U.S. Energy Storage: 2015 Year in Review

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1. Deployment Trends
A Record Year for U.S. Energy Storage Market With 221 MW of Deployments

Front of the Meter

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Annual Energy Storage Deployments (MW)</td>
<td>60</td>
<td>50</td>
<td>150</td>
<td>221</td>
</tr>
</tbody>
</table>

Behind the Meter

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Annual Energy Storage Deployments (MW)</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>25</td>
</tr>
</tbody>
</table>

Total

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Annual Energy Storage Deployments (MW)</td>
<td>65</td>
<td>55</td>
<td>160</td>
<td>246</td>
</tr>
</tbody>
</table>

U.S. Deployed More Energy Storage in Fourth Quarter of 2015 Than Previous Two Years

PJMT (Excl. NJ), California and Hawaii Led Utility, Non-Residential, and Residential Segments in 2015

Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review. *GTM Research is currently monitoring seven individual markets. Complete coverage of all markets is available in the full report.
Lithium-Ion Technologies Made Up 96% of 2015 Deployments (MW)

2. Market Drivers

Five Biggest Themes of 2015 and Beyond
Five Key Storage Market Drivers in 2015

#1 System Cost Reductions Continue at Rapid Pace

#2 Wholesale Markets’ Structures Develop to Include Storage

#3 Strong Renewables Growth Bolsters Storage Growth

#4 Storage Mandates and All-Source RFOs Become a Commonplace

#5 Storage Emerges As a Viable Technology for Grid Services
1) 41% Storage BOS Costs Reduction by 2020; Reach Below $400/kW

Storage BOS Costs to Reach $398/kW by 2020
Hardware Costs Reduce by 48%
Soft Costs Reduce by 31%
EPC Costs Reduce by 31%

1) Front-of-Meter System Prices Expected to Drop 20% over Next Two Years

Utility-Scale Price Trends Q4 2015, Energy Applications – 2 Hours ($/kWh)

- Q4 2015 System Price Ranges ($/kWh)
  - $1,400
  - $1,200
  - $1,000
  - $800
  - $600
  - $400
  - $200
  - $0

- Utility (Energy Application, $/kWh) - Q4 2015
  - $1,200
  - $900
  - $700
  - $500


Utility-Scale Price Trends Q4 2015, Power Applications ($/kW)

- Q4 2015 System Price Ranges ($/kW)
  - $1,400
  - $1,200
  - $1,000
  - $800
  - $600
  - $400
  - $200
  - $0

- Utility (Power Application, $/kW) - Q4 2015
  - $1,200
  - $1,000
  - $800
  - $650

- Utility (Power Application, $/kW) - 2017E
  - $1,200
  - $1,000
  - $800

2) Wholesale Markets’ Structures Evolving to Include Storage

- **CAISO** reduced performance threshold for frequency regulation.
- **CAISO** approved DERP framework.
- **PJM** reduced RegD cap of 40% from the previous cap of 62%. A Senior Task Force created to re-evaluate application of marginal benefit function to regulation market.
- **MISO** created a platform to address storage-related market rules and questions, ranging from development of a fast AGC signal to tariffs and storage classification.
- **SPP** implemented pay-for-performance compensation for frequency regulation.
- **ISO-NE** introduced energy-neutral regulation signal and different parameter sets to track conventional and energy-neutral dispatched resources.
- **ERCOT** established the DREAM Task Force to determine protocols and market rules for distributed energy resources.
- **FERC** issued order relating to third-party provision of primary frequency response.
- **CAISO** Board of Governors approved changes to the non-generator resource model under ESDER.

Source: GTM Research/ESA U.S. Energy Storage Monitor
3) Solar-Plus-Storage Benefits Vary in Duration and Frequency

Discharge Duration:
- Short
- Medium
- Long

Frequency of Use:
- Occasional
- Rare
- Frequent

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

Source: GTM Research
3) Tax Credit Extension to Spur Further Growth in Storage Paired With Renewables

Compared to the non-ITC scenario, GTM Research expects an additional 0.5 GW of storage paired with renewables from 2016-2020, a 33% increase compared to a scenario with no tax credit extension.

