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Solar arrays at Nellis Air Force Base, Las Vegas, Nevada.

Clean Energy for the Wild Blue Yonder

Expanding Renewable Energy and Efficiency in the Air Force

By Alexandra Kougentakis, Tom Kenworthy, and Daniel J. Weiss November 2009

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Introduction and summary

Reliance on foreign energy sources and global warming pose major threats to the United States' security. A report by the Center for American Progress earlier this year determined that "America's dependence on foreign oil transfers U.S. dollars to a number of unfriendly regimes, while robbing the United States of the economic resources it desperately needs for domestic development and American innovation."

The problem is particularly acute for the Department of Defense, which is the world's largest consumer of energy and whose military operations and facilities consume significant amounts of energy. In its 2009 report "Powering America's Defense," the military research organization CNA describes both domestic and overseas defense installations as "dangerously oil dependent, wasteful, and weakened by a fragile electrical grid."

DoD spent $3.4 billion on worldwide facility energy consumption in fiscal year 2007, $1.06 billion of which went to Air Force energy needs. These costs included electricity and direct use of fossil fuels such as oil, coal and natural gas, among other sources. Electricity constitutes the bulk of facility energy expenditures. In fiscal year 2007, DoD spent more than $2.5 billion on nearly 30 million megawatt-hours of electricity. The Air Force's portion was $700 million. Electricity accounts for 48 percent of total facility energy consumption, but it represents 66 percent of all facility energy expenditures thanks to rising fuel costs.

Spending on petroleum both undermines national security and consumes a large portion of the DoD's energy budget, diverting funds from other potential uses. Within DoD the Air Force is the largest consumer of petroleum, spending on petroleum-based fuels, including more than 3 billion gallons of aviation fuel, in FY 2007. This amounts to 56 percent of DoD expenditures on petroleum-based fuels, and 52 percent of such expenditures by the entire U.S. government.

The Air Force should address the security challenge posed by its massive electricity and petroleum use with a clean-energy strategy focused on deploying renewable energy and energy efficient technologies. Energy efficiency can reduce the risks to American soldiers and the burdens on military budgets, and expanding renewable energy for facility use—particularly on domestic bases in conjunction with the implementation of a national clean-energy smart grid—would bolster national security. The smart grid would replace the current, deteriorating conventional electricity grid with a national network of long-dis-

tance transmission lines that would deliver renewable energy to consumers via electrical substations. A number of important Air Force bases are in areas with ample solar energy resources, making the expansion of solar technologies an attractive option for them.

Nellis Air Force Base in Nevada already has a clean-energy strategy in place and can serve as an example of a starting point for other bases. President Barack Obama visited Nellis AFB to recognize the 100th day after the enactment of the American Recovery and Reinvestment Act. He commended the base for possessing "the largest solar electric plant of its kind in the entire Western Hemisphere." Nellis AFB proves that solar electricity is a viable alternative to fossil fuel generation, and it demonstrates the significant benefits the Air Force could enjoy from expanding solar energy and energy efficiency, including greater energy security, lower energy bills, and a reduction of greenhouse gas pollution.

This analysis will detail how the Air Force can start using more renewable energy and become more energy efficient while saving taxpayers money. It will first review clean-energy funding and programs already in place within the military and the Air Force, then examine military and private aviation facilities that have shifted to more renewables and efficiency before outlining challenges to a cleaner Air Force and providing recommendations on how to overcome these challenges. The paper also projects the benefits for 11 Air Force bases that have high solar energy potential based on the implementation of a solar energy and efficiency program similar to that at Hangar 25, a private aviation facility in California.

Specifically, this report recommends a pilot program to retrofit a small number of Air Force hangars at a high solar potential base. This pilot would use Hangar 25's program as a guide and would clearly show the benefits to be had from such a program. Other recommendations for making Air Force hangars more energy efficient include:

- DoD and DOE should collaborate for a "clean-energy task force" to guarantee maximum effectiveness and efficiency in greening projects.
- Invest in state projects that reward clean energy.
- Implement reforms that would speed clean-energy projects.
- Use smart solar financing vehicles that use third-party investments.
- Have small-scale renewable energy projects play a bigger role by providing learning opportunities.

Smart energy use in the military is growing

Some DoD officials have recognized the importance of a long-term energy strategy that emphasizes efficiency and effectiveness, and now the energy strain from two wars is focusing Pentagon leaders on prudent energy use, including factoring the cost of fuel into acquisition decisions.

