SolarCity CSI RD&D Project

- Develop firm, dispatchable grid-interactive combined photovoltaic and stationary storage: **FirmPV**
  - Installed in distributed, small increments
  - Enhance existing SolarGuard PV monitoring network for aggregate control
  - 12 pilot installations

- With Tesla Motors
  - Develop stationary Li-ion storage module

- With UC Berkeley - Professors Kammen & Callaway
  - Develop control strategies & analysis of system wide benefits

- PG&E Advisory Committee
About SolarCity

- Highest-Volume Solar Integrator in the U.S.
  - More than 10,000 projects completed or underway
  - Residential, commercial and government sectors
  - Energy efficiency upgrades
- 1000+ Employees
- >$700 Million in Project Financing
We Build Solar Cities

Soaring Heights Communities, Davis Monthan Air Force Base
The Largest Solar-Powered Community in the Continental U.S.
6MW Project, Including 2.7 MW of Roof Mounts
SolarGuard® - Every SolarCity System is Monitored

Online Account
- Tracks solar system production 24/7
- Viewable from computer, corporate website, lobby kiosk or iPhone

Monitoring & Repair Service
- SolarCity takes responsibility by continually monitoring
- We will dispatch repair crew if necessary
FirmPV Prototype

- Installed November 2009
- PV Generation: 4 kW
- Storage: 5 kW / 10 kWh
- Server Scheduled Charge and Discharge
FirmPV Opportunities

- FirmPV can provide:
  - Voltage regulation, PV ramp rate limiting, load time shifting, T&D Asset deferral
  - A solution for intermittency and load issues at the source
  - Reduced installation costs compared to standalone storage. Shared interconnect, communications, power conversion and labor
  - Faster deployment - simplified site qualification, and design
  - An incremental solution - only what is needed where it is needed most
FirmPV Communications and Integration

**Storage**
- Residential: 5 kW / 10 kWh
- Commercial: 20 – 100 kW / 20 – 200 kWh
- 3000 – 5000 cycles
Tesla Motors – Li-ion Stationary Storage

- Adapt Li-ion vehicle battery for stationary applications

- Why Li-ion?
  - Long life, low maintenance
  - High energy and power densities
  - Scalable in small increments
  - Rapidly dropping $/kWh

- Tesla Advantage
  - 50 MWh/yr volume growing to GWhs/yr in 2012
  - Deep understanding of all Li-ion chemistries
  - Automotive safety standards
  - Standardized cell form factor made in billions/year
UC Berkeley Research

- **PV variability characterization** – of 8,000 existing systems
  - Spatial scales, ranging from distribution feeder to load aggregation point, to the entire CAISO footprint
  - Time scales, ranging from sub-minute to hourly

- **Valuing Energy Services of PV + Storage**
  - Transmission and Distribution level

- **Planning a Decentralized Grid** - device models and control strategies
  - Decentralized / distributed control for voltage regulation
  - Methods need to be fail-safe and remotely adjustable
  - Centralized control for transmission level functions
  - Seek to minimize communication requirements
Pilot Installations

- **12 FirmPV Installations in California**
  - 2011 Lead-acid: 3 x residential, 3 x commercial
  - 2012 Li-ion: 3 x residential, 3 x commercial

- Test bed for storage control communication platform
- Battery cycle testing under various scenarios
- Quantify marginal design, permitting and construction effort
- Highlight product integration issues, needs for standards, and new products
Research Topic: How to apply success of PV finance methods to energy storage?
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