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Power Surge

How the Department of Defense Leverages Private Resources to Enhance Energy Security and Save Money on U.S. Military Bases

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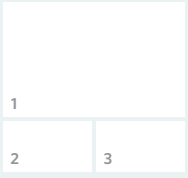
About the report

Original data presented in this report were compiled by Navigant Research, a component of Navigant Consulting's global energy practice. Navigant Research is a leading market research firm that provides in-depth analysis of global clean energy technology markets. A full description of the methodology and parameters Navigant Research used in developing data for this report can be found in Appendix A.



Cover photos:
1. Solar panels installation. Getty Images/iAaki antoAana plaza.
2. Wind turbines in front of a mountain. Getty Images/Panoramic Images.
3. Sailors talk electrical conservation. U.S. Navy photo by Jon Gagne.

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Foreword

By Senator John W. Warner, Retired

As the 20th century dawned, the Dreadnought was debuted by the Royal Navy, spawning a naval arms race between the United Kingdom and Germany. What made the Dreadnought different was its massive armaments and reliance on powerful new steam turbines.

Half a century later, the United States launched the USS Nautilus, a nuclear-powered submarine that similarly marked a new era in naval power.

Great militaries must always be at the forefront of innovation, embracing the energy technology of the day but always on watch, looking beyond the horizon. Maintaining freedom commands a tight link between energy and national security. And so it is today that we find America's armed forces in the forefront of the transition to renewable power and efficiency technologies.

As in the past, many of these recent innovations have been spawned by the introspection of America's military leaders and the brave men and women who serve. Painful lessons have been learned in years past about the vulnerability of fuel convoys in overseas combat operations and the risk of power failure on domestic and forward deployed bases. But as they have so often, America's soldiers, sailors, airmen, and marines identified the challenges, charted a course, and responded.

The Pew Charitable Trusts has issued a series of reports on achievements by our military. This research focuses on the energy security challenges at domestic defense installations, where 20 percent of the Department of Defense's power consumption occurs. Recent history has underscored the continuing role that soldiers and civilians on domestic bases provide, whether it is in supporting troops operating thousands of miles away or here at home assisting emergency response and relief operations for American communities suffering from natural disasters. None of this can happen unless our military installations have a diversity of efficient power sources they need every minute of every day of the year.

In the final years of my service in the United States Senate as Chairman of the Armed Services Committee, it was my honor and privilege to work with all levels of the military to develop policies and resources needed to respond to the facility energy challenge.

In late 2006, Congress passed a National Defense Authorization Act (Public Law 109-364), which called on the Department of Defense to produce or procure 25 percent of its energy from renewable sources by 2025. A year later, Congress enacted the Energy Independence and Security Act of 2007 (Public Law 110-140) setting key goals for facility power use and authorizing use of innovative mechanisms for leveraging private financing of advanced technologies. These and other forward-thinking policies developed by Congress and the Executive Branch alike have laid the groundwork for the department's clean energy initiatives.

This report documents how the U.S. military has responded brilliantly to these challenges and laws. In a relative few years, America's defense facilities have become much more efficient, reducing energy demands and increasing cost savings. Now our U.S. bases are planning to deploy substantial quantities of cutting-edge renewable power technology and for each service branch to install 1 gigwatt in the next dozen years.

These pursuits are not trivial. Installation energy innovation is consistent with objectives set by defense leaders and Congress alike. It is essential to the success of the military mission—ensuring the safety and security of the American people and troops. And the Department of Defense is accruing savings and meeting its mission in a more budgetarily sound manner.

Just as steam turbines and nuclear technology changed military calculus in the past, so it is today. Energy-efficiency measures are improving the working conditions for our troops by providing improved lighting and more effective heating and cooling technologies. Twenty-first century on-site solar, wind, and geothermal technologies and microgrids are helping to ensure that those lights and temperature controls never run out of electricity on our bases.

As ever, it is the individual men and women of the armed forces who are making these changes possible. Their remarkable service, spirit of ingenuity, and commitment to continuous improvement are reflected in the pages that follow. I hope you will be as inspired, as I am, by the progress they are making and join in helping to foster the energy transformation we need for our long-term security.

Overview

The U.S. Department of Defense defines installation energy security as the ability to assure access to reliable sources of energy and deliver that power to meet operational needs on its bases in the United States and abroad. The U.S. military needs safe, secure, reliable, and affordable energy to operate facilities on an uninterrupted basis. To meet essential power requirements, defense leaders have initiated far-reaching steps to harness advanced technologies capable of conserving energy, enabling on-site production from renewable sources, and saving taxpayers millions of dollars.

That effort began in earnest in 2008, when the department convened a prestigious task force, formed by the Defense Science Board, to explore the key energy challenges facing the military in the 21st century. The panel's report, *More Fight–Less Fuel*, called on the U.S. military to address two major challenges: the significant and growing demand for fuel in combat operations, and the vulnerability associated with almost complete reliance by military installations on the nation's aging and vulnerable commercial power grid.[1]

More Fight–Less Fuel prompted immediate responses by the U.S. armed forces. Across the Department of Defense, or DOD, a wide range of initiatives has been launched to address operational and installation energy challenges. The Pew Charitable Trusts tracks these energy initiatives.*

This latest report examines how the military is leveraging private-sector expertise and resources at home to deploy clean and efficient energy in service of economic, environmental, and national security interests. The report's research is derived from publicly available information, close collaboration with DOD officials and experts, site visits to installations across the United States, and a partnership with Navigant Research, a leading market research firm that analyzes global clean energy technology markets.

The Department of Defense has one of the world's largest inventories of real estate, with 550,000 buildings and structures encompassing an estimated 2.3 billion square feet. These facilities require energy to run the lights; power communications, computers, and other advanced electronics; and provide heating and cooling. To support and advance its missions, the military has prioritized energy security at all installations.

The research in this report details how defense leaders have initiated wide-ranging steps to harness advanced technologies to conserve energy, enable on-site production from renewable sources, and save taxpayers millions of dollars at these DOD facilities in the United States.

* In 2011, The Pew Charitable Trusts examined the extensive range of military clean energy initiatives in *From Barracks to the Battlefield: Clean Energy Innovation and America's Armed Forces,* with special focus on the Pentagon's efforts to address operational energy challenges overseas.

Key findings

Installation energy security is a topline priority

The ability to assure access to reliable sources of energy and deliver that power to meet operational needs on military bases in the United States and abroad is a priority for three reasons:

- Mission assurance: U.S. military installations must have their key energy requirements met 24 hours a day. The role of domestic military bases has expanded to support forward combat operations, emergency response, humanitarian relief, and homeland defense, and has reinforced the need for an uninterrupted power supply.
- Cost savings: Facing significant budget cuts, the Defense Department is seeking to reduce costs, and its $4 billion bill for facility energy represents a compelling target.[2] Over the past decade, the department has saved hundreds of millions of dollars in energy costs by deploying efficient and renewable technologies.
- Compliance: DOD must comply with laws enacted by Congress, executive orders, and goals established by military leaders, including requirements for 3 percent annual reductions in facility energy intensity (energy used per gross square foot) and obtaining 25 percent of its energy production or procurement from renewable sources by 2025.

Clean energy policies matter

42 million gallons

Amount of oil saved annually at Norfolk Naval Shipyard in Portsmouth, VA. The shipyard is powered by a waste-to-energy facility that began operation in 1987. Managed by the Southeastern Public Service Authority, the plant provides steam and electricity to the shipyard; excess energy is sold to Dominion Power.

Pew's past research has demonstrated that policy matters. Whether at the state, national, or international level, strong clean energy goals and policies are driving deployment of advanced energy goods and services. The same is true at the Department of Defense, which has developed a comprehensive and strategic energy plan.

In response to congressional legislation and military leadership, the U.S. Army, Navy, Air Force, and Marines have initiated effective policies and measures to ensure near- and long-term progress in energy security. The resulting Master Energy Performance Plan[3] has four parts.

- Reducing energy demand through conservation and efficiency. DOD is improving the efficiency of its existing buildings through retrofits, including the use of advanced lighting, heating, ventilation, and air conditioning technologies. New buildings will be built to the Silver certification requirements of the U.S. Green Building Council's Leadership in Energy and Environmental Design, or LEED.
- Increasing on-site electricity generation with renewable energy. Each military branch has adopted a goal of deploying 1 gigawatt of renewable energy by 2025.
- Enhanced energy management. The department is working to put in place advanced microgrids that

Naval facilities engineering teams upgrade the wastewater treatment plant at Joint Base Pearl Harbor-Hickam in Hawaii by replacing the floating steel roofs with fixed aluminum dome covers in 2011. The new covers help capture methane gas for future energy projects and for use as an alternative fuel source.

incorporate sophisticated controls for managing demand, producing and distributing power, and allowing bases to operate independently of the commercial grid. In 2012, military installations were home to more than 50 percent of the microgrid projects underway in the United States.[4]

- Facility energy innovation. Through the Environmental Security Technology Certification Program and its Installation Energy Test Bed, DOD is aiming to catalyze breakthroughs in efficiency, energy management, and renewables that can be replicated in defense facilities. The department has provided approximately $30 million annually for the Installation Energy Test Bed in recent years.[5]

$1.3 million Estimated annual savings from a combined heat and power system at the Marine Corps Logistics Base Albany, GA. The energy recovered by the integrated system supports essential base operations and reduces carbon pollution equal to that from the generation of electricity used by more than 1,200 homes. The base received the Environmental Protection Agency's Energy Star award in November 2013.

Leveraging private-sector expertise and financing

Facing budgetary constraints, the U.S. military is working to secure third-party financing as a means of obtaining energy infrastructure enhancements and associated energy security benefits at little or no upfront cost. Energy saving performance contracts and utility energy service contracts are increasingly used to engage energy service companies or utilities capable of identifying and financing efforts to improve efficiency. The private-sector

partner guarantees that the improvements will generate energy cost savings to pay for the project over the term of the contract. At contract's end, additional cost savings accrue to the agency.

The value of energy saving performance contracts across the armed forces has increased from $277 million in fiscal year 2010 to just over $411 million in fiscal 2012, a 49 percent increase. Use of utility energy service contracts totaled $47.2 million in fiscal 2012. Overall, third-party financing for energy-efficiency projects totaled $459 million in fiscal 2012.

$3.2 million

Savings from 1.5-MW rooftop solar array and shade structures at Marine Corps Air Ground Combat Center, Twentynine Palms, CA. Baker Electric Solar holds the 25-year contract.[6]

In the deployment of renewable energy, innovative third-party financing mechanisms include long-term power purchase agreements that rely on private developers to finance, build, and maintain projects while saving the military money over the life of the contract. At least 80 percent of future DOD renewable energy projects will be financed with these agreements.[7] For solar power, long-term contracts allow private developers to install and maintain the project in exchange for regular payments over a prescribed period, which allows the electricity to be offered at a guaranteed price lower than prevailing retail rates.

Clean energy efforts are accelerating

The Department of Defense has made progress toward modernizing its energy infrastructure and realizing the benefits of clean energy technologies.

Overall facility energy intensity (energy consumed per gross square foot of building space) has dropped 17.7 percent since 2003 and momentum is accelerating: energy intensity fell by 4.4 percent in fiscal 2012.[8] Between fiscal 2010 and 2012, the number of annual energy saving projects increased from 630 to 1,339, and direct appropriations for energy conservation projects rose by 115 percent, from $422 million to $907 million.

There is also progress in the deployment of renewable energy. In fiscal 2012, 4 percent of facility electricity consumption was derived from renewable energy sources, an increase of 29 percent over the 2011 level of 3.1 percent.[9] The number of renewable energy projects across the military increased by 54 percent from 454 in fiscal 2010 to 700 in fiscal 2012.

Navigant Research estimates that as much as 384 megawatts of installed renewable energy capacity existed on DOD installations as of mid-2013. By the end of 2018, base renewable energy capacity could increase more than fivefold, to 2.1 GW, and position each of the service branches to meet goals for deployment of 1 GW of renewable energy by 2025. During this time, solar photovoltaic, or PV, wind, and biomass are forecast to account for the majority of new, renewable energy installed capacity.

$101 million

Savings over 21-year energy saving performance contract at Pine Bluff Arsenal in Jefferson County, AR. The facility partnered with Trane Corp. in 2008 to put in place energy efficiency improvements for building controls, HVAC, and other technologies.[10]

Lessons learned from our research

Research conducted for this report, base visits, and dialogue with leaders at the military branches revealed the following energy security strengths, realities, and challenges:

Strengths

- Civilian and military personnel at the headquarters, regional, and base levels bring significant expertise.
- At bases across the country, thousands—and in some cases, millions—of dollars are being saved through advanced energy initiatives.

Realities

- Not all renewable energy technologies are appropriate for every geographic region. State and local laws and prevailing energy markets influence considerably the financial viability of efficiency and renewable power projects.
- Expectations surrounding these efforts should be set to reflect the complexity of these projects. It will take time to forge public-private partnerships and conclude the complex contracts associated with advanced energy projects. Similarly, the military will meet its goals through a modest number of medium-sized projects, rather than many small initiatives or a few mega-initiatives.
- The military's progress in enhancing energy security is possible because of a vital and growing network of public-private partnerships with utilities, energy service companies, and financial and technology experts.

Challenges

- Changing the culture surrounding how energy is generated and used is a priority. Military and civilian personnel need to be involved in base efforts up and down the chain of command.
- Military leaders have established energy security as a priority, but no value or premium has been identified to encourage public or private investment in advanced energy technologies that help ensure round-the-clock base operations.

The Department of Defense has embraced the challenge of enhancing energy security at its domestic installations. A comprehensive plan has been developed across the institution and by each service branch. Through these efforts, military missions have been strengthened, taxpayer dollars have been saved, and progress is being made toward achieving the goals set by Congress, the White House, and DOD leaders.

