities, the project required the upgrading of two VEC 34.5 kV/12.47 kV distribution substations from 34.5 kV to 46 kV. VEC hired RLC Engineering to facilitate the interconnection process and to serve as the project electrical engineers to design the collector system and communications for the wind project and 46 kV upgrade to VEC's Jay and Lowell Substations. The transmission line feeding Lowell 5 converted from 34.5kV to 46 kV. As a result, VEC rebuilt the substation to accommodate the higher transmission voltage.

In addition, a capacitor bank expansion was required at the Jay Tap #39 substation based on VELCO system modeling in order to improve 46 kV system voltage.

Newport Transformer T3 (2012)

In 2012, VEC purchased a new 13.44/17.92/22 MVA transformer that would become the eventual T3 transformer for the Newport Substation Rebuild. VEC was unable to back up the Newport loads completely, and the existing Newport distribution recloser yard did not have adequate working clearances. Therefore, VEC decided to replace T3 with a new transformer to help improve reliability.

Jay Peak #40 Expansion (2012-2013)

In 2011, VELCO and VEC constructed a substation west of Leavitt Circle in Jay, Vermont, to provide a redundant path and additional capacity to deliver power to the Jay area. VEC identified the need for the Jay Substation its 2008 Integrated Resource Plan. The lack of redundancy in transmission paths and the overloading when various events occur on the system have become reliability issues that could potentially impact VEC members in Franklin, Orleans, Essex and Caledonia Counties.

VEC discussed and studied the project with the Vermont System Planning Committee to review the opportunity to defer the project using non-transmission alternatives. VELCO and VEC determined that non-transmission alternatives could not provide a lower cost solution. An analysis prepared by a consultant for VEC and VELCO considered the need for this project and other upgrades in northern Vermont, and showed this project to be the least costly transmission

solution to solve the reliability problems. In addition, VEC designed the proposed substation to avoid the need to replace the wires on approximately 22 miles of lower voltage (sub-transmission) line, which would be more costly and likely have a larger environmental impact than the construction of the substation and other transmission improvements.

Derby #45 Substation Rebuild (2013)

VEC completed this project primarily to increase feeder backup capabilities and resolve inadequate working clearances. The prior working clearances within the Derby Substation were inadequate to perform maintenance functions -- such as voltage regulator or circuit recloser replacement -- with the substation energized, and VEC had difficulty switching within the substation due to these smaller spaces. As a result, Maintenance or outages of certain non-redundant substation equipment, such as the tap line, transmission tap switches, transformers, and buses, required member outages.

In order to provide for improved feeder back-up capability to VEC's surrounding area substation circuit loads (Derby Line #25, Newport #44, and Irasburg #42 substations), the transformer was upgraded from a 5/7 MVA to a 10/14 MVA transformer. The feeder backup configuration allows for substation maintenance without member outages, and minimizes member outages during substation outages.

Madonna #15 Rebuild (2013)

This project relocated the existing Madonna substation to a new location and upgraded the transformer. The existing substation was close to a stream that flooded the substation regularly. In addition to the flooding issues, the substation had very low clearances, especially in the winter with snow raising the ground level, which was a significant safety concern.

DOE SCADA Projects (2010-2014)

In 2011, VEC was the recipient of a ~ \$5.7million dollar grant from the Department of Energy. The grant allowed VEC to add SCADA automation and replace reclosers, relays and regulators at every substation and metering point on VEC's system. These investments took place over 4 years, and VEC was able to complete almost \$11.4 million worth of projects with a 50% cost share with the Department of Energy.

South Alburgh #28 Substation Rebuild (2014-2015)

This project relocated the substation to a new location. The upgrade was needed due to asset management concerns, overall condition, and insufficient working clearances. The substation was moved approximately 1 mile north, off Route 2 in Alburgh. VEC constructed a 46kV transmission line spur approximately 750 feet over to the new substation site situated adjacent to Route 2 along with three new distribution lines. VEC extended the existing transmission conductor and a new three-phase distribution to the existing substation to link the existing distribution feeders.

The upgrade project included new relays and protection systems, concrete oil containment, voltage regulators, lightning arresters, a new 10/14 MVA transformer, air-break switches, ground grid, SCADA and communications, steel structure, and battery system.

