CASE STUDIES IN SUSTAINING DoD READINESS

J. B. Berry
C. J. Coomer
R.C. DeVault
M. R. Hillard, Ph.D.
P. J. Hughes
M. P. Ternes
G. P. Zimmerman

Oak Ridge National Laboratory
P.O. Box 2008, Building 4500N, MS6200
Oak Ridge, Tennessee 37831
berryjb@ornl.gov
865/241-1939

Introduction

The Department of Defense (DoD) is maintaining readiness while reducing associated environmental impacts by improving efficiency. DoD has demonstrated this ability to sustain readiness by meeting challenges of environmental priorities through projects and research that are improving:

- the efficiency and reducing the cost of *building energy use and delivery technologies;*
- the efficiency of *transportation systems;*
- *emergency planning capabilities*; and
- environmental, technological, regional, and policy *analysis and assessments.*

DoD efficiency improvements are has illustrated by five projects that are case studies in sustaining DoD readiness.

(1) Army Installation of Geothermal Heat Pumps at Fort Polk, Louisiana. Oak Ridge National Laboratory (ORNL) performed an independent evaluation of a project that resulted in annual energy savings of 33% of electric consumption and 100% of gas consumed for heating and hot water. The Army incurred no initial costs, received all new equipment, and will save $345,000 per year on energy and maintenance costs for more than 4,000 homes during the 20-year contract.

(2) Energy Efficiency Guidebooks for Air Force and Army Housing. ORNL worked with the U.S. Air Force and U.S. Army in developing a series of three energy guides which will assist the military in attaining its current goals for new housing, provide housing quality comparable to that found in the private sector, and reduce energy consumption as mandated by the Energy Policy Act of 1992.

(3) Innovations in Energy Efficient Heat Pump Systems. ORNL researchers, in a joint effort with industry, developed prototype generator-absorber heat exchanger (GAX) heat pump units with a 33% improvement in measured heating efficiency over that of the best existing gas condensing furnace. The Frostless Heat Pump, a new concept in heat pumps for residential use developed by ORNL, is advancing energy-efficient heat pump technology.

(4) Air Force Mobility Command Deployment Analysis System (ADANS). ORNL developed and implemented a Deployment Analysis System for the Air Force's Air Mobility Command. This system was made operational

in early 1990, and since then has been used daily, 24 hours a day, to schedule over 100,000 operational missions and millions of potential wartime scenario missions.

(5) *Environmental Impact Assessments for Two Chemical Weapons Stockpiles*. ORNL's analysis led to an informed Army decision on how best to proceed with the development of alternative technologies for destroying chemical warfare agents stored at depots in Maryland and Indiana. The assessments included analysis of the fate of the resulting waste products.

These projects sustain DoD readiness through stewardship of natural resources while considering the interfaces between economic, energy, and environmental systems. Successful DoD projects have used ORNL researchers to analyze these interfaces and to identify and implement significant efficiency improvements.

Army Installation of Geothermal Heat Pumps at Fort Polk, Louisiana

Federal agencies of the United States are required by Executive Order 13123 to reduce their energy consumption by 35% relative to their usage in 1985 by the year 2010. To help meet this goal, geothermal heat pumps (GHPs) were installed to replace inadequate and aging heating and cooling systems in military housing units at Fort Polk, Louisiana (see Fig. 1). Under an energy savings performance contract, the Army and Co-Energy Group, an energy services company, installed GHPs in 4,003 housing units.

DoD selected ORNL to conduct an independent evaluation of this massive project. Experts analyzed the impacts of the retrofit on energy use, electrical demand and maintenance costs and documenting significant savings. Researchers also used data collected at Fort Polk to calibrate models for estimating energy savings, performing measurement and verification of energy savings, and designing GHP systems. The project verified actual energy and maintenance cost savings and built a solid foundation of confidence in GHP technology.

