Can The Smart Grid Enable More DG and Does Storage Have a Role

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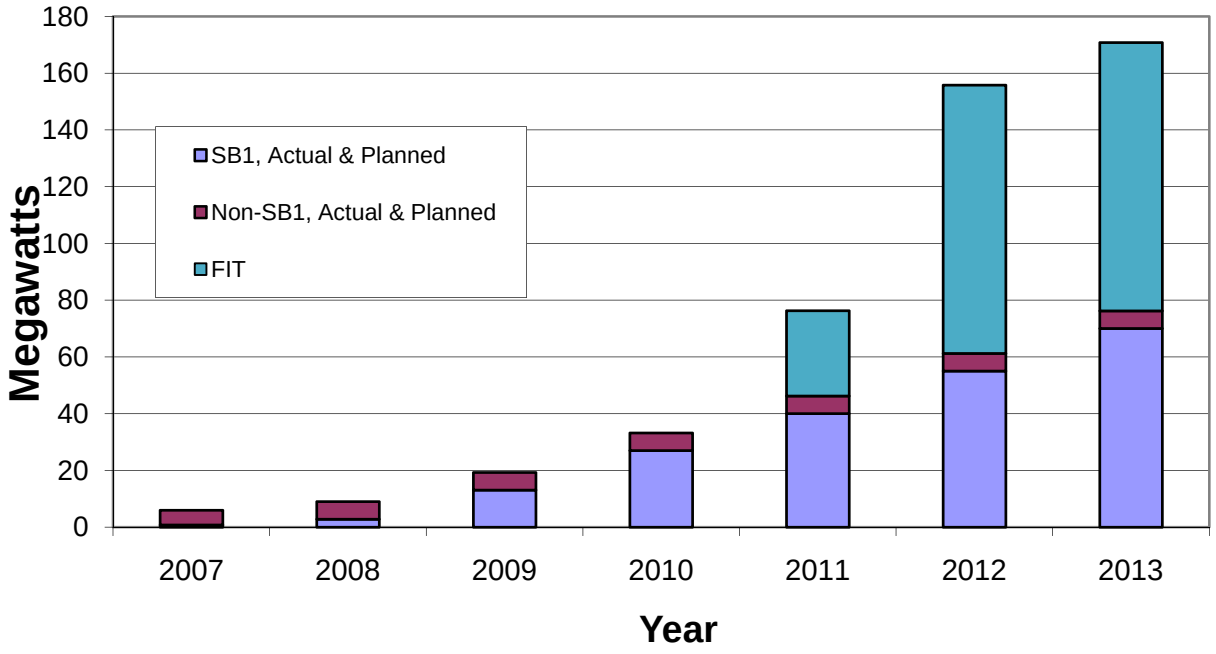
SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.SM

Role of PV In SMUD's Future

- About 20 MW installed today, 2,000+ Installations 0.5 kW to 6 MW
- Goal of 130 MW net-metered PV by 2016
- Rolled out Feed-in Tariff January 4, 2010
  - Eligible to <= 5MW distribution interconnected renewables
  - 100 MW cap for program
  - Value based tariff; not technology cost based
    - Energy; generation, transmission and sub transmission capacity; ancillary services; avoided GHG mitigation cost; avoided natural gas price hedge values included
  - Time of day delivery multipliers
  - **Full subscribed by January 11th with PV projects!**
  - Online in 2012

