Challenges and Solutions to Solar + Storage Interconnection

*Perspectives on Rule 21*

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CPUC Interconnection Discussion Forum
2018-09-20
Together…Shaping the Future of Electricity

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

Wind: Clean power often transmission-connected

Solar: Clean power delivered close to the point of use

Renewables and EV's are Transforming the Power Grid
Transformation of the Power System

**Bulk Storage:** Provide peaking and ramping service and increase grid flexibility

**Distribution Storage:** Give operators more control over power flow

**Customer-Sited Storage:** Decouple loads from the grid

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

California’s First ZNE Residential Community was a Collaborative Effort
20 PV Homes, 2 Transformers, 10 w/ BESS
Inside the ZNE Smart Home

- Smart Thermostat
- Smart Heat Pump Water Heater
- Solar & Storage
- Controllable Loads
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
### Maximum Power and Energy

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

*Maximum power output limitations apply

<table>
<thead>
<tr>
<th>13 kWh</th>
<th>10.8 kWh</th>
<th>5.0 kW</th>
<th>20.8 Iac</th>
<th>5.0 kW</th>
<th>2.16 hrs</th>
<th>10.8 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.5 kWh</td>
<td>16.2 kWh</td>
<td>5.0 kW</td>
<td>20.8 Iac</td>
<td>5.0 kW</td>
<td>3.24 hrs</td>
<td>16.2 hrs</td>
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</tr>
<tr>
<td>28 kWh</td>
<td>21.6 kWh</td>
<td>5.0 kW</td>
<td>20.8 Iac</td>
<td>5.0 kW</td>
<td>4.32 hrs</td>
<td>21.6 hrs</td>
</tr>
</tbody>
</table>
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.
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**

- **Storage**: 500kW/1hr
- **CAISO**
- **xfmr**: 750kVA
- **SCADA Recloser**
- **PV 82kW (New, IA executed)**
- **PV 20kW (New, IA executed)**
- ** Loads (Existing)**
- **PG&E**
- **Loads (Existing)**
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

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