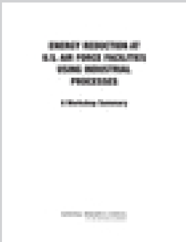

Energy Reduction at U.S. Air Force Facilities Using Industrial Processes: A Workshop Summary

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Gregory Eyring, Rapporteur; Committee on Energy Reduction at U.S. Air Force Facilities Using Industrial Processes: A Workshop; Air Force Studies Board; Division on Engineering and Physical Sciences; National Research Council

Energy Reduction at U.S. Air Force Facilities Using Industrial Processes

A Workshop Summary

Gregory Eyring, Rapporteur

Committee on Energy Reduction at U.S. Air Force Facilities Using Industrial Processes: A Workshop

Air Force Studies Board

Division on Engineering and Physical Sciences

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COMMITTEE ON ENERGY REDUCTION AT U.S. AIR FORCE FACILITIES USING INDUSTRIAL PROCESSES: A WORKSHOP

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Preface

The Air Force recognizes that energy is a strategic issue for the United States. To assist the Air Force in addressing this issue, the Air Force Studies Board (AFSB) of the National Research Council (NRC) drafted terms of reference (TOR) in April 2012 for a short workshop to bring together Department of Defense stakeholders and representatives of industry in order to highlight current approaches to industrial process energy with a goal of highlighting potential ways to reduce Air Force industrial process energy consumption.[1] The Deputy Assistant Secretary of the Air Force for Energy, Kevin Geiss, approved the TOR in April 2012 and the NRC approved the TOR in July 2012. The NRC then established the Committee on Energy Reduction at U.S. Air Force Facilities Using Industrial Processes: A Workshop to conduct a workshop, and the 3-day workshop was held on November 5-7, 2012.

The committee appreciates the support of Dr. Kevin Geiss, Deputy Assistant Secretary of the Air Force for Energy, who articulated a clear set of objectives for the workshop, and that of his staff. In addition, the committee thanks the many expert speakers and guests who contributed immensely to this undertaking. Finally, the committee's role was limited to planning the workshop. This workshop summary has been prepared by the workshop rapporteur as a factual summary of what occurred at the workshop.

Kenneth E. Eickmann, *Chair*
Committee on Energy Reduction at U.S. Air Force Facilities Using Industrial Processes: A Workshop

[1]Since 2006 the AFSB has produced several reports related to Air Force energy consumption, including the following, published by the National Academies Press, Washington, D.C.: *A Review of United States Air Force and Department of Defense Aerospace Propulsion Needs* (2006); *Improving the Efficiency of Engines for Large Nonfighter Aircraft* (2007); and *Examination of the U.S. Air Force's Aircraft Sustainment Needs in the Future and Its Strategy to Meet Those Needs* (2011). All are available at www.nap.edu.

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Daniel E. Hastings, Massachusetts Institute of Technology,
Gwen P. Holdmann, Alaska Center for Energy and Power,
Mark J. Lewis, IDA Science and Technology Policy Institute,
Lawrence T. Papay, PQR, LLC,
James B. Porter, Jr., Independent Consultant,
Maxine L. Savitz, Honeywell, Inc. (retired), and
Rebecca A. Winston, Winston Strategic Management Consulting.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the views presented at the workshop, nor did they see the final draft of the workshop summary before its release. The review of this workshop summary was overseen by Wesley L. Harris, Massachusetts Institute of Technology. Appointed by the NRC, he was responsible for making certain that an independent examination of this workshop summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this summary rests entirely with the author and the institution.

Contents

Acronyms and Abbreviations

AFB	Air Force Base
AFIT	Air Force Institute of Technology
AFMC	Air Force Materiel Command
AFRL	Air Force Research Laboratory
AFSC	Air Force Sustainment Center
ALC	Air Logistics Complex
AMC	Army Materiel Command
AMO	Advanced Manufacturing Office
AMRS	advanced meter-reading system
APTO	Advanced Power Technology Office
Btu	British thermal unit
CE	civil engineering
CII	Construction Industry Institute
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
EISA	Energy Independence and Security Act of 2007
EO	Executive Order
EPACT	Energy Policy Act of 2005
ESPC	Energy Savings Performance Contract
FEMP	Federal Energy Management Program
FY	fiscal year
GM	General Motors
HVAC	heating, ventilation, air conditioning
IPE	industrial process energy
MAJCOM	Major Command

