NDCEE

National Defense Center for Energy and Environment

DoD Executive Agent

Office of the Assistant Secretary of the Army (Installations and Environment)

Zero-Energy Housing (ZEH) for Military Installations

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Report Documentation Page

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Presentation Overview

- What is ZEH and why is the military interested
- What is driving ZEH
- Phase I results
- Scope of Phase II

Environmental Security Technology Certification Program

SUSTAIN SUPPORT DEFEND

Actus
Lend Lease

AIRBORNE

Pacific Northwest National Laboratory

7group

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ZEH Demonstration

Zero-Energy Home

- Designed to maximize occupant well-being while minimizing energy requirements
- Combines energy-efficient technologies and construction techniques with renewable energy systems (e.g., photovoltaics)

$$\textbf{Energy Consumption}_{\textbf{house}} = \textbf{Energy Generation}_{\textbf{house}}$$

- Team with RCI development partners and coordinate with Army Installation Management Command to ensure success
- Conduct integrated design, energy modeling and analysis to determine high-performance, cost-effective technology integration strategies
- Demonstrate and validate costs/benefits of operational performance related to energy and environment
- Disseminate results throughout the building industry, especially military housing

Drivers

- In FY06, 300,000 DoD homes used 11 trillion BTUs of electricity at a cost of $254M
- Military Housing Privatization Initiative of 1996 provides opportunity for private expertise/capital to be used for military housing (DoD is privatizing 195,000 homes by 2010)
- Executive Order 13423, Energy Policy Act of 2005, and Army policy require more energy-efficient/less polluting buildings
- Increased energy efficiency will reduce DoD electricity use and costs, increase energy security, reduce greenhouse gases, and potentially improve soldier living environment

Task Overview

- Phase I (conducted under NDCEE task 440)
  - Identified technology portfolio to reduce energy use by 51%, saving $800/home annually
  - Potential for $3.5M in annual energy savings at Ft. Campbell
- Phase II (to be conducted under ESTCP task)
  - Assist with the design of ZEH homes using energy modeling
  - Document the energy, economic, and environmental performance of the homes

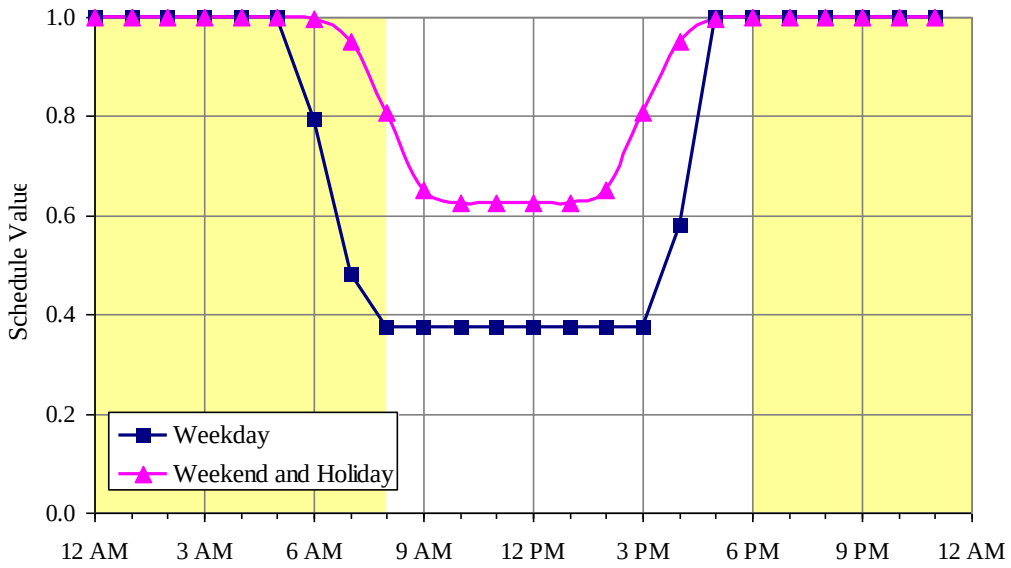
Integrated Design: Optimizing interconnecting relationships to produce a high-performance and cost-effective project