Island Pond #46 Transformer (2015)

The project included upgrading the existing 3.75 MVA transformer to a 12/16/20 MVA. When VEC rebuilt 23 miles of aged 34.5kV infrastructure as part of the NEK Connector project, it was necessary to increase the size of the Island

Pond #46 transformer to allow for feeder backup of VEC's Canaan #51 and Norton #50 substations. This improved reliability to the area and provided capacity for future economic growth incentivized by the EDA grant.

South Hero #29 Spare Transformer (2015)

VEC purchased and installed a new spare 115 kV/12.47 kV transformer at its South Hero 29 substation. The South Hero transformer is unique on VEC's system in that it transforms incoming 115 kV sub-transmission voltage to 12.47 kV distribution voltage. The majority of VEC's spare transformers are either 46 kV/12.47 kV or 34.5kV/12.47 kV, and there are no mobile substations in the state that would back up the current 115 kV/12.47 kV transformer. As a result, VEC decided the best solution to be a spare transformer to mitigate any future concerns regarding transformer maintenance or failure.

East Berkshire #30 Substation Rebuild (2015-2016)

The East Berkshire Substation Rebuild project was performed due to asset condition and insufficient working clearances of the existing substation.

The upgrade project included new relays and protection systems, concrete oil containment, voltage regulators, lightning arresters, a new 7.5/9.375 MVA transformer, air-break switches, ground grid, SCADA and communications, steel structure, and battery system.

VEC Newport #44 Reliability Project (2015-2016)

Newport #44 is VEC's largest substation when it comes to members and load. VEC rebuilt the existing substation to address condition concerns, insufficient working clearances, and insufficient capacity for VEC substation feeder loads, which had prevented VEC from performing work inside the substation without taking outages.

The upgrade project included new relays and protection systems, concrete oil containment, voltage regulators, lightning arresters, air-break switches, ground grid, SCADA and communications, steel structure and battery system. In addition, the project added two separate distribution busses, allowing VEC to split the distribution loads between two transformers. As such, VEC is able to place all of the loads on either transformer for reliability concerns without affecting the distribution loads.

VELCO Newport Exclusive Facilities (2015-2016)

A substation condition assessment performed by VELCO in 2012 identified a need to upgrade the VELCO Newport facility. The assessment identified asset condition as an issue, and plans started to replace the existing VELCO Newport substation. In order to save costs VEC and VELCO collaborated on this project and the VEC Newport #44 Reliability Project.

The VELCO Newport Exclusive Facilities project added new protection and controls associated with the 46 kV and 12.5 kV assets. VELCO added new 46 kV switches, lightning arresters and voltage transformers to the Mosher's Tap and West Charleston lines. In addition, VELCO replaced the existing 46/12.5kV (T3) transformer with a new 13.44/17.92/22 MVA transformer and improved the existing 46/12.5kV (T4) transformer.

Canaan #51 Transformer (2016)

This project replaced the existing 5/6.25 MVA transformer with a 5/6.25 MVA transformer at VEC's Island Pond #51 transformer. The replacement was primarily due to condition.

Derby Line #25 Retirement (2016)

To improve reliability, VEC built an emergency backup feed on Baxter Ave, which provided service to Tivoly, VEC's third largest member, along with the 503 members in Derby Line. This allowed VEC to retire its existing Derby Line #25 substation, located in a floodplain, and install a padmount transformer, three regulators, and a recloser on Baxter Ave in order to feeder back-up Tivoly which remains on the 25kV HQ feed.

Island Pond #47 Transformer (2017)

This project upgraded the existing 3.75 MVA transformer to a 5/6.25 MVA transformer at VEC's Island Pond #47 transformer. The replacement was primarily due to condition with heavy rust and corrosion present on key areas such as the oil inlets and outlets for the cooling fins, as well as the tank lid. VEC also took the opportunity to install a slightly larger base-rated transformer in anticipation of any potential future load growth. In addition, VEC upgraded the transformer and installed concrete oil containment.

Cambridge #03 Substation Rebuild (2017-2018)

The Cambridge substation rebuild was a major capital investment for VEC and an important upgrade for reliability. This joint venture with Green Mountain Power (GMP) included installing a second transmission tap line and associated breakers that automatically sectionalize GMP's B8 line so that if a fault occurs on one section of GMP's line, the new configuration will still allow energy to flow to VEC's substations while shutting off the faulted line.

The project was commissioned in early November of 2018 with clean up and project closing continuing in 2019.

Substation Pole Inspection (2018)

VEC completed a substation pole inspection in September 2018. The goal of the inspection was to identify any conditions or concerns at 23 substations and metering points that utilize wood structures. VEC tested 193 poles with only one (0.05% failure rate) failed the inspection. VEC will replace this pole, located in VEC's Montgomery #7 substation, before year-end 2019.

