



# Vermont Electric Cooperative Distributed Resource Interconnection Guidelines

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## 2 Introduction

This document is intended as a guideline for individuals requesting to interconnect energy sources to [Vermont Electric Cooperative](#)'s distribution network. Sources are referred to as distributed resources (DR) to encompass energy storage although sometimes the term generators is used since it is the most common subset of DR.

Different and/or additional requirements may need to be met by the owner of the generation project to ensure the final connection design meets all applicable standards and codes and is safe for the application intended.

All generation projects interconnecting to VEC's power system are required to obtain a Certificate of Public Good (CPG).

## 3 Available Options and Applications

### 3.1 General Overview

The following chart outlines the interconnection process and available options that projects must follow.

Size	Available Sizes	Rule/Process
Net Metering	<ul style="list-style-type: none"><li>○ Up to 500 kW</li></ul>	<ul style="list-style-type: none"><li>• <b>Vermont PUC Rule 5.100</b> (<i>up to 150 kW</i>)</li><li>• <b>Vermont PUC Rule 5.500</b> (<i>Greater than 150 up to but no greater than 500 kW, or if determined applicable by VEC</i>)</li></ul>
Standard Offer	<ul style="list-style-type: none"><li>○ Up to but less than 2.2 MW</li></ul>	<ul style="list-style-type: none"><li>• <b>Vermont PUC Rule 5.500</b></li></ul>
Power Purchase Agreement (PPA)	<ul style="list-style-type: none"><li>○ No size limit</li></ul>	<ul style="list-style-type: none"><li>• <b>Vermont PUC Rule 5.500</b> (<i>for projects 2.2 MW up to but less than 5 MW</i>)</li><li>• <b>ISONE Interconnections</b> (<i>for projects greater than or equal to 5 MW</i>)</li></ul>
Qualifying Facility (QF)	<ul style="list-style-type: none"><li>○ 2.2 MW and up</li></ul>	<ul style="list-style-type: none"><li>• <b>Vermont PUC Rule 5.500</b> (<i>for projects 2.2 MW up to but less than 5 MW</i>)</li><li>• <b>ISONE Interconnections</b> (<i>for projects greater than or equal to 5 MW</i>)</li></ul>

## 3.2 Net Metering

There are two available options in this section:

- Systems with a capacity less than or equal to 150kW
- Systems with a capacity greater than 150kW and up to 500 kW

Net metering projects are governed by [Vermont Public Utility Commission \(PUC\) Rule 5.100](#) which establishes standards and procedures governing application for, and issuance or revocation of, a Certificate of Public Good (CPG) for net metering systems. The application for a CPG is submitted to the PUC and also to the utility as is the interconnection application. Net metering applicants should review [Rule 5.100](#) and its Appendix A, [technical requirements](#), prior to reading the remainder of VEC's Interconnection Guidelines. The tariff outlining VEC's Current Rules and Regulations for Electric Service can be found [here](#).

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### 3.2.1 Net Metering systems with a capacity less than or equal to 150kW

The following application forms are available for Net Metering projects:

#### [Net Metering Application Form](#)

- Ground-mounted photovoltaic systems with a capacity of greater than 15 kW and up to and including 50 kW; and
- Non-photovoltaic and non-hydroelectric systems with a capacity of up to and including 50 kW.

#### [Net Metering Registration Form](#)

- Ground-mounted photovoltaic systems with a capacity of 15 kW or less,
- Roof-mounted photovoltaic systems with a capacity of 500 kW or less, and
- Hydroelectric facilities with a capacity of 500 kW or less.

VEC and the PUC prefer applications be filed through the PUC's ePUC process ([epuc.vermont.gov](http://epuc.vermont.gov)). Alternatively, paper copies can be mailed to: Vermont Electric Cooperative, 42 Wescom Rd, Johnson VT

At VEC's discretion any project under 150 kW may be required to fill out a 5.500 application and associated fee for further review per [PUC Rule 5.100](#)

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### 3.2.2 Net Metering systems with a capacity greater than 150kW and up to 500 kW

Projects greater than 150 kW are governed by [PUC Rule 5.500](#) which establishes the interconnection procedures and application form for "all proposed interconnections of generation resources within the State of Vermont which are not (i) lawfully subject to ISO-NE interconnection rules or successor rules approved by FERC, or (ii) subject to the Board's net metering rule (Rule 5.100) for which the interconnection provisions of those rules will govern."

The Rule 5.500 Standard Application form is generally used for all projects above 150kW connecting to distribution. Customers proposing eligible projects should review the 5.500 [Application Form](#) and [procedure](#) prior to reading the remainder of VEC's Interconnection Guidelines.

VEC and the PUC prefer applications be filed through the PUC's ePUC process ([epuc.vermont.gov](http://epuc.vermont.gov)). Alternatively, paper copies can be mailed to: Vermont Electric Cooperative, 42 Wescom Rd, Johnson VT

The [Net Metering Registration Form](#) should be used for the following projects in this category:

- Roof-mounted photovoltaic systems with a capacity of 500 kW or less, and
- Hydroelectric facilities with a capacity of 500 kW or less.

### 3.3 Standard Offer

VEPP Inc. is a not-for-profit Vermont corporation acting as the Purchasing Agent for the existing Public Utility Commission Rule 4.100 Projects and as the Standard Offer Facilitator for the Standard Offer Program. VEPP Inc. manages Vermont's Standard Offer program which may offer feed-in-tariff contracts to projects rated up to 2,200kW AC. For more information these projects please review <http://www.vermontstandardoffer.com/>

Standard offer projects 150 kW and less may apply for the "Certificate of Public Good for Standard Projects with a Plant Capacity of 150kW or less." Standard offer projects cannot qualify for net metering and follow a separate process.

Standard offer projects are governed by [PUC Rule 5.500](#). It is also important to consider a revenue source for your project prior to applying for interconnection. Once a project has been accepted into the Standard Offer Program the developer should submit a 5.500 application along with associated fee to VEC.

