A Green Prison:

Santa Rita Jail Creeps Towards Zero Net Energy (ZNE)

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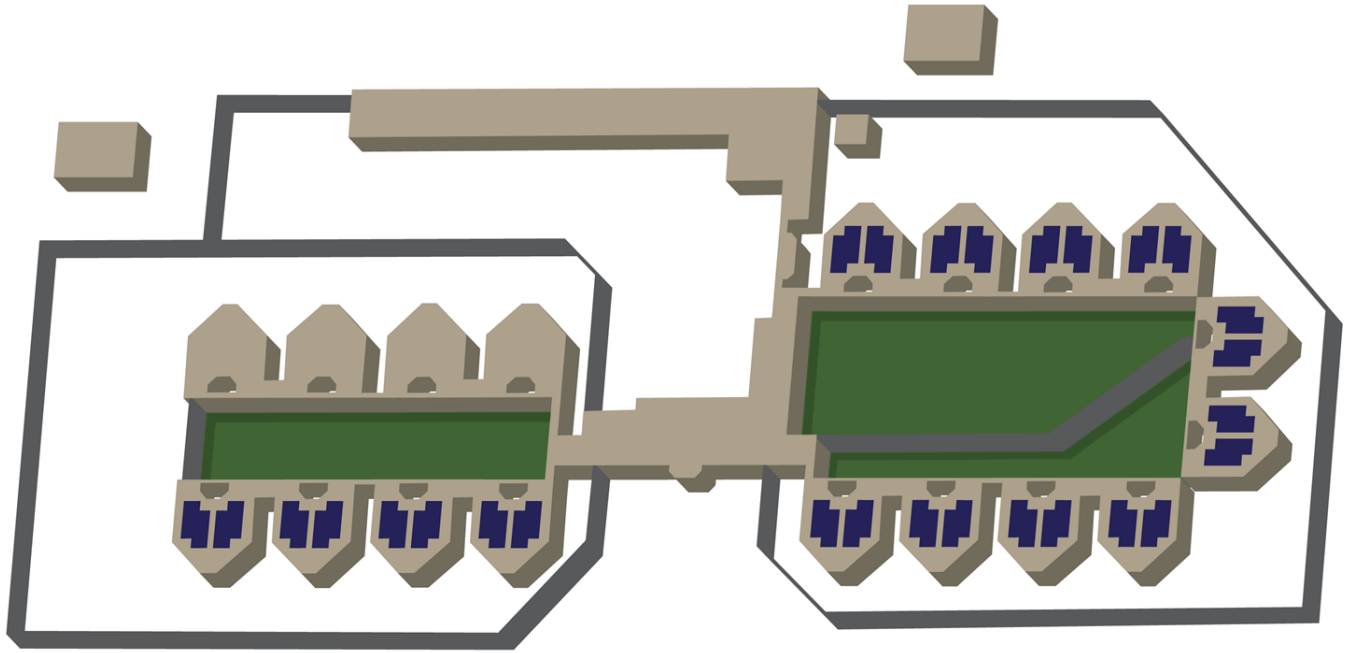
Santa Rita Jail: An Overview

SRJ Details

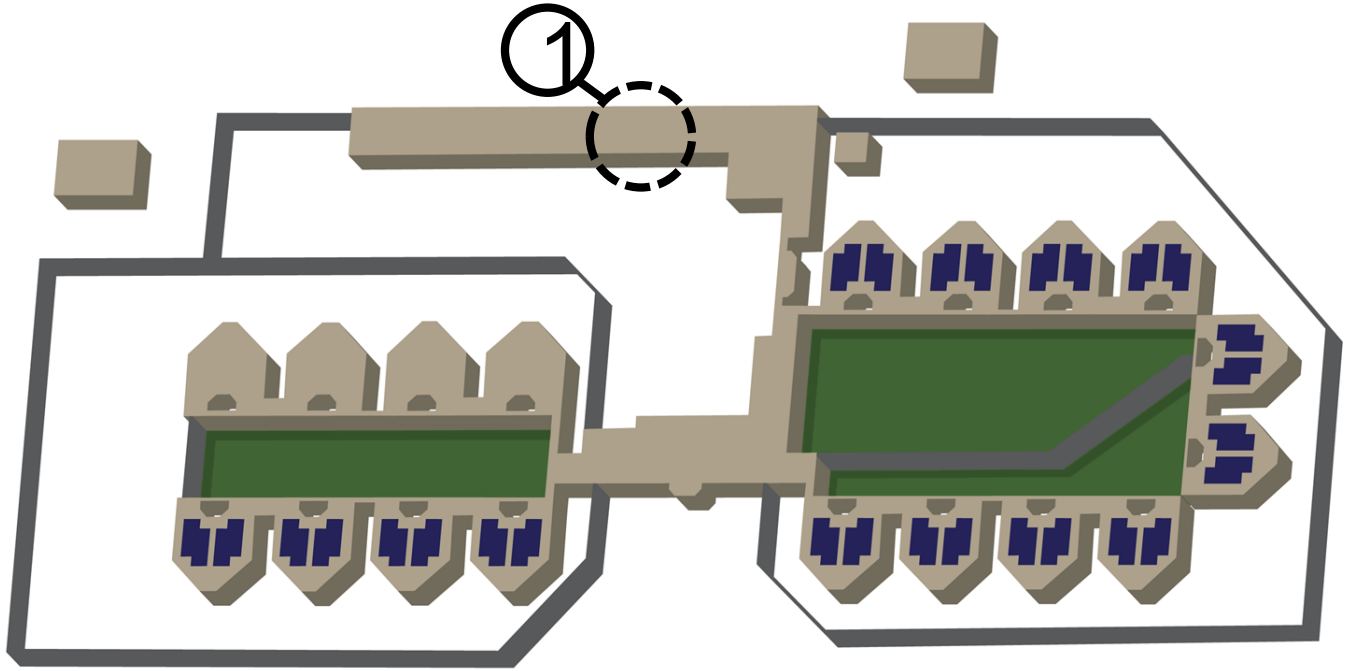
- 4,500 inmate facility
- 65 km east of San Francisco
- 3MW peak electricity demand
- Operated by Alameda County
- Ongoing microgrid demo project



Santa Rita Jail: An Overview

1 – Efficiency Improvements

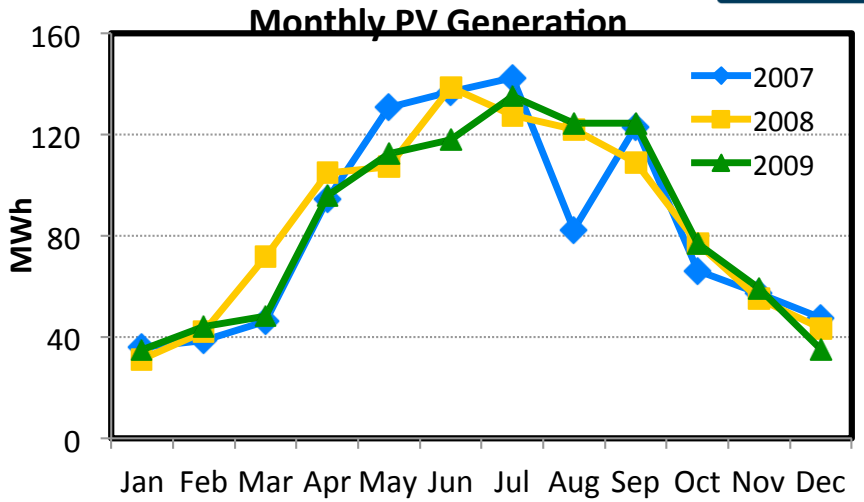
- Chiller replacement (2001)
- Lighting retrofits (2009, 2010)
- Freezer upgrade (2010)
- Approx. 900kW peak reduction

