

Energy storage on (and off) the grid

**Darren Hammell – Co-Founder &
Chief Strategy Officer**
Princeton Power Systems



princetonpower.com | info@princetonpower.com | [@PrincetonPower1](https://twitter.com/PrincetonPower1)

Company Overview



Leading global designer and manufacturer of power converters and energy storage systems for microgrids, electric vehicle (EV) charging, and advanced batteries for Smart Grid services.



Microgrids Energy Security, Island Power, Hybrid Solar/Diesel



Electric Vehicle Charging V2X Vehicle to Grid, Vehicle to Home, Vehicle to Building



Energy Storage Systems Advanced batteries from top-tier manufacturers

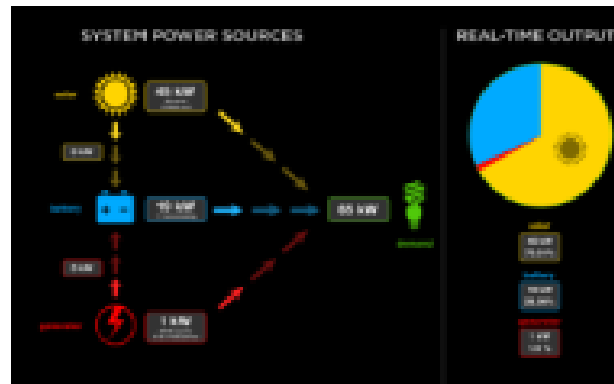
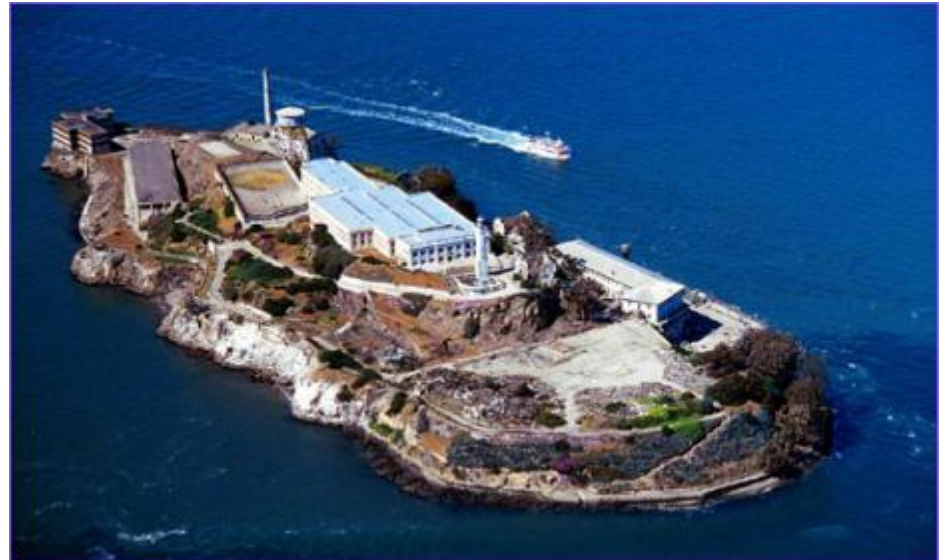


Alcatraz Island Microgrid: Summary

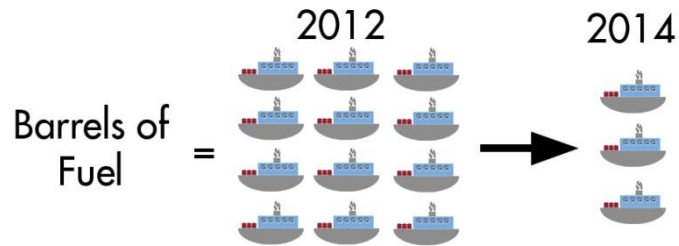
307 kWdc Solar
400 kW / 2 MWh Battery
2 x 350kW Diesel Gen
Princeton Power
- Energy Management Operating System (EMOS)
- GTIB-100 Converters

