SDG&E’s Energy Storage Implementation

DOE – Energy Advisory Committee

Thomas Bialek PhD, PE
Chief Engineer

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Existing Substation Energy Storage Projects

- 2 units (1 MW / 3 MWh) installed and in production

<table>
<thead>
<tr>
<th>Location</th>
<th>Size (kW/kWh)</th>
<th>Mfg/Integrator</th>
<th>Status</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrego Springs Microgrid</td>
<td>500/1500</td>
<td>Saft/Parker Hannifin</td>
<td>Production</td>
<td>Peak Shaving, Time Shifting, VAr Dispatch, Island Support, PV Smoothing</td>
</tr>
<tr>
<td>Pala Substation</td>
<td>500/1500</td>
<td>Greensmith</td>
<td>Production</td>
<td>Time Shifting, VAr Dispatch, PV Smoothing</td>
</tr>
</tbody>
</table>
### Existing Community Energy Storage Projects

- 12 units (260 kW / 391 kWh) installed with 7 in production

<table>
<thead>
<tr>
<th>Location</th>
<th>Qty</th>
<th>Size (kW/kWh)</th>
<th>Mfg/Integrator</th>
<th>Status</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>STC, Clairemont, Poway</td>
<td>3</td>
<td>25/72</td>
<td>Saft/Powerhub</td>
<td>Installed, technical evaluation</td>
<td>PV Smoothing, Peak Shaving, VAr Dispatch</td>
</tr>
<tr>
<td>Borrego Springs</td>
<td>3</td>
<td>25/50</td>
<td>Greensmith</td>
<td>Production</td>
<td>PV Smoothing, Peak Shaving, VAr Dispatch, Islanding</td>
</tr>
<tr>
<td>Century Park</td>
<td>1</td>
<td>50/82</td>
<td>Greensmith</td>
<td>Production</td>
<td>PV Smoothing, support for EV chargers</td>
</tr>
<tr>
<td>San Diego Zoo</td>
<td>1</td>
<td>100/100</td>
<td>PPS/Kokam</td>
<td>Production</td>
<td>PV smoothing, VAr support, schedule charge/discharge</td>
</tr>
<tr>
<td>UCSD MESOM</td>
<td>1</td>
<td>6/11</td>
<td>Sunverge/Kokam</td>
<td>Production</td>
<td>Support for EV chargers, mitigate demand charges, synchronize energy storage with PV array</td>
</tr>
<tr>
<td>SDSU Suites</td>
<td>1</td>
<td>18/32</td>
<td>Sunverge/Kokam</td>
<td>Production</td>
<td>Support for EV chargers, mitigate demand charges, synchronize energy storage with PV array</td>
</tr>
<tr>
<td>Santa Ysabel Microgrid</td>
<td>2</td>
<td>30/34 and 6/10</td>
<td>Saft and Sunverge</td>
<td>Production</td>
<td>Power smoothing for wind generation in support of islanding critical assets</td>
</tr>
</tbody>
</table>
**Planned SES Projects**

- 5 units (5 MW / 14 MWh) contracted Q4 2012, to be installed by Q2 2014
- Worked with Distribution Planning to identify locations SES would provide an alternative to traditional solutions

<table>
<thead>
<tr>
<th>Location</th>
<th>Size (MW/MWh)</th>
<th>Mfg/Integrator</th>
<th>Status</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrego Springs Unit 2</td>
<td>1/3</td>
<td>Saft</td>
<td>Site testing Operational</td>
<td>Peak Shaving, Time Shifting, VAr Dispatch, Island Support, PV Smoothing</td>
</tr>
<tr>
<td>C1243 (Ortega Hwy)</td>
<td>1/3</td>
<td>Greensmith</td>
<td>Installing</td>
<td>Peak Shave, Time Shifting, VAr Dispatch, Islanding</td>
</tr>
<tr>
<td>C75 Mt San Miguel</td>
<td>1/3</td>
<td>Greensmith</td>
<td>Installing</td>
<td>Reliability, Islanding, Power Quality</td>
</tr>
<tr>
<td>Julian</td>
<td>1/2</td>
<td>S&amp;C</td>
<td>Installing</td>
<td>Reliability, Islanding, Power Quality</td>
</tr>
<tr>
<td>North City West – Canyon Crest Academy</td>
<td>1/3</td>
<td>Saft</td>
<td>Installing</td>
<td>PV Smoothing, Power Quality, Islanding</td>
</tr>
</tbody>
</table>
Community Energy Storage (CES)

