Exh. Allen St.-SC-6

RLC ENGINEERING

FINAL REPORT

REVISION 1

JANUARY 15, 2025

DISTRIBUTION SYSTEM IMPACT STUDY

ER Allen St BESS

4,999 kW Battery Energy Storage System Project
Interconnection System Impact Study

For Green Mountain Power

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Revision History

Rev.	Date	Revised By	Reason
A	11/22/2024	JLT/JRE	Original Draft Release
B	12/17/2024	JLT	Revised Draft Release (Updated Project Path Coordination)
0	12/18/2024	JLT	Final Report Release
1	1/15/2025	JLT	Final Report Release (Updated Project Design)

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EXECUTIVE SUMMARY

On behalf of Green Mountain Power (GMP), RLC Engineering, LLC (RLC) conducted a distribution system impact study (Study) of the proposed ER Allen St BESS 4,999 kW battery energy storage system (BESS) project (Project), to be located in Barre City, Vermont, pursuant to the interconnection requirements of Vermont Public Utility Commission (PUC) Rule 5.500. The primary focus of this Study was to:

1. Assess compliance of the proposed Project with the requirements of distributed generation interconnecting to the GMP system according to the Green Mountain Power Interconnection Guidelines for Distributed Energy Resources (https://greenmountainpower.com/wp-content/uploads/2017/01/Final-2021-DER-Guidelines-2-2021-03-19.pdf).
2. Assess the steady state, time-based, and protection impacts of the proposed Project on the distribution systems served from the Barre South End substation.
3. Identify distribution system and substation upgrades that may be necessary to complete the interconnection of the Project.

The Study includes an evaluation of the following items:

- Steady State Load Flow Analysis
- Time Series Analysis
- Protection Evaluation
- Verification of Compliance with Standards

Note that all modeling and simulations were conducted using Eaton's CYME software.

Project Description

The BESS Project in Table 0-1 proposes to interconnect to the 37G1 feeder, which is supplied by GMP's Barre South End 34.5/12.47 kV substation.

Table 0-1: Project Interconnecting on the 12.47 kV Network

Project	Location	Developer	Maximum Output (kW)
ER Allen St BESS	Allen St, Barre City, Vermont Pole 16, Taglet 83920	ER Allen St Storage, LLC	4,999

The Project proposes the inverter and transformer design outlined in Table 0-2.

Table 0-2: Project Generators and Step Up Transformers

Generator(s)	# of Inverters	Step Up Transformer(s)	# of GSU's
EPC CAB1000/AC-3L.2	5*	Customer-Owned, 3 phase, 12.47 kV Grounded Wye** – 630 V Delta, 3,100 kVA, 5.75%Z	2
*Study completed with four (4) CAB1000 inverters but future augmentation will add one (1) additional inverter for a total of five (5) while maintaining the same total Project output of 4,999 kW **Note that the provided one-line specifies Ungrounded Wye on the primary GSU winding, however, the Study was completed with a Grounded Wye winding per GMP specifications			

The proposed interconnection complies with all applicable standards, provided all recommendations of this Study report are met.

Study Findings

GMP provided RLC with a detailed CYME model including the 37G1 (Project feeder), 37G2, 37G3 (adjacent feeders), and the Barre South End substation. The loading scenarios outlined in Table 0-3 were taken into account when applicable.

Table 0-3: Loading Scenarios

Loading Scenario	Native Loading Levels (kW)			
	37G1	37G2	37G3	Substation
37G1 Circuit Peak	1,607	4,122	3,755	9,521
Minimum Daytime	585	1,541	1,656	3,796
Minimum Nighttime	480	1,172	1,150	2,802

A summary of all simulation results and network upgrades necessary to mitigate adverse impacts caused by the Project is presented in Table 0-4.

Table 0-4: Study Results Summary

Analysis Type	Criteria	Results	Upgrades	Notes
Voltage	Steady State: 95% < V < 105%	No violations	None	
	Reconnection: 95% < V < 105%	No violations	None	
	Voltage Imbalance: Imbalance < 3%	No violations	None	
	Flicker: IEEE 1547-2018 Section 7.2.3 Compliance	Short and long term criteria violations observed with Project operating in Trinary AGC mode	Project shall only operate in Continuous AGC mode should it participate in the frequency regulation market	
Thermal	< 90% Conductor Ratings < 100% Fuse Ratings < 100% LTC Ratings < 100% Regulator Ratings < 100% Hydraulic Recloser Ratings	NULL_111059 LBS overloaded up to 320.9% 140K fuse at shared POI overloaded up to 242.4% ~1,875 ft. of 1/0 AAAC overhead conductor along Allen St overloaded up to 168.4% ~973 ft. of 4/0 AAAC overhead conductor along Prospect St overloaded up to 109.6% ~281 ft. of 4/0 AAAC overhead conductor outside of the SS loaded up to 103.5%	Upgrade NULL_111059 LBS to a device with a rating >321 A. A 600 A device was assumed for the Study 140K at the shared POI must be bypassed and fault indicators must be installed Reconductor ~2,848 ft. of overhead line along Prospect St and Allen St to 477 18/1 ACSR Reconductor ~281 ft. of overhead line outside of the substation to 477 18/1 ACSR	GMP shall make final determination on all device replacements and line designs
Protection Evaluation	% of Pickup - Peak Load ≤ 67% Full Load Current	No violations	See RLC's proposed device settings in Table 2-2 and Table 2-3	37G1 - 46.91% | 1014021_PRIOH - 54.81%
	% of Pickup - Full Generation ≤ 83% Full Load Current	No violations		37G1 - 45.47% | 1014021_PRIOH - 70.13%
	Protective Reach Reach ≥ 3	No violations		**37G1 breaker relay reach:** Pre-Project: (LLL/LG) - 5.47/6.97 Post-Project: (LLL/LG) - 5.43/6.91 **1014021_PRIOH recloser reach:** Post-Project: (LLL/LG) - 7.65/8.00
	Coordination Maintain GMP Margins	No violations		
Ground Fault Overvoltage	Transmission Load:Gen > 2	No violations	None	GMP requires that the minimum load-to-generation ratio on transmission systems be greater than 2.0, including all distributed resources without direct transfer trip (DTT) from the operating devices under study. In this instance, the minimum load-to-generation ratio is less than 2.0. For the Project, this issue will be addressed by an existing 3V0 protection scheme. As such, temporary overvoltage at the subtransmission level need not be studied further
	Distribution Inverter DER > 500 kW	DER Project is > 500 kW	A GMP installed recloser at the PCC is required	A GMP installed electronic recloser is required that will address this issue. GMP requires a recloser at the point of common coupling (PCC) for inverter-based distributed generation greater than 500 kW. In addition, the inverter settings shall be modified from the default settings to comply with the ISO-NE Default New England Bulk System Area Settings Requirement (ASR).
Islanding	Inverter DER ≥ 1,000 kW	DER Project is ≥ 1,000 kW	Reclose block is required. GMP shall make final determination on the design and cost of reclose block in a Facilities Study	GMP requires reclose block for all projects greater than or equal to 1,000 kW, where a PCC recloser is otherwise required, and where the summation of line segment DER is greater than ½ of the minimum line segment load. For the Project, reclose block will be required at the PCC, the POI, the existing upstream line recloser, and the 37G1 substation breaker

1 LOAD FLOW EVALUATION

1.1 Voltage Levels and Imbalance

Steady state load flow simulations were performed to verify compliance with ANSI C84.1 Range A distribution voltage limits (±5%) and GMP voltage imbalance criteria, which mandates that all three phase lines contain less than 3% imbalance.

Simulations were conducted with all voltage regulating equipment set to regulate at either the top or bottom of their respective bandwidths in order to present the most conservative results possible from a high or low voltage standpoint.

A voltage results summary is shown in Table 1-1. Note that small customer violations were ignored for this analysis.

Table 1-1: Steady State Voltage Evaluation Summary

Evaluation	Scenario	Project Site Output (kW)	Voltage Violations	Notes
Peak Loading, No Generation, Max BESS Charging	Pre-Project	N/A	No violations	Regulators tested at bottom of band
	Post-Project	5,030	No violations	
Peak Loading, Max Generation Max BESS Discharging	Pre-Project	N/A	No violations	Regulators tested at top of band
	Post-Project	-4,966	No violations	
Light Daytime Loading, Max Generation, Max BESS Discharging	Pre-Project	N/A	No violations	Regulators tested at top of band
	Post-Project	-4,966	No violations	
Light Nighttime Loading, Max Generation Except PV, Max BESS Discharging	Pre-Project	N/A	No violations	Regulators tested at top of band
	Post-Project	-4,966	No violations	

As shown, the Project does not cause concern for voltage violations.

1.2 Reconnection Voltages

A voltage evaluation was performed to confirm that the reconnection of generation facilities after an outage would not result in ANSI C84.1 Range A violations. The reconnection simulations and evaluations were performed in four steps:

1. Load flow was run on the system with no generation online and all voltage regulation equipment allowed to adjust.
2. All pre-Project generation that is not interconnected to the distribution system through a recloser was brought online at full output with all voltage regulation equipment held fixed.
3. All voltage regulation equipment was allowed to adjust with only pre-Project generation in service.
4. The existing recloser-connected generation and the Project were interconnected simultaneously with all voltage regulation equipment held fixed.

