ENERGY INITIATIVES IN THE DEPARTMENT OF DEFENSE

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ABSTRACT

The Department of Defense (DOD) is the world's largest consumer of energy. The Department has recognized that dependence on foreign sources of oil is a strategic threat to our national security. In order to overcome this threat, the DOD's goals are to reduce the consumption of energy by 20% by 2025 and be a net zero consumer of energy at its installations and sites by 2030.

To do so, the DOD has established a Department of Defense Energy Security Initiatives tasked with reducing demand, assuring supply, improving processes, and establishing and monitoring energy metrics. Two aggressive programs implemented at installations and sites to promote more efficient operation include asset preservation and asset management.

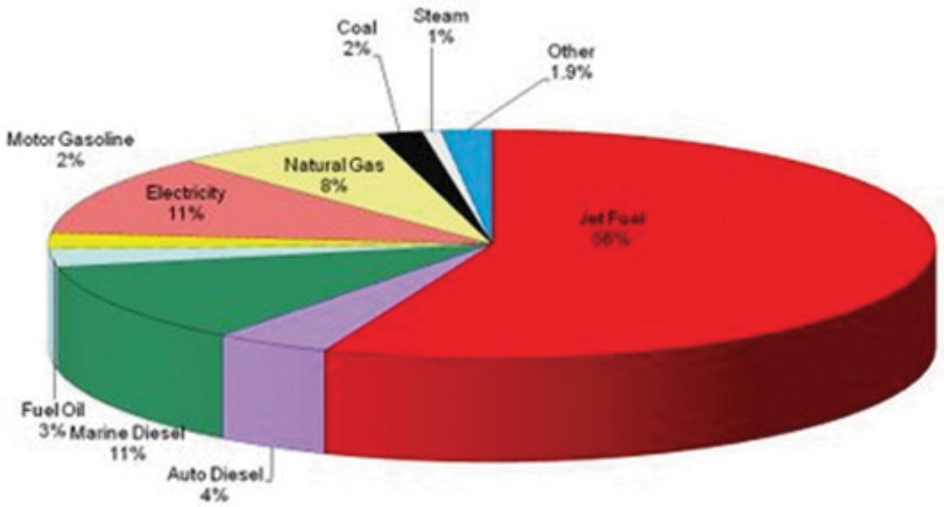
The asset preservation program is a systematic process of assessing facilities' condition in order to optimize maintenance and renewal projects.

Asset management initiatives include using facility space more efficiently, demolishing outdated and inefficient buildings, and developing activity management plans that will help installations' engineers formulate short and long-term investment strategies.

The first step in the process of improving energy efficiency at any DOD installation or site is to conduct an energy audit. The Energy Independence and Security Act of 2007 require Federal Agencies to identify buildings and plants that comprise 75% of energy use, conduct energy audits (baseline and 100% every 4 years), and benchmark the energy performance of buildings. Finally, the DOD will use the Energy Star Portfolio Manager to collect, warehouse, and track energy use data and performance benchmarks.

Pursuing lower energy consumption and higher efficiency will increase the combat and sustainment capabilities of the DOD. Lower energy consumption and reduced reliance on petroleum-based products will give our military forces greater freedom to maneuver and reduce pressure on supply lines across the entire spectrum of its missions.

DEPARTMENT OF DEFENSE SITE DELIVERED ENERGY CONSUMPTION IN FY 2008: 889 TRILLION Btu



THE PROBLEM

According to Brian Lally, Director of Facility Energy and Utilities Privatization of the Office of the Deputy Under Secretary of Defense (Installations and Environment), the DOD accounts for about one percent of the United States' total annual energy consumption. In 2008 its energy bill amounted to $20 billion, including $4 billion to operate and sustain 536 installations and 5,429 sites. The DOD burns approximately

395,000 barrels of oil per day – more than any other private or public organization, about as much as the entire country of Greece, and more than 100 other countries. Inside the US, it uses 78 percent of the energy consumed by the Federal Government.

The DOD has recognized that this level of consumption impacts its combat and sustainment capabilities. In response, it has set goals of reducing baseline consumption by 20 percent by 2025 and becoming a net-zero energy consumer at its installations and facilities by 2030. To meet these ambitious goals, the DOD plans to convert from petroleum to alternate forms of energy while increasing efficiency of energy use. Lower energy consumption and reduced reliance on petroleum-based products will increase transport and supply options for activities ranging from Expeditionary Operations to Disaster Relief and Humanitarian Operations.