### 3.4 Power Purchase Agreement (PPA)

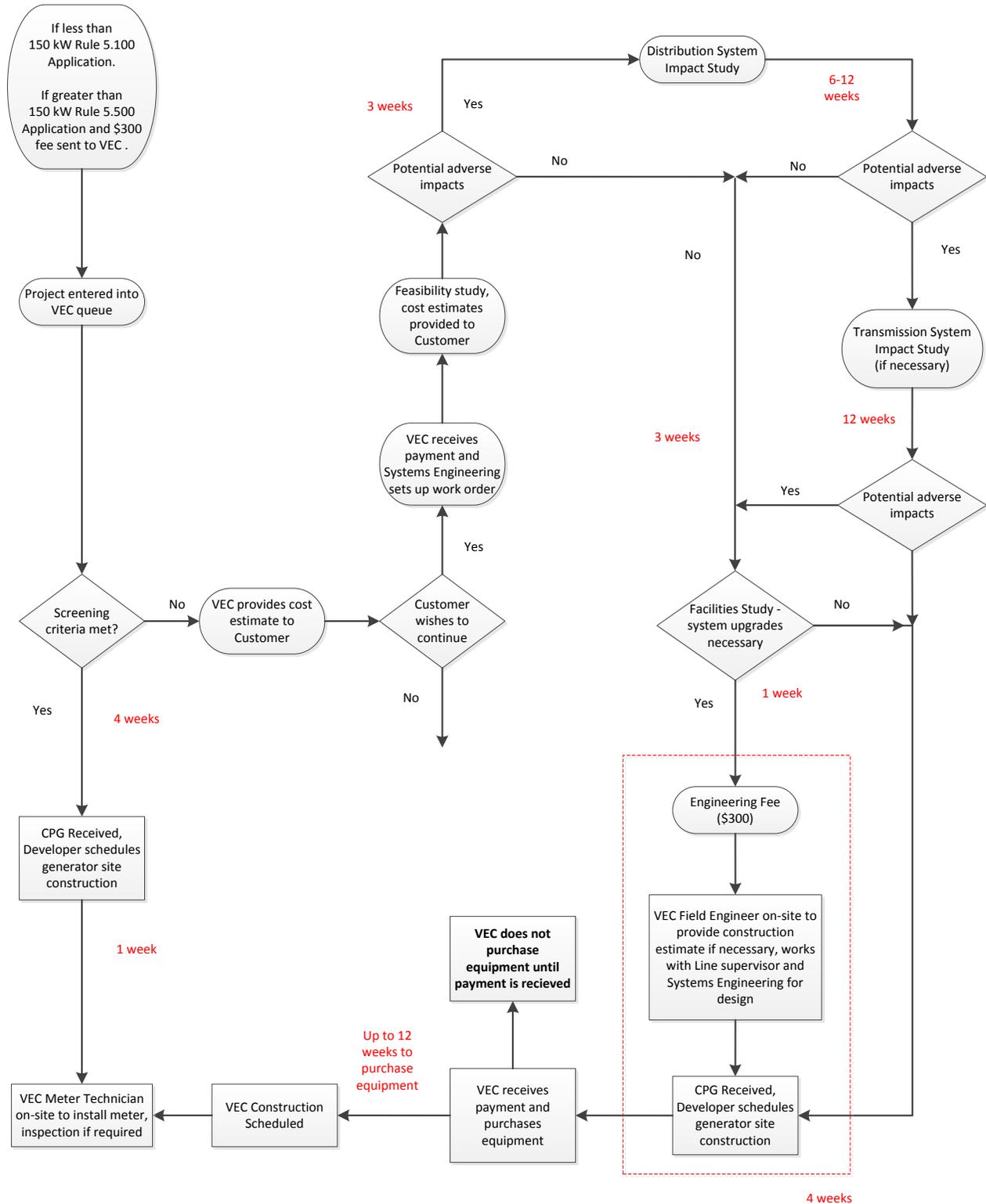
Vermont Electric Cooperative may offer direct power purchase agreements (PPA) when VEC considers the interconnection to be mutually beneficial. Please contact Craig Kieny, Manager of Power Planning at [ckieny@vermontelectric.coop](mailto:ckieny@vermontelectric.coop) for more information. PPA projects are governed by [PUC Rule 5.500](#).

### 3.5 Qualifying Facility (QF)

For projects greater than 2.2 MW please visit the ISONE website and review the ISONE Interconnection process. <https://www.iso-ne.com/participate/applications-status-changes/new-modified-interconnections/>

# 4 Interconnection Review

## 4.1 Basic Overview of the Process



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## 4.2 VEC Queue

VEC will assign each complete application a position in the Interconnection Queue based upon the date-and time-stamp of the Interconnection Requester's completed 5.500 application, when applicable, and 5.100 application when the 5.500 application is not required. The date-and time-stamp of the Application will be used to determine the cost responsibility for any System Upgrades necessary to accommodate the interconnection. Interconnection requests may be studied serially or in clusters for the purpose of the System Impact Study. If the number and timing of interconnect requests for a specific area is such that interconnection requests directly impact each other, requiring the utility to study the projects serially in order to determine system impact, VEC will notify the Interconnection Requester that its review of the project will be on hold until VEC has completed its study or review of projects ahead of the DR Customer in the Interconnection Queue.

## 4.3 Screening Criteria

All DR interconnections will be modeled using VEC's MilSoft WindMil distribution circuit analysis program.

Along with modeling the interconnection VEC also follows the criteria in [PUC Rule 5.506](#) as well as the [IEEE 1547](#) guidelines mentioned in [Section 3.3.2](#).

