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Net Zero Energy Installation (NZEI) Activities: Compliance and Energy Security

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Federal Energy Management Program - Mission Statement

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.

Contents

Net Zero Energy Installation (NZEI) Activities: Compliance and Energy Security

- NZEI systems approach
- Utilization of NZEI assessment for compliance and energy security
 - Meeting compliance requirements (initial energy security characterization)
 - DoD NZEI projects
 - Facilitating energy security micro-grid planning and design
- Grid integration capabilities
- Closing thoughts

NZEI Systems Approach

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

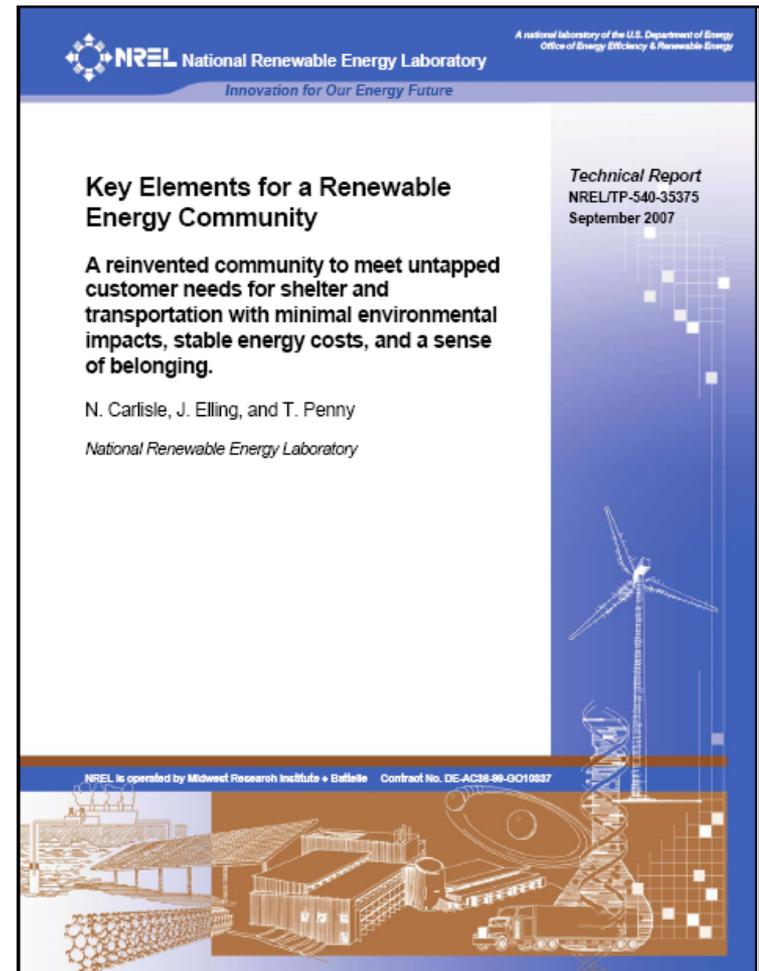
Systems Approach

- Developing an optimal compliance and 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.

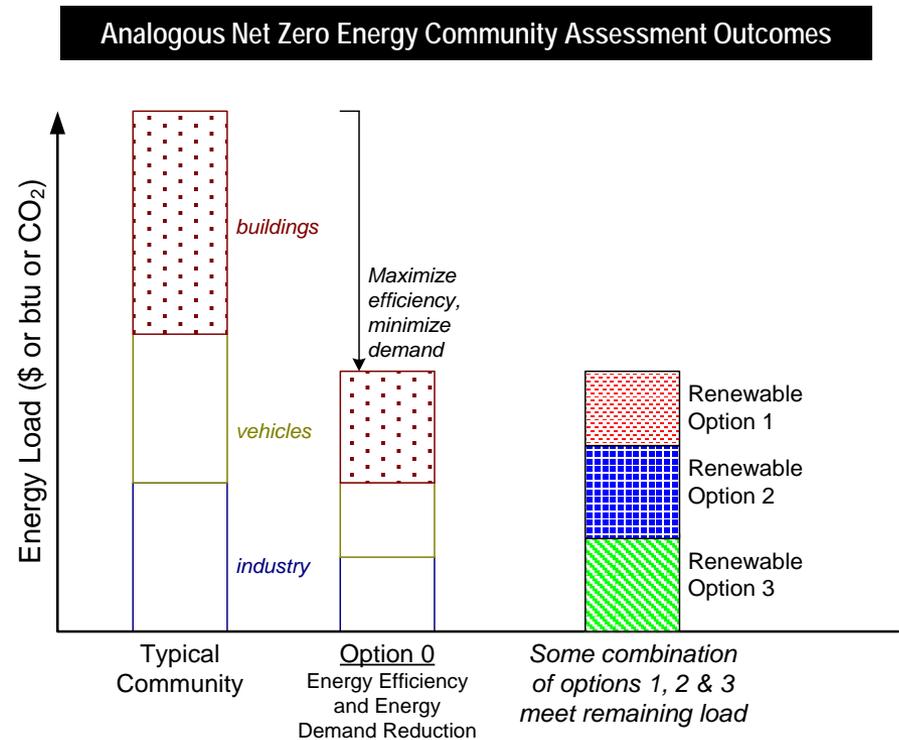
NZEI Premise: Net Zero Energy Communities (circa 2007)

- **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 Initiative 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)



NZEI Systems Assessment Elements

- **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



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

DoD NZEI Projects (Representative)

- DoD-DOE Initiative NZEI projects
 - MCAS Miramar
 - U.S. Air Force Academy
 - Army Pahokuloa Training Center (HI)
 - Navy-site selection pending
- PACOM NZEI related projects
- Ft. Bliss
 - Army Tiger Team Net Zero/Energy Security Demonstration site
- NORTHCOM: Ft. Carson
- Marine Forces Reserves: Federal City New Orleans (FCNO)
 - Climate Neutral Community Initiative (CNCI)
- Navy San Nicolas Island
- DESC DFSP San Pedro



U.S. AIR FORCE



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 completed June, 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



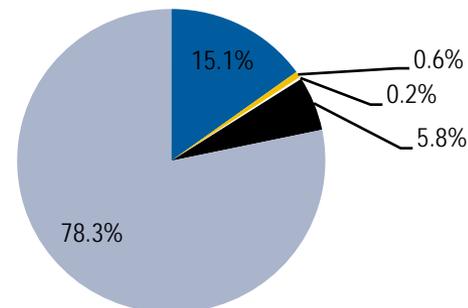
MCAS Miramar NZEI Results

Key Results

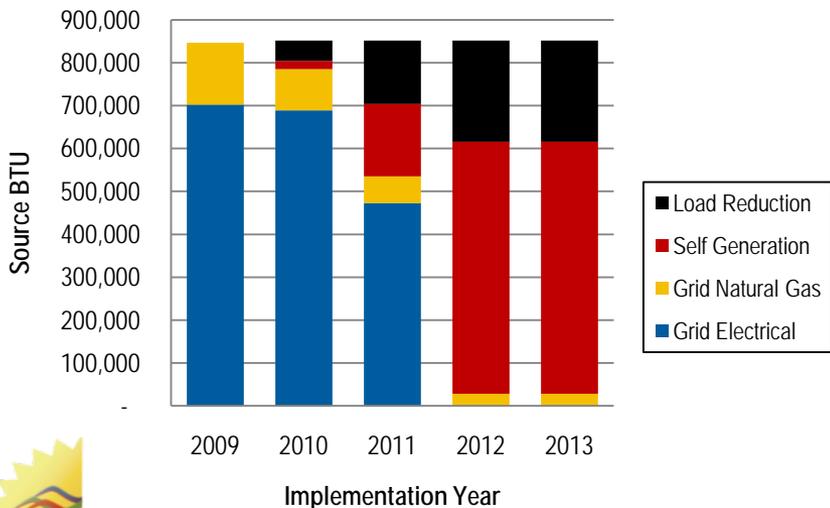
- 95% reduction in facility source Btu
- Increased energy security due to on-site renewable generation
- Reduced costs
- Environmental benefits
- Exceeds federal plus military goals and mandates

Recommended Solution: Overall Source MBtu Profile

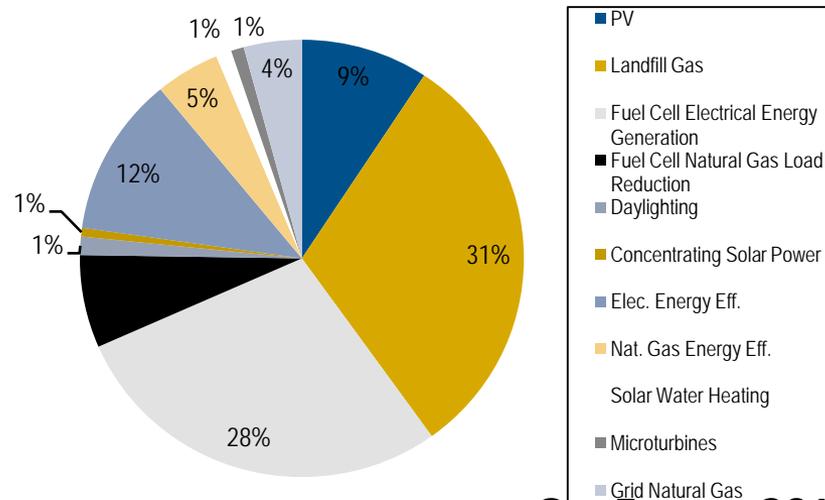
EE/RE Natural Gas Fleet Commuters Tactical



Recommended Facility Source Btu Reduction Plan



Recommended Solution: Facility Source Btu Breakdown



NZEI Facilitated Micro-grid Implementation

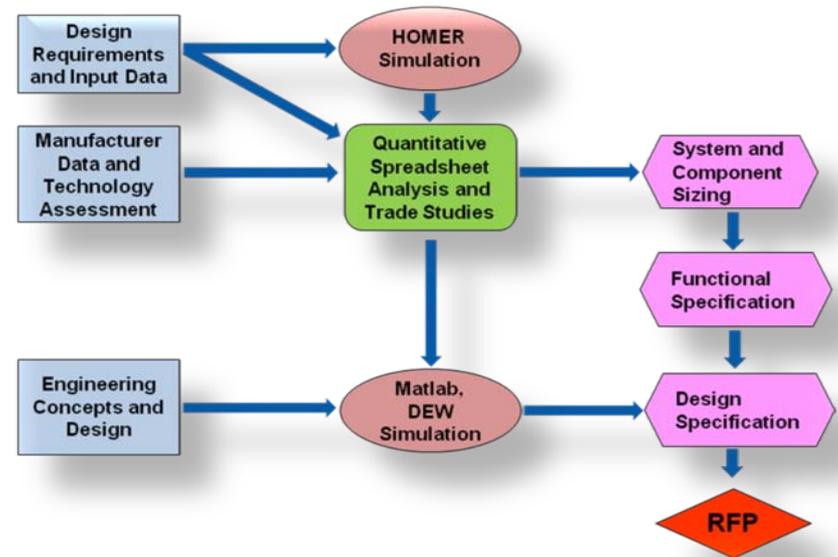
NZEI systems approach optimal for micro-grid facilitation (energy and security nexus)

- Minimizes loads (buildings (retrofits and new construction), transportation, etc.)
- Maximizes use of renewable energy resources (high penetration scenario)
- Identifies grid related opportunities (bi-directional energy flows)
 - Sale of power(micro-grid business case), demand response, etc.
- Characterizes micro-grid (micro-grid "baseline")
 - Base distribution system/grid interface (one-line electrical diagram)
 - Distributed energy resources (diesel generators/storage and renewable energy combination)

Energy Security Micro-grid Planning and Design Process (NZEI Facilitated)

Micro-grid RFP development scope of work

- Determine site energy requirements
- Classify loads
- Classify available and potential generation
- Evaluate ability of generation to supply loads
- Develop a control strategy
- Determine equipment requirements
- RFP development



Micro-grid System Design: Requirements Development

- **Initial design assumptions (site sets requirements)**
 - Identification of critical loads (installation-wide or more limited secure operations)
 - Desired extended continuity of operations
- **Critical load requirements are evolving**
 - Electric Grid Security Council (DoD,DHS,etc.)
 - DFAA 2009: Sec. 335. Mitigation Of Power Outage Risks For Department Of Defense Facilities And Activities

Micro-grid System Design Overview

Micro-grid Elements

- Distributed energy resources (DERs)
 - Diesel-generators (critical micro-grid DER)
 - Renewables (key to extending continuity of operations, will be high penetration scenario)
 - Other fossil fueled resources
- Back-up power systems (typically batteries)
 - Ensure continuity of operations
 - Provide an energy storage buffer for intermittent renewables
 - Enable seamless switchover from utility grid interconnection to intentional islanding
- Micro-grid controls
 - Control requirement: maintain required frequency and voltage levels
 - Grid disconnect and seamless resynchronization
 - Micro-grid start-up ("black start")
 - Load control (interfaces with SCADA and EMCS)
 - Supply control (optimized operation of DERs)