Derby Transformer Replacement (2019)

In 2016, VEC noticed a sharp increase in hydrogen levels at its 46 kV Derby #45 substation transformer during a routine Dissolve Gas Analysis (DGA) test. The transformer exceeded condition "4" for hydrogen and condition "3" for total dissolved combustible gasses identified in IEEE C57.139-2015. VEC made an attempt in 2017 to remedy the issue (loose connection); however, the hydrogen rise continued into 2018. The transformer was sent to Pennsylvania for further review, and it was determined that it would need to be rewound. VEC expects to reinstall this transformer in summer 2019.

Delayed Projects

VEC delayed the following projects due to changes in priorities.

- Hinesburg #19 substation rebuild (including transformer and concrete oil containment)
- North Troy #41 substation transformer replacement and concrete oil containment
- West Charleston #48 substation rebuild (including transformer and concrete oil containment)
- Sheldon #32 substation rebuild (including transformer and concrete oil containment)
- Fairfax #1 substation rebuild (including transformer and concrete oil containment)
- Johnson #14 substation rebuild (including transformer and concrete oil containment)
- Montgomery #7 substation rebuild (including transformer and concrete oil containment)

Transmission

KCW project (2011-2012)

See description in Substation section above.

Irasburg – Barton Tap (H16) - 2015-2020

The VEC H16 line is an 18.6-mile 46 kV sub-transmission line that feeds VEC’s Burton Hill substation, the towns of Barton and Orleans, and a commercial VEC member, Portland Pipe. Portland Pipe is a pipeline pumping station that had been a high-use member but has been off-line for several years. This project consists of a condition assessment and replacement of VEC’s oldest transmission poles, many of which are in poor condition.

In 2009, VEC inspected and treated all of its transmission poles at ground line. However, VEC has expanded the condition assessment to review pole top conditions. Because of this condition assessment, VEC replaced 74 of the 168 poles/structures on this line since 2012.

Delayed Projects

VEC delayed the following projects due to budgetary constraints and condition assessments. They are discussed further below, as they remain part of our future plans.

- Madonna #15 transmission pole replacements
- Hinesburg #19 transmission pole replacements
- South Alburgh #28 transmission pole replacements
- Fairfax #1 transmission pole replacements
- Johnson #14 transmission pole replacements

1.3.2 SCADA and Cybersecurity

SCADA Data Archiver Upgrade (2015-2016)

In 2015, VEC installed 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. In addition, VEC has built dashboards using OSIsoft ProcessBook and Vision to enable mobile access to SCADA data for use by field personnel.

SCADA System Upgrade (2016-2017)

In early 2017, VEC completed an upgrade of its OSI SCADA system. The new SCADA system included hardware and software upgrades needed to maintain support and provide more robust system speeds. The upgrade included new features such as advanced display capabilities for situational awareness and significantly improved maintenance and administration tools designed to ensure security and integrity of system configurations and updates. VEC typically upgrades its SCADA hardware and software on a four to five year cycle to maintain hardware and software that is supported and updated with security patches, fixes, and updates.