A more energy-efficient strategy for the military should begin with the budget process. The military currently receives funding for energy-related programs from the federal budget and the American Recovery and Reinvestment Act. Principal funding avenues for energy initiatives through the federal budget include new construction via the Military and Construction appropriations bill; the Sustainment, Restoration, and Modernization accounts; and the Facilities Operations account in the Operations and Maintenance appropriations bill.

The American Recovery and Reinvestment Act allocated $4.3 billion to DoD for facility upgrades, including energy-related improvements, and an additional $120 million in ARRA funds went to DoD's Energy Conservation Investment Program to meet efficiency goals that would enhance national security while cutting costs. ARRA also allocated another $300 million to DoD to develop energy-efficient technologies, which brings the total energy-related funding measures from ARRA to DoD to $4.7 billion.

ECIP funds are for projects that save energy and water usage and reduce the Defense Department's costs, and they've been successful in the past.[1] Previous ECIP investments produced efficiency improvements that have saved $4 for every $1 invested. Efficiency also has great potential for cutting costs and energy use. Several major national studies have found that energy efficiency investments can reduce energy consumption by 30 to 50 percent, and they can save as much as 70 percent when combined with a strong integrated building design model.

ECIP plays an important role in helping DoD secure energy supplies for the country. The program also helps the military minimize its vulnerability to interruptions in its energy supply. The military increasingly employs "onsite energy generation" that creates self-sufficient "islands" for its bases. Renewable energy sources figure prominently in this shift, and expanding their use as well as employing more energy efficiency techniques further enhances national security.

DoD continues to make progress in its efforts to reduce its energy use, save tax dollars and employ clean, homegrown renewable energy. Hopefully, the Air Force will use some of the funds provided by the American Recovery and Reinvestment Act to take these next steps. Combined with the recommendations below, the Air Force could dramatically increase its energy and dollar savings.

The Air Force can be a clean power partner

The Air Force has the greatest need to boost energy efficiency and renewables use because it is the single largest consumer of both petroleum-based fuels and facility energy in the country. It recognizes this need and is starting to move forward. In 2008 it released its Infrastructure Energy Strategic Plan, which goes beyond the scope of the DoD-wide ECIP and uses smart energy policies to guide improvements in current and future infrastructure, to expand renewable energy, and to manage costs. The plan estimates that a $1.5 billion investment in facilities through FY 2015 would reduce energy costs by $2.2 billion. The Air Force has saved on efficiency before—an assessment of savings in the 20-year period that ended in FY2005 concluded that it avoided nearly $3 billion in utility costs through earlier facility energy conservation measures.

The IESP sets specific goals for the Air Force, including:

- Reduce energy infrastructure costs 20 percent by 2020.
- Reduce facility energy intensity (the amount of energy required for each unit of output or activity) by 3 percent per year through 2015.
- Reduce base water use by 2 percent per year through 2015.
- Increase use of renewable energy by annual targets (3 percent, 5 percent, 7.5 percent, and 25 percent) through 2025.
- Reduce ground vehicle fuel use by 2 percent per year through 2015.
- Increase alternative fuel use by 10 percent per year through 2015.

The Air Force is also the largest purchaser of clean energy in the entire U. S. government. "Green energy sources" now account for 5 percent of all Air Force energy use. With more than 426 gigawatt-hours generated from these sources in 2008, the Air Force is the leading government participant in the Environmental Protection Agency's Green Power Partnership, and has received the Green Power Leadership Award. Investments in wind, solar, and other renewable sources make the Air Force the seventh largest clean-energy consumer in the country. A large portion of this energy is from biomass, which has significantly lower carbon dioxide emissions compared to fossil fuels.

The Air Force can play a major role in helping the United States once again become the global leader in solar energy. By the end of 2008 the global market for solar photovoltaic energy had increased by 110 percent, by 5.95 gigawatts. The United States is the third largest market with 6 percent, yet it lags far behind Spain and Germany, which respec-

tively comprise 41 and 31 percent of the global market for solar energy. Even though solar photovoltaic technology was first developed in the United States, President Ronald Reagan slashed support for the nascent technology in the 1980s. In 1996, the U.S. had 45% of the world market share of PV. It dropped to 10% in 2005. The Department of Energy Loan Guarantee Program for low-carbon energy projects provides federal assistance to solar energy companies that could otherwise fall victim to the financial crisis, but much could be done to expand solar and the Air Force can be a big help. Nellis Air Force Base in Nevada and Hangar 25 in California offer innovations that other bases can emulate.

