Challenges and Solutions to Solar + Storage Interconnection

Perspectives on Rule 21

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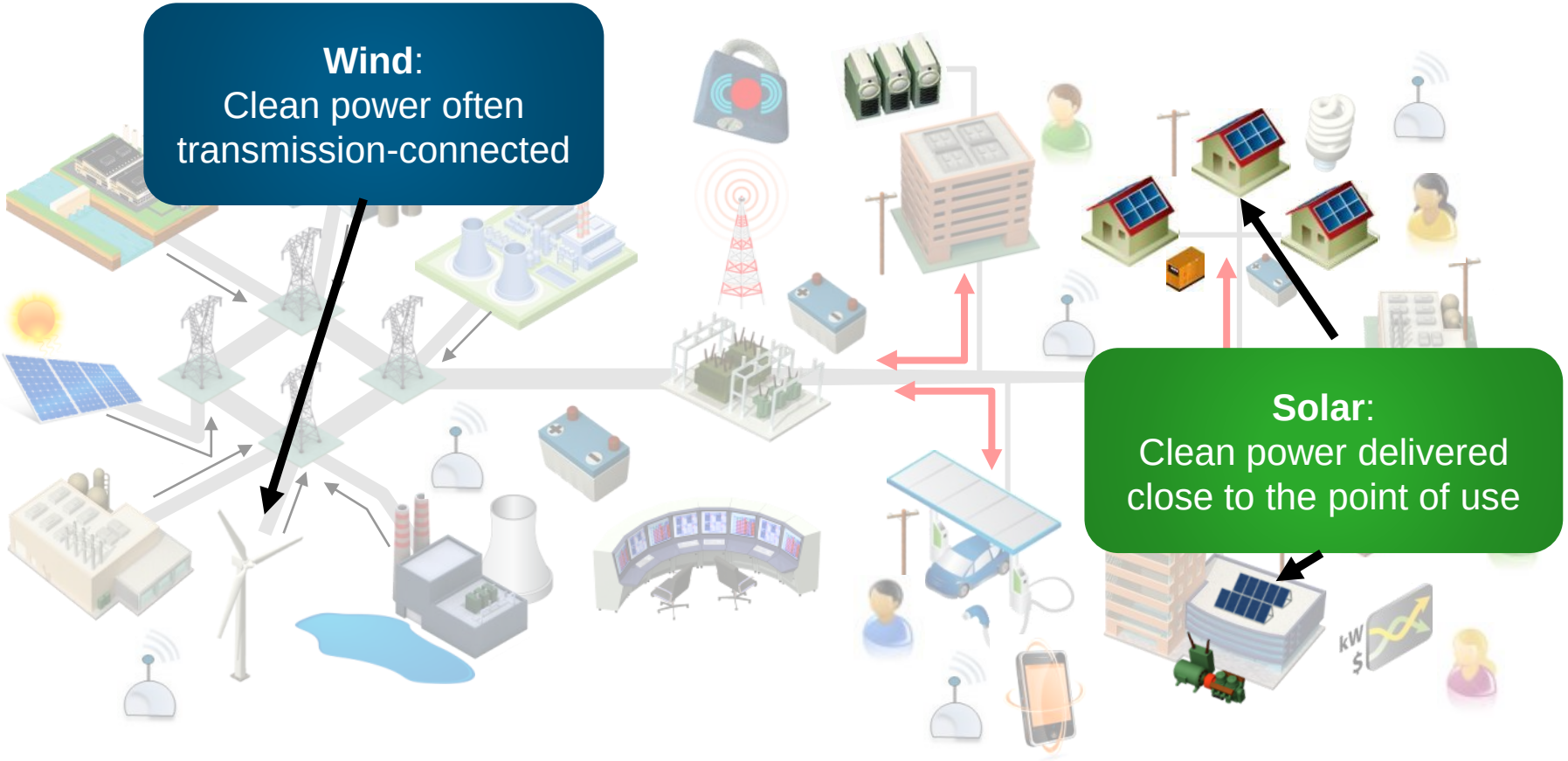
EPRI's Mission