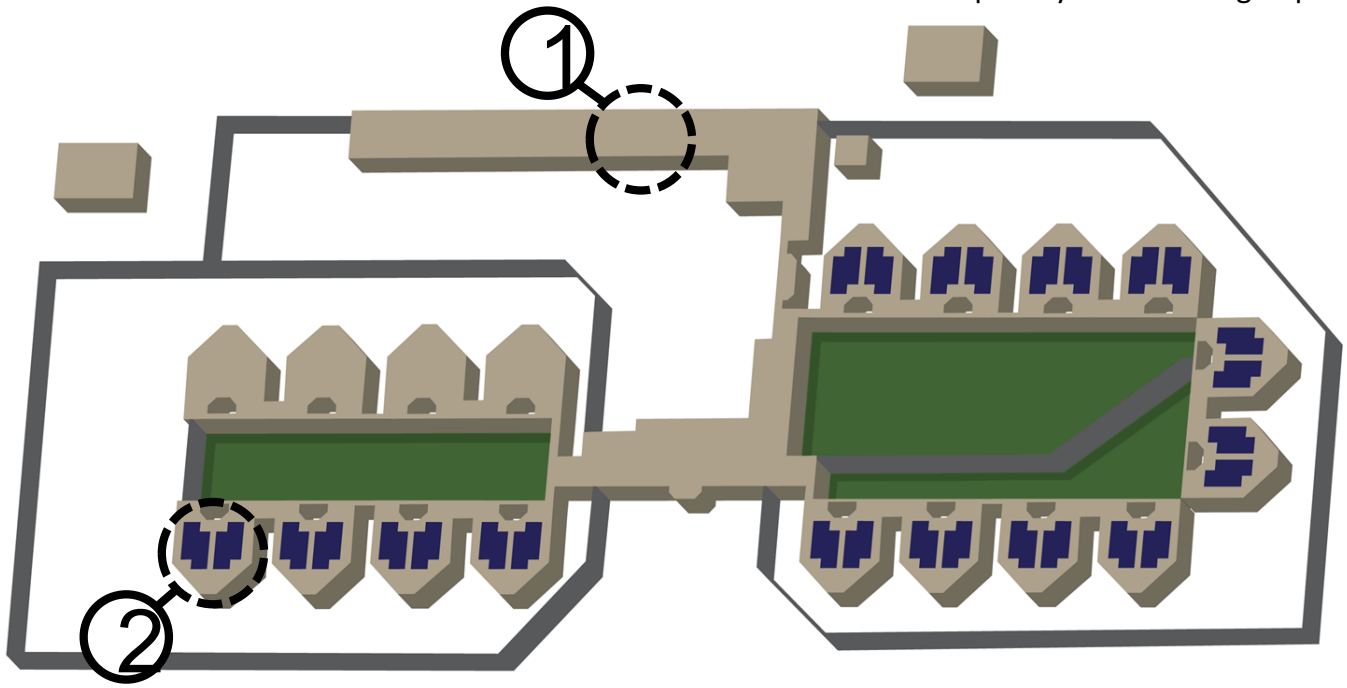


Santa Rita Jail: An Overview

2 – PV System

- 1.2MW rating
- Installed 2001-2002
- 700kW observed peak output

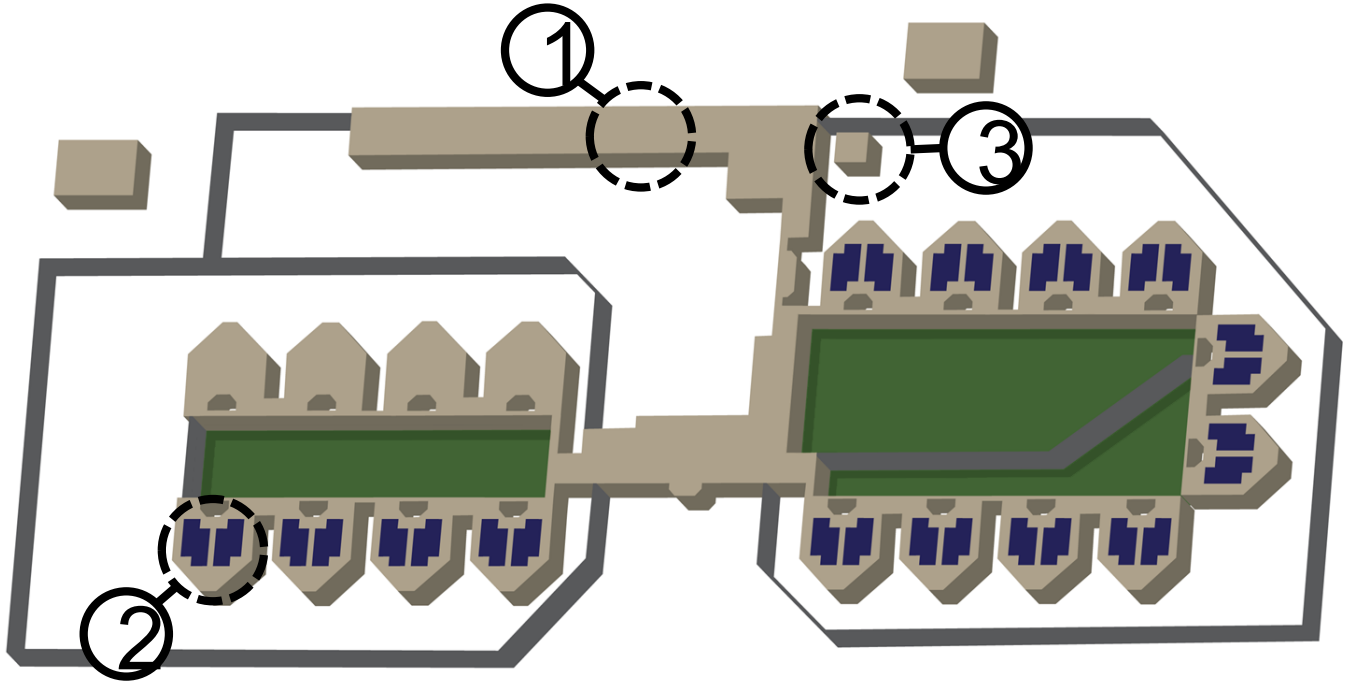




Santa Rita Jail: An Overview

3 – Fuel Cell

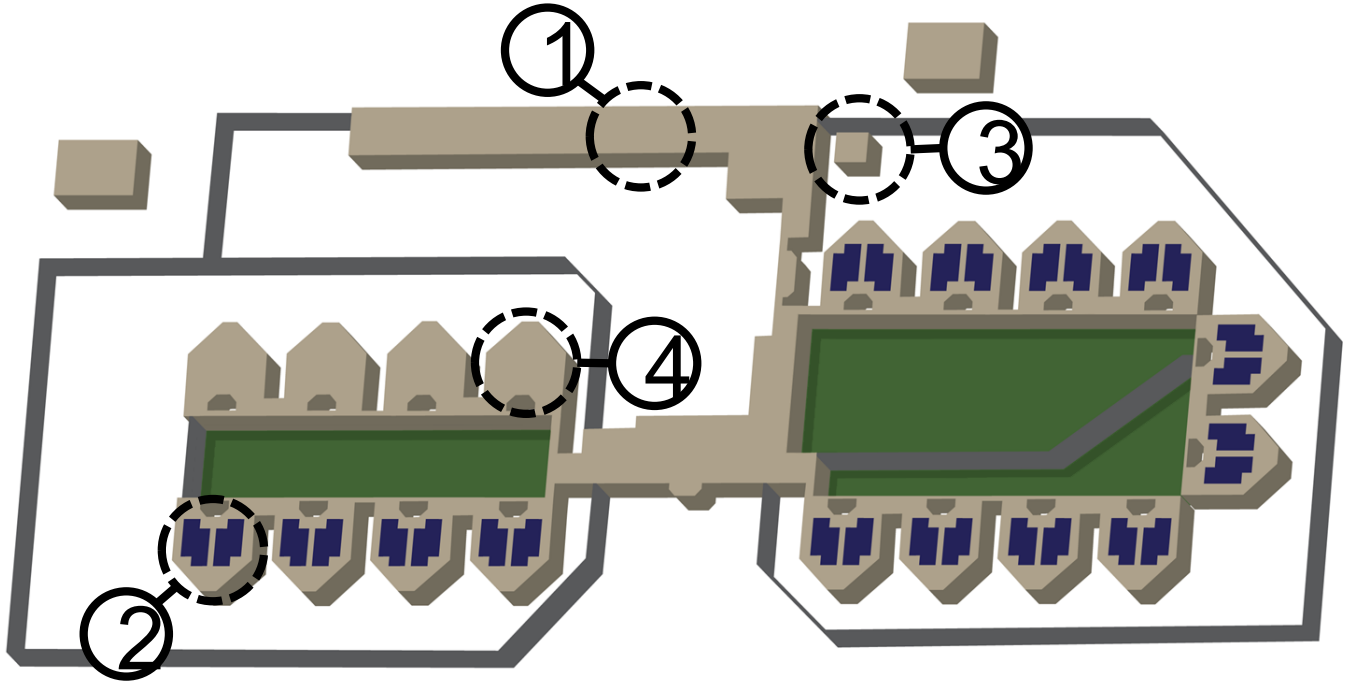
- Molten Carbonate with CHP
- Rated at 1MW
- Installed 2006
- Base load electricity supply
- Provides approx. 15% of DHW



Santa Rita Jail: An Overview

4 – Solar Additions (Proposed)