Fuel consumption patterns create huge operational demands across the tactical spectrum. Fuel delivery and supply line protection in the combat zone require manpower that could otherwise be dedicated to combat operations. Roughly one half of logistics tonnage for operations in places like Iraq is comprised solely of the movement of fuel, according to the 2008 Defense Science Board Task Force on Energy Security. The consumption of fuel at American forward operating bases in combat zones has risen from 50 million gallons to 500 million gallons a year over the past five years *(Washington Post, April 13, 2009)*.

An Office of Naval Research report found that the fully accounted cost of a gallon of gasoline on the battlefield in Iraq and Afghanistan ranged from $15 a gallon to as much as $400 per gallon, dependent on the situation. In-flight delivery of fuel for the Air Force runs approximately $42 a gallon. The DOD also uses 30 million megawatt hours of electricity per year at a cost of over $2 billion. Almost 98 percent of the electricity supplied to DOD installations comes from the civilian market, which makes them susceptible to the increasing spate of large-scale outages.

The Power Surety Task Force and the Army's Rapid Equipping Force are demonstrating spray foam insulation and a solar power and storage system in Fort Belvoir housing. These precursors could lead to buildings routinely powered by solar arrays.

UNDERSTANDING THE DOD'S GOALS AND PRIORITIES

Department of Defense Energy Security Initiatives include the following:

- Reduce Demand
- Assure Supply
- Improve Processes
- Establish and Monitor Energy Metrics

REDUCE DEMAND

In order to enhance mission effectiveness, the systemic demand for fuel from platforms, weapons, and fixed and tactical installations must be reduced. The DOD is exploring – and has been successfully implementing – technologies that would reduce consumption.

The installations community has made significant progress in reducing energy consumption (over 30% since 1985). In FY 2007, the Department reduced energy usage by over 10% from the 2003 baseline and has a mandate to continue reducing consumption by three percent per year through 2015. The following describes initiatives underway to reduce energy consumption / dependence in DOD facilities, platforms, and operations.

FACILITIES:

- **Net-Zero Plus Initiative at the National Training Center (NTC), Fort Irwin, California.** NTC is currently exploring the feasibility of removing their facilities completely from the electric grid, with the potential to sell "green" energy back to the California grid. The Army has named Fort Irwin as a Net-Zero Plus Installation.
- **Efficient technologies for housing demonstration, Fort Belvoir, Virginia.** The Power Surety Task Force and the Army's Rapid Equipping Force are demonstrating spray foam insulation and a solar power and storage system in Fort Belvoir housing.
- **Pentagon Wedge 5 Renovation.†** The Pentagon Renovations office has approved the use of LED light fixtures in place of the fluorescent and other lights used in the previous renovated wedges.

PLATFORMS:

- **Fuel efficiency for turbine engines.** The Highly Efficient Embedded Turbine Engine (HEETE) initiative, part of the Versatile Affordable Advanced Turbine Engine (VAATE) program, is developing high-pressure ratio, high temperature core technology, with the potential to reduce fuel consumption up to 25% over current systems. HEETE is addressing the highest technical risk element in new engine development – the high pressure compressor component.
- **Efficient engines for Unmanned Aerial Vehicles (UAVs) and generators.** The Small Heavy Fueled Engine

demonstration is a three year program, initiated in FY 2008, anticipated to increase fuel efficiency and power density by 20% for UAVs and generators.

- **Fuel efficient equipment on ground vehicles.** The Fuel Efficient Demonstrator (FED) is testing the feasibility and affordability of achieving significant decreases in fuel consumption in a tactical vehicle, without sacrificing the performance or capability.

- **Diesel hybrid vehicle testing.** The Department is testing various diesel hybrid vehicles. Hickam Air Force base is testing a plug-in parallel hybrid drive system designed to be integrated into a step van that will provide improved efficiency, superior performance and greater fuel economy. The system consists of a 2.5 liter/75 kilowatt (kW) diesel engine, a 97 kW AC induction motor, and a continuous variable transmission. The Air Force is also testing and demonstrating Heavy Duty Hybrid Electric Class 8 Mack Trucks, with Integrated Starter Alternator Motors which assist the diesel engine in providing power to the drive train.

OPERATIONAL EFFICIENCIES:

In an effort to demonstrate the operational efficacy of demand reduction coupled with alternative/renewable power, the Power Surety Task Force installed energy efficient structures (domes, sprayfoam insulation, renewable power generators, and efficient heating, ventilating, and air conditioning systems) in training areas. These structures demonstrate a holistic approach that can provide an estimated energy savings of about 60%.

ASSURE SUPPLY

- **Renewable Energy:** In FY 2007, the DOD reduced energy usage by over 10% from the 2003 baseline and almost 12% of electricity consumed was generated from renewable energy sources. The DOD is increasing use of "traditional" renewable energy sources (e.g., solar, wind, etc.) and is also exploring new technologies, such as ocean and wave harvesting.

