High Penetration Solar Forum

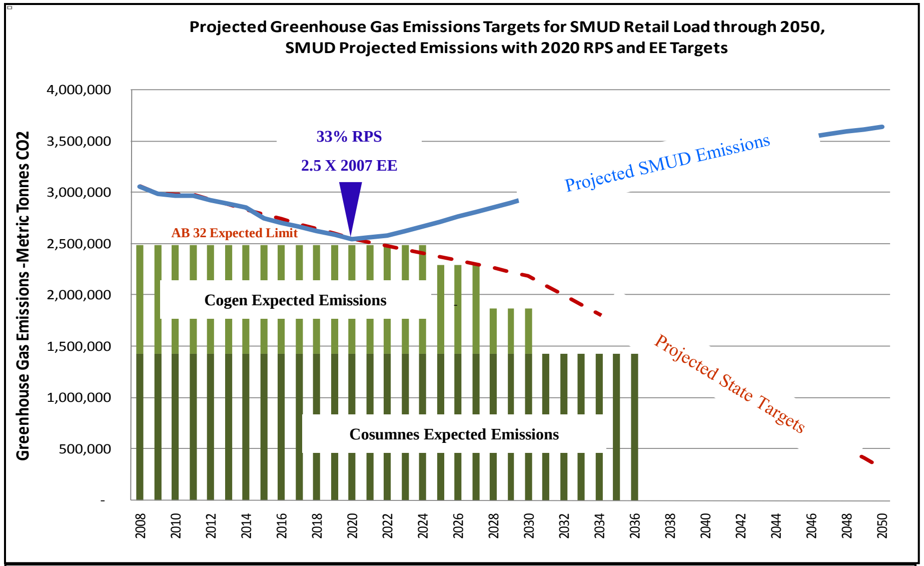
March 2011

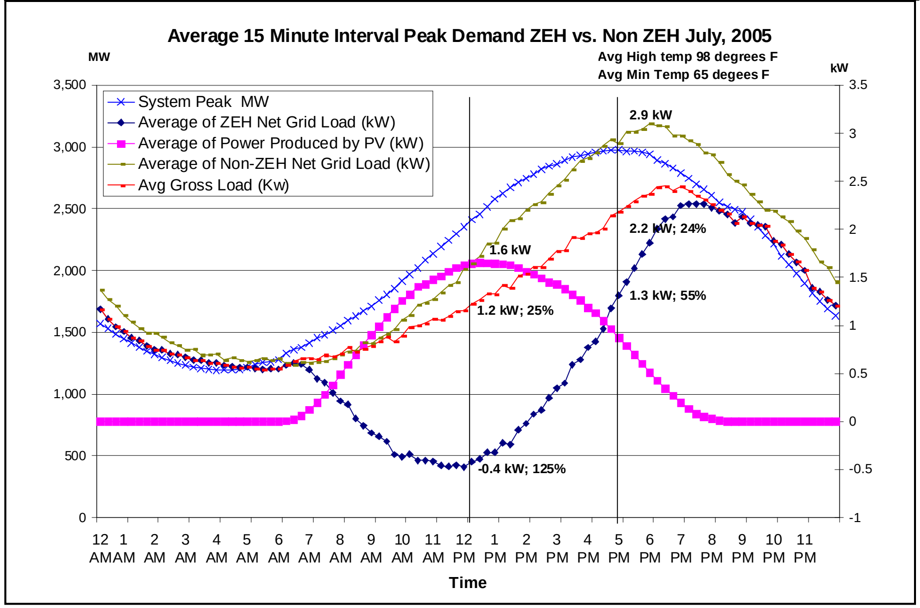
SMUD PV and Smart Grid Pilot at Anatolia

Mark Rawson

SMUD

Challenges, Barriers or Problems





- GHG regulations
  - Reshaping energy supply
- RPS-driven wind and solar energy additions
  - Expect 500-800 MW local PV over next 20 years
  - Solar — forecasting capabilities not well developed
  - Solar — peaks 4-5 hours before utility peak
- Summer peak load
  - 400 MW problem for 40 hours

Focus Areas

Technical Issues	Contribution of Project
Issue 1: Grid-connected PV systems cannot be fully integrated into the Smart Grid until there is sufficient two-way communication and control capability between the utility and PV inverters.	• Demonstration of communications between the utility and energy storage located both behind the meter and on distribution feeders • Demonstration of communications and control capability using both broadband and Advanced Metering Infrastructure (AMI) network backhaul • Examination of the capabilities and limitations of managing PV and storage inverters through smart meters