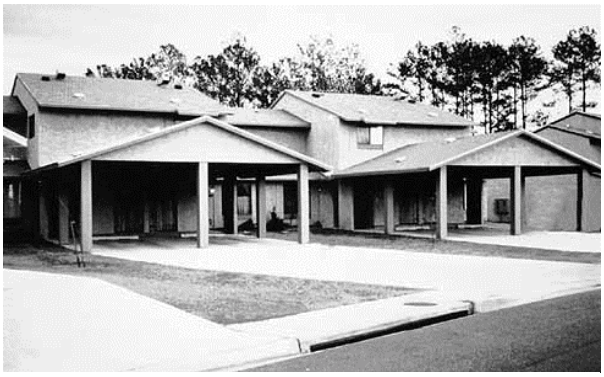


Fig. 1. Family housing units at Fort Polk, Louisiana.

In a typical year, the Fort Polk project saves 33% of pre-retrofit electric consumption and 100% of the natural gas formerly consumed for heating and hot water. Summer peak demand for electricity decreased by 43%. Electrical energy savings and reduction of peak demand dramatically improved the annual electric load factor, allowing the Army to negotiate lower utility rates for the entire base. Cutting electricity use also reduces emissions of sulfur and nitrous oxides, as well as reducing CO_2 emissions by 22,400 tons per year.

By including maintenance and operation of the new GHPs in the contractor's scope of work under the performance contract, the Army realized sigificant maintenance cost savings in addition to energy and demand savings. The Army avoids the ongoing costs of replacing aging equipment upon failure and the services of a previous maintenance subcontractor. Co-Energy Group is performing maintenance duties for 18¢/ft^2, saving the Army 6¢/ft^2/year. The Army incurred no initial capital costs, received all new equipment, and will save $345,000 per year on energy and maintenance costs during the 20-year term of the performance contract.

For their trailblazing project at Fort Polk—renewing the heating and cooling systems in 4,003 homes and lowering operating costs, without tapping government capital appropriations—the Army and Co-Energy Group were awarded Vice President Gore's Hammer Award. The Hammer Award recognizes work that makes government "work better and cost less" and symbolizes efforts to "hammer away" at unnecessary bureaucracy and costly inefficiency.

Energy Efficiency Guidebooks for Air Force and Army Housing

DoD is currently engaged in an effort to meet new housing needs, upgrade housing quality to a level comparable to that of private-sector housing, and reduce energy consumption in compliance with mandates of the Energy Policy Act of 1992. U.S. military housing, built 20 – 40 years ago, shelters more than 350,000 families and is in need of energy-efficiency improvements. DoD's goal of improving energy efficiency in Air Force and Army family housing is being supported by ORNL specialists who provide state-of-the-art expertise and guidebooks on building design, retrofits, and inspections for energy efficiency.

The *Design Guide for Military Family Housing: Energy-Efficient Revitalization and New Construction* was written for architectural and engineering firms that are developing detailed specifications for revitalization and new construction designs for DoD. The Design Guide provides information and analytical tools to enable the designer to make prudent and cost-effective decisions regarding the type and extent of energy efficiency measures to be implemented as part of new construction or revitalization of military family housing.

The *Retrofit Guide for Military Family Housing: Energy-Efficiency Weatherization and Improvements* was written to provide a framework within which to structure components of a comprehensive weatherization program. The guide offers helpful suggestions and sample contract language to develop and implement a retrofit program. The guide describes how to hire building energy consultants to perform audits, how to identify efficiency measures, and how to select installers to implement energy efficiency retrofits.

An *Inspection Field Manual* was written to identify the important energy-efficiency features that an inspector should examine during field inspection of military family housing. The manual defines "standard-of-practice" installation for the inspector. The manual is intended specifically for use on construction projects that follow the Design Guide, but can also be a useful reference for any energy audit of a housing construction project, such as projects that follow the Retrofit Guide.

Design Guide for Military Family Housing: Energy-Efficient Revitalization and New Construction

Written for architectural and engineering firms that develop detailed revitalization and new construction designs and specifications.

Retrofit Guide

Written to provide a framework within which to structure the components of a comprehensive retrofit program, as well as helpful suggestions and sample contract language to develop and implement energy efficiency upgrades.