Typical Island Load 90-120 kW
Peak Island Load 300 kW

~2M Annual Visitors



Fuel Savings of the Microgrid



2,000 gallons per week diesel in 2010
500 gallons per week in 2013

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%

< 15% kWh losses

- Battery charge/discharge losses
- Converter, line and distribution losses

Days of Data:	365
---------------	-----

Economics of Alcatraz

Electricity cost in 2010: \$0.76/kWh

Electricity cost today: ~\$0.71/kWh

Expensive ...but

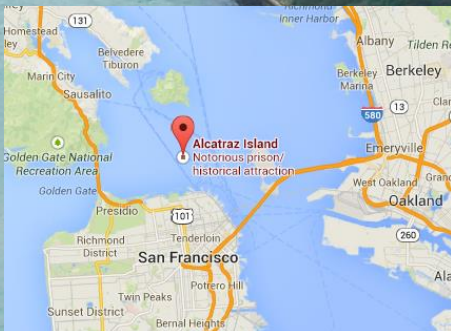
Cellhouse roof renovations

Historical preservation requirements

Design-in-place battery, converter room

PV panels @ ~\$3-4/W

**Pilot of microgrid technologies
achieved goal of fuel savings and
increased reliability**



Control Technology: Site Controller and GTIB-100

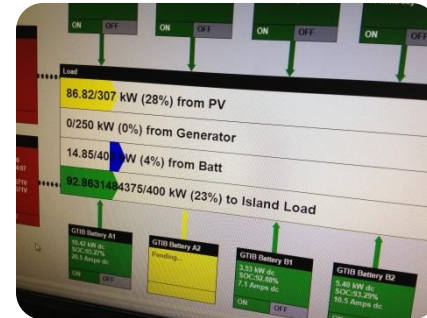


GTIB-100

2-port Bi-directional
100 kW, off-grid

Product Features

- Bi-directional
- Grid-tied / Off-grid
- Advanced Battery, Solar, Microgrid Functions
- UL 1741 & CE Listed



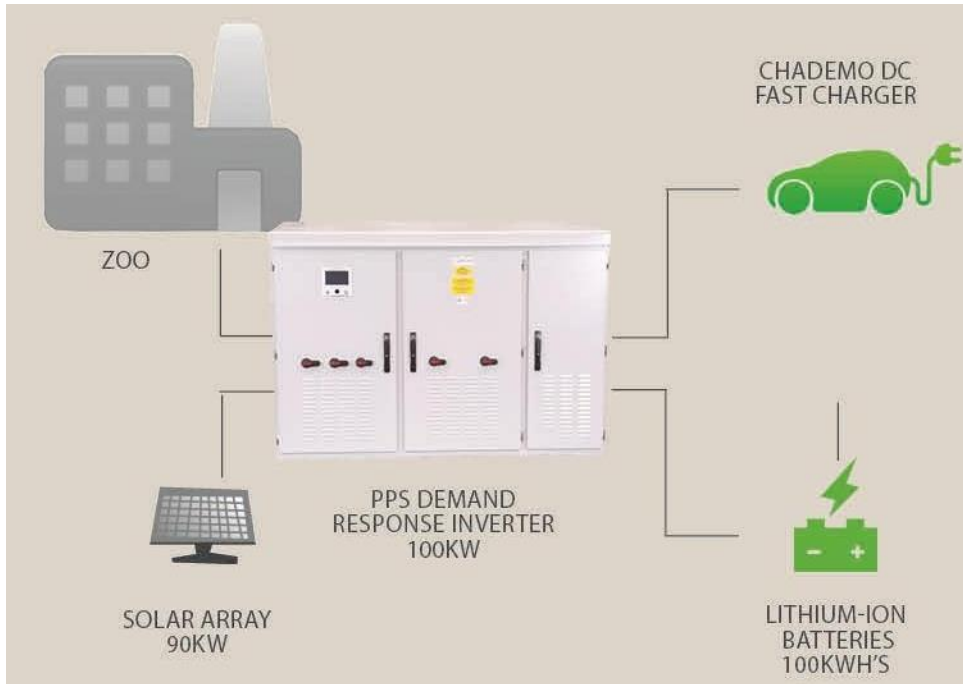
Site Controller

Central Monitoring
& Control Platform

Product Features

- Monitors and Manages Microgrid Assets
- Central Access Point
- Microgrid Control Functions (eg Gen-Set synch)

San Diego Zoo EV Microgrid



- EV DC Fast-Charging direct from PV
- Off-grid EV charging, seamless transition
- Local community backup power
- Utility-controlled demand response capability

- **System Size:** 90kW Solar and 100kW/100kWh's Batteries
- **Components:** (1) PPS DRI-100 4-port Inverter, (2) Lithium-ion batteries, (3) 75 kW PV array, (4) PPS Site Controller, (5) EV Fast-Charge Station & Multiple EV Level II AC Chargers



Case study: Los Angeles Air Force base.



- 1st fleet of bi-directional EV charging stations
 - CHAdeMo charging using the multi-port GTIB-30
 - 2014 Nissan LEAF's
- Commercial solution for ancillary service markets
 - EV OEMs and 3rd party fleet management software
 - Revenue offsets EV fleet lease expense

Island Microgrid Economics Today

Installed cost: ~\$3.5 / W

Electricity cost ~\$0.25-35/kWh
including fuel

Retrofits are less than constructing
new distribution

Annobon Island 5.0 MW Microgrid Equatorial Guinea

5 MW solar

5 MW Diesel Gen-sets

5 MW / 10 MWh Durathon Batteries

20x BIGI-250 3-Port Converters

Princeton EMOS

Commissioning Q2 2015





PRINCETON
POWER SYSTEMS

Clean Power Made Simple™

Darren Hammell, Co-Founder & Chief Strategy Officer
dhammell@princetonpower.com
www.princetonpower.com

Thank you