Focus Areas

Technical Issues	Contribution of Project
Issue 2: The production characteristics of distributed PV in a high penetration scenario have not been sufficiently tested, and utilities have not been able to develop adequate models and forecasting techniques with which to consider distributed PV as a grid resource.	• Leverage over two years of distribution feeder monitoring in a high penetration SolarSmart Homes^{SM} community • Expand the existing monitoring platform to include high resolution monitoring at fifteen (15) homes and three (3) distribution transformers • Model the distribution system impacts from the implementation of storage to firm intermittency of PV production, shift PV production to system peak, and reduce overall peak load

Focus Areas

Technical Issues	Contribution of Project
Issue 3: While energy storage is seen as a potential solution for "firming" the variable output of PV, there is a lack of experimental data to show how effective storage might be for overcoming these problems.	• Both Residential Energy Storage (RES) and Community Energy Storage (CES) will be integrated with existing rooftop PV and operated in a real world utility distribution system • The systems will be sized to test capacity firming of PV and how it could provide value for customers (end-users) and utilities

Key R&D Questions Addressed

Strategic Objective 1	**Understand how the integration of energy storage could enhance the value of distributed PV resources within the community**
Key Research Questions	• Does the location of energy storage significantly change the utility's ability to "firm" customer load and distributed PV capacity? • How much storage is necessary to accomplish the desired PV and load firming effects? • Can an integrated PV/energy storage system provide service reliability benefits for customers?
Strategic Objective 2	**Determine if the addition of energy storage could add value for the utility**
Key Research Questions	• Can energy storage in a high penetration solar deployment help support SMUD's "super-peak" from 4 PM to 7 PM, particularly when PV output drops off after 5PM? • Does the location of energy storage significantly affect the ability of the utility to manage the resource? • How variable is PV output within a community or distribution feeder, and what is the potential operating impact for the utility?

Key R&D Questions Addressed

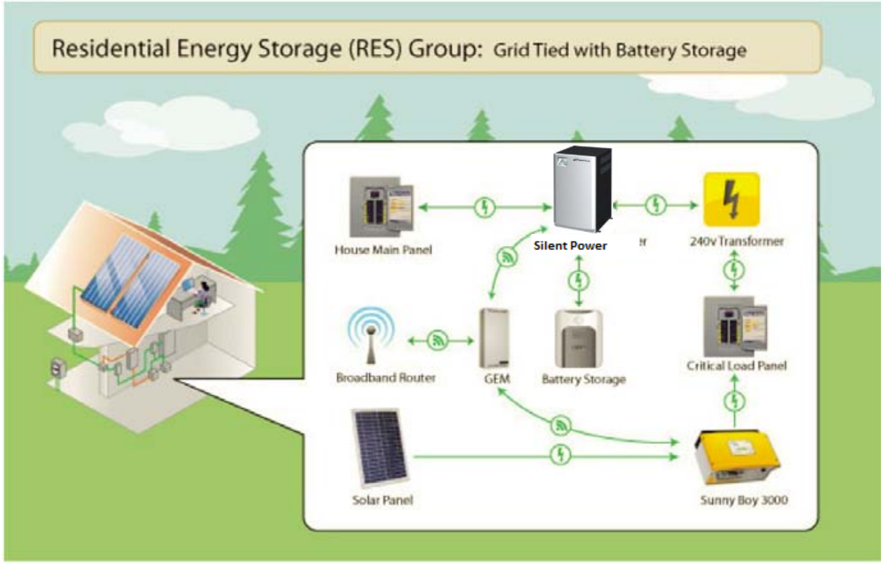
Strategic Objective 3	Determine how to leverage SMUD's AMI investment to manage a distributed PV/energy storage resource
Key Research Questions	• Can a smart meter be used to monitor and control a PV and storage system, and to what extent? • What are the practical challenges associated with using AMI for managing PV and storage? • What are the technical requirements for integrating inverters and smart meters, and what codes, standards and reference designs must be developed?
Strategic Objective 4	**Determine if capacity firming and advanced pricing signals will influence the energy usage behaviors of customers**
Key Research Questions	• Do the customers who have capacity firming capability (energy storage) behave differently than those who do not? • How does energy storage impact the customer's ability/desire to respond to pricing signals?

