Summary

• NREL has been supporting DoD Net Zero Energy efforts since 2009
  o DoD is most interested in cost savings, energy security, and goals/mandates

• Installations are like small cities with huge potential for change
  o 2 B sq. ft., $4 B facility energy, 29 M acres

• Net zero energy installation -> produce as much energy as you consume
  o Systems thinking for energy projects

• Good progress to date but many more projects are needed to reach net zero
  o Miramar and Fort Hunter Liggett are leading the way
Net Zero Process

**Assessment**

**Baseline**
- Current energy consumption

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

**Renewable Energy**
- Deployment of renewable energy

**Electrical Systems**
- Interconnection and microgrid

**Implementation**
- ESPC, PPA, UESC, Appropriations

**Execution**

**Project Development**
- Transaction support and additional analysis
Miramar Summary

• NREL completed NZEI assessment in 2010

• MCAS Miramar energy projects to date:
  o Numerous energy efficiency projects
  o ~1.5 MW of solar PV plus solar parking lot and street lights
  o Solar thermal pool heating
  o 3 MW landfill gas PPA
  o ESTCP energy storage project
  o Currently approximately 50% renewable electricity

• NREL completed microgrid assessment in 2012
  o Conceptual design plan
    – Load analysis
    – Electrical modeling
    – Financial analysis
  o Project awarded construction funding
Army Net Zero Support

- FY11 Select installations
- FY12 Develop strategies
- FY13 and FY 14 Project Development
Army NZEI Real Property (One size doesn’t fit all)

Square Feet

# Of Buildings

EUI

% Change EUI 2003/2010

Net zero installation strategy is location dependent
Renewable Energy Resource Example

Portfolio Screening and Single Site Detailed Mapping
Portfolio Analysis Example

Agency Can Save $168M in Energy Costs Over 25 Years By Implementing RE

Portfolio analysis can help identify candidate locations for net zero
Solar Pricing
(Modeled Overnight Capital Cost of PV)

Solar price decreases of ~50% are making net zero more cost effective

Source: Photovoltaic System Pricing Trends: Historical, Recent, and Near-Term Projections 2013 Edition, NREL and LBNL
New Construction Example: West Point

<table>
<thead>
<tr>
<th>Projects</th>
<th>FY 2013</th>
<th>FY 2014</th>
<th>FY 2015</th>
<th>FY 2016</th>
<th>FY 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadet Barracks Building</td>
<td></td>
<td>Cadet Barracks</td>
<td>Camp Buckner, Phase 1 Barracks</td>
<td>Grant Barracks Modernization</td>
<td>Mac Short Barracks Modernization</td>
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<tr>
<td>Scott Barracks Modernization</td>
<td>Scott Barracks Modernization</td>
<td>Camp Buckner, Phase 1 Barracks</td>
<td>Grant Barracks Modernization</td>
<td>Mac Short Barracks Modernization</td>
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<tr>
<td>Waste Water Treatment Plant</td>
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<td>Pershing Barracks Modernization</td>
<td>Mac Long Barracks Modernization</td>
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<tr>
<td>Ammunition Supply Point</td>
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<td></td>
<td>Camp Natural Bridge, Phase 1</td>
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</tbody>
</table>

New Construction can significantly increase baseline energy use but provides excellent opportunity for cost effective EE/RE projects.
NZEI Example: Kwajalein

Phase 1 NZEI Strategy: (think strategy)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Total Initial Investment ($)</td>
<td>117,653,180</td>
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<tr>
<td>Annual Fuel Savings (gallons)</td>
<td>2,301,806</td>
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<tr>
<td>Annualized Fuel Cost Savings ($/year)</td>
<td>10,012,806</td>
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<tr>
<td>Annualized RE O&amp;M Costs ($/year)</td>
<td>-730,000</td>
</tr>
<tr>
<td>Base Case Life-Cycle Cost ($)</td>
<td>226,108,994</td>
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<tr>
<td>RE-diesel Case Life-Cycle Cost ($)</td>
<td>182,132,160</td>
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<tr>
<td>Life-Cycle Cost Savings ($)</td>
<td>43,976,816</td>
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<tr>
<td>Base Case LCOE ($/kWh)</td>
<td>0.281</td>
</tr>
<tr>
<td>RE Case LCOE ($/kWh)</td>
<td>0.226</td>
</tr>
</tbody>
</table>

Phase 2: Project Development (think steel in the ground)

- Cooling load analysis for seawater air conditioning
- ESPC project development support
- Wind met tower procurement, installations, and analysis
- Wind project sitting
- Solar PV and OTEC support

Contribution from EE/RE

- Wind 35%
- Energy Efficiency 25%
- PV 18%
- SHW 5%
Development Process

- Project Fundamentals
- Development
- Construction
- Operations

Time

- Site
- Resource
- Off-take
- Permits
- Technology
- Team
- Capital

Risk

Unknowns
Example Projects Supported

• Net zero building design support
• Biomass technical assistance
• Wind technical assistance
• RE operations and maintenance (O&M) guidance
• Energy conservation measures technical assistance
• Electric vehicle infrastructure strategy

Moving forward with many projects despite challenges
Ft Carson: Deep Dive Retrofit Study

Incremental Life Cycle Cost (millions of dollars)

Energy Use Intensity (kBtu/ft²·yr)

Max Tech Package (NZE +):
+ Replace workstation computer equipment with high efficiency equivalents
+ Increase exterior wall insulation by R-8.7
+ Increase roof insulation by R-10 and add cool roof membrane
+ Add high SHGC window inserts

Net Zero Energy Package (NZE-Ready +):
+ Install PV on 75% of the roof area

Net Zero Ready Efficiency Package (Cost Min +):
+ Install vacancy sensors in common areas
+ Increase exterior wall insulation by R-5.7
+ Reduce support equipment plug load density by 25%
+ Replace HVAC with GSHP and DOAS

Cost Minimum Package (Baseline +):
+ Reduce LPD to 0.4 W/ft² (65% reduction)
+ Install vacancy sensors in enclosed offices
+ Daylight open offices
+ Install controllable plug strips in offices

Simulation Data
Optimization Curve
Cost Neutral Line

Net Zero Energy
Interconnection Example: Camp Parks

- 500 kW average load
- 4-5 MW PV needed for net zero
- Funded 2 MW PV project will export power
- CA has 1 MW net metering limit
- Expansion of feed in tariff to 3 MW helps

Installation can’t interconnect enough PV to be net zero without utility involvement
Sample Projects to Date

• **Energy Efficiency**
  o Several ESPC’s projects
  o Many smaller appropriations funded projects

• **Renewable Energy**
  o Numerous installed systems:
    – Solar PV, solar hot water, GSHP, etc.
  o Many projects in development
    – e.g. 18 MW PV at Ft. Detrick and 2 MW at Parks

• **Demonstrations projects**
  o Waste to energy, solar CHP, fuel cell, and biomass gasification

Many more projects needed to reach net zero!
Lessons Learned

- Net Zero does not equal energy security
- Goals and mandates require incentives and enforcement
- Behavior/culture change is also needed
- Construction designs need to sync with net zero goals
- Thermal NZE is the most difficult to accomplish
- Projects are difficult at many installations
- Implementation support is critical to success

An engaged and motivated team is the key differentiator
Thank You and Resources

My Contact Info:
samuel.booth@nrel.gov or 303-275-4625

NREL Guide to Net Zero Energy Assessment:
http://www.nrel.gov/docs/fy10osti/48876.pdf

NREL Net Zero Energy Analysis for MCAS Miramar: