

Energy-Storage and Balancing Services for Local Solar Integration:

***Recent Solar Plus Market Research
Highlights and Trends***

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**Community
Solar Value
Project**



Solar Plus Market Research

PV + Batteries + Demand Response (PV + B + DR)

- Companies
- Projects
- Analysts

Sources

- Trade press
- Company web sites
- Analyst research reports
UBS, CITI, Bernstein

1H 2015 (emphasis on Q2)

Current events and forward look

Technology forecast experience

Mid 2015 Market Indicators

- **Competition quickened in May with Tesla's news**
Announced steep price reductions late April
Booked \$800 million orders first week in May
- **PV+B+DR for demand charge management**
"Baird Equity Research ... clear economic case ... in the near term to customers like Amazon, Target and Wal-Mart" GreenTech Media, June 9, 2015
- **TX and NY utilities propose > GW scale battery build**
Oncor 5 GW, Con Ed \$1 Bn
- **Micro-grids now with PV+B+DR + conventional DG**
E.G. Schneider Electric, S&C Electric, Oncor
- **UBS forecasts 80% battery projects to be utility-scale**
Expects price point €100/kWh by 2025

Ancillary Services Examples

- **Con Edison Development**

8 MWh battery to firm and provide a 2 hour ramp at 10 MW PV plant in CA

- **Tesla**

Offer to aggregate fleet of residential and commercial batteries to sell ancillary services to grid operators; revenue sharing with battery customers

- **AES Energy Storage**

65 MW of storage and is building capacity up to 260 MW by 2016
Wind integration and grid stability services

- **RES Americas**

Frequency regulation services in PJM; building up to > 50 MW capacity

- **SCE, PG&E, SDG&E**

Each installing storage to integrate renewables at scale

Sophisticated Offers PV+B+DR

Demand Charge Management; Micro-grids

- Gexpro

“...new model of delivering energy storage system solutions in packages designed for easy deployment by solar and energy developers...”

- Elecyr

Digital micro-grids “combine energy storage with solar power to give you grid independence day or night...in the smallest house or an entire city.”

- EnerNoc

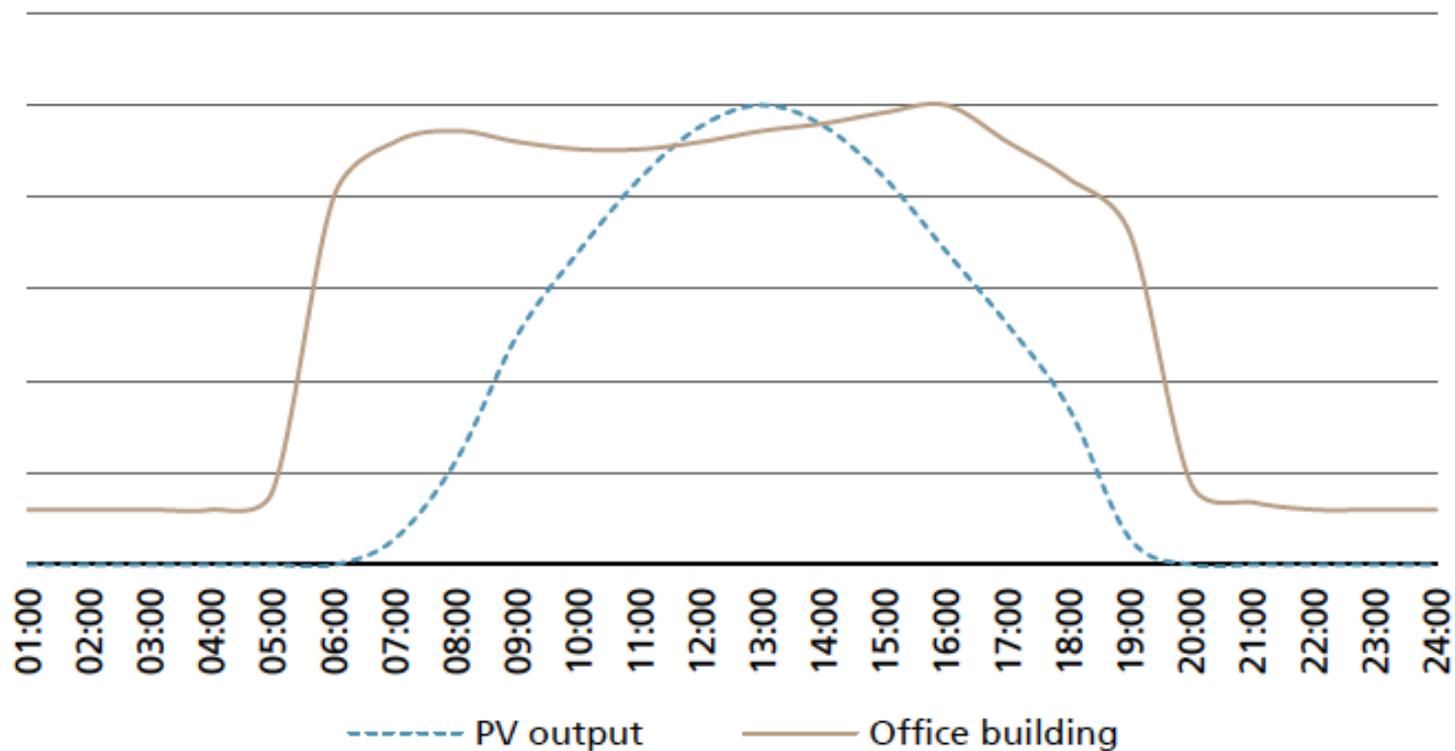
DR plus Tesla batteries in California C&I customers, including Amazon data center and Slater Bros. Supermarkets

