



**PRINCETON
POWER SYSTEMS**
Clean Power Made Simple™



Alcatraz Island Micro-grid

Alcatraz Island, San Francisco, CA

A Commercial-scale Microgrid System was designed and built on Alcatraz Island as a solution to high diesel fuel costs, pollution in the bay area, and high carbon emissions. When a ship's anchor ruptured the underwater power lines in 1950, that linked the island to San Francisco, Alcatraz turned to diesel generators as its primary source of power.

In 2010, Princeton Power Systems was excited to take on the challenge of enabling the historic landmark and tourist attraction, "The Rock," to become its own clean and efficient independent power source.

"The National Park Service is excited about making this switch to solar power on Alcatraz. It has been one of the most challenging and rewarding goals to meet in striving toward a more sustainable operation in the Golden Gate National Recreation Area."

- **Alexandra Picavet**
Public Affairs Officer,
NPS



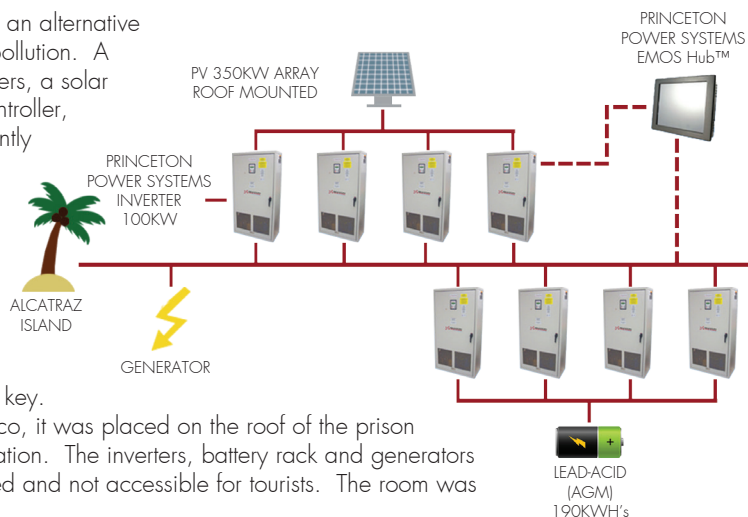
MICROGRID DESIGN

This project reflects the National Park Service's initiative to find an alternative way of powering the island in order to reduce fuel costs and pollution. A microgrid system, comprised of Princeton Power Systems inverters, a solar array, advanced batteries, a Princeton Power Systems Site Controller, and back-up generators, was selected as a way to independently power the island. Designing and building the system on one of California's and the US' most well-known historic landmarks with over 1 million visitors per year, created many challenges.

Component Placement: Preserving the island in pristine condition while completing the installation was the greatest challenge. Given that a system of this size requires a large construction effort, component placement was key.

To prevent the solar array from being visible from San Francisco, it was placed on the roof of the prison in a flat configuration rather than a traditional angled configuration. The inverters, battery rack and generators were placed in the old generator room, as this space is isolated and not accessible for tourists. The room was also protected from the harsh salt water environment.

Commissioning: The fragile natural environment and wildlife, particularly the birds (Alcatraz is an old Spanish word for pelican) added to the challenge. Extra attention was given to the solar panels after being damaged by rocks and shells dropped from overhead birds. Despite the coarse condition of the generator room, engineers were able to insulate the room to prevent future problems and ensure reliable long-term operation.



Princeton Power Systems GTIB-100

- 96.5% Efficient
- Built-in MPPT for PV
- High Round-trip Efficiency for Battery Charging
- Wide Input Voltage Range
- Easily Configured for Microgrids
- Off-grid and On-grid Capability



...Making it the best choice for the Rock.

Princeton Power Systems Site Controller

- Generator Start/Stop
- Short and long term data logging
- Data plotting and exporting for external systems
- Data aggregation
- Remote kiosk display
- Battery Management System
- PV Smoothing
- Modbus Slave Functionality (allows the transmission of any device parameter over Modbus)
- Programmable scheduling any parameter change to any device at periodic times)



Highlights

System Size: 400kW (PV), 400kW (Battery)/1900kWh's

Components: (8) 100kW Princeton Power Systems Grid-tied inverters (GTIB-100), 350kW PV Array, Princeton Power Systems Site Controller, (2) Diesel Generators, and Lead-Acid (AGM) Battery Rack.

