Title
Integration & Operation of a Microgrid at Santa Rita Jail

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Environmental Energy Technologies Division

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Integration & Operation of a Microgrid at Santa Rita Jail

Team: Nicholas DeForest, Judy Lai, Michael Stadler, Gonçalo Mendes, Chris Marnay & Jon Donadee
Project Partners: Lawrence Berkeley National Laboratory, Chevron Energy Solutions & Alameda County

Introduction
Santa Rita Jail is a 4,650 remote facility located in Dublin CA, approximately 40 miles (65 km) east of San Francisco. Over the past decade, a series of Distributed Energy Resources (DER) installations and efficiency measures have been undertaken to transform the 30W facility into a “Green Jail”. These include a 1.2MW rated rooftop PV system installed in 2002, a 1MW molten carbonate fuel cell with CHP and inverters to lighting and HVAC systems to reduce peak loads. With the upcoming installation of a large-scale battery and fast static disconnect switch, Santa Rita Jail will become a true microgrid, with full CERTS Microgrid functionality. Consequently, the jail will be able to seamlessly disconnect from the grid and operate as an island in the event of a disturbance, reconnecting again once the disturbance has dissipated. The extent to which that jail is capable of islanding is principally dependent on the energy capacity of the battery—one focus of this investigation. Also presented here are overviews of the DER currently installed at the jail, as well as the value it provides by offsetting the purchase of electricity under the current Pacific Gas & Electric (PG&E) tariff.

Santa Rita Jail

Tariff Structure
Santa Rita Jail currently purchases its electricity under PG&E’s E-20 tariff. The tariff (Table 1) employs time of use (TOU) charges for energy and power demand. TOU rates vary both by month, with “summer” and “winter” periods, as well as hour of the day, with “off-peak”, “part-peak” and “max-peak” periods. There is an additional charge for the maximum monthly power demand. Given the time sensitivity of the E-20 tariff, there is strong incentive to push electricity purchases off-peak. (see Optimization & Scheduling) 2009 monthly electricity bills are given in Figure 1, by power and energy charges.

Table 1: Structure of PG&E E-20 Tariff

<table>
<thead>
<tr>
<th>Charge Type</th>
<th>Energy</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Max Peak</td>
<td>$11.04</td>
<td>12:00-18:00, M-F</td>
</tr>
<tr>
<td>Part Peak</td>
<td>$2.59</td>
<td>8:00-12:00, 18:00-21:30, M-F</td>
</tr>
<tr>
<td>Off Peak</td>
<td>$0.82</td>
<td>8:30-21:30, M-F, Weekends</td>
</tr>
<tr>
<td>Winter Max Peak</td>
<td>$7.45</td>
<td>00:00-06:00, M-F, Weekends</td>
</tr>
<tr>
<td>Off Peak</td>
<td>$0.76</td>
<td>8:30-21:30, M-F, Weekends</td>
</tr>
</tbody>
</table>

1 - Microgrid/Macrogrid Connection
Currently, the jail does not have the ability to seamlessly disconnect from the grid in the event of a disturbance. After the the DER is commissioned with the battery, the jail can push electricity produced on-site. These conditions have frequently contributed to problems with DER at the jail; sometimes requiring the fuel cell to trip off. Once off, the fuel cell requires several hours to ramp back up to full output. While short, these outages have a potentially significant economic impact by setting monthly power demand charges. Outages are also suspected to have a detrimental effect on the life of the fuel cell stack. By installing a fast static disconnect switch and battery, these issues can be avoided in the future, while also improving reliability at the jail, by way of CERTS Microgrid functionality.

2 - PV System
Installed at 1.2MW the roof-mounted PV system at Santa Rita Jail has a historic peak generation of only about 750kW. Of the four PV arrays present at the jail, one has deteriorated significantly, contributing to the new output.

4 - Battery
The installation of a large-scale battery at Santa Rita Jail provides added reliability, plus the potential to shift electricity purchase to less expensive off-peak times. The specifications of the battery will determine the extent to which it can accomplish these tasks. The jail has considered two battery technologies recently, and while this decision is not based entirely on economics, such a comparison has been conducted here to demonstrate how well each fits this specific microgrid application. Assumptions for battery specifications are outlined in Table 2.

Table 2: Battery Specifications

<table>
<thead>
<tr>
<th>Battery</th>
<th>Technology</th>
<th>Capacity</th>
<th>Power</th>
<th>Efficiency</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sodium-Sulfur</td>
<td>12,000 kWh</td>
<td>4,000 kW</td>
<td>0.77</td>
<td>0.83</td>
</tr>
<tr>
<td>B</td>
<td>Li-Iron Phosphate</td>
<td>2,000 kWh</td>
<td>2,000 kW</td>
<td>0.002</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Optimization & Scheduling
The battery is the very last-dispatchable DER at the jail, utilizing CERTS Customer Adoption Module (CERTS-CAM) optimal battery scheduling is determined for several scenario-weeks. This has been conducted for an operational fuel cell (Scenario 1) and, more realistically, a short fuel cell outage (Scenario 2). The savings as a result of the battery are also tabulated (Table 3).

The higher capacity of Battery A allows it to reduce max-peak power demand charges more than Battery B. A is also capable of islanding for longer durations than B, which is of value in microgrid applications. Despite its lower capacity, B still captures a significant portion of potential demand charge savings B can allow for short periods of islanding. Its installation should also help mitigate disturbance-related fuel cell outages.

Table 3: Results of CERTS-CAM Weekly Operations Optimization

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Battery</th>
<th>Energy Savings</th>
<th>Power Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>$626</td>
<td>$12,558</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>$459</td>
<td>$9,560</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>$747</td>
<td>$570</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>$2,144</td>
<td>$11,363</td>
</tr>
</tbody>
</table>

Note: Power savings assume that monthly demand charges are set during the week investigated.

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