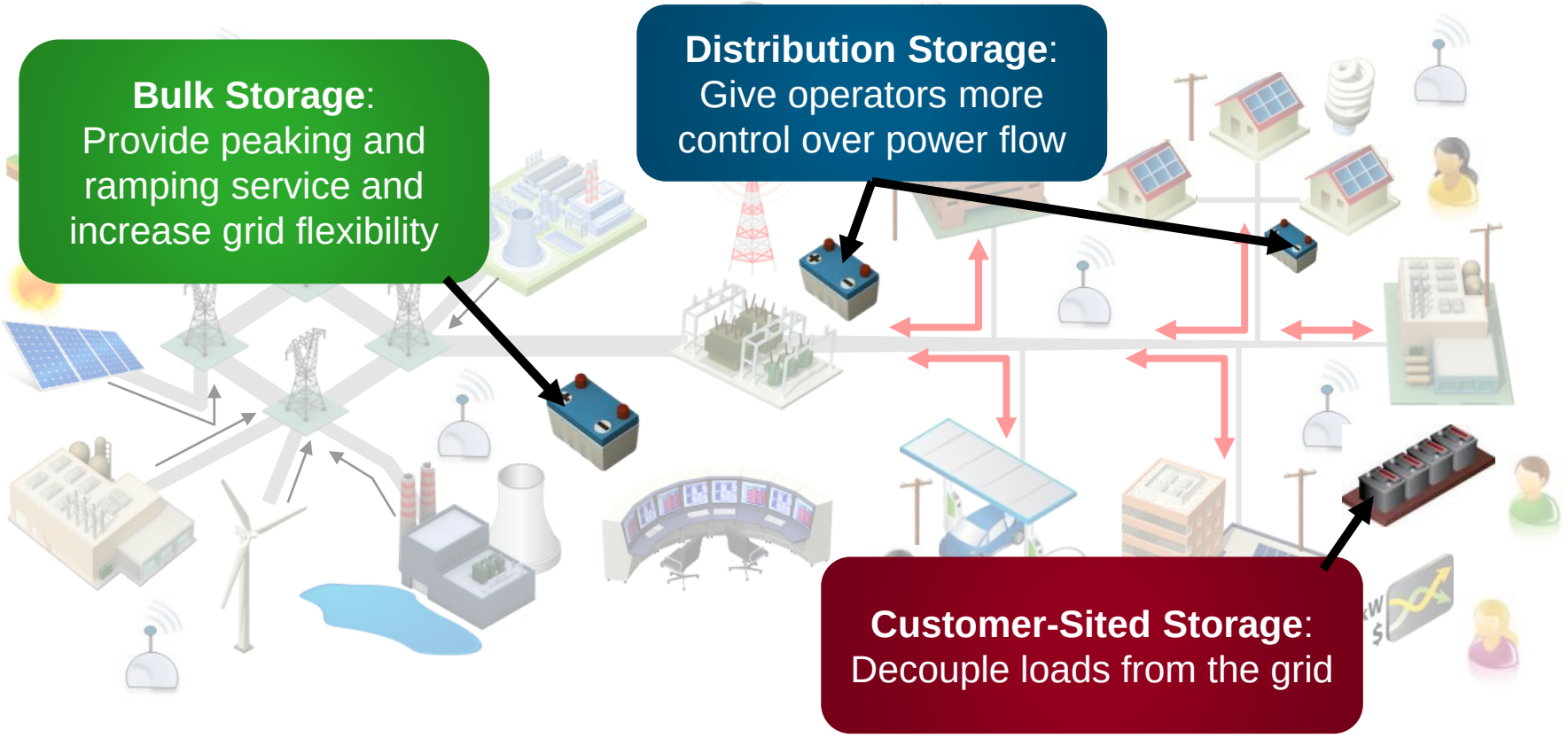
Advancing ***safe***, ***reliable***, ***affordable*** and ***environmentally responsible*** electricity for society through global collaboration, thought leadership and science & technology innovation

Transformation of the Power System



Renewables and EV's are Transforming the Power Grid

Transformation of the Power System



Energy Storage is Playing Key Roles Across the Grid

Case Study: California's First Zero Net Energy Residential Community in Fontana

Case Study: Zero Net Energy Homes in Fontana, CA

20 PV Homes, 2 Transformers, 10 w/ BESS

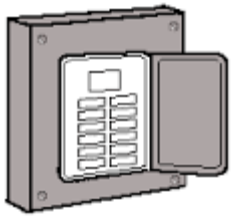
Inside the ZNE Smart Home

Smart Thermostat

Solar & Storage

? ? ?

Smart Heat Pump Water Heater



Controllable Loads

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Permitting Approval Subject to Code