The energy security imperative for installations

> "Military installations are almost completely dependent on a fragile and vulnerable commercial power grid, placing critical military and Homeland defense missions at unacceptable risk of extended outage.... The Task Force recommends DOD launch a comprehensive program to assess and mitigate site-specific risks based on mission criticality; risk and duration of outage; and cost effectiveness of risk mitigation options, such as greater efficiency, islanding, renewable sources, distributed generation, and higher commercial grid reliability where necessary.[11]"
>
> **James R. Schlesinger,** *former secretary of defense and former energy secretary, and retired Air Force General* **Michael P.C. Carns,** *co-chairmen, Defense Science Board*

The rationale for base energy security initiatives is threefold: mission assurance, cost savings, and compliance.

Mission assurance

The role of U.S.-based military installations has evolved and grown in recent years. What was once a mission focused exclusively on troop training and development now includes active support of overseas operations. The advent of advanced telecommunication and war-fighting technologies, such as unmanned aerial vehicles, has provided new opportunities and responsibilities for soldiers, seamen, airmen, and Marines who serve at fixed installations.

U.S. military installations are also becoming more involved in homeland defense, emergency response, and humanitarian relief at home and abroad. Given logistical expertise, skilled personnel, and equipment, domestic military installations are playing an expanded role in responding to natural disasters—hurricanes Katrina and Sandy, for example—and other situations in which the military's emergency service and overall capabilities have proven critical.

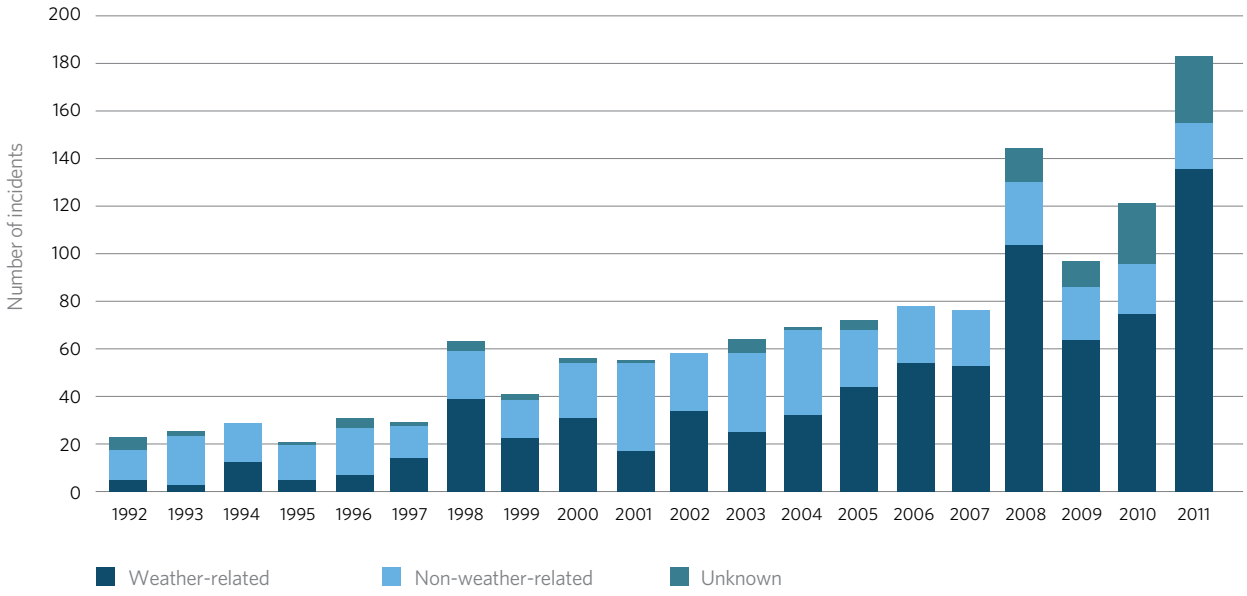
To fulfill both long-standing and expanded missions, U.S. military installations must be able to meet key energy requirements 24 hours a day, without exception (Figure 1). The department's 500 domestic bases are 99 percent reliant on the commercial power grid for essential electric power needs.[12]

> **87** Number of power outages of eight hours or longer at domestic military bases during FY2012. The financial impact is estimated at more than $7 million.[13]

Figure 1

Significant U.S. Electric Grid Disturbances

1,333 weather- and non-weather-related incidents, 1992–2011



Source: Evan Mills, "Electric Grid Disruptions and Extreme Weather, report to the National Climatic Data Center" (May 2012), 14, http://evanmills.lbl.gov/presentations/Mills-Grid-Disruptions-NCDC-3May2012.pdf

The military's near-total dependence on an aging and vulnerable power grid puts mission assurance at risk.[15] The commercial electricity infrastructure is susceptible to natural disasters as well as cyber and physical attacks. In recent decades, the incidence of significant power disturbances across all sectors served by the commercial electric grid has more than doubled.[14]

Cost savings

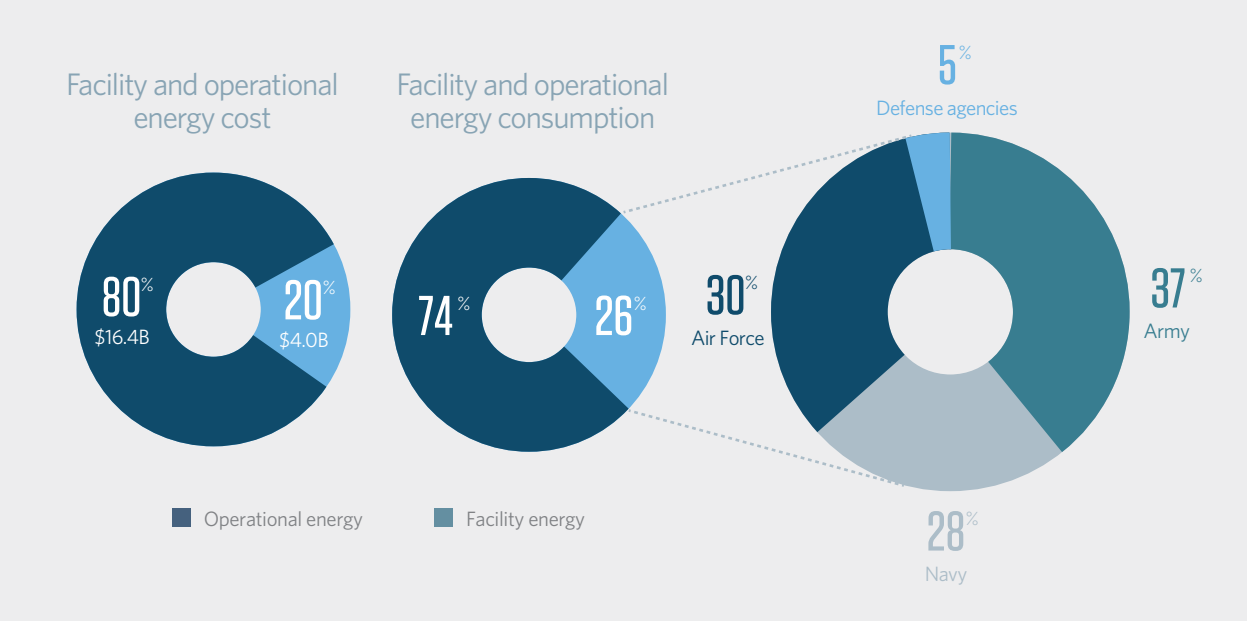
Saving money and acting as an effective steward of taxpayer resources are key rationales for DOD energy security initiatives, especially with the current budget austerity. Even before recent sharp budget cuts, the Pentagon recognized that the end of major combat operations in Iraq and Afghanistan would lead to decreased military budgets. Leaders, therefore, view the military's large annual cost for installation energy as a promising opportunity for cost savings.

As one of the world's largest energy users, DOD pays one of the biggest facility power bills. In fiscal 2012, DOD consumed more than 200,000 billion British thermal units, or Btu, of energy in its facilities at a cost of $4 billion (of which $3.8 billion was for power, heating, and cooling)[16] (Figure 2). The power required to run military installations accounts for 20 percent of DOD's overall energy bill and is equivalent to 1 percent of all energy used in the U.S. commercial sector.[17]

Efficiency and advanced energy technologies offer DOD the opportunity to reduce its overall utility bill while maintaining the robust services required to operate installations. The Air Force estimates that its $1.1 billion

Figure 2

DOD Energy Cost and Consumption, by Function, FY2012



Source: Department of Defense, *Annual Energy Management Report* (2012), 16

energy bill in 2012 would have been $300 million higher if not for efficiency and conservation measures undertaken over the past decade.[18] The Navy reports $1.6 billion of life-cycle savings from advanced energy investments over the past decade.[19]

In addition to near-term budgetary savings, energy-efficient and renewable technologies hold promise for reducing long-term costs and can pay dividends for decades. These technologies reduce DOD's exposure to rising electricity prices. Since 2003, the average retail price of electricity across all sectors of the U.S. economy has risen 33 percent, to 9.9 cents per kilowatt-hour.[20] Long-term, fixed-price contracts for renewable energy at lower rates lock in savings for the military and hedge against price increases. Renewable energy technologies are likely to become even more attractive investments because costs have been dropping consistently in recent years. Since 2008, solar module prices have declined by 80 percent and those for wind turbines by 30 percent.[21]

Key DOD Facility Energy Performance Goals

- Reduce facility energy intensity 30 percent between 2003 and 2015.
- Ensure that renewable energy accounts for 7.5 percent of base energy consumption in 2012 and beyond.
- The Air Force, Army, and Navy each will generate 1 GW of renewable energy by 2025.
- Initiate $1.2 billion worth of third-party contracts over fiscal 2012 and 2013.

U.S. Army Col. Courtney Paul, right, shows Katherine Hammack, center, assistant secretary of the Army for installations, energy and environment, and Dr. Rebecca Johnson, Maneuver Support Center of Excellence deputy to the commanding general, a solar panel site at Fort Leonard Wood, MO, in 2011. Paul is director of the Capability Development and Integration Directorate at the fort.

Compliance

Domestic defense installations are aggressively pursuing efficiency, renewable power, and other energy security initiatives to comply with goals and standards enacted by Congress, articulated through executive orders, and set by military leaders. Congress, for example, has included efficiency, renewable energy, and/or other advanced technology provisions for facilities in legislation passed every year since 2005.[22]

A number of energy policies govern the Department of Defense, its facilities, and those of other federal agencies. These include:

- **The National Energy Conservation Policy Act**

  Signed into law in 1978, it provides the underlying foundation for energy management by federal agencies. It is regularly updated and amended by Congress, including in the legislative provisions highlighted below.

- **The Energy Policy Act of 2005**

  Established requirements and authorizations for:

  - Metering of suitable federal buildings by the beginning of fiscal 2012.
  - Energy-efficient product procurement.
  - Use of energy saving performance contracts through fiscal 2016.
  - Federal building standards that exceed by at least 30 percent industry standards set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers.
  - Renewable electricity consumption for federal agencies to increase to at least 3 percent of facility electricity consumption for fiscal 2007-09; 5 percent for fiscal 2010-12; and 7.5 percent thereafter.

- **Energy Independence and Security Act of 2007**
  - Amended the National Energy Conservation Policy Act to require agencies to improve energy intensity from fiscal 2006 to fiscal 2015. By fiscal 2015, agencies are to have improved energy intensity by 30 percent as compared with an fiscal 2003 baseline.[23]
  - Expanded authority to facilitate use of energy saving performance contracts.
- **National Defense Authorization Act 2007**
  - Codified DOD's articulated goal of securing 25 percent of its energy from renewable resources by 2025.

Periodically, the president of the United States issues executive orders that compel federal agencies to act. Those most relevant to DOD energy efforts are:

- **Executive Order 13423,** issued by then-President George W. Bush on Jan. 24, 2007, requires federal agencies to:
  - Reduce energy intensity 3 percent annually;
  - Ensure that at least half the renewable energy requirement established in the Energy Policy Act of 2005 comes from new energy sources.[24]
- **Executive Order 13514,** issued by President Barack Obama on Oct. 5, 2009, requires federal agencies to:
  - Establish a senior sustainability officer and submit an annual Strategic Sustainability Performance Plan to the Council on Environmental Quality between fiscal 2011 and fiscal 2021.
  - Ensure that new federal buildings designed in 2020 or later are net zero for energy—or not using more energy than they produce—by 2030.

Finally, each military service has established unique energy goals and performance standards. Many of these mirror congressional mandates, but others stand alone. The Army, Air Force, and Navy have each pledged to generate 1 GW of distributed renewable energy on installations by 2025. In 2012, the DOD pledged to initiate $1.2 billion worth of projects financed by third parties over fiscal 2012 and 2013.

Base energy security strategies

Efforts to enhance energy security at installations are coordinated by the deputy undersecretary of defense for installations and environment, who oversees the Facility Energy Program.[25]

As mandated by Congress in fiscal 2011 under the National Defense Authorization Act (P.L. 111-383), then-Deputy Undersecretary Dorothy Robyn produced the department's first Energy Performance Master Plan in fiscal 2011[26] that outlined the DOD's strategy to save money, achieve established goals, and assure the continuity of essential operations at installations. In her March 2012 testimony to Congress, she described[27] the four-part strategy to reduce demand through efficiency, increase on-site generation with renewable sources, enhance energy management, and encourage innovation.

> "Unleashing war fighters from the tether of fuel and reducing our military installations' dependence on a costly and potentially fragile power grid will not simply enhance the environment; it will significantly improve our mission effectiveness."
>
> **Dorothy Robyn,** *former deputy undersecretary of defense, in testimony before the Senate Energy and Natural Resources Committee, May 20, 2010*

Strategy #1: Reducing energy demand through conservation and efficiency

Enhanced efficiency and conservation are often the most cost-effective and cleanest energy resources available. Consequently, saving energy has emerged as a front-line strategy to meet performance goals. By reducing its consumption, the department and its installations can more easily achieve renewable energy targets and other goals tied to overall energy use.

The Department of Defense has long been a leader within the federal government in saving energy and reducing demand. Many efficiency measures have been employed to help reduce consumption in DOD's buildings, including installing advanced lighting equipment and controls, efficient heating and cooling equipment, and windows that control incoming sunlight to maximize efficiency.