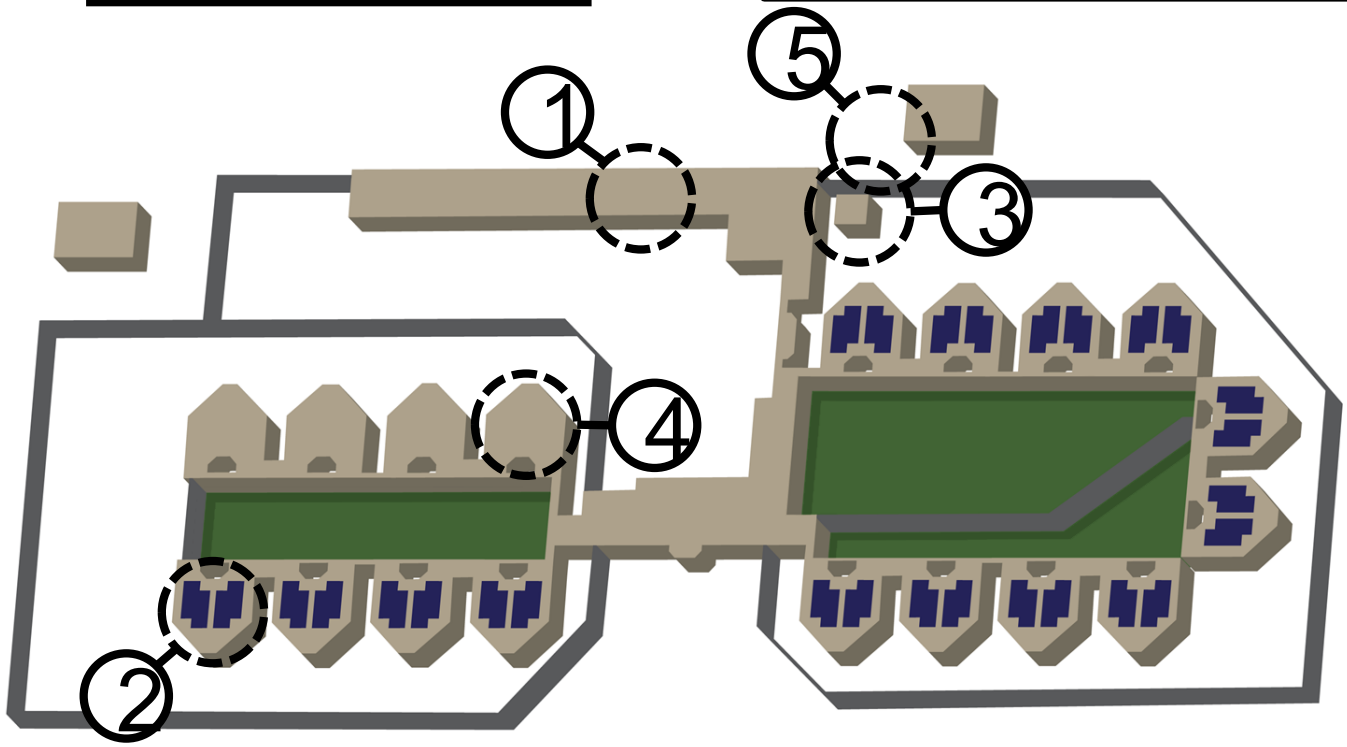
- Replacement of faulty array (220kW)
- Tracking array (240kW)
- Solar-thermal system (40% DHW)



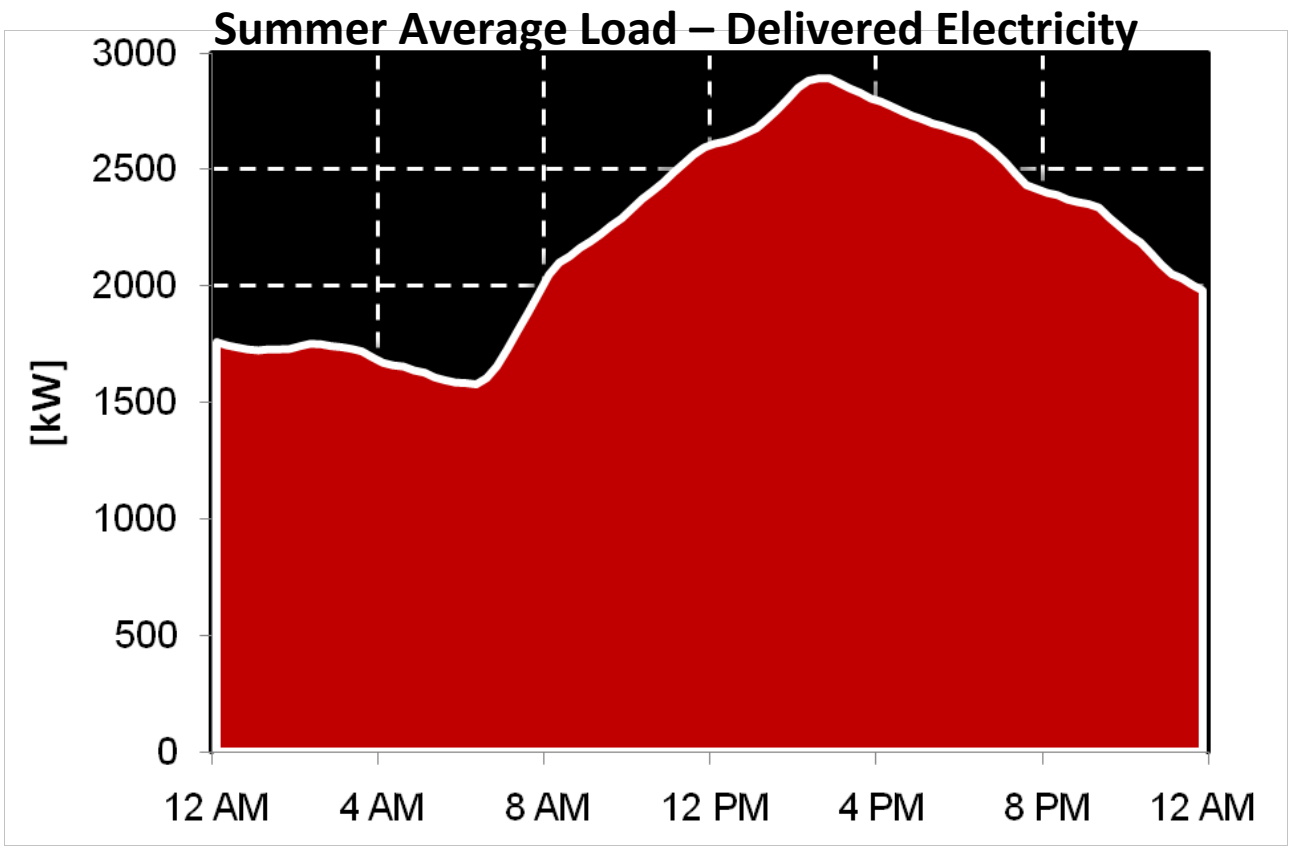
Santa Rita Jail: An Overview

5 – Electric Storage (Proposed)

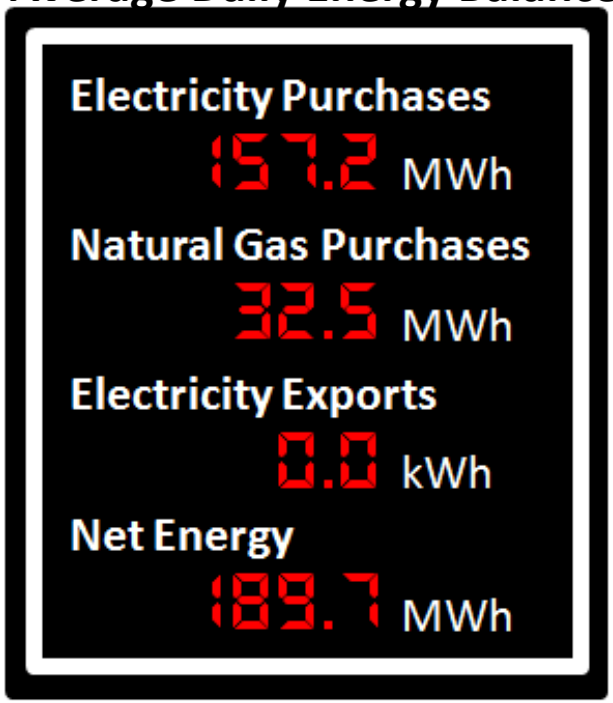
Initial battery specifications:
- –Sodium-sulfur (NaS)
- –12MWh capacity
- –2MW rating
- –77% AC-AC efficiency

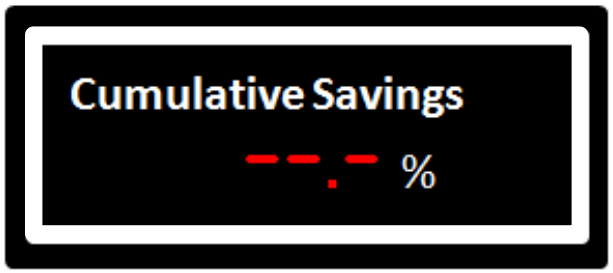


SRJ: Approaching ZNE?



