U.S. SOLAR-PLUS-STORAGE MARKET
Drivers, Economics And Outlook

July 2015

EES Reception

Ravi Manghani
Senior Analyst, Energy Storage
GTM Research
About Greentech Media

Greentech Media provides online news, market research and industry conferences covering the topics that matter to the green technology market. Sign up for our newsletter, watch a free webinar, download a whitepaper and more online! www.greentechmedia.com
GTM Research, a division of Greentech Media, is the leading source of intelligence on the transformation of the U.S. electricity sector. We focus in three key areas: solar power, energy storage, and grid edge technology. GTM Research's analysis also underpins Greentech Media's webinars and events.
Agenda

1. The State of U.S. Solar-Plus-Storage
2. Non-Residential Segment
3. Utility-Scale Segment
4. Utility-Scale Segment
5. Outlook
The State of U.S. Solar-Plus-Storage
Solar-Plus-Storage Deployments and Installation Share in the U.S.

Source: GTM Research
Behind-the-Meter Incentive Programs and Pilots

California PUC added advanced energy storage as a qualified technology for the Self-Generation Incentive Program in 2009. 2015 base incentive level for energy storage is $1.46/W and is set to decrease by 10% annually.

APS 2 MW solar-plus-storage; $1 million rebates for pilot program, residential non-volumetric charges that could impact storage

In 2014, New Jersey BPU issued a competitive solicitation for a renewable electric storage incentive. The program budget was $3 million and awarded to 13 storage projects totaling 8.75 MW paired with renewable generation. 2015 round of funding will likely total $6 million.

In winter of 2015, several bills introduced to establish tax credits for grid-connected and off-grid storage systems; PUC ordered Hawaiian Electric to streamline interconnection requirements for customer-sited energy storage with solar. Stem has 1 MW pilot program underway.

In 2014, Con Edison and NYSERDA initiated a Demand Management Program to achieve 125 MW of peak demand reduction in summer. Battery storage has a base incentive level of $2.10/W and thermal storage of $2.60/W.

U.S.: DOE $15 million funding behind-the-meter solar and storage integration

In 2014, Con Edison and NYSERDA initiated a Demand Management Program to achieve 125 MW of peak demand reduction in summer. Battery storage has a base incentive level of $2.10/W and thermal storage of $2.60/W.

In 2014, Con Edison and NYSERDA initiated a Demand Management Program to achieve 125 MW of peak demand reduction in summer. Battery storage has a base incentive level of $2.10/W and thermal storage of $2.60/W.

In 2014, New Jersey BPU issued a competitive solicitation for a renewable electric storage incentive. The program budget was $3 million and awarded to 13 storage projects totaling 8.75 MW paired with renewable generation. 2015 round of funding will likely total $6 million.

In winter of 2015, several bills introduced to establish tax credits for grid-connected and off-grid storage systems; PUC ordered Hawaiian Electric to streamline interconnection requirements for customer-sited energy storage with solar. Stem has 1 MW pilot program underway.

In 2014, Con Edison and NYSERDA initiated a Demand Management Program to achieve 125 MW of peak demand reduction in summer. Battery storage has a base incentive level of $2.10/W and thermal storage of $2.60/W.

In 2014, New Jersey BPU issued a competitive solicitation for a renewable electric storage incentive. The program budget was $3 million and awarded to 13 storage projects totaling 8.75 MW paired with renewable generation. 2015 round of funding will likely total $6 million.

In winter of 2015, several bills introduced to establish tax credits for grid-connected and off-grid storage systems; PUC ordered Hawaiian Electric to streamline interconnection requirements for customer-sited energy storage with solar. Stem has 1 MW pilot program underway.

Source: GTM Research
Battery and System Costs Will Continue to Drop

Source: GTM Research
Solar-Plus-Storage Benefits Vary in Duration and Frequency

Discharge Duration
- Short
- Medium
- Long

Frequency of Use
- Occasional
- Frequent
- Rare

Benefits:
- Ancillary Services
- Renewables Smoothing
- Peak Demand Charges
- DR Revenues
- DG Electricity Sales
- Fuel Costs
- Power Quality
- Time-of-Use Shifting
- Resiliency

Source: GTM Research
Non-Residential Segment
Primary Drivers of Non-Residential Adoption – TOU Shifting and Demand Reduction