For new buildings, the department ensures that all construction is consistent with a Silver rating in accordance with the U.S. Green Building Council's Leadership in Energy and Environmental Design, or LEED, the framework for building design, construction, operation, and maintenance.* New buildings must exceed the prevailing standards promulgated by the American Society of Heating, Refrigerating and Air-Conditioning Engineers by at least 30 percent.[28]

To help identify the potential for energy-efficiency efforts at existing buildings, the military has initiated extensive efforts to meter and audit its facilities, as the Energy Policy Act of 2005 requires. As of fiscal 2012, 83 percent of covered DOD buildings had received independent meters allowing for monitoring of energy consumption data that helps inform conservation and efficiency measures.[29]

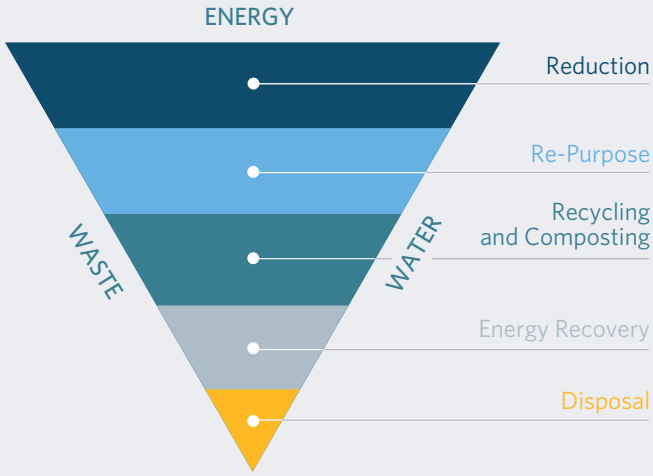
* LEED certification by the U.S. Green Building Council is the recognized standard for measuring building sustainability. It is designed to promote design and construction practices that increase profitability while reducing the negative environmental impact of buildings and improving occupant health and well-being. The LEED rating system offers four certification levels for new construction: Certified, Silver, Gold, and Platinum.

Net Zero Energy Installations

The Department of Defense's exploration of net zero energy installations dates to 2008, when collaborative efforts with the Department of Energy and the National Renewable Energy Lab began.* Subsequently, Executive Order 13514, issued in October 2009, directed that all federal buildings entering the planning process in 2020 and thereafter be designed to achieve net zero energy by 2030.

As a result of collaborative discussions and emerging building standards, in October 2010 the Army launched a pilot program to explore the potential for its bases to become net zero for one or all of its systems for energy, water, and waste (Figure 3). As of the end of 2012, the Army had initiated 17 pilot projects at installations and designated Fort Detrick, MD; Fort Bliss, TX; Fort Carson, CO; Sierra Army Depot, Fort Hunter Liggett, and the Parks Reserve Forces Training Area, CA; Kwajalein Atoll in the Marshall Islands; and West Point, NY, as net zero energy installations. The Oregon Army National Guard also pledged to explore net zero energy for its installations.†

Figure 3
Net Zero Hierarchy



Source: U.S. Army Garrison Fort Detrick, MD, http://www.detrick.army.mil/responsible/images/zerohierarchy.png

A number of activities have been initiated at these pilot bases in the areas of energy efficiency, renewable energy, heat recovery and cogeneration, and metering and controls. After a thorough analysis of these efforts, best practices have been identified on the importance of conducting building envelope analyses (on-site inspections to determine building conditions), utilizing energy management controls, the value of resource efficiency managers, and the contribution of alternative financing mechanisms in energy project development.‡

Based on progress to date, the Army plans to expand the net zero concept to all permanent installations. Under the planned policy, all bases would undertake assessments and implement cost-effective steps for moving toward net zero aims.§

* National Renewable Energy Laboratory, "Net Zero Energy Military Installations: A Guide to Assessment and Planning" (Aug. 2010), 2, http://www.nrel.gov/docs/fy10osti/48876.pdf.

† U.S. Department of Defense news release, "Army Identifies Net Zero Installations" (April 20, 2011), http://www.defense.gov/releases/release.aspx?releaseid=14420.

‡ U.S. Army, "Net Zero Progress Report 2012" (May 2013), 19, http://usarmy.vo.llnwd.net/e2/c/downloads/296777.pdf.

§ Ibid, 27.

DOD relies on both public and private financing mechanisms to advance its initiatives on energy efficiency and conservation. The most common approach has been the direct funding of such measures out of congressional appropriations. There are several budgetary accounts through which funds for each service branch are allocated for these efforts, including the military construction program and the Sustainment, Restoration, and Modernization Program. In addition, the Defense Working Capital Fund and, significantly, the Energy Conservation Investment Program are sources of financing.

The latter program was initiated more than a decade ago as a dedicated fund for advancing energy efficiency across the military. In recent years, the Department of Defense has requested $150 million from Congress for the Energy Conservation Investment Program, as it was in fiscal 2013.[30]

Until recently, the Office of the Secretary of Defense awarded these allocations, with each service branch receiving funds. More recently, the program has been revised to encourage open competition in projects across the military branches, and it is focusing less on small projects and more on initiatives that can leverage the investment for larger projects.[31]

With appropriated dollars, DOD typically uses either fixed-price contracts for goods and services delivered according to specifications and on a timeline, or multiple-award task order contracts, which can be awarded to several contractors for an "indefinite quantity" of goods and services delivered over an undefined period. These contracts are often called ID/IQ, or umbrella contracts.

To fund these efficiency programs, the Department of Defense has turned to private, third-party contracts that leverage private-sector expertise and resources. Contractors design, finance, build, operate, and maintain a project; they are paid from savings that occur over the term of the contract, thereby requiring little or no upfront capital from DOD. When the contract ends, all savings revert to the base. The department has used these third-party contracts extensively, awarding more than $5 billion worth between 1999 and 2011.[32]

$170 million

Savings over 20-year energy saving performance contract launched in October 2012 at Tinker Air Force Base, OK, with Honeywell to initiate wide-ranging energy-efficiency improvements.

There are two types of third-party financing mechanisms used to advance energy-efficiency measures:

Energy saving performance contracts: Under these agreements, companies or utilities identify and finance energy-efficiency opportunities on bases at little or no upfront cost to the military and without congressional appropriations. Companies guarantee that the improvements will generate enough cost savings to pay for the project over the term of the contract. After the contract ends, additional cost savings accrue to the agency. The savings must be guaranteed, and federal agencies may enter into a multiyear contract for a period not to exceed 25 years.

The military has used these contracts for several decades, and they make sense when appropriated funding is unavailable. But energy saving performance contracts also involve complicated agreements and certain financial costs, such as interest payments, that are not incurred with directly funded projects.

The value of these contracts across the armed forces has risen from $277 million in fiscal 2010 to just over $411 million in 2012, a 49 percent increase.

Utility energy service contracts: This financing mechanism is essentially a performance contract undertaken directly with a utility. Under these agreements, the utility is the contractor that initiates energy saving measures and is paid from the resulting savings. As utilities become more involved in demand-side management, they are more active in pursuing these contracts with the military and better able to offer expertise in serving energy-efficiency goals.

Use of utility energy service contracts has increased almost 3 percent, from $46 million in fiscal 2010 to $47.2 million in 2012.

Strategy #2: Increasing on-site generation with renewable energy

In recent years, DOD has focused on deploying cost-effective renewable energy technologies on bases to increase on-site generation and enhance facility energy security. On-site generation of renewables can be paired with advanced microgrids (see below), energy storage, and advanced energy management technologies that allow facilities to operate even when the commercial grid fails. Energy managers can then direct available energy to operations centers, hospitals, and other mission-critical activities.

DOD has two primary requirements related to use of renewable energy technologies. The first, mandated by the Energy Policy Act of 2005, requires military branches to consume a certain percentage of renewable energy. If energy is produced on bases but not consumed by the military, it does not count toward the act's requirement.

> **11%** Annual amount of energy needs met from 6-MW solar array at the U.S. Air Force Academy. The project, completed in partnership with Colorado Springs Utilities and SunPower, will save $1 million annually.[33]

The second directive, outlined in energy performance goals and its master plan for the Department of Defense under 10 U.S. Code subsection 2911(e), compels DOD to produce or procure a certain percentage of renewable energy as compared with total facility energy consumption.

Historically, the Department of Defense has purchased renewable energy credits from private projects to meet some of its Energy Policy Act and 2911(e) performance goals. These credits are based on the amount of renewable energy produced and can be sold and traded in the marketplace by facility operators. In the past, DOD has bought renewable energy credits to meet as much as 20 percent of its goals, but in fiscal 2011 it reduced purchases by 50 percent.[34] In its 2012 Strategic Sustainability Performance Plan, the department indicated that it would reduce reliance on purchased credits and "focus on developing renewable energy on its own installations." [35]

Moving forward, the DOD will put in place renewable energy projects primarily through two means. Smaller projects (less than 1 MW) will be pursued through agency funding mechanisms such as the Energy Conservation Investment Program or other military construction funding. The vast majority of efforts will be undertaken through larger projects (more than 1 MW) financed by third parties under power purchase agreements or enhanced use leases.[36] The Department of Defense has the authority under 10 U.S. Code subsection 2922(a) to enter into contracts of up to 30 years with private energy-production facilities and is one of the federal agencies with the authority to enter into enhanced use leases.[37]

Solar Energy at Davis-Monthan Air Force Base

In June 2013, construction began on a 14.5-MW solar array at Davis-Monthan Air Force Base in Tucson, AZ. When completed, it will be the largest solar project in the Air Force's renewable energy portfolio,* surpassing the 14-MW facility at Nellis Air Force Base, NV.

The SunEdison solar company will finance, construct, operate, and maintain the project over the course of a 25-year power-purchase agreement. The Davis-Monthan base will buy the power produced at the facility at a rate lower than current electric prices. As a result, the project is estimated to save the base about $500,000 per year in energy costs while providing 35 percent of its electricity needs.†

When the project is completed in late 2013, Davis-Monthan will have 20.5 MW of solar power capacity. The Soaring Heights housing community on the base already has 6 MW of ground- and roof-mounted solar in operation.‡

* Ryan Revock, "Air Force's Largest Solar Project Planned for Davis-Monthan" (June 14, 2013), http://www.tucsonsentinel.com/local/report/061413_dm_solar/air-forces-largest-solar-project-planned-davis-monthan.

† Air Force Civil Engineer Center, http://www.afcec.af.mil/energy/renewableenergy/upcomingprojects/index.asp.

‡ Ryan Revock, "Air Force's Largest Solar Project."

$200,000 Annual cost savings from a 1.5-MW wind turbine at Tooele Army Depot, UT, installed in 2010 through the Energy Conservation Investment Program.

Source: U.S. Army, "Installation Management Energy Portfolio, 2010-2017" (Sept. 15, 2010), 27, http://army-energy.hqda.pentagon.mil/docs/Energy_Portfolio_15_Sep_10.pdf

The two primary third-party financing mechanisms for renewable energy projects are detailed below.

Power purchase agreements: These contracts are between the military and a private entity that designs, finances, builds, and operates a renewable energy project. In most cases, the project is constructed on military land, but it can be located on private property. Under a power purchase agreement, the military agrees to buy the power produced by the renewable energy project, usually at a fixed price over a period of up to 30 years.[38] These agreements have been used in the private sector for more than a decade, but the first military one was concluded at Naval Air Weapons Station China Lake in 2012.[39]

These contracts are attractive to the military because limited appropriated dollars are not needed to cover the high upfront capital outlays for renewable energy projects. Because they are financed over a long period, power purchase agreements allow the military to reduce its energy bill. Contract terms provide for annual payments equal to or less than what is charged for conventional electricity. Since the military has no tax obligation, developers can take advantage of tax credits available to privately develop renewable energy projects, thereby making the financing of these projects more favorable.

$13 million

Savings projected for the 20-year power purchase agreement at Naval Air Weapons Station China Lake, CA. The 13.8-MW solar project with SunPower reduces base energy needs by 30 percent.

Power purchase agreements are relatively new and involve complex contractual provisions. As a result, they often demand protracted negotiations—especially as the military and private contractors sort through the requirements—and can result in projects taking two years or more to conclude. Experts expect that the time required to complete these contracts will be reduced with the successful use of a power purchase agreement at China Lake and other recent projects. The military is working to familiarize itself with private-sector practices in third-party financing, and the industry is learning how to accommodate certain government requirements, such as clauses that allow the government to terminate contracts for cause or convenience, as might be necessary with a base closure.

Navigant Research estimates that at least 80 percent of future DOD renewable energy projects will be financed with power purchase agreements.[40]

Enhanced use leases: This financing mechanism allows the military to lease underutilized property to third parties interested in developing a renewable energy project on the land. Because these leases involve complicated contracts, they are often used for larger projects. Under such a lease, a military base may receive

Enhanced Use Lease at Holloman Air Force Base

The Air Force and New Generation Biomass have entered into an enhanced use lease at Holloman Air Force Base in Alamogordo, NM. New Generation Biomass is building a 20-MW biomass facility to be known as the Black Bear Biomass plant on 80 underutilized acres on the base.

Power produced by the Black Bear facility will feed into the commercial electric grid for sale to customers of El Paso Electric Company. The Air Force may buy some of the power under a long-term, fixed-price power purchase agreement. The base will also receive lease payments.

The Black Bear Biomass plant will operate off wood residue and wastes that otherwise would go unused. This will create a wood-waste market from which local forest management companies, orchards, sawmills, and landfills will profit. The removal of excess wood residue from forests will also reduce the potential for forest fires.

When completed in 2015, the project is expected to provide enough power for 26,000 homes. The project will require a $70 million private investment and is projected to create 300 construction jobs and 80 long-term jobs at the facility.*

* Erin Voegele, "N.M. Biomass Plant Moves Forward With Help of City Commission," *Biomass Magazine*, Jan. 18, 2013, http://biomassmagazine.com/articles/8532/n-m-biomass-plant-moves-forward-with-help-of-city-commission.

direct payments or other consideration for the use of its land by private project developers. In some cases, enhanced use leases are paired with power purchase agreements; in other cases, they stipulate that bases will receive renewable energy on a priority basis whenever commercial grid service is interrupted.