A reconnection results summary is shown in Table 1-2. Note that pre-Project customer violations were ignored for this analysis.

Table 1-2: Reconnection Voltage Evaluation Summary

Evaluation	Scenario	Voltage Violations
Peak Loading, No Generation, Max BESS Charging	No Generation, Regulation Adjusting	No violations
	BESS Online, Full Charging, Regulation Fixed	No violations
Peak Loading, Max Generation Max BESS Discharging	No Generation, Regulation Adjusting	No violations
	Non-Recloser Generation Online, Regulation Fixed	No violations
	Regulation Adjusting	No violations
	Recloser Generation Online, Regulation Fixed	No violations
Light Daytime Loading, Max Generation, Max BESS Discharging	No Generation, Regulation Adjusting	No violations
	Non-Recloser Generation Online, Regulation Fixed	No violations
	Regulation Adjusting	No violations
	Recloser Generation Online, Regulation Fixed	No violations
Light Nighttime Loading, Max Generation Except PV, Max BESS Discharging	No Generation, Regulation Adjusting	No violations
	Non-Recloser Generation Online, Regulation Fixed	No violations
	Regulation Adjusting	No violations
	Recloser Generation Online, Regulation Fixed	No violations

As shown, the Project does not cause concern for reconnection voltage violations.

1.3 Voltage Flicker

Voltage flicker testing was conducted with CYME's Long Term Dynamics module to evaluate compliance with IEEE 1547-2018, Section 7.2.3, which is based on IEEE 1453-2015. This equates to ensuring short- and long-term flicker severities (P_{st} and P_{lt}) are within their short- and long-term flicker emission limits (E_{Pst} and E_{Plt}) of 0.35 and 0.25, respectively. Note that short-term simulations were conducted over 600 seconds and long-term simulations were conducted over 2 hours. Therefore, long-term simulations were comprised of 12 short-term simulations in series and short-term emissions were determined based on the most conservative results seen across all 12 short-term simulations.

GMP provided two output profiles that were used to simulate potential Project BESS volatility due to Automatic Generation Control (AGC) signals mandated by ISO New England (ISO-NE) for frequency regulation:

1. Continuous AGC Mode
2. Trinary AGC Mode

Within these profiles, the most volatile 2 hour intervals were chosen and used for Long Term Dynamics modeling. Figure 1-1 displays the Continuous AGC Mode profile used and Figure 1-2 displays the Trinary AGC Mode. Note that the Trinary AGC Mode profile was simulated over the full 2 hours, but only the first 300s are shown for graphical purposes as the signal is periodic and repeating after the initial increase from P = 0%.

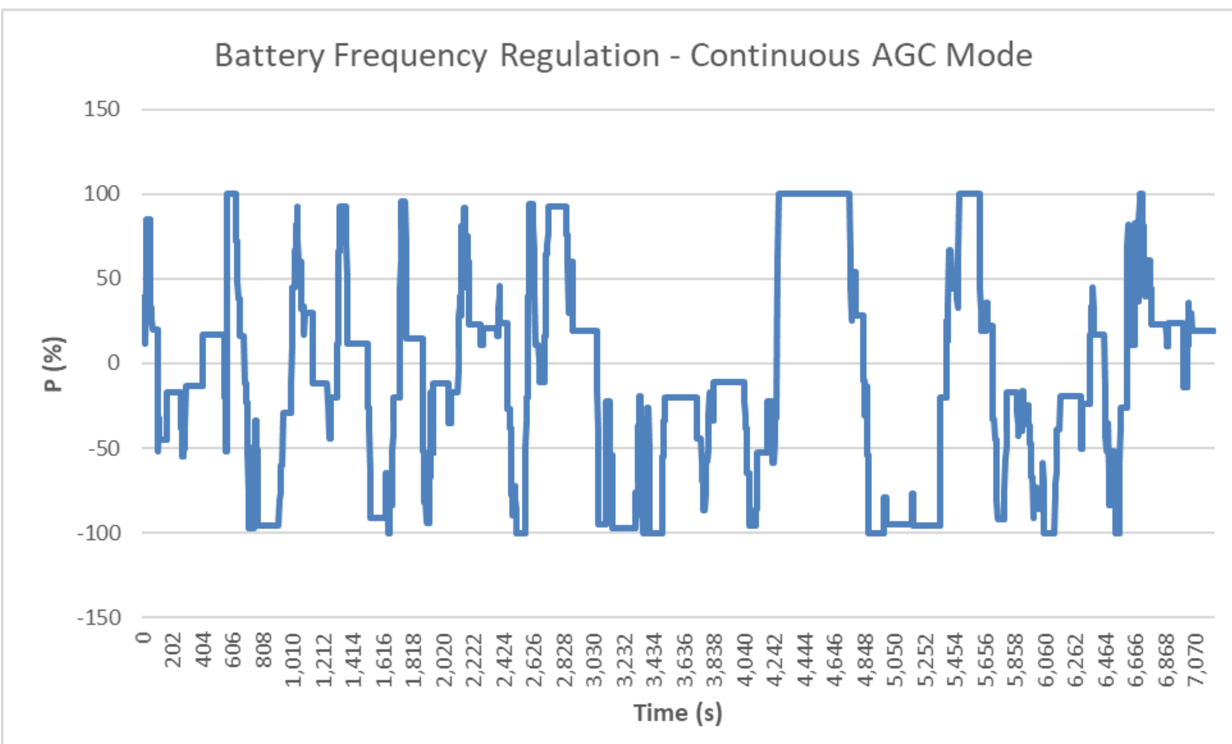


Figure 1-1: 2 Hour Volatile BESS Profile – Continuous AGC Mode

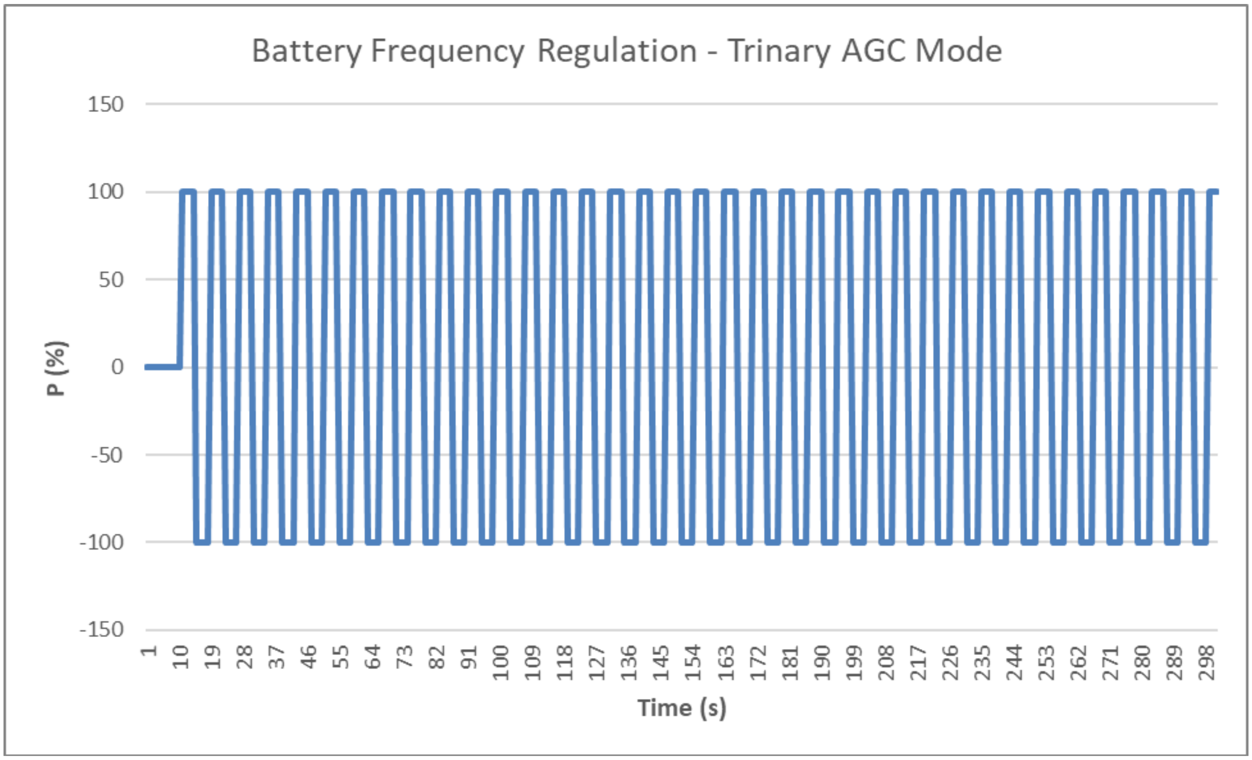


Figure 1-2: 2 Hour Volatile BESS Profile – Trinary AGC Mode

Both profiles were run independently across the Substation Peak, Minimum Daytime, and Minimum Nighttime load profiles identified in Table 0-3. Results from these simulations can be seen in Table 1-3.