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### 4.3.1 PUC Rule 5.506 Fast Track Screening Criteria

- (1) The proposed Generation Resource's Point of Interconnection must be on a portion of the Interconnecting Utility's distribution or transmission system that is not otherwise subject to the ISO-NE interconnection procedures.
- (2) For interconnection to a Radial Feeder, the aggregated generation, including the proposed Generation Resource, on the circuit will not exceed the circuit's minimum load coincident with expected times of generation operation, if available, or if minimum load is not available, 15% of the line section annual peak load as most recently measured at the substation.
- (3) For interconnection of a Generation Resource to the load side of spot network protectors, the proposed Generation Resource must utilize an inverter-based equipment package and, together with the aggregated other inverter-based generation, shall not exceed the smaller of 5% of a spot network's maximum load or 50kW.
- (4) The proposed Generation Resource, in aggregation with other generation on the distribution circuit, shall not contribute more than 10% to the circuit's maximum fault current at the point on the high voltage (primary) level nearest the proposed Generation Resource.
- (5) The proposed Generation Resource, in aggregation with other generation on the distribution circuit, shall not cause any distribution protective devices and equipment (including, but not limited to, substation breakers, fuse cutouts, and line reclosers), or Interconnection Requester equipment on the system to exceed 87.5% of the short-circuit interrupting capability; nor is the Generation Resource proposed for a circuit that already exceeds 87.5% of the short-circuit interrupting capability.

- (6) For interconnection of a proposed single-phase or effectively grounded three-phase Generation Resource where the primary distribution system is three-phase, four-wire, the Generation Resource shall be connected line-to-neutral. For interconnection of a proposed single-phase or three-phase Generation Resource where the primary distribution system is three-phase, three-wire, the Generation Resource shall be connected line to line.
- (7) If the proposed Generation Resource is to be interconnected on a single-phase shared secondary, the aggregate generation capacity on the shared secondary, including the proposed Generation Resource, shall not exceed 20kW.
- (8) If the Generation Resource is single-phase and is to be interconnected on a center tap neutral of a 240 volt service, its addition will not create an imbalance between the two sides of the 240 volt service of more than 20% of the service transformer nameplate.
- (9) The proposed Generation Resource is not located in an area where there are known or posted transient stability limitations to generating units located in the general electric vicinity, including but not limited to known harmonic issues.
- (10) No system modifications, in excess of limited preparations that do not necessitate a Facilities Study, are required to facilitate the interconnection of the Generation Resource.
- (11) The aggregated generation, including the proposed Generation Resource, on a distribution circuit, will not cause any distribution protective devices and equipment, including but not limited to conductors, substation transformers, line stepdown transformers, substation breakers, fuse cutouts and line reclosers, or customer equipment on the system, to compromise the device's continuous duty ratings and protection settings as determined by the Interconnecting Utility.
- (12) Voltage drop caused by starting up synchronous or induction generators is within acceptable limits meaning that inrush current caused by the startup of the proposed Generation Resource up to once per hour, is not greater than 3% of the available fault current or does not cause greater than a 3% voltage deviation at the Point of Interconnection as modeled in an unbalanced load flow. Voltage drop due to starting the proposed Generation Resource more than once per hour meets a tighter inrush-current tolerance to be determined by the Interconnecting Utility. This criterion is applicable only to synchronous or induction Generation Resources.
- (13) The Interconnection Requester certifies that the proposed Generation Resource meets the applicable codes and standards of Section 5.514 or is a certified equipment package under Section 5.513. Flicker caused by the proposed Generation Resource shall comply with [IEEE Std. 1453](#).
- (14) For any single Generation Resource, the available utility short circuit current at the Point of Interconnection divided by the rated output current of the Generation Resource is no less than:
  - (a) 50 for Generation Resources of less than 100 kW;
  - (b) 40 for Generation Resources from 100 kW to less than 500 kW; and
  - (c) 20 for Generation Resources equal to or greater than 500 kW.

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## 4.3.2 IEEE 1547 Recommendations

**Section 4.1.1** requires that the generators not actively regulate the voltage at the point of common connection.

**Section 4.1.2** requires that the generators not disrupt the area grounding nor have an undue effect on ground fault protection of the circuit.

**Section 4.1.3** requires that synchronization not cause large voltage fluctuations or flicker issues.

**Section 4.1.4** deals with issues associated with interconnection with a secondary spot network.

**Section 4.1.5** requires that the generators not energize the distribution circuit when the circuit is de-energized. VEC will perform commissioning tests to prove that the resource cannot parallel or re-energize a dead utility buss and the presence of the three phase lockable disconnect switch to provide a visual opening for line-worker safety during de-energized line work operations.

**Section 4.1.6** requires that generators above 250 kVA have monitoring provisions to provide connection status, real and reactive power output and the voltage at the point of common coupling.

**Section 4.1.7** requires the installation of a readily accessible, lockable switch with a visible opening be installed between the Area EPS and the DG unit.

**Section 4.1.81** requires that the interconnection system shall be capable of withstanding electromagnetic interference in accordance with [IEEE standard C37.90.2-1995](#) without misoperation.

**Section 4.1.8.2** requires that the system withstand voltage and current surges in accordance with [IEEE C62.41.2-2002](#) or [C37.90.1-2002](#), as applicable.

**Section 4.1.8.3** requires that the interconnection paralleling device be capable of 220% of the interconnection voltage.

**Section 4.2.1** requires that the DR unit shall cease to energize the Area EPS for faults on the Area EPS circuit to which it is connected.

**Section 4.2.3** requires the generator to trip within specific times when the voltage is outside of preset limits.

**Section 4.2.4** requires that the DG shall sense high and low frequency conditions and trip within specified times.

**Section 4.2.6** requires that the DG not reconnect until the distribution system is within the limits specified by Range B of ANSI C84.1-1995 and a frequency range of 59.3-60.5 Hz. The applicable B Range values are 424 to 508 volts. In addition, a time delay for up to five minutes prior to re-energizing shall be included in the generator relaying.