Role of PV In SMUD's Future

Installed and Forecast Solar Capacity



Role of PV In SMUD's Future

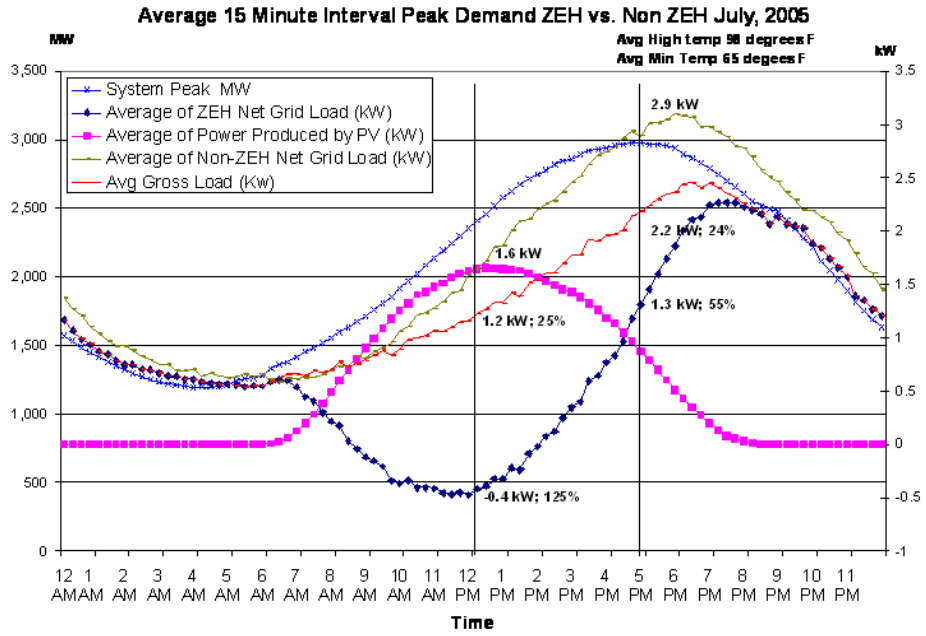
- SMUD is in midst of Integrated Resource Plan for 2010 – 2030
  - -One scenario anticipates between 500-800 MW of local solar

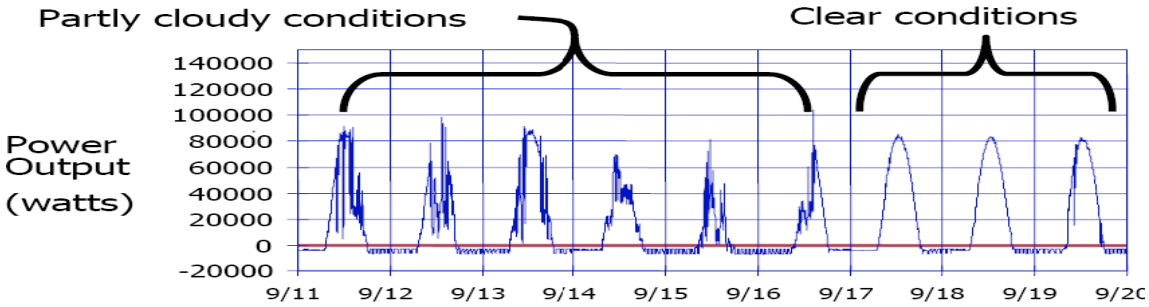
- Many solar industry reports suggest grid-parity possible within 5-10 years

- Total commercial rooftop potential >1,000 MW

- Total brownfield/greenfield potential in Sacramento many times our energy needs

PV Issues For SMUD





- PV coupled with high efficiency measures can reduce home peak load by 55%
- Significant shift still between solar peak and system peak
- Intermittent production resulting from party cloudy conditions

Importance of Variability

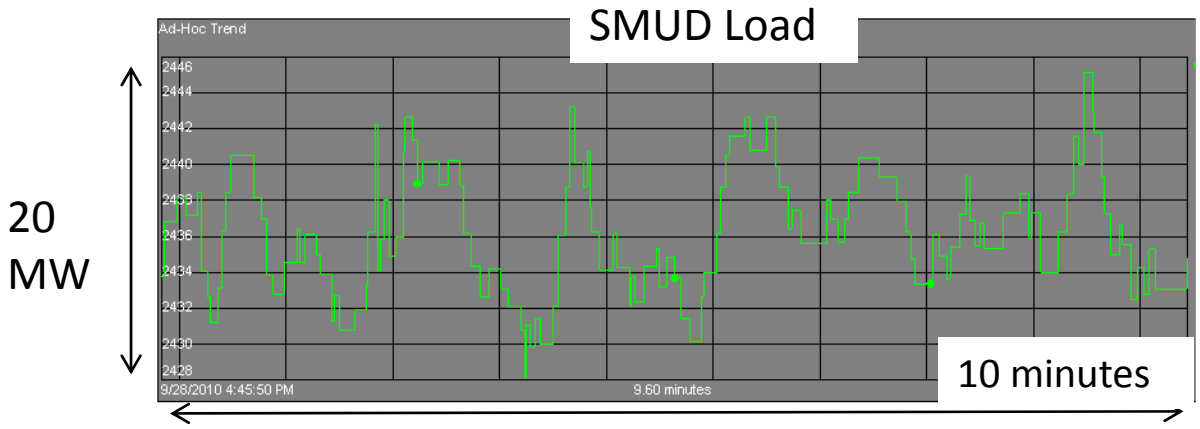
- Current expectations are that up to 50% of a large PV system output can be lost in 1 minute

