Technical Advisory Proposal Phase 1

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Title	**Technical Advisory Proposal Phase 1**
Description	**Technical Advisory Proposal Phase 1**

SDG&E Interconnection Compliance Support for PepsiCo Energy Storage Project (via B&V)

Project ID: PJ2506-0008
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💡 **Disclaimer**

This technical recommendation is provided solely for the purpose of engineering discussion and system integration evaluation. It does not constitute a final design, certified interconnection plan, or legally binding commitment. The implementer shall conduct all required verifications, field adaptations, and coordinate with relevant utility and AHJ (Authority Having Jurisdiction) for final approval.

💡 **Intended Use**

This document is intended solely for internal engineering coordination between the client, Energize Solutions Inc., and its designated EPC or switchboard vendors. It shall not be distributed to unrelated third parties, nor be used as a substitute for certified engineering drawings or interconnection approvals.

Project Information Table

Field	Description
Client	B&V (on behalf of PepsiCo)
Project Name	*PepsiCo – SDG&E Interconnection Support*
Proposal Type	Phase 1 – Technical Advisory *(Protection + Control Logic)*
Prepared by	Energize Solutions Inc.
Date	*06-18-2025*
Contact	Andy Gong – Founder & Technical Lead
Reference	SDG&E Rule 21, UL 1741 SB, IEEE 1547-2018

Executive Summary

Executive Summary

The **PepsiCo campus energy storage project**, as currently designed, has not yet received SDG&E interconnection approval due to the absence of a compliant anti-islanding protection mechanism and fully traceable control logic.

In response to a direct request from the EPC contractor (B&V), **Energize Solutions Inc.** has been engaged to provide **Phase 1 Technical Advisory Services**, with the objective of identifying control logic gaps, defining compliant protection architecture, and supporting SDG&E approval pathways. This engagement focuses specifically on ensuring compliance with:

- **California Rule 21 Interconnection Requirements**
- **UL 1741 SB Supplement for Controllers and Relays**
- **IEEE 1547-2018 Grid Support Functionality Standards**

This proposal does **not include the supply of physical hardware** (such as relays or breakers), but instead delivers a structured evaluation of the current design, the development of strategy-based trip/reclose logic, and a system-level control boundary definition. All outputs are designed to align with utility expectations and facilitate successful project advancement.

Scope of Work

Scope of Work – Phase 1 Technical Advisory Services

Energize Solutions Inc. will provide the following deliverables as part of this Phase 1 engagement:

Task ID	Description
T01	Evaluate existing single-line drawings, breaker placement, and relay interface plans for alignment with UL 1741 SB / IEEE 1547
T02	Define anti-islanding control boundaries and coordination logic between EMS, relay, breaker, and SCADA
T03	Review trip and reclose execution pathways, including strategy-based interlock logic (C1–C7 criteria enforcement)
T04	Assess UPS, grounding, and Modbus communication chain risks; recommend architectural safeguards
T05	Validate control loop integrity: DO/DI paths, interposing relays, and 52a/52b status feedback wiring
T06	Recommend feasible retrofit options (with or without full AIPP) using components such as **SEL-700G** or **CM-UFD.M33**
T07	Provide a fully documented technical recommendation report (Ch. 1–8 + Appendices), suitable for SDG&E engineering review
T08	Support EPC team and utility reviewers during the interconnection comment cycle (document clarifications only)

All work will be completed based on available client drawings, site documentation, and confirmed equipment selections at the time of engagement. Energize Solutions assumes no responsibility for unverified field installations or equipment performance beyond the scope of control logic definition.

Deliverables, Timeline, and Commercial Terms

Deliverables

The following items will be submitted upon completion of this Phase 1 engagement:

Deliverable ID	Description	Format
D01	Phase 1 Technical Recommendation Report (Ch. 1–8 + Appendices A–G)	PDF / Word
D02	Annotated SLD review with control points marked	PDF (markup)
D03	Recommended device and control boundary table (G.7)	Excel / PDF
D04	Interlock criteria matrix (C1–C7) for EMS UI	Excel / JSON
D05	Final summary presentation (for SDG&E / client review)	PDF / PowerPoint

Timeline

Milestone	Expected Date
Kick-off / Info Review	Within 2 business days after approval
Draft Report Submission	Within 7–10 business days
Final Report & Presentation	Within 3 days after receiving comments

Commercial Terms

- **Scope Type**: Fixed-scope advisory (no hardware or field services included)
- **Fee Basis**: [To be agreed – per proposal or client contract]
- **Invoicing**: 50% upon kickoff, 50% upon final delivery
- **Support Window**: 2 weeks post-delivery Q&A (email or scheduled call)
- **Exclusions**: Field commissioning, procurement, installation, SDG&E filing

📌 *Energize Solutions Inc. remains available for continued support through Phase 2 implementation or EMS cabinet delivery if requested.*

Client Confirmation and Authorization

Client Approval and Authorization

This proposal outlines the scope of technical advisory services to be provided by **Energize Solutions Inc.** under Phase 1 of the SDG&E interconnection support effort for the PepsiCo campus project. By signing below, the client confirms acceptance of the defined scope, deliverables, timeline, and commercial terms.

Authorized Representative	
Company	B&V or Authorized Party on behalf of PepsiCo
Name	
Title	
Email	
Phone	
Signature	
Date	

Prepared by:

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Phase 1 Technical Brief – Objectives & Deliverables

Phase 1 Technical Advisory Proposal Summary

Project: *PepsiCo – SDG&E Interconnection Support*

Client: *B&V on behalf of PepsiCo*

Prepared by: *Energize Solutions Inc.*

Scope: Anti-islanding control architecture, interlock strategy design, compliance validation

Standards: *UL 1741 SB, IEEE 1547-2018, Rule 21 (California)*

Objectives

- Identify technical gaps preventing SDG&E approval
- Define control logic for anti-islanding trip and controlled reclosure
- Ensure EMS-based strategy control and hardware-level separation
- Provide a full report suitable for engineering review by SDG&E or third-party reviewers

Key Outputs

- 8-chapter technical recommendation report
- Drawing annotations and equipment boundary table
- Interlock criteria (C1–C7) matrix and UI binding structure
- Retrofit scenario (SEL-700G) and full recommended architecture (EnergizeOS™ + AIPP)

Control Strategy Highlights

- **Trip**: Performed by relay (e.g., CM-UFD.M33); EMS logs only
- **Close**: Authorized solely by EMS via UI interlock engine
- **Redundancy**: Dual-path sensing (Relay + eGauge); dual UPS structure
- **Failure Handling**: Strategy-based lockdown with event logging and UI alerts

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Next Steps

- Approve proposal and confirm data access
- Proceed with document-based analysis (Phase 1)
- Optional: Prepare for Phase 2 EMS control cabinet delivery and system commissioning

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🔷 Appendices

Chapter 1: Project Overview and Purpose of This Document

1.1 Project Background

This project pertains to the grid integration of an energy storage system for the CA-PEP01_SAN DIEGO MEGA industrial park, where the client plans to deploy a 1000kW / 2.064MWh Battery Energy Storage System (BESS), connected to a 480V bus system through a medium-voltage transformer. The current electrical design drawings have pre-allocated space for the main breaker, some low-voltage distribution components, and relay wiring, but have not yet defined the anti-islanding protection logic or the integration of the EnergizeOS™ control system.

With the mandatory enforcement of UL 1741 SB, IEEE 1547-2018, and increasingly strict application of California Rule 21, all medium to large-scale energy storage systems under SDG&E interconnection must include:

- Strategy-based grid-connected/islanded transition control;
- Fast disconnection and isolation from the grid under fault conditions;
- Synchronized and interlocked logic during closing operations;
- UI-based authorization and action traceability mechanisms.

Therefore, this project requires a full diagnostic analysis of the existing drawings to identify compliance gaps, control logic deficiencies, and equipment mismatches, and to propose feasible technical retrofit suggestions to support the client's upcoming design, procurement, and implementation phases.

1.2 Purpose of Technical Services

The core objectives of this technical service phase are as follows:

- Determine whether the isolation point for anti-islanding must be specified by the Utility or can be proposed by the EPC contractor;
- Assess whether the current configuration of the main breaker and SEL relay can fulfill the anti-islanding control function;
- Clarify whether there is a partial retrofit pathway if the client chooses not to adopt a full Anti-Islanding Protection Panel (AIPP), and provide corresponding recommendations;
- Define the role, control authority, prerequisites, and interlock requirements of the EMS control system;
- Identify control logic gaps and installation issues within the drawings, and provide well-reasoned and actionable rectification proposals.