Table 1-3: IEEE 1547-2018 Voltage Flicker Evaluation Summary

Loading	LTD Simulation	BESS Continuous AGC Mode				BESS Trinary AGC Mode			
		PCC		Criteria Compliance Determination		PCC		Criteria Compliance Determination	
		P_{st}	P_{lt}	Short Term Pass?	Long Term Pass?	P_{st}	P_{lt}	Short Term Pass?	Long Term Pass?
Peak Daytime	1	0.0950	0.1080	Yes	Yes	0.5406	0.5405	No	No
	2	0.1086		Yes		0.5397		No	
	3	0.1520		Yes		0.5406		No	
	4	0.0957		Yes		0.5406		No	
	5	0.1158		Yes		0.5406		No	
	6	0.1336		Yes		0.5406		No	
	7	0.1013		Yes		0.5406		No	
	8	0.0000		Yes		0.5406		No	
	9	0.0887		Yes		0.5406		No	
	10	0.1064		Yes		0.5406		No	
	11	0.1140		Yes		0.5406		No	
	12	0.0619		Yes		0.5406		No	
Minimum Daytime	1	0.0861	0.0950	Yes	Yes	0.4581	0.4611	No	No
	2	0.1520		Yes		0.4606		No	
	3	0.1098		Yes		0.4615		No	
	4	0.0000		Yes		0.4615		No	
	5	0.1182		Yes		0.4615		No	
	6	0.1351		Yes		0.4615		No	
	7	0.0000		Yes		0.4615		No	
	8	0.0000		Yes		0.4615		No	
	9	0.0000		Yes		0.4615		No	
	10	0.0000		Yes		0.4615		No	
	11	0.0718		Yes		0.4615		No	
	12	0.0697		Yes		0.4615		No	
Minimum Nighttime	1	0.0868	0.0968	Yes	Yes	0.4803	0.4795	No	No
	2	0.1086		Yes		0.4795		No	
	3	0.1182		Yes		0.4795		No	
	4	0.1086		Yes		0.4795		No	
	5	0.0941		Yes		0.4795		No	
	6	0.1105		Yes		0.4795		No	
	7	0.1098		Yes		0.4795		No	
	8	0.0000		Yes		0.4795		No	
	9	0.0823		Yes		0.4795		No	
	10	0.1013		Yes		0.4795		No	
	11	0.0861		Yes		0.4795		No	
	12	0.0651		Yes		0.4795		No	

As shown, the Project does not comply with voltage flicker criteria while under the Trinary AGC mode across all scenarios. It should be noted that a Shape Factor (F) of 0.20 was required for these simulations, which reflects a ramped output over approximately 1s rather than instantaneously stepped. Therefore, the Project shall limit maximum output changes (100% to -100%, or 4,999 kW to -4,999 kW) to a 1s interval to comply with IEEE criteria. If the Project is to participate in the frequency regulation market, it shall only operate in the Continuous AGC mode.

GMP shall make final determination on ramping rates and controls used to achieve this behavior.

1.4 Thermal

Steady state load flow simulations were performed to examine power flows through feeder and substation devices. GMP thermal criteria dictates that the following ratings not be exceeded:

1. 90% of conductor ampacity ratings
2. 100% of sectionalizing fuse continuous ratings
3. 100% of load tap changer or regulator continuous ratings
4. 100% of hydraulic recloser continuous ratings
5. 100% of regulator continuous ratings, without load bonus

A thermal results summary is shown in Table 1-4. Note that small customer violations were ignored for this analysis.

Table 1-4: Steady State Thermal Evaluation Summary – Existing System

Evaluation	Scenario	Project Site Output (kW)	37G1 Flow (kW)	Thermal Violations
Peak Loading, No Generation, Max BESS Charging	Pre-Project	N/A	1,607	No violations
	Post-Project	5,030	6,783	NULL_111059 LBS overloaded up to 303.9% 140K fuse at shared POI overloaded up to 173.4% ~1,875 ft. of 1/0 AAAC overhead conductor along Allen St overloaded up to 125.8% ~281 ft. of 4/0 AAAC overhead conductor outside of the SS loaded up to 105.4%
Peak Loading, Max Generation Max BESS Discharging	Pre-Project	N/A	-900	No violations
	Post-Project	-4,966	-5,693	NULL_111059 LBS overloaded up to 286.6% 140K fuse at shared POI overloaded up to 242.4% ~1,875 ft. of 1/0 AAAC overhead conductor along Allen St overloaded up to 168.4% ~973 ft. of 4/0 AAAC overhead conductor along Prospect St overloaded up to 109.2%
Light Daytime Loading, Max Generation, Max BESS Discharging	Pre-Project	N/A	-1,917	No violations
	Post-Project	-4,966	-6,701	NULL_111059 LBS overloaded up to 320.9% 140K fuse at shared POI overloaded up to 240.6% ~1,875 ft. of 1/0 AAAC overhead conductor along Allen St overloaded up to 167.9% ~973 ft. of 4/0 AAAC overhead conductor along Prospect St overloaded up to 109.6% ~281 ft. of 4/0 AAAC overhead conductor outside of the SS loaded up to 103.5%
Light Nighttime Loading, Max Generation Except PV, Max BESS Discharging	Pre-Project	N/A	486	No violations
	Post-Project	-4,966	-4,378	NULL_111059 LBS overloaded up to 209.2% 140K fuse at shared POI overloaded up to 161.2% ~1,875 ft. of 1/0 AAAC overhead conductor along Allen St overloaded up to 112.9%

The following upgrades were implemented to address the violations shown in Table 1-4:

1. Reconductor ~1,875 ft. of 1/0 AAAC overhead conductor along Allen St to 477 18/1 ACSR (between Tags '37766' and '83919')
2. Reconductor ~973 ft. of 4/0 AAAC overhead conductor along Prospect St to 477 18/1 ACSR (between Tags '37531' and '37766')
3. Reconductor ~281 ft. of 4/0 AAAC overhead conductor outside of the substation to 477 18/1 ACSR (between Tags '38404' and '38398')
4. Upgrade the NULL_111059 LBS to a device with a rating greater than 321 A. 600 A LBS was assumed for this study
5. The 140K fuse ('119') at the shared POI of "ER Allen St BESS" and "I Love Cows PV" must be bypassed and fault indicators must be installed

The thermal evaluation was repeated with the upgrades and the results are shown in Table 1-5. GMP shall make final determination on all upgrades.

Table 1-5: Steady State Thermal Evaluation Summary – Thermal Upgrades

Evaluation	Scenario	Project Site Output (kW)	37G1 Flow (kW)	Thermal Violations
Peak Loading, No Generation, Max BESS Charging	Pre-Project	N/A	1,607	No violations
	Post-Project	5,030	6,721	No violations
Peak Loading, Max Generation Max BESS Discharging	Pre-Project	N/A	-900	No violations
	Post-Project	-4,965	-5,790	No violations
Light Daytime Loading, Max Generation, Max BESS Discharging	Pre-Project	N/A	-1,917	No violations
	Post-Project	-4,965	-6,800	No violations
Light Nighttime Loading, Max Generation Except PV, Max BESS Discharging	Pre-Project	N/A	486	No violations
	Post-Project	-4,965	-4,423	No violations

As shown in Table 1-5, the Project does not cause concern for thermal violations with the thermal upgrades.

2 PROTECTION EVALUATION

2.1 % of Pickup, Reach, and Coordination

A protection evaluation was conducted to evaluate compliance with the following GMP criteria:

1. % of Pickup – Non-fault currents shall not exceed 67% of the phase pickup of an electronic recloser under peak load conditions
2. % of Pickup – Non-fault currents shall not exceed 67% of the phase pickup of an electronic recloser under the conditions of 0% load and 100% generation
3. Reach – Pickup levels shall not be less than 3.0 for bolted LLL and LG faults
4. Coordination – Margins shall be maintained per GMP's standards between protective devices from the Project to the substation

Simulations were performed for respective evaluations and a protection results summary is shown in Table 2-1.

Table 2-1: Protection Evaluation Summary

<table>
<tr><th>Evaluations</th><th>Results</th><th>Upgrades/Remediations</th><th>Notes</th></tr>
<tr><td>% of Pickup
(≤ 67% Full Load Current at Peak Load, Max BESS Charging)</td><td>No violations</td><td rowspan="4">See RLC's proposed device settings in Table 2-2 and Table 2-3</td><td>37G1 - 46.91%
1014021_PRIOH - 54.81%</td></tr>
<tr><td>% of Pickup
(≤ 83% Full Load Current at Minimum (Day) Load, 100% Generation)</td><td>No violations</td><td>37G1 - 45.47%
1014021_PRIOH - 70.13%</td></tr>
<tr><td>Protective Reach
(Reach ≥ 3)</td><td>No violations</td><td><u>37G1 breaker relay reach:</u>
Pre-Project
(LLL/LG) - 5.47/6.97
Post-Project
(LLL/LG) - 5.43/6.91

<u>1014021_PRIOH recloser reach:</u>
Post-Project
(LLL/LG) - 7.65/8.00</td></tr>
<tr><td>Coordination
(Maintain GMP Margins)</td><td>No violations</td><td></td></tr>
</table>

Table 2-2 summarizes the proposed settings for the existing 37G1 breaker. Table 2-3 summarizes the proposed settings for the new 1014021_PRIOH recloser and the ER Allen St PCC GMP recloser.