- With 250 MW of PV, loss of 125 MW in 1 minute would exceed SMUD's contingency requirements

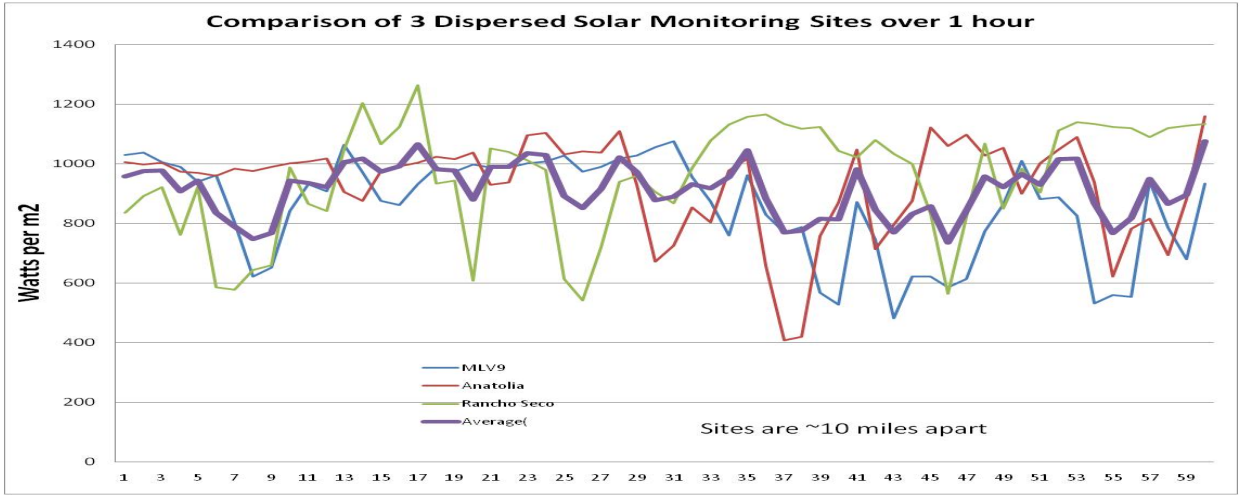
- Minute to minute load fluctuations at SMUD are much smaller ~10-20 MW

- Correlation of dispersed large systems currently not well known

Importance of Variability



20% Variability in 1 minute for solar Resource (3 site Average)



Near Term Integration Issues Distribution System

- Evaluating impact of variable solar resource on distribution feeder voltage levels

- Validation of caps on capacity on feeders at 100% of minimum daytime load

- Identification and testing of appropriate mitigation strategies to accommodate higher penetrations on feeders (e.g., curtailment via SmartGrid, storage)

