The Kuwait Energy Efficiency Project

A team from the Logistics Innovation Agency and Area Support Group–Kuwait studied energy consumption at a Kuwait base camp and found a way to improve operational energy efficiency.

■ By John J. Yates

Based on the operational needs of the combatant commander and the recognition that energy is a critical resource necessary to accomplish regional sustainment missions, the Department of the Army G-4's Logistics Innovation Agency partnered with Area Support Group–Kuwait to improve operational energy efficiency within a Kuwait base camp.

Operational energy includes the energy needed to train for, conduct, and support military operations. The scope of operational energy is significant; the Department of Defense consumed more than 87 million barrels of fuel in fiscal year 2014 alone.

As such, Army leaders have emphasized the need to improve energy efficiency at forward locations. Energy efficiency is a vital component of the broader need to fundamentally reduce the demand characteristics of the force.

This article explores the use of operational energy within a base camp and summarizes the results of the Kuwait Energy Efficiency Project (KEEP), which may be leveraged for the current and future operational environments.

Issues Affecting Sustainment

To better understand future challenges and potential solutions, it is important to recognize the issues that affect sustainment requirements. These include such dynamics as Soldiers deploying and operating for longer periods of time, over greater distances, at a higher operational tempo, and in semi-independent modes.

In the realm of operational energy, three main factors should be considered when addressing efficiency improvements at base camps. The first factor is how energy is generated and distributed. Power, in many cases, must be generated locally at base camps using inefficient spot generators, which add to overall fuel consumption.

Secondly, energy consumption by base camp assets and the overall efficiency of those assets must be considered in the context of the mission and corresponding logistics support requirements. For example, tents tend to be used for many temporary base camp facilities just for portability.

However, tents are very inefficient insulators. At more enduring locations—especially in environments with extreme weather conditions—more highly insulated shelter capabilities should be considered.

The third factor involves the distance and vulnerability of the lines of communication. Often, fuel must be delivered across long distances under dangerous circumstances. In fiscal year 2007, more than 6,000 convoys supplied fuel to forward-stationed U.S. forces in Afghanistan and Iraq. Therefore, capacity, duration, performance, distance, and operating tempo must be considered when developing a comprehensive plan.

To address these operational challenges, as well as quality of life concerns, Area Support Group–Kuwait and the Logistics Innovation Agency implemented energy efficiency improvements in Kuwait as a proof of principle.

Completed in July of 2017, the KEEP effort included four key focus areas:

- ☐ Replacing selected billeting tents with energy efficient, rigid-wall shelters.
- ☐ Improving prime power operations.
- ☐ Improving power distribution.
- ☐ Collecting and analyzing energy consumption data.

While KEEP capabilities were implemented only at one base camp, similar energy efficiency capabilities and savings could be realized at other camps. In the end, with prudent planning and the use of energy resources, missions can be extended and logistics demand can be reduced. This article will examine the technologies used to improve operational energy.

Energy Efficient Shelters

Temporary base camps within harsh desert environments tend to have large energy footprints that rely on the use of thermally inefficient shelters, such as tents and other uninsulated facilities. Not surprisingly, a study at a Kuwait base camp found that housing was the largest consumer of energy.

Hence, the first priority was to replace selected billeting tents with energy efficient, relocatable shelters. The KEEP insulated shelters incorporated right-sized efficient heating and air conditioning units, LED lighting, and smart thermostats.

Based on energy consumption data, the shelters used about 78 percent less energy compared to the tents they replaced. In addition, the one-story shelters were fitted with solar panels on the roof. When factoring in the power generated through the solar panels to help satisfy requirements at the point of need, the actual energy savings were even greater. (See figure 1.)

Analysis confirmed that replacing tents with energy efficient shelters at larger and more enduring base camps can significantly reduce energy consumption and improve quality of life.

In more tactical and mobile settings, it may be necessary to reduce the weight and volume of the shelters to allow for easier transport, which could result in less insulated and less energy efficient shelters or in higher costs to incorporate more efficient alternative insulation options.