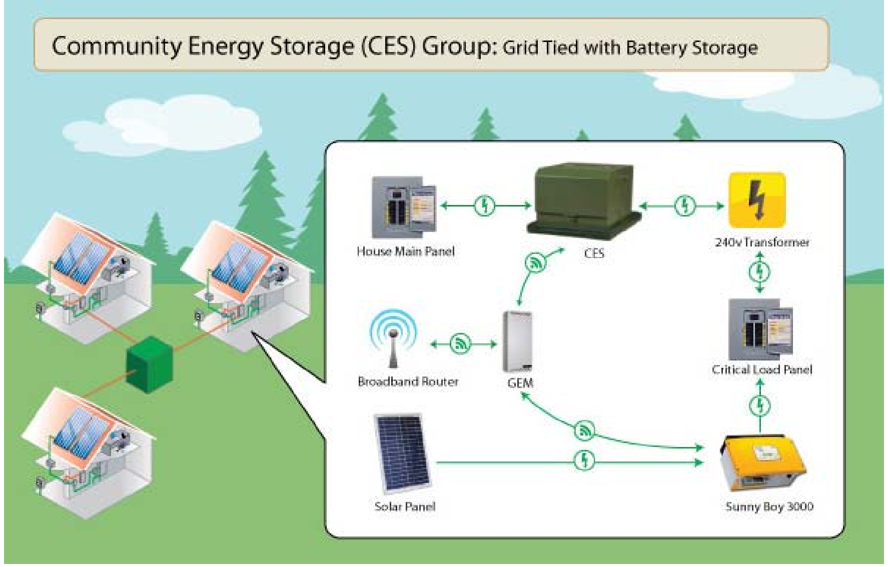
Approach

Demonstration at Anatolia SolarSmart[SM] Community with Lennar Homes

Over 270 homes with $2kW_{ave}$ PV installed

Approach



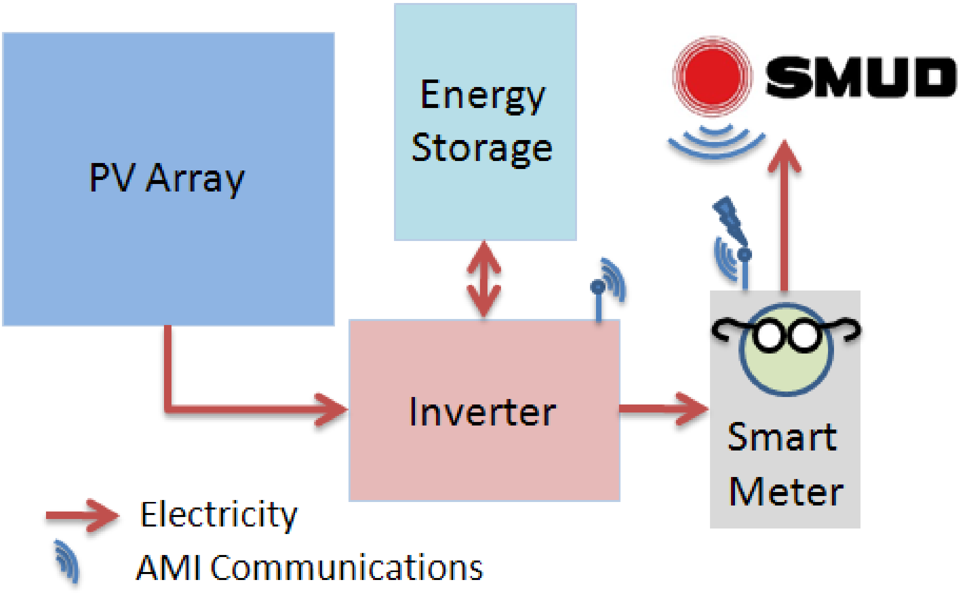


- Control group of 25 homes with PV
- RES Group – 15 units
  - UL listed Silent Power units
  - 10kW$_{peak}$/8.8 kWh SAFT Li-ion
- CES Group – 3 units
  - Connected to secondary of 50 kVA pad mounted transformers serving 9-12 homes
  - 30 kW/30 kWh SAFT Li-ion batteries
- Installing utility and customer 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