- Powerit

“...“Manage local storage, generation, and energy consumption to minimize demand from the utility, reducing peak charges and impact on the grid.”
Dispatchable DR offers from \$125 - \$250/kW

Office Building Load and Solar

Figure 55: Load profile of an office building is decent fit with solar PV (MW)



Source: UBSe

Source: UBS, June 2, 2015

Storage Market Growth Forecasts

GreenTech Media US Historic and Near Term

<u>Year</u>	<u>MW</u>
2013	44
2014	62
2015	220

Analyst Opinions

- CITI

- January 2015 (prior to TESLA announcement)
- \$400 Billion, 240 GW battery market in US by 2030
Mostly on substations and D circuits
- \$230/kWh by about 2022, and \$150/kWh by 2030
- \$230 equals cost of pumped hydro storage

- Bernstein Research

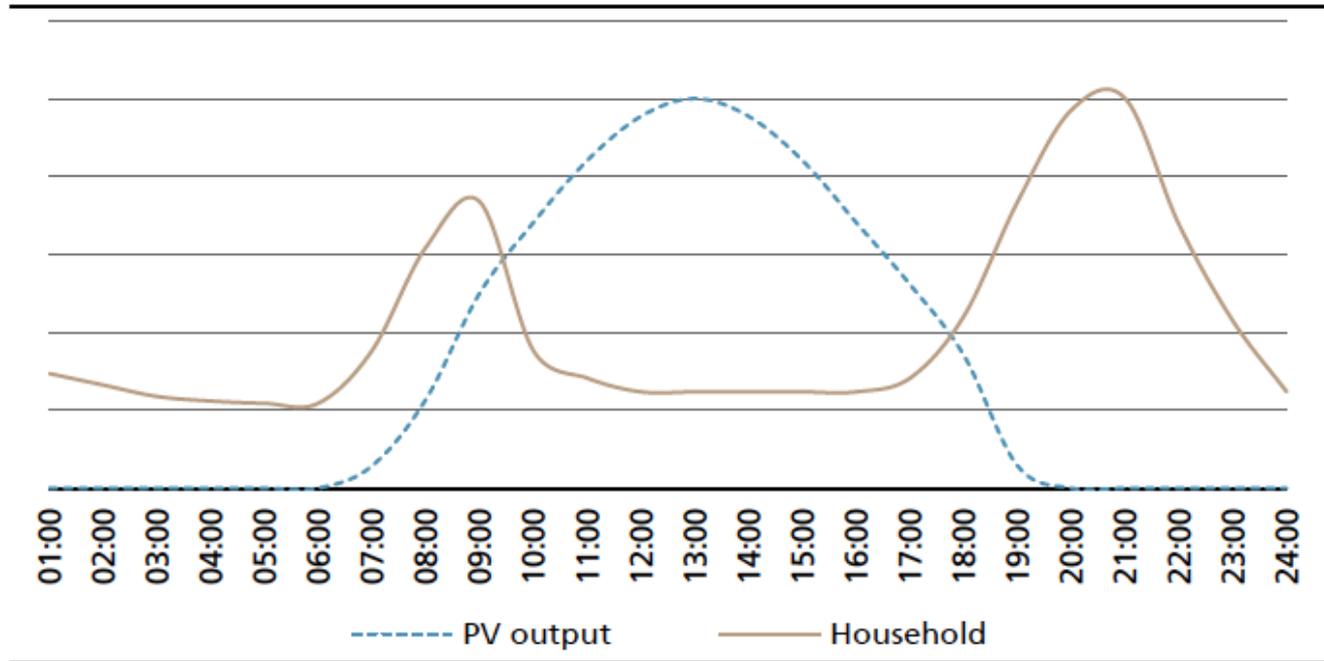
- May 2015
- *Unsubsidized* PV + B will be cheaper than grid power
2018 Australia, Japan, Spain
2020 California and other parts of US
- *Excludes* all ancillary services revenue

- UBS

- June 2015
- Strongly discounts grid defection; sees 80% storage at utility scale
- Costs to fall from €360 to €100/kWh by 2025