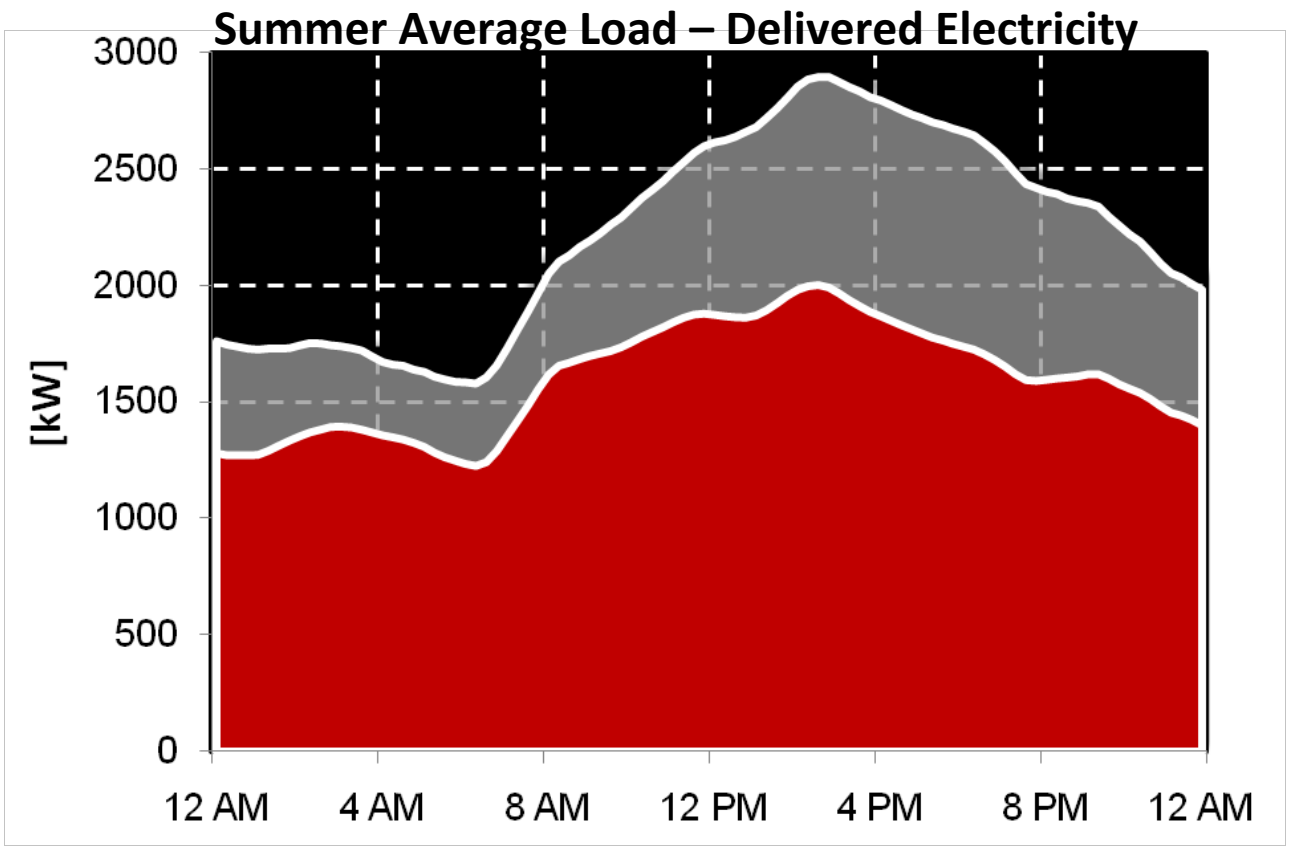
Average Daily Energy Balance*





***primary energy**

SRJ: Approaching ZNE?



Average Daily Energy Balance*

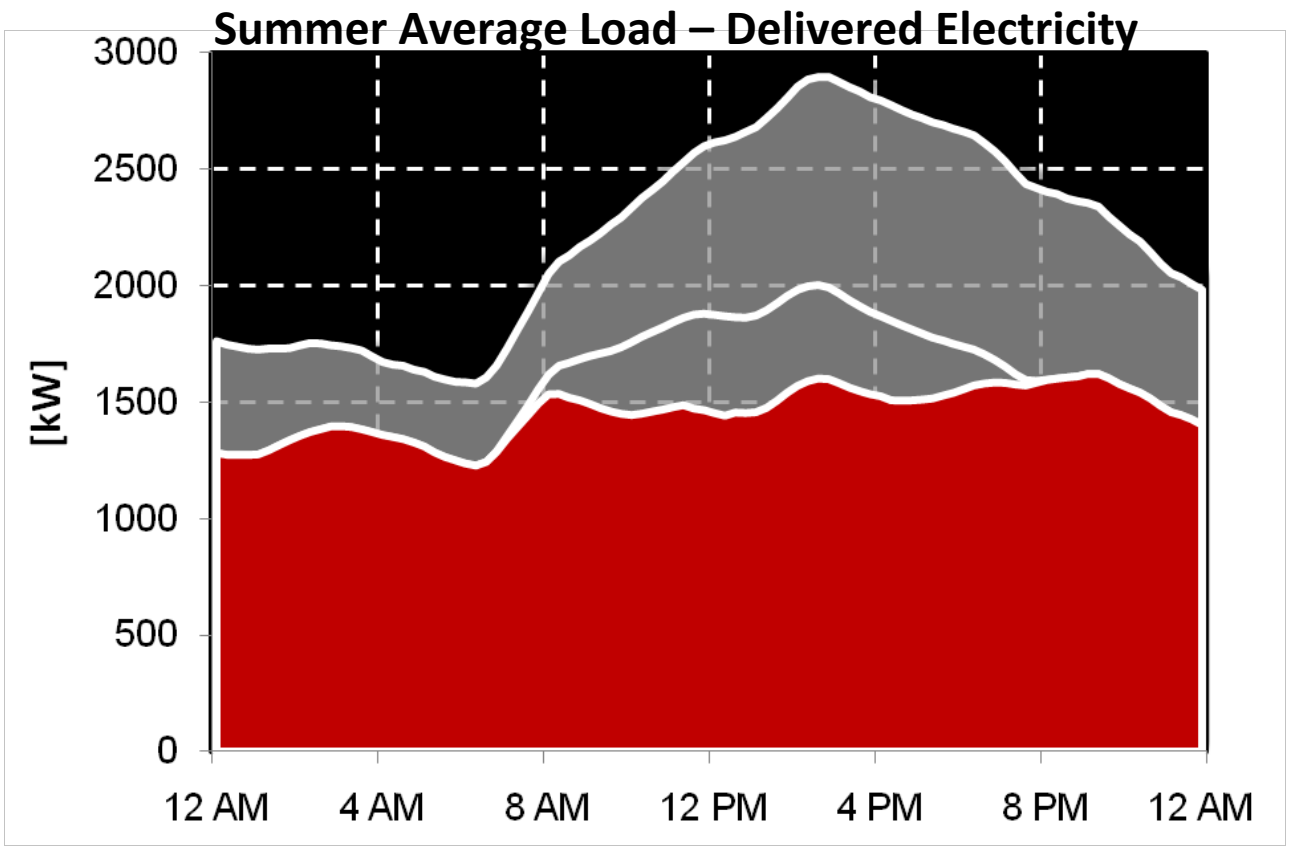
Electricity Purchases	113.1 MWh
Natural Gas Purchases	32.5 MWh
Electricity Exports	0.0 kWh
Net Energy	145.6 MWh

Cumulative Savings	23.2 %

Measure 1: Efficiency Improvements

***primary energy**

SRJ: Approaching ZNE?