Table 2-2: Existing Recloser/Breaker Proposed Settings

Device	Existing Pickup (A)	Existing Curve	Existing Time Dial	Recommended Pickup (A)	Recommended Curve	Recommended Time Dial
37 – 51T	-	-	-	681.6	U4	1.60
37 – 51NT	-	-	-	960	U4	7.20
37 – 51B	1,620	U4	1.10	1,620	U4	1.40
37 – 51NB	480	U4	7.20	480	U4	10.00
37G1 – 51P	700	U4	2.00	700	U4	3.00
37G1 – 51N	480	U4	3.00	480	U4	5.50

Table 2-3: New Recloser Proposed Settings

Device	Type	Relay	Cont. Rating	Inter. Rating	Recommended Pickup (A)	Recommended Curve	Recommended Time Dial
1014021_PRIOH Recloser	Viper-ST	SEL-651R	800	12,000	51P/G: 480	51P/G: C3	51P/G: 0.23
ER Allen St PCC GMP Recloser	Viper-ST	SEL-651R	800	12,000	51P/G: 330	51P/G: C3	51P/G: 0.26

Figure 2-1 and Figure 2-2 shows the phase TCC plot for all devices upstream of the Project PCC as well as Project GSU magnetizing inrush.

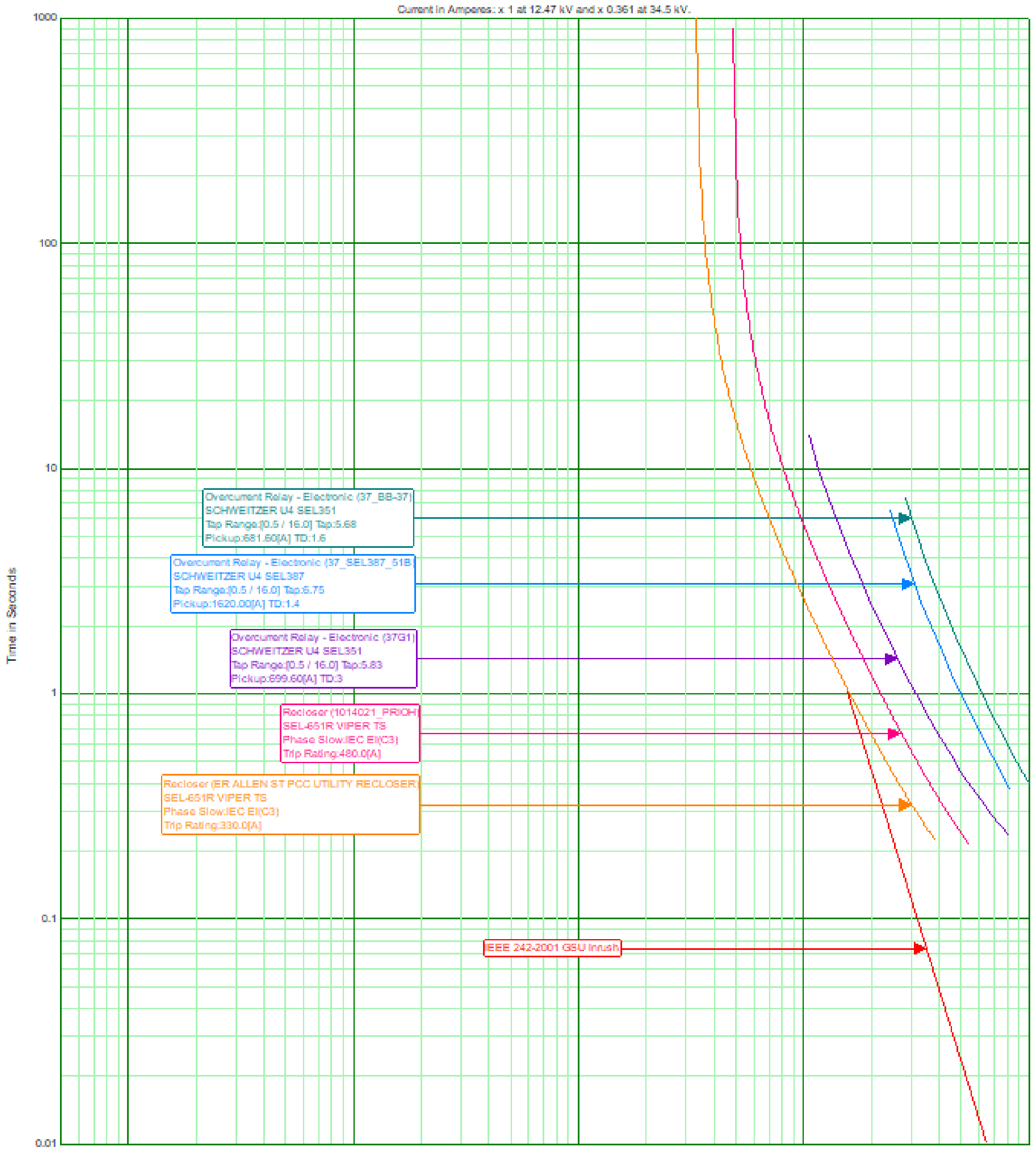


Figure 2-1: Device Coordination TCC Plot with GSU Magnetizing Inrush (Phase)

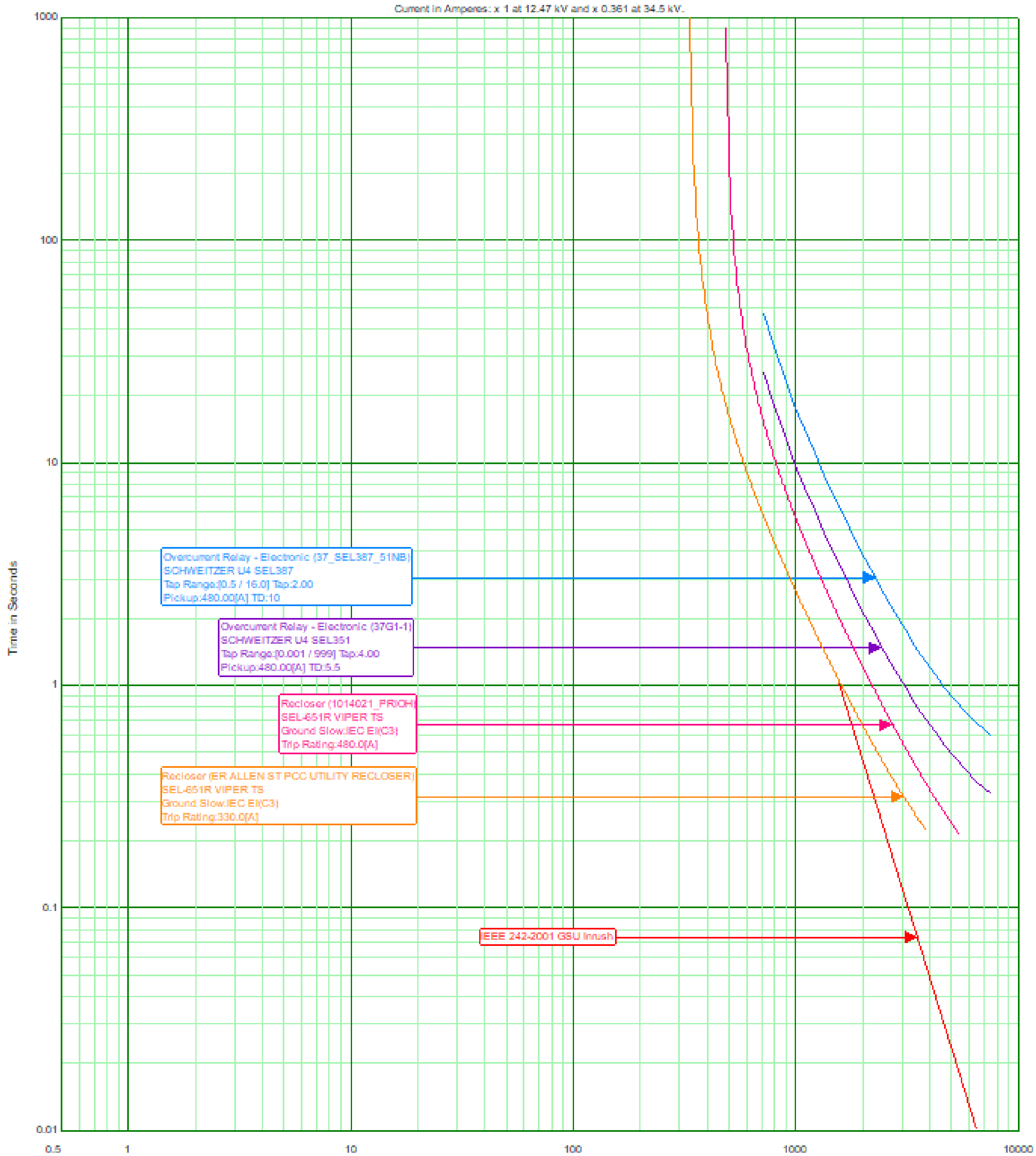


Figure 2-2: Device Coordination TCC Plot with GSU Magnetizing Inrush (Ground)

As shown, the Project does not cause concern for any protection violations. GMP shall make final determination on all protection upgrades to maintain reliability.