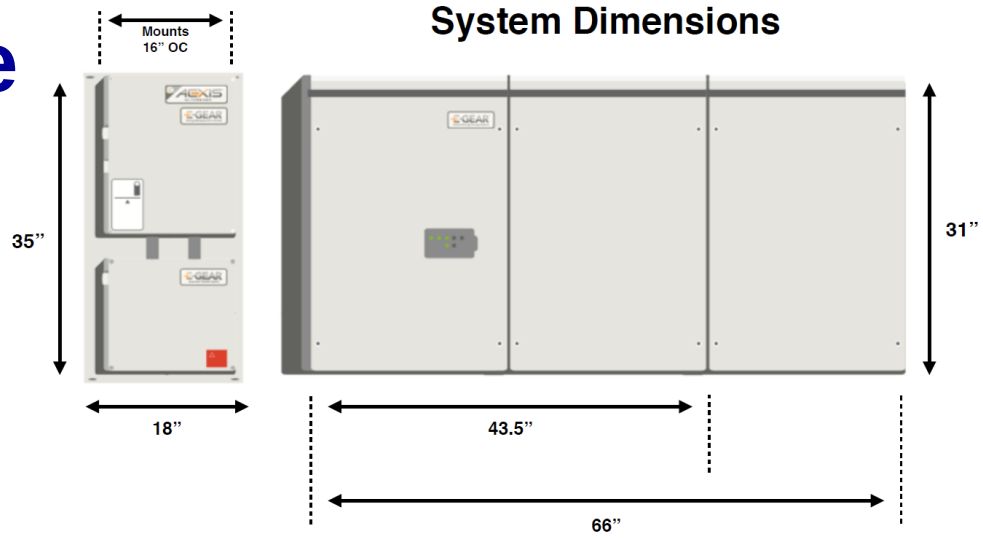
Building Code: Originally planned an outdoor installation for ease of service in operation and maintenance. Restrictions on natural gas line interference forced indoor/garage installation.

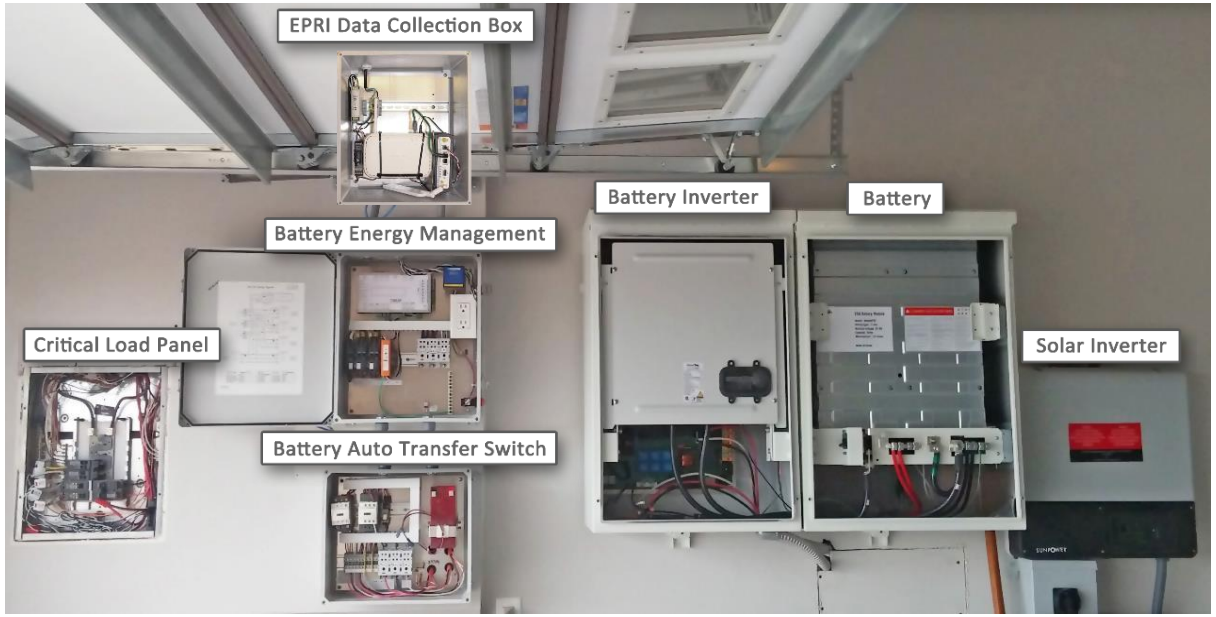
Mechanical Code: 300lb, wall-mounted system required additional structure/bracing

Fire Code: BESS with total weight exceeding 1000 lb/454 kg requires spill control and enclosure requirements. Also see proposed NFPA 855 and CA Fire Code.