**Section 4.3.1** requires that the system not inject DC current greater than .5% of the full rated output current at the point of interconnection.

**Section 4.3.2** requires that the GR not result in objectionable flicker for other customers on the distribution circuit.

**Section 4.3.3** sets a standard for harmonics. The generator must satisfy IEEE 519-1992 for the harmonic content, as indicated by Table 3-3 below.

Table 3-3 IEEE 519-1992

Harmonic Order	Level Allowed Relative to the Fundamental for Odd Harmonics*
2nd to 10 <sup>th</sup>	4.0%
11th to 16 <sup>th</sup>	2.0%
17th to 22 <sup>nd</sup>	1.5%
23rd to 34 <sup>th</sup>	0.6%
35th or higher	0.3%
Total Harmonic Distortion	5.0%

\*Even harmonics are limited to 25% of the odd harmonic values

**Section 4.4.1** requires that the generator not unintentionally island a portion of the distribution circuit and be de-energized within two seconds of a condition that would lead to islanding.

**Section 5.** Lists the performance tests required to be conducted to demonstrate that the interconnection meets the requirements laid out in Section 4. The Project will be required to conduct and document the results of these tests prior to normal operation of the units in parallel with the Vermont Electric Cooperative System. The specific test requirements are listed in Appendix E.

### 4.3.3 Governing Bodies and Affected Utilities

[The Independent System Operator for New England \(ISO-NE\)](#) requires notification of any applications for generators rated larger than 1MW. The application and studies completed for projects rated 5MW or larger must be submitted to the ISO-NE Stability and Transmission Task Forces and Reliability Committee. The task forces will determine if an additional transmission study and/or stability model are required. Please refer to ISO-NE Planning Procedure 5-1 for more information.

If the planned generation has the potential to impact a portion of the area electric power system (EPS) not operated by VEC, VEC will notify the affected utility. The affected utility may apply interconnection requirements above and beyond those of VEC which may cause delays to the interconnection process beyond VEC's control.

### 4.3.4 Voltage Quality

The DR Customer shall not cause the service voltage at other customers to go outside the requirements of ANSI C84.1-1995, Range A ([IEEE 1547-4.1.1](#)).

VEC reviews voltage impacts of distributed resources using a detailed model of the distribution circuit when available. If the model indicates potential risk a supplemental review or System Impact Study may be required.

Single phase generators are screened to verify they will not cause a voltage unbalance exceeding 3% anywhere on the three phase interconnecting circuit ([ANSI C84.1](#)).

DR facilities are not permitted to cause an increase in the nominal voltage at the PCC in excess of 105% during steady state conditions.

If these criteria cannot be met, the DR Customer may be required to pay for upgraded regulator controls with co-generation mode. If the existing controls are not designed for co-generation power flow mode, the DR Customer is responsible for replacement costs. In certain scenarios VEC will furnish and install at the cost to DR Customer, line regulators to address voltage concerns.

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### **4.3.5 Conductor ampacity, Device ratings & Interrupter phase pick up**

The aggregated generation, including the proposed Generating Resource, on a distribution circuit cannot exceed:

1. 80% of the phase pickup of an electronic recloser
2. 90% of the conductor ampacity rating,
3. 100% of a sectionalizing fuse continuous rating
4. 100% of the load tap changer or regulator continuous rating
5. 100% of a hydraulic recloser continuous rating

A supplemental review may permit the project to fast track if the fuse or hydraulic recloser rating can be raised to the next standard size while maintaining adequate protection and coordination to other existing sectionalizing points. If the supplemental review is inconclusive, a System Impact Study is required.

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### **4.3.6 Available Service**

If the generator size, design, or system impacts require three phase service and three phase service is not available at the PCC the project may require a supplemental review or study. Additional review or study is dependent on the scope of the necessary upgrades.

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### **4.3.7 Load to Generation Ratio**

The Minimum Load to Generation Ratio (MLGR) is evaluated at specific points of interest along the feed to the PCC. It is preferable to evaluate 12 months or more of load data to capture seasonal changes.

Load data may not be available at specific points, particularly protective devices distant from the substation. If load data is not available, it may be approximated using circuit modeling software.

When generation exceeds the minimum load at any of the following circuit points ( $MLGR \leq 1$ ), a supplemental review is required. The supplemental review is to confirm the interconnection will not cause negative system impacts, or such impacts can be resolved with limited and low cost system upgrades. If the supplemental review is inconclusive, a [System Impact Study \(SIS\)](#) is required.

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### 4.3.8 Distribution Bus

When the minimum bus load is exceeded, distributed resources may cause backfeed onto the transmission system. The transmission service operator (TSO) may not be Vermont Electric Cooperative and the TSO may choose to apply additional requirements to the interconnection.

If the minimum load of the distribution bus is exceeded the system area VEC reviews for interconnection impacts increases significantly. VEC will verify there is not a temporary overvoltage damage risk for the arresters and other equipment used on the serving transmission circuit. The DR Customer may be responsible for replacement costs to increase the maximum continuous over voltage (MCOV) rating of the associated arresters or to install an overvoltage protection scheme.

The maximum allowable aggregate generation on a substation transformer is 100% of the top rating. Above this amount requires the substation transformer to be resized. Substation capacity changes require PUC approval and changes to the station's certificate of public good.

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### 4.3.9 Integration with Area EPS Grounding

The grounding scheme of distributed resources cannot cause over-voltages that exceed the rating of the equipment connected to the area EPS and cannot disrupt the coordination of the ground fault protection of the area EPS in accordance with the [Institute of Electrical and Electronics Engineers \(IEEE\) Standard 1547-2003](#) Section 4.1.2. The following screens are intended to evaluate this risk.

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### 4.3.10 Circuit Ties

If the proposed PCC can be served by another circuit breaker during feeder back-up, all of the screening criteria may need to be evaluated during the feeder back-up scenario.