- **Solar power:** Solar power is the largest contributor to the Air Force's renewable energy development program. In December 2007, the Air Force commissioned the largest photovoltaic solar array in the Americas (14.2 megawatts) at Nellis Air Force Base. It supports about one-fourth of the base's energy usage per day and saves and estimated $1 million annually. In 2007, the Air Force continued to lead the Federal Government in green power purchases, with 37 bases meeting some portion of their base-wide electricity requirements from commercial sources of wind, solar, geothermal, or biomass.

- **Geothermal power:** The Navy has made good use of the authority in 10 U.S.C. 2922a to receive revenues from geothermal power facilities. The 270 megawatt plant at China Lake, CA, developed in the 1980s, provides enough power to supply 180,000 homes. The Navy recently awarded a contract to build a 30+ megawatt geothermal plant at Fallon Naval Air Station, NV, and the Department is looking at other opportunities for similar public/private ventures.

- **Other potential energy generation technologies:** The Navy is testing other energy sources for their feasibility to produce energy cost effectively. It installed its first wave power buoy at Marine Corps Base Kaneohe Bay, Hawaii, and is partnering with industry to test a second buoy. In addition, the Navy is contracting with a commercial firm to provide a technology dem-

onstration of tidal energy harvesting in the Puget Sound area.

- **Solar roofs:** Thin-film solar panels are being used increasingly by the DOD. Naval Base Ventura County installed an 87 killowat rooftop amorphous silicon thin-film photovoltaic (PV) laminate system on a building in Port Hueneme, CA, The Navy has also installed photovoltaic parking garages at Naval Base Coronado, North Island, CA, each producing one megawatt of power.

- **Alternate Fuels/Energy Sources**
  - The Air Force's goal is to cost-effectively acquire 50% of its continental US aviation fuel via a synthetic fuel blend utilizing domestic feedstocks and produced in the US by 2016. It intends the synthetic fuel purchases to be sourced from suppliers with manufacturing facilities that engage in carbon dioxide capture and effective reuse, resulting in the use of fuels that have a "greener" life cycle.
  - The Navy is conducting research on the effective use of alternative logistics fuels in naval power systems. These efforts include addressing the impacts these fuels have on engine internals and fuel distribution system components, optimizing fuel composition, and improving the combustion process.
  - Carbon Capture and Reuse involves the development of an algae-based CO2 absorption system which produces algae oils that can be further developed into jet fuel.
  - **Biodiesel life extension program (O28 O2Diesel™).** Military vehicles can experience mechanical problems when using standard biodiesel, as stagnant biodiesel develops microbial growth leading to contamination and degradation. The Air Force is completing a $5 million demonstration using an ethanol/biodiesel fuel blend (7% ethanol/20% pure biodiesel), with tests conducted on numerous vehicles in a variety of different climates. The new blend (O28 02Diesel™) eliminates and prevents the contamination while reducing particulate matter emissions by up to 80%.
  - **Hydrogen technology testing.** The Air Force Advanced Power Technology Office (APTO) is conducting hydrogen technology and capability demonstrations at Hickam AFB. The Navy is continuing a hydrogen fuel station and nontactical fuel cell vehicle (FCV) demonstration at Camp Pendleton Marine Corps Base, CA.
  - **Waste-to–energy systems.** The Air Force APTO is working to integrate a waste-to-energy system at Eielson Air Force Base, Alaska. This system will be an advanced gasification-based core technology with the capacity to convert 10 to 50 tons per day of a wide variety of waste materials into one megawatt of clean electricity, to be used on-site by the base, thereby reducing the amount of electricity purchased from the local grid.

IMPROVE PROCESSES

- **Energy in the requirements development process.** In August 2006, the Vice Chairman of the Joint Chiefs of Staff signed a memorandum establishing the requirement for an energy-related Key Performance Parameter (KPP) for new acquisition programs to be selectively applied. KPPs are attributes or characteristics of a system that are considered critical or essential to the development of an effective military capability. The methodology and procedures for establishing program relevant energy KPPs are under development.

- **Energy in the acquisition process.** The acquisition process is currently under revision to more accurately value energy. In April 2007, the Under Secretary of Defense (Acquisition, Technology and Logistics) signed a policy memorandum to use the fully burdened cost of fuel as a major basis for all trade analyses for acquisition programs. The memo also established three pilot programs (the Joint Light Tactical Vehicle (JLTV), alternative ship propulsion for the next generation cruiser (CG(X)) and the Next Generation Long Range Strike (Next Generation Bomber)) to validate the approach and to facilitate development of policies and procedures for how to apply it in the acquisition process.