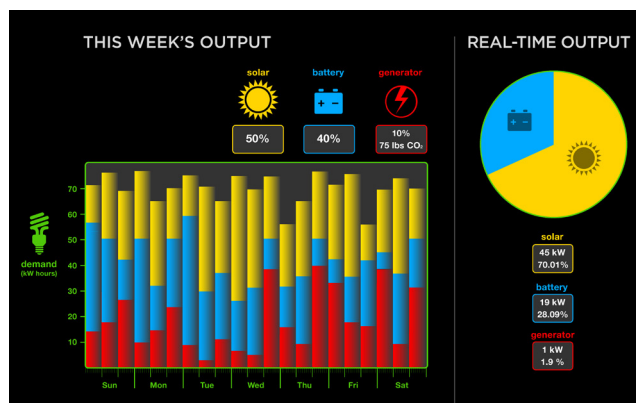
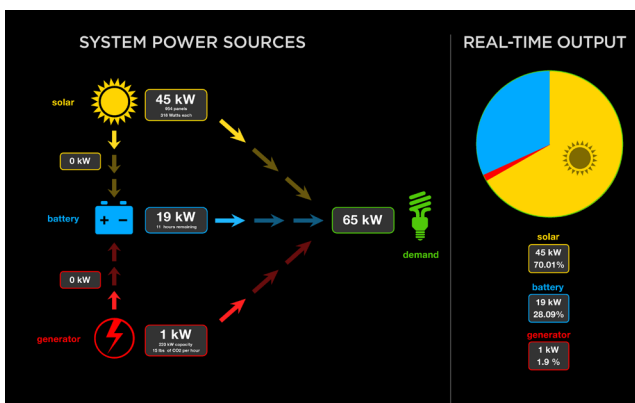
Loads: 50-80kW/day

Installation Date: August 2012

Location: San Francisco, CA

Annual Savings: Reduces approximately 80% of the island's carbon emissions

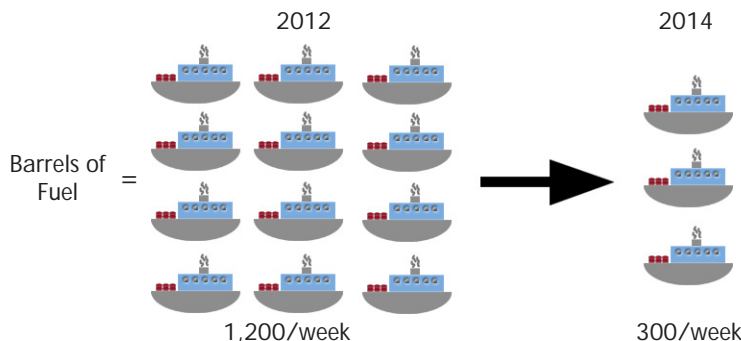
ALCATRAZ ISLAND INFORMATION KIOSK



The information kiosk on Alcatraz Island allows tourists to see the daily, weekly, and yearly performance of the microgrid system. As seen above, the kiosk shows how much of the island's power is produced by solar, battery storage, and generator.

While the majority of the island's power is produced by solar, batteries provide additional help when the sun is not present, as does the generator when both solar and battery storage are not available. The generator is automatically turned on and run at maximum efficiency to recharge the battery, then turns off for 3-4 days at a time.

EFFICIENCY OF THE ALCATRAZ MICROGRID



Total days of runtime	669
Total system operating hours	16,056
Total GTIB-100 run time hours	128,448
12-month Operating Data	
Total solar kWh:	281,050
Average solar kWh per week:	5,405
Total generator kWh:	350,640
Average generator kWh per week:	6,743
Average island load kW:	63
Total annual consumption kWh:	552,052
Generator output % by kWh:	64%
PV output % by kWh:	51%
Days of Data:	365

- <15% kWh losses
- Battery charge/discharge losses
- Converter, line and distribution losses