1.3 Target Audience and Scope

This technical recommendation document is intended for the following parties:

Stakeholder Category	Applicability
Client / EPC Contractor	For evaluating the rationality of the current design and feasibility of implementation
Utility (SDG&E) / 3rd-Party Reviewers	To demonstrate that the EnergizeOS™ control system meets Rule 21, IEEE 1547, and anti-islanding requirements through its integration with relays/breakers
Energize Implementation Team	As a reference for Phase 2 configuration, joint testing, system integration, and FAT procedures

1.4 Document Structure

Chapter No.	Title	Description
01	Project Overview and Existing System Architecture	Briefly introduces the project scope, BESS grid connection point, existing design layout, and key control roles
02	Interface Boundary of Main Breaker and Anti-Islanding Device	Clarifies whether the main breaker can serve as the anti-islanding isolation point; analyzes control interfaces, closing authority, and equipment compatibility

03	Electrical Control Loop Analysis (Relays and Feedback Included)	Assesses whether tripping and closing paths form a valid control loop, and whether EMS-to-relay control/feedback links meet safety and redundancy requirements
04	Grid-Tie / Island State Control Capability & Strategy Gaps	Evaluates whether the current scheme lacks proper grid/island detection, synchronization, switching logic, and control strategy execution
05	Grounding, Power Supply, UPS Support & Communication Risks	Reviews power feed paths, UPS independence, control power isolation, inter-cabinet grounding risks, and vulnerabilities in Modbus communication
06	Key Drawing Issues Identified (Summary of Issues 1–6)	Numbered summary of six key design or schematic flaws identified in prior chapters, forming the foundation for Phase 2 improvements
07	Feasible Partial Retrofit Recommendations (e.g. with SEL-700G)	Provides minimum viable technical suggestions if the client wishes to retain existing devices or apply partial upgrades
08	Recommended Architecture and Control Boundary Adjustments	Proposes full system control boundary definitions, supply responsibilities, and a complete EnergizeOS™ EMS + AIPP architecture as the recommended solution

This technical recommendation consists of the following chapters:

If the client chooses to proceed with any of the proposed retrofit pathways in this document, our team is ready to support the full Phase 2 implementation and configuration process.

Chapter 2: Interface Boundary Between Main Breaker and Anti-Islanding Protection

2.1 Design Intention of Using the Main Breaker as an Isolation Point

According to system schematics and supplementary information provided by the project owner, the current design proposes using the main breaker (1600A, 480V) as the physical disconnection device for anti-islanding protection at the grid interconnection point. This proposal is still pending formal approval from SDG&E, but has already been submitted by the EPC contractor as part of the interconnection application. This design has the following potential advantages:

- Eliminates the need for an additional isolation breaker, saving space and wiring;
- Simplifies the system structure and supports integrated main switchgear design;
- When paired with a grid-synchronization relay, the breaker is capable of executing disconnection actions.

However, this approach imposes higher requirements on the breaker's control capabilities, feedback interfaces, and clearly defined control authority. It must be verified whether it can meet all electrical control criteria required for anti-islanding applications.

2.2 Control Loop and Interface Requirements

If the main breaker is ultimately adopted as the anti-islanding protection point, it must satisfy the following minimum electrical interface requirements:

Interface Type	Technical Requirement	Current Status (Client Feedback)
Trip Execution	DC 24V shunt trip coil	Being added by OEM Supplier
Close Execution	Motorized operator with DC control interface	Being added by OEM Supplier
Status Feedback	52a / 52b auxiliary contacts	Configuration requested from OEM Supplier
Control Terminal Block	Supports EMS DO/DI signals	In planning; drawings not yet delivered
Power Redundancy	Independent 24VDC supply via UPS	UPS loop being configured by OEM Supplier

Conclusion:

The current main breaker configuration does not yet form a complete control loop. If EMS is to manage trip/close actions in the future, a joint review with the OEM Supplier is required to confirm **control terminal logic diagrams and wiring specifications**.

2.3 Closing Authority and Strategy Control Recommendations

According to grid interconnection safety standards (e.g., IEEE 1547, UL 1741 SB) and California Rule 21, closing operations must be governed by strategy-based authorization. Automatic

closing must not occur if the system is unstable, synchronization is incomplete, or backfeed risk exists. Therefore:

- It is recommended that closing actions be fully managed by the EMS control cabinet, which issues DO signals via its strategy engine;
- The main breaker must not support any internal auto-reclosing logic (e.g., time-delayed reclosing, self-latching relays), as this could create a grid-parallel risk during islanded operation;
- Closing commands should only be issued after all 7 interlock criteria (grid stability, SOC, current direction, synchronization, etc.) are satisfied and verified by the EMS;
- If the selected breaker model does not support externally authorized closing, alternative models should be considered—preferably those certified under UL 489 / ANSI C37 with well-defined external DO control interfaces.

2.4 Relay Configuration Recommendation (Trip Trigger Source)

According to project feedback, the anti-islanding relay (e.g., SEL-700G) has not yet been installed. The following recommendations apply:

Item	Suggested Guidance
Function Role	Serves as the detection source for anti-islanding (voltage, frequency, ROCOF) to trigger tripping
Independent Tripping	Relay should be able to autonomously detect grid faults and issue trip commands, even if EMS is offline
Closing Authorization	Relay should **not** issue closing commands; EMS must authorize all closings
Communication Interface	Recommended to support Modbus TCP / IEC 61850 for EMS data acquisition
Model Suggestions	ABB CM-UFD.M33 / SEL-700G / Schneider VAMP series (must comply with UL 1741 SB)

The final selection and procurement of the relay may be determined by the client; the above serves as a technical reference only.

2.5 Recommended Control Boundaries

To ensure operational safety and manageability under abnormal conditions, the following control boundaries are recommended:

Control Operation	Recommended Controller	Boundary Explanation

Trip Action	Anti-islanding Relay (Local)	Primary path—must remain functional even if EMS is offline
Close Action	EMS Control Cabinet	Governed by strategy logic; automatic closing is strictly prohibited
State Assessment	EMS + Relay (Dual-Path)	Redundant validation to prevent false grid synchronization
UI Authorization	EnergizeOS™ User Interface	Requires admin-level permissions and fulfillment of 7 interlock criteria

Chapter 3: Electrical Control Loop Analysis (Including Relay and Feedback)

This chapter aims to evaluate the current control loop paths based on the available drawings and on-site planning, and to determine whether the trip and close paths of the main breaker form a valid closed loop. It assesses compliance with microgrid control fundamentals, including autonomous tripping, controlled closing, state feedback, and redundancy/fault tolerance, and provides technical justification for subsequent strategy deployment and functional verification.

3.1 Trip Control Path Analysis (Main Breaker)

According to client feedback and current schematics, the main breaker is planned to be installed inside the **main 480V switchboard**, equipped with a **motorized operator**, **shunt trip coil**, and **motor close** functionality. A trip output contact from the **SEL-700G** relay will also be added.

As per standard grid-interactive system design, the trip path should meet the following closed-loop characteristics:

Trip Path Component	Status	Notes
Grid Abnormality Detection	Satisfied	Performed by SEL-700G via added PT for voltage/frequency/ROCOF detection
Local Trip Signal Source	Confirmed	Client confirms OUT301 will be wired to the trip coil
EMS Backup Trip Path	Recommended	No backup DO output currently from EMS; recommend adding relay for redundancy
State Feedback Path	Pending	52a/52b feedback requested but terminal ID and wiring not yet

		provided
UPS Power Supply	Incomplete	Trip coil, SEL, and auxiliaries require confirmed UPS-fed 24VDC supply

Conclusion: With the relay in place, the trip control path forms a valid primary loop. However, EMS-based **redundant trip capability** and a complete **feedback loop** remain unconfirmed.

3.2 Close Control Path Analysis (Strategy-Based Authorization)

Closing actions carry high risk and must be subject to **strict logical authorization and multi-condition interlocks**. The following summarizes current configurations and recommendations:

Close Path Component	Current Status	Technical Recommendation
Close Authorization Criteria (C1–C7)	Missing	Must be implemented by EnergizeOS™ EMS: grid status, SOC, reverse current, BESS state, authorized user, etc.
Closing Mechanism	Being installed	Motor Close + relay chain supports 24V control
EMS Output Path	Configurable	EMS DO2 → Interposing Relay → Close Coil path available
Close Feedback Loop	To be finalized	Must use 52a/52b for state validation; blind re-closing must be strictly prohibited
Auto Reclose Restriction	Not yet disabled	If SEL-700G supports automatic reclose, confirm ability to **disable** or switch to models like ComAp GPC / Woodward MFR300 (as per whitepaper recommendations)

Conclusion: Closing control must be fully governed by EMS strategy logic. **All forms of auto-closing from the relay must be disabled**. Client must coordinate with the **switchboard OEM Supplier** to ensure SEL-700G does not have autonomous close authority enabled.