ESTABLISH AND MONITOR METRICS

The final goal focuses on DOD's progress by establishing performance targets based on quantifiable result. These metrics will help increase awareness and visibility on energy issues, incentivize, measure, and reward programs, and change the DOD's culture to value energy.

How the DOD Will Meet Their Energy Security Goals for Installations

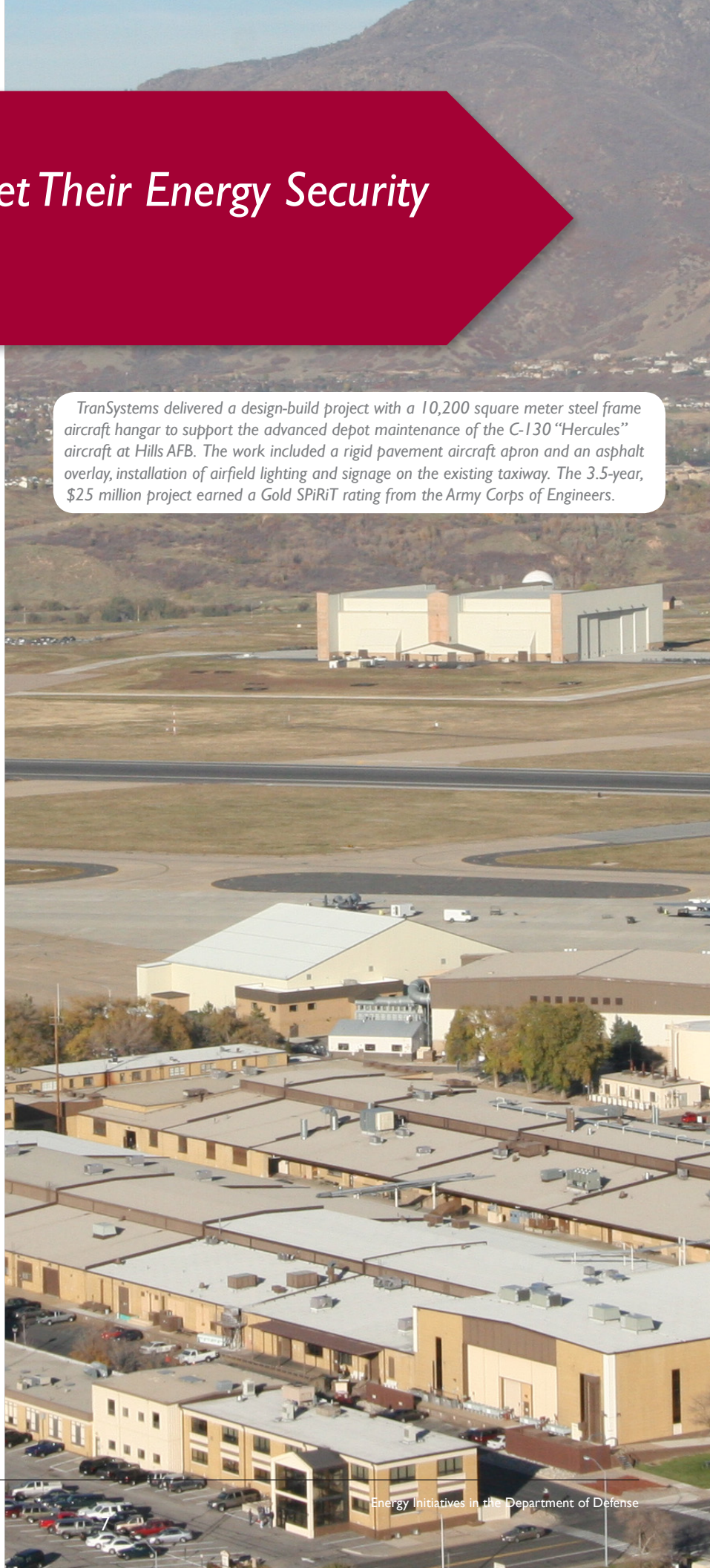
ASSET PRESERVATION

The asset management program is a systematic process for facility condition assessments to optimize maintenance and renewal projects. The Army Corps of Engineers' Construction Engineering Research Laboratory has developed three software programs to assist building and property owners to effectively maintain and mange their assets. The three programs; BUILDER, ROOFER, and MicroPAVER are currently being maintained by many of the initial users (Army, NAVY, FAA, and FHA).