If the circuit tie is not between breakers with identical settings, a supplemental review becomes likely. If the supplemental review identifies system impacts during feeder back-up, a System Impact Study or operating protocol restriction may be required. Some of VEC's radial circuits employ automatic restoration schemes to operate circuit ties which increases the likelihood of a supplemental review or study.

In the event distributed resources must be curtailed during feeder back-up, the generation typically interconnected to the serving breaker has priority to remain in operation. VEC will provide information, if available, on how frequently feeder backup was used in the past but cannot guarantee its use will not increase in the future.

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### 4.3.11 Transformer Size

When the proposed interconnection is modeled using VEC's MilSoft WindMil distribution circuit analysis program, VEC will verify that generator step up or the service transformer at the point of interconnection is larger than the size of the generator or service loads.

If the transformer is not large enough the DR customer will be required to purchase a larger transformer.

## 4.4 Feasibility Study

If the proposed interconnection does not meet the necessary screening criteria listed in section 3.3 VEC may send the DR customer a Feasibility Study Agreement and a Feasibility Study. VEC will perform this task at the request of the DR customer.

[PUC Rule 5.508](#) provides guidelines for a Feasibility Study which lists analyses that VEC will perform given that the project does not pass VEC's screening criteria:

- 1) Initial identification of any instances where the short-circuit capability limits of any protective device (circuit breaker, recloser, fuse, etc.) would be exceeded as a result of the interconnection;
- 2) Initial identification of any thermal overload or voltage limit violations resulting from the interconnection;
- 3) Initial review of grounding requirements and system protection; and
- 4) Description and non-binding estimated cost of facilities required to interconnect the facility to an electric distribution power system or directly to a transmission system and to address the identified short-circuit and power-flow issues.

VEC will provide the DR Customer with a Feasibility Study Report which describes the results of the study. If system upgrades are required as a result of the Feasibility Study Report a Facilities Study Agreement will be sent to the DR Customer and a [Facilities Study](#) will be performed.

## 4.5 Distribution System Impact Study

If VEC's initial screening shows the potential for adverse impacts on VEC's Distribution system VEC will send the customer a System Impact Study Agreement and perform a Distribution System Impact Study.

According to [PUC Rule 5.509](#) a Distribution System Impact Study shall consist of a distribution load-flow study, an analysis of equipment-interrupting ratings, protection coordination study, voltage drop and flicker studies, protection and set point coordination studies, and grounding reviews, and the impact on system operation, as necessary.

VEC will provide the DR Customer with a System Impact Study Report which describes the results of the study. If system upgrades are required as a result of the System Impact Study Report a Facilities Study Agreement will be sent to the DR Customer and a [Facilities Study](#) will be performed.

## 4.6 Transmission System Impact Study

If VEC's initial screening shows the potential for adverse impacts on VEC's Transmission system VEC will send the customer a System Impact Study Agreement and perform a Transmission System Impact Study.

According to [PUC Rule 5.509](#) a Transmission System Impact Study shall consist of a short-circuit analysis, a stability analysis, a power-flow analysis, voltage-drop and flicker studies, protection and set-point-coordination studies, and grounding reviews, as necessary.

VEC will provide the DR Customer with a System Impact Study Report which describes the results of the study. If system upgrades are required as a result of the System Impact Study Report a Facilities Study Agreement will be sent to the DR Customer and a [Facilities Study](#) will be performed.

## 4.7 Facilities Study

If any of the studies in sections 3.4, 3.5, 3.6 or the Feasibility Study shows the potential for adverse impacts on VEC's Distribution or Transmission systems VEC will send the customer a Facilities Study Agreement and perform a facilities study.

The facilities study will be a joint effort between VEC and the DR Customer and in some cases contractors acting on the behalf of VEC and the DR Customer. The study will outline the necessary upgrades/designs to VEC's Distribution or Transmission systems, along with the costs associated with these upgrades. Cost allocation for the study and resulting system upgrades are listed in [PUC Rule 5.510](#)

If screening identifies system deficiencies not caused by the generator interconnection, a hold may be placed on the project approval until the issues are corrected. VEC aims to correct deficiencies within 6 months of identification, however, equipment lead time and the scope of corrective action can cause a hold of up to one year or more.

Deficiencies could include but are not limited to:

- a) Load/voltage Imbalance
- b) Reactive Power compensation corrections
- c) Overloaded equipment
- d) Protection Coordination

## 4.8 Project Commissioning and Inspection

All generator interconnections connecting to VEC's Distribution or Transmission System may require an inspection of the interconnection. Below is VEC's inspection checklist:

- Verify the transformer size can carry the full output of the generator without being overloaded.
- Verify that the capability for visual opening exists
- Verify condition of billing meter
- Place label on meter with kW rating and type of generation
- Verify secondary wire size

For projects larger than 150 kW a commissioning test will be required and VEC shall be given 10 business days' written notice, or as otherwise mutually agreed to by the Parties, of the tests and the DR will have one of its representatives present. If the Project successfully demonstrates compliance during this joint on site commissioning, it will be allowed to operate interconnected in parallel with the VEC electric system. Below is VEC's commissioning procedure:

- Safety Tailboard conducted by Utility and Resource to identify and point out unique safety precautions of both electrical systems for the attendees.
- Witness automatic-synchronizing of generator tie breaker (systems in parallel).
- Witness anti-islanding protections by opening generator disconnecting device while monitoring generator output voltage. Voltage should go to zero within 2 seconds.
- Witness inverters won't close on dead-bus.
- Witness 5 minute time delay before re- synch-check and re-close.
- Commission of generation meter.

## 4.9 Equipment Requirements

### 4.9.1 Generator Step Up Transformer

VEC will provide, if requested by the DR Customer, the generator step up (GSU) transformer when the rating is 500kVA or below with a standard secondary distribution voltage.

