Net Zero Energy Installations

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Key Points

• A net zero energy installation (NZEI) is one that produces as much energy from on-site renewable sources as it consumes

• NZEI assessment provides a systematic approach to energy projects

• Goal of analysis is to lead to project implementation

• DoD is leading the way and has great potential
**Background**

**DoD Energy**
- $3.5B in facility energy FY09
- 2 B square feet
- Average EUI 104
- 29 M acres of land (1.2% of U.S.)

**Baseline**
- Current energy consumption

**Energy Efficiency**
- Retrofit improvement potential
- New construction design optimization

**Renewable Energy**
- Deployment of renewable energy

**Electrical Systems**
- Interconnection and microgrid

**Transportation**
- Reduce and replace fossil fuel use
NZEI Project Locations

- PTC
- Ft. Carson
- MCAS
- U.S. AFA
- NSF
- MARFORRES
NZEI Project Site Data Summary

Land area in acres

- AFA: 18,500 acres
- Miramar: 23,000 acres
- Ft. Carson: 137,403 acres
- MarForRes: 29 acres
- Pohakuloa: 133,000 acres

Facility area in ft²

- AFA: 6,100 ft²
- Miramar: 6,800 ft²
- Ft. Carson: 14,630 ft²
- MarForRes: 620 ft²
- Pohakuloa: 308 ft²

MWh/yr

- AFA: 101,169 MWh/yr
- Miramar: 66,544 MWh/yr
- Ft. Carson: 164,407 MWh/yr
- MarForRes: 9,628 MWh/yr
- Pohakuloa: 1,718 MWh/yr

MMBtu/yr

- AFA: 1,718 MMBtu/yr
- Miramar: 4,000 MMBtu/yr
- Ft. Carson: 80,000 MMBtu/yr
- MarForRes: 137,403 MMBtu/yr
- Pohakuloa: 0 MMBtu/yr
NZEI Project Facility Energy Distribution

- **Miramar**
  - 37% Electric Energy
  - 63% Thermal Energy

- **MARFORRES**
  - 100% Electric Energy

- **Ft. Carson**
  - 38% Electric Energy
  - 62% Thermal Energy

- **Pohakuloa**
  - 14% Electric Energy
  - 86% Thermal Energy

- **AFA**
  - 67% Electric Energy
  - 33% Thermal Energy

**Legend**
- Thermal Energy
- Electric Energy
Sample Analysis From Miramar

Baseline Annual Energy Usage Information

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Electricity (kWh)</td>
<td>66,543,615</td>
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<td>Natural Gas (therms)</td>
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<td>Fuel (Gallons)</td>
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Building Portfolio Breakdown

- Housing: 19%
- Hangar: 12%
- Office: 9%
- Warehouse: 18%
- Garage: 3%
- Brig: 2%
- Other: 37%

Microgrid Operation with PV and Generators

- AC Primary Load
- PV Power
- Generators Power
Miramar Implementation Scenario

**Available Financing Options**
- Appropriations
- Utility Energy Services Contracts (UESC)
- Energy Savings Performance Contracts (ESPC)
- Power Purchase Agreement (PPA)

**Other Considerations**
- Utility requirements
- NEPA

**Miramar Projects**
- Landfill gas = PPA
- PV = ECIP/ARRA/ESPC
- Boilers / solar hot water = ARRA
- Efficiency = ESPC
- Solar pool = appropriations
- Fuel cell = PPA
- Microturbines = ESPC
- Daylighting = ESPC

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**Projected Energy Costs “Business As Usual” 2010-2020**

**Energy Cost ($)**
- Nat. Gas Cost
- Elec. Cost

**Estimated Annual Savings from Recommended Scenario**

**Savings ($)**
- (5,000,000) to 0
- (10,000,000)
- (15,000,000)
- (20,000,000)
- (25,000,000)
MCAS Miramar NZEI Summary

Results: 90% NZEI source Btu reduction

Implementation

- 20-year project lifetime analysis
- Capital costs ~$60M
- $26 million in savings
- NPV of $6.7 million
Fort Carson NZEI Summary

Results: 95% NZEI source Btu reduction

Implementation
- 35-year simple payback
- Cost: $842 million
- NPV (40yr): $96 million

![Pie chart showing energy sources and their contributions.