Electrical Code:

- NEC 110.26(F): Energy storage systems in garage must be protected from physical damage.
- NEC 480.9(A): Proper garage ventilation.
- NEC 690.5(C) & 690.55: warning labels/ signage



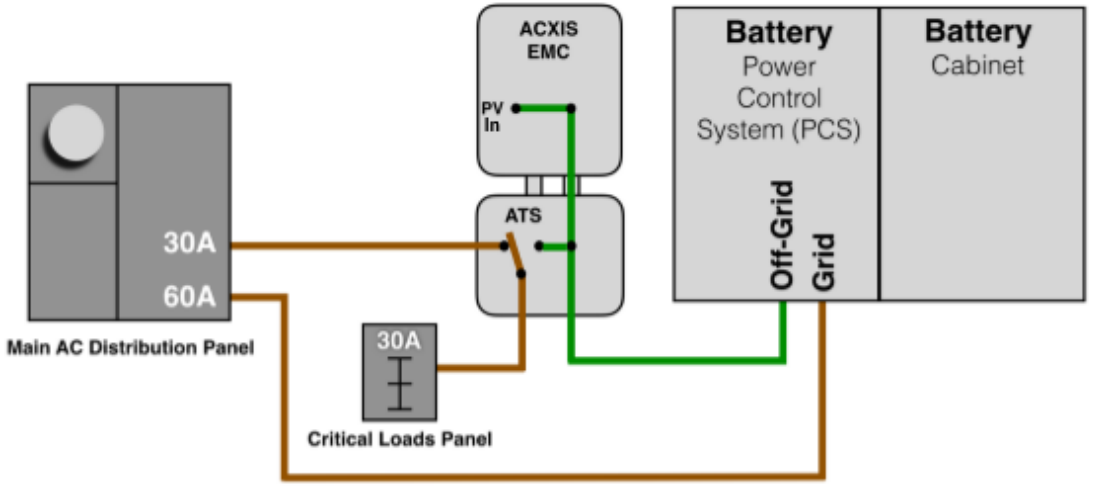


2 Month Effort; Homeowner, Builder, AHJ, Utility Required Education

Interconnection Process

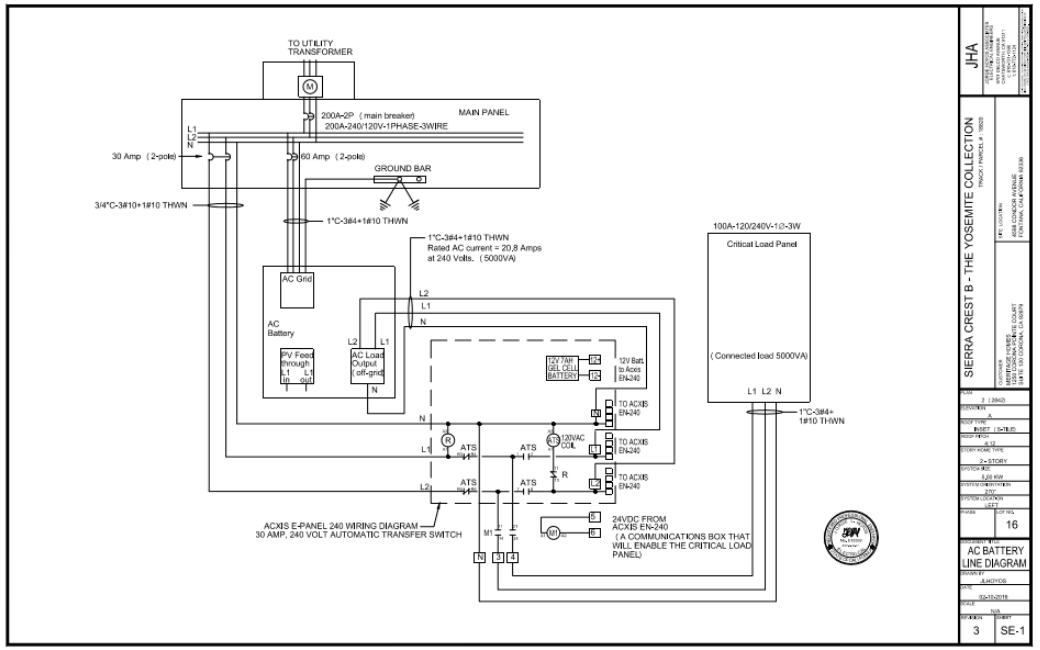
Application Timeline:

- Filed in SCE territory under Rule 21 Fast Track
- 3 months start to finish; Int. Mgr req'd site visit
- Today:15 day time to signoff following online submittal



Interconnection Process:

- SCE required consolidated solar PV plus storage single-line diagram
- Solar installer responsible for PV O&M; submits PV only interconnection
- BESS vendor responsible for BESS O&M: resubmit PV + BESS interconnection
- Configuration impact:
  - PV + BESS resiliency function not available
  - PV cannot supply BESS under grid isolation



Design of BESS integration and ATS required 3 Months Effort

Pacifica PV + BESS: Tale of Two Projects

BESS Hardware Options at Pacifica Projects

Maximum Power and Energy

Label Rated DC Energy	Maximum Usable AC Energy	Max Charge/ Discharge Power	Max Charge/ Discharge Power (amps)	Max PV input / critical load power	Est. battery drain time (Full Power)	Est. battery drain time (1kW draw)
6.5 kWh	5.4 kWh	3.2* kW	13.5* Iac	3.2* kW	1.6 hrs	5.4 hrs