Department of Defense facilities encompass 28.5 million acres of land,[41] providing ample opportunity to deploy renewable energy and generate value from underutilized assets. But half or more of these lands were withdrawn from the Department of Interior for use by the military. As a result, the Interior Department has been working with DOD on a framework for ongoing cooperation. In 2012, then-Defense Secretary Leon Panetta and then-Interior Secretary Ken Salazar signed a memorandum of understanding that committed the two departments to work together to encourage development of renewable energy projects on withdrawn lands.[42] The memorandum sets out key principles for cooperation, but concrete agreements between the two must still be reached before leases on these lands can be developed.

Strategy #3: Enhanced energy management

The department is at the forefront of efforts to harness and deploy advanced microgrids as a means of enhancing progress in military energy security. Microgrids are small versions of a conventional power grid in which power generation technologies are linked via transmission lines to buildings. They incorporate sophisticated controls for managing energy demand and distributing electricity in the most efficient and strategic manner.

In many respects, advanced microgrids are emerging as the hub of DOD's overall strategy for energy security. They enable energy managers to take full advantage of on-site generation and advanced management tools, and to direct available power to mission-critical activities on base, such as operating unmanned aerial vehicles that support combat operations. Microgrids also allow bases to separate from the grid as a self-generating "island."

Many installations have rudimentary capabilities to continue operations if the commercial grid shuts down. For example, bases have traditionally used backup generators to maintain basic operations if an outage occurs. But these capabilities have numerous limitations. They are older and cannot integrate distributed generation; they do not allow for energy storage or incorporate advanced load controls; and they are not suited for wide distribution of energy.[43] In contrast, cutting-edge advanced microgrids enable sophisticated management of both supply and demand.

In 2012, military installations were home to more than 50 percent of the microgrid projects underway in the United States.[44] A 2012 study by the Massachusetts Institute of Technology found that 44 DOD installations were working with or exploring such systems.[45] That year, the department's microgrid capacity more than doubled, to 578 MW, from 228 MW a year earlier.[46] Advanced projects are underway in locations across military branches, including a demonstration of Lockheed Martin technology at Fort Bliss, a United Technologies design at Joint Base McGuire-Dix-Lakehurst, NJ, and a General Electric technology at Twentynine Palms Marine Corps Air Ground Combat Center, CA.

DOD has also commissioned several analyses of business models and opportunities that could help it better harness the benefits of advanced microgrids. The nonpartisan and nonprofit group Business Executives for National Security recently completed a study for the department on business models that can be used in deploying microgrids.[47] ICF International, a consulting firm, has also completed an analysis for DOD on the ways microgrids on bases can generate revenue—for example, by tying into utilities' demand response programs.[48]

In addition to its work with microgrids, the department has developed a central enterprise energy information management system that will enable standardized and improved collection of energy use and cost data.

Smart Solar Enhances Energy Management

Fort Bliss in El Paso, TX, is employing a range of innovative energy strategies as it seeks to become one of the Army's first net zero facilities by 2018. The base is exploring a power purchase agreement with El Paso Electric for a 20-MW solar array that would meet 14 percent of its electricity requirements.*

Rooftop solar panels will be installed on base military housing, which is operated by Balfour Beatty Communities through a partnership with Solar City. More than 4,000 homes will generate 13.2 MW of power.†

To further enhance energy security, Fort Bliss has completed installation of an advanced microgrid, which was built by Lockheed Martin. It will test integration of the solar generating capacity and utilize "smart" technology, enabling critical base operations to continue even if the commercial power grid goes down.

* Andy Medici, "Fort Bliss Signs $120M Agreement for DoD's Largest Solar Project," *Federal Times,* April 8, 2013, http://www.federaltimes.com/article/20130408/FACILITIES04/304080002/Fort-Bliss-signs-120M-agreement-DoD-8217-s-largest-solar-project.

† David Burge, "Solar Panels Rise on Fort Bliss Homes: Step to Energy Self-Sufficiency," *El Paso Times,* Feb. 27, 2013, http://www.elpasotimes.com/newupdated/ci_22674101/fort-bliss-dedicates-first-wave-homes-solar-panels.

Department-wide and base-level energy managers will be able to use this system to strengthen operations and make data-driven decisions about cost-effective energy enhancements.

DOD has also established the Energy Grid Security Executive Council to coordinate agency and interagency efforts (as recommended in *More Fight—Less Fuel*) aimed at protecting the integrity of military power supplies and reducing risks.

Strategy #4: Facility energy innovation

The final component of the Department of Defense's energy effort is innovation with the Environmental Security Technology Certification Program—one of the agency's environmental research programs—and its Installation Energy Test Bed as key aspects. The latter initiative was launched in 2009 to help demonstrate technologies that hold potential for major energy security improvements at departmental facilities. In recent years, the Installation Energy Test Bed has received approximately $30 million per year.[49]

The Installation Energy Test Bed has five focus areas:

- Microgrids and storage technologies.
- Energy-efficiency technologies (lighting, heating and cooling systems, and combined heat and power).
- Building management and controls.
- Software tools.
- On-site generation technology.

An advanced metering infrastructure smart meter is shown near the Catering and Conference Center at the Washington Navy Yard, DC, in 2011. The smart meter records energy consumption data every 15 minutes and sends the information to a single, secure system. The meters are intended to enable managers to monitor and control energy systems throughout the installation.

SPIDERS Shows Power of Microgrids

Smart Power Infrastructure Demonstration for Energy Reliability and Security, commonly known as SPIDERS, is a collaborative microgrid technology demonstration involving the U.S. Pacific and Northern commands, the Department of Energy, and the Department of Homeland Security, with initial demonstrations being undertaken at Fort Carson in Colorado and Camp Smith in Hawaii. This program aims to test the viability of the Energy Surety Microgrid methodology developed at Sandia National Laboratories; it directly links energy surety—safety, security, reliability, sustainability, and cost effectiveness—with critical power needs. These efforts also are testing how the methodology can ensure energy security and sustainability for mission-critical activities during grid power outages.

As of mid-2013, the initiative had an estimated 85 projects underway at military installations.[50] These projects typically receive $100,000 to $1 million in funding and are designed to help validate performance and cost characteristics of cutting-edge technologies. The program also seeks to identify promising equipment and strategies that can be replicated in DOD installations, including waste-to-energy and building-integrated photovoltaic solar systems.

The Installation Energy Test Bed is playing a key role in financing deployment and testing of microgrids, supporting more than a dozen pilot programs utilizing various products and private-sector partners. In addition, demonstrations of advanced lighting technologies and window films have been subsidized, and waste-to-energy projects are being explored.

Progress in energy efficiency and renewable energy

The Department of Defense has made tangible progress toward modernizing its energy infrastructure and benefiting from enhanced energy security and reduced costs. Progress has occurred utilizing both energy efficiency and renewable energy sources, and has been achieved through targeted use of appropriated funds and leveraging private-sector expertise and financing.

The advancements outlined below result from positive momentum in each of the service branches, as enumerated in the service profiles at the end of this report.

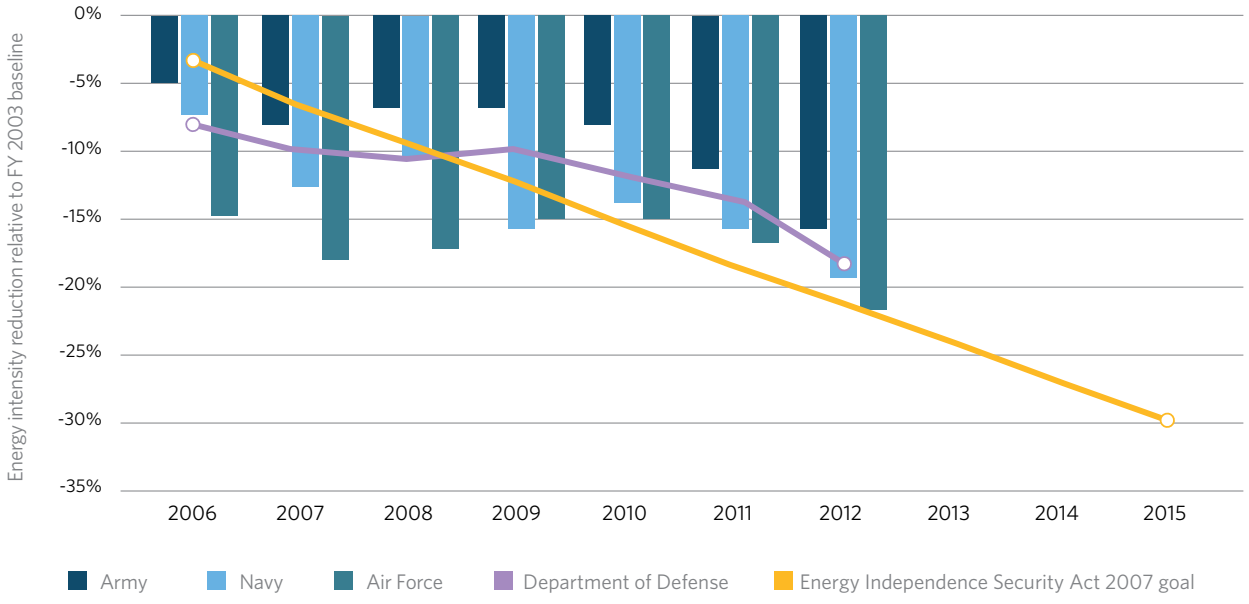
Energy intensity has fallen

DOD has made significant progress in reducing its facility energy intensity, which tracks the amount of energy consumed, in British Thermal Units, or Btu, per unit of gross square foot, or GSF, of building space. The 2007 Energy Independence and Security Act set an annual reduction goal for energy intensity of 3 percent at facilities. By the end of fiscal 2015, DOD and other federal agencies must reduce energy intensity by 30 percent from a fiscal 2003 baseline.

By the end of fiscal 2012, the department's energy intensity had dropped 17.7 percent since 2003 (Figure 4). Although this was short of the fiscal 2012 target of 21 percent, momentum has been accelerating. DOD energy intensity fell by 4.4 percent in fiscal 2012 alone, as investments in energy efficiency began to produce meaningful results. This sharp improvement in fiscal 2012 followed a 1.9 percent reduction in energy intensity in fiscal 2011. Figure 4 enumerates energy intensity reductions between 2006 and 2012.

Figure 4

Reduction in DOD Energy Intensity, FY2006-12



Source: Department of Defense

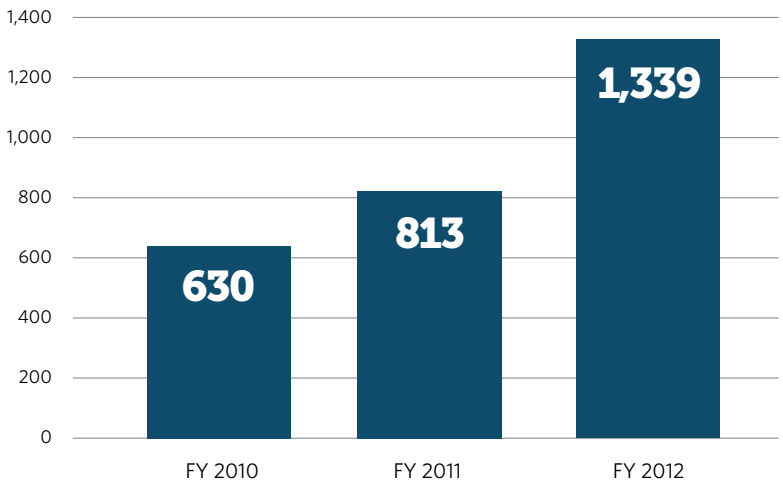
The military's success in reducing energy intensity is a result of each branch's efforts. The Army has improved its energy intensity performance by 8.5 percent since 2009, with a 3.9 percent reduction just in 2012. The Navy recorded a 3.8 percent decrease in 2012, and the Air Force, with a 4.9 percent decline, was set on track to meet the Energy Independence and Security Act's 2007 goal.

Energy-efficiency projects have doubled

Energy intensity reductions by DOD are due in large part to an increased priority for conservation projects at military installations. Between fiscal years 2010 and 2012, the military increased the number of annual energy-saving projects from 630 to 1,339, up by 29 percent in 2011 and by 65 percent in 2012 (Figure 5).

Figure 5

Number of Energy Conservation Projects on U.S. Military Bases, FY2010-12



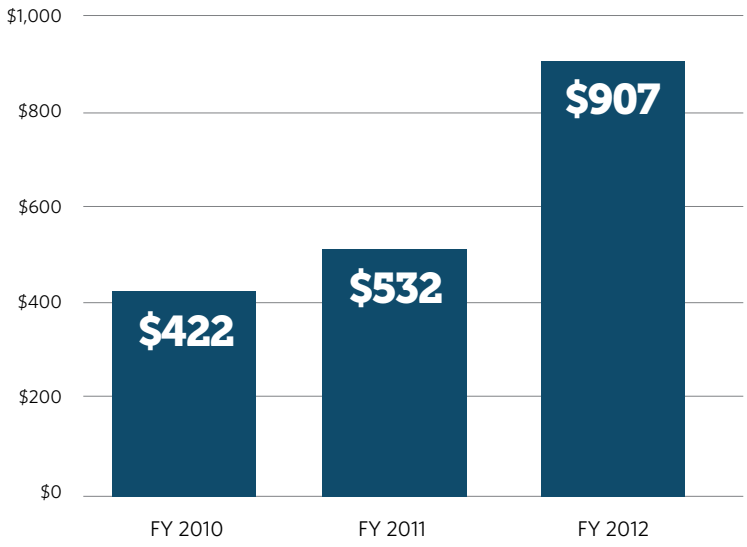
Source: Department of Defense, Navigant Research

Direct funding for energy efficiency has increased

An increase in direct funding has helped with some of the department's progress in reducing energy intensity and expanding the number of projects. Appropriations for Department of Defense energy conservation projects have increased by 115 percent over the past three years, from $422 million to $907 million (Figure 6). The Navy (including the Marine Corps) had direct funding for efficiency initiatives increase by more than 2,200 percent in 2012.