MW	megawatt
MWh	megawatt-hour
NRC	National Research Council
O&M	operations and maintenance
POM	Program Objective Memorandum
PV	photovoltaic
R&D	research and development
R&M	restoration and maintenance
UESC	Utility Energy Service Contract
USAF	U.S. Air Force
WAGES	water, air, gas, electricity, steam

Overview

The Department of Defense (DoD) is the largest consumer of energy in the federal government.[1] In turn, the U.S. Air Force is the largest consumer of energy in the DoD, with a total annual energy expenditure of around $10 billion.[2] Approximately 84 percent of Air Force energy use involves liquid fuel consumed in aviation whereas approximately 12 percent is energy (primarily electricity) used in facilities on the ground.[3] This workshop was concerned primarily with opportunities to reduce energy consumption within Air Force facilities that employ energy-intensive industrial processes—for example, assembly/disassembly, painting, metal working, and operation of radar facilities—such as those that occur in the maintenance depots and testing facilities. Air Force efforts to reduce energy consumption are driven largely by external goals and mandates derived from Congressional legislation and executive orders. To date, these goals and mandates have targeted the energy used at the building or facility level rather than in specific industrial processes.

In response to a request from the Deputy Assistant Secretary of the Air Force for Energy and the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering, the National Research Council, under the auspices of the Air Force Studies Board, formed the Committee on Energy Reduction at U.S. Air Force Facilities Using Industrial Processes: A Workshop. The terms of reference called for an ad hoc committee to plan and convene one 3-day public workshop to discuss: (1) what are the current industrial processes that are least efficient and most cost ineffective? (2) what are best practices in comparable facilities for comparable processes to achieve energy efficiency? (3) what are the potential applications for the best practices to be found in comparable facilities for comparable processes to achieve energy efficiency? (4) what are constraints and considerations that might limit applicability to Air Force facilities and processes over the next ten (10) year implementation time frame? (5) what are the costs and paybacks from implementation of the best practices? (6) what will be a

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[1]Col Douglas Wise, Chief, CE Operations and Readiness Division, HQ AFMC/A70, "AFMC Facility Energy Program," presentation to the workshop on November 5, 2012.

[2]Ibid.

[3]Ibid. The workshop focused on the approximately 12 percent of Air Force energy consumed by facilities.

proposed resulting scheme of priorities for study and implementation of the identified best practices? (7) what does a holistic representation of energy and water consumption look like within operations and maintenance?[4]

In short, the purpose of this workshop was not an in-depth analysis of energy reduction opportunities in all of the industrial processes being used at Air Force facilities, though some of the presentations touched upon opportunities in specific industrial operations (e.g., painting of vehicles at General Motors). Instead, the workshop participants reviewed and discussed the status of energy reduction initiatives already taken or planned, and discussed ways in which the Air Force could improve its approach in order to address the use of industrial process energy more effectively.

Most of the participants who spoke at the workshop indicated that the Air Force has a solid overall energy strategy, and that the representatives from the Air Force maintenance and test depots who attended the workshop have a nuanced and well thought out understanding of: (1) energy usage in general; (2) process energy, in particular; and (3) opportunities for addressing associated challenges without impact to the Air Force mission. It was the opinion of many in the workshop that with the right vision from leadership and access to resources, the facility managers the participants heard from are well positioned to implement improvements. The discussion focused on opportunities in seven areas: (1) management and leadership; (2) budgets and funding; (3) information resources; (4) metrics; (5) culture change; (6) personnel and training; and (7) investment opportunities.

MANAGEMENT AND LEADERSHIP

To most participants who spoke at the workshop, it appeared that the Air Force has a solid overall energy strategy, and that the representatives from bases such as Arnold Air Force Base and Tinker Air Force Base have a nuanced and well thought out understanding of energy usage in general and process energy and opportunities for addressing the associated challenges without impact to the mission. With the right vision from leadership and access to resources, the facility managers that workshop participants heard from appear to be well positioned to implement improvements.