- **Frequency of Use**: Occasional, Frequent
- **Discharge Duration**: Short, Medium, Long
- **Charges and Time-of-Use Shifting**
  - **Peak Demand Charges**: Frequent, Short
  - **Time-of-Use Shifting**: Rare, Long
- **Customer-site application**
- **Front-of-meter application**
- **Both sides of meter**

Source: GTM Research
Lifetime Commercial Solar-Plus-Storage System Economics

System Economics for Large Office - 450 kW Solar, 375 kW/750 kWh Storage (USD Millions)

- Energy Savings: $2.3 million
- Demand Charge Savings: $4.5 million ~ Double that of Energy Savings
- State Storage Incentive: $3.6 million

Revenue/Savings
- Energy Savings
- Demand Charge Savings
- State Storage Incentive
- Battery Replacement Cost
- Inverter Replacement Cost
- Total Tax Payment

Costs
- System Cost (Excluding benefits)
- O&M Cost
- Interest Payment

Total Value
- ITC Credit
- Total System Value
Residential Segment
Primary Drivers of Residential Adoption - TOU Shifting

- Frequency of Use: Occasional, Frequent, Rare
- Discharge Duration: Short, Medium, Long

- Time-of-Use Shifting
- Resiliency

Source: GTM Research
# Hawaiian Electric Case Study

## Customer Profile

<table>
<thead>
<tr>
<th>Customer Profile</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Type</td>
<td>Large Residential</td>
</tr>
<tr>
<td>Utility</td>
<td>Hawaiian Electric (HECO)</td>
</tr>
<tr>
<td>Tariff</td>
<td>Schedule TOU-R</td>
</tr>
<tr>
<td>Year of Installation</td>
<td>2018</td>
</tr>
</tbody>
</table>

## Scenario 1 - Today

- Full Retail NEM
- Weighted Avg. Electricity Price: $0.38/kWh
- Optional Time-of-Use Pricing

## Scenario 2 - Theoretical

- PV Export Price Drops to $0.16/kWh

Source: GTM Research
How Residential Energy Storage Actually Works

Reduce Export

Avoid Peak Prices

Export (kWh)

Export - Solar Only
Export - Solar Plus Storage

First Year Revenue/Savings on Excess Solar Generation

Year 1 - Revenue/Savings

$250

$200

$150

$100
$50
$0

Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

NEM Revenue (Current)
FIT Revenue (Proposed) w/o Storage
FIT Revenue (Proposed) w/ Storage
Storage Savings (Proposed)

Source: GTM Research
Storage Can Improve Residential Solar Economics in Lower Export Tariff Scenario - Hawaiian Electric Company

Unlevered Internal Rate of Return (%)

- Solar - Current NEM: 21%
- Solar - Proposed Tariff: 13%
- Solar-Plus-Storage - Proposed Tariff: 13%

Source: GTM Research
Utility-Scale Segment
Primary Drivers of Utility-Scale Adoption – Renewable Smoothing and Electricity Sales (TOU)

- Renewables Smoothing
- DG Electricity Sales
- Ancillary Services
- DR Revenues
- Power Quality
- Resiliency

Source: GTM Research
Utility-Scale Solar-Plus-Storage Explored in Five Flavors

- **Anahola Solar Farm, Kauai, HI**
  - 6 MW on 12 MW PV

- **Three 4 MW Projects at PG&E-Owned Solar Sites in CA (AB 2514 RFO)**

- **Jacumba, San Diego, CA**
  - 10 MW with 20 MW PV

- **Salinas, Puerto Rico**
  - 3.6 MW on 15.5 MW PV

- **PPAs or Auction Mechanisms**
  - TBD

- **Mandates and Utility Procurements**

- **Co-Location with Benefits**

- **Capacity Needs**

Source: GTM Research
Outlook
Annual U.S. Solar-Plus-Storage Market to Reach 769 MW by 2020

Percentage of Solar-Plus-Storage Installations / Total Solar Installations

Source: GTM Research
Annual California Solar-Plus-Storage Market to Reach 422 MW by 2020

Source: GTM Research
Annual U.S. Solar-Plus-Storage Market to Cross $3.1 Billion by 2020

Source: GTM Research
Thank You!

Ravi Manghani
Senior Analyst, Energy Storage
GTM Research
manghani@gtmresearch.com