The Nellis Air Force Solar Project: What happens in Vegas should happen elsewhere

The Air Force could dramatically ramp up its use of solar energy. A study by Sandia National Laboratories in 2004 concluded that, "Nearly all military bases have potential for one or more economically viable solar projects." In a 2007 report, Booz Allen Hamilton assessed all domestic Air Force bases for potential renewable energy use and identified 18 bases in seven states—the majority in the Southwest and West—with particularly significant potential for solar energy.[2]

Nellis Air Force Base in Las Vegas has grasped this potential. It's home to the nation's largest photovoltaic array, a 14-megawatt installation that covers 140 acres and provides up to 25 percent of the base's electricity needs. It reduces carbon emissions by 24,000 tons per year, or the equivalent of taking 1,700 cars off the road. The solar array also cuts energy costs by $1 million per year.

The project was completed in December 2007, but the original idea started developing more than three years earlier. Lessons learned from that lengthy contracting process can be applied to future solar energy ventures on Air Force bases and save significant time and money. The Nellis AFB project demonstrated that a number of important steps should be taken to minimize solar project costs, including:

- Establish a competitive solicitation process for proposals.
- Sign an indefinite term utility contract.
- Create a small core team to streamline project evaluation.
- Involve all stakeholders at the beginning, including landowners and those in contracting, legal, environmental, engineering, and security fields.
- Secure funds early for environmental assessments, environmental building solutions, and legal surveys.

Many Air Force bases have high potential for solar energy, but Nellis AFB had a number of advantages that favored solar energy deployment. Its location in southern Nevada gave it a particularly strong solar resource, and Nevada state laws encourage renewable energy development.

Nellis and other bases have received awards for their energy strategies. The Federal Energy Management Program is a division of DOE whose mission is to facilitate "the Federal Government's implementation of sound, cost-effective energy management and invest-

ment practices to enhance the nation's energy security and environmental stewardship." In recent years FEMP has given the Air Force a number of awards for energy efficiency and management. Last year Nellis received an award for its multitiered energy strategy, which improved base infrastructure and reduced energy consumption at low cost.

But Nellis isn't the only Air Force facility that's been recognized for its clean-energy efforts. In 2006 Andrews AFB in Maryland received an award for a comprehensive strategy that involved water conservation retrofits and installation of energy efficient technologies, cutting fuel oil usage by 1.9 million gallons. Andrews AFB will soon be home to one of the Air National Guard's most sustainable and energy-efficient buildings. The building, which is an expansion project of the base's Air Guard Readiness Center, has been certified by the U.S. Green Building Council as a Leadership in Energy and Environmental Design project.

While the Air Force has made significant progress, it still faces a number of challenges in fully realizing its renewable energy potential. The primary obstacles are legal and administrative. The Air Force has addressed some of the administrative hurdles through the Infrastructure Energy Strategic Plan, recognizing that changes are needed in planning, programming, and budget practices. There is also the hurdle of Air Force compliance with the different provisions of various state renewable energy laws. Yet the success of the solar array deployment at Nellis AFB demonstrates that such challenges are surmountable.

Nellis provides valuable lessons for future Air Force solar energy projects, and it presents a new business model for the Air Force to best capitalize on available renewable energy sources. There are similar leasing agreements for large-scale solar projects under consideration at a number of other bases around the country, including three that are assessed in this report. The success in addressing technical difficulties, and regulatory and legal issues, together with the benefits from reduced costs and greater energy security, are strong arguments for policies that will accelerate such deployment.

Nellis activates nation's largest PV Array

The solar field, comprised of more than 72,000 panels, was completed after 26 weeks of construction and three years of planning. The array is expected to produce more than 25 percent of Nellis' electricity. (U.S. Air Force photo by Master Sgt. Robert Valenca)

Hangar 25: Clean-energy hangar of the future

Hangar 25 at the Bob Hope Airport in Burbank, CA, is the world's first aviation facility to receive the U.S. Green Building Council's platinum certification in Leadership in Energy and Environmental Design, and it offers a financially viable model to dramatically reduce electricity and oil consumption, and generate solar electricity. It was built by Shangri-La Construction, a green building company, and is operated by Avjet Corporation.[3] In August 2009, the 50,000 square-foot private hangar received the jet that carried President Bill Clinton and the two journalists he helped free from North Korea.