*Maximum power output limitations apply

13 kWh	10.8 kWh	5.0 kW	20.8 Iac	5.0 kW	2.16 hrs	10.8 hrs

19.5 kWh	16.2 kWh	5.0 kW	20.8 Iac	5.0 kW	3.24 hrs	16.2 hrs

26 kWh	21.6 kWh	5.0 kW	20.8 Iac	5.0 kW	4.32 hrs	21.6 hrs

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Comparison of Interconnection Processes

Pacifica A: Residential with Existing Solar PV

- PG&E required cancellation of solar contract and previous agreement
- New submittal to solar + storage interconnection via paper/scan
- Interconnection under PG&E Rule 21 Non-Export for Fast Track PTO
- Solar plus Storage is AC-coupled
- Solar PV is maintained and managed from the Storage BESS
- Metering required to determine power flow between PV and BESS systems

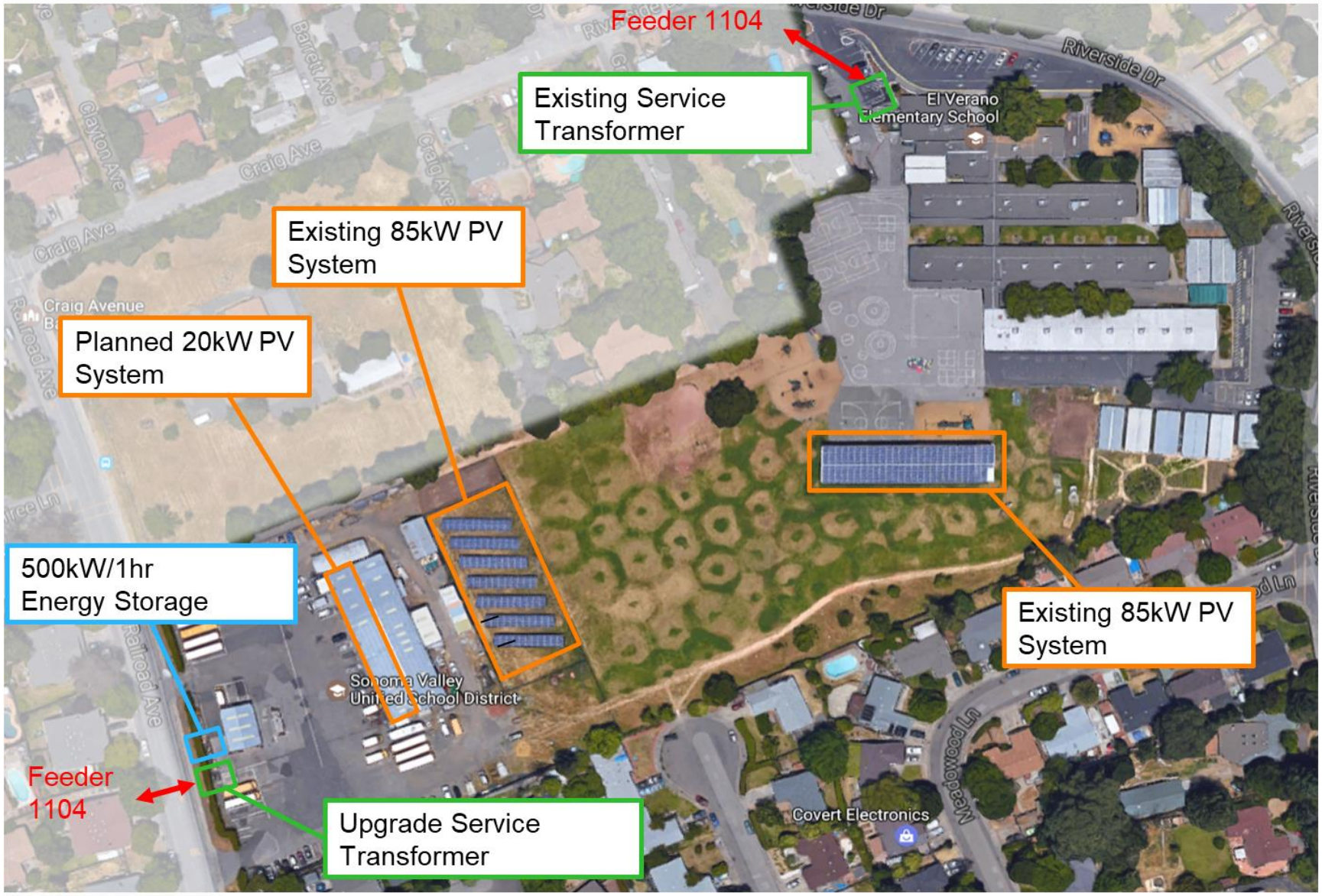
Pacifica B: Residential with New Solar PV