Inspection Field Manual

Written to identify the important energy-efficiency features that an inspector should examine during

Innovations in Energy Efficient Heat Pump Systems

In a joint effort with industry, researchers at ORNL developed a prototype generator-absorber heat exchanger (GAX) heat pump unit that does not use a compressor or environmentally damaging refrigerants (see Fig. 2). Instead, refrigerant vapor is absorbed in a solution that is pumped to a generator chamber where it is heated with natural gas. The refrigerant boils off as a high-pressure vapor. A major environmental advantage of the GAX cycle is its use of ammonia and water rather than long-lived, environmentally damaging refrigerants. GAX units consume substantially less power. The measured heating efficiency of GAX units were 33% better than that of the best existing gas condensing furnace. The GAX heat pump fueled by natural gas is expected to increase the efficiency of new gas heating and cooling units by 40% over existing

technology. This energy efficiency results in reduced carbon, sulfur, and nitrous oxide emissions from the burning of fossil fuels in power plants and in reduced seasonal peak electricity demands. For consumers, the energy efficiency of the GAX cycle translates into lower energy bills.

The frostless heat pump is a recent invention that could be deployed to further enhance energy savings (see Fig. 3). This new concept in heat pumps for residential use minimizes the formation of frost on outdoor heat pump coils and could further advance energy-efficient heat pump technology. The Frostless Heat Pump avoids wasting heated indoor air for defrosting outdoor heat-exchange coils in cold weather. In contrast, conventional heat pumps reverse the airflow to melt the frost using indoor air, which subsequently lowers indoor air temperatures. The Frostless Heat Pump avoids this problem by adding a moderate amount of heat to the accumulator. This increases both the temperature of the refrigerant entering the outdoor coil and the heating capacity. Heating capacity is increased due to the fact that most of the heat to the accumulator is delivered to the indoor coil. This process keeps the outdoor coil warmer—and therefore reduces the likelihood of frost—but also can heat a house faster, thereby shutting off the cycle before frost forms. If frost does form, the pump does not reverse airflow but shuts off the indoor fan and uses accumulator heat to defrost the outdoor coil. ORNL has received a U.S. patent for this innovation.

Fig. 2. Generator-absorber heat exchanger heat pump

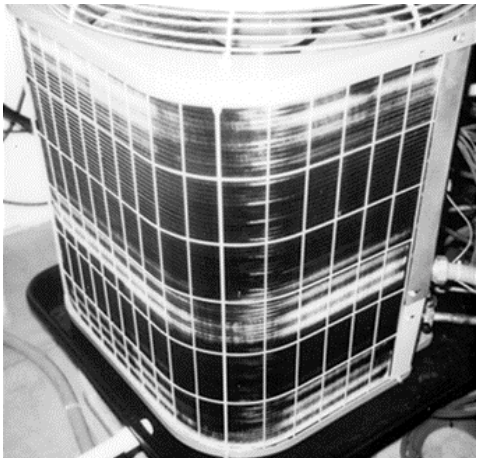


Fig. 3. Frostless heat pump.

Research and development of the GAX heat pump systems and Frostless Heat Pump documents the economic and environmental benefits of these new technologies. DoD is deploying these energy efficient technologies—helping sustain DoD's commitment to the economy and environment.

Air Force Mobility Command Deployment Analysis System (ADANS)

Air Force's Air Mobility Command's (AMC) predecessor, the Military Airlift Command (MAC), began a partnership with ORNL in 1987 to design and develop an integrated airlift planning and scheduling system. Two major goals of the new system were to:

- provide that the capability to schedule consistent airlifts in peacetime or wartime, and
- integrate the historical "stovepipe" scheduling systems into a single system that has a common user interface and centralized database.

This new system is the AMC Deployment Analysis System (ADANS). The system was made operational in early 1990, and since then has been used daily, 24 hours a day, to schedule over 100,000 operational missions and millions of potential wartime scenario missions. As a deployment planning system, the goal of ADANS is the effective movement of cargo and passengers within a specified time period. Airlift is an extremely expensive and limited resource.