Power Improvements

Similar to what is found at U.S. facilities, centralized power delivery over an electrical grid is the most energy efficient means of meeting power requirements. Consequently, it is usually desirable from an energy savings perspective to leverage a host nation's power infrastructure in conjunction with a local power backup capability.

However, many base camps generate power locally using a combination of centralized power and point-of-need spot generation. The decision to generate power locally is normally dictated by a number of operational and technical factors such as the size of the camp, mobility requirements, mission duration, electrical standards, availability of power, and security considerations.

The KEEP project focused on local power generation and distribution. The analysis showed that both centralized and spot generators were oversized and underutilized.

To save energy, the KEEP team recommended and helped to implement a policy change that increased the central generators' utilization rates from 60 to 70 percent, which resulted in more efficient use of existing generators. This simple policy change saved approximately 60,000 gallons of fuel per year. Additionally, the team assisted with automating the power plant's controls, which eliminated the need to manually turn the generators on and off.

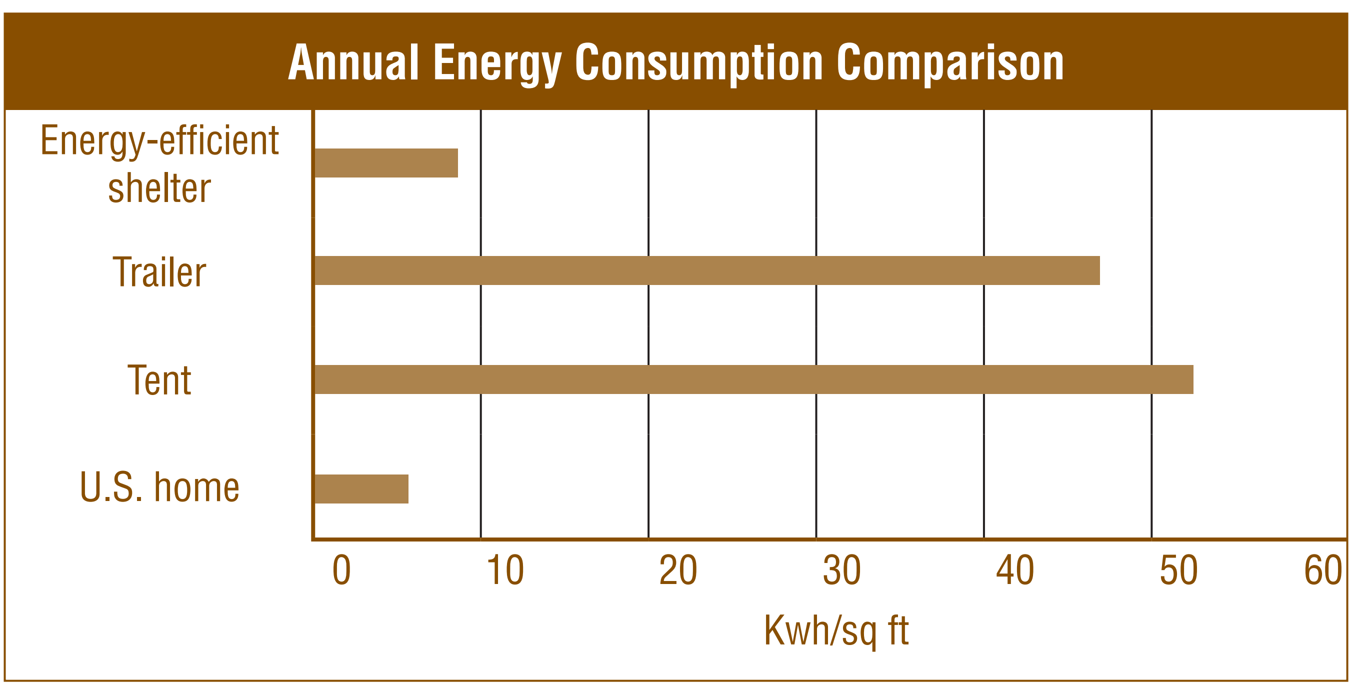
In other areas at the camp, the KEEP team found grossly oversized and underused spot generators. Analysis showed that by eliminating as many of these generators as possible, and by resizing the remaining generators to better match the load, additional efficiencies could be obtained.