2.2 Ground Fault Overvoltages

Transmission: GMP requires that the minimum load-to-generation ratio on transmission systems be greater than 2.0, including all distributed resources without direct transfer trip (DTT) from the operating devices under study. In this instance, the minimum load-to-generation ratio is less than 2.0. For the Project, this issue will be addressed by an existing 3V0 protection scheme. As such, temporary overvoltage at the sub-transmission level need not be studied further.

Distribution: A GMP installed electronic recloser is required that will address this issue. GMP requires a recloser at the point of common coupling (PCC) for inverter-based distributed generation greater than 500 kW. In addition, the inverter settings shall be modified from the default settings to comply with the ISO-NE Default New England Bulk System Area Settings Requirement (ASR) as detailed below in Section 3.2.

2.3 Islanding

GMP requires reclose block for all projects greater than or equal to 1,000 kW, where a PCC recloser is otherwise required, and where the summation of line segment DER is greater than ½ of the minimum line segment load. For the Project, reclose block will be required at the PCC, the POI, the existing upstream line recloser, and the 37G1 substation breaker.

2.4 Ground Fault Detection

The system as proposed does NOT maintain the zero sequence continuity between the Point of Common Coupling ("PCC") and the Point of DER Connection ("PoC") due to the proposed configuration of the transformer. This results in a break in the zero-sequence network between the Reference Point of Applicability (RPA) and the project inverters.

As a result of this zero-sequence break, the customer must design, own, install and commission a supplemental DER device to obtain compliance with IEEE 1547 at the RPA.

The supplemental device's equipment, design and commissioning are subject to GMP approval. All commissioning tests for the composite system shall be performed based on written test procedures provided by the customer and approved by GMP prior to commissioning. The commissioning shall, at a minimum, demonstrate the full compliance of the composite system with ISO-NE requirements which relate to IEEE 1547 parts 6.2 & 6.4.

3 COMPLIANCE WITH STANDARDS

3.1 Vermont PUC Rule 5.500, Section 5.510

The Project is required to comply with Section 5.510 "Codes and Standards" of the PUC Rule 5.500. Note that the Project must comply with the most up to date versions of the standards provided in Table 3-1 within a 6-month grace period.

Table 3-1: Vermont PUC Rule 5.500, Section 5.510 Compliance Summary

Item	Standard/Code	Details
A	IEEE 1547	See Section 3.2
B	UL 1741	See Section 3.3
C	IEEE Standard 929-2000	Standard withdrawn
D	NFPA 70 (2002) National Electric Code	Customer to ensure compliance with latest version
E	IEEE Standard C37.90.1-1989 (R1994)	Customer to ensure compliance with latest version
F	IEEE Standard C37.90.2 (1995)	Customer to ensure compliance with latest version
G	IEEE Standard C37.108-1989 (R2002)	Not applicable to Project
H	IEEE Standard C57.12.44-2000	Customer to ensure compliance with latest version
I	IEEE Standard C62.41.2-2002	Customer to ensure compliance with latest version
J	IEEE Standard C62.45-1992 (R2002)	Customer to ensure compliance with latest version
K	ANSI C84.1-1995	See Sections 1.1
L	IEEE Standard 100-2000	Proper terminology used
M	NEMA MG 1-1998	N/A – Project is inverter-based
N	IEEE Standard 519-1992	Project is IEEE 1547 and UL 1741 Compliant

As shown, the Project complies with all standards applicable to the 37G1 interconnection. All standards applicable to Project-side low voltages are outside the scope of this Study.

3.2 Default New England Bulk System Area Settings Requirement

The Project is required to comply with ISO New England's (ISO-NE) "Default New England Bulk System Area Settings Requirement" (ASR) (effective January 1, 2024).

The inverter datasheet states compliance with UL 1741 SB and IEEE 1547-2018. However, the Project must also comply with the following ISO-NE ASR tables as applicable:

- Table IV: Inverters' Voltage Trip Settings
- Table V: Inverters' Voltage Ride-through Capability and Operational Requirements
- Table VI: Inverters' Parameters of frequency droop (frequency power) operation

Since the current Project one-line contains no settings, these must be added. GMP shall make final determination on all Project settings.

3.3 IEEE and UL Standards

The Project is required to comply with IEEE 1547-2018 and UL 1741 SB. As discussed in Section 3.2, the Project inverters state compliance with UL 1741 SB and IEEE 1547-2018.

4 CONCLUSIONS and RECOMMENDATIONS

The primary objective of this Study was to assess the impacts of the Project on the GMP system, and to identify system modifications and conditions required for interconnection. Please note that this Study makes no determination regarding tariffs applicable for Project operation.

The following conclusions and conditions are based on the assessments described in Sections 1, 2, and 3:

1. The Project is compliant with the interconnection requirements in PUC Rule 5.500 and the Green Mountain Power Interconnection Guidelines for Distributed Energy Resources on the condition that all requirements in this Study are satisfied.

2. The Project caused existing conductors to be overloaded up to 168.4% of their respective ratings. To eliminate these violations, the following upgrades were implements:
   a. Reconductor ~1,875 ft. of 1/0 AAAC overhead conductor along Allen St to 477 18/1 ACSR (between Tags '37766' and '83919')
   b. Reconductor ~973 ft. of 4/0 AAAC overhead conductor along Prospect St to 477 18/1 ACSR (between Tags '37531' and '37766')
   c. Reconductor ~281 ft. of 4/0 AAAC overhead conductor outside of the substation to 477 18/1 ACSR (between Tags '38404' and '38398')

   GMP shall make final determination on all line designs.

3. A 100 A LBS in the Project Path ('NULL_111059') LBS shall be upgraded to a device with a rating greater than 321 A. 600 A LBS was assumed for this study. GMP shall make final determination on all device upgrades.

4. The 140K fuse ('119') at the shared POI of "ER Allen St BESS" and "I Love Cows PV" must be bypassed and fault indicators must be installed. GMP shall make final determination on all protection upgrades to maintain reliability.

5. The Project does not comply with voltage flicker criteria while operating under the Trinary AGC mode across all scenarios tested. It should be noted that a Shape Factor (F) of 0.20 was required for these simulations, which reflects a ramped output over approximately 1s rather than instantaneously stepped. Therefore, the Project shall limit maximum output changes (100% to -100%, or 4,999 kW to -4,999 kW) to a 1s interval to comply with IEEE criteria. If the Project is to participate in the frequency regulation market, it shall only operate in the Continuous AGC mode.

6. A GMP recloser shall be installed at the PCC to address ground fault overvoltage concerns. The Project will be responsible for the monthly recurring cost of communications to GMP from the PCC recloser.

7. Reclose block will be required at the 37G1 substation breaker, 1014021_PRIOH recloser, and the GMP PCC recloser. The equipment and costs required would be determined in a Facilities Study.

8. The customer must design, own, install and commission a supplemental DER device to obtain compliance with IEEE 1547 at the RPA. The supplemental device's equipment, design and commissioning are subject to GMP approval. All commissioning tests for the composite system shall be performed based on written test procedures provided by the customer and approved by GMP prior to commissioning. The commissioning shall, at a minimum, demonstrate the full compliance of the composite system with ISO-NE requirements which relate to IEEE 1547 parts 6.2 & 6.4.

9. Because the Project capacity exceeds 1,000 kW, GMP is required to submit a generator notification form to ISO-NE per ISO-NE Planning Procedure 5-1. ISO may determine that a Proposed Plan Application (PPA) is required, which may result in additional study consistent with ISO Study and Performance Requirements in Planning Procedures 5-6 and 5-3. GMP will keep the Project apprised of any updates regarding the ISO-NE review.