Users can take a proactive approach to maintenance and repair strategies to reduce costs while achieving or extending facility and system service life (do more with less). These programs develop and organize asset inventories, document representative conditions, develop prediction models for rates of deterioration, report on past and predicted future performance, and develop maintenance and repair scenarios.

ASSET MANAGEMENT

Asset management initiatives include managing facility space more efficiently, demolishing outdated and inefficient buildings, and developing activity management plans that will help installations' engineers formulate short and long-term investment strategies. Engineers are now using industry standards to measure and prorate space, categorize how space is



TranSystems delivered a design-build project with a 10,200 square meter steel frame aircraft hangar to support the advanced depot maintenance of the C-130 "Hercules" aircraft at Hills AFB. The work included a rigid pavement aircraft apron and an asphalt overlay, installation of airfield lighting and signage on the existing taxiway. The 3.5-year, $25 million project earned a Gold SPiRiT rating from the Army Corps of Engineers.

The Air Force will also identify structures that no longer provide a return on investment. Each Major Command must reach an annual demolition target in order to achieve a total space reduction goal of 56 million square feet by 2020.

used, and allocate for square footage and average costs. In 2010, the Air Force will conduct an inventory of all administrative to determine and track the following:

- Embedded space such as administrative space in warehouses and aircraft hangers
- Actual cost per square foot to charge appropriately for leased space
- Reduction of 28% to 35% in square footage per person by adopting GSA standards
- Retrieval of real property records, and
- Alignment with other facility-related initiatives such as condition assessments and mission importance

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ENERGY AUDITS

The Energy Independence and Security Act of 2007 require Federal Agencies to perform energy audits. The following summarizes the procedures and tools involved.

1. Identify "covered facilities" – military installation buildings/plants – that comprise 75% of agency building energy use. These facilities must conduct audits (100% every 4 years) and benchmark building energy performance
2. Use Energy Star Portfolio Manager* to collect, warehouse, and track energy use data and performance benchmarks. Energy Star Portfolio Manager can be found at http://www.energystar.gov/index.cfm?c=business.bus_index
3. Perform audits at the building level with focus on larger buildings (where most practical)
4. Collect data for benchmarking:
   - **a.** Quantify gross floor area:
     - i. Installation
     - ii. Specific real property facility classes/subsets
   - **b.** Use bills to quantify installation energy use by fuel type
   - **c.** Enter information
5. The DOD is moving forward aggressively to reduce its dependence on foreign oil. This initiative is vital to our national defense and will be a key issue in the Quadrennial Defense Review.
6. In order to achieve these goals, the DOD will need to embrace the initiatives described in this paper to better use the valuable resources they currently have and exploit new technologies for saving energy. Most of all, there must be a cultural change to ensure that energy initiatives are prioritized. In achieving

their energy security goals, the DOD will gain greater mobility, flexibility and maneuverability – all important to saving lives in the theater of operations.

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11. Utilize EPA benchmarking tools to evaluate current facility performance and new designs.

The US EPA provides benchmarking tools for 10 prominent U.S. building types. These tools address electric and non-electric fuels simultaneously and also normalize for the key drivers of energy use specific to each building type.

Portfolio Manager is EPA's tool that allows users to track the energy performance of and benchmark buildings within the entire portfolio.

Target Finder is EPA's tool that allows users to estimate the energy performance benchmark or target a new building design. Using this tool, the user can test various designs to achieve a desired target performance.

12. Take advantage of the Energy Audit Checklists that have been developed. For example, the Washington State University Energy Program has produced a comprehensive energy audit checklist.

13. Encourage auditors to become certified. An Energy Auditor can be become Certified Energy Auditor by completing an application, participating in an online or live seminar and taking the Certified Energy Auditor exam with the *Association of Energy Engineers*.

FIVE YEAR OUTLOOK

In the next five years, energy initiatives will concentrate on the following:

- Improve current infrastructure (HVAC/controls, plumbing, water systems, central plants, interior lighting, distribution, low speed vehicles, etc.)
- Plan future infrastructure with energy savings in mind (develop better designs, implement greener construction practices, increase use of alternate fuels, etc.)
- Expand renewable energy usage
  - Develop solar, wind, geothermal, biomass
  - Purchase renewable energy credits
  - Explore hydrogen technology

The first "Energy Audit" to take place in the field.

- Emphasize energy conservation programs
  - Energy awareness (outreach, training, and awards)
  - Resource Efficiency Manager
  - Defense Utility Energy Reporting System (DUERS)
  - Advanced metering
  - Energy surveys and audits
  - Third party financing
    - Energy saving performance contracts
    - Utility energy savings contracts/utility privatization

CONCLUSION

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