- Identification of priority areas and limits for PV on our distribution system

Medium-Term Integration Issues – Bulk Power System

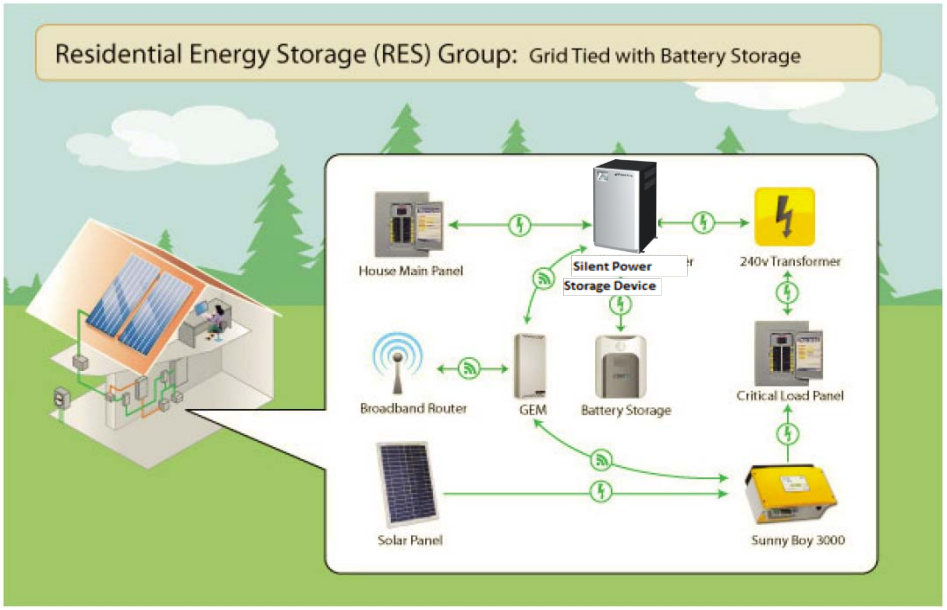
- Evaluation of variability impacts on regulation requirements

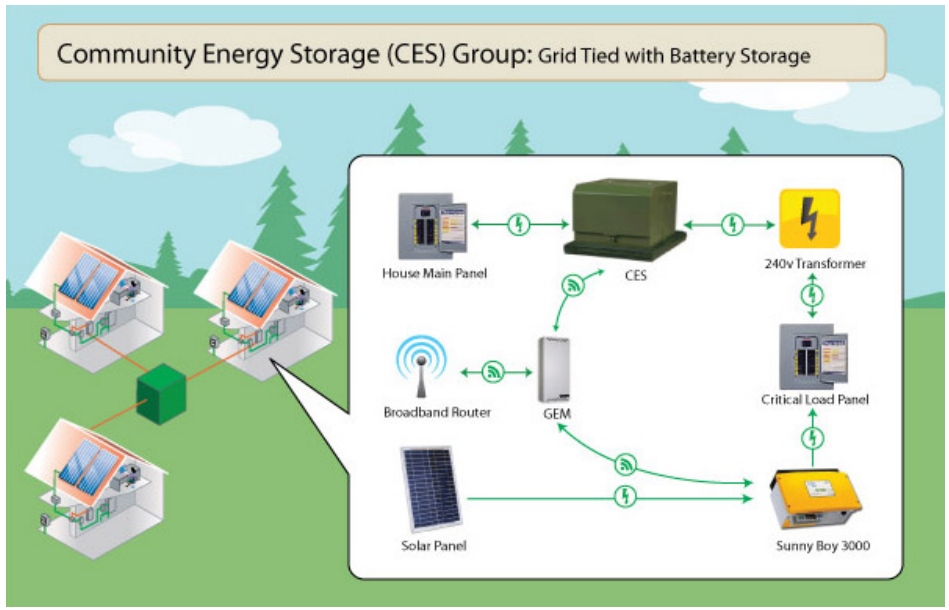
- Evaluation of forecasting error impacts on ancillary services requirements and associated costs

- Redesign of distribution system as a supply source to bulk power system

SMUD PV & Smart Grid Pilot at Anatolia

ARRA FOA 85 High Penetration Solar Development (DOE Award DE-EE0002066)