Integrated design - mixed-humid climate - resident conservation incentives

Energy Modeling via eQUEST

Computer-based tool that simulates a building's energy usage

- Optimize the building design
- Allow the design team to prioritize investment strategies



Occupancy Profile

Weather Data - Building Envelope - Internal Gains Schedules - Systems

Phase I Approach

- Baseline energy modeling
  - established baseline energy usage
  - validated results using metering data (quantity) and US DOE Residential Energy Survey Data (system usage)
- Design charette to identify alternative technologies
- Evaluated alternative technologies using energy modeling

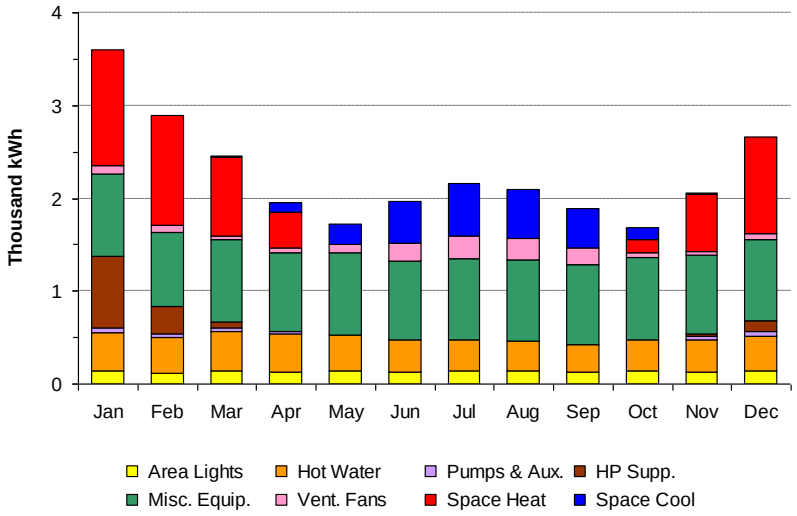
Identification of Alternative Technologies

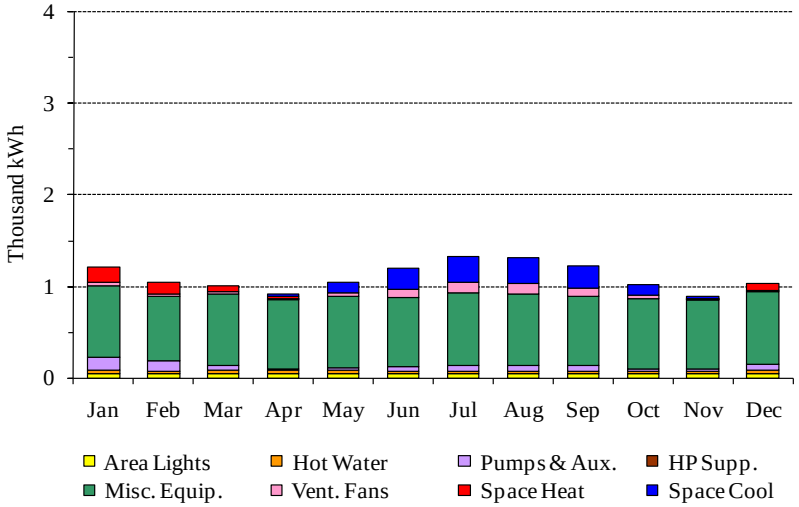
Category	Technology Option
HVAC System	Improved SEER, GSHP, two zone GSHP
Water	Electric tank, GSHP assist
Orientation	North, South, East, West
Wall Construction	Wood and steel studs: various sizes, SIPs, ICF
Insulation	Batt with several R-values, spray foam, SIP, ICP
Windows	Double-glaze, low e vinyl, e film
Roof	Asphalt, rubber, concrete, metal
Foundation	Slab w/wo insulation, crawlspace with batt, spray & perimeter ins
Doors	Metal insulated, wood frame, no French doors, fins
Overhangs	House, windows
Attic Space	R30/R45 blown w/ radiant barrier, vapor retarder, attic fan, rb drape
Lighting	Fluorescent, compact fluorescent, daylighting
Appliances	Energy Star, high efficiency