4) California IOUs Started Procurement toward AB 2514 in 2014

<table>
<thead>
<tr>
<th>Point of Interconnection</th>
<th>2014 Original</th>
<th>2014 Adjusted</th>
<th>2016</th>
<th>2018</th>
<th>2020</th>
<th>Total</th>
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<tbody>
<tr>
<td><strong>Southern California Edison</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td>50</td>
<td>0</td>
<td>65</td>
<td>85</td>
<td>110</td>
<td>310</td>
</tr>
<tr>
<td>Distribution</td>
<td>30</td>
<td>16.3</td>
<td>40</td>
<td>50</td>
<td>65</td>
<td>185</td>
</tr>
<tr>
<td>Customer</td>
<td>10</td>
<td>0</td>
<td>15</td>
<td>25</td>
<td>35</td>
<td>85</td>
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<tr>
<td>Subtotal SCE</td>
<td>90</td>
<td>16.3</td>
<td>120</td>
<td>160</td>
<td>210</td>
<td>580</td>
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<tr>
<td><strong>Pacific Gas &amp; Electric</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<tr>
<td>Customer</td>
<td>10</td>
<td>6.5</td>
<td>15</td>
<td>25</td>
<td>35</td>
<td>85</td>
</tr>
<tr>
<td>Subtotal PG&amp;E</td>
<td>90</td>
<td>78</td>
<td>120</td>
<td>160</td>
<td>210</td>
<td>580</td>
</tr>
<tr>
<td><strong>San Diego Gas &amp; Electric</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>22</td>
<td>33</td>
<td>80</td>
</tr>
<tr>
<td>Distribution</td>
<td>7</td>
<td>6</td>
<td>10</td>
<td>15</td>
<td>23</td>
<td>55</td>
</tr>
<tr>
<td>Customer</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>8</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Subtotal SDG&amp;E</td>
<td>20</td>
<td>16</td>
<td>30</td>
<td>45</td>
<td>70</td>
<td>165</td>
</tr>
<tr>
<td><strong>Total, All Three Utilities</strong></td>
<td>200</td>
<td>110.3</td>
<td>270</td>
<td>365</td>
<td>490</td>
<td>1,325</td>
</tr>
</tbody>
</table>

*SDG&E LCR RFO is for a minimum of 25 MW, maximum set at 800 MW.
## 4) Progress by California IOUs for 2014 Energy Storage Procurements Under AB 2514

<table>
<thead>
<tr>
<th>Utility</th>
<th>2014 Proposed Target</th>
<th>Actual Procurements</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG&amp;E</td>
<td>50 MW transmission, 24 MW distribution</td>
<td>7 projects totaling 75 MW selected in December 2015</td>
<td>First projects expected to be on-line by May 2017</td>
</tr>
<tr>
<td>Southern California Edison</td>
<td>16.3 MW distribution (Plus Local Capacity Requirement procurement)</td>
<td>2 projects totaling 16.3 MW selected in September 2015</td>
<td>Projects can start as early as January 1, 2017; must be interconnected by December 1, 2024</td>
</tr>
<tr>
<td>SDGE</td>
<td>10 MW transmission, 6 MW distribution (Plus Local Capacity Requirement procurement)</td>
<td>12 MW solicited through LCR RFO. 4 MW sought through distribution deferral RFP, but elected not to procure any storage through the RFP.</td>
<td>Project can be on-line as early as 2017, interconnection required by January 1, 2022</td>
</tr>
</tbody>
</table>

4) Other Notable Utility Procurements from New York to Guam!

**Oregon**
- Oregon DOE and U.S. DOE awarded $295,000 under Electrical Energy Storage Demonstration Project RFP.

**Colorado**
- PSC Colorado/Xcel Energy submitted two storage project proposals under the Innovative Clean Technologies program.

**Arizona**
- APS issued an all-source RFP to procure between 400 MW and 600 MW of capacity resources by 2020. TEP selected two 10 MW storage projects under REST.

**Guam**
- Guam Power Authority is soliciting bids for up to 40 MW of energy storage.

**New York**
- PSEG Long Island amended its South Fork Resources RFP and issued a New Renewable Capacity and Energy RFP. Con Edison and Orange and Rockland issued a Grid-Scale Energy Storage RFI.

