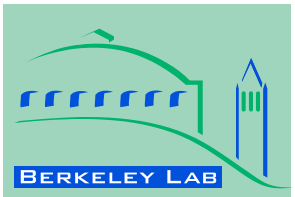

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Integration & Operation of a Microgrid at Santa Rita Jail

Nicholas DeForest, Judy Lai, Michael Stadler, Gonçalo Mendes, Chris Marnay & Jon Donadee

Environmental Energy Technologies Division

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Disclaimer

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 4,500 inmate 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 **3MW** 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 retrofits 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 dependant 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.

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.

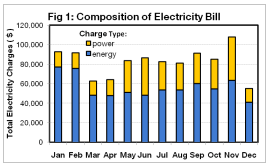
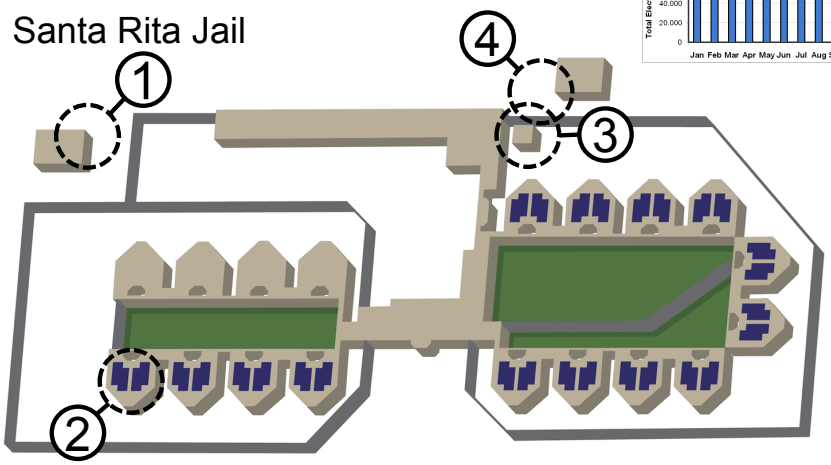


Table 1: Structure of PG&E E-20

Charge Type		power	energy	Duration
Summer	Max Peak	$11.04	$0.14040	12:00-18:00, M-F
	Part-Peak	$2.59	$0.09807	8:30-12:00, 18:00-21:30, M-F
	Off-Peak	-	$0.07992	21:30-8:30, M-F; Weekends
	Maximum	$7.45	-	
Winter	Part-Peak	$0.82	$0.08585	8:30-21:30, M-F
	Off-Peak	-	$0.07664	21:30-8:30, M-F; Weekends
	Maximum	$7.45	-	
		[$/kW]	[$/kWh]	

Santa Rita Jail



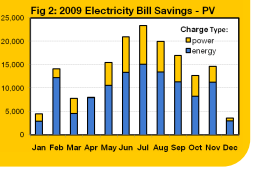
1 - Microgrid/Macrogrid Connection

Currently, the jail does not have the ability to seamlessly disconnect from the grid in the event of a disturbance. Also, under its current agreement with the utility, it cannot export 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.

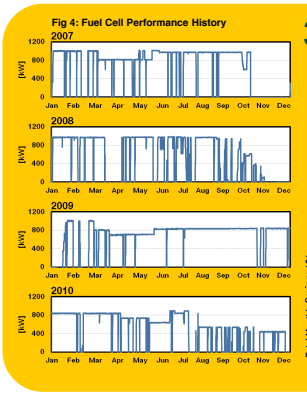
2 - PV System

Rated at **1.2MW**, the roof-mounted PV system at Santa Rita Jail has a historic peak generation of only about **700kW**. Of the four PV arrays present at the jail, one has deteriorated significantly, contributing to the low output.