The only three phase transformer configurations VEC will provide transformers are low voltage grounded wye or delta, and high voltage grounded wye. The DR Customer remains responsible to meet all additional functional, equipment, and operating requirements.

For facilities above 500kVA, the DR Customer is responsible to provide the GSU. The following are acceptable configurations based on generator type:

Generator Type	HV Winding	LV Winding
Rotating Machine	Grounded Wye	Delta
Inverter	Grounded Wye	Grounded Wye

The DR Customer is responsible to ensure there is no backfeed from the GSU or facility when the generator is out of service and is responsible for all consequences resulting from such backfeeds.

VEC has standardized on a pad mounted transformer for installations above 100 kVA single phase or 300kVA three phase.

### Effective Grounding

All forms of distributed resources are to be designed to support maintaining the effective grounding of VEC's distribution circuits.

With respect to the VEC distribution system, the use of a grounded wye primary winding in the transformer will ensure that the distribution system voltage remains within acceptable limits in the brief time that it takes for the main breaker serving the site to open during fault conditions.

To be considered an effectively grounded source, rotating generators must meet the design criteria of [IEEE C62 Section 92.1](#). Ungrounded rotating generators require two levels of utility controlled zero sequence overvoltage elements (59N) from a microprocessor relay. VEC requires a wye-grounded to delta generator step-up (GSU) transformer with an electronic recloser on the utility side for ungrounded rotating generators, unless the generator breaker relay has a current transformer in the system neutral of the GSU to sense ground faults on the grid which trips the generator breaker without the need for the VEC electronic recloser.

Inverter based generators must be UL certified and provide an equivalency to effective grounding. Effective grounding equivalency is defined as providing adequate protection to limit over-voltages to 125% of rated phase to neutral voltage. VEC accepts UL certification as adequate to meet this screening requirement unless specific operating issues have been recorded with the selected inverter.

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## 4.9.2 Metering

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### Net Meter

VEC uses bi-directional smart meters throughout most of its territory. No additional revenue metering or communication is usually required if a net meter facility is installed at an existing service point. If the net metering facility is photovoltaic and eligible for the gross solar adder, an additional gross solar meter will be installed at cost to the DR Customer.

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### Group Net Meter

Often group net meter facilities have a new service extension for the sole use of exporting generation. In this case the revenue meter also acts as the gross meter. Self-contained metering is generally used at facilities with 200 amps or less of generation or load. When a self-contained meter is used, the Customer is expected to provide and install the socket and VEC will provide the meter. Self-contained metering on three phase 480/277V services requires a Customer provided lockable disconnect discussed in Vermont Utilities Electric Service Requirements Manual .

For facilities with 400 amps of generation or load VEC will supply the meter, associated instrument transformers, and meter socket. Installation of this equipment will be coordinated with the customer's electrician.

For facilities with between 200 and 400 amps of load or generation, the metering could be either type. At sites of every rated capacity the customer should verify the planned metering type with the distribution designer assigned to the project and confirm installation responsibilities.

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### Feed-In-Tariff (FIT) & Power Purchase Agreements (PPA):

For FIT and PPA facilities, the DR Customer is responsible to pay for the full cost of a meter and associated equipment for measuring hourly intervals including communication equipment. Generally, the DR Customer is responsible to request, have installed, and maintain a data quality phone line from the local telephone service provider to the metering point for MV90 access.

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### General:

If the facility will be secondary metered but the DR Customer's generator uses a non-standard service voltage, the DR Customer may be responsible to provide the metering accuracy rated instrument transformers and stock replacements of each. The DR Customer should verify VEC is able to supply the instrument transformers, particularly when 1000VDC inverters are used.

Secondary metering may be permissible even if the step up transformer is owned by the DR Customer. VEC will determine loss adjustments for the meter based on the facility design. If the DR Customer supplies the generator step up transformer and it is above 500kVA, the DR Customer is responsible to supply a certified transformer test report to VEC for loss compensation.

VEC does not permit shared use of instrument transformers for protection and metering.

For facilities above 1MW, VEC may require primary metering. If the site conditions do not easily accommodate pole mounted primary metering, VEC may consider secondary metering unless multiple step up transformers preclude a single secondary metering point.

The Customer is responsible to ensure their facility metering complies with all maintenance and testing requirements of the programs or incentives for which it is registered and the Customer is responsible for any associated cost. VEC may request verification of the meter at any time but all costs associated with such testing shall be borne by VEC should the metering prove to be accurate within 2%.

## 4.10 Manual AC Disconnect Switch

VEC will furnish and install a ganged, manually-operated isolating switch near the Point of Interconnection to isolate the Generating Facility from VEC's Distribution or Transmission System. The device does have to be rated for load break but not provide over-current protection.

### The device must:

- (i) Allow visible verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.)
- (ii) Include markings or signage that clearly indicates open and closed positions.
- (iii) Be capable of being reached:
  - a. For Emergency purposes quickly and conveniently 24 hours a day by Distribution Provider personnel for construction, operation, maintenance, inspection, testing or to isolate the Generating Facility from Distribution Provider's Distribution or Transmission System without obstacles or requiring those seeking access to obtain keys, special permission, or security clearances.
  - b. For Non-Emergency purposes during normal business hours. Distribution Provider, where possible, will provide notice to Customer for gaining access to Customer's premises.
- (iv) Be capable of being locked in the open position
- (v) Be clearly marked on the submitted single line diagram and its type and location approved by Distribution Provider prior to installation. If the device is not adjacent to the PCC, permanent signage must be installed at a Distribution Provider approved location providing a clear description of the location of the device.

## 4.11 Circuit Breaker

Circuit breakers or other interrupting equipment located at the Point of Common Coupling (PCC) must be Certified or "Listed" (as defined in Article 100, the Definitions Section of the [National Electrical Code](#)) as suitable for their intended application. This includes being capable of interrupting the maximum available fault current expected at their location.