During late 1990 and early 1991, ADANS was used to plan and schedule the largest airlift in history—Operations Desert Shield/Desert Storm—to support the Persian Gulf war. A typical round trip using a C5 aircraft to and from the Persian Gulf region costs approximately $280,000 and burns about one million pounds of fuel. During the early

stages of Desert Shield, before ADANS was in place, control of the flow of aircraft was managed entirely within the execution system. There was no automated support for planning and coordinating missions. This old system resulted in lost opportunities for consolidation of loads and did not make efficient use of the flying hours and fuel expended.

ADANS integrates input variables to determine global mission developments (see Fig. 4). The system is used to coordinate near-term missions—flight scheduling over the next few days. ADANS also provides tools for long-range planning and determining mission requirements, such as crew and fuel requirements. By their very nature, airlift operations are limited in time and resources. The goal of ADANS is to maximize what can be done with those resources—the operation will consume a certain amount of fuel and cost based on the time available and the aircraft that can be deployed in a given timeframe. The most important metric in these crisis situations, whether it is aid to Turkish earthquake victims or support to NATO operations in Kosovo, is how much of the most critical requirements can be delivered in the time available. The goal is for DoD to be a good steward of the resources of time, money and fuel.

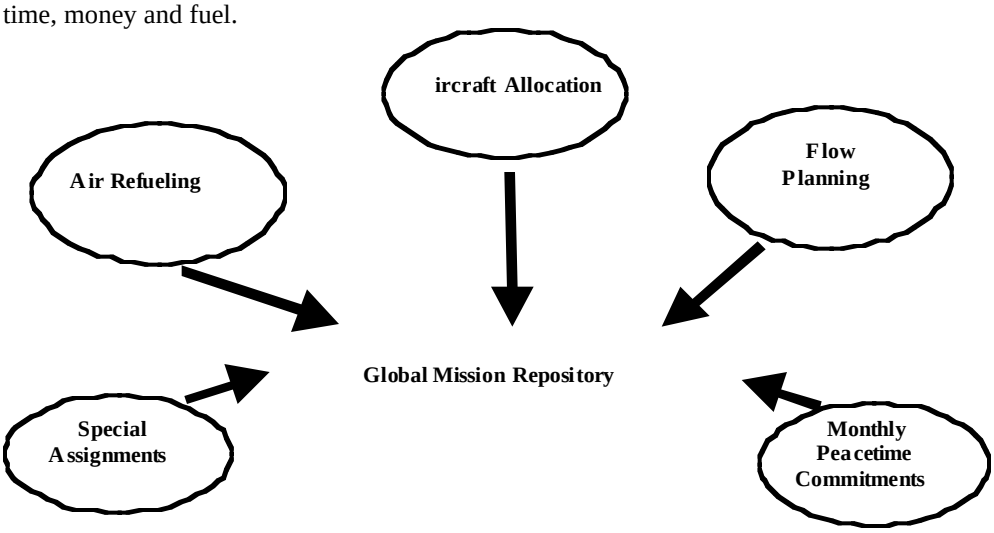


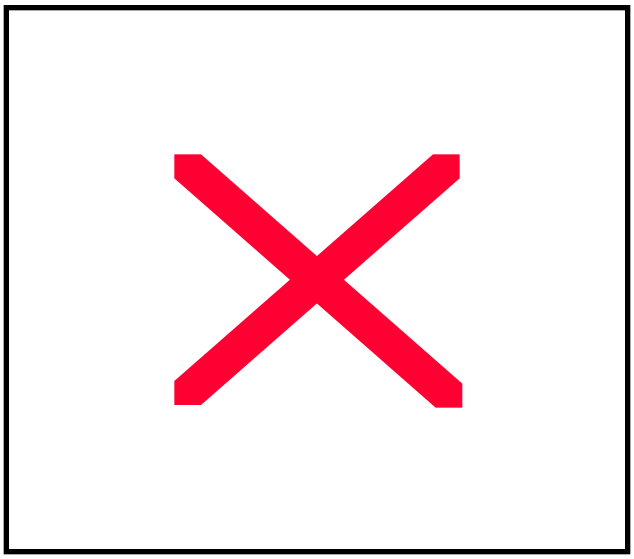
Fig. 4. Air Mobility Command's Deployment Analysis System.