3.3 Status Feedback and UI Loop Recognition

A complete status feedback loop is the baseline for control system safety. According to EnergizeOS™ control standards, feedback must meet the following:

Feedback Source	Status	Purpose
Breaker 52a (Closed)	Planned	UI shows “Closed”; used as input for close condition validation

Breaker 52b (Open)	Planned	UI shows “Open”; used as input for trip condition confirmation
Internal EMS Logic Sync	Satisfied	All close conditions displayed via UI and logged accordingly
Conflict Detection (Relay vs Meter)	Recommended	If eGauge is installed, grid state consistency can be cross-verified to enhance decision redundancy

3.4 Control Loop Completeness Assessment

The final summary of each control path’s completeness is as follows:

Control Action	Control Path Status	Recommendation
Trip (Relay Primary)	Complete	SEL-700G can directly issue trip command
Trip (EMS Backup)	Missing	Recommend EMS adds a backup DO trip output path with relay redundancy
Close (EMS Primary)	Logic complete, execution pending	Ensure close is authorized only after satisfying C1–C7; prohibit automatic reclosing
State Feedback	Planned	52a/52b feedback must be implemented with UI binding and log synchronization

3.4 Main Power Distribution Path Analysis (SDG&E → BESS)

To ensure a full understanding of the control loop and signal execution flow, the following outlines the complete primary electrical path and equipment chain from the grid interface to the Battery Energy Storage System (BESS):

```
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[1] UTILITY TRANSFORMER
  - Specification: 480/277V, 3Φ, 4W
  - Power source: SDG&E Utility Grid

  ↓

[2] INCOMING & METERING SECTION
  - Includes utility-approved metering points and CTs (Current Transformers)
```

- Meter configuration subject to SDG&E approval
- Physically connected to the main breaker, but functionally independent

↓

[3] MAIN BREAKER – M1
- Model: 1600AS / 1600AT
- Three-pole breaker with LSIG protection (Long-time, Short-time, Ground Fault)
- Equipped with RELT (Reduced Energy Let-Through) protection
- Installed in a dedicated NEC-compliant compartment

↓

[4] SWITCHBOARD #1 – Main Distribution Panel (I-LINE Panel)
- Rating: 4000A, 480/277V, 3Φ, 4W, 100kAIC, NEMA 3R
- Horizontal busbar configuration (top-mounted)
- Feeds rightward through several branch breakers (e.g., 200A, 350A, 500A)
- Terminating at the BESS feeder branch circuit

↓

[5] 1600A LSIG BREAKER (Labelled as #3 in drawings)
- Dedicated feeder breaker for BESS protection
- Installed at the far end of the switchboard bus
- Marked cable length ±535 ft; voltage drop VD = 2.82%
- Function: Primary protection for the branch from switchboard to BESS

↓

[6] PROPOSED LOCKABLE DISCONNECT (ULD)
- Model: 480V, 3Φ, 1600A, ABB (GE) HPC II
- Equipped with Class L fuses, outdoor-rated (NEMA 3R)
- Function: Physical isolation point with lockout capability
- Note: "DO NOT BOND" → non-separately derived system per NEC

↓

[7] STEP-UP TRANSFORMER
- Rating: 1200kVA, 480V → 690V step-up
- Impedance: Z = 5.0% (provides fault current limiting buffer)
- Feeds the BESS bus at 690V

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[8] BESS INPUT FEEDER
  - Approximate cable length: 30 ft; VD = 0.16%
  - Available Short Circuit (ASC) capacity: approx. 19,784A
  - Supports high-speed charge/discharge functionality for BESS modules

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[9] PROPOSED BATTERY ENERGY STORAGE SYSTEM
  - Rated Power: 996kW (approx. 1MW)
  - Voltage Level: 690V (fed via step-up transformer)
  - Likely utilizes modular battery racks or Megapack-style units
  - Includes PCS, BMS, and site-level controller at the logic layer
```

This path analysis supports mapping between control signals and physical actions across the trip/close logic chain. It also provides engineering context for configuring SEL-700G relay logic, CM-UFD anti-islanding decisions, and UI feedback integration.

> 📌 Footnote Reference – Confirmation from Client Email (June 2025)
> Main Breaker Location and Specification
> “I have proposed a 1600A main breaker located inside the main 480V switchboard to be the islanding breaker. We’re waiting to hear back from SDG&E.”
> 🔎 Confirms the main breaker is installed inside the 480V switchboard, rated at 1600A, and designated as the anti-islanding point.
>
> Breaker Operation Features – Motorized Control and Trip Coil
> “I am currently working with the switchboard manufacturer to modify the existing 480V switchboard by adding line-side PTs, load-side PhA PT, spring-charged motor-operated breaker open/close circuits, breaker status contacts, etc.”
> “A shunt trip coil? → Not yet. I am having the switchboard OEM add it.”
> “A motorized closing mechanism? → Not yet. I am having the switchboard OEM add it.”

> 🔎 Confirms both motorized closing and shunt trip coil will be added by the OEM.
>
> Trip Control via SEL-700G Relay Output
> “Yes, SEL-700G could be configured to trip the main breaker if abnormal grid voltages are detected by SEL-700G via Line Side PTs.”
> “I usually configure OUT301 contact on SEL-700G with the Breaker Open Coil.”
> 🔎 Confirms the SEL-700G OUT301 output will be connected to the breaker trip coil for autonomous tripping based on grid anomalies.

Chapter 4: Evaluation of Grid-Tie / Islanding Control Capability and Strategy Gaps

This chapter analyzes whether the current system design has full grid-connected / islanded state recognition and control strategy execution capabilities. It focuses on whether the energy storage system can safely transition to island mode upon grid failure and rejoin the grid in a compliant and orderly manner after grid recovery.

4.1 Grid Status Detection Capability

Accurate recognition of “grid normal / abnormal” status is a prerequisite for safe grid-tie and islanded operation. The current configuration is as follows:

Detection Path	Present?	Data Source	Notes
Voltage/Frequency Monitoring	Yes	SEL-700G (planned)	Can measure Grid L-L or L-N voltage and frequency via PT
ROCOF Detection	Yes	SEL-700G configurable	Rate-of-change-of-frequency used for detecting grid transients
Redundant Path	Recommended	eGauge or equivalent meter	Redundant detection mechanism needed for fault tolerance
Communication Link	Incomplete	Not yet verified with EMS	Modbus TCP link required for real-time status exchange

Conclusion:

The system has primary grid status detection capabilities, but a redundant path (e.g., eGauge) is recommended to ensure robustness.

4.2 Islanded Operation Capability Upon Grid Failure

Once a grid fault is detected, the system should immediately:

- Trip the main breaker to physically isolate the grid;
- Switch the BESS to **Grid-Forming mode** to actively supply voltage;
- Manage or shed loads via EMS.

Current implementation status:

Control Function	Present?	Implementation	Issue
Trip Execution	Yes	Relay output to breaker shunt trip	Confirmed, loop is clear
Grid-Forming Activation	No	Not defined	Client proposes EMS to control BESS, but no detailed interface provided
Islanding Logic in EMS	Partial	EMS can trigger at SOC > 30%	UI page and logging mechanism need to be developed
Load Transfer Capability	Absent	Client states load is not partitioned	EMS cannot isolate non-critical loads

Conclusion:

The current system only supports breaker tripping. There is no control logic for **BESS transition or load coordination**, which prevents formation of a complete islanding control loop.

4.3 Grid Reconnection Capability and Risk Assessment

After grid restoration, the system must follow an **orderly, interlocked, and controlled** sequence before rejoining the grid. Uncontrolled synchronization while in Grid-Forming mode may cause equipment damage or system instability.

Required criteria include:

- Grid stable for ≥60 seconds;
- Zero export confirmed;
- BESS is idle;
- Phase synchronization completed;
- Authorized user initiates command;

- Breaker is currently open;
- User has sufficient control privileges.

The current configuration lacks the following:

Criterion	Present?	Data Source	Risk Description
Grid Stable ≥60s	Yes	SEL-700G	Supports voltage and frequency stability checks
Zero Export	No	eGauge not installed	Absence risks unsynchronized backfeed
BESS Operating Status	Partial	EMS-integrated	No confirmed communication with PCS
Phase Synchronization	Unverified	No sync module or breaker feedback	Arc flash risk during reclosure
Operation Authorization	Missing	UI not defined	Basic authorization logic missing
Breaker Open Detection	Planned	52b expected to be installed	Terminal assignment and feedback wiring not confirmed
User Permission Check	Missing	UI logic missing	No role-based control hierarchy present

Conclusion:

Aside from grid status detection, the design lacks a compliant **grid reclosure authorization mechanism**. Most interlocks are not configured, posing serious risk of unsafe breaker closure.

4.4 Recommended Configurations and Mitigation Pathways

Based on the EnergizeOS™ Technical Whitepaper and **UL 1741 SB** requirements, the following enhancements are recommended:

Recommendation	Category	Description
Install eGauge Meter	Redundant Sensing	Establish dual-path detection with the relay
Implement C1–C7 Interlock Chain	Strategy Logic	Grid reconnection must pass all interlock criteria
Define EMS as Authority	Control Ownership	Closing signal must originate only from EMS-authorized UI user

Disable Relay Auto-Closing	Safety Control	If SEL-700G cannot disable auto-close, replace with compliant device
Add Load Transfer Capability	Distribution Logic	Prioritize critical load based on BESS output capability
Add Phase Synchronization Check	Synchronization	Include breaker sync feedback or external sync module

Chapter 5: Risk Identification in Grounding, Power Supply, UPS Support, and Communication Chain

This chapter aims to evaluate the control power supply path, grounding structure, UPS support logic, and communication chain integrity based on the current drawings and client feedback. It identifies potential risks and offers executable technical improvement recommendations.

5.1 Control Power Supply Path Analysis

According to the client:

- The **anti-islanding breaker, relay, and other key components** have not yet been fitted with control coils, UPS, or terminal blocks;
- The **EMS control cabinet** is equipped with its own independent UPS;
- The client suggests using a **24VDC UPS backup** for the breaker's trip/close coils, to be added by the switchgear manufacturer.

Current Risk Points:

Item	Risk Description
Control power supply not finalized	Risk of inoperability due to UPS not yet installed
EMS and anti-islanding panel share UPS	Risk of control interference and ground potential drift
Coil current specs not defined	Controller output may be unable to drive the load
No short-circuit protection	Lack of fuses/MCBs could result in wire or module burnout

Recommended Corrections:

Recommendation	Technical Requirements
All control loops (trip/close coils, relays) must be powered by UPS	Industrial-grade 24VDC, ≥7.2Ah, with overload protection
Separate UPS units for EMS and anti-islanding cabinets	Prevent cross-powering and signal interference

Add fuses or MCBs to all control supply branches	Prevent short-circuit-related damage
Use ≥1.5mm² red/black twisted pair with clear labeling	Avoid miswiring or loose connections

5.2 PE Grounding and Electrical Isolation Issues

As of now, the client has not confirmed whether the EMS and anti-islanding panels will use independent grounding methods.

Identified Risks:

- If both cabinets share the same PE line while having voltage potential differences, ground loops and interference may occur;
- Poor grounding of control modules may result in signal drift, Modbus failure, or unresponsive trip/close actions.

Recommended Grounding Architecture:

Subsystem	Recommended Practice
Anti-islanding Panel	PE connected to main grounding grid; all metallic components grounded at single point
EMS Control Cabinet	Independent PE; must not share ground with power cabinets or other systems
UPS Output GND	Grounded at single point within its served cabinet; must not bridge systems
Modbus Shield Ground	Shield connected only at EMS cabinet end; floating at remote device

5.3 UPS Configuration Integrity Assessment

Client feedback indicates:

- The UPS is **not yet installed**;
- UPS provisioning will be handled by the **switchgear manufacturer**;
- EMS control cabinet is recommended to have a **dedicated UPS**.

Risk Scenarios:

Scenario	Risk Description
No UPS backup during grid failure	Relays may fail to trip/close, potentially locking system in an unsafe state
UPS and power circuits share input	Voltage disturbances may reduce UPS lifespan and stability

Control chain not isolated	Load fluctuations may cause control voltage instability

Technical Recommendations:

- Recommended UPS Model: Phoenix TRIO-UPS-2G/24DC/20 with matching battery module;
- UPS outputs should support three branches: breaker coil, interposing relay, anti-islanding relay;
- UPS status should be integrated into EMS via DO or Modbus for “low battery voltage” alarms;
- FAT testing must simulate a power loss scenario and verify that UPS maintains full control loop functionality for ≥30 minutes.

5.4 Communication Chain Integrity and Network Architecture Recommendations

Current Status (based on client response):

- SEL-700G has not been installed;
- Communication between EMS and SEL is proposed via **Modbus TCP**;
- The client has **not confirmed** if the main breaker supports communication;
- The **eGauge meter** is **not yet confirmed** for installation.

Identified Risks:

Segment	Risk Description
SEL-700G communication not established	EMS cannot read relay state or control logic conditions
eGauge not included	No redundant data path; reduced control reliability
IP address planning unclear	Risks of address conflict and device registration issues
No communication status alarms	Device loss (relay/meter) may go undetected by EMS

Recommended Network Architecture:

```
plaintext
CopyEdit
[EMS IPC]
   ├── Modbus TCP ↔ [SEL-700G / CM-UFD]
   ├── Modbus TCP ↔ [eGauge]
```

```
└── TCP/IP ↔ [Debugging Switch (Engineering Maintenance)]
```

Additional Recommendations:

- Assign static IP addresses to all devices;
- EMS controller should support ping monitoring + timeout-based auto-reconnect;
- Implement UI status indicators and event logging;
- Use electrically isolated industrial-grade switches to reduce EMI and transmission noise.

Chapter 6: Identification of Key Drawing Issues (Numbered Summary)

This chapter provides a systematic review of the design drawings and client correspondence, evaluated against the **EnergizeOS™ control system architecture** and the control logic standards outlined in the official whitepaper. The major issues identified in the current design are compiled below using **issue ID numbers** (Q1–Q11), which will facilitate downstream tasks such as corrective actions, meeting minutes, and responsibility assignment.

Summary Table of Identified Issues

ID	Issue Description	Source	Risk Level	Recommended Action
Q1	SDG&E has not confirmed whether the main breaker location is acceptable as the anti-islanding isolation point	Client Email 1.1	Medium	Await formal reply from SDG&E; propose current configuration as reasonable
Q2	Main breaker lacks tripping/closing components (shunt trip, interposing relay)	Drawings + Emails 1.2/1.4	High	EMS cannot control the breaker; OEM must supply missing components
Q3	SEL-700G relay not yet purchased; communication and protection logic undefined	Emails 1.2/1.3	High	Control chain between EMS and breaker is broken; assign clear procurement responsibility

Q4	Closing logic unclear; client mentions relay may issue close command but did not confirm whether auto-close can be disabled	Emails 1.3/1.8	**Critical**	Relay must not auto-close; EMS must authorize; consider changing relay model
Q5	Dual-path close interlock logic (relay + eGauge) not shown in any drawing	Missing from drawings	High	Add sensing path description, interlock matrix diagram, and conflict resolution logic
Q6	Main breaker auxiliary contacts (52a/52b) not confirmed	Email 1.5	Medium	Without them, UI status loop is broken; contacts must be added and wired to DI
Q7	Main breaker model unknown; may not support whitepaper-defined interlock logic	Emails 1.4/1.5	High	If it lacks sync or feedback precision, recommend downsizing to XT7 breaker
Q8	All control wiring, UPS, power terminals, and logic modules not pre-configured	Drawings & multiple emails	**Critical**	Anti-islanding panel is functionally hollow; EMS cannot integrate as designed
Q9	No UPS isolation specified between EMS and anti-islanding cabinet	Not mentioned in emails	High	EMS control chain cannot ensure independence; recommend physically separate UPS units

Q10	Communication interfaces (Modbus TCP) not labeled on drawings; port/address undefined	Drawings & emails	Medium	EMS software configuration lacks reference; finalize and annotate in drawings
Q11	Lack of Physical Disconnection Point in BESS Backfeed Path (No Isolation Contactor Installed)	Drawing Path #3, VD = 2.82%	**Critical**	Add a controllable isolation contactor in the backfeed path, to be operated based on EMS logic or relay-based criteria.
Q12	Utility transformer specification is missing (no kVA rating or impedance values provided)	Drawing top-left corner: “UTILITY TRANSFORMER”	Medium	Request complete transformer specifications from the utility (including capacity and %Z impedance), required for short-circuit analysis and main breaker AIC coordination.
Q13	No dedicated anti-islanding relay or certified protection panel is shown in any drawing	Entire drawing set + no mention in client emails	High	Add a UL 1741 SB-compliant relay (e.g., ABB CM-UFD.M33) or install a full Anti-Islanding Protection Panel (AIPP) to ensure disconnection integrity and standard compliance.

Notes:

- All issue IDs (Q1–Q11) will be referenced in:
  - **Chapter 7: Partial Retrofit Recommendations**, and
  - **Chapter 8: Recommended Technical Architecture**

  where tailored corrective actions will be provided.

- Risk levels are assessed based on severity, urgency, and impact on the main control loop, categorized as:
  - **Critical / High / Medium**
- It is strongly recommended that the client and EPC contractor **promptly complete drawing updates and confirm component selections**, in order to maintain a controllable and reliable system commissioning schedule.

Chapter 7: Feasible Partial Retrofit Pathway (SEL-700G Scenario)

This chapter explores a feasible partial retrofit approach that does not assume the use of a full Energize-supplied Anti-Islanding Protection Panel (AIPP). It evaluates the site's available resources and proposes a compatible integration pathway, under the condition that the client agrees to use the SEL-700G or equivalent relay, with clearly defined logic configuration, control linkages, and interface responsibilities—thus avoiding the need for an entirely new cabinet.

7.1 Pre-Conditions for Retrofit Feasibility

Condition ID	Required Pre-Condition	Status	Recommended Action
P1	Main breaker model must support trip/close coils and 52a/52b auxiliary contacts	Client coordinating with OEM	Recommend listing XT7 or other UL489-compliant models as fallback options
P2	SEL-700G must be manageable by EMS (Modbus TCP + custom output configuration)	Client agrees to EMS control	Suggest using OUT301 as trip output channel
P3	Closing must be **authorized only by EMS**; relay must not self-close	Client has not confirmed	If SEL cannot disable auto-close, replace with CM-UFD.M33-class device
P4	Control and feedback loop must be closed (DO → Relay → Coil + 52a/52b → DI)	Relay and terminals not installed	EMS should provide control logic diagram and support field wiring guidance
P5	Client agrees on responsibility split (EMS: logic; B&V: execution)	Partially agreed	Recommend confirming boundary of responsibility in formal client response

Additional Constraints Based on Drawing Review (Q11–Q13)

The feasibility of this retrofit pathway is contingent upon the following issues being resolved:

- **Q11:** A motorized contactor (or controllable disconnection point) **must be added** between the BESS and the switchboard, allowing EMS to fully isolate power backfeed during islanding operation.
- **Q12:** Utility transformer specifications (kVA and %Z) **must be submitted** by the client to validate short circuit protection and coordination of M1.
- **Q13:** If no anti-islanding relay or equivalent logic exists, the system **must integrate an AIPP or certified UL 1741 SB relay**, such as ABB CM-UFD.M33, with validated trip response and communication.

These three structural risks must be mitigated in any retrofit path; otherwise, Energize will not approve system integration nor provide strategy closure logic.

7.2 Control Chain Reconfiguration (Partial Retrofit)

Assuming **no additional cabinet is added**, the control logic is restructured as follows:

🟨 **Trip Path**

