Battery Energy Storage in the California Market

Asresh Guttikonda
Tom Williard
Sage Energy Consulting
(415) 663-9914
www.sagerenew.com

May 7, 2020
About Sage

Independent Energy Consultants to Public Agencies Since 2009

- 100+ CA Public Agencies
- 350+ MW of Energy Projects
- Generation, Storage, Fleet Electrification, Zero Net Energy
- Planning, Finance, Procurement, Project Mgt, Commissioning, Performance Mgt
- Certified SBE Based in San Rafael, CA
OUTLINE

✦ Market Drivers in California
  • Grid services, Resiliency, Policy and Tariff Support

✦ Technology Overview
  • Main Type, Cost Trends

✦ Energy Storage Services
  • Regional, Utility and Customer

✦ Economic Value
  • Where does BESS value come from?

✦ Implementation
  • How BESS is implemented
MARKET DRIVERS IN CALIFORNIA
Microgrids for Grid Resiliency

- PSPS events due to wildfires likely to continue in future.
- A Microgrid can operate independently from the grid with a group of distributed energy resources to power critical infrastructure.
- BESS integral to storing renewable energy for consumption on demand.
- Various Scales:
  - Home/Building
  - Campus (Santa Rosa Junior College)
  - Utility (SDG&E Borrego Springs)
Flattening the Duck Curve

+ Overgeneration from integration of renewables on grid; low/negative wholesale energy prices.
+ Store excess energy during mid-day and discharge during evening ramp.
+ Fast response times with lower environmental impact.

Source: CAISO
Other Grid Services

- Frequency Response
- Voltage Regulation
- Black Start
- Spinning Reserve
- Reduced Curtailment
- Capacity Firming
California Policy and Tariff Support

+ CA Legislature and State
  • SB100 - California Renewables Portfolio Standard Program
  • SB700 - Extending SGIP Program
  • SB1339 - Microgrid Legislation
  • SB1215 - Local Government De-energization Event Resiliency Program
  • Title 24 update ZNE

+ CAISO
  • Energy Storage and DER Initiative

+ CPUC/Utility
  • PG&E Option S Tariff
  • 2019-2020 Electric Resource Portfolio
Federal and State Incentives

+ 26% ITC until the end of 2020
  • 22% in 2021, 10% in 2022 (Commercial); 0% (Residential)

+ MACRS
  • 100% bonus depreciation before Jan. 1, 2023 (TJCA 2017)

+ SGIP Incentives for energy storage
  • Step 3 – Large Storage (Step 2 for PG&E)
  • Step 5 – Small Residential (waitlisted)
  • System size >2 hour reduces incentive amount

NEW! SGIP Equity and Resiliency
  • Equity = $0.85/W
  • Equity Resiliency = $1.00/W
  • Application portal open now
  • Applications can be submitted May 12th
  • Will likely be oversubscribed on day 1

Source: NREL
TECHNOLOGY OVERVIEW
Battery Chemistries

+ Lithium-ion (~95% of US Grid Market)
  - Highly developed - more bankable
  - High energy density, portable
  - 30 min to 4-hour applications
  - 75-85% round trip efficiency
  - No moving parts, high reliability
  - Degrade over time, require replacement/disposal strategy

+ Redox Flow (~4% of US Grid Market)
  - Lower energy density
  - 4-hour+ applications
  - 65-75% round trip efficiency
  - Pumps reduce reliability
  - Do not degrade significantly, long service and cycle life

Source: NREL
Cost Trends

- $207/kWh in 2018, $144/kWh in 2022
- 8-10%/year of cost reduction through 2022

Year-Over-Year Decline in Battery Price and BOS Cost, 2013 – 2022e

Source: GTM Research
BESS APPLICATIONS & SERVICES BY MARKET SECTOR

ISO/RTO | Utility (Front of Meter) | Customer (Behind the Meter)
BESS Services by Area and Duration

Source: DOE SHINES Program
BESS Services by Market Sector

Source: NREL
Regional ISO/RTO Services – CAISO

• What is CAISO?
  • California Independent System Operator
  • Manages electricity flow across transmission lines in 80% of CA and part of Nevada
  • Coordinates energy resources and operates a wholesale power market
  • Forecasts electrical demand and dispatches lowest cost generation

• ISO/RTO BESS Services
  • Frequency Regulation
  • Ramping/Spinning Reserves
  • Voltage/Reactive Power Support
  • Energy Arbitrage/Renewables Firming
  • Black Start
BESS Services