The hangar combines an emphasis on cost-conscious sustainable design with a 100 percent clean-energy delivery system. In fact, the 1,530 rooftop photovoltaic panels produce from 110 to 200 percent of the building's electricity needs. The building is a net zero energy installation, generating all power to meet its needs onsite, with the ability to make a profit by selling the excess electricity. In 2009 alone, Hangar 25 returned approximately 175.8 megawatt-hours of clean, renewable electricity back to the grid.

Its advanced sustainability strategies vastly reduce both energy consumption and operational expenses. The LEED platinum certification—the U.S. Green Building Council's highest rating—was accomplished with a capital expenditure comparable to traditional construction costs while simultaneously decreasing operational costs to approximately $.02 per square foot. At $276 per square foot to construct, Hangar 25 shatters the myth that green building requires a cost premium. Historically, Air Force hangar construction costs are $187 to $208 per square foot, depending on the purpose of the hangar. A hangar construction project initiated by the Delaware Air National Guard last year with numerous clean-energy features, including a geothermal heating and cooling system, is estimated to cost $325 per square foot. A Hangar 25-style strategy would achieve huge reductions in energy costs and carbon emissions at a lower cost.

Hangar 25's sustainability strategies can be adopted at other airplane hangars and at most other kinds of buildings as well. These include:

- Cool roofing that reflects the sunlight off of a building's rooftop while minimizing the temperature of the roof itself, thereby reducing heat gain and urban heat island effects.
- Efficient building ventilation and air conditioning strategies.
- Drought-tolerant landscaping that reduces water and electricity use.[4]

- Site paving of other surfaces with a high solar reflectance index material to reflect solar radiation.
- Use of daylight in 95 percent of spaces through skylights and windows.
- Thermal mass effect of concrete floor, which retains and re-emits heat energy.
- Reduced exterior lighting.

The combination of the solar array and energy efficient strategies translates to annual savings of nearly 134 tons of coal, over 4.2 million cubic feet of natural gas, and 41,000 gallons of fuel oil. The reduction in fossil fuel use means a cut of 288 metric tons of carbon dioxide emissions from building operations.

Aircraft housed within hangars could also see major oil savings under Hangar 25's program. The hangar can house three Boeing 737 airplanes. For ground and maintenance operations Hangar 25's planes plug into a ground power unit that uses electricity provided by the building's solar array. This eliminates the need to run the plane's auxiliary power unit, which provides power for all functions other than propulsion. The APU typically uses 50 to 60 gallons of jet fuel per hour.

A 737 at Hangar 25 uses roughly 120 gallons less of jet fuel every day during scheduled maintenance in the solar-powered hangar. The average cost of jet fuel was $3.02 per gallon in 2008, saving each airplane more than $130,000 in jet fuel costs. The planes housed at Hangar 25 to date have saved 43,200 gallons of jet fuel through the use of solar power. Additionally, all ground equipment is electric instead of diesel and is also powered by the facility's solar panels. This reduces oil use and global warming pollution as well as conventional air pollutants.

Hangar 25

The world's first aviation hangar to achieve Platinum certification under the U.S. Green Building Council's LEED® (Leadership in Energy and Environmental Design) Rating System™. Hangar 25, located at the Bob Hope Airport in Burbank, California. (Photo courtesy of Shangri-la Construction)

Hangar 25 can be a model for the Air Force

The renewable energy and efficiency techniques adopted at Hangar 25 would enable the Air Force to go far beyond the progress at Nellis AFB and elsewhere to achieve its clean-energy goals. Rooftop solar paneling and energy-efficient building technologies could conceivably be used in any building type, but for illustrative purposes the proposal below describes the benefits of retrofitting aircraft hangars.

We estimated the potential for clean energy at 11 out of the 18 high-solar resource bases—as identified by Booz Allen Hamilton—that have hangars to illustrate benefits to the Air Force of implementing a Hangar 25-style plan.[5] The number of hangars and their dimensions are used to estimate building energy savings and pollution reductions on a hangar-by-hangar basis. In addition, an estimate of reduced jet fuel use is produced using the numbers and types of aircraft at Nellis AFB.