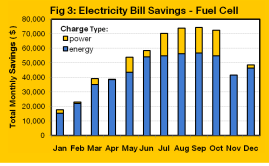
Despite this underwhelming performance, the value of PV is evident in **Figure 2**. Because PV output coincides with peak times, it effectively offsets some purchases of electricity at the most expensive rates.

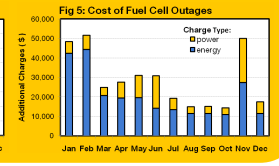


3 - Fuel Cell



Santa Rita Jail is equipped with a **1MW** molten carbonate fuel cell with CHP. Waste heat from the fuel cell is used to provide approximately **15%** of hot water demand at the facility. The 2009 electricity bill savings from the fuel cell are given in **Figure 3**. Natural gas cost calculations are not presented here. The fuel cell has been plagued by frequent outages—a fact made clear by **Figure 4**. The fuel cell stack required replacement at the end of 2008 and again in 2010. The 2009 cost of outages can be seen in **Figure 5**. Observe that even short outages can have a significant impact on power demand charges. **(see June, November 2009)**





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 fit this specific microgrid application. Assumptions for battery specifications are outlined in **Table 2**.

Table 2: Battery Specifications

Battery		A	B
Technology		Sodium-Sulfur	Li-Iron Phosphate
Energy Capacity	[kWh]	**12,000**	**4,000**
Power	[kW]	2,000	2,000
Roundtrip Efficiency	[-]	0.77	0.83
Decay	[%/hr]	0.002	0.005
Min. SOC	[-]	0.2	0.2

Optimization & Scheduling

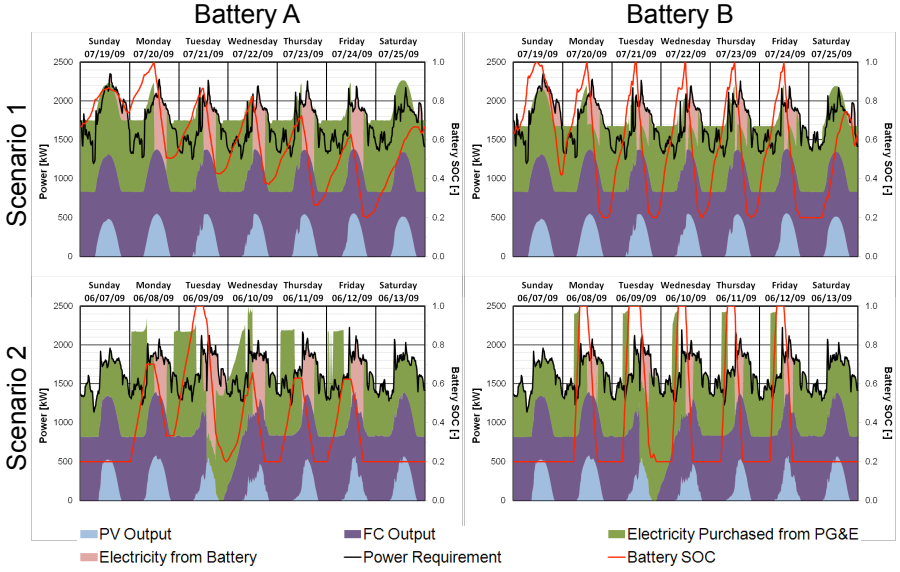
The battery is the only truly dispatchable DER at the jail. Utilizing LBNL's Distributed Energy Resources Customer Adoption Model (**DER-CAM**) optimal battery scheduling is determined for several scenario-weeks. This has been conducted for an operational fuel cell (**Scenario 1**) and, more realistically, 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 to 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 DER-CAM Weekly Operations Optimization

Savings from Storage				
Battery			A	B
Scenario	1	energy	$626	$459
		power	$12,586	$9,560
	2	energy	$747	$570
		power	$21,244	$11,363

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



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Contacts: Chris Marnay **chrismarnay@lbl.gov**, Nicholas DeForest **ndeforest@lbl.gov**