BUDGETS AND FUNDING

No Air Force budget line is specifically devoted to energy. Several participants expressed that these diverse sources tend to lead to a fragmented, ad hoc approach to energy projects that lacks a long-term vision, is sub-optimized, and can lead to "color-of-money" constraints. Those participants generally felt that the Air Force use of Energy Savings Performance Contracts, per presidential order, is a good mechanism for

[4]Finally, it is important to note that this rapporteur-authored workshop summary does not contain consensus findings and recommendations, which are produced only by ad hoc NRC study committees.

providing funding for infrastructure and efficiency improvements in the absence of other funding sources. They accomplish the goal of reducing energy usage (intensity), although they do not result in cost savings to the Air Force over the near term and may actually result in cost increases if a contract needs to be “bought out” due to base closure or shifting priorities. Nonetheless, absent other funding sources, they appear to be a valid mechanism and worth implementing.

INFORMATION RESOURCES

Several participants noted that Air Force personnel should look for opportunities to identify which processes offer the biggest energy reduction return on investment (ROI) and to leverage what they know and how they do what they do through collaboration and networking with subject matter experts and consortia of organizations concerned with making processes better, faster, cheaper, safer, and more energy-efficient. Several participants noted that the Air Force Research Laboratory (AFRL) is well positioned to help the Air Force improve its energy usage and has published a description of its energy focus. However, it appeared to several participants that the relationship between the depots and AFRL is limited. They felt that AFRL could be tasked with helping the depots. This tasking would be consistent with a focus on next-generation technologies. Improvement of industrial processes is a fertile field for innovative engineering research.

METRICS

Several participants agreed that the Air Force would benefit if it had a coherent and transparent set of metrics that related energy use to the accomplishment of the mission—the desired metric for making a value proposition to decision makers and commanders. For industrial processes, this might be energy used per unit of product (e.g., General Motors uses MWh per vehicle). One way of accounting for surges in activity might be to normalize existing energy intensity metrics to the number of direct labor hours. Many participants felt that the Air Force should consider concentrating more effort on developing a set of metrics that permit it to improve its mission capability while lowering energy use and cost.

CULTURE CHANGE

Culture change needs to occur throughout the organization, and must be supported by the upper level of leadership. Many participants felt that the Air Force is making good progress toward metering individual facilities; however it is imperative that the information get back to the individual users of that facility who are in the best position to enact small, incremental changes. The Air Force estimates that behavior change can result in a 2 percent improvement in energy usage for buildings. However, one participant stressed that the overarching goal should be toward a culture shift at all levels of the organization—culture being defined as behaviors that individuals engage in even when no one is looking.

PERSONNEL AND TRAINING

Many participants expressed that it is important that individuals at all levels of management and responsibility are aware of the importance of addressing energy security/surety and costs, and that, at times, improving efficiency and reliability can result in enhancement to the mission. Some participants suggested that having mandated energy training throughout the Air Force might be a driver toward greater understanding of the problem. For example, classes are offered by the Air Education and Training Command. Another suggestion was for process managers to have energy efficiency written into their job description and performance evaluations and receive appropriate training. A key target for improving energy awareness is the acquisition community, to get life cycle energy use to be one of the criteria on which acquisition decisions are made.

INVESTMENT OPPORTUNITIES

Several speakers noted that the civil engineering (CE) community has shown the Air Force that energy reduction projects are a good investment—typically returning $2 in savings for every $1 invested. One speaker noted that specific processes such as painting offer opportunities for improvement (as the General Motors presentation showed) but there is no budget for it. The CE community typically does not own either the industrial process or the budget. Participants noted that other processes that are good candidates for efficiencies are those that generate or transfer heat or involve rotating equipment. One participant noted several potential areas for future Air Force investment:

- Work process design and associated training and audit protocols focused on business effective energy management.
- Standardization of all common, repetitive processes such as machining, parts/equipment cleaning, painting, etc. across all sites.
- Engineering evaluation of rotating and heat exchange equipment to establish life cycle energy use and operating costs.
- Formal assessments of current operations vs. standard protocol to identify short and long-term improvement actions and projects (see Appendix E for possible areas to consider).

1

Introduction

The Department of Defense (DoD) is the largest consumer of energy in the federal government at approximately $20 billion in 2011.[1] In turn, the U.S. Air Force is the largest consumer of energy in the DoD, with a total annual energy expenditure around $10 billion.[2] As shown in Figure 1-1, about 84 percent of Air Force energy is liquid fuel consumed in aviation, and about 12 percent is energy (primarily electricity) used in facilities on the ground. However, the facilities of some Air Force commands consume a comparatively high proportion of their command's total energy. For example, in the Air Force Materiel Command (AFMC), 84 percent of energy consumption occurs in facilities (at a cost of $300 million) and only 13 percent is consumed in aviation.[3,4]

INDUSTRIAL PROCESS ENERGY

This workshop was concerned primarily with opportunities to reduce energy consumption within Air Force facilities, and particularly to reduce consumption of "process energy,"[5] whichincludes energy used in industrial and test operations, laboratories, medical facilities, and data centers. A key focus of the workshop is a subset

[1]Col Douglas Wise, Chief, CE Operations and Readiness Division, HQ AFMC/A70, "AFMC Facility Energy Program," presentation to the workshop on November 5, 2012.

[2]Ibid.

[3]Ibid.

[4]AFMC's primary mission is supporting weapon system acquisition. This is in contrast to Air Combat Command, a separate Air Force Major Command, which devotes much more resources to aviation-related energy. SOURCES: AFMC Factsheet. Available at http://www.af.mil/information/factsheets/factsheet.asp?id=143. Accessed January 23, 2013. Air Combat Command Factsheet. Available at http://www.af.mil/information/factsheets/factsheet.asp?id=137. Accessed January 23, 2013.

[5]Air Force Instruction 90-1701 defines "process energy" as "Energy directly consumed in manufacturing, maintenance, equipment overhaul, rehabilitation or refurbishment, destruction, warehousing, and similar processes, not related to the comfort and amenities of the occupants of the facility."

of process energy termed "industrial process energy" (IPE), which includes the energy-intensive industrial processes that occur within Air Force facilities, such as the following:

- Assembly and disassembly
- Avionics testing
- Engine testing
- Composite construction
- Chemical cleaning
- Heat treating
- Painting and de-painting
- Plating
- Metalworking
- Nondestructive inspection

IPE has been defined as "energy consumed by high-intensity processes or mission-critical applications that are not the traditional creature comforts of the building (e.g., heating, cooling, lighting, and domestic hot water)"[6] as shown

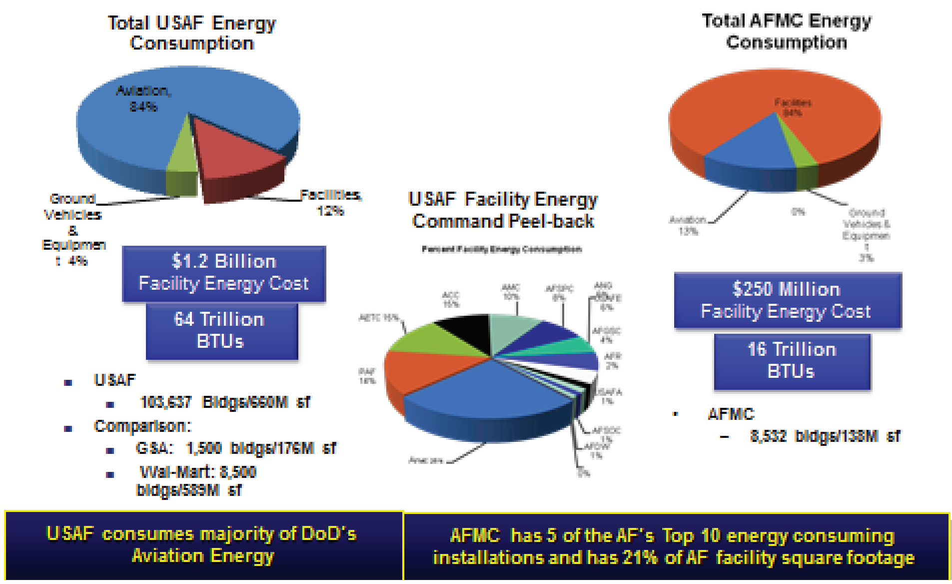

FIGURE 1-1 Breakdown of energy usage in the U.S. Air Force (USAF) and the Air Force Materiel Command (AFMC). NOTE: GSA, General Services Administration; sf, square feet. SOURCE: Col Stephen Wood, Vice Commander, 72nd Air Base Wing, presentation to the workshop, November 5, 2012, Washington, D.C.

[6] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Federal Energy Management Program.

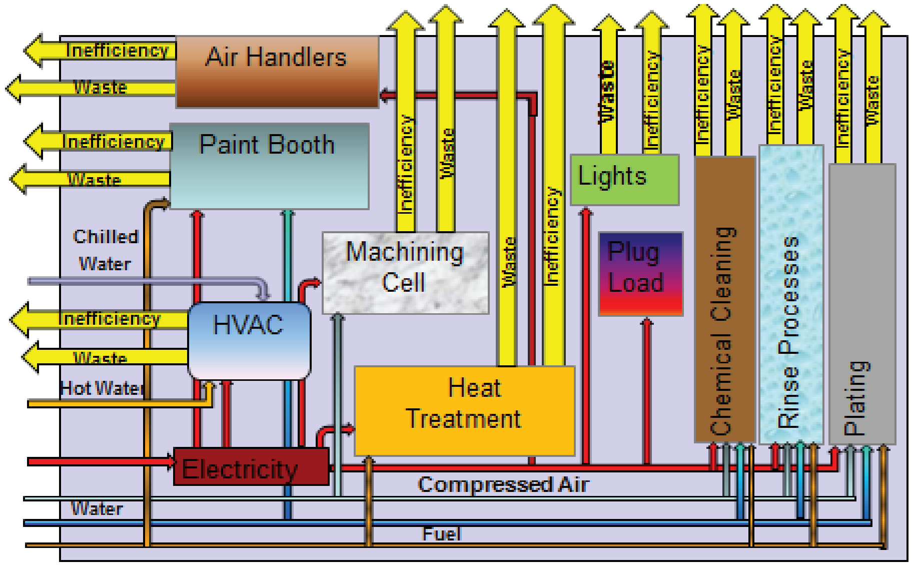

FIGURE 1-2 Examples of industrial process energy use and opportunities to improve efficiency. NOTE: HVAC, heating, ventilation, air conditioning. SOURCE: Col Douglas P. Wise, HQ AFMC A70, presentation to the workshop, November 5, 2012, Washington, D.C.

schematically in Figure 1-2. An estimated 35-50 percent of AFMC's energy consumption at its Air Logistics Complexes (ALCs) is process energy—primarily industrial process energy. Thus, although IPE is not a large fraction of overall Air Force energy use (approximately 1 percent) and has received relatively little attention, investments in IPE efficiency are expected to yield high rates of return. These reductions in energy use enhance overall Air Force energy security; the savings can be applied to enhance mission capability in other areas.

ENERGY REDUCTION GOALS AND MANDATES

The efforts of the Air Force to reduce energy consumption are driven largely by external goals and mandates derived from congressional legislation—the Energy Policy Act of 2005 (EPACT) (Public Law No. 109-58) and the Energy Independence and Security Act of 2007 (EISA) (Public Law No. 110-140)—and Executive Order 13423 (EOs), shown in Figure 1-3. To date, these goals and mandates have targeted the energy used in facilities only and not the larger amount used in aviation operations. The primary metric used in setting the goals is energy intensity, as measured in British thermal units (Btu) per square foot of facility space. The goal for facility energy is an intensity reduction of 3 percent per year from 2003 to 2015. The Air Force has made considerable progress toward its goals, having invested hundreds of millions of dollars ($274 million in FY 2011) in projects that have reduced facility energy intensity by 16 percent since the base year, 2003.[7] However, as shown in Figure 1-4, AFMC efforts are expected to fall short of the goal of a 30 percent reduction by 2015. Unless changes are made in the way that AFMC operates, targets, and funds energy-efficiency projects, the gap between goals and performance in 2015 is expected to be approximately 14 percentage points. Each additional percent of energy-intensity reduction is estimated to require an investment of $100 million. The AFMC is looking at reducing its use of industrial process energy as a way to help reach its facility energy-reduction goals.

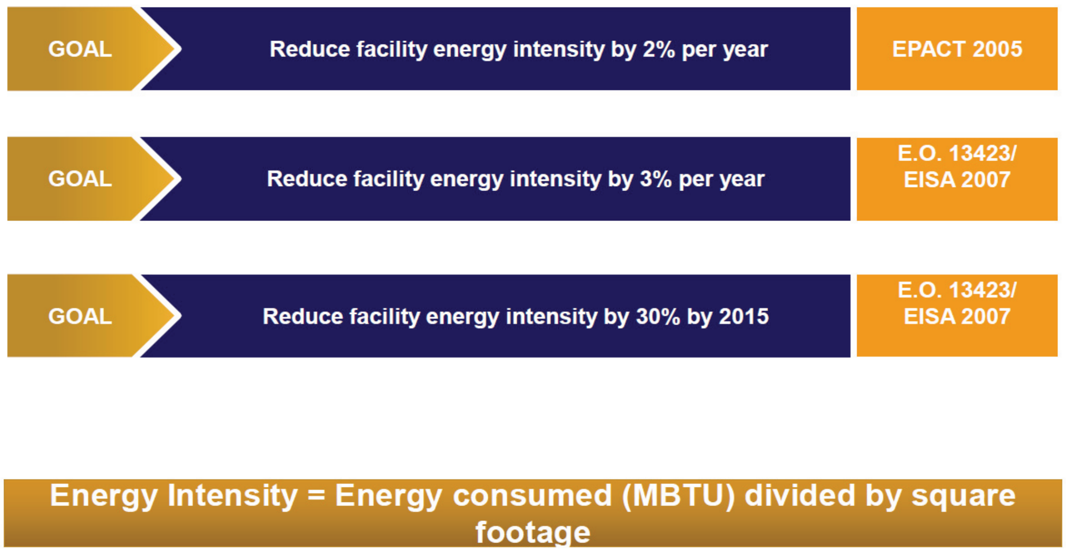

FIGURE 1-3 Mandates and goals for reducing energy intensity in U.S. Air Force facilities. NOTE: EPACT, Energy Policy Act; E.O., Executive Order; EISA, Energy Independence and Security Act. SOURCE: Kevin Geiss, Deputy Assistant Secretary for Energy, U.S. Air Force, presentation to the workshop, November 5, 2012, Washington, D.C.

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[7] Kevin Geiss, Deputy Assistant Secretary of the Air Force for Energy, "National Academies Workshop: Energy Reduction at Air Force Facilities Using Industrial Processes," presentation to the workshop on November 5, 2012.

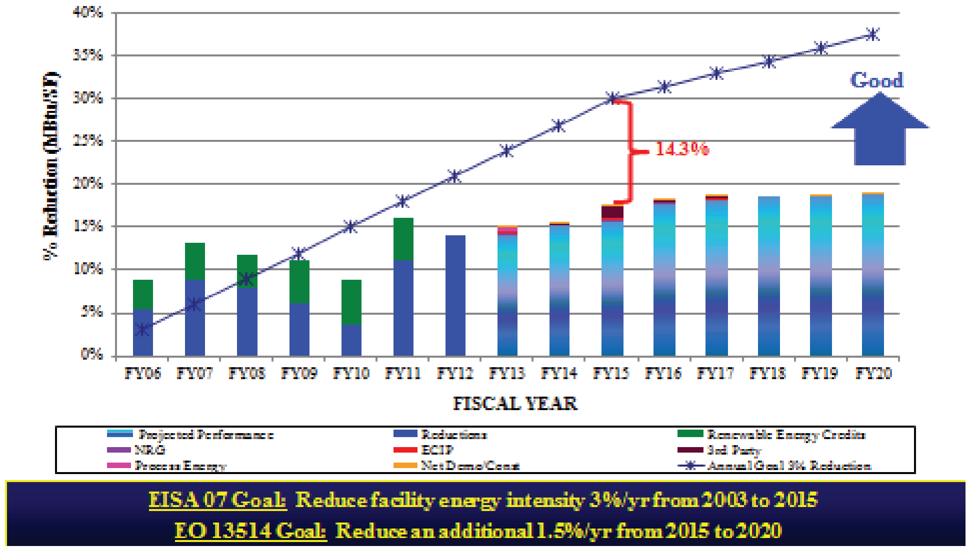

FIGURE 1-4 The gap between mandated reduction in energy intensity at Air Force Materiel Command (AFMC) facilities and actual performance is expected to increase. NOTE: NRG, Energy Conservation Initiative; ECIP, Energy Conservation Investment Program; EISA, Energy Independence and Security Act; EO, Executive Order; SOURCE: Col Douglas Wise, HQ AFMC A70, presentation to the workshop, November 5, 2012, Washington, D.C.