Estimated carbon dioxide reductions for 11 high-solar potential Air Force bases under Hangar 25-style plan

All bases would see big savings and pollution cuts.

AFB Name	Location	Number of Hangars	Estimated annual CO2 reductions from building (metric tons)
Atlus AFB	Atlus, OK	6	1,997
Beale AFB	Marysville, CA	19	2,809
Davis-Monthan AFB	Tucson, AZ	21	4,284
Edwards AFB	Mojave Desert, CA	20	10,224
Gila Bend AFB	Gila Bend, AZ	1	55
Holloman AFB	Alamogordo, NM	25	6,013
Kirtland AFB	Albuquerque, NM	8	3,609
Laughlin AFB	Del Rio, TX	4	954
Luke AFB	Avondale, AZ	11	2,228
Nellis AFB	Las Vegas, NV	17	2,060
Sheppard AFB	Wichita Falls, TX	16	5,780

The Air Force's implementation of Hangar 25 clean-energy strategies would help meet the following goals set out in the Air Force Infrastructure Energy Strategic Plan:

- Increase renewable energy use to 25 percent by 2025.
- Reduce vehicle fuel use by 2 percent per year.

The lack of a mandatory metering policy for buildings on Air Force bases makes it difficult to determine how much solar-powered energy efficient buildings would increase the percentage of renewable energy use. But an efficiency overhaul combined with solar energy deployment could make certain buildings net-zero energy users. Both increased efficiency and the expansion of solar energy use are official Air Force goals.

The Air Force IESP cites building lifecycle costs as a major concern, stating, "the application of life-cycle-based decision making and smart operations practices in managing Air Force assets—will drive [a] cultural change [that recognizes and eliminates waste in all areas of our operations]." Building operations and maintenance costs are an important consideration for the Air Force in implementing this change. For Hangar 25 those costs are 88 percent less than in an average conventional hangar—two cents per square foot compared to 19 cents per square foot. The hangar demonstrates that efficiency and solar energy technologies are technically feasible and economically affordable.[6]

Much higher construction costs are often cited as a concern when deciding whether to conduct a "green" building retrofit or renovation. The Hangar 25 model, along with several studies, demonstrates that those concerns are largely unfounded. Assessment methods vary: Some studies make a direct comparison of clean-energy project costs with the anticipated cost of the original project, while others tally up the costs of all the individual sustainability features. But regardless of the approach, renovations can achieve a significant level of sustainability for an added cost of 1 to 6 percent and yield substantial long-term savings.

We can estimate the energy savings of such a strategy for Air Force hangar buildings by adjusting for building size (see methodology). For the 11 Air Force bases that are assessed in this proposal, the use of solar energy and efficiency techniques could reduce coal consumption by 18,500 metric tons of coal each year, reduce natural gas use by nearly 600 million cubic feet, and save nearly 5.7 million gallons of fuel oil.[7] The Air Force would consume 66.7 million kilowatt-hours less electricity from the grid, resulting in an estimated savings of over $6.6 million to taxpayers.

Not only would this save money for the Air Force, but it would actually counter the current trend in which ballooning costs mean that the Air Force must pay more for energy every year. Even though Air Force facilities reduced energy consumption through efficiency by 11 percent between 2001 and 2007, Air Force utility bills rose by 35 percent within that time period. A Hangar 25 clean-energy building strategy would also reduce the carbon dioxide pollution of the 11 Air Force bases discussed here by a total of over 40,000 metric tons per year.

Airplanes consume large amounts of fuel even during routine maintenance operations while they are stationed in hangars. While Nellis AFB already saves $1 million a year with its current solar array, the advantage of the solar rooftop hangar model is that it can achieve additional significant electricity and fuel savings. And the planes' reduction in carbon dioxide pollution could exceed 23,600 metric tons per year.

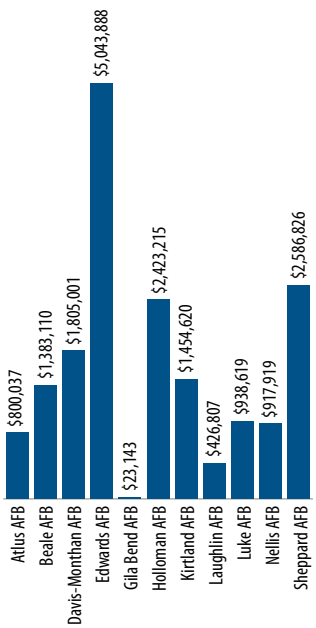
The aircraft could be plugged into the solar electricity delivery system, which would save Nellis AFB nearly $7.5 million annually on jet fuel costs.[8] Actual savings on fuel costs would likely be even higher because in addition to reducing jet fuel consumption, plugging directly into the hangar's electricity delivery system would eliminate costly expenditures on auxiliary power unit maintenance, since the solar electricity would replace it as the power source. Further, any ground electric vehicles could be powered by solar electricity, as is the case in Hangar 25.

