TROPEC FY2012-FY2013 Lab Summary

Mission: *Reduce Operational Energy Consumption in Tropical Environments while maintaining or improving warfighter capability.*

Goal: *Reduce operational energy consumption at PACOM expeditionary basing by 25% in 32 months.*

Method: *By combining Department of Energy expertise in energy efficiency & demand reduction with Pacific Command and System Experimentation Division expertise in operations in tropical environments and through a process of technology identification, review and assessment, provide strategy and acquisition professionals with insight and information on material and non-materiel solutions.*

Background: Oak Ridge National Laboratory (ORNL) and Lawrence Berkeley National Laboratory (LBNL) are Department of Energy (DOE) laboratories that provide technical support to the TROPEC program. ORNL is the lead laboratory and focuses on technologies for expeditionary shelters, environmental control units (ECUs), and base camp "hotel" loads including kitchens, laundry equipment, water heating, and water pumping. LBNL focuses on energy efficient technologies for lighting, data processing and communication systems; electronics; and power distribution systems. Each lab conducts laboratory assessments of I-Net technology applicants in their respective technical areas and assists PACOM and MEC in field assessments of these technologies.

General Activities:

- Reviewed expeditionary technologies submitted to TROPEC's I-Net for military energy impact, readiness, and suitability.
- Prepared 3D building information models (BIM) of typical military billeting/admin tents.
- Evaluated performance of promising tent/ECU configurations in tropical climates using DOE's EnergyPlus software.
- Evaluated potential of military and commercial ECU technologies via energy use modeling
- Evaluated results from CV 2012 field demonstration by developing a tent tropical energy use predictive model based on measured tropical performance data.
- Acquired and modified commercial digital control devices with occupancy sensing capability for controlling ECUs in Balikatan 2013 field demonstration.
- Constructed a natural exposure testbed at ORNL for shelter and ECU technology assessment when conditions are similar to tropical weather in the PACOM AOR.
- Benchmark assessed radiant barrier technology and multiple HVAC systems at ORNL's testbed.

TROPEC Testbed at ORNL, Summer 2013

- Executed a laboratory assessment of air-to-water technology for condensing potable water from air.
- Conducted analytical assessment of a proposed integrated sensible/latent heat exchange technology for tents.
- Executed a laboratory assessment of a plasma lighting technology for exterior area lighting at base camps.
- Analyzed an LED replacement lamp for the fluorescent string-lights typically used in tactical shelters.
- Conducted a laboratory assessment of a solar-powered lighting cart for exterior area lighting at base camps.
- Conducted a laboratory assessment of one liquid cooling and two containerized technologies for cooling data processing equipment in tactical command posts.
- Assessed the energy and load savings potential of a voltage regulation technology.
- Analyzed the potential application of a commercial energy-monitoring system for use at base camps.
- Adapted a commercial, occupancy-based lighting control system for use in admin tents at Crimson Viper 2012.
- Collected baseline energy use data at the Cobra Gold 2013 field exercise.

Server technology in Test Chamber 1

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General Findings/Recommendations:

- ORNL modeling and testbed data showed that significant reductions in ECU loads could be achieved by using radiant barriers in various configurations. Field and testbed assessments, however, indicated rapid surface oxidation occurred in moist environments that could reduce effectiveness. Recommend alternate radiant barrier solutions be pursued to avoid oxidation issues.
- Unlike commercial HVAC units, military ECU compressors operate continuously regardless of whether the thermostat is satisfied. To significantly reduce fuel use at the generator requires downsizing the ECU, switching to modulating capacity ECUs, and/or improving shelter performance so that more than one tent can be served by a single ECU.
- Occupancy-based control of lighting in administrative tents can reduce lighting energy use by up to 50%, but current commercial products need to be adapted to be easier to install and configure in a contingency base.
- Plasma lighting technology can reduce area lighting energy requirements by up to 25% compared with standard metal-halide lamps. it also offers other benefits such as dimmability and faster re-strike time.
- LED replacement lamps for existing fluorescent shelter string-light fixtures may not be a desirable approach due to thermal management problems within the light fixture and poor light distribution within the shelter.
- Solar-powered light carts can provide adequate area illumination while reducing generator fuel use for lighting by at least 60%, and eliminating the need for a generator entirely in some locations.
- Liquid-cooled servers and containerized cooling technologies have the potential to completely eliminate waste heat from computing equipment in command posts, in turn reducing ECU energy use. By avoiding compressor-based cooling, high-temperature liquid cooling appears to have the greatest savings potential of these approaches.
- Lab assessment indicated that condensing water from air could use 73% less fuel than transporting water. Tropical climates are optimum for these systems. Low humidity (desert) climates can negate most of their fuel savings value. Comparison to historical data for military reverse osmosis (RO) systems showed condensing water would use at least 30 times more energy than RO.
- Analytical assessment of an integrated sensible/latent heat exchange system indicated the concept could save 16% of ECU energy. However, multiple issues related to integration with existing tents and ECUs would have to be addressed. Logistics impact related to the size, weight, and volume of the intended system must also be considered.

Measuring Light Distribution from Solar Powered Light Cart

Tent 3D Building Information Model

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