NREL Distributed Energy Resource Grid Integration Capabilities Overview

Distributed Energy Resources



Fuel Cell



PV



Microturbine



Wind



Energy Storage



PHEV - V2G



Generator

Interconnection Technologies



Inverter

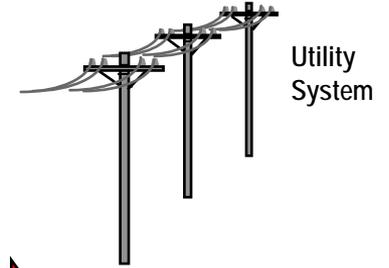


Switchgear,
Relays, & Controls

Functions

- Power Conversion
- Power Conditioning
- Power Quality
- Protection
- DER and Load Control
- Ancillary Services
- Communications
- Metering

Electric Power Systems



Utility System



Microgrids

Loads

Local Loads
Load Simulators



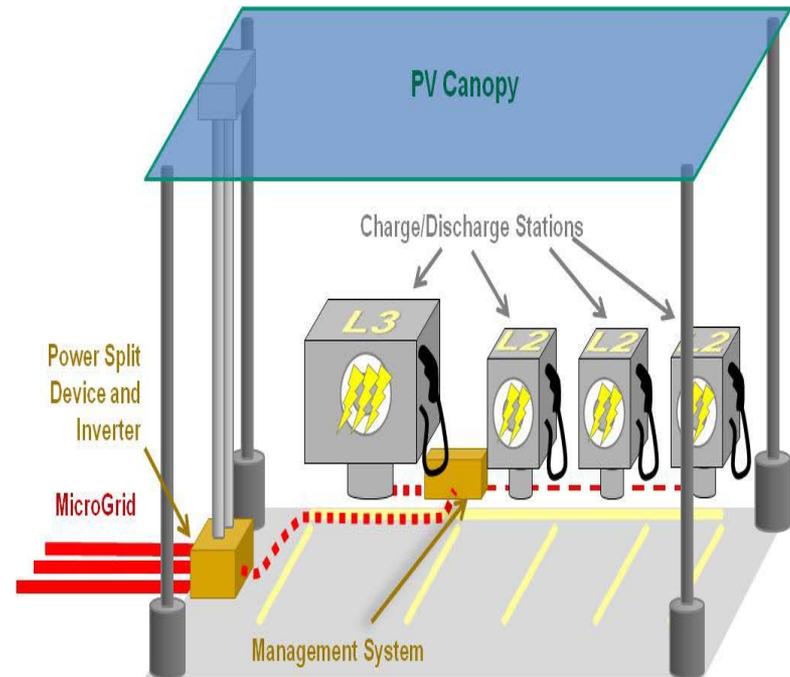
Vehicle to Grid (V2G) Demonstration (Ft. Carson)

- V2G technology provides stability management of micro-grids with large scale renewables (critical technology deployment)
 - Power flow management technology, communications infrastructure and systems operation scenarios need to be defined
- Ft. Carson pilot and demonstration (proposed)
 - Transportation technology assessment and EV grid integration recommendations for system design
 - Integration analysis of a renewable energy management unit for PEVs to be integrated with micro-grid critical loads
- Army TARDEC program providing five Smith EV vehicles /charging infrastructure



NREL PHEV/V2G Pilot Renewable Charging Station

- **Demonstration Renewable Charging Station**
 - Combination of PV providing shade to vehicles and energy to the micro-grid along with vehicle energy management portals
- **V2G-capable vehicles tested to existing grid integration standards**
 - Bi-directional Level III fast charge system planned to provide understanding of attributes and grid impacts
 - Systems optimization analysis to understand the scalability to satisfy several vehicles to 1000s of vehicles.



NREL Micro-grid Testing Capabilities



- Extensive testing capability at Distributed Energy Resources Test Facility (DERTF)
 - Distributed energy systems integration
 - Power electronics
 - Renewable electrolysis for H₂ production
 - Codes and standards
 - Distributed systems modeling
- Testing capability will be expanded to medium voltage and includes “hardware in line” at the new Energy Systems Integration Facility (ESIF)

NREL Energy Systems Integration Facility (ESIF)



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

Closing Thoughts

- Developing an optimal compliance and energy security approach requires “systems thinking” (integrated decision making)
- Challenge: compliance vs. security and long term cost management requirements (compliance mindset not necessarily optimal)
 - Path to energy security through EO 13514
- DoD is a viable test bed for grid security
- Expeditionary FOB applications (tactical micro-grids) represent significant opportunity

An aerial photograph of a large industrial or research facility. The facility consists of several large, multi-story buildings with light-colored facades and flat roofs. Some buildings have solar panels installed on their roofs. The surrounding area is a mix of green grass and brown earth, with some snow patches. In the background, there are large solar panel arrays. The overall scene suggests a large-scale energy or research project.

Thank You!
QUESTIONS?

For more information:

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