Residential Load and Solar

Figure 57: Load profile of solar PV and a typical residential consumer

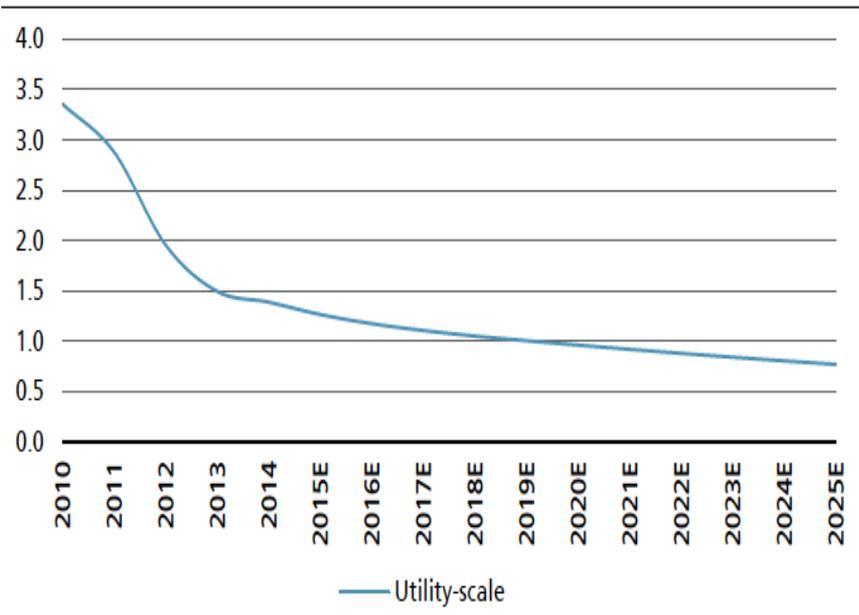


Source: UBS

PV and Battery Forward Cost

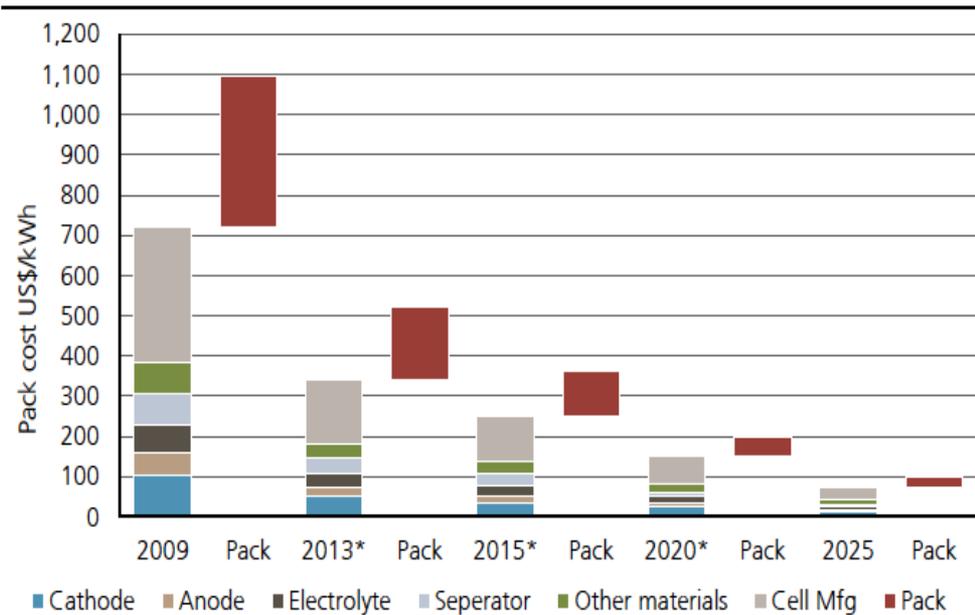
UBS – expect technology costs to fall for next decade
 Solar cost forecasts consistent with SunShot

Figure 47: Utility-scale solar capex per W evolution (€/W)



Source: UBSe

Figure 76: Battery cost should decrease by c75% over the next 10 years



Source: Tesla, Umicore, industry estimates, UBSe – Note: Excludes BoS costs

Source: UBS, June 2, 2015

Near-Term Overview – IMHO

PV, B, and DR prices keep falling; technology drives
Past price and performance not indicative of future opportunities

Ancillary services markets beginning to open
Improving economics and performance for PV+B+DR will push this

C & I demand charge management will pressure utilities
Revenue erosion w/o defection

Third party tech firms continue to innovate
danger plus opportunity for utility business

Majority of storage plays will likely be utility-scale

Tesla strategy and C&I market will play key roles

“Assimilation is inevitable,
resistance is futile”

The Presenter and the Project

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The Community Solar Value Project is focused on improving community-solar program value, through solar + storage + demand-response and other strategies, at electric utilities in Sacramento and beyond. It is led by Extensible Energy, LLC, and draws on expertise from three energy consulting firms. Contact John Powers, john@extensibleenergy.com



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