Net Zero Energy Installation (NZEI) Activities

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Net Zero Energy Installation (NZEI) Activity Session Agenda

• Dod Net Zero Energy Installation Activities Overview - Mr. Bob Westby, NREL

• Renewable Energy Optimization Assessment Tool - Dr. Andy Walker, NREL

• Energy security serving the load separately (“electrical islanding”) approach and assessment tools - Dr. Bill Kramer, NREL

• Project progress and lessons learned
  ▪ MCAS Miramar: Mr. Randy Monahan, MCAS Miramar
  ▪ USAFA: Mr. Jeff Bedard, NREL
  ▪ Marforres Federal City New Orleans NZEI Assessment/Climate Neutral Initiative Demonstration Project: Ms. Jessica Katz, NREL
The Department of Energy's Federal Energy Management Program's (FEMP) mission is to facilitate the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship.
Summary ("bottom line up front")

- Net Zero Energy Installation (NZEI) optimal approach to achieving compliance and security objectives

- NZEI is systems approach
  - Loads minimized
  - Renewable energy use maximized
  - Systematic microgrid implementation facilitated

- Multiple DoD NZEI activities currently supported across the Services
Systems Approach: NZEI Premise

“Today, systems thinking is needed more than ever because we are becoming overwhelmed by complexity.”*

Systems approach

• Developing an optimal energy security approach requires “systems thinking” (discipline for seeing wholes)

• Progress will require more complex and integrated decision-making

• Solutions require a combination of strategies; EE/RE technologies; linking values to human behavior; new roles for stakeholders and new public policy

*Senge, P. 2006. The Fifth Discipline. 5-22.
**NZEI Concept**

- **Net Zero Energy Community (ZEC) definition:** A community that has greatly reduced energy needs through efficiency gains such that the balance of energy needs for vehicles, thermal energy, and electric energy within the community is met by renewable energy.”

- **DoD-DOE NZEI Task Force NZEI definition:** A military installation that produces as much energy on or near the installation as it consumes in its buildings and facilities (maximizing the use of renewable energy resources)
Approach: NZEI Systems Assessment Overview

**Baseline**
- Current energy consumption

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

**Renewable Energy**
- Deployment of renewable energy

**Electrical Systems**
- Interconnection and microgrid

**Transportation**
- Reduce and replace fossil fuel use

**GHG**
- Baseline and reductions
Approach: NZEI Assessment Support Software Tool Suite

- **Efficient building retrofits**
  - Pre-Engineering Analysis tool - systematic energy efficiency and renewable energy assessment

- **Efficient new buildings**
  - Opt E-Plus (commercial buildings)- informs/optimizes design (energy modeling) process
  - B-Opt – counterpart tool for residential (base housing) applications

- **Renewable energy utilization**
  - Renewable Energy Optimization (REO) “tool” - preliminary screening to determine the least cost combination for facility RE (optimization process)

- **Electric grid opportunities (microgrid/secure operations)**
  - Hybrid Optimization Model (HOMER) tool
    - Optimizes the system design by simulating various configurations of distributed energy resources
    - Simulates hour-by hour operation of the system and load profile to evaluate performance/ lowest cost of energy
  - Distributed Engineering Workstation (DEW) tool-power flow analysis

- **Fleets**
  - Fleet Optimization tool – identifies optimal fleet strategies
NZEI Facilitated Microgrid Implementation

NZEI systems approach optimal for achieving security and compliance goals

- Minimize loads (buildings (retrofits and new construction), transportation, etc.)
- Integration of distributed energy resources (DER)
  - Maximize use of renewable energy resources (high penetration scenario)
    - Sale of power in grid-tied mode critical to overall economics
  - Fossil fueled DERs integral part of microgrid supply solution
- Electric grid related opportunities (grid-tied and load served independently (“islanded”) scenarios)
  - Smart Grid (demand response, advanced metering infrastructure (AMI), etc.)
  - Microgrid (NZEI microgrid baselining assessment)
Microgrid System Design Overview

• Initial design assumptions (site sets requirements)
  ▪ Identification of critical loads (installation-wide or more limited secure operations)
  ▪ Desired extended continuity of operations

• Illustrative microgrid control sequence
  ▪ Loss of grid--disconnect from grid
  ▪ Back-up power source (e.g. battery) starts up DGs
  ▪ Critical load control/management
  ▪ Renewables optimally introduced and operated to reduce DG operation
  ▪ Resynchronization with the grid
Microgrid System Design Overview (cont.)

Microgrid elements

- Distributed Energy Resources (DERs)
  - Diesel-generators--critical microgrid DER
  - Renewables--maximize renewable DERs ((key to extending continuity of operations, will be high penetration RE scenario, must account for intermittency)
- Back-up power systems (typically batteries)--ensure continuity of operations, provide an energy storage buffer for intermittent renewables, and enable seamless switchover from utility grid interconnection to intentional islanding
- Microgrid controls
  - Grid disconnect and seamless resynchronization
  - Microgrid start-up
  - Load control (interfaces with SCADA and EMCS)
  - Supply control (optimized operation of DERs)
DoD NZEI Projects

- DoD-DOE Initiative NZEI projects
  - Marine Corps Air Station Miramar
  - US Air Force Academy
  - Army Pahokuloa Training Center (HI)
  - Navy-site selection pending

- PACOM NZEI projects
- NORTHCOM
- Marine Forces Reserves: Federal City New Orleans (FCNO)
- Navy San Nicolas Island
- DESC DFSP San Pedro
DoD-DOE Initiative NZEI Task Force

Background
• DoD, Army, Air Force, Navy, Marines and DOE joint task force (Initiative formally implemented in 2008)
• Pilot NZEI demonstration sites at each of the Services

Goals
• Create a repeatable template for planning and developing net zero energy installations across the Services (draft template complete 5/2010)
• Affect major increases in deployed energy efficiency and renewable energy

Approach
• Task Force coordination and oversight, select pilot installations
• Comprehensive systems perspective
• Support begins with planning, continues through project implementation
Pohakuloa Training Area NZEI

- Army Training Area on Hawaii (300,000 square feet of facilities)
- 400 kw peak electrical load ($0.35 per kWh)
- Preliminary EE/RE Analysis
  - Lighting upgrades and controls
  - Solar hot water systems
    - Planning solar radiant heating demonstration
  - Photovoltaic's as preferred renewable
  - Energy storage is a challenge
- RFP issued for 150 kW of PV (utility interconnection policies could limit renewables penetration)
- Air traffic control operation identified as potential critical load (security) application
• Integrated, multi-lab FEMP ARRA funded activity
  - NREL, PNNL, ORNL, LBNL

• Overall project
  - Comprehensive efficiency and renewable energy assessments
  - HI (focus), Guam, Japan, Alaska
  - Coordinated with Hawaii Clean Energy Initiative (HCEI) activities

• NZEI assessment
  - Camp Smith (PACOM HQ)
    - Completion during FY2010
    - Potential JCTD microgrid project
Ft. Bliss

- Integrated, multi-lab FEMP ARRA funded activity
  - NREL, SNL
- Army Tiger Team Net Zero/Energy Security Demo site
- NREL (RE assessment and project development)
  - RE projects (onsite and sale of power)
    - Small scale PV
    - Geothermal (10-20MW)
    - Wind (10-120 MW)
    - MSW/CSP (30 MW)
  - Integrated RE Master Plan development
  - PIES for onsite RE projects
- SNL (cyber security/energy security)
  - Microgrid assessment for main Cantonment
Renewable Power Siting

- **10-20 MW Wind Farm**
  - 2000 acre site
  - Site OK for:
    - Ft. Bliss Range
    - Holloman AFB
  - <1 Mile to 345kV EPE line

- **Wholesale Power to EPE**
  - Distribute to Ft. Bliss - High Cost

- **Geothermal 10-20 MW**
  - On-site Distribution

- **Waste to Energy/CSP Hybrid 30 MW**
  - On-Site Distribution
Innovation for Our Energy Future

NORTHCOM

- Integrated, multi-lab FEMP ARRA funded activity
  - NREL, PNNL, SNL

- NREL (lead lab)
  - Eight DoD base Renewable Energy Optimization (REO) assessments
  - Regional renewable energy assessment
  - Electric vehicle grid integration (V2G demonstration, ESTCP proposal)
  - Baseline microgrid assessments (AFA and Ft. Carson(?))
  - NREL (transmission assessment/issues)

- SNL (cyber security/energy security)

- PNNL (grid policy issues)

- DoD elements of potential regional grid initiative
Rocky Mountain Secure Smart Grid Initiative: Multi-Utility, Multi-Objective Projects

- Ft. Collins ZED
- Xcel SmartGridCity
- US AF Academy
- Cheyenne Mtn
- Fort Carson
- FE Warren AFB
- PV REA
- Ft Collins Utility
- Buckley AFB
- CO Springs Utility
- Peterson AFB
- Pueblo Arsenal
- Black Hills Energy
• NREL has extensive experience with integration of distributed and renewable energy into microgrids. This includes both technical and economic evaluations.
• NREL also has extensive testing capability at its Distributed Energy Resources Test Facility (DERTF) to evaluate microgrid components and systems.
• This testing capability will be expanded to medium voltage microgrids at the Energy Systems Integration Facility (ESIF).
NREL Energy Systems Integration Facility (ESIF) Capabilities

- Research facility for testing of electrical systems:
  - Renewable energy generating systems integration
  - Plug-in hybrid vehicles and electrical storage systems
  - Hydrogen energy systems, production, and storage
  - High performance computing capability (200+ teraflop) for research modeling and simulation (expansion capability to 1,000 teraflops)
  - Will allow for collaboration and industrial partnering
  - Showcase “Green Computing” Data Center

153,400 sq. ft. Occupancy 2012
Behavior Change

• Behavioral programs (organizational and individual) benefits potentially on a par with technical changes
• Primary E.O 13514 GHG reduction strategy
• Behavioral research in energy efficiency *
  ▪ Behavioral program costs compare favorably with average cost of other energy efficiency programs (examples: 2.5¢/kWh vs. 1.6-3.3¢/kWh and 5.5-6.4¢/kWh)
  ▪ Behavioral programs can be cost effectively scaled
• Behavior change addressed in MCAS Miramar NZEI final report (pending)
• U.S. Army Garrison Hawaii (USAG-HI) Awareness Campaign
  ▪ Energy awareness campaign (FEMP ARRA funding)
  ▪ Includes performance metrics to measure campaign success (premise: randomized, controlled field trial in representative population)

Closing Thoughts

- Challenge: compliance vs. security and long term cost management requirements (compliance mindset not necessarily optimal)
  - Path to energy security through EO 13514
- DoD is viable test bed for grid security
  - NZEI facilitated DoD microgrid projects are test bed candidates
- Expeditionary applications (tactical microgrids) significant opportunity
- Critical load requirements are evolving (guidance as available needed)
Thank You!

QUESTIONS?

For more information:

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