Producer's Generating Facility and Interconnection Facilities shall be designed so that the failure of any single device or component shall not potentially compromise the safety and reliability of VEC's Distribution and Transmission System. The DR customer's paralleling-device shall be capable of withstanding 220% of the Interconnection Facility

rated voltage ([IEEE 1547-4.1.8.3](#)). The Interconnection Facility shall have the capability to withstand voltage and current surges in accordance with the environments defined in [IEEE Std C62.41.2-2002](#) or [IEEE Std C37.90.1-2002](#) as applicable and as described in L.3.e ([IEEE 1547-4.1.8.2](#)).

## 4.12 High and Low Side Protection

The high side circuit protection will be fuses unless a recloser is required to provide back-up protections. The main secondary protection will be a fuse. Each inverter will be protected with a circuit breaker.

## 4.13 Relaying

All rotating generators require a “utility grade” relayed circuit breaker although exceptions may be granted if the generator is interfaced with a [UL certified inverter](#). Only utility grade equipment is permitted for protection relaying. Only protection accuracy class instrument transformers are permitted for use with protective relaying. All relay functions can be combined in a single microprocessor based unit.

Where an inverter is used, the settings below refer to the inverters internal protective functions.

Over and under-voltage, over and under-frequency, phase over-current with voltage control, and either zero-sequence over-voltage or neutral over-current and synchronizing relay functions are required. Additional relay functions may be specified by VEC. Settings will be as specified by VEC after review or be otherwise in compliance with [UL 1741/IEEE 1547](#) or acceptable engineering practices. The generation facility operator shall provide relaying functions to clear both phase and ground short circuit faults on the VEC system. The operating characteristics shall be reviewed and approved by VEC at commissioning, but VEC assumes no responsibility for the adequacy of these settings.

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### 4.13.1 Power Factor

The DG Facility shall produce power at power factor levels between 0.98 leading and 0.98 lagging at the Interconnection Point, unless otherwise requested, in writing, from VEC or applicable Standards.

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### 4.13.2 Frequency Settings

VEC controls system frequency, and the Generating Facility shall operate in synchronism with VEC’s Distribution or Transmission System. Whenever VEC’s Distribution or Transmission System frequency at the PCC varies from and remains outside normal (nominally 60 Hz), the DER Facility’s Protective Functions shall cease to energize VEC’s Distribution or Transmission System within the stated maximum trip time.

“Maximum Trip time” refers to the time between the onset of the abnormal condition and the DER Facility ceasing to energize VEC’s Distribution or Transmission System. Protective Function sensing equipment and circuits may remain connected to VEC’s Distribution or Transmission System to allow sensing of electrical conditions for use by the “reconnect” feature. The purpose of the allowed time delay is to allow a Generating Facility to “ride through” short-term disturbances to avoid nuisance tripping. Set points shall not be user adjustable (though they may be field adjustable by qualified personnel).

Unless otherwise required by VEC, a trip frequency of 59.3 Hz and a maximum trip time of 10 cycles shall be used.

Underfrequency set point and clearing times are not permitted above the curve in Figure 1 in order to comply with [PRC-006-NPCC-1 Requirement 13](#) on generator underfrequency settings.

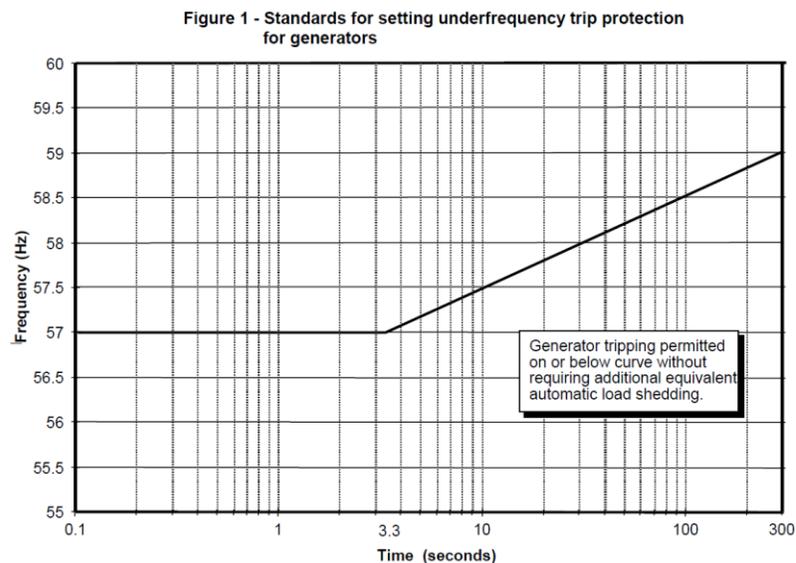


Figure 1 - NPCC Standards for setting underfrequency trip protection for generators

#### 4.14 Direct Transfer Trip

For a Generating Facility that cannot detect Distribution or Transmission System faults (both line-to-line and line-to-ground) or the formation of an Unintended Island, and cease to energize VEC’s Distribution or Transmission System within two seconds, VEC may require a Direct Transfer Trip (DTT) system or an equivalent Protective Function.

When generation exceeds the minimum load at the source distribution substation (The Minimum Load to Generation Ratio, MLGR, is less than or equal to 1) further evaluation may be necessary. VEC may require a mitigation strategy to address Transient Ground Fault Over Voltage (TGFOV) on the transmission system due to the distribution generation being an ungrounded source to transmission line faults.

VEC will install, own, and operate a Customer billable Direct Transfer Trip (DTT) scheme from upstream sectionalizing devices to a Company owned reclosing device near or at the point of interconnection. The communication requirements for DTT include a latency of less than 35 milliseconds and ability to alarm on loss of a communication path. VEC uses [Schweitzer Engineering Laboratories’](#) mirrored bits® communication protocol with either non-licensed MDS radio paths or fiber optic communication paths however alternatives will be considered if they meet the communication requirements.