- New joint submittal to solar + storage interconnection
- Interconnection under PG&E Rule 21 Non-Export for Fast Track PTO
- Solar plus Storage is DC-coupled
- Solar PV is jointly maintained and managed with the Storage BESS
- Advantageous in clarity of installation and interaction of power between PV + BESS

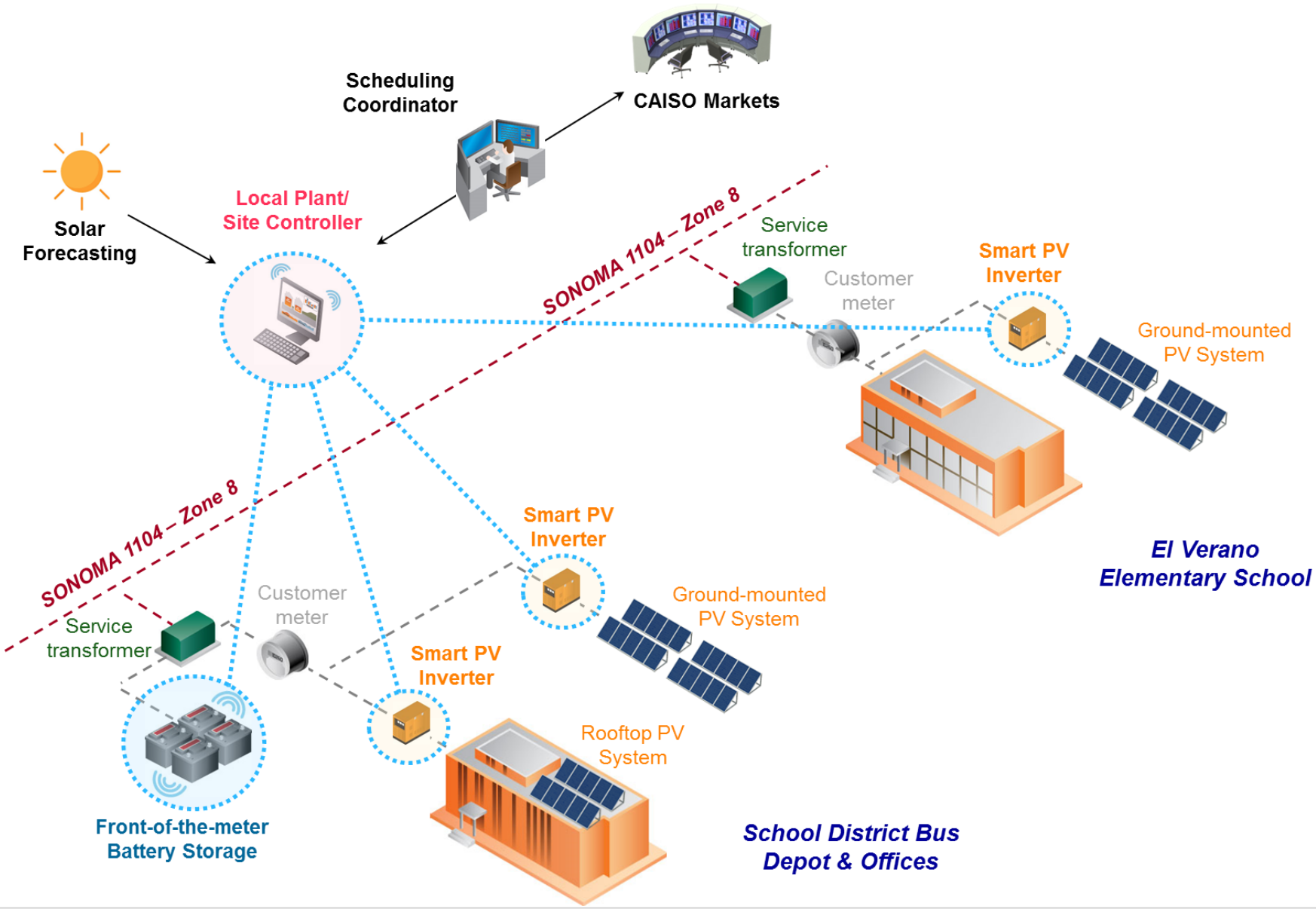
Sonoma FTM WDT to BTM R21

Key Research Questions

1. **Grid Readiness for High DER Penetration**
   - How can DER assets be jointly managed to mitigate adverse PV impacts and increase PV hosting capacity?
2. **Value-Stacking Demonstration**
   - Customer, Distribution, Wholesale Market
3. **Storage Mandate: Can Smaller Units Help?**
   - Evaluate the practicality of smaller-sized, distribution-connected storage to help IOUs to meet policy mandates.