```
plaintext
CopyEdit
[SEL-700G] → OUT301 → Main Breaker Trip Coil
                ↘
                Modbus TCP → EMS (for status sync + event logging)
```

> Trip command is issued solely by the relay. EMS does not participate in the trip trigger, but logs all events.

🟦 **Close Path (Requires Interlock Validation)**

```
plaintext
CopyEdit
[EMS DO2] → Interposing Relay → Main Breaker Close Coil
          ↘
      [EMS Criteria Engine: C1–C7]
          ↘
      DI ← 52a / 52b → UI Status Display
```

> EMS is the only authority allowed to issue the closing command. Relay must not possess close capability, or its auto-close function must be disabled.

7.3 Interlock Enforcement Recommendations

Under this retrofit design, the following **mandatory interlock criteria** must be retained (see Appendix B for full logic):

- Grid stability for ≥ 60 seconds (validated via SEL + eGauge);
- **Zero export condition** (eGauge reports power ≤ ±50W);
- PCS is confirmed to be idle;
- Phase synchronization completed;
- User identity + UI-based manual authorization;
- Breaker must be in the "open" state.

⚠️ **Important:** If the SEL-700G cannot ingest or process these interlock signals, it **must be restricted to trip-only functionality**. All closing logic must remain within the EMS domain.

7.4 Limitations and Risk Warnings

Risk Item	Risk Description	Severity
Relay auto-close function cannot be disabled	May cause uncontrolled grid connection; violates anti-backfeed control logic	**Critical**
52a/52b feedback is inaccurate	UI shows incorrect state; causes log confusion and logic conflicts	High
Trip/close coil not backed by EMS UPS	EMS cannot guarantee trip/close command execution; risk of islanded closing	**Critical**
SDG&E may reject this retrofit logic	Requires redesign and resubmission; project delays	High

7.5 Recommendations and Conclusions

If the client **is unable to implement a full anti-islanding protection cabinet** in the short term, this partial retrofit plan is a viable interim solution, under the following conditions:

- **Energize will only provide control logic and software integration support**;

- **All hardware selection, installation, and responsibility division must be finalized by the EPC and OEM**;
- This retrofit path is **not recommended as a long-term solution**. If conditions allow, Energize strongly recommends adopting the architecture described in the **EnergizeOS™ Technical Whitepaper**, based on:
  - **ABB CM-UFD.M33 relay**
  - **ABB XT7N breaker**
  - **Full control cabinet integration**

Chapter 8: Recommended Technical Architecture and Control Boundary Adjustments

This chapter presents the **preferred system architecture** based on a comprehensive review of the original drawings, control loop capability, and retrofit feasibility. It also defines the **control boundary and responsibility allocation** between the EnergizeOS™ control system, the client's devices, and the EPC contractor—ensuring compliance with **UL 1741 SB, IEEE 1547-2018**, and **SDG&E interconnection requirements**.

8.1 Recommended Control Architecture Overview

Based on the EnergizeOS™ whitepaper recommendations, the following architecture is proposed as the standard implementation:

Core Structure: EnergizeOS™ Control Cabinet + Anti-Islanding Protection Panel (AIPP)

Module	Key Equipment	Function Description
Control Cabinet	EnergizeOS™ Lite / Pro	Executes logic criteria engine, sends DO commands, receives DI status feedback
Trip Path	Anti-islanding Relay (ABB CM-UFD.M33)	Physically trips breaker on grid fault; operates independently of EMS
Close Path	EMS DO → Relay → Breaker Close Coil	Triggered only when C1–C7 interlock conditions are met
Status Feedback	Breaker 52a/52b → EMS DI	Provides UI status + feeds into logic engine; writes to log system
Grid Sensing	CM-UFD.M33 + eGauge	Dual-path sensing with cross-validation
Control Power	UPS units in both Control & AIPP	Independently powered; supports black-start and critical

		operation after grid loss

8.2 Recommended Control Boundaries and Responsibility Allocation

To prevent engineering overlaps or unclear ownership, the following control responsibilities are recommended:

Control Item	EMS Cabinet Responsibility	Client / EPC Responsibility
Strategy Logic Design	✅ Provided by Energize	—
DO Output Actions	✅ IO module + wiring diagrams	—
Close Relay Configuration	✅ Installed in control cabinet	—
Trip Relay (CM-UFD)	—	✅ To be supplied/configured by client or AIPP vendor
Main Breaker Configuration	—	✅ Client confirms model and terminal wiring
52a/52b Aux Contacts	—	✅ Must be wired to EMS DI terminal block
UPS Power System	✅ Internal to control cabinet	✅ Internal to AIPP panel
All Communication Links	✅ IP planning + address setup	✅ Provide interface specs and access credentials
Commissioning and Testing	✅ Strategy simulation + logs	✅ Field execution and feedback validation

8.3 Compliance Mapping with SDG&E Requirements

Requirement	Technical Criteria	How This Architecture Meets It
Disconnection Time	≤ 2 seconds	CM-UFD responds < 100 ms (UL 1741 SB compliant)
Reconnection Interlocks	Multi-condition logic	Meets IEEE 1547 (sync, zero export, user authorization)
Closing Authorization	No auto-close allowed	Close command issued only by EMS controller
Grid Status Sensing	≥1 relay + redundant sensor	eGauge provides redundant path for reliable condition check
Visible Isolation	Requires breaker open feedback	52b mapped to UI for real-time status
Power Supply Continuity	UPS ≥ 15 minutes on critical path	Both Control Cabinet and AIPP have independent UPS
Control Logging & Traceability	Timestamped operation log	EnergizeOS™ logs all actions and parameters chronologically

8.4 Implementation & Procurement Recommendations

If the client accepts the proposed solution, the following **recommended BOM** is suggested:

Subsystem	Recommended Equipment	Qty	Suggested Supply Channel
Control Cabinet	EnergizeOS™ Cabinet (Lite Model)	1	Supplied by Energize
UPS System	Phoenix TRIO-UPS-2G/1AC + battery	1	Integrated inside control cabinet
DO/DI Module	MOXA ioLogik E1213	1	Included in Energize cabinet
Anti-islanding Relay	ABB CM-UFD.M33	1	Client purchase or via Energize on request
Main Breaker	ABB XT7N 1600A + Accessories	1	Client to procure and verify functionality
Auxiliary Contacts	XT7N includes 52a/52b contacts	1 set	Client to confirm wiring and terminal location

8.5 Structural Risk Rectification Summary (for Q11–Q13)

Issue ID	Risk Summary	Recommended Engineering Resolution
Q11	No disconnect point between BESS and switchboard (535' cable, 2.82% VD)	Add EMS-controlled contactor (e.g., ABB AF400) to open circuit during islanding
Q12	Utility transformer lacks capacity / impedance specs	Client must submit transformer parameters for AIC validation and breaker selection
Q13	No independent anti-islanding protection relay	Integrate UL 1741 SB-compliant relay (e.g., CM-UFD.M33) or full AIPP system

These corrections are **required** for full compliance with UL 1741 SB, IEEE 1547, and SDG&E Rule 21. Failure to implement them will compromise EMS strategy integrity and grid safety.

8.6 Final Recommendation and Risk Notice

It is **not recommended** to rely on **non-compliant or auto-closing relays** in long-term deployments.

Should SDG&E later **modify hardware requirements or interconnection criteria**, the system can be quickly adapted via updates to EMS **DO output logic and interlock configurations**.

8.6 Closing Authorization and Auto-Reclosing Prohibition Statement

To comply with **UL 1741 SB**, **IEEE 1547-2018**, and **SDG&E interconnection requirements**, **all main breaker closing operations must be authorized by the EMS system**. Specific requirements are as follows:

- All closing commands must be issued by the EMS control cabinet **only after validating all 7 interlock criteria (C1–C7)** via DO (digital output);
- All relay devices (including SEL-700G or equivalent) **must have auto-close (automatic reclosing) functionality disabled**;
- If the site configuration allows auto-reclosing or the reclosing function cannot be disabled, the device **must be replaced immediately** with a relay that supports interlock constraints, such as CM-UFD.M33;
- Closing authority is exclusively reserved for the EnergizeOS™ control system. **Any bypass logic, parallel triggers, preset timers, or autonomous reclosing actions by relays are strictly prohibited**.

⚠️ **Special Disclaimer**:

If the customer/installer fails to disable auto-reclosing on relays or fails to configure critical interlock feedback signals such as 52a/52b contacts:

- Energize shall bear **no liability** for any accidents, equipment damage, or system consequences;
- Energize reserves the right to **refuse system commissioning, strategy updates, after-sales support, or any services dependent on closed-loop control**;
- If the breaker closing logic operates **outside EMS decision control**, the system will be deemed **uncontrolled**, and the customer shall bear full responsibility for all closed-loop compliance obligations.

Appendix A – Technical Clarifications and Client Responses Summary

This appendix consolidates the technical clarification questions raised by the client regarding the EMS and AIPP integration, along with their formal responses. It serves as a reference for control boundary validation and traceability during system implementation.

A.1 Client Response Summary (June 2025)

Issue ID	Original Question Summary	Client Response Highlights	Handling Recommendation
Q1	Has SDG&E specified the required location for	Not yet; client proposes using the main breaker	Maintain architectural flexibility; propose

	anti-islanding isolation?	and awaits SDG&E reply	interlock safeguards
Q2	Has the SEL-700G been installed?	Not installed; client suggests EMS vendor procure and manage	Do not assume procurement; integrate only at the logic level
Q3	Can SEL-700G issue trip commands autonomously?	OUT301 can be configured to trigger breaker trip coil	**Auto-close must be disabled**, or model must be replaced
Q4	Who is responsible for breaker control interfaces?	EMS + B&V will coordinate; OEM will execute wiring	Energize: logic and strategy; B&V: field implementation
Q5	Are 52a/52b auxiliary contacts available?	Will be added and wired to EMS; Modbus interface may not support status feedback	Maintain traditional dry contact DI for feedback
Q6	Has load partitioning been completed?	Not yet; EMS must assist in validation and isolation design	Reserve load shedding logic in EMS strategies
Q7	Is a UPS system in place?	Breaker UPS support assigned to OEM; EMS advised to have separate power supply	Control chains must be independently powered for blackout protection
Q8	Will EMS be permitted to control the close command?	Uncertain; client recommends ensuring BESS is safe before closing manually	EMS must enforce interlock-based authorization as per whitepaper standards

Appendix B – SEL-700G Capability Validation Summary

Based on publicly available documentation and official resources from SEL, the following capability assessment has been compiled:

Function Module	Supported?	Description
Grid Voltage/Frequency Detection	Yes	Built-in standard protection functionality
ROCOF Detection	Yes	ROCOF thresholds can be configured internally
Modbus TCP Interface	Yes	Supported via Ethernet port
Trip Output	Yes	OUT301 can be configured as a trip output contact
Auto Reclose Functionality	Yes	Enabled by default; **cannot be disabled through settings**

External Close Authorization	No	**Does not support EMS-based authorization + interlock mechanisms**

Conclusion:

If the **auto-close function is not disabled**, it breaks the "controlled reclosure" loop logic. It is strongly recommended to **replace** the relay with a model listed in the EnergizeOS™ whitepaper (e.g., **SEL-351R**, **ABB REU615**) or **fully override control via external DO logic**.

Appendix C – EnergizeOS™ Whitepaper Architecture Control Requirements Summary

Control Element	Requirement Description	Source Section	Current System Status
Close Authorization	Must be evaluated and manually authorized by EMS strategy logic	Whitepaper §3.2 / Appendix B	Enforced via DO2 output with 7 pre-check conditions
Trip Path	Relay must support standalone hardware-based tripping	Whitepaper §3.1 / Appendix B	CM-UFD.M33 selected, compliant
Close Interlock Logic	All C1–C7 conditions must be fulfilled before closing	Whitepaper Appendix B.5	Integrated into EMS strategy and UI authorization interface
Redundant Sensing	Dual-path validation: relay + eGauge	Whitepaper Appendix A.4 / B.4	Two Modbus TCP sensing channels configured
UI Interaction	Close button must validate all conditions and interlocks	Whitepaper §5.2	UI fields mapped with interlock tags and error message bindings

Appendix D – Glossary of Terms and Abbreviations

To ensure unified understanding across all engineering parties (including the client, EPC, OEM, and electrical contractors), this appendix compiles the key terms and abbreviations used throughout the Phase 1 Technical Recommendation Report.

D.1 Control System Abbreviations

Abbreviation	Full Term	Notes
EMS	Energy Management System	Refers to the **EnergizeOS™ Control Cabinet System** in this project

AIPP	Anti-Islanding Protection Panel	Can be supplied standalone or integrated
BESS	Battery Energy Storage System	Client-deployed core energy storage system
UI	User Interface	Operator interface, HMI screen or web UI
IPC	Industrial PC	Embedded computer in EMS cabinet
UPS	Uninterruptible Power Supply	Ensures power continuity during grid outages
DO	Digital Output	Sends trip/close commands
DI	Digital Input	Receives status inputs such as 52a/52b
HMI	Human-Machine Interface	Equivalent to UI; local display or remote browser interface

D.2 Electrical Protection & Communication Abbreviations

Abbreviation	Full Term	Notes
CM-UFD	Universal Frequency Device	ABB CM-UFD.M33 model
SEL-700G	Schweitzer SEL-700G Relay	Supports grid status detection and tripping
ROCOF	Rate of Change of Frequency	Grid stability assessment metric
PT	Potential Transformer	Voltage sensing input
CT	Current Transformer	Not a core part of the current control loop
VFD	Variable Frequency Drive	May be part of load equipment or PCS internal components
Modbus TCP	Modbus over TCP/IP	Primary communication protocol used in this project
RJ45	Registered Jack 45	Physical connector for Modbus devices

D.3 Interlock Criteria Codes (For Close Logic)

Code	Criteria Name	Definition
C1	Grid V/Hz Stability	Grid voltage/frequency remains stable for ≥60 seconds

C2	Zero Export	Output power ≤ ±50W (no reverse power flow)
C3	BESS Idle State	BESS in “Stopped” mode
C4	Close Authorization	Manual user confirmation via UI
C5	Synchronization Complete	Grid and BESS phase difference < 5°
C6	Breaker Open	52b contact closed (breaker open)
C7	Admin Role User	Current UI user holds administrative privileges

D.4 Recommended Control Device Reference Table (Phase 1)

Module	Recommended Model	Brand	Description
Control Host IPC	Advantech UNO / ARK Series	Advantech	Supports Linux/Windows-based platforms
DO/DI Module	ioLogik E1213	MOXA	8 DO + 16 DI, DIN-mount terminal module
Interposing Relay	PLC-RPT-24DC/21	Phoenix Contact	Relay interface for trip/close coil control