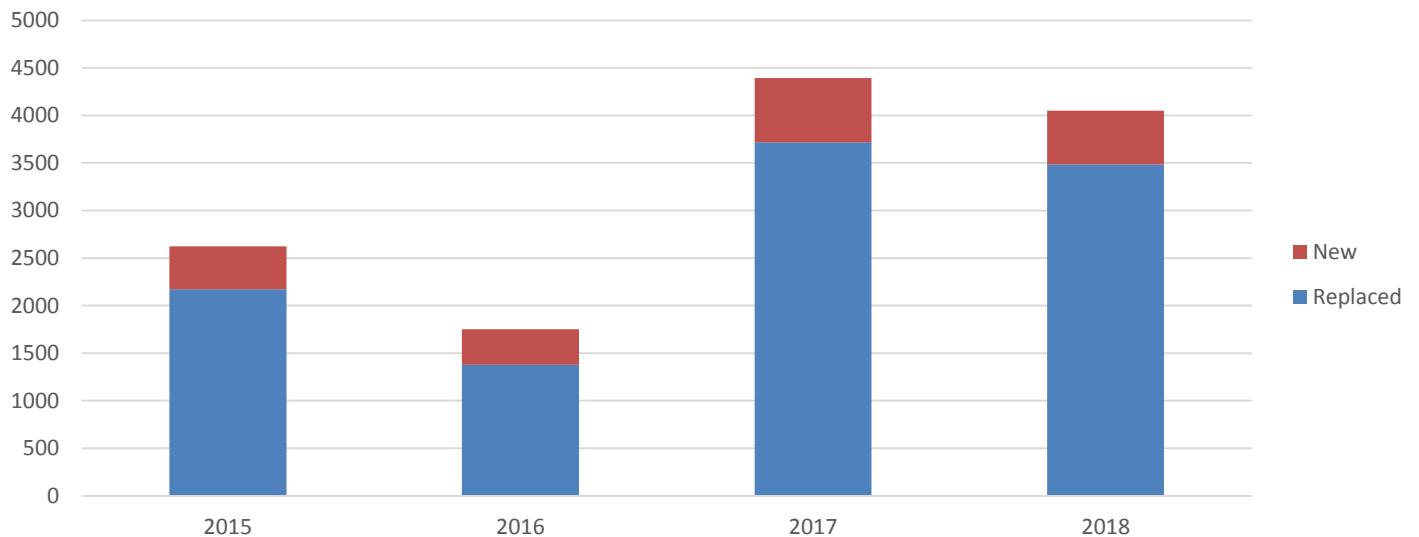
1.3.3 Metering

Meter Replacements (2015-2018)

Since January of 2015, VEC replaced or installed approximately:

- 1,450 2S AMI meters with remote disconnects
- 10,000 2S AMI meters
- 60 non-AMI (opt-out accounts)
- 268 commercial meters (various meter forms)

Number of Meters Installed/Replaced 2015-2018



For the past two years, VEC has been replacing approximately 3,000-3,500 meters with newer Advanced Metering Infrastructure (AMI) modules (2s, self-contained, UMT) that are capable of working with the planned AMI upgrade.

1.3.4 Information Technology

Cybersecurity

VEC installed a SIEM (Security Information and Event Management) in 2017. This system enabled significant improvements to categorizing and speed of system events and threats. The SIEM aggregates and logs information from a variety of VEC systems. In addition to the SIEM, VEC also installed several new core firewalls to replace units that were approaching the end of their warranty period.

Modernizing IT Tools (2015-2018)

In 2018, VEC installed a new Virtual Environment purchased and implemented for business applications. VEC expects this virtual environment to reduce spending in the future, as virtualizing requires fewer servers and extends the lifespan of existing hardware. In addition, the system also provides greater business continuity and ability to recover from hardware failures.

1.3.5 Facilities

- Richford Warehouse backup generator (2015) - VEC installed a backup generator in the Richford warehouse to ensure operations personnel have power the event of an outage.
- Cold Storage Barn at Johnson Facility (2015-2016) - VEC constructed a cold storage barn at the Johnson facility to move equipment indoors to preserve the equipment and eliminate a need to chip them out from snow and ice. In 2016, VEC installed a racking system in the cold storage building to hold materials such as transformers.
- Ergonomic Improvements (2015, 2018) - As part of our employee health and wellness initiative, VEC installed approximately 30 sit-stand desks for employees as well as ergonomic chairs for the Control Center operators to help prevent musculoskeletal injuries.
- Johnson Operations Area Improvements (2015, 2018) - VEC renovated its existing operations area in 2015 to provide an improved working environment with more meeting spaces and privacy for the control center. In addition, in 2018 VEC installed a portable wall in the Operations office area to provide more privacy for staff.
- Johnson Charging Station (2017) - VEC installed a level-2 electric vehicle charging station at its Johnson headquarters in 2017 for use by its employees and members.
- Johnson Facility Roof Replacement (2017) - VEC completed the replacement of the Johnson garage and warehouse roof with a new membraned, insulated roof in 2017. This new roof eliminated leaks, ice dams and water infiltration into the building.
- Security Improvements (2016-2018) - Every year we develop plans to improve VEC's physical security. In 2016, VEC installed an exterior security camera at the Newport warehouse to be able to monitor trespassers or intruders. In 2017, VEC installed a security fence around the Grand Isle facility property to prevent break-ins. Later that year motion detectors, we added cameras and intrusion alarms to the Johnson server and communications rooms, as well as the Newport backup server room. In 2018, VEC upgraded Johnson office security by adding bullet resistant glass at reception area and added swipe access controls on doors.