It would take about 10 months of fuel savings for the average hangar at Nellis AFB to cover the costs of remodeling given Hangar 25's construction cost of $276 per square foot. The remodeling cost could be even lower since Hangar 25 was newly constructed and the Nellis AFB hangars would be retrofitted.

The Air Force could achieve important energy security goals by following Hangar 25's program of reducing energy consumption and employing solar energy. For civilians, periodic blackouts and brownouts are at best an annoyance and at worst a catastrophe, as the 2003 blackout that affected eight northeastern U.S. states and a Canadian province makes clear. The consequences of even a brief power outage for a DoD installation could cause a national security crisis. Onsite generation would protect Air Force bases from fluctuations in the national grid, and extra power that might not be needed for the Air Force's own use could be sold to the local utility and serve as a source of revenue.

Annual fuel oil and electricity savings for 11 high-solar Air Force bases

Air Force bases would save millions on electricity and heating costs by using a solar electricity system.



Impediments to a cleaner Air Force

DoD's commitment to innovation holds great promise for broader energy reform. Dr. Richard Andres of the National Defense University notes that "The U.S. military is probably better at mobilizing action and committing funds to R&D than any organization in the world." Technology hurdles for clean energy and efficiency will require DoD to undertake significant research efforts, but it should not overlook the importance of energy reforms in both reducing costs and emissions.

Unfortunately, some state and local laws can stymie the most effective implementation of a high efficiency, solar-powered energy strategy at Air Force hangars. DoD facilities must coordinate with state utilities to build their own energy generation sources. In states with a renewable electricity/portfolio standard, DoD may have difficulty selling any renewable energy credits that it would generate from on-base wind or solar energy facilities.

There are also a number of technical challenges for deploying renewable energy at DoD installations, such as:

- Small generators of renewable energy typically have difficulty connecting to the conventional grid.
- Buildings on bases lack the capability to measure energy use, making it difficult to estimate exact energy needs.
- Photovoltaic panels' reflectivity and wind turbines that can interfere with radar.

Yet the fact that the Air Force is already a large consumer of renewable energy is clear evidence that such challenges can be overcome. Photovoltaic technology innovations can reduce reflectivity to safe levels, and the energy auditing of all federal buildings was mandated in the Energy Independence and Security Act of 2007. DoD research efforts will lead to even more solutions to these technological hurdles.

The many benefits of an efficient solar-energy building strategy form a strong argument for policy changes that promote clean-energy use. The Department of Energy should grant DoD a waiver from the current more restrictive energy policies mentioned above so it can apply these strategies at the hangars on solar-ready Air Force bases. Estimates indicate that this policy would affect just over half a percent of all Air Force buildings.

While the waiver that we propose here would apply to only a tiny fraction of Air Force buildings, solar energy projects need not be limited to the bases assessed in this proposal. A number of other bases, such as Buckley AFB in Colorado and Hill AFB in Utah, are also deploying solar energy installations to reduce their dependence on fossil fuels.

Recommendations for an Air Force clean hangar strategy

Hangar 25 demonstrates that large hangars can employ solar electricity and efficiency measures and save money. The first step in a clean hangar strategy for the Air Force should be a pilot program to retrofit hangars at an Air Force base with high solar energy potential that would yield the clearest evidence of the effectiveness of Hangar 25's measures at an AFB. The goal of the pilot program should be to retrofit hangars to meet LEED Platinum standards that employ the applicable sustainability measures used at Hangar 25.

Assuming that the pilot test succeeds the DoD should take the following steps to speed the deployment of these clean-energy technologies to other high solar potential AFB.

DoD and DOE collaborate on a "clean-energy task force"

Total costs for specific greening projects depend on several factors, and according to one assessment these include "building type, project location, local climate, site conditions, and the familiarity of the project team with sustainable design." The last factor—the project team—is the easiest to control. The Air Force should create a specialized "clean-energy task force" to guarantee maximum effectiveness and efficiency in greening projects. Such a team would be responsible both for the research studies on specific sites and the planning and implementation of projects.