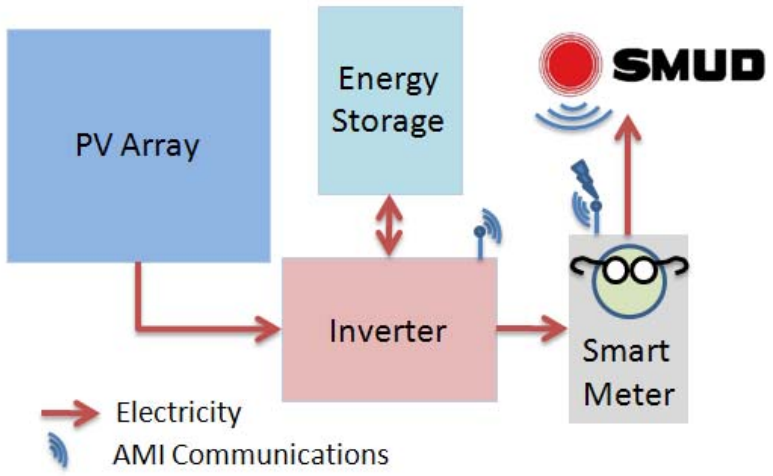


- **Anatolia SolarSmart^{SM} Homes Community**
  - High building efficiency measures
  - 2kW PV systems
- Installing 15 RES (10kW/8.8kWh) and 3 CES (30kW/30kWh)
- Will firm renewables, reduce peak load and improve reliability
- Partners include GridPoint, SunPower, Navigant, NREL, SAFT (lithium ion)
- Installing utility and customer portals to monitor PV, storage, customer load
- Sending price signals to affect changes in customer usage
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

SMUD PV & Smart Grid Pilot at Anatolia (Cont'd)

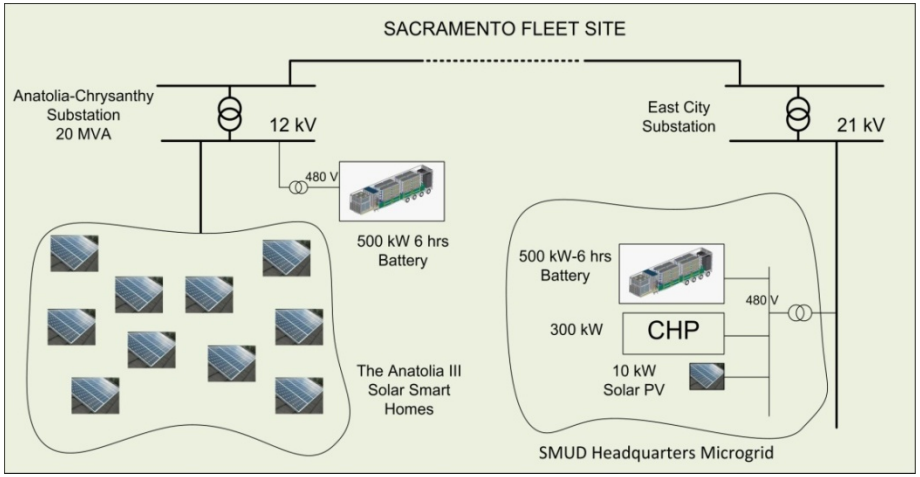
Inverter Communications

- Demonstrate inverter monitoring via AMI communication from smart meter to inverter
- Demonstrate receiving data, querying for faults, sending control signals
- Utilized as actively controlled contributors versus passive devices on the grid



Storage for Grid Support

ARRA FOA 36 Storage Demonstrations (DOE Award DE-OE0000224)



Benefit	Metric	Sacramento Fleet
Peak load reduction	Peak Load	5-10%
T&D loss reduction	T&D Losses	2%
Reduced cost of power interruption	CAIDI/SAIDI/SAIFI improvements	10%
Reduced damages as a result of lower GHG/carbon emissions	MWh served by renewable sources	TBD
Reduced cost to serve peak energy (energy arbitrage)	Hourly marginal cost data	70%