Average Daily Energy Balance*

Electricity Purchases
102.8 MWh

Natural Gas Purchases
32.5 MWh

Electricity Exports
0.0 kWh

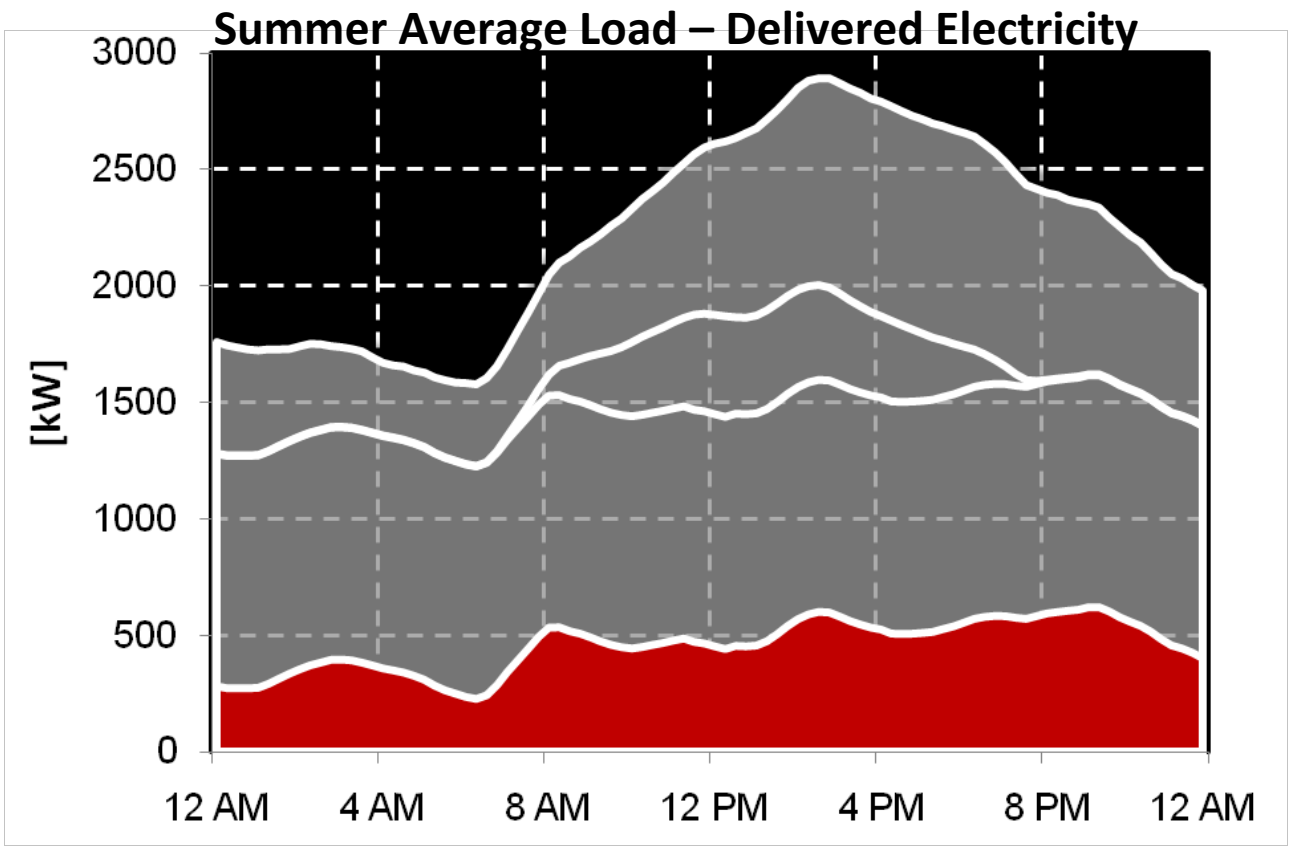
Net Energy
135.3 MWh

Cumulative Savings
28.7 %

***primary energy**

Measure 2: PV Installation

SRJ: Approaching ZNE?



Average Daily Energy Balance*

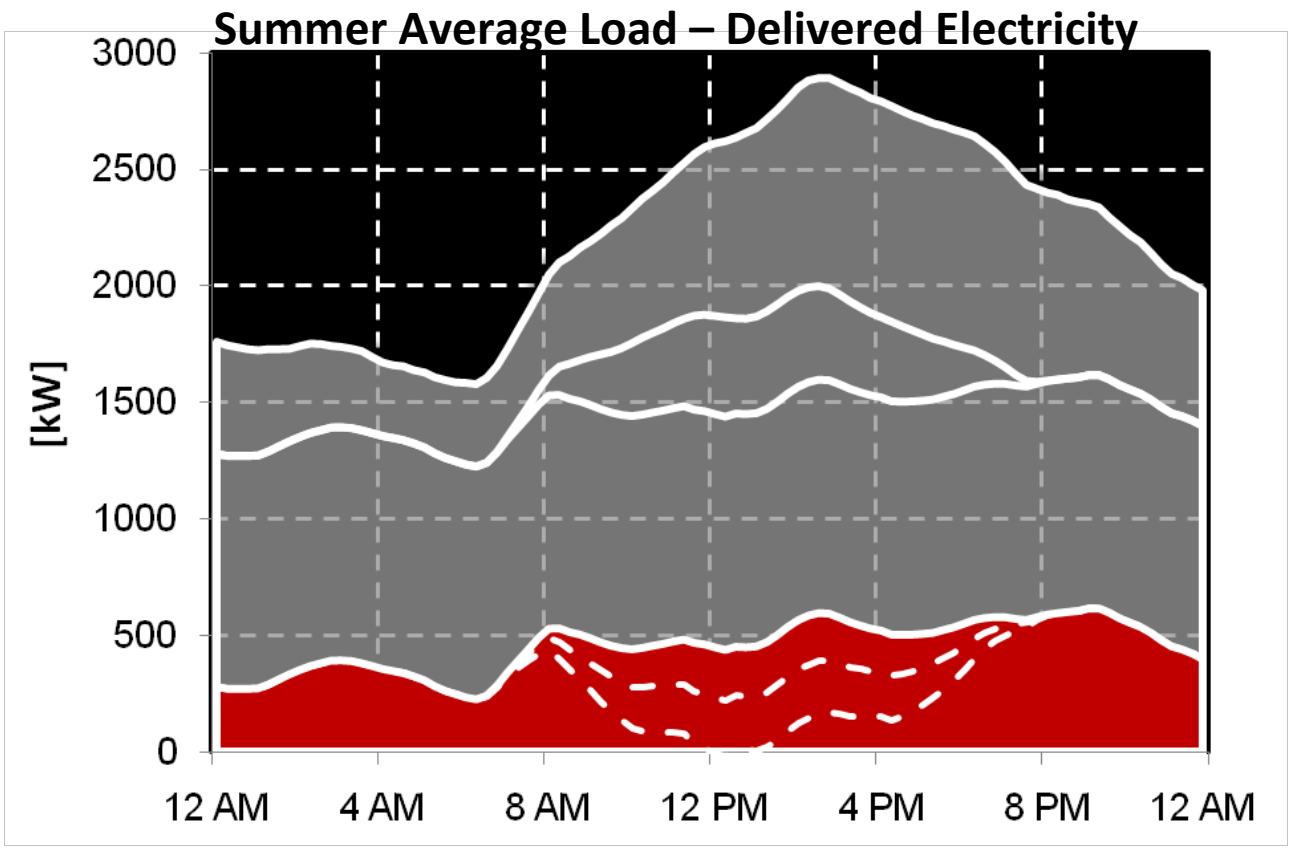
Electricity Purchases	32.2 MWh
Natural Gas Purchases	89.3 MWh
Electricity Exports	0.0 kWh
Net Energy	121.5 MWh

Cumulative Savings	36.0 %

Measure 3: Fuel Cell

***primary energy**

SRJ: Approaching ZNE?



Measure 4: Proposed PV & Solar-Thermal additions

Average Daily Energy Balance*

Electricity Purchases	21.1 MWh
Natural Gas Purchases	77.9 MWh
Electricity Exports	18.1 kWh
Net Energy	98.9 MWh