AMC has continued this partnership with ORNL for over 10 years. ADANS has been upgraded to accommodate AMC's changing role in today's military transportation environment. More than ever before, DoD needs the capability to rapidly transport military troops, equipment, and supplies into any part of the world—and do it economically on a moment's notice. Whether the need is to provide humanitarian relief or respond to military aggression, the fastest way—and sometimes the only way—to accomplish this task is by air. Using ADANS sustains DoD readiness by allowing planners to balance the effectiveness of moving personnel and cargo against the cost of the movement.

Environmental Impact Assessments for Two Chemical Weapons Stockpiles

An ORNL interdisciplinary team prepared two environmental impact statements (EISs) on pilot-testing technological alternatives to incineration for the destruction of mustard chemical warfare agent, at Aberdeen Proving Ground, Maryland, and the nerve agent VX at Newport Chemical Depot, Indiana. For the mustard agent, the Army proposed to demonstrate the feasibility of a neutralization process that uses hot water followed by biotreatment to destroy the mustard agent, which is now stored in bulk containers (a non-explosive storage configuration). Following the biotreatment step, the treated effluent would be discharged into the Chesapeake Bay. For the VX nerve agent, the proposal involved chemical neutralization with sodium hydroxide followed by treatment in a supercritical water oxidation (SCWO) unit. The VX agent is also currently stored in bulk containers. The treated effluent from the SCWO unit could be discharged into the Wabash River.

Each of the two EISs assessed the potential environmental impacts of the design, construction, and operation of facilities to test the neutralization process. Two alternatives were addressed in each EIS: demonstration of the



proposed pilot facility or continued storage of the chemical without conducting the pilot testing (the no-action alternative). This assessment found that the environmental impacts of facility construction would be minor and would be similar to those resulting from construction of any medium-sized industrial facility. Based on air quality and water quality analyses that also considered the effects of routine emissions and effluents on human health and wildlife, no appreciable adverse impacts to human health or the environment would be expected during the 9-month period of pilot testing. Preliminary risk analyses and accident assessments indicated that either alternative—operation of the proposed facility or continued storage of the chemical agents—could involve similar accidents. Based on this analysis, the Army made an informed decision on how best to neutralize the chemical warfare agents and dispose of the resulting waste products.

Summary

DoD has improved efficiency by implementing projects that emphasize conservation of energy and protection of the environment. These projects have contributed to sustaining DoD readiness while reducing associated environmental impacts by saving energy and costs through technology improvements, systems analyses, and logistics support. The DoD is demonstrating this ability to sustain readiness by meeting challenges of environmental priorities through projects and research that are improving:

- the efficiency and reducing the cost of *building energy use and delivery technologies;*
- the efficiency of *transportation systems;*
- *emergency planning capabilities*; and
- environmental, technological, regional, and policy *analysis and assessments.*

DoD has implemented five projects that illustrate how DoD readiness can be sustained while reducing environmental impacts:

1. The Army installed Geothermal Heat Pumps at Fort Polk, Louisiana.
2. Publication and use of *Energy Efficiency Guidebooks for Air Force and Army Housing.*
3. DoD supported innovations in energy efficient heat pump systems.
4. The Air Mobility Command (AMC) developed and uses an *Air Force Mobility Command Deployment Analysis System (ADANS).*
5. The Army used an *Environmental Impact Assessments for Two Chemical Weapons Stockpiles* as the basis for deciding how best to destroy chemical warfare agents.

These projects sustain DoD readiness through stewardship of natural resources while considering the interfaces between economic, energy, and environmental systems. Successful DoD projects analyzed these interfaces, and identified and implemented significant efficiency improvements. ORNL, a multi-program, multi-disciplinary National Laboratory, has supported DoD's efforts to improve readiness while meeting environmental objectives.