Figure 6

DOD Direct Funding for Energy-Efficiency Projects, FY2010-12



Source: Department of Defense, Navigant Research

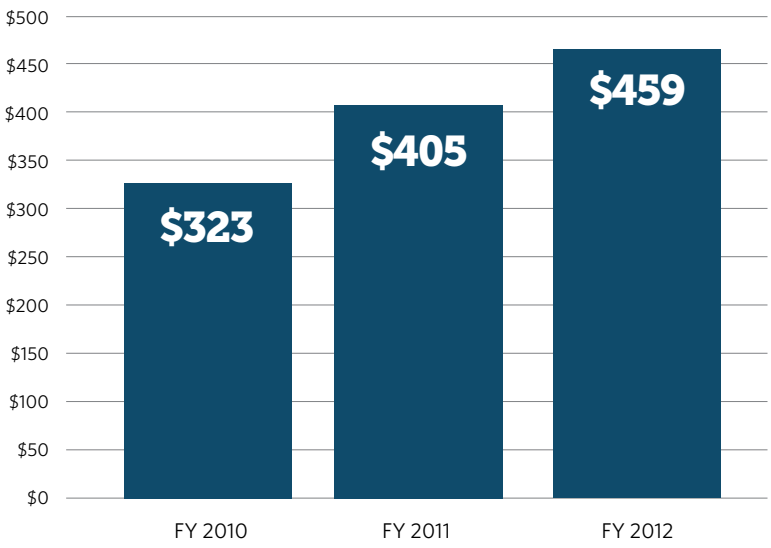
The DOD's fiscal 2013 budget includes more than $1.1 billion for investments in conservation and energy efficiency, and nearly all for existing buildings. The bulk is in the military's operations and maintenance accounts and is to be used for sustainment, restoration, and modernization projects. These projects typically involve retrofits to lighting, heating, and insulation, as well as new roofs and energy management systems.[51]

Use of third-party financing for energy-efficiency projects has increased

The Department of Defense has sharply boosted its use of third-party mechanisms that leverage private-sector expertise and resources to deploy new energy infrastructure and improve energy efficiency. The value of energy saving performance contracts across the armed forces has increased from $277 million in fiscal 2010 to just over $411 million in fiscal 2012, a 49 percent increase. Use of utility energy service contracts totaled $47.2 million in fiscal 2012, a 3 percent increase over fiscal 2010. Overall, the value of DOD third-party energy-efficiency contracts has increased by 42 percent, from $323 million in 2010 to $459 million in 2012 (Figure 7).

Figure 7

DOD Nongovernmental Third-Party Funding for Energy-Efficiency Projects, FY2010-12



Source: Department of Defense, Navigant Research

Renewable energy development is accelerating

The department has several decades of experience with energy-efficiency projects and initiatives, but its renewable energy efforts are newer. The 2012 pledge by each military service branch to deploy 1 GW of renewable energy by 2025 has spurred increased activity the past two years. Although deployment numbers have not shown significant change, the data below reflect DOD's increased priority for renewable energy projects and indicate that new renewable energy projects implemented across the department will rise sharply in coming months and years.

DOD is bound to meet two renewable energy goals—one established by the Energy Policy Act of 2005, the other codified in the National Defense Authorization Act of 2007.

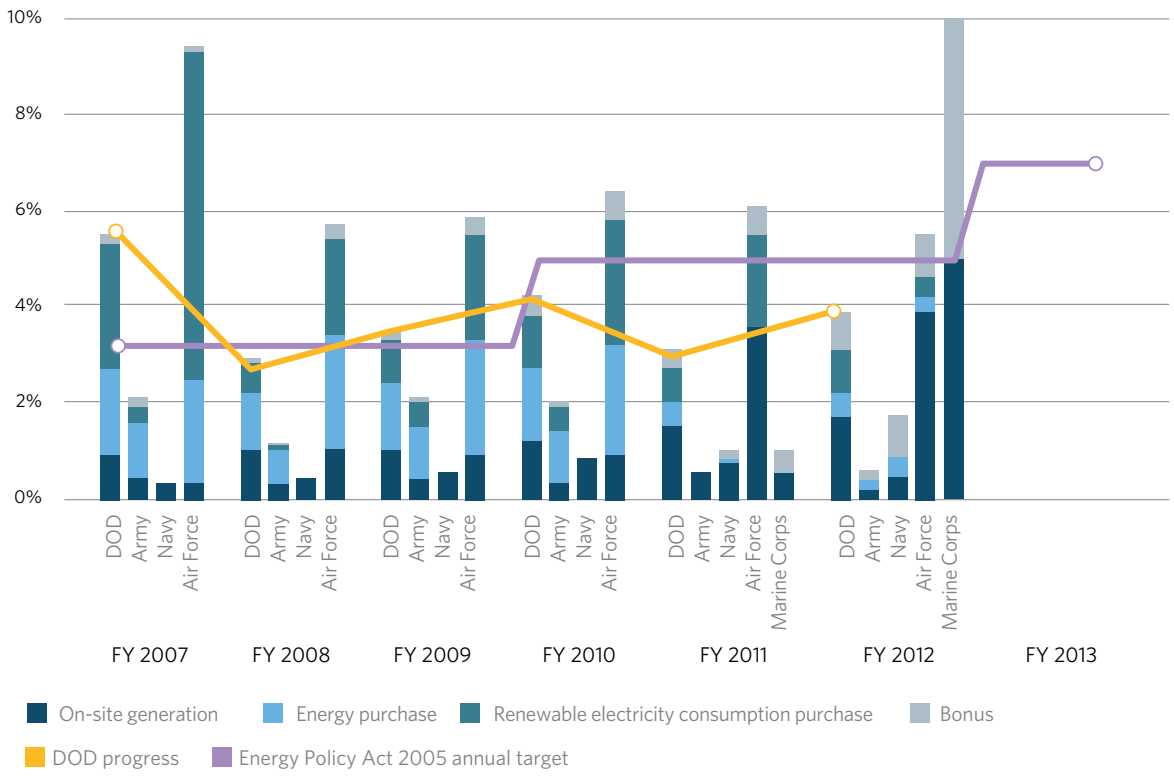
Renewable energy consumption is growing

In fiscal 2012, 4 percent of the department's facility electricity consumption came from renewable energy sources (Figure 8). This was short of the 5 percent requirement under the Energy Policy Act, but up 29 percent over the 2011 level of 3.1 percent. Both the Air Force and Marine Corps exceeded 2012 targets.

Figure 8

DOD Progress Toward Energy Policy Act's 2005 Goals

Renewable electricity consumption as a percentage of total installation electricity consumption



Source: Department of Defense

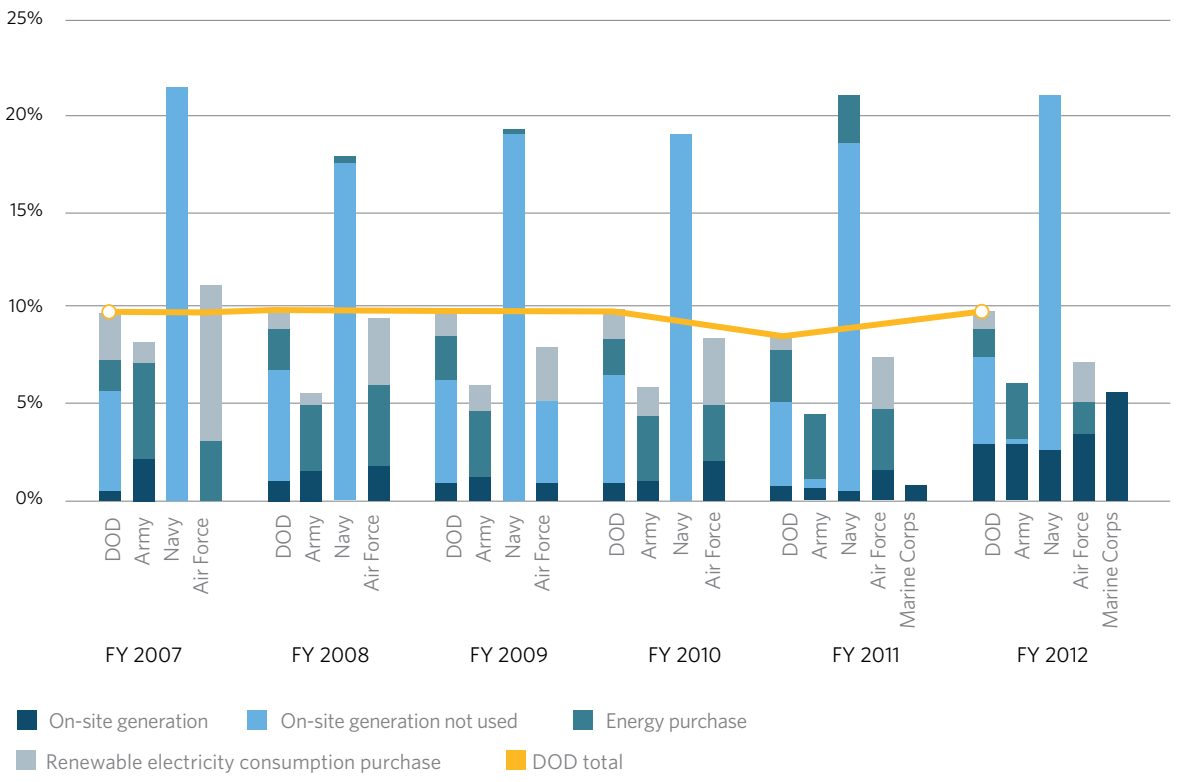
Renewable energy production and procurement increased

The department also made advancements in producing or procuring renewable energy as stipulated by the energy performance goals and master plan for the Department of Defense under U.S. Code subsection 2911(e). In fiscal 2012, the military produced or procured 9.6 percent of its electricity from renewable energy sources—a 13 percent increase over 2011 levels (Figure 9). The Navy led all other military components by a wide margin and contributed 50 percent of the DOD's overall production and procurement. This is primarily due to the large output from the 170-MW geothermal energy plant at the Naval Air Weapons Station China Lake, CA, which has been in operation since the late 1980s. The China Lake project exemplifies the difference between the DOD's progress toward the goals laid out by the Energy Policy Act and the U.S. Code 2911(e) goals: The power produced at China Lake is not consumed on base, so it does not count toward the Energy Policy Act goal but does contribute toward attainment of the 2911(e) target.

Figure 9

DOD Progress Toward 2911(e) Goal

Renewable energy produced or procured as a percentage of total electricity consumption



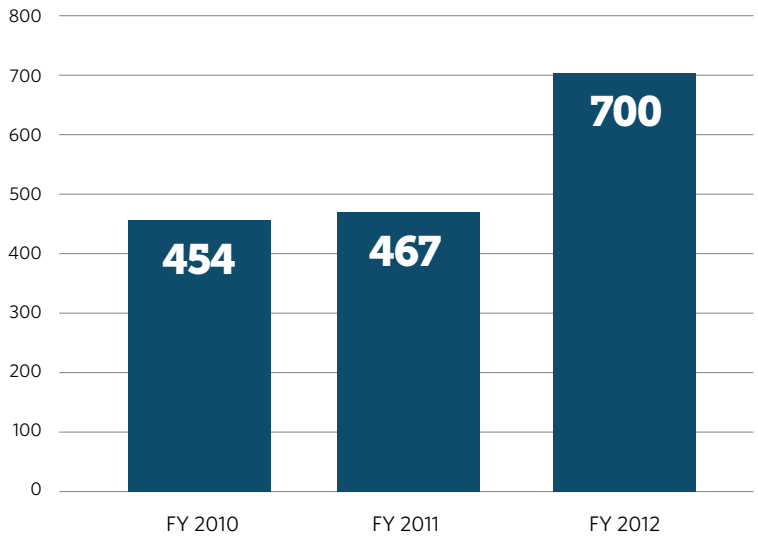
Source: Department of Defense

Number of renewable energy projects initiated is growing

The number of renewable energy projects on bases has risen from 454 in fiscal 2010 to 700 in 2012, an increase of 54 percent. As a result, renewable energy generation from DOD projects increased by 42 percent between fiscal 2011 and 2012. In 2011, DOD generated 5,300 billion Btu from its 467 projects. In 2012, 7,500 billion Btu were produced from 700 projects (Figure 10).

Figure 10

DOD Number of Renewable Energy Projects, FY2010-12



Source: Navigant Research, Department of Defense

Deployment of renewable energy capacity will grow

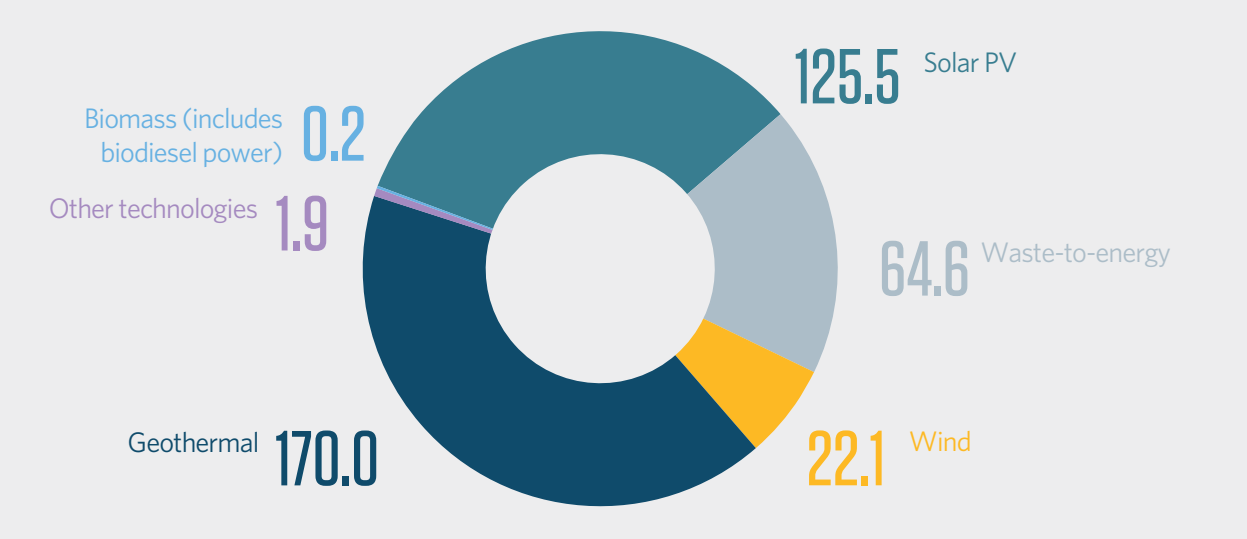
Navigant Research estimates that 384 MW of installed renewable energy capacity exist on DOD installations as of 2013. Of this total, almost 45 percent comes from the geothermal energy plant at Naval Air Weapons Station China Lake, CA, a project that has been in place for 25 years. With 125.5 MW of installed capacity, solar energy is the second-largest component of the military's deployed renewable energy, accounting for 33 percent of the total.