DTT is specifically considered for rotating machines that do not pass anti-islanding screens individually, or with aggregate generation on the feeder section. DTT may need to be added to existing facilities due to the increase of other forms of generation in the same feeder sections.

When transfer trip is required, the DR Customer is responsible to provide the following in the facility design:

A circuit breaker capable of receiving an external trip via a shunt trip or undervoltage release.

An ungrounded DC source from an uninterruptible power source to the VEC communications and controls cabinet. The preferred voltage is 24VDC and the power requirements of Company equipment connected to the 24VDC source typically do not exceed 35W but should be verified prior to purchase of the power supply.

## 4.15 Gang Operated Switch

All **three phase** DR facilities with a rated capacity greater than 150 kW AC will require the installation of a Customer purchased, VEC owned, motor operated switch near or at the point of interconnection. This is required for line maintenance and for the safety VEC personnel. It is also required to provide the utility with metering data and to prevent unintentional islanding as mentioned in the [SANDIA Suggested Guidelines for Assessment of DG Unintentional Islanding Risk](#)

## 4.16 Telemetry, Monitoring, and Control

Generation facilities rated above 150kW require telemetry. At minimum this is to include:

- Real Power (kW, MW)
- Reactive Power (kVAR, MVAR)
- Voltage (kV, V)
- Frequency (HZ)
- Current (A)
- Power Factor
- Control (if >150 kW)

All values are to be delivered in near real time, defined as samples every 5 seconds or less with less than one second delivery delay.

VEC will provide, at cost to the customer, a remote terminal unit (RTU) to provide the utility with visibility of the output of the generator. The implementation of supervisory control and data acquisition (SCADA) to the inverters, including remote power factor adjustment, active power curtailment, ramp rate, and scheduling, will depend upon the site and terms of the generation interconnection agreement.

If necessary, the customer is responsible to provide a suitable environmentally controlled space for telemetry equipment inside a generator building. At locations without a generator building, the customer will be billed for a pole mounted, heated, rack mount cabinet for placement of the RTU and associated network service provider equipment.

The telemetry cabinet requires battery backup and 120V station service. The responsibility to supply and maintain battery backup and station service should be agreed upon between the VEC and the customer prior to execution of the generator interconnection agreement and can vary depending upon the facility design.

## 4.17 Communications

The customer is responsible for all communication costs associated with engineering access, metering data, and telemetry at distributed resource sites. Acceptable forms of communication include:

- a) Business Grade, Private Cellular (Compatible Network)
- b) Business Grade, Private Ethernet LAN
- c) VEC Fiber Optic Cable (where available)
- d) VEC operated, licensed radios

## 4.18 Inverter

The DR facility is responsible to verify compliance with Vermont [PUC Rule 5.500](#) section 5.511(B).

VEC requires all inverters connected to the area EPS to be lab tested by a [Nationally Recognized Testing Laboratory \(NRTL\)](#) and certified to conform with all the tests of [IEEE 1547.1](#). [UL1741](#) is the preferred certification for inverters, however, VEC may accept comparable certifications from other NRTLs. VEC may accept field testing by an NRTL, however, if all test conditions specified by [IEEE 1547.1](#) cannot be completed in the field additional protection requirements may be applied.

A time delay mechanism must be employed to limit the restart of the generator to a pre-determined minimum time. This is required to prevent the units from starting more often than the flicker limits allow. The relay scheme must include a time delay function and the proposed setting is to stagger the 4 units start from 5 to 10 minutes, which will be adequate with respect to utility breaker reclose coordination and provide a minimum impact on system voltage.

## 4.19 Rotating Machines

### Synchronous Generator

Synchronous Generators are to be designed in accordance with all applicable [IEEE](#), [ANSI](#), and [National Electrical Manufacturers Association \(NEMA\)](#) national standards.

### Induction (Asynchronous) Generator

DR Customers are responsible to supply their own form of excitation to meet power factor requirements

## 5 Service Guidelines

The [Vermont Electric Cooperative Service Requirements Manual](#) is the authority on all services attached to VEC's distribution system. An additional source of information is the tariff governing electric service extensions and relocations.

## 6 Appendices

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### 6.1 Definitions

Please see the Definitions section of the Rule 5.500 procedure available [here](#) and also applicable to this document.

Note, Rule 5.500 has the following definition for Point of Interconnection: ***The point at which the interconnection between the Interconnecting Utility's system and the Interconnection Requester's equipment interface occurs.***

In practice VEC employees sometimes use point of interconnection to reference where Utility owned interconnection facilities for a specific generator “take-off” from the main line which serves other customers. The demarcation between the Utility owned interconnection facilities and the interconnection Requester’s equipment is more commonly referred to as the Point of Common Coupling, or PCC.

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### 6.2 Limitation of Liability and Disclaimer

All interconnections are governed by, and the DR Customer should refer to, applicable laws, rules, regulations, tariffs, regulatory decisions and interconnection agreement governing the interconnection process. These Interconnection Guidelines are not a substitute for said laws, rules, regulations, tariffs, regulatory decisions and the interconnection agreement. The Interconnection Guidelines are available solely to provide customers, contractors, and other parties with additional useful guidance regarding Vermont Electric Cooperative’s typical distributed resource interconnection process. In all instances, the content and information provided by Vermont Electric Cooperative is superseded by the applicable laws, rules, regulations, tariffs, regulatory decisions and interconnection agreement governing the distributed resource interconnection process. Vermont Electric Cooperative must not be held liable under any circumstances for any reliance on these interconnection guidelines or errors, omissions, inaccurate, and/or outdated content or information provided herein. Vermont Electric Cooperative reserves the right to amend any of the requirements at any time. Any person wishing to make a decision based on the content of this document should consult with Vermont Electric Cooperative prior to making any such decision.