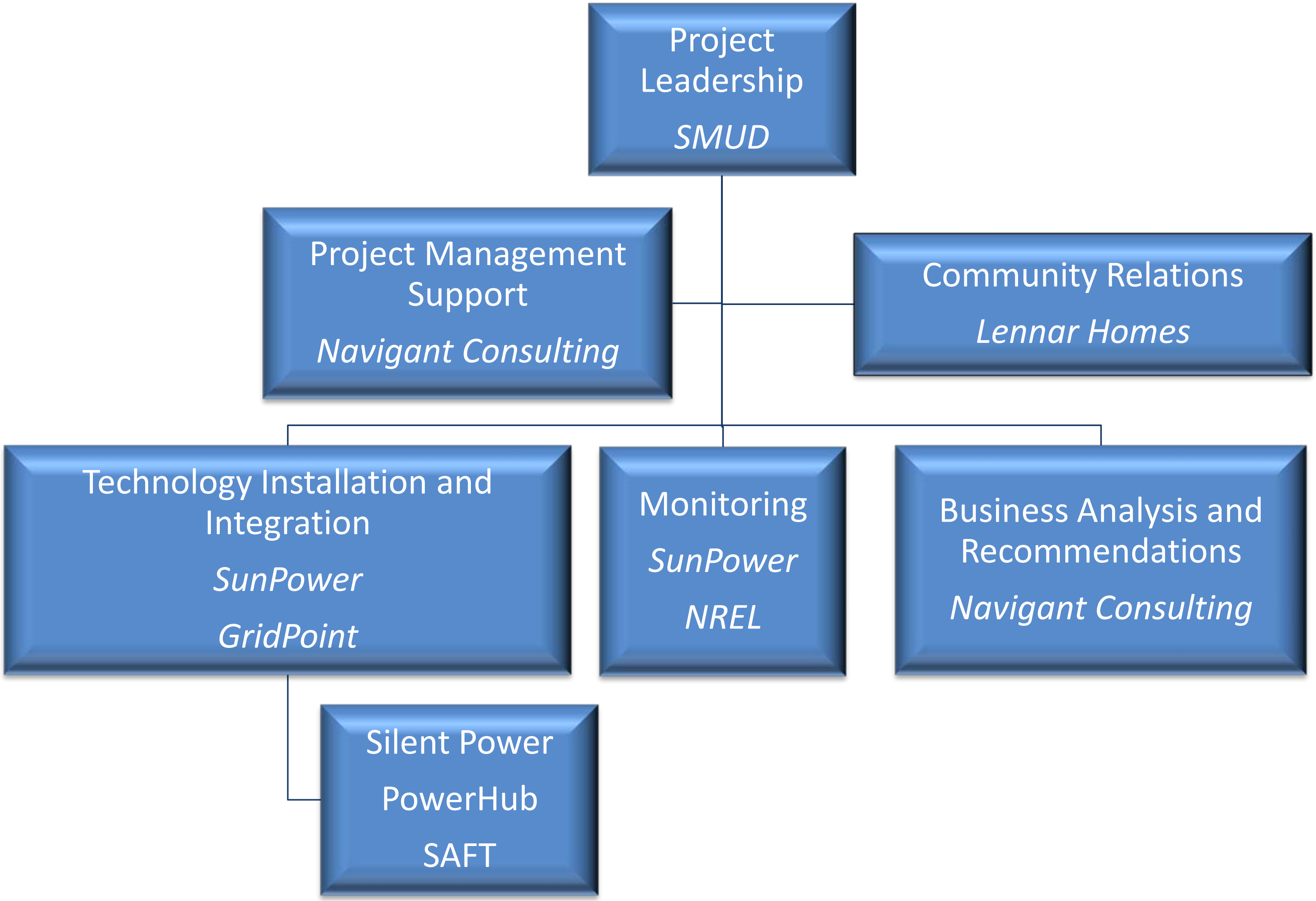
Approach

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



Collaborations



Schedule

Activity	End Date
• PV and Storage Benefits Framework	Feb 2011
• Monitoring Plan	Mar 2011
• Customer Recruitment	Apr 2011
• RES Fabrication and UL Listing	May 2011
• CES Fabrication	Aug 2011
• RES Installation	Jun 2011
• CES Installation	Sep 2011
• Monitoring Data Analysis Reports	Q3 2011- Q3 2012
• Strawman Functional Specification for Inverter/Smart Meter Communications and Control	Q2 2012
• Business Model and Deployment Strategies Report	Q3 2012

Key Deliverables

Deliverable Name	Status
• RES Design Specification	In Process
• CES Design Specification	Draft
• Data Collection and Transfer Protocol Architecture	Draft
• Operating Scenario Specification	Draft
• PV and Storage Benefits Framework	Draft
• Customer Recruitment Information, Troubleshooting Process and Agreement	Draft
• Monitoring Plan	Draft
• Monitoring Data Analysis Reports	Not started
• Strawman Functional Specification for Inverter/Smart Meter Communications and Control	Not started
• Business Model and Deployment Strategies Report	Not started

Project Budget

DOE Funds:	$4,300,971	Cash
SMUD Match:	$1,452,020	Cash and In-kind Labor
CEC Match:	$ 500,000	Cash
SunPower Match:	$ 176,995	In-kind Labor
Total	**$6,429,986**	

Summary

- SMUD is planning for sustainable energy supplies by 2050
- GHG goals/regulation driving SMUD to more renewables and other low carbon solutions
- 400 MW / 40 hour peak load problem
- Transmission constraints driving SMUD to local solutions
- Local renewables for SMUD means intermittent PV
- Smart Grid deployment will enable SMUD customer solutions such as demand response, PV and storage <u>and</u> is key to maintaining reliable energy services
- SMUD needs to under nexus of Smart Grid, PV and Storage to enable our sustainable energy future
- This R&D project and others in our portfolio are addressing key, foundational issues for broader deployment of PV in high penetrations

Q &A

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