ISO/RTO
Capacity and Services

Source: EIA
**BESS Services**

**Utility Services (in front of the meter)**

- Resource Adequacy
- Renewables Firming
- Transmission Congestion Relief
- Transmission Deferral
- Distribution Deferral

**Example**

- **Resource Adequacy/Peaker Plant Replacement**
  - 567 MW Li-ion BESS project in Bay Area
  - Proposal to CPUC to replace 3 gas-fired peaker plants
  - CPUC approved, being implemented

<table>
<thead>
<tr>
<th>Counterparty (Project Name)</th>
<th>Storage Technology</th>
<th>Connection Point</th>
<th>Term (years)</th>
<th>Discharge Duration (Hours)</th>
<th>Size (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynergy Marketing and Trade, LLC (Vistra Moss Landing Energy Storage)</td>
<td>Lithium Ion Batteries</td>
<td>Transmission</td>
<td>20</td>
<td>4</td>
<td>300</td>
</tr>
<tr>
<td>Hummingbird Energy Storage, LLC (Hummingbird Energy Storage)</td>
<td>Lithium Ion Batteries</td>
<td>Transmission</td>
<td>15</td>
<td>4</td>
<td>75</td>
</tr>
<tr>
<td>Micronoc Inc. (mNOC AERS Energy Storage)</td>
<td>Lithium Ion Batteries</td>
<td>Customer (Behind the Retail Meter)</td>
<td>10</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Tesla, Inc. (Moss Landing Energy Storage)</td>
<td>Lithium Ion Batteries</td>
<td>Transmission</td>
<td>20</td>
<td>4</td>
<td>182.5</td>
</tr>
</tbody>
</table>

Total Capacity (MWs): 567.5
BESS Services

+ **Customer Services** (behind the meter)
  - TOU Bill Management
  - Peak Shaving/Demand Charge Reduction
  - Renewables Firming
  - Backup Power/Resilience

Where most energy storage is deployed:
Customer sited, behind the meter
BESS SIZING CONSIDERATIONS
CUSTOMER SITED SYSTEMS

kW and kWh | Rated and Actual Capacity
Battery System Sizing - kW/kWh

Battery storage size is rated in two ways
- kW – this is the peak discharge (and often the charge) rate
- kWh – this is storage capacity
- Battery systems are often referred to as “1-hour, 2-hour, or 4-hour”
  - This is the length of time it would require to completely discharge a full battery
  - kWh/kW = 200kWh/50kW = 4 hours

Actual, Rated and Lifetime Capacity
- Is all the capacity usable? (or just 80%)
- How much of the rated capacity is usable after 10 years?
BESS ECONOMIC VALUE
CUSTOMER SITED SYSTEMS

Value Streams and Stacking | Financing | Utility Tariffs
For Customers (behind the meter), value stream stacking is limited.

**Value Streams and Stacking**

- Primarily demand cost reduction
- Can sometimes utilize energy arbitrage
  - Limited by ITC financing with solar
- Other value streams limited
  - Regulation and tariffs moving slowly and unpredictable
  - Contract issues: Customer value preservation with conflicting applications
BESS Economic Value

Proposed PG&E A-6 Tariff and TOU Periods

Energy Value

Hours of Day

Solar Generation

$0.19

$0.25

$0.25

$0.29

$0.29

$0.25

Summer Off

Summer Mid

Summer Peak

Solar Generation
Tariff Change Example: PG&E Option S

+ New “Storage Friendly” tariff (October 2019)

+ Pilot program to address lack of tariff support for storage
  - Applies to E19 and E20 rate customers only (medium/large commercial)
  - Based on Option R solar friendly tariff
  - Hourly demand charges (instead of peak monthly)
  - No demand charges during middle of day
  - Capped at 150 MW of storage

+ Will have strong impact on energy management
BESS AND MICROGRIDS
Microgrids – Important Considerations

1) Set Goals

Define by function first

1. Critical functions, must have
2. Duration

2) Assign Value to Resilience (VOR)

What are your costs of not operating?

• Facilities, loss of business, client claims, reputation...
• Cost to parents and local businesses for homecare of children
• Lost tax revenue
Microgrids – Important Considerations

3) Assess Existing Equipment

Switchgear and Existing Generation/Storage Assets
1. Assess condition – reconfiguration possible?
2. Retrofits can be difficult/expensive
3. Can existing resources handle it?