- Natural Gas, 7%
- Efficiency, 24%
- GSHP, 26%
- CSP, 9%
- PV-carport, 6%
- PV-rooftop, 6%
- PV-ground mount, 5%
- Wind, 3%
- Biomass Heat, 8%
- Solar Hot Water, 1%
- Solar Vent Preheat, 2%
- Renewable Fleet, 1%
- Non-Renewable Fleet, 1%]
Pohakuloa Army Training Area (Hawaii) NZEI Summary

Energy Efficiency
- 300,000 ft² of facilities, with water trucked in
- Many old facilities that could be replaced limits potential
- 22% reduction through measures like lighting and controls

Renewable Energy
- Planning ARRA-funded PV (60 to 100 kW)
- Reconnect existing 15 kW PV system to grid
- Wind turbines of ~500 kW (excellent resource easy net zero)
- Solar hot water (will displace propane use)

Electrical Systems
- Small system with 400 kW peak load
- Past distribution grid issues but have ability to interconnect renewables
- Strong candidate for a microgrid

Implementation
- Energy storage is a challenge
- Utility regulations could limit technology sizes
- Capital investment of $3 M needed for 98% source Btu reduction
Naval Support Activity South Potomac

Dahlgren / Pumpkin Neck
- 4,321 acres
- 834 buildings - 3,270 KFt²
- Energy cost $9.8 million/year
- Potential efficiencies to be gained in data centers
- Implementing smart meter program
- Waste-to-Energy and GSHP feasibility studies

Indian Head / Stump Neck
- 3,228 acres
- 1,591 buildings - 4,102 KFt²
- Energy costs $14 million/year
- Decentralize steam system
- Potentially replace coal plant to gas plant
- Solar ventilation preheat opportunities

NZEI Status
Data collection 95% complete
Analysis 15% complete

Energy cost data from third party report
Project Implementation Planning

**Site**
- Where will the project be located
- Proximity to grid and thermal hosts

**Resource**
- Available land
- Years of life left at landfill

**Off-take**
- Who will buy the power and/or thermal energy
- Levelized costs

**Permits**
- Interconnection
- Emissions limits for criteria pollutants

**Technology**
- Technical performance goals (MWh per year, time of delivery, cost)
- Willingness to take technology risk

**Team**
- Who is the technology partner/developer

**Capital**
- Ownership structure
Project Execution

Credit: Blaise Stoltenberg, NREL
Army Net Zero Site Selection

- NREL support to develop program, application, and reviews
- 53 Installations applied for NZEI
- Applications reviewed and scored
  - Leadership, cost, resource, policy, past projects, etc.
- Net-Zero (Energy/Water/Waste) Pilot Installations:
  - Fort Bliss
  - Fort Carson
- Net-Zero Energy Pilot Installations:
  - Fort Detrick
  - Fort Hunter-Liggett
  - Kwaljalein Atoll
  - Parks Reserve Forces Training Area
  - Sierra Army Depot
  - West Point

“Net Zero is a Force Multiplier”
The annual wind resource data shown are a composite of available high-resolution wind power resource produced by NREL, AWS TrueWind Solutions, states and other organizations. For states that did not have high resolution data available, low resolution wind power resource data produced by the 1987 “Wind Energy Atlas of the United States” is shown. For more information, visit Wind Powering America: http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_resource_attributes_map.html

The data was screened to eliminate areas unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map has been visually enhanced to better show the distribution of ridge crests and other wind features.
Example Results: Site-Specific Studies

Concentrating Solar Power (1% Slope)
Sierra Army Depot, CA

Annual average direct normal solar resource data are shown. The data are a 10 km satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2005.
Complexities of Net Zero Water, Energy, and Waste

- Water, energy, and waste are interconnected in complicated ways
  - Energy requires water to produce
  - Water requires energy to treat and transport
  - Waste requires energy to transport and can be used to create energy

Accounting for this can be very difficult.
Thank You!

QUESTIONS?

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