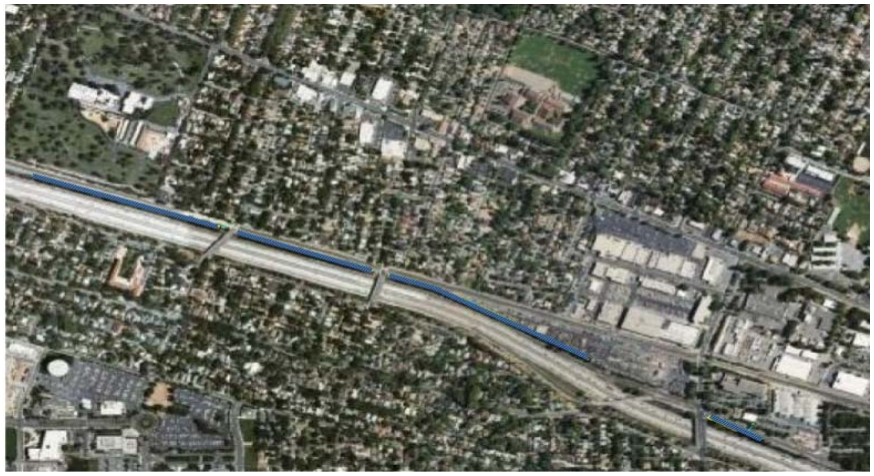
- Installing two Premium Power 500kW/6 hours zinc bromine flow batteries systems
- Partners include Premium Power, National Grid, SAIC, NREL, Syracuse University
- Will firm renewables, reduce peak load and cost to serve peak, and improve reliability
- Operating as a fleet of distribution assets
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

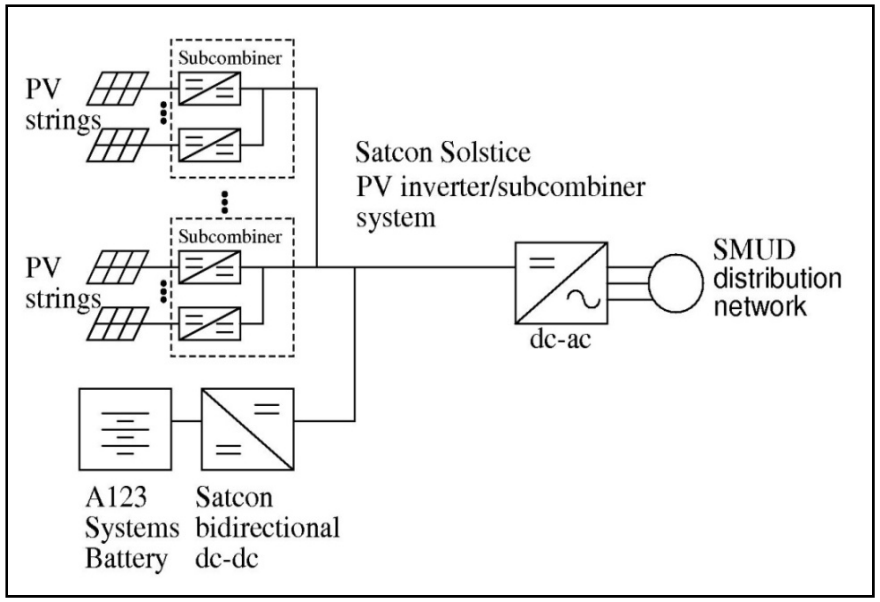
Sacramento Solar Highways

- 1.4MW of PV and CPV at two sites within US 50 corridor
- Project in planning stage
- Two phases of feasibility study complete
- Environmental study is underway

- Large number of technical and safety criteria
- Initial site survey resulted in East Sacramento and Rancho Cordova site selection

Sacramento Solar Highways Augmentation





- New grant to add advanced technology
- $4.2M grant from CEC PIER
- SMUD is subcontractor to Satcon; A123 is other partner
- Advanced technologies:
  - Satcon 500kW Solstice advanced inverter technology
  - A123 500kW/500kWh lithium ion battery system
- Objectives
  - 5-12% improved solar harvest
  - Minimize impact of variability
  - Control ramp rates
  - Voltage regulation and voltage sag mitigation
  - Peak load shifting

Additional Inverter Functionality Being Considered for Future Demonstrations

- Automatic Voltage Control technologies to possibly mitigate voltage fluctuations caused by PV intermittency in high penetration circuits
- Voltage Sag/Swell Ride-through
- Over/Under Frequency Ride-through
- Dynamic VAR Support