DoD currently lacks the engineers and designers to make such improvements to military installations. A deliberate effort to create a clean-energy task force would solve this problem while creating jobs and saving on long-term facility energy costs. Hangar 25's example affirms the suitability of this approach: The project's integrated project delivery and building integrated modeling meant that construction costs and construction time for Hangar 25 were essentially equivalent to conventional hangars. The integrative design-build method for Hangar 25 ensured cost effective construction and demonstrated that an efficient solar-powered hangar is a cost competitive alternative.

Collaboration between DoD and the Department of Energy would be appropriate for this initiative. A precedent for such a partnership already exists with the DoD's Energy Security Task Force, whose stated purpose is "to define an actionable investment roadmap for lowering DoD's fossil fuel requirements and developing alternate fuels for use by the Department."

Employing clean-energy experts from architects to engineers in all aspects of project development and implementation would result in an effective integrated design model. This approach together with an integrated team process decreases the need for alterations during the construction process. Even in nongreen buildings, changes made in the course of a project necessitate change orders that "can increase the cost of designing a building by as much as 30 percent and total project cost by 10 percent."

Invest in projects in states that reward clean energy

It is no coincidence that the first solar-powered LEED-certified aviation facility in the country is located in California because the state has policies and programs that favor deployment of renewable energy sources. Nevada, where Nellis AFB is located, has an energy policy that also favors these sources, and a recently enacted law, S.B. 395, strengthens the initiatives for renewable energy development, building efficiency standards, and greenhouse gas reduction even more. Nevada's renewable portfolio standard—which requires utilities to produce a certain amount of energy from renewable sources—has included a specific mandate for solar energy since 1997, and the revision in S.B. 395 calls for 6 percent of the state's electricity from renewable sources to be from solar resources by 2016.

Finally, net metering laws such as those in California and Nevada encourage energy consumers to install renewable energy systems at home, resulting in lower energy bills and greenhouse gas emissions.

Air Force reforms would speed clean-energy projects

The Air Force Infrastructure Energy Strategic Plan identifies needed reforms in the planning, programming, and budgeting process to speed the development of energy infrastructure projects. The plan proposes a strategy that begins with identifying energy requirements for individual facilities, and secures funding via public investment through Air Force appropriations and private sector financing from public-private partnerships. Changes in accounting and budgeting practices, as well as incentives, will require adjustments to congressional appropriations for military facilities.

In FY 2008 the Air Force established an energy management and strategic investment mechanism to utilize public funding most effectively. Key goals include creating policy and procedures for reinvestment of funds saved through energy conservation. Another of the program's stated objectives is a partnership with DOE designed to encourage the use of renewable energy on Air Force bases.

Use smart solar financing tools

One difficulty with government-funded initiatives is the restriction on the types of investments DoD can make, especially for money saved on reduced energy consumption. These restrictions make third-party financing through the private sector an attractive option, and the Air Force has identified a number of ways to raise these funds. The Booz Allen Hamilton report focused on one of the options, enhanced use leases. Other possibilities are energy savings performance contracts, utility energy service contracts, and standard leases. All of those options use private party market investments, and they all create incentives for increasing energy efficiency. Both the government and the third-party financiers profit from the arrangements.

MMA Renewable Ventures, which owns the solar array at Nellis AFB, financed the installation with a standard lease of the federally owned land on the base. Under the arrangement Nellis AFB purchases power from MMA Renewable Ventures through a power purchase agreement under a 20-year contract. As part of the agreement with the state utility, MMA Renewable Ventures sells renewable energy credits to Nevada Power. The Nevada renewable energy standard sets a target for 20 percent of electricity sales to come from renewable sources by 2015, and the arrangement between MMA, Nevada Power, and Nellis AFB helps to meet the state target. According to the procurement briefing for Nellis AFB's solar array, the source selection team for the project carefully assessed the financing options over a multiyear period before deciding on the most appropriate one.

Small projects could play a big role

Small-scale renewable energy projects also have an important role to play in expanding renewable energy use in the Air Force. Small installations can provide valuable learning opportunities for Air Force officials that can facilitate future larger development opportunities, and they start setting in place the technical infrastructure that is needed.