- Three Units
- 30 kW, 72 kWh Each
- Saft Lithium Ion Batteries
- Powerhub Inverter and Cabinet
- 120/240 V Single Phase
- Current Uses
  - Ad-hoc testing (Skills)
  - Daily peak shaving (Clairemont)
  - Temporarily offline for repair, previously used for PV smoothing (Poway)
Borrego Community Energy Storage (CES)

• Three Units
• 25 kW, 50 kWh Each
• 120/240 V Single Phase interconnection
• Kokam Lithium Ion batteries
• S&C Inverter and Cabinet

• Currently Online and available for:
  • Islanding
  • Constant Output
  • Peak Shaving
  • Arbitrage
  • PV Smoothing
  • VAr Dispatch
**CES PV Smoothing Operation**

- Units capable of smoothing intermittency caused by fluctuating power output
- Operational variables can be user-defined i.e. Ramp rate control, time constant

![Graph showing power output with red and blue lines](image)

![Diagram of PV system components](image)
CES - Borrego Flood Outage 9/6-7

- No outage seen at St. Vincent CES unit site
Procurement Issues

- Limited market availability, long lead times, extended supply chains
- “Turnkey” contracts do not cover all work/costs required for commissioning
  - E.g. land, environmental, site preparation, electrical interconnection / upgrades, software integration
- Vendor financial strength inconsistent
- Some vendors exaggerate their capabilities
  - Systems not ready to be commercially deployed (e.g. Flow battery used to model / forecast GRC storage projects, but not actually available on a commercial basis)
  - Inability to perform full Factory acceptance test (e.g. full power test, PV smoothing test)
- Some vendors are unable to offer full “turnkey” projects
- Some vendors refuse to provide hard quotes (they offer budgetary estimates, subject to extras)
- Most vendors do not offer extended warranties – those that do, are they going to be around? Is capacity degradation covered (usually not)?
- Usable capacity of battery systems is 10-20% less than nameplate capacity (cells cannot be discharged to 0%)
Design / Engineering Issues

• No validated models to size capacity & duration of units
  – What do you need, and where, for what application[s]?

• Large, heavy units require significant space and civil/structural engineering (concrete pads, retaining walls, etc.)

• Lack of utility construction standards
  – SDG&E is developing these for our service territory – e.g. requiring a SCADA switch in front of each large battery system

• Cooling requirements can be significant if the units are in operating areas with high ambient temperatures (15kW to 30kW common for 500 kW system).
  – Passive vs. active cooling: passive requires additional space, active requires additional equipment and associated maintenance, and electrical demand

• Noise considerations if units are installed in populated areas. Inverters operating at high kW levels can produce a loud, high-frequency sound.

• Safety, environmental and permitting issues
Construction / Installation Issues

• Physical
  – Battery yards require walls or fences, possibly sound barriers
  – Battery yards need to be large to accommodate (equipment, working space, ingress/egress, cranes), similar in many respects to a substation
  – Battery containers require large concrete pads or piers; seismic requirements must be met
  – Environmental restrictions – e.g. species protection, materials used in equipment, storm water runoff
  – Large footprint for minimal MW, MWh – easement and other right-of-way issues

• Electrical
  – Large batteries require SCADA switches for quick isolation (increases cost, complexity)
  – Some battery systems require non-standard transformers
  – Some installations require non-standard cables that are flexible enough to be trained inside the inverter cabinets (e.g. those used on hybrid locomotives that support a very tight bend radius)

• IT
  – Communication requirements, availability, reliability
  – Hardened, reliable secure environments are required
Operations Issues

- Lack of integration between network management systems (OMS/DMS, IT network systems) and battery controls / element management systems
  - New functions and interfaces
- Cloud based web-portal or other custom control systems for each vendor
- Immaturity of integrated solutions
- Communications between systems sporadic
  - E.g. local communications between devices (battery/PCS), and backhaul to utility
- Vendor support – some vendors more responsive than others
  - Spare parts, repairs, software fixes
- Scaling of solution is non-trivial – not as simple as just adding more modules
- Failure modes are different for each solution / vendor
- Fire protection / suppression requirements for lithium-based chemistries are significant
Net Load and Flexible Capacity Needs – SDG&E

System Low Days

Net Load

1500 MW in 2.5 Hours

Hour Ending Pacific Standard Time (PST)
Questions?

Thank You

Thomas Bialek
Chief Engineer

TBialek@semprautilities.com

www.sdge.com/smartgrid/