Accordingly, the team developed a long-range plan to eliminate spot generators, which could save more than a million gallons of fuel per year. Further savings could also be made by expanding centralized power capabilities or by leveraging local microgrids.

Even though eliminating or resizing spot generators (which are always on) can result in significant energy savings, care should be taken to understand the seasonal variation of energy loads. For instance, one of the most significant sources of energy consumption in a desert environment is the power needed to run air conditioning units.

In general, the KEEP team's data indicated that air conditioning units consume approximately 60 to 70 percent of the overall energy used by billeting assets in summer months. The end result is that the power requirements for summer months in desert

Figure 1. This chart compares data from the U.S. Energy Information Administration's 2011 energy consumption data, 2010 U.S. Census data based on average home square footage, and energy consumption data collected in Kuwait.



climates can be twice as large as the power needed for winter months.

So, when right-sizing power generation and distribution, it is important to understand that seasonal and other variations in power and unintended consequences such as power outages could occur. Gaining knowledge in relation to how power is used over time and across mission profiles is a critical factor in supporting future mission planning within complex and demanding operational environments.

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Energy Consumption Data

Unlike at U.S. facilities, very few energy meters are used at base camps outside the continental United States. This is due to a lack of policy requiring energy meters and the temporary nature of the camps.

For the KEEP project, the team successfully metered billeting tents, trailers, and energy efficient shelters. Capturing energy consumption data was necessary for measuring energy savings, gaining knowledge of the loads based on the type and size of assets, assisting with the proper sizing of generators, and supporting decision-making.

In the future, it would be worthwhile to periodically capture energy consumption data on a sample set of facilities. Doing so would further contribute to the knowledge of electrical loads and the effectiveness of energy saving efforts.

In particular, metering showed that using relocatable shelters resulted in greater than 70 percent energy savings per square foot when compared to smaller, uninsulated tents. It also showed that power consumption varies considerably based on the season.

Because of the extreme conditions in Kuwait, temperature specifications of the meters should be considered carefully since many commercial meters cannot withstand desert conditions. Another consideration is the onboard meter data storage and associated capabilities to store and forward data automatically.

The KEEP team decided to automate meter data reporting and ensured that the meters had enough memory to hold data for over six months in case data could not be downloaded on a regular basis.

Other Potential Improvements

In addition to the KEEP efforts, many other energy reduction opportunities exist. These include emphasizing conservation efforts, encouraging commercial industry to propose novel solutions, making more extensive use of solar shading, improving insulation levels at existing facilities, and fine-tuning electrical impedance to maximize power transfer, which is commonly referred to as power factor correction.

Although power factor corrections were not implemented as part of KEEP, calculations showed that correcting the power factor at substations would result in overall energy savings of 1 to 1.5 percent and reduce the stress on the distribution system. Additionally, more extensive use of renewable energy sources could further reduce the need to transport fuel and improve the energy security posture.

Of note, the KEEP project used photovoltaics to supplement energy production for one-story shelters, which resulted in an additional 41 percent energy savings. Although this was implemented only in the one-story billeting shelters, the data clearly indicates that more extensive use of photovoltaic energy sources shows great promise for energy production in the desert.

Published in May 2015, The Army Energy Security Sustainability Strategy (available at https://www.army.mil/e2/c/downloads/394128.pdf) outlines the Army's goals for optimizing energy use, ensuring access to energy, building resiliency, and driving innovation. The KEEP effort is consistent with these goals.

Results from this project are helping inform the development of future capabilities that will meet the energy demands of the future operational environment. Specifically, the Army captured and analyzed energy consumption data and implemented technologies to improve energy efficiency, quality of life, and the operational energy security posture within a base camp.

Continuing to make advances in the areas of demand reduction and point-of-need satisfaction are central to minimizing requirements for external sustainment support. A continued focus on energy efficiency and alternative and flexible sources of energy will help support lengthening a brigade combat team's days of supply in order to increase maneuverability and mobility.

Implementing more effective energy management and introducing new power and energy processes and technologies will undoubtedly improve the Army's ability to support future multi-domain operations.

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