Final Modeled Design Savings

Technology/Design Element	Savings over Baseline
Metal Roof	0.04%
Overhangs on French Doors	0.1%
R45 Attic Insulation	0.7%
North Facing Orientation	2.0%
Compact Fluorescent Lighting	3.7%
High Efficiency Appliances	9.0%
6” Structural Insulated Panels	14.0%
Ground Source Heat Pump (HVAC)	19.9%
GSHP (HVAC and Hot Water)	29.1%

Phase I Modeling Results





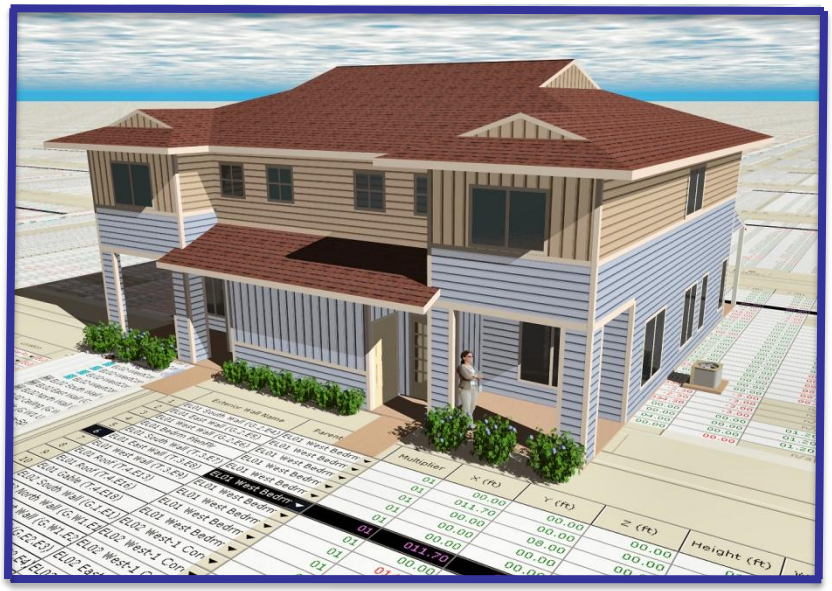
Baseline Performance
27,100 kWh/year

Alternative Design Energy Performance
13,200 kWh/year

Phase II: Development Plan

Design Phase

- Conduct whole building integrated design to optimize house design
  - Goal setting workshop
  - Integrated design charette
  - Energy modeling and analysis



  - Cost estimates and environmental impacts
  - Determination of appropriate renewable energy technology

Construction and Monitoring

- Document construction techniques and costs for control homes and demonstration homes
- Install monitoring equipment in each home
- Move four similar families into the homes and educate them on energy conservation and home operation
- Verify homes meet design specifications and operate as designed

Performance Validation

- Energy, Environmental and Cost Analysis
  - Energy consumption, cost and use patterns
  - Environmental impacts, including indoor environmental quality (humidity, temperature, air pollutants)
  - On-site energy production
  - Maintenance costs and labor-hours
  - Occupant comfort and satisfaction
  - Life-cycle, net present value, simple payback and Return on Investment (ROI) analysis

Technology Transfer

- Energy and construction industry conferences
- Case study
- ESTCP reports
- Incorporate lessons learned into over 38,000 military housing units and 4,900 hotel rooms that ACTUS is building nationwide

Anticipated Results

- Reduce energy use by at least 70%
- Use of on-site renewable energy meeting remaining demand
- Reduce water usage by 100,000 gallons per house
- Reduce energy-related pollutants by 50,591 pounds per year per home
- Transferable Results

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