Appendix A – Project One-Line Diagram

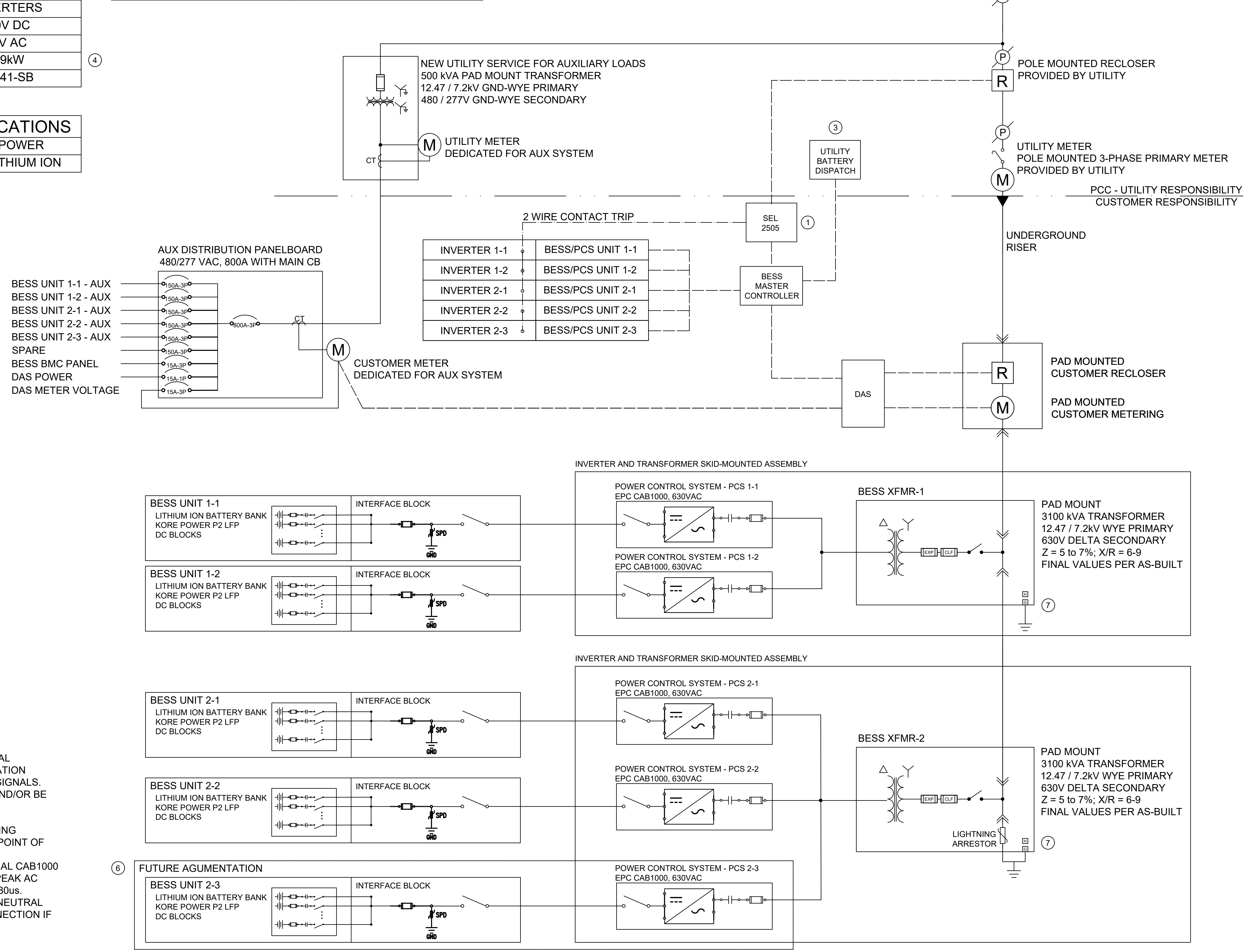
INVERTER SPECIFICATIONS	
MANUFACTURER	EPC POWER
PART #	CAB1000
TOTAL INVERTERS	5 INVERTERS
MAX DC VOLTAGE	1500V DC
NOMINAL AC VOLTAGE	630V AC
MAX AC OUTPUT POWER	1369kW (4)
LISTING	UL1741-SB

SYSTEM SUMMARY	
PEAK AC OUTPUT	DERATED TO 4,999 kW AT POC (5)
EXPECTED BESS RUNTIME	4 HOURS

EXPECTED BATTERY SPECIFICATIONS	
MANUFACTURER	KORE POWER
TECHNOLOGY	P2 LFP LITHIUM ION

EXACT CONFIGURATION OF EQUIPMENT TO BE DETERMINED BY UTILITY

LINE TYPE
- —·—·—·— = TRIP
- — — — — = COMMUNICATION
- ———— = POWER



NOTES:
1. UTILITY INVERTER MOMENTARY CESSATION SIGNAL
2. UTILITY SERIAL COMMUNICATION SIGNAL. SUBSTATION TRANSFORMER LOADING AND FEEDER LOADING SIGNALS.
3. UTILITY DISPATCH SIGNAL CAN BE HARD WIRED AND/OR BE SENT VIA EMAIL REQUEST
4. INVERTERS TO BE SOFTWARE LIMITED.
5. INVERTER FINAL LIMIT WILL BE CONFIGURED DURING COMMISSIONING FOR MAX EXPORT LIMIT AT THE POINT OF COMMON COUPLING.
6. FUTURE AUGMENTATION WILL ADD ONE ADDITIONAL CAB1000 INVERTER. THIS WILL ADD AN ADDTIONAL 2,415A PEAK AC FAULT CURRENT CONTRIBUTION. TIME TO PEAK 380us.
7. UNGROUNDED WYE WITH FULL-VOLTAGE-RATED NEUTRAL BUSHING (HO), AVAILABLE FOR GROUNDING CONNECTION IF REQUIRED BY UTILTIY.

ENCORE RENEWABLE ENERGY
PO BOX 1072
BURLINGTON, VT 05401
802-861-3023
ENCORE.ECO

encore RENEWABLE ENERGY

ALLEN STREET BESS
4.999 MW AC BESS
BARRE, VT
44.187875, -72.211570

NOT FOR CONSTRUCTION

ISSUED FOR IX APPLICATION

ONE LINE

E-101

Appendix B – Interconnection Application

Date and Time Received: ______ Certificate of Public Good Case No.
Unique Application Number : 01-13-2025 ZB - Revisions highlighted in yellow.
Including a 5th inverter to account for future augmentation. MWac will remain 4.999 throughout the life of the project. AC capacity corrected to 4.999MWac from 4.996.
Transformers updated to accommodate three inverters.

Rule 5.500 Application for Interconnection of Distributed Energy Resources Greater than 150 kW

This form may be made available in an electronically fillable format and it is permissible to submit the form with electronic signatures.

Preamble and Instructions:
An owner of a distributed energy resource who requests interconnection to a State-regulated distribution or transmission facility must submit an application to the Interconnecting Utility. An application is accepted as complete when it provides all applicable information required along with the required Application fee. A site plan and one-line diagram must be supplied with the Application. Additional information to evaluate a request for interconnection may be required after an Application is deemed complete.

1. Applicant Information:

Name: Allen St Storage, LLC

Address [eSITE ID]: Allen St (44.19023506218619, -72.50942276062085)

City: Barre State: VT Zip: 05641

Telephone (Day): (802) 861 3023 (Alternate): (802) 735 9340

Email: doug@encore.eco

Utility Consumption Meter Number (if applicable): ______

Name of Utility: ______

Representative: (e.g., System installation contractor or coordinating company, if appropriate)
Name: Doug MacDonald

Address: 50 Lakeside Ave Unit 110

City: Burlington State: VT Zip: 05401

Telephone (Day): ______ (Alternate): ______

Email: doug@encore.eco

Will the Generation Resource be used for any of the following? Check all that apply

Net-Metering?	Yes☐	No■
Group Net-Metering? (If yes, please provide group information directly to your utility)	Yes☐	No■
Non-Exporting?	Yes☐	No■
To participate in the Standard Offer Program?	Yes☐	No■
Participate in the wholesale electricity market?	Yes☐	No☐
Qualifying Facility[1] where 100% of output will be sold to Interconnecting Utility?	Yes■	No☐
Qualifying Facility[1] intending to sell power at wholesale to an entity other than Interconnecting Utility?	Yes☐	No■

Other (describe): Full Tolling Agreement with GMP having control of charging and discharging

[1] Evidence of FERC QF Certification will be required prior to commercial operation.

For an energy storage system, check the mode of operation below: (Check all that apply)

- ✔ Peak Shaving
- ☐ Retail Demand Management
- ✔ Emergency/Back-up
- ✔ Frequency Regulation
- ✔ Wholesale market participation(describe)____________________________________
- ✔ Other (describe) Solar soaking per GMP storage use policies

2. Project Specifications:

All power ratings should be listed in AC throughout unless otherwise noted

Physical Address [eSITE ID] : ☐ Same as above

(44.189576, -72.506457)

City:____State:____________________Zip: _________

Is this an amendment to an existing system? Check One Yes☐ No▣

If YES, what is existing CPG# ______________

Please describe the proposed amendment: ____

Requested Point of Interconnection (Include on site plan) GMP Feeder 37GI - Pole Tag 83920

Requested in-service date: ____

Energy Source: Check all that apply

☐ Solar ☐Wind ☐Hydro

▣ Energy Storage ☐Other: ____________________________

Interconnection Configuration? Check One

▣ Generation Meter ☐Behind Consumption Meter

Total number of inverters to be interconnected pursuant to this Application: 4

Total Aggregate Nameplate Rating for all generators (kW): 5476 kW

5476kW at commissioning
6845kW at augmentation around year 10

Generating Export Capacity [2] (kW): 4996 kW at POI

4999kW at POI

Individual Generator Data:

Provide for each Generator, use additional sheets if needed.

Type of Generator: Check One

▣ DC Generator or Solar ☐Synchronous ☐Induction ☐Other______ Generator Manufacturer, Model Name & Number: EPC CAB 1000

Power Rating per generator 1369kw derated to 1249kw

[2] As limited by any export controls.

Photovoltaic (PV) Data

Panel Manufacturer__________________________Model___________________________________

Quantity of PV panels_________ Power Rating per panel (DC Watts)________________________

Total Power Rating (DC Watts)_________________

☐ Roof Mount

☐ Ground Mount

☐ Other

System Orientation: ☐fixed mount ☐1-axis tracking ☐ 2-axis tracking

Individual Inverter Data (if any):

Provide for each inverter, use additional sheets if needed.