4) Determine Microgrid Type/Approach

Goals, VOR, existing conditions, budget, incentives

- **Basic** – manually operated disconnect, manual load shedding (turning off circuits)
- **Typical** – ATS with critical load panel
- **Automated** – fully automated at each circuit
BESS IMPLEMENTATION
BESS Implementation

**+ An IT Solution**
- It’s all about the software
- Data inputs:
  - Site usage
  - Critical loads
  - Generation (Solar PV, fuel cells)
  - Active tariff
  - Time of day
  - BESS parameters
    - Capacity, charge, temp,
    - Import/export limits
  - Historical trends

**+ Vendor Configurations**
- Software-only
  - STEM
  - Geli
- Integrators (most BESS vendors)
  - Renewable Energy Systems Group
  - AES Energy Storage
  - NEC Energy Solutions
- Vertical (hardware + software in-house)
  - Tesla
  - Engie/Green Charge Networks
  - Wartsila/Greensmith
BESS Implementation

+ Footprint

• Residential
  ▪ Floor or Wall Mounted
  ▪ LG Chem 5 kW/9.8 kWh ~6 SF
  ▪ Tesla Powerwall-2 5 kW/14 kWh ~9 SF

• Commercial
  ▪ Concrete pad
  ▪ 250 kW/500 kWh ~100 SF
  ▪ Height ~8 ft
Siting Considerations

- **General**
  - Close to main service
  - Spare conduits
  - Footprint reservation

- **Title 24 Part 9 California Fire Code 2019 (Section 1206)**
  - **Outdoor Systems:**
    - Minimum 5 feet from the Lot lines, Public ways, Buildings, Combustible/Hazardous materials
    - Minimum 10 ft from any point of egress
    - Vehicle impact protection
    - Secured against unauthorized entry
  - **Indoor Systems:**
    - Fire Suppression System, Smoke and gas detection
    - Battery arrays (not to exceed 250 kWh, listed UL 9540) spaced 3 ft apart and from room walls.
    - 75’ above the lowest level of fire department vehicle access or 30’ below the finished floor of lowest exit discharge
    - Room separated from the remainder of the building by a fire barrier (1-2-hour rating)

### Maximum Allowable Battery Quantities

<table>
<thead>
<tr>
<th>Battery Technology</th>
<th>Maximum Allowable Quantities</th>
<th>Group H Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow batteries</td>
<td>600 kWh</td>
<td>Group H-2</td>
</tr>
<tr>
<td>Lead acid, all types</td>
<td>Unlimited</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Lithium, all types</td>
<td>600 kWh</td>
<td>Group H-2</td>
</tr>
<tr>
<td>Nickel cadmium (Ni-Cd)</td>
<td>Unlimited</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Sodium, all types</td>
<td>600 kWh</td>
<td>Group H-2</td>
</tr>
<tr>
<td>Other battery technologies</td>
<td>200 kWh</td>
<td>Group H-2</td>
</tr>
</tbody>
</table>

BESS Implementation

**Indoor Systems**
Commercial BESS Example

+ CA Public School District High School.
+ 1 MW/1MWh BESS
+ Total enclosure ~900 SF, BESS pad ~half the total area
+ Height ~9 ft
• Peak Shaving/Demand Charge Reduction
  ▪ Took almost a year to stabilize system function
  ▪ Vendor connected one system to wrong meter, requiring major rework of interconnection

• TOU Bill Management (energy arbitrage)
  ▪ Limited because system financed using Federal ITC
  ▪ Batteries can only be charged from solar PV

• Backup Power/Resilience
  ▪ Would like to augment portable backup generators
  ▪ Limited because of SGIP requirements for discharge cycles, uneconomic to set aside significant portion of battery capacity as reserve without considering Value of Resilience
PG&E’s 182.5MW, 730MWh at Moss Landing (approved in March 2020).

Part of larger 567 MW/2,270 MWh project with three other firms.

Footprint ~4.5 acres

Address local capacity requirements, participate in CAISO market, providing energy and ancillary services.

Source: Tesla
7 contracts, projects ranging from 50 MW to 230 MW.

For comparison, total installed capacity in US was 523 MW in 2019.

Hybrid projects, most co-located with solar PV.

Increase grid reliability and help integrate more renewable generation.

SCE procures 770 MW of battery storage to bolster California's grid as gas plants approach retirement.
THANK YOU

© COPYRIGHT 2020
SAGE ENERGY CONSULTING, INC.
SAGERENEW.COM