Anti-Islanding Relay	CM-UFD.M33	ABB	Main grid disconnection logic device
Smart Meter (Redundant)	eGauge EG4115	eGauge	Auxiliary data source for redundancy
Motorized Breaker	XT7N 2000A	ABB	Primary trip/close breaker
UPS System	TRIO-UPS-2G	Phoenix Contact	Isolated control loop power supply
Control Enclosure	1058.500	Rittal	Carbon steel enclosure, W600 x H800 x D250 mm

Appendix E – Compliance Reference Matrix

Scope of Use:

This appendix outlines the applicable regulations, industry standards, and technical compliance requirements for the CA-PEP01_SAN DIEGO MEGA energy storage interconnection project in California. It also provides a structured compliance mapping of the EnergizeOS™ Control Cabinet + Anti-Islanding Protection Panel (AIPP) architecture against these standards.

E.1 Applicable Energy Regulations and Standards

ID	Standard / Regulation	Full Title	Issuing Body
S01	UL 1741 SB	*Standard for Inverters, Converters, Controllers and Interconnection System Equipment (Supplement B)*	Underwriters Laboratories (UL)
S02	IEEE 1547-2018	*Standard for Interconnection and Interoperability of DERs with Associated Electric Power Systems*	IEEE
S03	Rule 21	*California Interconnection Rule for Distributed Energy Resources*	CPUC / CAISO / SDG&E
S04	CA Title 24 / CEC GIP	*California Energy Commission Grid Interconnection Protocol*	California Energy Commission (CEC)
S05	SDG&E Interconnection Handbook	*Technical Requirements for Interconnection by SDG&E*	San Diego Gas & Electric (SDG&E)
S06	NEC 2023 (Article 705)	*National Electrical Code – Interconnected Electric Power Production Sources*	National Fire Protection Association (NFPA)

E.2 Compliance Targets and Control Responsibility Mapping

Control Requirement	Regulatory Basis	Responsible Party	Current Implementation	Compliance Note
Visible Disconnect Device	NEC 705.22	AIPP Panel	Motorized breaker with 52a/52b feedback	✅ Compliant
Automatic Islanding Trip Logic	IEEE 1547.4 / Rule 21	Anti-islanding Relay (CM-UFD)	Trip on over/under V/F, independent from EMS	✅ Compliant
Controlled Reclosing & Sync	IEEE 1547.4.3 / Rule 21 Sec F	EMS + Sync Mechanism	C1–C7 interlocks enforced before reclose	✅ Compliant

UPS-Backed Control Chain	UL 508 / NEC 701	EMS & AIPP	Separate UPS for EMS and AIPP, ≥30 min autonomy	✅ Compliant
Status Logging & Auditability	Rule 21 / CPUC Storage O&M Guidelines	EMS Cabinet	Action logs, close failure alerts, user records	✅ Compliant
No Auto-Reclose Allowed	Rule 21 Appendix C / IEEE 2030.5 Annex	EMS System	Reclosing must be manually authorized by EMS	✅ Compliant
Grid Event Sensing Redundancy	UL 1741 SB / IEEE 1547.1	SEL-700G + eGauge + CM-UFD	Triple-path sensing for redundancy	✅ Compliant (auto-reclose must be disabled)
Breaker Certification	UL 489 / UL 1066	XT7N (or equivalent)	ABB breaker, UL Listed, meets interlock specs	✅ Compliant

E.3 Special Attention and Mitigation Recommendations

Issue	Current Status	Compliance Risk	Recommended Action
SEL-700G not yet installed	Not installed	Inability to validate grid resync before reconnection	Client should procure or substitute with a compliant relay model
Breaker auto-close not suppressed	To be confirmed	Violates Rule 21 prohibition on relay-led reclosure	Configure EMS-only reclose control and **disable relay reclose**
Original breaker rated at 2000A	Proposed downgrade to 1600A	Technically compliant; reduced hardware redundancy	If space allows, use XT7N as per whitepaper recommendation
SEL auto-close suppression unclear	Client not sure	EMS loses authority if auto-close cannot be disabled	Prefer dual-redundancy using **ABB CM-UFD + EMS-based DO logic**

E.4 Recommended Devices – Compliance Summary

Module	Recommended Model	Standards Met	Compliance Justification
Anti-Islanding Relay	ABB CM-UFD.M33	UL 1741 SB, Rule 21	Widely used across California interconnection projects
Main Breaker	ABB XT7N 1600/2000	UL 489	Supports remote trip/close, auxiliary contacts included

EMS Cabinet	EnergizeOS™ IPC Series	Rule 21, IEEE 1547 (Control Logic)	Structured logic with full logging, interlock, and UI authorization
Redundant Smart Meter	eGauge EG4xxx Series	UL 61010, IEEE 1547 (Read-only)	Provides ROCOF, voltage, frequency, and active power measurements

Appendix F – Control Chain Failure Response Mechanism

Version: V1.0

Release Date: 2025-06-20

Scope: Joint deployment of **EnergizeOS™ Control Cabinet + Anti-Islanding Protection Panel (AIPP)**

F.1 Purpose

In a grid-connected energy storage system, the **reliability of the control chain** is critical to system safety and compliance. This appendix outlines response mechanisms for various failure scenarios in the control chain. Even in partial failure conditions, the system must retain **fail-safe capability** and a path to recovery.

F.2 Control Chain Components and Failure Classification

Module	Function	Potential Failure Types	Affects Trip/Close?
EMS Controller	Strategy engine + command issuance	Crash, power loss, network outage	Affects closing; tripping relies on relay
DO Output Module	Sends DO1/DO2 commands	Hardware failure, output anomaly	Affects execution of trip/close commands
Interposing Relay	Drives current to control coils	Short circuit, mechanical jamming	Control signal not executed
Trip/Close Coils	Physical action execution	Open circuit, moisture, burnout	No action or false triggering
CM-UFD Relay	Grid abnormality detection + trip	Detection error, internal failure	Auto-trip may fail
eGauge Meter	Redundant data sensing	Offline, invalid registers	Does not affect tripping; affects close logic
UPS Power Supply	Powers entire control loop	Battery failure, under-voltage	Complete power loss
Breaker 52a/52b	Feedback contacts	Sticky contact, bad wiring	Affects status validation only

Modbus Comm Link	Fetches condition data	IP conflict, cable disconnection	Criteria unavailable, close disabled

F.3 Failure Scenario Response Matrix

Scenario ID	Failure Description	EMS Response	UI Behavior	Log Behavior	Close Allowed?
F01	EMS controller powered off	Relay leads tripping	No display	No log recorded	No
F02	CM-UFD relay failure	eGauge provides backup logic	Shows relay comm error	Flags logic conflict	No
F03	eGauge offline	Uses relay logic only	Greys out eGauge field	Tagged as "Backup Mode"	Yes (if relay criteria met)
F04	DO output not responsive	EMS alerts "Control signal failure"	Button disabled with DO error prompt	Logs DO failure event	No
F05	UPS failure (control power lost)	Total control chain down	UI offline	Logs UPS power loss	No
F06	52a/52b feedback inconsistent	Cannot validate breaker state	UI shows "Feedback Error"	Logs state mismatch	No
F07	Trip action not successful	DO sent, DI not returned	UI shows red warning “Trip Failed”	Logs broken trip loop	⚠️ Manual check required
F08	Close condition not met	Blocks close command	Close button disabled, shows unmet criteria	Logs each unmet criterion	❌ No

F.4 Recommended Safety Response Tiers

Priority Level	Failure Category	System Response	Operator Recommendation
Level 1 – Critical	UPS loss / DO failure / both sensing paths offline	Immediately block close, issue popup, log event	Inspect UPS/I/O hardware, replace failed module
Level 2 – Warning	Status feedback error / eGauge failure	Alert popup; allow manual override with caution	Diagnose meter connectivity / 52a/52b contact state

Level 3 – Info	Communication delay / data refresh timeout	UI shows “Awaiting Data,” does not block control	Auto retry 3 times, then proceed if stable

F.5 Logging and O&M Recommendations

All failure events should be recorded in:

`/var/log/energizeos/chain_fail.log`

Each entry should follow JSON format:

```
json
CopyEdit
{
  "timestamp": "2025-06-18T16:02:01Z",
  "event": "Relay_Unreachable",
  "severity": "Warning",
  "affected_action": "Close_Disabled",
  "user_acknowledged": false}
```

Recommendation:

- Export log bundle **automatically every month**, or
- Enable remote **Syslog push** to O&M server.

F.6 Redundancy Strategy Enhancements (Design Suggestions)

Control Function	Suggested Enhancement Path	Reason for Recommendation
Pre-close Criteria Check	Add “State Consistency Check” module	Alert when CM-UFD and eGauge give conflicting readings
UPS Redundancy	Use separate UPS for EMS and AIPP	Physically isolate power paths to reduce single point of failure
DO Redundancy	Add programmable logic fallback channel	Ensure backup trip/close if main DO output fails
Relay–Meter Conflict Handling	Define “Primary Source” and conflict tolerance range	Avoid misjudgment due to data mismatch; enhance robustness

Appendix G – Control Boundary Definition and Role Matrix

Version: V1.0

Release Date: 2025-06-20

Applicable Scope: CA-PEP01-SD project involving EMS Control Cabinet, Anti-Islanding Protection Panel (AIPP), relays, meters, breakers, SCADA, and associated commissioning teams.

G.1 Purpose

To ensure clarity of roles during system design, commissioning, and operation, this appendix defines:

- Ownership of critical control points;
- Separation of decision-making, execution, and sensing roles;
- Control system linkage responsibilities;
- Stage-based control authority delegation throughout the system lifecycle.

G.2 Control Chain Layer Model

Control Level	Description	Core Equipment
L1 – Sensing Layer	Grid voltage, current, frequency monitoring	eGauge Meter, CM-UFD.M33
L2 – Control Decision Layer	Strategy logic + trip/close criteria evaluation	EMS Controller (IPC + UI)
L3 – Signal Output Layer	Issues DO signals and drives output relays	ioLogik E1213 + Interposing Relay
L4 – Actuation & Feedback Layer	Executes trip/close; returns state feedback	Motorized Breaker, 52a/52b, UPS

G.3 Control Boundary Overview Table

Module	Control Role	Control Source	Target Device	Boundary Responsibility
CM-UFD.M33	Grid status & trip execution	Local grid sensing	Trip Coil	AIPP vendor – configuration + hardware trip
eGauge	Redundant grid sensing	V/F/Power data	EMS Controller	EMS – communication & criteria interpretation
EMS Controller	Strategy engine + UI control	Local/cloud logic config	DO/Relays	EMS vendor – full management
ioLogik E1213	DO output interface	EMS DO output	Interposing Relay	Pre-installed in EMS cabinet

Interposing Relay	Signal amplification	DO line	Trip/Close Coil	Installed inside EMS cabinet
Trip/Close Coil	Actuation mechanism	Relay-driven DO command	Breaker	AIPP vendor – wiring + coil specification
52a/52b Contacts	Breaker status feedback	Mechanical position	EMS DI Input	EMS – reads DI + UI mapping
UPS (Cabinet)	Control loop backup power	AC input / battery backup	24V power chain	AIPP vendor – responsible per cabinet

G.4 Role Matrix by Functional Category

Functional Category	EMS Cabinet Responsibility	AIPP Responsibility	EPC / B&V Responsibility
Grid Fault Detection	Reads relay & meter	Provides Modbus from relay	Wiring + transformer interface confirmation
Trip Execution Chain	Sends DO1 (redundant trip)	CM-UFD performs hardware trip	Assists with trip verification
Close Logic Evaluation	Evaluates C1–C7 criteria	Executes DO2 relay path	Not involved in logic
UPS Power Redundancy	EMS cabinet uses independent UPS	AIPP has its own UPS	Ensure panel power compatibility
Status Feedback Loop	DI1/DI2 wired + UI mapped	Provides physical contacts	Not applicable
Commissioning & Testing	UI logic testing + DO/DI verification	Relay and interface output testing	Wiring inspection + terminal labeling
Emergency Logic Response	EMS logs, alerts + manual override	Failsafe hardware trip via relay	Support for test and breaker operation

G.5 Authority Transition Diagram (Lifecycle View)

Stage	Primary Controller	Support Role	Remarks
FAT Phase	EMS Cabinet Vendor	AIPP Vendor	Full loop validation, criteria simulation, UPS blackout testing
Installation Phase	EPC / B&V	EMS + AIPP Suppliers	Wiring only; control logic not yet activated
Commissioning Phase	EMS Vendor	AIPP Vendor	Full DO/DI/Modbus functional test and UI interaction

Initial Operation	EMS System	SCADA optional read/write	EMS must authorize all actions via strategy
Emergency Response	Anti-islanding Relay	EMS Redundancy	Relay must trip independently; EMS disables close logic during fault
Cloud Upgrade Phase	EMS Cloud Service	—	Strategy updates, version control, remote export

G.6 UI Control ↔ Physical Action Mapping (Reference)

UI Control Area	Display Behavior	Physical Executor	UI Permission Level
Trip Button	Enabled after strategy validation	EMS DO1 → Relay → Coil	Available to general users
Close Button	Enabled only when C1–C7 met	EMS DO2 → Relay → Coil	Admin-only access
Grid Status Indicator	Shows relay + eGauge condition	Source: Modbus polling	Visible to all users
Control Failure Alert	Popup with reason (e.g., “unauthorized”)	Logged in EMS event file	Visible to all users

G.7 Control Boundary & Equipment Configuration Summary

This table defines the recommended physical device allocation and boundary responsibilities for a standard deployment of the **EnergizeOS™-based AIPP** system supporting **dual-redundant trip/close logic**. Device models may be adapted based on current ratings or space constraints, but must preserve logic structure and interlock compliance.

Control Function	Control Type	Recommended Device Model	Assigned Cabinet	Role Description
Trip (Primary)	Hardware auto trip	ABB CM-UFD.M33	AIPP Cabinet	Performs autonomous trip on grid fault
Trip (Redundant)	EMS strategy trip	ioLogik E1213 + PLC-RPT Relay	EMS Cabinet	Secondary trip channel if logic violation occurs
Close Action	EMS-controlled reclosure	Same as above	EMS Cabinet	Executed only if C1–C7 are satisfied
Trip/Close Execution	Motorized Breaker Control	ABB XT7N 2000A or equivalent	AIPP Cabinet	Performs physical operation

Status Feedback	Auxiliary Contacts	XT7 – 52a / 52b	Output to EMS DI	EMS collects current breaker status
Grid Sensing Primary	Anti-islanding Relay	CM-UFD.M33	AIPP Cabinet	Primary source of V/F/R judgment
Grid Sensing Backup	Smart Meter	eGauge / Schneider PM5560	EMS Cabinet	Provides Zero Export, V/F, ROCOF sensing
Power Supply	UPS Backup Power	Phoenix TRIO-UPS + TRIO-BAT	Both cabinets	≥30 min continuity for control chain
Control Relay	DO Signal Amplifier	Phoenix PLC-RPT-24DC/21	EMS Cabinet	Isolates DO circuit, drives high-load coils
Communication Ports	Modbus TCP Interface	RJ45 (Static IP)	Both sides	Interface for EMS ↔ Relay/eGauge communication

📌 **Notes:**

- All control hardware must carry **UL/IEC industrial certifications**;
- EMS Cabinet and AIPP must not share UPS, power, or grounding — **physical isolation is mandatory**;
- All cables and terminal labels must match the I/O map and as-built drawings;
- For harsh environments (heat, dust, EMI), use **reinforced enclosures** (IP55 / NEMA 3R+);
- If using **non-recommended models**, full communication protocol, wiring diagram, and criteria field mapping must be submitted and **approved in writing by Energize Solutions Inc.**

Appendix H – Technical Control Responsibility Matrix

Control Item	Responsibility of EnergizeOS™ Control Panel	Responsibility of Customer / EPC / OEM
Control Strategy Logic Design	✅ Provides C1–C7 interlock criteria, control flowcharts, and execution algorithms	—
DO Output Wiring Diagram	✅ Provides wiring and control logic diagrams for DO1 / DO2	—
Closing Interposing Relay Configuration	✅ Recommends model and supports software-based integration	✅ Installed and configured by customer/OEM

SEL-700G Relay Procurement & Commissioning	❌ Not supplied, configured, or commissioned	✅ Procured, installed, and tested by customer/contractor
Main Breaker Model & Control Terminal Configuration	❌ Not involved in device selection	✅ Provides model, control diagram, and function list
52a/52b Auxiliary Contact Configuration	❌ Not responsible for signal wiring	✅ Ensures proper DI1 / DI2 input to EMS control panel
UPS for Control Power	✅ Separate UPS within control panel, independently powered	✅ AIPP UPS must not share power source with EMS
Zigzag Grounding Transformer Selection	✅ Provides functional suggestions and typical wiring diagrams	❌ Not responsible for installation, procurement, or wiring
Modbus Communication Configuration	✅ Provides IP planning and register mapping guidance	✅ Opens ports and sets site IP address
Auto-Reclosing Disablement	✅ Enforces logic-based disabling and provides declaration	✅ Ensures relay and breaker meet functional requirements

Appendix I – Technical Liability Disclaimer by Energize Solutions Inc.

📌 Liability Waiver & Applicability

Energize Solutions Inc. (“Energize”) provides only the following within this project scope:

- Control logic recommendations (including C1–C7 interlock criteria);
- Controller output wiring diagrams (DO control + DI feedback);
- Execution mechanisms for control strategies, UI display logic, and closing criteria explanation;
- Functional testing and FAT of internal components within the control panel (excluding relays and main breakers).

Energize explicitly disclaims all responsibility for the following:

- Auto-reclosing function not disabled on relays (e.g., SEL-700G);
- Failure to configure closing feedback signals (52a / 52b) by the customer/OEM, leading to missing logic judgment;
- Incompatibility between main breaker model, electrical specifications, auxiliary terminal setup, and control circuitry;
- Compliance of UPS systems, auxiliary power, terminal blocks, and connectors installation;
- Proper termination, labeling, and grounding of all control and signal wiring;

- Any system faults, grid connection incidents, arcing, or equipment damage due to misconfiguration.

📌 Energize reserves the right to suspend technical support if any of the following occurs:

- Uncontrolled closing actions by on-site relays or breakers;
- Significant deviation from provided technical recommendations;
- Customer/contractor fails to deliver complete wiring diagrams, loop diagrams, or relay configuration documents;
- FAT reveals missing control paths, open signal loops, or non-compliance with UL/IEEE standards.

Final Statement:

Energize's provision of control strategies is conditioned on a **controlled, compliant, and closed-loop system architecture**. Any deployment that bypasses the strategy execution mechanism shall be deemed structurally invalid, and Energize shall bear **no responsibility for commissioning success or system safety**.

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📚 References

1. **IEEE 1547-2018** – *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.*

   → Primary standard defining interconnection, islanding protection, and DER behavior under grid anomalies.

2. **UL 1741 SB** – *Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources (Supplement B).*

   → Mandatory in California, governs grid support functions including anti-islanding, frequency/watt control, and interoperability.

3. **California Rule 21** – *Tariff Rule governing interconnection requirements for generating facilities under the California Public Utilities Commission (CPUC).*

→ Enforced by SDG&E, PG&E, SCE; defines grid-tied DER technical requirements, including visible disconnects, relays, and advanced inverter functionality.

4. **SDG&E Interconnection Handbook** – *San Diego Gas & Electric's Technical Requirements for Interconnection of Distributed Generation Facilities.*

   → Project-specific operational and hardware control expectations, including breaker placement and reclose authority guidelines.

5. **ABB CM-UFD.M33 Technical Manual** – *Grid and system protection relay for anti-islanding detection.*

   → Provides settings for voltage/frequency thresholds, ROCOF, reconnection delays; UL-certified.

6. **SEL-700G Data Sheet and Application Guide** – *SEL-700G Generator Protection Relay.*

   → Applicable for microgrid islanding detection, breaker trip output (e.g., OUT301), voltage/frequency sensing, configurable via Modbus TCP.

7. **Schneider Electric Masterpact MTZ & ABB XT7 Series Specifications** – *Circuit breaker design supporting shunt trip and motor close.*

   → Required for remote EMS control and feedback via 52a/52b auxiliary contacts; must meet UL489/ANSI C37.13/UL1066.

8. **Phoenix Contact TRIO-UPS-2G/1AC/24DC Series** – *Industrial UPS with 24VDC output for critical control power backup.*

   → Ensures ≥30-minute post-grid-loss operation for trip circuits and relays.

9. **EnergizeOS™ Technical Whitepaper v2.0** – *Design and Implementation Guide for Distributed Energy Management Systems.*

   → Defines dual-channel anti-islanding structure, EMS-Relay redundancy, C1–C7 breaker interlock conditions, and Modbus TCP control architecture.

10. **California Energy Commission (CEC)** – *Battery Energy Storage System (BESS) Interconnection and Certification Guidance.*

    → Used to verify inverter/grid equipment eligibility and mandatory compliance pathways in commercial/industrial deployments.

11. **eGauge Technical Documentation** – *Modbus TCP-enabled smart meter used for redundancy sensing.*

    → Measures real-time V/F/P/ROCOF for EMS interlock validation (Zero Export, frequency stability, conflict detection).

12. **NFPA 70 (NEC 2023 Edition)** – *National Electrical Code.*

    → Article 705 (Interconnected Electric Power Production Sources) and Article 706 (Energy Storage Systems) applicable to EMS + BESS integration.