

High Penetration Solar and Energy Storage

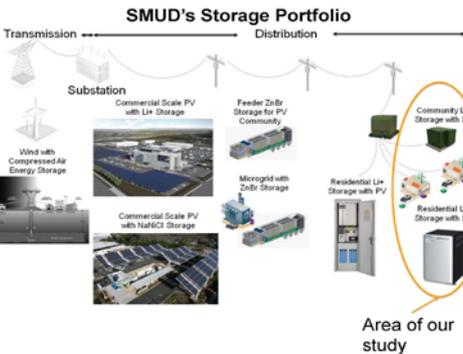
Sacramento Municipal Utility District

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SYSTEMS INTEGRATION

Why Storage

- Greenhouse gas regulations and renewable portfolio standards driving solar installations in SMUD's service territory
- Creates uncertainties with integration
 - Solar forecasting is not developed enough for minute ahead forecasts during variable weather
 - Solar peaks 4 to 5 hours before utility peak
 - Distribution system reliability could be impacted
 - Grid operation costs could increase
- To manage these issues, SMUD is studying energy storage at all levels of its electricity system.

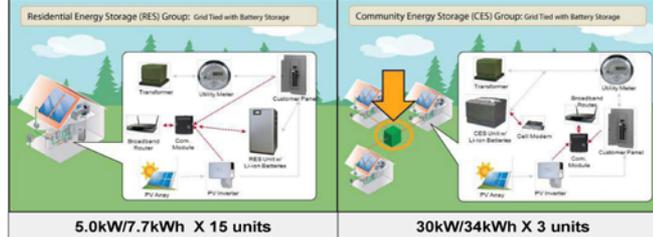


Project Partners



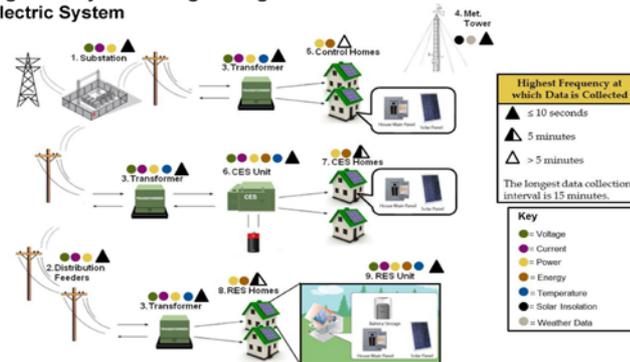
Our Project

PV and Energy Storage Demonstration at Anatolia Subdivision



Storage deployed in all solar community with 300 homes built

High Fidelity Monitoring Throughout the Electric System



Energy Storage Devices

RES Unit



- First UL listed grid-connected residential energy storage product
- Vendor: Silent Power, Inc.
- Capacity: 7.7 kWh of storage at 5.0 kW

CES Unit



- Each CES unit serves 6 to 12 homes
- Vendor: Powerhub Systems
- Capacity: 34 kWh of storage at 30 kVA.

Results to Date

Customer Recruitment and Installation

RES Installation



- Units passed UL 1741 (IEEE 1547) testing
- Recruited 15 host customers
- Installed 15 units

CES Installation



- NREL conducted 1547 compliance testing
- Installed 3 units

Test Plan

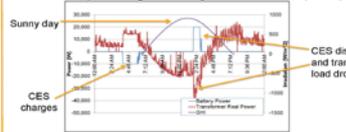
Operating Scenario	Verify and Level		Applies to RES	Applies to CES
	Battery Maximum Capacity	Discharge Initiation		
1 Load Firming	100%	N/A	✓	✓
2 Load Firming	75%	N/A	✓	✓
3 Load Firming	50%	N/A	✓	✓
4 Load Firming	25%	N/A	✓	✓
5 Frequency Regulation	100%	N/A	✓	✓
6 Phase Balancing	100%	N/A	✓	✓
7 Load Shifting by Energy	100%	N/A	✓	✓
8 Load Shifting by Price	100%	N/A	✓	✓
9 Load Shifting during Super Peak	100%	4:00 PM	✓	✓
10 Load Shifting during Super Peak	100%	5:00 PM	✓	✓
11 Load Shifting during Super Peak	100%	6:00 PM	✓	✓

- Operating scenarios test the storage units' capabilities and value during different seasons (i.e. weather patterns) of the year.
- RES customers on Time Of Use rates

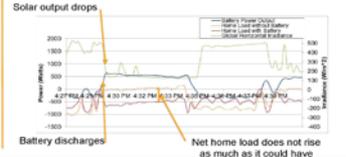
Initial Results



CES Responding to Utility Commands (4/22)



RES Responding to Drop in Solar Output (5/3)



Initial Lessons Learned

- Customer Recruitment** – Homeowners more receptive to hosting RES than expected.
- Technology Readiness and Integration** – Technology testing and deployment taking longer than expected.
- Data Management** – High resolution data management requires careful planning.

Snap Shot of Customer Portal



Powering forward. Together.