WATER CONSUMPTION GOALS AND MANDATES

In addition to reducing energy intensity at Air Force facilities, another area that the Air Force is targeting for efficiency is fresh-water use. In the United States, water is relatively cheap compared to electricity, but at facilities located on islands or forward operating bases, water must be brought in at great expense. Furthermore, in the next 10 to 20 years, access to potable water is expected to increasingly become an issue. Executive Order 13514 has set a goal of reducing water use by certain federal agencies by 2 percent per year from 2007 to 2020.[8] The Air Force is relatively comfortable with its progress in meeting this goal at the moment, but it recognizes that energy use and water use are often interconnected, and it is interested in developing an integrated plan for meeting its energy- and water-reduction goals.

[8]For additional information on Executive Order 13514, *Federal Leadership In Environmental, Energy,And Economic Performance*, see http://www.whitehouse.gov/assets/documents/2009fedleader_eo_rel.pdf. Accessed January 11, 2013.

WORKSHOP TERMS OF REFERENCE

In April, 2012, the Air Force Deputy Assistant Secretary for Energy requested that the National Research Council (NRC) conduct a workshop titled "Energy Reduction at Air Force Facilities Using Industrial Processes," and produce a summary report. The terms of reference (TOR) for this workshop are shown in Box 1-1.

BOX 1-1

Terms of Reference

An ad hoc committee will plan and convene one 3-day public workshop to discuss: (1) what are the current industrial processes that are least efficient and most cost ineffective? (2) what are best practices in comparable facilities for comparable processes to achieve energy efficiency? (3) what are the potential applications for the best practices to be found in comparable facilities for comparable processes to achieve energy efficiency? (4) what are constraints and considerations that might limit applicability to Air Force facilities and processes over the next ten (10) year implementation time frame? (5) what are the costs and paybacks from implementation of the best practices? (6) what will be a proposed resulting scheme of priorities for study and implementation of the identified best practices? (7) what does a holistic representation of energy and water consumption look like within operations and maintenance?

The committee will develop the agenda for the workshop, select and invite speakers and discussants, and moderate the discussions.

The topics at the workshop will also consider effective strategies and business approaches to foster culture change and select technology portfolios that could reduce infrastructure energy and water consumption and increase resilience at military installations while assuring energy for mission critical capabilities across the Department of Defense. Special attention will be given to installations that have antiquated facilities, massive industrial processes, and demolition/consolidation opportunities. The workshop will use a mix of individual presentations and question-and-answer sessions to develop an understanding of the relevant issues. Key stakeholders would be identified and invited to participate. One individually authored Workshop Summary document will be prepared by a designated rapporteur.[1]

[1] Finally, it is important to note that this rapporteur-authored workshop summary does not contain consensus findings and recommendations, which are produced only by ad hoc NRC study committees.

WORKSHOP STRUCTURE, SCOPE, AND APPROACH

This 3-day workshop, which took place November 5-7, 2012, in Washington, D.C., consisted of a series of presentations to workshop participants by invited speakers (the workshop agenda is provided in Appendix B), with each presentation followed by general discussion. Broadly, the first day was devoted to presentations on energy-reduction efforts by the Air Force and the other services, the second day to presentations on commercial industry initiatives, and the third day to discussion among all participants.

It quickly became apparent that neither the expertise represented nor the time available would permit an in-depth analysis of energy-reduction opportunities in all of the industrial processes being used at Air Force facilities, as outlined in the first paragraph of the TOR (see Box 1-1). Although some of the presentations—especially those by industry representatives—touched on energy-reduction opportunities in specific industrial operations (e.g., the painting of vehicles at General Motors), most dealt with energy-reduction initiatives, programs, information resources available, and strategies for implementing culture change with respect to how energy is used in the Air Force.

2

Presentations and Comments

The workshop participants heard a series of presentations on energy-conservation efforts within the military services and in private-sector companies representing the aircraft, chemical, automobile, and armaments industries (see the workshop agenda, Appendix B). Abstracts of these presentations are provided in Appendix D. A brief summary of the main points of the presentations and the ensuing discussion is given next, in chronological order of presentation.