Navigant projects that 322 MW of additional renewable energy capacity is in development at DOD bases and will be added over the next 24 months, bringing capacity to 706 MW—an 84 percent increase over 2013 levels (Figure 12). Of the capacity under development, 64 percent is solar photovoltaic, 20 percent is wind energy, and biomass projects will account for 9 percent.

Looking ahead, almost 1.4 GW in capacity could come on line over the next two to five years (Figure 14). If all projects in the planning stage come to fruition, DOD's capacity would increase to 2.1 GW, and by the end of 2018 would be on track to meet its goal of deploying 3 GW by 2025 to comply with congressional mandates for renewable energy use (Figure 13). In the planning process, across DOD components, solar power accounts for 68 percent and biomass for 16 percent of the planned renewable energy capacity and additions.

Figure 11

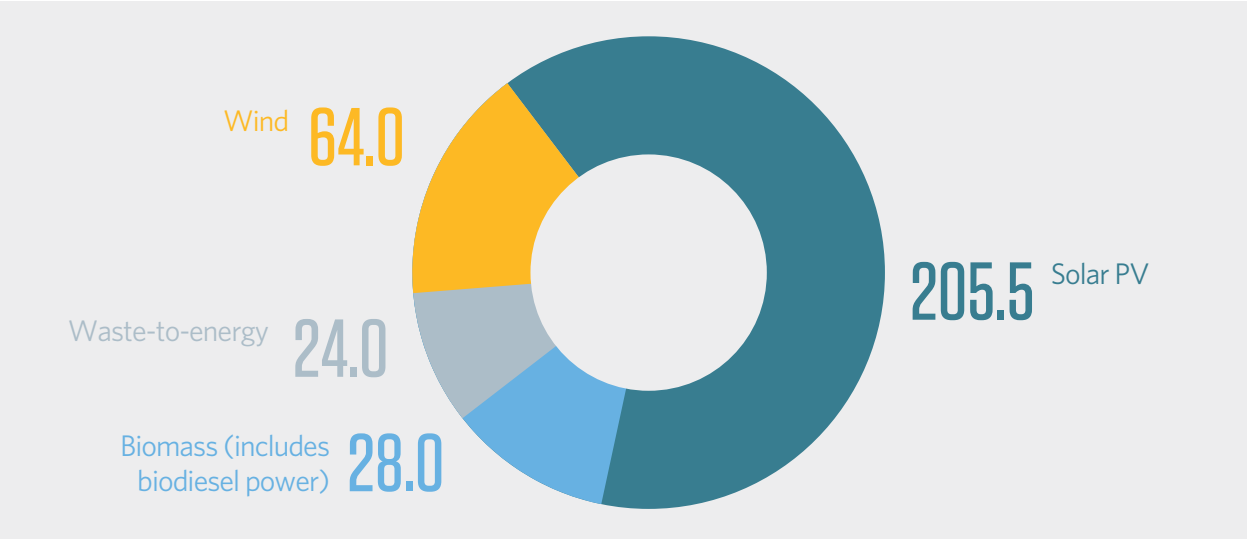
DOD Current Installed Renewable Energy Capacity, by Technology (megawatts)



Source: Navigant Research, Department of Defense

Figure 12

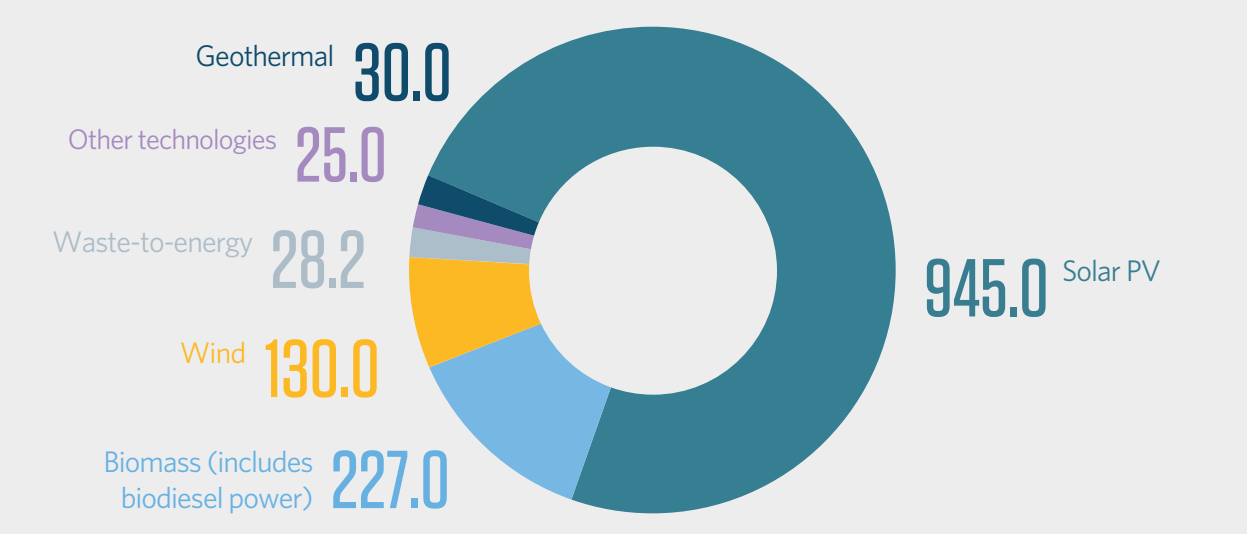
DOD Renewable Energy Capacity in Development Through 2015 (megawatts)



Source: Navigant Research, Department of Defense

Figure 13

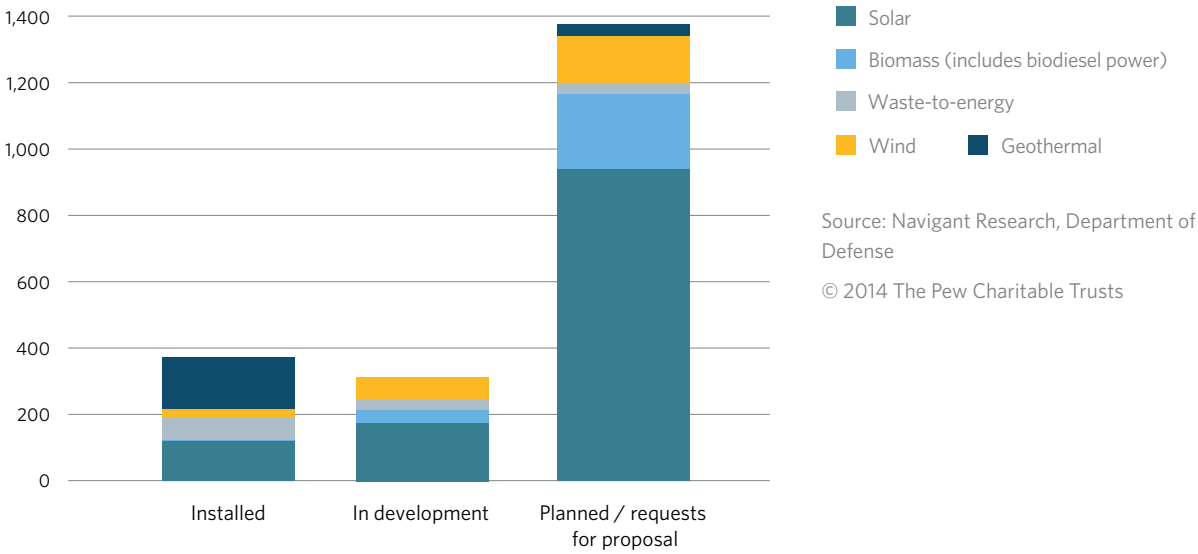
DOD Renewable Energy Capacity Planned Through 2018
(megawatts)



Source: Navigant Research, Department of Defense

Figure 14

DOD Renewable Energy Capacity Installed, in Development, and Planned, by Technology
(megawatts)



Source: Navigant Research, Department of Defense

Lessons learned: DOD's strengths, realities, and challenges

The Department of Defense has a sound rationale and implementation strategy, and concrete results to back up its growing commitment to the use of clean and efficient energy at its facilities. These efforts are harnessing private-sector technologic and financial innovations to strengthen energy security, budgetary savings, and compliance with mandates established by Congress and military leaders.

In the course of this research, including base visits and dialogue with leaders of military branches, several energy security strengths, realities, challenges, and opportunities were identified. These include:

Strengths

The military has extensive energy expertise

The military has considerable energy expertise at the headquarters, regional and base levels. The central support mechanisms at the Air Force Civil Engineering Command, the Army's Energy Initiatives Task Force, and the Naval Facilities Engineering Command, among others, offer substantial experience and knowledge in support of installation energy efforts and headquarters policy guidance.

The base energy managers with whom Pew met were deeply committed to meeting the needs of military personnel and operations as careful stewards of scarce taxpayer resources. There is value in empowering base energy managers with staff, authority, and attention from commanders. They have launched many initiatives to save the military significant amounts of money, and reinforcing these efforts makes sense for effective base operations and efficient use of funds.

DOD energy initiatives are saving taxpayer dollars

At bases across the country, thousands—and, in some cases, millions—of dollars are being saved through advanced energy initiatives. The Air Force reports that its annual energy bill would be $300 million higher if not for initiatives over the past decade. The Navy reports that it has attained $1.6 billion worth of life-cycle savings from advanced investments in a little more than a decade.[51]

40% Energy intensity reduction from 2003 to 2010 at U.S. Army Garrison Fort Hunter Liggett, CA, resulting from efficiency improvements.

Site visits demonstrated how improved heating and cooling technology will save Fort Irwin, CA, $200,000 annually. Efficiency improvements at Twentynine Palms Marine Corps Base, CA, will save $138 million in energy costs over 20 years.

U.S. Navy Construction Electrician 3rd Class Robert Schiller, left, and Construction Electrician Constructionman Greg Langdon add a new section of drill steel to a T2W Ingersol-Rand Water Well-Drilling Rig in Twentynine Palms, CA, in 2009. Seabees from Naval Mobile Construction Battalion 1 drilled three 800- to 1,000-foot holes in the area to assist the U.S. Navy Geothermal Program Office in their research of local geothermal energy potential.

Realities

Local conditions are critical

As in other matters of real estate management, location is key. Efficiency measures can be deployed almost anywhere, but some renewable energy technologies are more appropriate to certain regions. There is considerable potential for deploying biomass energy technologies in the Southeastern United States and solar technologies in the Southwest. There are unique sites favorable for geothermal energy development and promising opportunities for wind energy on the coasts and in other corridors of the country.

Similarly, state and local laws and regulations—including renewable energy and energy-efficiency resource standards—and prevailing electricity rates influence considerably the financial viability of these projects. Base energy managers are operating in a dynamic marketplace in which clean energy deployment is happening with greater frequency and speed.

Managing expectations

Meeting the pledge to deploy 1 GW of renewable energy will take years to achieve for the service branches. Advanced energy technologies—from energy efficiency to renewables to microgrids—are complex, and the widespread dispatch of some technologies in the commercial marketplace is only beginning. Developing power purchase agreements and enhanced use leases is a relatively new endeavor for the military, which also must

undertake extensive environmental reviews and work within government requirements. These conditions can prove challenging for private financiers. For example, military experts note that compliance with the Energy Policy Act of 2005's renewable energy consumption requirements encourages federal agencies to retain renewable energy credits that third-party developers often need to make private financing available.

There are emerging precedents, such as the Naval Air Weapons Station China Lake power purchase agreement, that can provide a template for streamlining future efforts. Still, in light of the military's detailed processes and necessary due diligence, it can take years to put into place energy saving performance contracts and power purchase agreements.

It is likely that the military will meet its goals through a modest number of medium-sized projects, rather than many small initiatives or a few megadeals. While there is potential to develop 500-MW projects on military bases in the Southwest, for example, no initiatives have been completed to date. In contrast, there are more medium-size, 10- to 20-MW projects that are installed or in development on Army, Navy, and Air Force bases. The consensus among experts is that these will likely be the backbone of future progress.

The importance of public-private partnership

The military's progress in enhancing energy security is born of a vital and growing network of public-private partnerships with utilities, energy service companies, financial and technology experts, among others. At Fort Irwin, close cooperation is occurring between base energy managers and Southern California Edison. Under the Army's "Building by Design" initiative, the base energy manager receives input from utility experts on ways to save energy and incorporate advanced technology in new building plans. In Hawaii, the Navy is a co-funder, along with the Department of Energy, of the Energy Excelerator program, which supports private companies working on solar installations and advanced microgrids.

The private sector has substantial expertise in advanced technologies and emerging financial innovations to offer military leaders and base managers. Nurturing public-private partnerships in service of the Pentagon's energy security objectives is essential for long-term success.

Challenges

Changing culture

The facility energy security strategies for the Army, Air Force and Navy all reference the importance of changing the culture by involving soldiers, sailors, airmen and Marines in energy initiatives. Although it is easy to take energy for granted and assume that major systems such as lights and HVAC will operate without interruption, the power does go out, as soldiers have learned during extended outages in triple-digit heat. The military has noted the need to cultivate support for energy security from every level of its chain of command.

Military leaders and others providing oversight might consider how incentives could encourage participation by personnel from the entry level to command leadership. For instance, personnel in military housing at the Naval Air Weapons Station China Lake are participating in a novel Resident Energy Conservation Program. It rewards residents for conserving energy and directs the monetary savings into maintenance and other community enhancements.