Smaller investments are also suitable for locations that have fewer renewable resources, and smaller deployments may be possible even in areas not noted for a particular renewable resource. At Hill AFB in northern Utah, a new ground-based photovoltaic array system officially came online at the end of June 2009. The 1,400 solar panels have a 230 kW electricity generation capacity, enough to power 25 homes per year. Hill AFB is identified in the Booz Allen Hamilton report as having high wind energy potential, but the report doesn't consider the base's solar resource.

Conclusion

The Air Force deserves recognition for its steps to increase its energy efficiency and the amount of renewable energy it uses. But like the rest of the American economy, such efforts are long overdue and must be accelerated.

The Air Force must be creative and innovative to meet its goals of boosting renewable energy use, cutting costs, and increasing energy security. Making efficiency a priority is critical to reducing its future energy bills, and using solar energy to expand renewable energy use will likewise make it less vulnerable to the rising cost of fossil-fuel based energy. The installation of highly energy efficient technologies on Air Force bases is a crucial first step in reducing consumption, and the greatest reductions can occur at hangars that are at a LEED platinum level.

To speed and smooth this transition the Air Force must undertake a pilot project to convert a base with high solar energy potential to a high-efficiency solar-powered facility such as Hangar 25, and collaborate with the Department of Energy to evaluate and replicate this project. Assuming the project succeeds the Air Force should focus on hangar conversion projects in states that reward clean energy, use effective solar financing vehicles, and undertake small projects first to demonstrate that this approach will succeed.

Methodology

The data for the reduced energy consumption and emissions of Hangar 25 is available on the facility's official website in the "eco-charts" of the "Green Aspects" section.

To obtain data on the number and sizes of hangars on the 18 Air Force Bases identified with high solar energy potential, CAP filed Freedom of Information Act requests with each base. Responses were received from only 11 bases due to either a lack of hangars on some of the bases or failure to respond based on security reasons.

To estimate the energy savings that could result from implementing fuel efficiency measures similar to those at Hangar 25, the ratio of each Air Force hangar size and Hangar 25 was used to estimate the proportionate reductions in coal, natural gas, fuel oil, and electricity consumption as well as carbon dioxide pollution reductions. To estimate electricity cost savings, the average 2007 electricity price per kilowatt-hour according to the Energy Information Administration for each state in which the bases are located was multiplied by the estimated kilowatts saved per hangar.

For airplane fuel cost savings, the specific aircraft at Nellis AFB were compared with those at Hangar 25. There are 113 permanently assigned aircraft at Nellis AFB. A review of the aircraft types found that on average, the dimensions of the planes were half the equivalent size of a Boeing 737, which is the type of aircraft housed in Hangar 25. Fuel use reductions were calculated by converting total annual fuel oil reductions for the three airplanes of Hangar 25 to the 113 airplanes at Nellis AFB at half the fuel savings per plane.[9] Carbon emissions reductions were similarly calculated. The average price of jet fuel for 2008 according to EIA was used to determine the estimated savings in costs that would result from the elimination of jet fuel use for ground operations.

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Endnotes

1 Office of the Assistant Secretary of Defense, Energy Conservation Investment Program Guidance, available at http://www.acq.osd.mil/ie/fim/library/ECIPINST.pdf (last accessed May 2009).

2 Booz Allen Hamilton, "Renewable Energy Enhanced Use Lease Opportunity Summary Report" (August 2007).

3 The owner of Shangri-La Construction is a donor to the Center for American Progress.

4 Pumping water to Southern California consumes 20 percent of California electricity.

5 This data was generated from Freedom of Information Act requests to all 18 bases identified in the study. Eleven bases responded to this request.

6 Hangars eligible for retrofitting with solar panels must be capable of holding photovoltaic panels. The average weight of a typical photovoltaic installation is 2.5 pounds per square foot. Hangar buildings whose roofs are not currently able to handle the weight would require renovation.

7 The savings for the Air Force are based on the energy savings of Hangar 25, but actual savings may vary due to the different climatic conditions and variation of electricity fuel mixes from one location to the next. Cost savings are estimated for electricity and fuel oil, and reduction of other fuels would result in further energy bill reductions.

8 We estimated jet fuel savings only at Nellis AFB because there was data available about its planes and their fuel consumption.

9 This estimate is illustrative, rather than definitive, because of other important differences between civilian and military aircraft.

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