Inverter Manufacturer: EPC

Model Name & Number: CAB 1000

Version Number: 3L.2

Nameplate Rating: (kW) 1369 (kVA) 1369 (AC Volts) 630

Quantity of units installed: 4 5

If Power Factor not Unity:

Rated Power Factor: (Underexcited)_______________(Overexcited)____________________

Minimum Power Factor: (Underexcited)_______________(Overexcited)____________________

Do export controls apply to this inverter? (Check one) Yes■ No☐

- Is the inverter UL 1741 / IEEE 1547.1 Compliant?

  Yes■ No☐

- Is the inverter certified per UL 1741-SA and compliant with ISO-NE's Inverter Source Requirements Document (ISO-NE SRD)?

  Yes■ No☐

- Is the inverter certified per UL 1741-SB and compliant with ISO-NE's Default IEEE 1547-2018 Setting Requirements?

  Yes■ No☐

If Yes to any of above bullets, include testing certificate or manufacturer a data sheet describing the inverter's UL 1741/IEEE 1547.1 listing.

This BESS will be located at the same facility as Encore's I Love Cows solar project. These projects will be utility metered separately.

Battery Storage/Backup Information

Is this Battery an add-on to an existing customer-generator facility? Yes ☐ No ■

If Yes, existing CPG #:___________________________________

Is this Battery:

Battery (DC Coupled – No Export) + Solar	Yes ☐	No ☐
Battery (AC Coupled - Export) + Solar	Yes ☐	No ☐
Battery Only (AC Coupled - Export)	Yes ■	No ☐
Battery (DC-Coupled – No Export)	Yes ☐	No ☐

☐ Other (describe if coupled with another energy resource):____________________________

Does the battery share an inverter with a Renewable Energy system? Yes ☐ No ■

If Yes, can the battery be charged from the Electric Utility electric distribution grid? Yes ☐ No ☐

If No, how is the battery Energy Storage System prevented from being charged by the electric distribution system? BESS is not prevented from being charged by the electric distribution system

Shared Inverter Information (DC coupled inverters with multiple sources)

Quantity:_____________________

Battery System Manufacturer: ______________Model:______________ Battery Type:_______________

Battery Charge/Discharge Rating (kW AC): ___________Battery Energy Capacity (kWh):__________

DC Source/Prime Mover: ________________________________

Do export controls apply to this inverter? (Check one) Yes☐ No☐

Lagging Reactive Power Limit at Rated Real Power Output (MVAR)	
Leading Reactive Power Limit at Rated Real Power Output (MVAR)	
Lagging Reactive Power Limit at Zero Real Power Output (MVAR)	
Leading Reactive Power Limit at Zero Real Power Output (MVAR)	

- Is the inverter UL 1741 / IEEE 1547.1 Compliant?

  Yes☐ No☐

- Is the inverter certified per UL 1741-SA and compliant with ISO-NE's Inverter Source Requirements Document (ISO-NE SRD)?

  Yes☐ No☐

- Is the inverter certified per UL 1741-SB and compliant with ISO-NE's Default IEEE 1547-2018 Setting Requirements?

  Yes☐ No☐

If Yes to any of above bullets, include documentation provided by the inverter manufacturer describing the inverter's UL 1741/IEEE 1547.1 listing.

Dedicated Inverter Information (inverters with only batteries for DC source)

Quantity: 4 5

Battery System Manufacturer: KORE Model: P2 Battery Type: LFP Lithium Ion

Battery Charge/Discharge Rating (kW AC): 1249 kW DC Battery Energy Capacity (kWh): 4996 each

1249-1250kW AC each at commissioning. 999-1000kw AC each at augmentation

5000 each, derated

DC Source/Prime Mover: BESS

Do export controls apply to this inverter? (Check one) Yes■ No☐

Lagging Reactive Power Limit at Rated Real Power Output (MVAR)	0.431 per inverter
Leading Reactive Power Limit at Rated Real Power Output (MVAR)	0.431 per inverter
Lagging Reactive Power Limit at Zero Real Power Output (MVAR)	0.431 per inverter
Leading Reactive Power Limit at Zero Real Power Output (MVAR)	0.431 per inverter

- Is the inverter UL 1741 / IEEE 1547.1 Compliant?

  Yes■ No☐

- Is the inverter certified per UL 1741-SA and compliant with ISO-NE's Inverter Source Requirements Document (ISO-NE SRD)?

  Yes■ No☐

- Is the inverter certified per UL 1741-SB and compliant with ISO-NE's Default IEEE 1547-2018 Setting Requirements?

  Yes■ No☐

If Yes to any of above bullets, include documentation provided by the inverter manufacturer describing the inverter's UL 1741/IEEE 1547.1 listing.

Battery Intended Use and Operation

Please provide a sequence of operations explaining how the system will operate under normal and off-grid conditions (explain how the battery will disconnect and reconnect to the grid). Please provide the type of switching and indicate if it is self-contained or utilizes separate components. An example would be self-contained device with DC to AC inverter, battery charger, and integrated AC transfer switch. On your one-line diagram please label the various equipment (inverter(s), charge controllers, switches, etc.) so that your written operational equipment discussion matches the one-line diagram. If your system rated kW outflow to the grid is restricted by control logic (outflow kW is less than inverter total capacity), then indicate the worst case outflow capacity.

~~BESS and solar are separately metered. BESS to be controlled by BESS Master Controller which is connected to the GMP Battery Dispatch.~~

Limited-Export / Non-Export / Limited-Import Data:

If multiple export control systems are used, provide for each control system and use additional sheets if needed.

Is export controlled to less than the Total Aggregate Nameplate Rating? Yes ■ No ☐

Method of export limitation:

■ Power Control System ☐ Reverse Power Protection

☐ Minimum Power Protection ☐ Other (describe): ____

Export controls are applied to how many generators? ■ Multiple ☐ One

If Power Control System is used, open loop response time: 1.5sec typical, 3sec max (s)

Power Control System output limit setting: (kW) 4996 (kVA) 4996 4999kW 4999kVA

Energy Storage System Power Control System operating mode:

■ Unrestricted ☐ Export Only ☐ Import Only ☐ No Exchange

Describe which Generators the export control system controls: All

<u>Rotating Machines Data</u>:

Manufacturer, Model Name & Number: ____

Version Number: ____

Nameplate Output Power Rating: (kW) ____________________ (kVA) ___________________

Rated Power Factor: (Underexcited) ________________(Overexcited) __________________

Minimum Power Factor: (Underexcited) _____________(Overexcited) __________________

☐ Single phase ☐ Three phase (check one)

List of adjustable set points for the protective equipment or software: ______________________

Export Capacity Requested (kW) : _____________________

Do export controls apply to this machine? Yes ☐ No ☐

RPM Frequency: _________________________________

Neutral Grounding Resistor (If Applicable): ____

List components of the Interconnection Equipment Package that are UL or IEEE Certified:

Equipment Type	Certifying Entity
1.	______________________________
2.	______________________________
3.	______________________________
4.	______________________________

Synchronous Generators

Direct Axis Synchronous Reactance, Xd: _______________P.U.

Direct Axis Transient Reactance, X' d: _______________P.U.

Direct Axis Subtransient Reactance, X" d: _______________P.U.

Generator Saturation Constant (1.0): ___________________

Generator Saturation Constant (1.2): ___________________

Negative Sequence Reactance, X2: _______________P.U.

Zero Sequence Reactance, X0: _______________P.U.

KVA Base: ___________________

Field Volts: ___________________

Field Amperes: ___________________

For synchronous generators, provide appropriate IEEE model block diagram of excitation system, governor system and power system stabilizer (PSS) in accordance with the regional reliability council criteria. A PSS may be determined to be required by applicable studies. A copy of the manufacturer's block diagram may not be substituted.

Induction Generators

Motoring Power (kW): ________________

I22t or K (Heating Time Constant): ________________

Rotor Resistance, Rr: ______________P.U. Rotor Reactance, Xr: ___________P.U.

Stator Resistance, Rs: ______________P.U. Stator Reactance, Xs: ___________P.U.

Magnetizing Reactance, Xm: _____________P.U.

Short Circuit Reactance, Xd: _____________P.U.

Exciting Current: _____________Amps

Temperature Rise: ________________

Frame Size: ________________

Design Letter: ________________

Reactive Power Required in Vars (No Load): ________________

Reactive Power Required in Vars (Full Load): ________________

Total Rotating Inertia, H: ________________Per Unit on kVA Base

3. Transformer and Protective Relay Specifications

Will a transformer be used between the generator and the Point of Common Coupling?

Yes ■ No ☐

Will the transformer be provided by the Interconnection Customer? Yes ☐ No ☐

(a) Transformer Data: (if applicable, for Interconnection Customer-Owned Transformer)

Is the transformer? ☐Single phase ■Three phase (check one)

Size: 2800 x 2 3100x2 kVA

Transformer Impedance: 5.75 percent on 2800 x2 3100 x2 kVA Base

If Three Phase:

Transformer Primary	12.47	Volts	☐ Delta	■ Wye	☐ Grounded Wye
Transformer Secondary	630	Volts	■ Delta	☐ Wye	☐ Grounded Wye
Transformer Tertiary	________	Volts	☐ Delta	☐ Wye	☐ Grounded Wye

(b) Transformer Fuse Data: (if applicable, for Interconnection Customer-Owned Fuse)

Enclose/Attach copy of fuse manufacturer's Minimum Melt and Total Clearing Time-Current Curves

Manufacturer: ________________Type: ___________

Size: ______________________Speed: ___________

(c) Interconnecting Circuit Breaker: (if applicable)

Manufacturer: ____________________________ Type: ________________________________

Load Rating (Amps): _________Interrupting Rating (Amps)_________Trip Speed (Cycles): _______

(d) Interconnection Protective Relays: (if applicable)

If Microprocessor-Controlled:

List of Functions and Adjustable Setpoints for the protective equipment or software:

	Setpoint Function	Minimum	Maximum
1.	TBD in final design		
2.			
3.			