Energy security is a priority without a premium

Energy security is a priority at the Pentagon and its branches and on bases. But military policy makes clear that the cost of "clean power" should be equivalent to or less than that of conventional/traditional power on a life cycle basis. In other words, there is a priority for energy security and clean energy, but no premium for them. Energy security and clean energy goals are something of an unvalued mandate. Policymakers should consider ways to value energy technologies to help ensure that no mission will be compromised because of extended power failures.

Solar panels line the roof of the commissary building at Los Angeles Air Force Base, CA, in 2011. Installation of the panels was part of ongoing energy conservation efforts on base.

Conclusion

Over the past decade, the Department of Defense has embraced the challenge of enhancing energy security at its domestic installations. A comprehensive plan has been developed across the military and by each service branch to do so. Through these efforts, military missions have been strengthened, taxpayer dollars have been saved, and progress is being made toward achieving goals set by Congress, the executive branch, and military leaders.

DOD's clean energy initiatives are gathering momentum, due in part to its significant engagement of the private sector and leveraging of third-party financing to deploy technologies for energy efficiency and renewable energy. In the coming months and years, the department's energy consumption will decline, renewable energy capacity will grow, and deployment of microgrids will expand. As a result, the military's energy security will be strengthened in service of combat operations, humanitarian response, and homeland defense.

Appendix A: Methodology

This report draws on a variety of research sources, including publicly available data, site visits to Department of Defense facilities, discussions with defense and industry experts, and research and databases provided by Navigant Research, an energy market research arm of Navigant Consulting.

The quantitative data developed by Navigant Research and presented in this report are derived from relevant literature as well as phone and in-person interviews with representatives from every part of the value chain—including but not limited to technology companies, utilities, and other service providers; industry associations; government agencies; and the investment community. Forecasts are developed from Navigant Research project databases, interviews, and evaluation of prevailing policies and incentives. The data presented in this report are up to date as of August 2013.

In this report, annual installed capacity refers to nameplate capacity of installations completed, expressed in megawatts (MW) or gigawatts (GW). Technology definitions are as follows:

- Biomass electric power: Electricity-generating power systems that use biomass feedstocks. In biomass power systems, electricity is produced from biomass, generally via combustion of the feedstock or a derived product, which, in turn, drives power-generating turbines. Data include biopower, waste-to-energy, and biogas.
- Solar electric power: Solar power projects of more than 1 MW. This category includes solar photovoltaic and concentrating solar photovoltaic power projects but does not include solar thermal (hot-water) projects.
- Geothermal power: Grid-connected geothermal power plants, not geothermal heating systems.
- Wind: Onshore and offshore wind installations.

Figures are based on best estimates available at the time of calculation. Annual revenues, shipments, and sales are based on end-of-year figures unless otherwise noted. All values are expressed in 2013 U.S. dollars unless noted. Percentages may not add up to 100 due to rounding.

Brig. Gen. Robert F. Castellvi, right, commanding general of Marine Corps Installations East and commander of Marine Corps Base Camp Lejeune, NC, recognizes members of the Energy Team at Marine Corps Logistics Base Albany after the Georgia base was given the U.S. Environmental Protection Agency's Energy Star Combined Heat and Power Award for the base's highly efficient CHP systems, which increase the reliability of the electricity supply.

Appendix B: Service profiles

Air Force

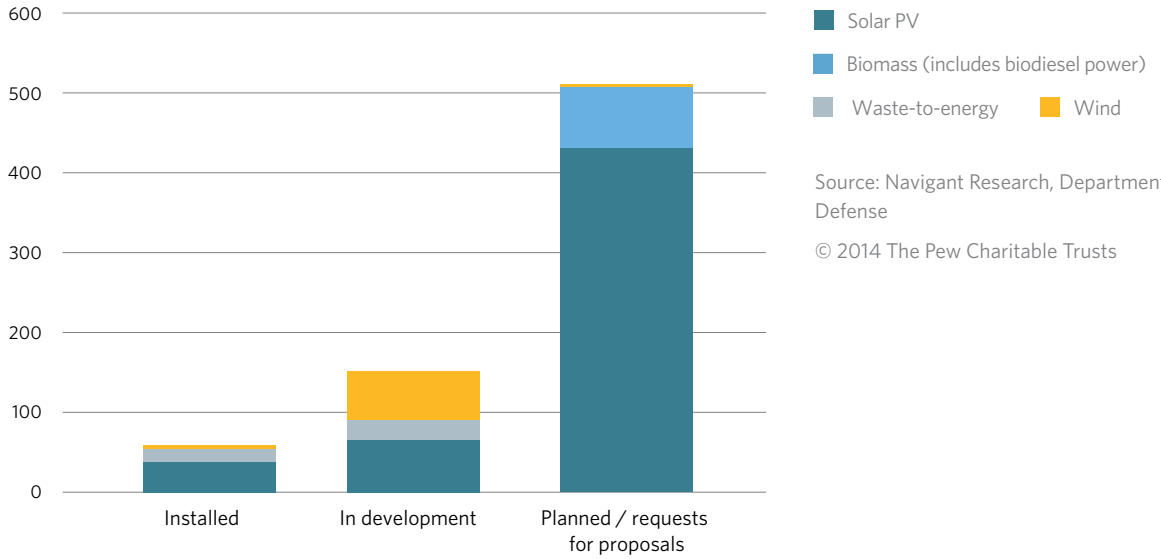
The U.S. Air Force is a leader in efficiency and the deployment of renewable power and is the only branch of the military to have met its facility energy goals. In fiscal 2012, 6.9 percent of its electricity was produced or procured from renewable sources. The Air Force also has reduced its facility energy intensity by 21.2 percent, surpassing the 21 percent goal established in the Energy Independence and Security Act of 2007. The Air Force estimates that it has avoided more than $1 billion in costs as a result of the enhancements it has undertaken since 2003.

Energy security efforts across Air Force installations are facilitated and supported by the Air Force Civil Engineer Center. Its Energy Directorate at Tyndall Air Force Base, FL approves energy saving performance contracts and helps guide development of renewable power opportunity assessments at major commands and bases. Real estate experts at the Civil Engineer Center offices in San Antonio help develop enhanced use leases that allow underutilized property to be leased to third parties interested in developing a renewable energy project on the land.

The Air Force has 60 MW of installed renewable energy capacity, second highest among the service branches. In addition, 152 MW is in development, and there are plans to install an additional 508 MW of renewable capacity within 60 months. In October 2010, the Air Force released new policy guidance for energy saving performance contracts in anticipation of issuing more than $1.5 billion of efficiency investments for fiscal 2012 to 2017 that will save 9.2 trillion British thermal units. By utilizing third-party financing to meet its renewable power goals, the Air Force expects to achieve $1 billion of financing in the next five years.

Service Profiles

Air Force Renewable Energy Capacity, 2013
(megawatts)



Source: Navigant Research, Department of Defense

Table 1

Renewable Energy Use by the Numbers, FY2012

Facility energy cost	$1.1 billion
Key facility energy goals	
Facility energy consumption	15 percent reduction from 2010 baseline by 2020
Energy efficiency	30 percent reduction in energy intensity by 2015 and 1.5 percent annually through 2020 (based on 2003 baseline)
Renewable energy	1 GW installed on bases accounting for 25 percent of electricity use by 2025
Net zero	Buildings constructed after 2020 achieve net zero energy use by 2030
Facility energy progress	
Total renewable energy produced/procured	6.9 percent of electricity consumption
Renewable energy capacity installed	60 MW
Renewable energy in development	152 MW
Renewable energy planned	508 MW
Energy intensity reduction	21.2 percent relative to 2003 baseline
Number of energy-efficiency projects	283
Budget and third-party financing for efficiency	
Energy-efficiency appropriations for facilities	$219 million
Energy saving performance contracts	$174 million
Utility energy service contracts	$500,000

Source: Department of Defense

Army

The U.S. Army has some of the military's most-effective mechanisms for the deployment of on-site renewable energy generation projects. Its Energy Initiatives Task Force provides central guidance and oversight for the Army's effort to generate 1 GW of renewable energy by 2025. In the next five years, clean energy capacity on Army installations is projected to increase by more than 1,200 percent to 580 MW. The task force is working with base staff to leverage private-sector financing for projects of 10 MW or more.

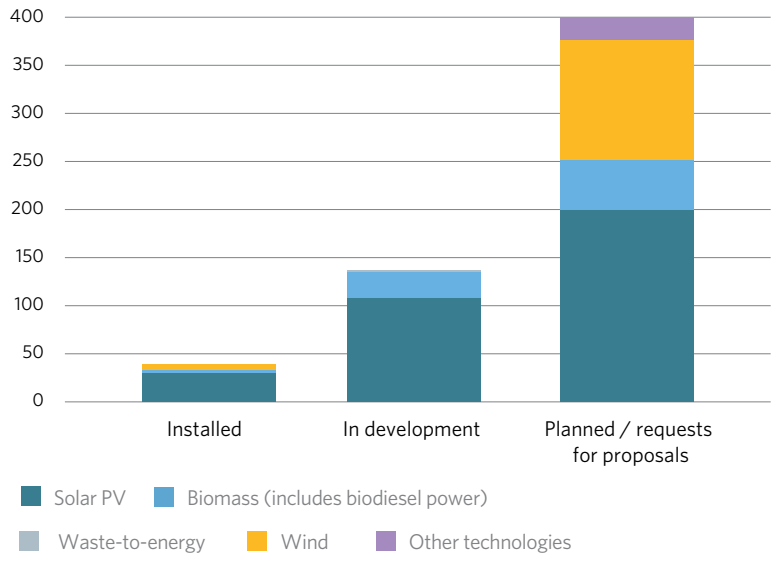
To this end, the Army has issued a $7 billion multi-award task order that will use a single solicitation to select qualified contractors in geothermal, solar, wind, biomass, and other technologies to pursue projects on various bases. These initiatives will be operated pursuant to long-term power purchase agreements in which the contractor assumes the construction costs.

On other key energy measures, the Army lags behind the other service branches. For example, only 5.9 percent of its electricity consumption is produced or procured from renewables. And the reduction at facilities of energy intensity, or energy use per gross square foot, by 15.7 percent since 2003, is well below the 21 percent goal established by the Energy Independence and Security Act of 2007.

In recent years, the Army has prioritized energy security measures and is moving rapidly toward compliance. Use of third-party financing mechanisms has increased by 68 percent since fiscal 2010 and in 2012 reached a one-year record of $235 million worth of energy saving performance contracts and utility energy service contracts. Between 2012 and 2017, the Army expects to save 18,600 billion Btus worth of energy on the basis of $3 billion worth of investment, the majority of which will involve private financing.

Service Profiles

Army Renewable Energy Capacity, 2013
(megawatts)



Source: Navigant Research, Department of Defense

Table 2

Renewable Energy Use by the Numbers, FY2012

Facility energy cost	$1.3 billion
Key facility energy goals	
Energy management plans	100 percent of installations by 2017
Energy efficiency	30 percent reduction in energy intensity by 2015 (based on 2003 baseline)
Renewable energy	1 GW installed on bases accounting for 25 percent of electricity use by 2025
Net zero	Five installations will achieve net zero energy use by 2020
Facility energy progress	
Total renewable energy produced/procured	5.9 percent of electricity consumption
Renewable energy capacity installed	44.6 MW
Renewable energy in development	133 MW
Renewable energy planned	402 MW
Energy intensity reduction	15.7 percent relative to 2003 baseline
Number of energy-efficiency projects	321
Budget and third-party financing for efficiency	
Energy-efficiency appropriations for facilities	$112 million
Energy saving performance contracts	$216.5 million
Utility energy service contracts	$18.7 million

Source: Department of Defense

Marine Corps

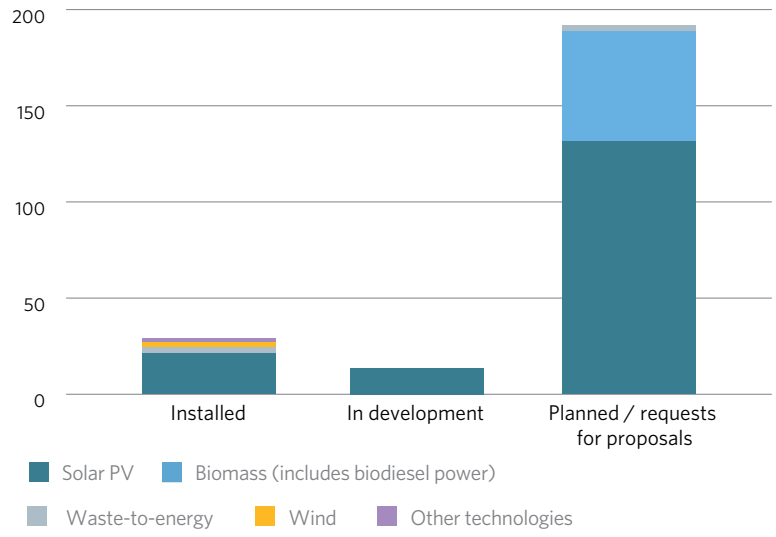
The U.S. Marine Corps produces or procures 5.4 percent of its electricity from renewable power. It hosts two major microgrid demonstrations at the Marine Air Ground Task Force Training Command Twentynine Palms, CA, and the Marine Corps Air Station Miramar, CA. Twentynine Palms has almost 5 MW of solar energy projects and advanced cogeneration facilities that provide reliable electricity, mechanical power, or thermal energy by capturing heat that is wasted during electricity generation, making it one of the most energy-secure facilities in the military. The Marines also have installed several waste-to-energy facilities, and others are in development.

The Marine Corps plans to use power purchase agreements and other private financing mechanisms to expand deployment of renewable energy. Major projects in the planning phase include a 100-MW solar photovoltaic installation at Marine Corps Air Station Yuma, AZ, a 25-MW biomass facility and an 8.2-MW solar facility at Camp Lejeune, NC, and a 20-MW solar photovoltaic array at Camp Pendleton, CA.

The Marine Corps has reduced its energy intensity by 18.9 percent from fiscal 2003 levels, although this is below the 21 percent reduction goal established by the Energy Independence and Security Act of 2007. To achieve greater savings, the branch has sharply increased direct funding for energy-efficiency initiatives, from $2 million in 2011 to more than $184 million in 2012. Similarly, the number of energy-efficiency projects increased from 9 in 2011 to 311 in 2012. The Marine Corps expects to invest $678 million in energy-efficiency improvements from fiscal 2012 to 2017 that will save 2,500 billion Btu of energy.