Project Architecture

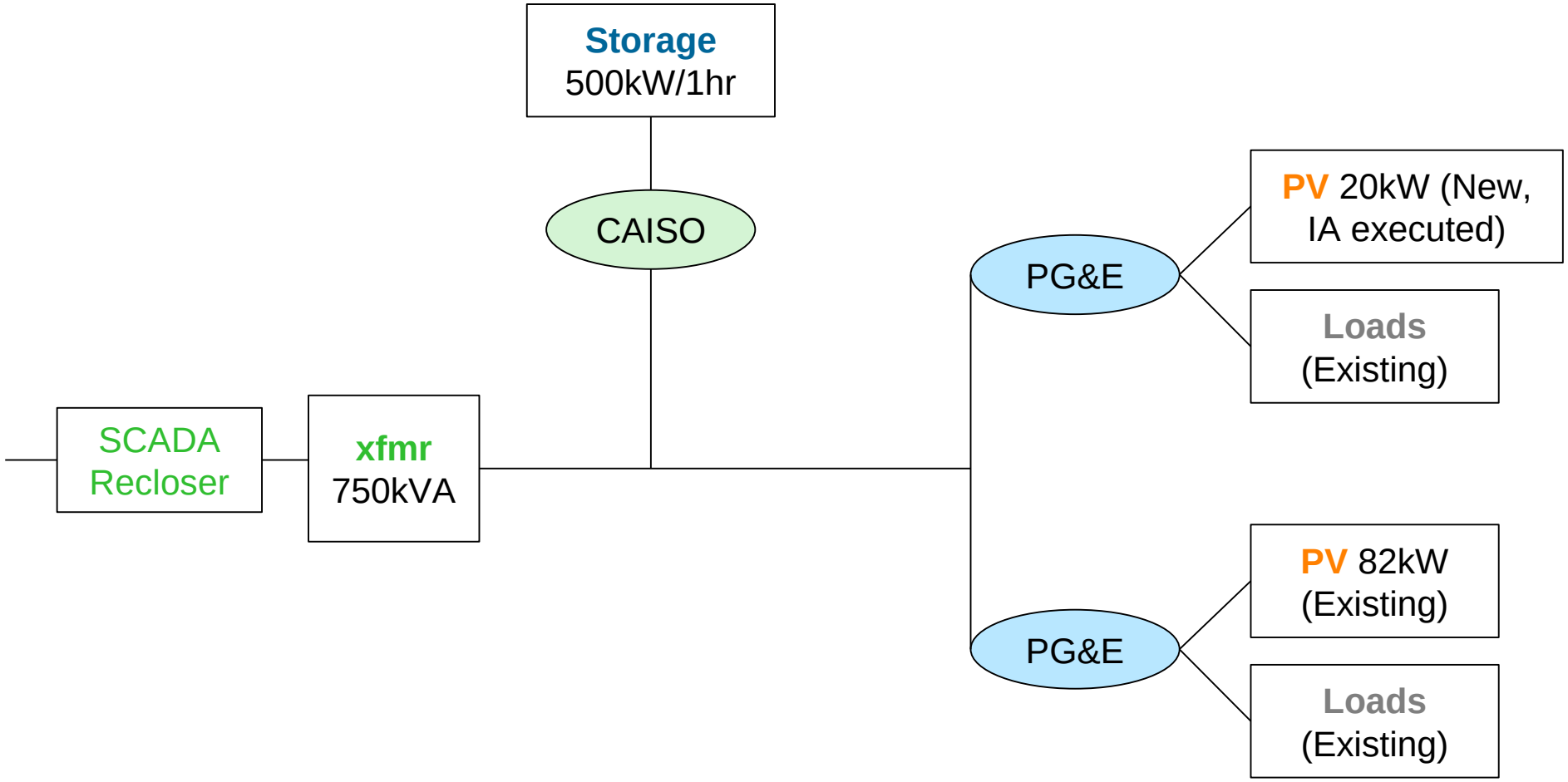


Interconnection Adjustment: FTM WDT to BTM Rule 21

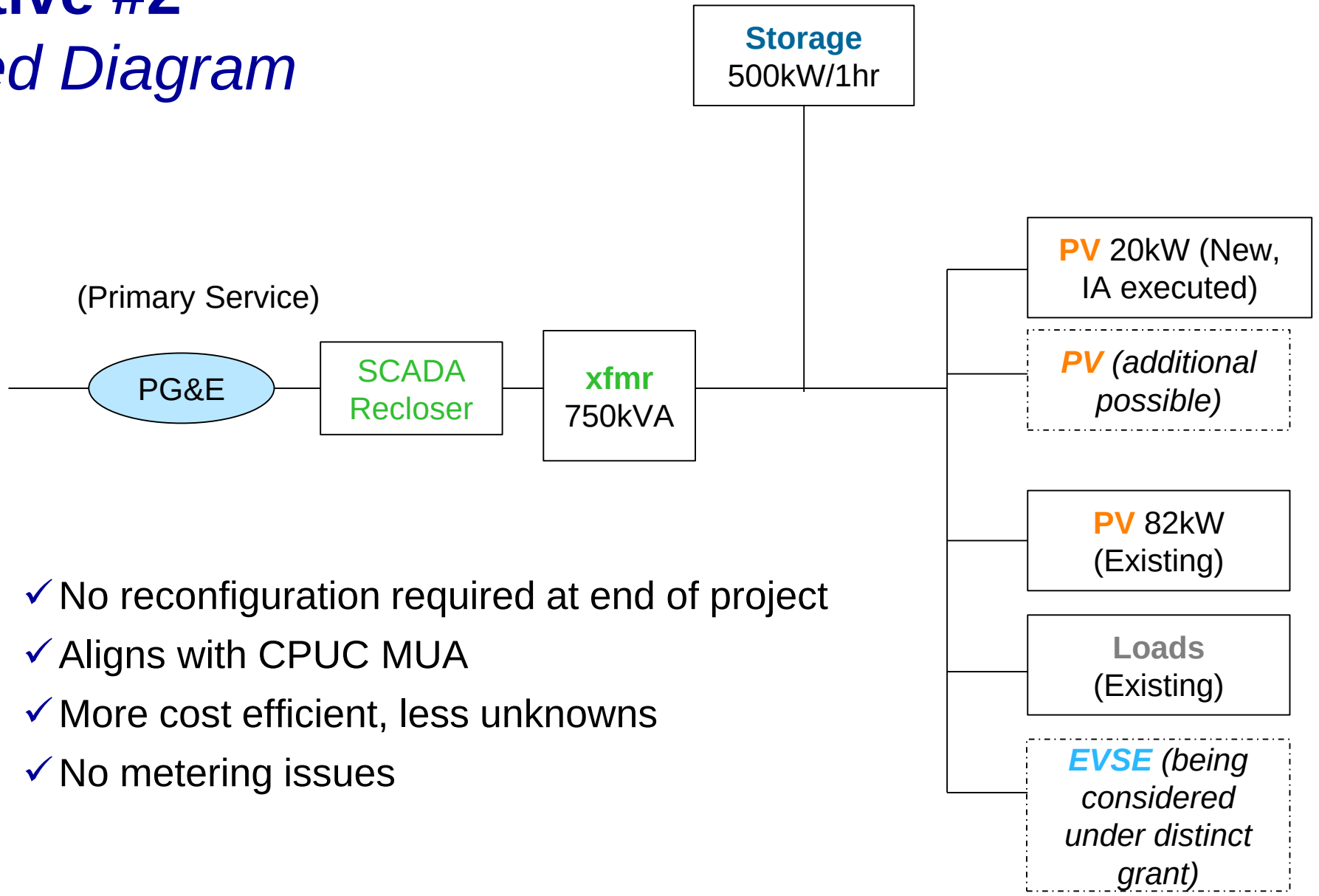
- **Challenge #1: WDT - Cost Inefficiency & Unknowns**
  - Initial Significant WDT Costs
  - Extended Duration of Approval Process
  - Additional Costs to Decommission Project
- **Challenge #2: FTM Contradicts New CPUC MUA Rules**
  - CPUC Decision 18-01-003 (January 11, 2018)
    - A resource can provide services in the domain to which it is interconnected, and domains upstream
    - Under this framework, a FTM storage should not provide backup power to a single customer
- **Challenge #3: No Existing CAISO Framework for MUA**
  - Complex metering arrangement for backup
  - Significant Fees for ISO metering hardware and services

Initial Configuration Considered

Simplified Diagram



Alternative #2
Simplified Diagram



- ✓ No reconfiguration required at end of project
- ✓ Aligns with CPUC MUA
- ✓ More cost efficient, less unknowns
- ✓ No metering issues

Comparison of Alternatives

FTM Wholesale vs. BTM retail

Project Goals		FTM WDT	BTM R21-NEM
Demonstrate Value Stacking Approaches for DER	*Hosting capacity*	Possible	Equally possible
	Backup service	Metering issues, technical uncertainties (recloser), not aligned with CPUC MUA rules	Possible
	CAISO participation	Possible, but costly and with uncertainties	Not possible, but can be simulated with focus on MUA, providing potentially higher research value
Critical evaluation of smaller-scale storage deployments		Possible	Equally possible
Integrated management of multiple DER assets		Possible	Equally possible

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