(e) Discrete Components: (if applicable)

(Enclose/Attach Copy of any Proposed Time-Overcurrent Coordination Curves)

Manufacturer: TBD in final design Type:_______________ Style/Catalog No.:__________

Proposed Setting: ____

Manufacturer:____________________ Type:_______________ Style/Catalog No.:__________

Proposed Setting: ____

Manufacturer:____________________ Type:_______________ Style/Catalog No.:__________

Proposed Setting: ____

(f) Current Transformer Data: (if applicable)

(Enclose/Attach Copy of Manufacturer's Excitation and Ratio Correction Curves)

Manufacturer: TBD in final design.

Type:__________________ Accuracy Class:______________ Proposed Ratio Connection:_________

(g) Potential Transformer Data: (if applicable)

Manufacturer: TBD in final design.

Type:__________________ Accuracy Class:______________ Proposed Ratio Connection:_________

4. General Information

Enclose/Attach copy of site electrical one-line diagram showing the configuration of all Project equipment, current and potential circuits, and protection and control schemes. This one-line diagram must be signed and stamped by a licensed Professional Engineer.

Is one-line diagram enclosed? Yes ■ No ☐

Enclose/Attach copy of any site documentation that indicates the precise physical location of the proposed Project and all protective equipment and labels Point of Interconnection on existing electrical system (e.g., USGS topographic map or other diagram or documentation).

Is site documentation enclosed? Yes ■ No ☐

Enclose/Attach copy of any site documentation that describes and details the operation of the protection and control schemes.

Is available documentation enclosed? Yes ☐ No ■

Enclose/Attach copies of schematic drawings for all protection and control circuits, relay current circuits, relay potential circuits, and alarm/monitoring circuits (if applicable).

Are schematic drawings enclosed? Yes ☐ No ■

5. Applicant Signature (may be electronic)

I hereby certify that, to the best of my knowledge, all the information provided in this Interconnection Application is true and correct.

Signed: _______________

Title: Chief Commercial Officer

Date: 4/16/24

Operation is contingent on Utility approval to interconnect the Project and receipt of all other required regulatory approvals.

Appendix C – Generation Specifications

epcpower

CAB1000/AC - 3L.2 | Model 50-100181
Bidirectional Energy Storage & Microgrid PCS

AC	AC configuration | max. cables per phase **(1)**	3-wire (3P3W) | 6 x 600 kcmil or 6 x 300 mm²						
	Nominal AC voltage (+/- 10%) **(2)**	480 VRMS	600 VRMS	630 VRMS	660 VRMS	690 VRMS		
	Nominal AC current (export/import)	1255 ARMS						
	AC export/import capacity @ 40°C **(3)**	1043 kW	1304 kW	1369 kW	1435 kW	1500 kW		
	Max overload capacity @ 40°C, starting from 66% full load **(8)**	120 % for 2 sec and 110 % for 5 min						
	Reactive power capacity **(4), (5)**	Power Factor 0,8...1 leading/lagging						
	Allowed grid short ckt. current ratios	Current mode: >4 | Voltage mode: all						
	Max. fault current allowed from AC source	100 kA (AC RMS) throated version | 180 kA (AC RMS) non-throated version						
	Normal frequency range	50 / 60 Hz (configurable)						
	Harmonic distortion	UL1741 / IEEE 1547, <2% TDDi at rated power per IEEE 519 <3% according to VDE-AR-N 4110/4120						
	Efficiency (@ 690 VAC): Peak | CEC | Euro	98.8% | 98.4% | 98.5%						
DC	DC voltage range, maximum **(6)**	720 - 1500 VDC	900 - 1500 VDC	945 - 1500 VDC	990 - 1500 VDC	1035 - 1500 VDC		
	DC voltage range, at nominal power **(6)**	761 - 1200 VDC	951 - 1500 VDC	999 - 1500 VDC	1046 - 1500 VDC	1094 - 1500 VDC		
	Recommended minimum battery voltage	1,65 x nominal AC voltage						
	Maximum DC current	1400 ADC						
	Max. fault current allowed from DC source	180 kA (with internal DC fuses, per input)						
	Number of DC inputs | max. cables per pole	1 | 8 x 600 kcmil or 8 x 300 mm²						
	Max. deviation of DC voltage between parallel units	150 VDC						
Environmental								
	Ambient temperature (operation)	-20°C to 60°C (-40°C as option)						
	Ambient temperature (storage)	-40°C to 60°C						
	Relative humidity	5 to 100% non-condensing						
	Protection degree	Outdoor: IP55 / NEMA 3R. Salt fog kit available for coastal sites.						
	Max elevation	3,000m+ [9,842 ft.+] (Consult EPC for any higher elevation)						
	Max noise level (A-weighted equivalent)	<70 dB @ 3m						
	Seismic	ICC-ES AC 156 Sds @ 1.35 G						
	Altitude derating (current)	10% per 1,000m above 1000m elevation						
	Temperature de-rating	1.7% per degree °C from 40-55 °C						
Cabinet								
	Maximum dimensions (H x W x D)	mm: [2281 x 1000 x 1636] in.: [89.8 x 39.4 x 64.4]						
	Weight	1370 kg [3020 lb.]						
	Mounting	Pad mount / skid mount						
	Cooling	Hybrid liquid / air, temperature controlled						
Certifications								
	Safety	UL 1741	C22.2 No. 107.1-16	IEC 62477-1, IEC 62909-1				
	EMC	FCC Part 15 subpart B	IEC/EN 61000-6-2, 6-4	EN 55011	CISPR 32; CISPR 11	IEEE C37.90.2		
	Utility interconnect	UL 1741 (SB)	IEEE 1547-2018	CA Rule 21	Hawaii Rule 14	AS4777.2	VDE-AR-N 4110/4120/4130	EN 50549-2
Protections								
	AC disconnection	Contactor						
	DC disconnection	Motorized disconnect						
	AC fuses | DC fuses **(7)**	2 x 1000 A, 200 kAIc (24kA SC min)	3 x 750 A, 210 kAIc (20kA SC min)					
	AC | DC surge protection (SPD)	Type 2 (Optionally Type 1-heavy duty)	Type 1-heady duty					
	Safety features	F-stop, AC / DC overvoltage, AC timed overvoltage, inst. & timed overcurrent, overtemperature (both instantaneous and time-overload), condensation, etc.						
	Ground fault detection (optional)	IMD						
Control								
	Control interface	CAN, Modbus TCP/IP						
	Command latency	1 ms (CAN), 3 ms (Modbus TCP/IP)						
	Response time; (time to accomplish full power step)	down to 2 ms; adjustable longer via parameters						
	On-off grid transitions (optional)	Yes | UPS mode available						
	Black-start capable (optional)	Yes; requires external control power						
	Grid-tied control modes	Voltage mode	PQ (power)	DQ (current)	cos φ (pf)	STATCOM		
	Grid-support functions	Active/Reactive control	Volt/VAR	Hz/Watt	Volt/Watt | L/HVRT & L/HFRT	Inertia	ramp rate, etc.	
	Islanded control modes	V&f	droop control	VSG	Ok to parallel with other sources			
	Island overload avoidance	active inrush limiting for starting large loads						
	Control power voltage	208 V 1-ph 60 Hz or 240 V 1-ph 50 Hz						
	Self-consumption: Abs. Max. | Typ. 100% load, 30C | 50% load, 30C [standby]	2400 W | 1500 W | 1200 W [160 W]						

(1) Throat connection available as an option. Max 4 unit parallel connection allowed with throat connection due to current limit. Up to 6 inverters parallel connection allowed when using cable connection for AC.

(2) Nominal voltage 480-690 VAC +/- 10%. Consult EPC Power for ratings of alternative AC voltages.

(3) Power ratings at nominal line voltage and at cos φ = 1. Available power reduced in proportion to any AC voltage reduction from nominal.

(4) With nominal DC and nominal AC voltage. Reactive power capability will vary depending on DC and AC voltage range requirements at inverter terminals. Additonal reactive power capability available as option.

(5) Overexcited (leading) is reactive power that increases AC voltage at inverter terminals. Under excited (lagging) is reactive power that decreases the reactive power at inverter terminals

(6) DC voltage range at nominal AC voltage and at cos φ = 1. Minimum DC voltage increases with higher AC voltage and if reactive power is required. See manual for details.

(7) Consult EPC Power for higher interrupt current requirements. Minimum available grid fault currents must be observed for proper operation of AC fuses.

(8) Overload capacity depends on used DC voltage, it is reduced in lower DC values. Contact EPC power for detailed overload capacity.

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