Service Profiles

Marine Corps Renewable Energy Capacity, 2013
(megawatts)



Source: Navigant Research, Department of Defense

Table 3

Renewable Energy Use by the Numbers, FY2012

Facility energy cost	$240 million
Key facility energy goals	
Energy efficiency	30 percent reduction in energy intensity by 2015 (based on 2003 baseline)
Renewable energy	Meet 50 percent of installation energy requirements with alternative energy by 2020
Facility energy progress	
Total renewable energy produced/procured	5.4 percent of electricity consumption
Renewable energy capacity installed	26 MW
Renewable energy in development	12 MW
Renewable energy planned	191 MW
Energy intensity reduction	18.9 percent relative to 2003 baseline
Number of energy-efficiency projects	311
Budget and third-party financing for efficiency	
Energy-efficiency appropriations for facilities	$184 million
Energy saving performance contracts	None
Utility energy service contracts	None

Source: Department of Defense

Navy

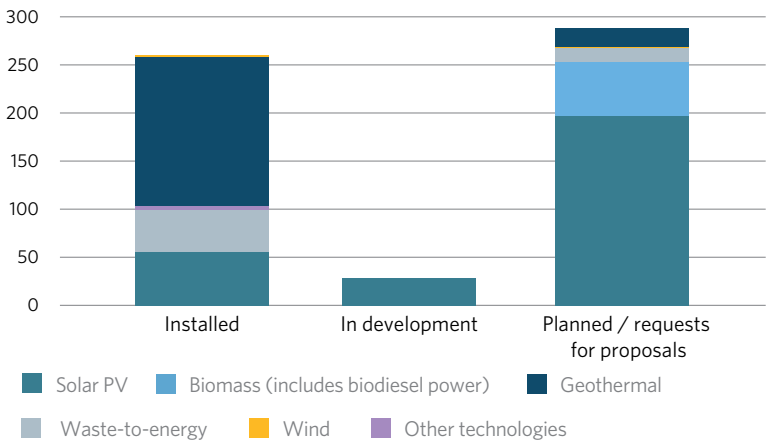
The U.S. Navy has long been a leader in the Department of Defense's energy security and clean energy efforts. Since the late 1980s, the service has hosted the military's largest renewable energy project—a geothermal plant at Naval Air Weapons Station China Lake, CA, Western Mojave Desert. This 170-MW facility generates roughly half of all the military's renewable energy. Because of this project and a large biomass plant at the Norfolk Naval Base, VA, the Navy was able to produce or procure from renewables 20.6 percent of the electricity it consumed in 2012. However, energy from the China Lake geothermal facility is not used by the base and therefore does not count toward the Energy Policy Act of 2005 goal. As a result, only 1.7 percent of the Navy's overall base energy consumption comes from renewable sources.

The Navy has reduced its energy intensity—energy use per gross square foot—by 19.1 percent from fiscal 2003 levels, slightly below the 21 percent reduction goal established by the Energy Independence and Security Act of 2007. Of the 251 efficiency projects underway, the service relied heavily on direct funding, with $374 million allocated for such projects compared to $22 million for third-party-financed projects. The Navy expects to invest $2.4 billion in efficiency improvements for fiscal years 2012-2017 that will save 12,500 billion Btu of energy.

As part of these plans to expand deployment of renewable energy, it will utilize power purchase agreements and other private financing mechanisms. On this point, the Navy is leading the other service branches, having concluded the military's first power purchase agreement using long-term contracting authority for a 13.8-MW solar array at China Lake. It is pursuing a broad portfolio of renewable energy projects including geothermal facilities at Naval Air Stations Fallon, NV, and Chocolate Mountain, CA, as well as solar projects at Naval Air Station Lemoore, CA, and waste-to-energy projects at naval bases in San Diego and Guantanamo Bay.

Service Profiles

Navy Renewable Energy Capacity, 2013
(megawatts)



Source: Navigant Research, Department of Defense

Table 4

Renewable Energy Use by the Numbers, FY2012

Facility energy cost	$1 billion
Key facility energy goals	
Energy efficiency	30 percent reduction in energy intensity by 2015 (based on 2003 baseline)
Renewable energy	1 GW installed on bases by 2020*; 50 percent of shore energy requirements met by alternative sources by 2020
Net zero	50 percent of installations achieve net zero energy use by 2020
Facility energy progress	
Total renewable energy produced / procured	20.6 percent of electricity consumption
Renewable energy capacity installed	254 MW
Renewable energy in development	25 MW
Renewable energy planned	284 MW
Energy intensity reduction	19.1 percent relative to 2003 baseline
Number of energy efficiency projects	271
Budget and third-party financing for efficiency	
Energy-efficiency-appropriations for facilities	$374 million
Energy saving performance contracts	$21 million
Utility energy service contracts	$28 million

Notes:

* Combined goal for the Marine Corps and Navy.

Source: Department of Defense

Endnotes

[1] Defense Science Board Task Force on DOD Energy Strategy, *More Fight–Less Fuel* (Feb. 2008), 3, http://www.acq.osd.mil/dsb/reports/ADA477619.pdf.

[2] Department of Defense, "Annual Energy Management Report Fiscal Year 2012" (June 2013), 16, http://www.acq.osd.mil/ie/energy/energymgmt_report/FY%202012%20AEMR.pdf.

[3] Department of Defense, "Annual Energy Management Report Fiscal Year 2011" (Sept. 2012), C-3, http://www.acq.osd.mil/ie/energy/library/FY.2011.AEMR.PDF.

[4] "Microgrid Market to Boom Despite Drop-off in DOD Funds," *Smart Grid Today*, May 1, 2013, http://www.smartgridtoday.com/articles/9392-microgrid-market-to-boom-despite-drop-off-in-DOD-funds.

[5] Army Sgt. 1st Class Tyrone C. Marshall Jr., "Robyn: Defense Department Fills Void in Clean Energy Testing," American Forces Press Service (Feb. 9, 2012), http://www.defense.gov/News/NewsArticle.aspx?ID=67132.

[6] "Marine Corps Project Advances on Solar Energy Projects and Secures Awards," SunPower Corp., http://us.sunpowercorp.com/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername3=Content-Disposition&blobheadervalue3=attachment%3B+filename%3DBEQ_Final.pdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1300281570963&ssbinary=true.

[7] Navigant Research, "Renewable Energy for Military Applications" (2012), 27, http://www.navigantresearch.com/research/renewable-energy-for-military-applications.

[8] Department of Defense, "Annual Energy Management Report Fiscal Year 2012," 18.

[9] Ibid., 32.

[10] Department of Energy, "DOE ESPC Awarded Projects Report," line 280, https://www1.eere.energy.gov/femp/docs/do_awardedcontracts.xls.

[11] Defense Science Board Task Force on DOD Energy Strategy, *More Fight—Less Fuel*, 7.

[12] Business Executives for National Security, "Power the Fight: Capturing Smart Microgrid Potential for DOD Installation Energy Security" (fall 2012), 14, http://www.bens.org/document.doc?id=187.

[13] Department of Defense, "Annual Energy Management Report Fiscal Year 2012," 53.

[14] House Energy and Commerce Committee Subcommittee on Energy and Power (May 31, 2011) (statement of Paul Stockton, assistant secretary of defense), http://democrats.energycommerce.house.gov/sites/default/files/image_uploads/Testimony_EP_05.31.11_Stockton.pdf.

[15] Evan Mills, "Electric Grid Disruptions and Extreme Weather, report to the National Climatic Data Center" (May 2012), http://evanmills.lbl.gov/presentations/Mills-Grid-Disruptions-NCDC-3May2012.pdf.

[16] Department of Defense, "Annual Energy Management Report Fiscal Year 2012," 16.

[17] Ibid, 15–16.

[18] House Appropriations Committee Subcommittee on Military Construction and Veterans Affairs (April 12, 2013) (statement of Kathleen Ferguson, acting assistant Air Force secretary), 17, http://appropriations.house.gov/uploadedfiles/hhrg-113-ap18-wstate-fergusonk-20130412.pdf.

[19] Department of the Navy, "Strategy for Renewable Energy" (Oct. 2012), 4, http://www.secnav.navy.mil/eie/ASN%20EIE%20Policy/DASN_EnergyStratPlan_Finalv3.pdf.

[20] Energy Information Administration, "Average Retail Price of Electricity to Ultimate Customers," table 5.3, http://www.eia.gov/electricity/data.cfm#sales.

[21] "Solar PV Module Prices Have Fallen 80% Since 2008, Wind Turbines 29%," CleanTechnica.com (May 6, 2013), http://cleantechnica.com/2013/05/06/solar-pv-module-prices-have-fallen-80-since-2008-wind-turbines-29.

[22] Congressional Research Service, "Department of Defense Energy Initiatives: Background and Issues for Congress" (Dec. 10, 2012), 53–64, http://www.fas.org/sgp/crs/natsec/R42558.pdf.

[23] Department of Energy, "Energy Independence and Security Act of 2007: Major Provisions of Interest to Federal Energy Managers," http://www1.eere.energy.gov/femp/news/news_detail.html?news_id=11683.

[24] Environmental Protection Agency, departmental advisory detailing agency requirements for implementing Executive Order 13423, http://www.epa.gov/oaintrnt/practices/eo13423.htm.

[25] Department of Defense, "Facilities Energy and Privatization Directorate, guidance document on facilities energy strategy," http://www.acq.osd.mil/ie/energy/index.shtml.

[26] Department of Defense, "Annual Energy Management Report Fiscal Year 2011," C-3.

[27] House Armed Services Committee Subcommittee on Readiness (statement of Dorothy Robyn, deputy undersecretary of defense) (March 29, 2012), http://www.acq.osd.mil/ie/download/robyn_testimony_hasc%20mar292012.pdf.

[28] Ibid., 2–3.

[29] Department of Defense, "Annual Energy Management Report Fiscal Year 2012," 65.

[30] Department of Defense, "Defense Wide Budget Documentation—2014" (April 2013), http://comptroller.defense.gov/defbudget/fy2013/budget_justification/pdfs/07_Military_Construction/15-Energy_Conservation_Investment_Program.pdf.

[31] Ibid., 2.

[32] Congressional Research Service, "Department of Defense Facilities Energy Conservation Policies and Spending" (Feb. 19, 2009), 12–13, http://www.fas.org/sgp/crs/natsec/R40111.pdf; and Department of Defense, "Annual Energy Management Report Fiscal Year 2012," 76.

[33] Don Branum, "Academy Hits Switch on 6-MW Solar Array," *Academy Spirit,* June 13, 2011, http://www.usafa.af.mil/news/story.asp?id=123259829.

[34] Department of Defense, "Annual Energy Management Report Fiscal Year 2011," 32.

[35] Department of Defense, "Strategic Sustainability Performance Plan—FY 2012" (Sept. 20, 2012), ES-6 http://www.acq.osd.mil/ie/download/green_energy/DOD_sustainability/2012/DOD%20SSPP%20FY12-FINAL.PDF.

[36] House Appropriations Committee Subcommittee on Military Construction, Veterans Affairs, and Related Agencies (statement of John Conger, acting deputy undersecretary of defense) (April 12, 2013), 17, http://appropriations.house.gov/uploadedfiles/hhrg-113-ap18-wstate-congerj-20130412.pdf.

[37] Department of Defense, "Guidance on Financing of Energy Projects Policy" (Nov. 9, 2012), 3, http://www.acq.osd.mil/ie/energy/library/Policy_Financing%20of%20Energy%20Projects%209Nov2012.pdf.

[38] "SunPower, MetLife Implement First 20-Year Solar PPA for Military" (Nov. 18, 2011), http://www.cleanenergyauthority.com/solar-energy-news/sunpower-and-metlife-implement-20-year-solar-ppa-111811.

[39] Pike Research (now Navigant Research), "Renewable Energy for Military Applications" (2012), 27.

[40] Department of Defense, "Base Structure Report, Fiscal Year 2012 Baseline," http://www.acq.osd.mil/ie/download/bsr/BSR2012Baseline.pdf.

[41] Department of the Interior, "Interior and Defense Departments Join Forces to Promote Renewable Energy on Federal Lands" (Aug. 6, 2012), http://www.doi.gov/news/pressreleases/Interior-and-Defense-Departments-Join-Forces-to-Promote-Renewable-Energy-on-Federal-Lands.cfm.

[42] House Energy and Commerce Committee Subcommittee on Energy and Power (statement of Paul Stockton).

[43] "Microgrid Market to Boom," *Smart Grid Today*.

[44] Department of Defense, "DOD Study Finds Microgrids Offer Improved Energy Security for DOD installations" (July 10, 2012), http://www.serdp.org/News-and-Events/News-Announcements/Program-News/DOD-study-finds-microgrids-offer-improved-energy-security-for-DOD-installations.

[45] "Over 400 Microgrid Projects Underway En Route to $40 Billion Market," CleanTechnica.com (April 3, 2013), http://cleantechnica.com/2013/04/03/over-400-microgrid-projects-underway-en-route-to-40-billion-market.

[46] Business Executives for National Security, "Power the Fight."

[47] Jeffrey Marqusee, "Microgrids and DOD Facilities" (paper presented at the Department of Energy's Electricity Advisory Committee meeting, Washington, June 12, 2012), http://energy.gov/sites/prod/files/Presentation%20to%20the%20EAC%20-%20Microgrids%20and%20DOD%20Facilities%20-%20Jeffrey%20Marqusee.pdf.

[48] Department of Defense, "Robyn: Defense Department Fills Void."

[49] Senate Appropriations Committee Subcommittee on Military Construction, Veterans Affairs, and Related Agencies (statement of John Conger, acting undersecretary of defense for installations and the environment) (May 9, 2013), 17, http://www.appropriations.senate.gov/ht-military.cfm?method=hearings.view&id=2d73b2f9-649e-43d3-802b-1184aa362e21.

[50] Department of Defense, "Annual Energy Management Report Fiscal Year 2011," 14.

[51] Department of the Navy, "Strategy for Renewable Energy."