1.3.6 Fleet

Prior Fleet Purchases (2015-2018)

Over the past two years, VEC replaced one large bucket truck, one small bucket truck, two digger trucks, six small vehicles, four trailers. . All replaced vehicles were determined to have reached the end of useful life using the criteria above, and all replacement vehicles had more capabilities and options, including hands free technology, back up cameras, and in the case of the buckets and diggers, greater load capacities and extended reach.

1.3.7 Operations & Maintenance Projects

The following section details VEC's prior Operations and Maintenance related projects (O&M) as well as activity as projects moving forward.

Analysis of the 46kV System (Not Completed)

In the prior IRP, VEC planned to hire RLC Engineering to update studies on the 46 kV transmission system in 2016. VELCO identified a voltage constraint but the load that was predicted for the area in question (Jay Peak, Barton Tap) never materialized. As a result, VEC worked with VELCO to conclude that the analysis was no longer needed until such a time when prior load forecasts were indicated.

Volt/VAR Optimization (Not Completed)

VEC also mentioned that initial testing of Conservation Voltage Program (CVR) would begin in 2016. As mentioned in the [Voltage Regulation](#) section, due to efficiency programs in Vermont lighting load has gradually been displaced by lower watt alternatives such as Compact Fluorescent Lamps (CFLs) and Light Emitting Diodes (LEDs). As a result, CVR has become less effective at conserving energy than in the past when incandescent lighting accounted for nearly 80 percent of residential service loading. As such, an investment into a CVR system has been delayed.

Electronic Staking (2015)

In 2015, VEC finalized implementation of electronic staking for its distribution and transmission design. By utilizing electronic staking project, information directly imported into VEC's work order and material management flow, and GPS data is imported directly into VEC's GIS. This project eliminated paper, staking sheets for new projects, decreased significant amounts of redundant data entry in the office, and drastically reduced design time.

Incident Command Structure (ICS) Review (2017-2018)

In 2017, VEC made changes to update VEC's implementation of the Incident Command System (ICS) to make VEC more effective in responding to all types of emergencies, not just outage restoration.

FEMA officially adopted the ICS system as a national standard after the 9/11 incident in 2001. Over the past 18 years, utilities have adopted this standard when responding to emergencies, especially with larger outage restoration. This system is an "on-scene", all-hazard incident management concept. It allows users to adopt an integrated organizational structure with considerable internal flexibility. It is a proven management system based on successful business practices and is the result of decades of lessons learned in the organization and management of emergency incidents. VEC now uses a consistent ICS organizational structure and response for all types of emergencies, including, but not limited to, storm restoration, cyber security attacks, and facility impacts (e.g., fire, floods, etc.).

The ICS system allows VEC to:

- Meet the needs of incidents of any kind or size (scalability)
- Allow personnel from a variety of agencies to meld rapidly into a common management structure
- Provide logistical and administrative support to operational staff
- Be cost effective by avoiding duplication of efforts
- Minimizes span of control to 3 to 7 direct reports with 5 being optimal through a unified command structure and unity of command (each personnel has one "boss")

Other improvements to our processes included:

- Using SharePoint for communication and information tracking
- Mutual Aid response/receiving procedures
- Better use of contract resources (e.g., local and other cooperative)
- Better information for FEMA declarations
- Ability to obtain FEMA mitigation dollars for system hardening and upgrades
- Updates to OP-56 and OP-57 documentation.

Enhancement of Capital Planning Process (2016-2017)

In early 2017, VEC completed an overhaul of VEC's capital budgeting and planning process. The goal of the overhaul was to:

- Develop an objective prioritization framework to ensure that capital projects with the highest value to the VEC membership are prioritized effectively.
- Adjust existing budgeting strategies and methodologies to ensure estimates are used in budgeting process and training of budgeting process is provided to stakeholders
- Develop a short and long range capital plan

Since the overhaul, VEC has finished its fiscal year within 5% of its capital budget target, something that had not happened since 2010.

System Load and Voltage Study (2017-2018)

VEC completed a [System Load and Voltage Study](#) in 2018 that reviewed all of VEC's 74 distribution circuits via equipment loading, voltage performance, and phase load balancing design criteria. This system-wide study covers any constraints identified to occur between 2017 and 2027.

The constraints were developed into specific projects, then prioritized based on time and importance of need, and have been entered into specific budget years for completion. The study identified 75 projects and around \$16 million of system improvements. Around \$1.9 million was identified as non-discretionary and is projected to be completed before the end of 2019. The vast majority of constraints were related to voltage tolerance and balance.