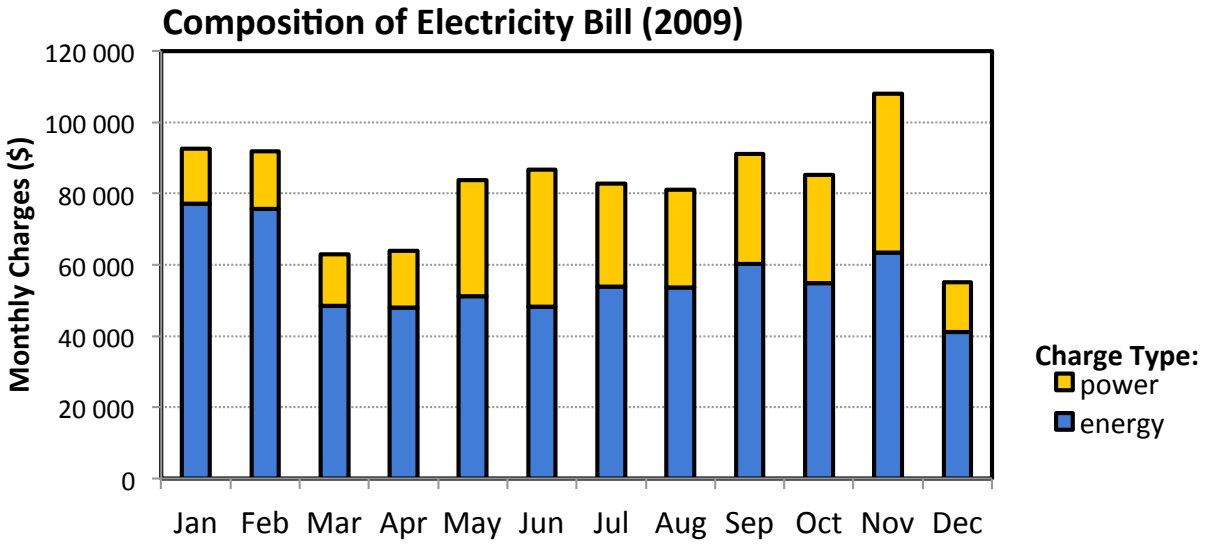
Cumulative Savings	47.9 %

***primary energy**

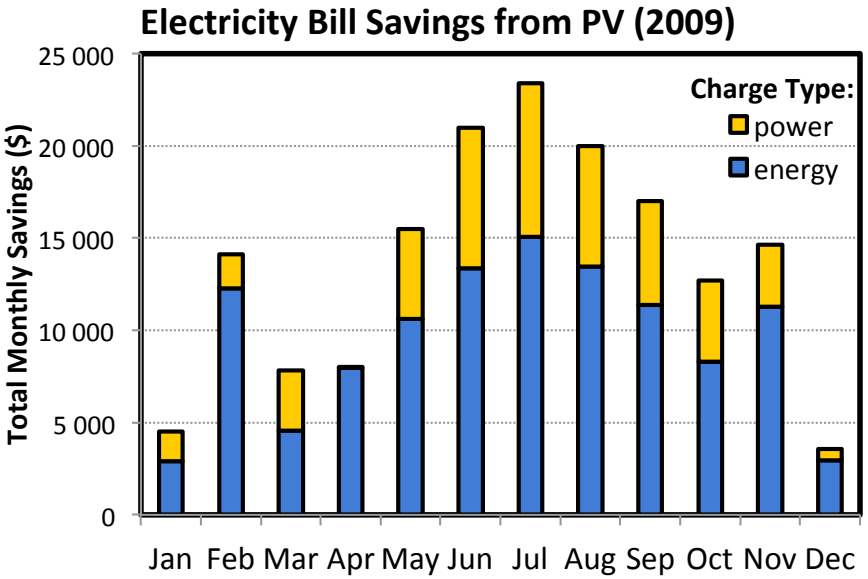
Tariff Details

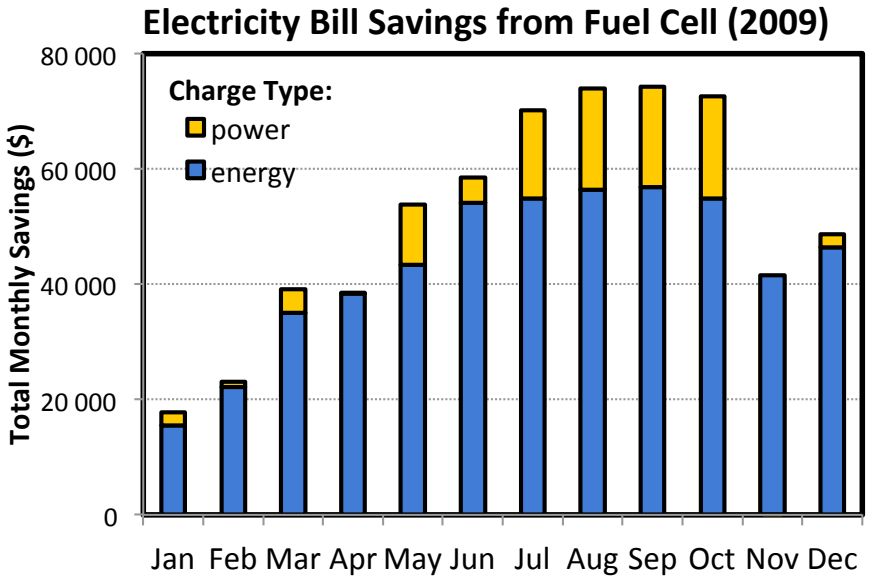
Pacific Gas & Electric E-20 TOU Tariff Structure

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]	



Value of On-site Generation

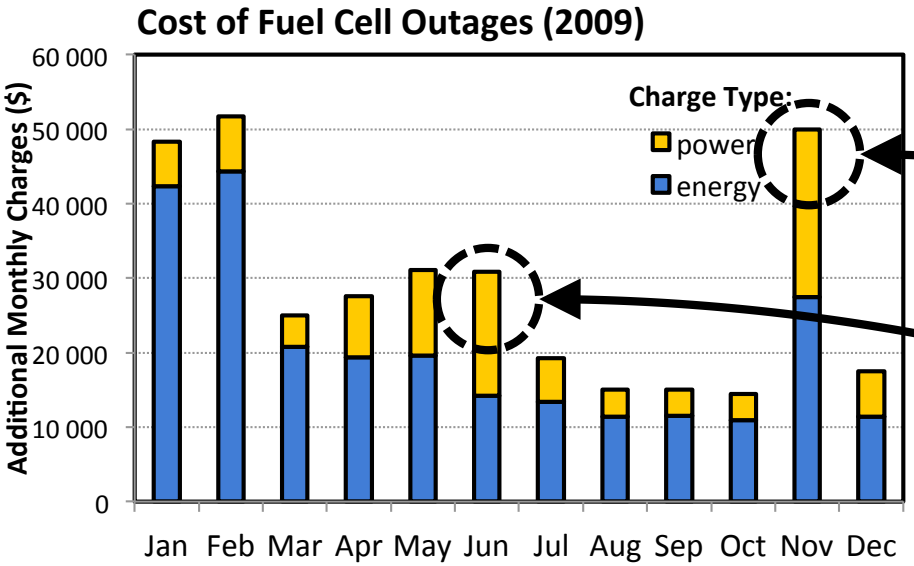


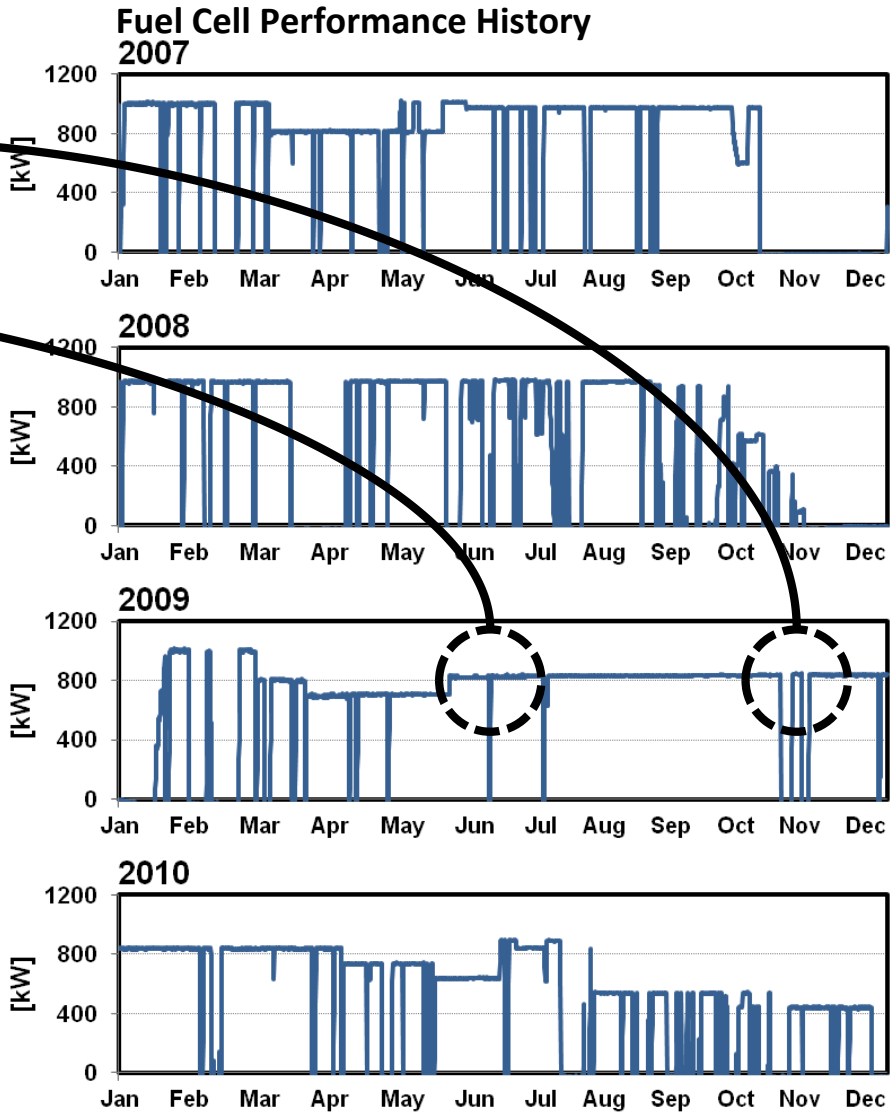


- Despite performing below rating, PV offsets electricity purchases at highest on-peak rates.
- PV effectively reduces summer power demand charges

- Fuel cell effective at reducing monthly energy demand charges.
- Some months see little to no power demand charge savings.
- Why is this?