**Texas**
- Austin Energy issued an RFI to solicit information on energy storage technology.

**Hawaii**
- KIUC entered in a 20-year PPA with SolarCity for power from a 13 MW/52 MWh lithium-ion storage system.

**Federal**
- U.S. DOE announced funding under Grid Modernization Initiative.

Source: GTM Research/ESA U.S. Energy Storage Monitor
5) Significant Early Activity in Behind-The-Meter Storage for Grid Services

- IRM2 Pilot
- SSP and XSP Pilots
- LCR Program
- EV and Storage Pilot
- Energy Exelcerator/Stem Pilot; Oahu EV Charging Pilot
- Tesla Powerwall Innovate Pilot
- Demand Management Program; Virtual Power Plant REV project
- PJM Projects
- Maryland Energy Administration ‘Game Changer’ Grant
- Glasgow Electric Plant Board VPP Project
- Frito-Lay FRRS Pilot

Source: GTM Research/ESA U.S. Energy Storage Monitor

## 5) Green Mountain Power to Use Behind-the-Meter Storage to Reduce Peak Capacity and Transmission Costs

<table>
<thead>
<tr>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Number of Systems (Est.)</strong></td>
<td>75</td>
<td>225</td>
</tr>
<tr>
<td><strong>Ownership</strong></td>
<td>End-customer</td>
<td>End-customer</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>End-customer</td>
<td>Partial GMP Control</td>
</tr>
<tr>
<td><strong>Utility Services</strong></td>
<td>None</td>
<td>Capacity costs: Forward Capacity Market (FCM) – 75% participation  Transmission costs: Regional Network Service (RNS) – 50% participation</td>
</tr>
<tr>
<td><strong>End-customer Benefits</strong></td>
<td>Back-up, Solar self-consumption, and TOU shifting</td>
<td>Back-up, Solar self-consumption, and TOU shifting [Not mutually exclusive with utility services at all times]</td>
</tr>
<tr>
<td><strong>End-customer Payments</strong></td>
<td>$6,500 plus installation costs paid by customer to GMP. Receives monthly bill credit of $31.76/month for 10 years</td>
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</tr>
</tbody>
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Source: Green Mountain Power, GTM Research
5) Con Edison VPP Pilot to Test Revenue Streams from Multiple Benefits

**Key Features**

- 1.8 MW/4 MWh virtual power plant
- Partners: SunPower and Sunverge
- 20-year contract, demonstration phase for 2+ years
- Projected cost: $12M over project lifetime
- Con Edison estimates 8% returns by 2021, profitable within 10 years

**Project Goals**

- Determine network benefits for grid from aggregate solar-plus-storage systems
- Determine customer resiliency benefits and assess customers’ willingness to pay for resiliency services
- Monetization value of grid services in competitive markets
- Inform rate design for and development of distribution-level markets through testing of different rate design mechanisms via VPP subgroups

**Assumptions**

- **Value Streams**: Monthly resiliency payments (to SunPower or Con Ed), VPP’s grid services (DR, firm capacity), revenue as distribution service platform (DSP) provider, referral fees
- **Cost Structure**: Initial investment in storage systems, system O&M
- **Resiliency Fees**: Con Ed will test various price levels and payment structures to inform rate design and develop product offering; Con Ed currently values capacity at $20/kW-month using a forward cost curve
- **Revenue** from VPP services and resiliency payments may lead to profitability before 2021
- **Three-Phase Assessment**: Customer leads vs. customer signups, system integration (ability to consistently receive and respond to dispatch signals, response accuracy, response speed, communication latency, system uptime), and dispatch performance
- **Project Length**: Demo for 2+ years, but leases for 20; VPP seen as long-term business model
3. Outlook
Utility-Scale Energy Storage Capacity By Requested Commissioning Date (MW)

- U.S. Utility-Scale Energy Storage Pipeline Dominated by California [Duh!]
- But There’s More to Interconnection Queue

U.S. Annual Energy Storage Deployments Will Cross 1 GW in 2019, Reach 1.7 GW by 2020

U.S. Energy Storage Market to Reach $2.5 Billion by 2020, Sixfold Growth From 2015

Thank you!