Problems with Generation

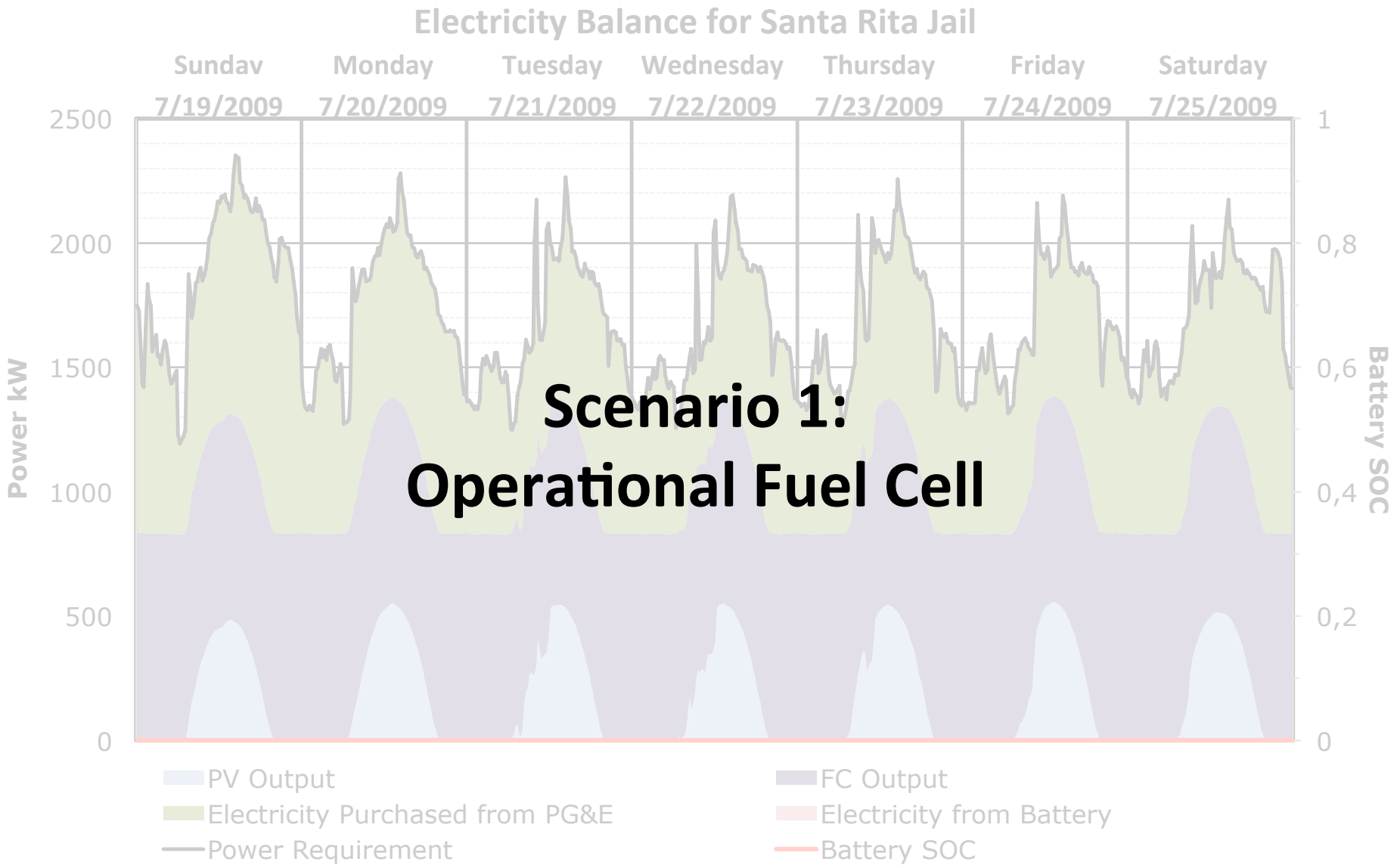




- Fuel cell experiences frequent outages.
- Even short outages can have significant economic impacts, by setting monthly power demand charges
- How can this be avoided?

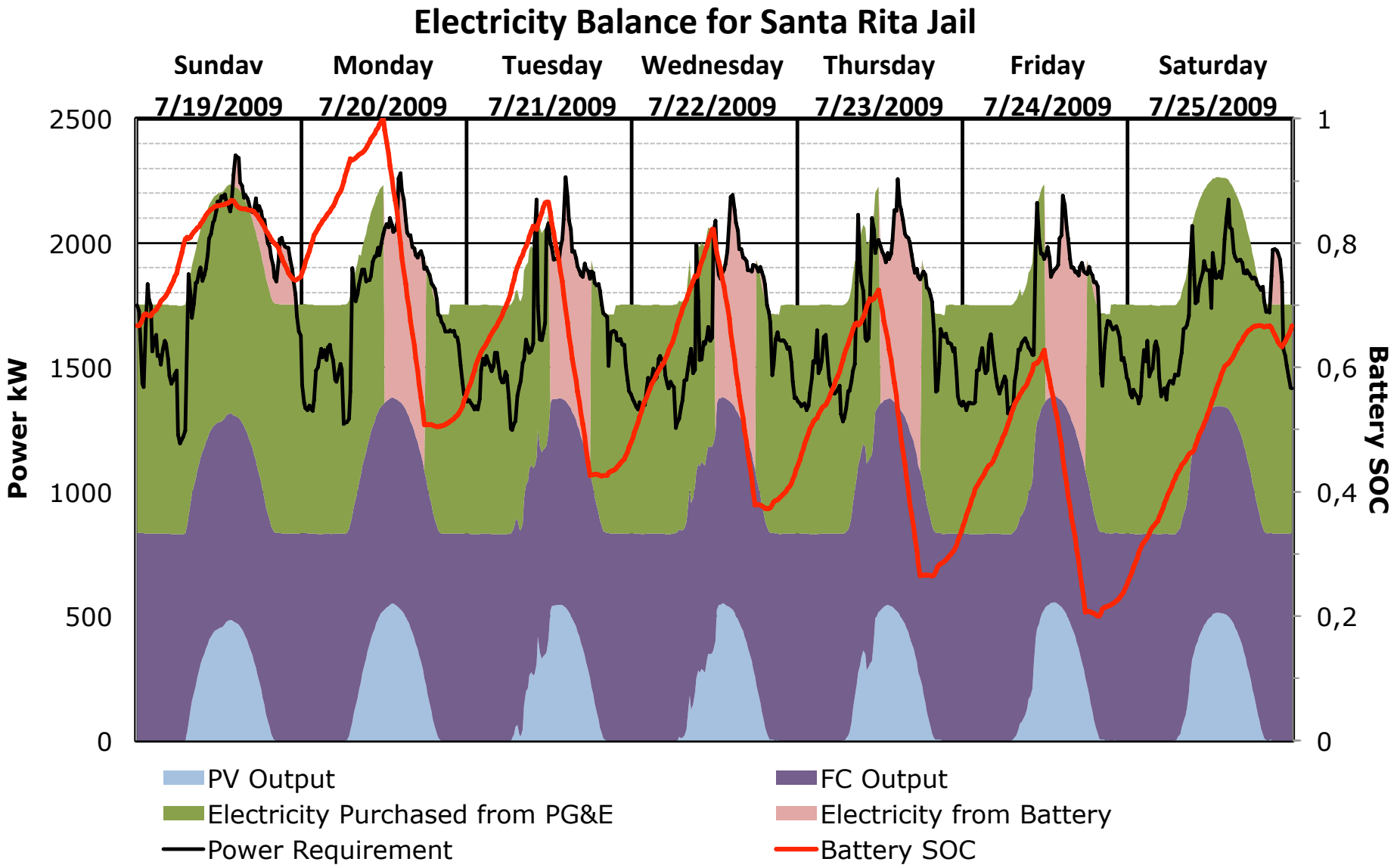
Electric Storage

Optimal Battery Scheduling

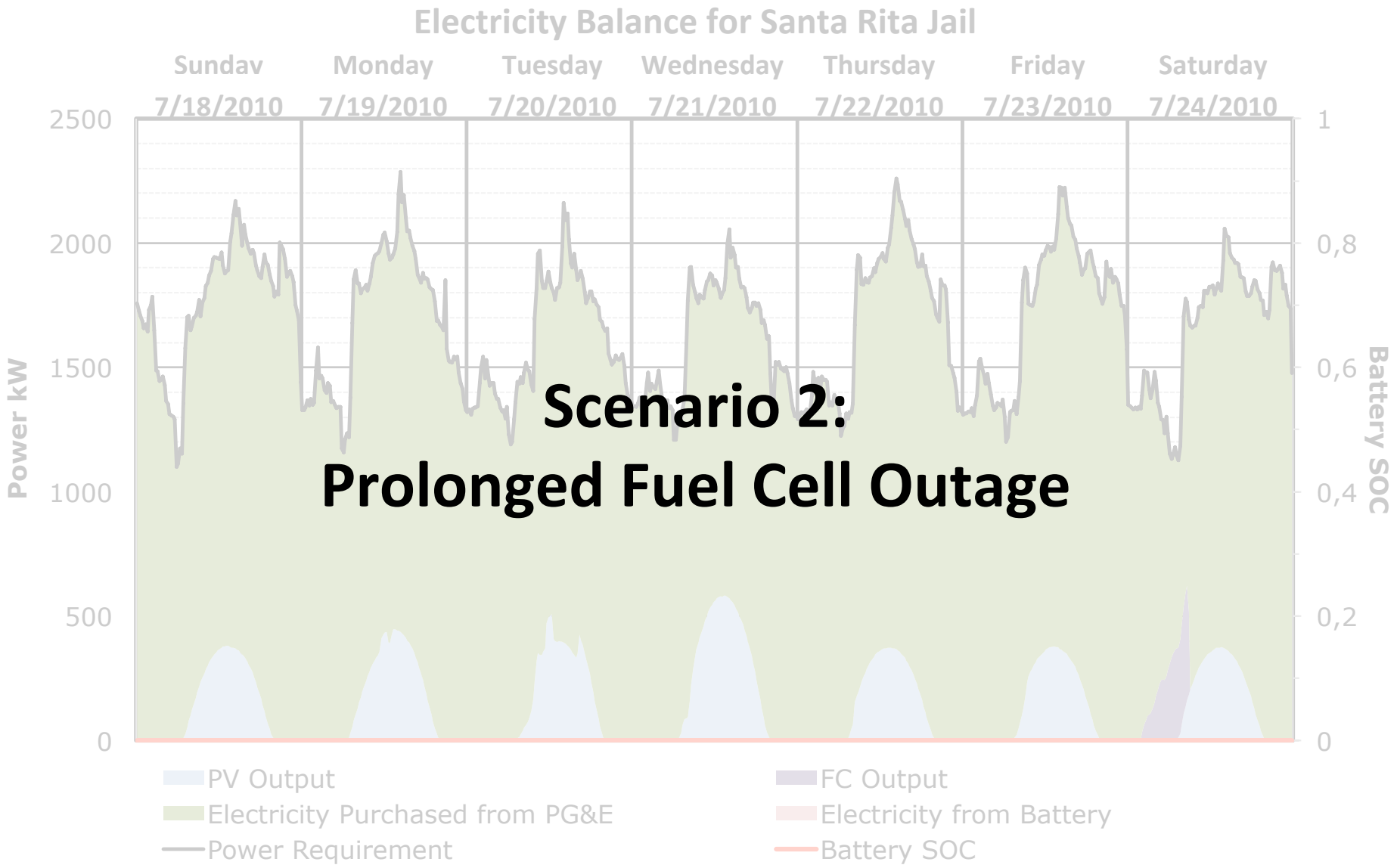


Scenario 1:
Operational Fuel Cell

Optimal Battery Scheduling

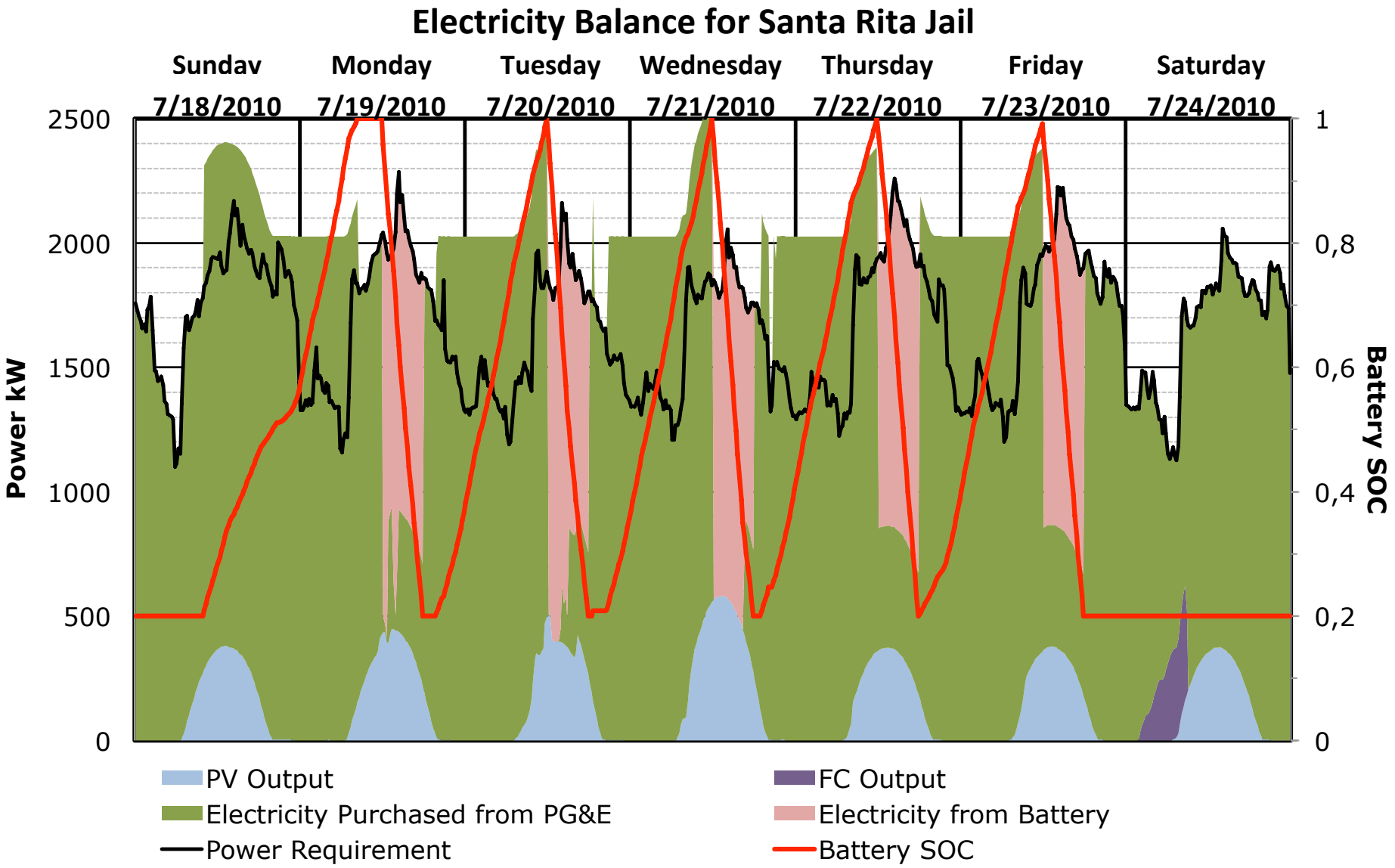


Optimal Battery Scheduling



Scenario 2:
Prolonged Fuel Cell Outage

Optimal Battery Scheduling



Value of Storage

Weekly Savings from Storage			
Scenario	1	energy	$626
		power	$12,586
	2	energy	$1,163
		power	$15,017

Note: Results assume maximum power charge is set during week investigated. These savings apply to whole month.

Electricity Purchases Δ		
Scenario	1	↑5.7%
	2	↑4.3%

Scenario	1	**Operational fuel cell**
	2	**Fuel cell offline**

Conclusions

- Diverse DER equipment at SRJ push closer to ZNE
- Despite increasing net-energy, storage has clear economic benefits
- More generation, exports required to meet ZNE; must offset facility and FC natural gas purchases