MONDAY, NOVEMBER 5, 2012

Kevin Geiss, Deputy Assistant Secretary of the Air Force for Energy

Kevin Geiss, Deputy Assistant Secretary of the Air Force for Energy, presented the primary motivation for reducing energy consumption—to support the Air Force mission. He discussed the Air Force's three-fold strategy: (1) reduce demand, (2) increase supply, and (3) change the culture, and noted progress toward the goals shown in Figure 1-3 in Chapter 1. A key need is to install meters to provide data on electricity use with finer precision so that they can determine what specific processes and equipment are using the energy and where the major opportunities are. Each facility's energy use is unique and dynamic as workloads change. Furthermore, Geiss noted, culture change takes time. Personnel need to be encouraged to be innovative and must receive appropriate training to be able participate effectively in efforts aimed at reducing energy consumption. Without more data on energy use, "You don't know what you don't know." The question was raised as to whether there is any evidence that installation of smart meters actually results in energy savings. The biggest gains may require automated energy management control systems—that is, going beyond just providing data for energy analysis.

Joseph Sikes, Director of Facilities Energy Privatization, Office of the Deputy Under Secretary of Defense for Installations and Environment

Joseph Sikes, Director of Facilities Energy Privatization, Office of the Deputy Under Secretary of Defense for Installations and Environment, emphasized the main objective of Department of Defense (DoD) energy projects—to do the mission better. Recent initiatives have included expanding the use of renewables, installing microgrids, and technology development. At the end of the year, all of the military services will report data on energy use. This information will be put into an online database to increase visibility. An annual energy management report is expected to be released in March 2013, in which all bases will be listed by energy-intensity and energy-reduction targets. Sikes noted that facilities use 20 to 25 percent of DoD energy. The energy-intensity metric (British thermal units per square foot) is far from ideal, but “one we are stuck with.” Unless it is adjusted for changes in external factors, it can give the wrong answer. For instance, when soldiers return from deployments overseas, energy use on U.S. bases goes up, even if the buildings have become more efficient. In that case, British thermal units per person would be a better metric. Also, consolidation of data centers or demolition of unneeded buildings, which can be desirable from an efficiency point of view, reduces the overall square footage and therefore increases the energy-intensity metric. Most of the direct spending on energy within DoD is on expanding renewable-energy projects. In principle, renewables provide a distributed source of energy at a base, and so a base is more secure in a crisis if it is set up so that it can be switched from the grid to a local microgrid on the base. Unfortunately, we are not there yet, and the renewable projects do not pay back the investment unless the bases are on islands (e.g., Kwajalein, Shemya, Diego Garcia) or are otherwise difficult to supply (e.g., Djibouti).

Sikes related that considerable gains in reducing energy use can be made just by gridding the generators on a base so that energy output can be tuned to the electricity demand. The Navy has done considerable work on optimal gridding of shipboard generators. Another opportunity involves peak shaving and demand-side management, in which bases can save a lot of money by working with local utilities. He also noted that there is a memorandum of understanding among major federal agencies (including the Department of Energy [DOE], the DoD, and the Department of Homeland Security) to promote emergency-management cooperation with local authorities, and that military bases are working more closely with government and private entities outside the base. If closer cooperation could be established between the DoD, local energy utilities, and federal regulators of local utilities, then some of these costs could be reduced at many installations. The local utilities are not depending on the fees from the bases, but they have to keep a higher capacity level by law because the solar capacity is not counted.

One participant noted that the metric for renewable energy—the quantity procured or produced divided by total energy—does not actually address either energy reduction or energy security. It is important to review this metric so that it does not cause unintended consequences. Another observer noted that although the acquisition of new military systems and equipment provides a unique opportunity to consider life-cycle energy efficiency, there is currently no directive to the acquisition community to enable serious investment in energy reduction. Stated differently, this not just as an investment in energy reduction, but as part of the life cycle cost of purchasing and operating the equipment, rather than just the capital cost for it. More efficient equipment is often more costly upfront, but less expensive when considering the full lifecycle costs. Energy considerations need to be threaded throughout the business analysis in acquisition decisions, and they need to be codified in guidance that carries weight.

Paul Bollinger, Director, Boeing Energy

According to the presentation by Paul Bollinger, Director, Boeing Energy, Boeing takes a life-cycle approach to reducing its environmental footprint—including that related to energy consumption, greenhouse gases, water consumption, hazardous waste, and solid waste. It has an integrated management system for measuring and reporting on progress, with a roll-up that can focus on sites, regions, or enterprise-wide results. “It comes down to culture,” he said. More than 6,000 employee-involvement teams meet once per week. Boeing received the 2012 Environmental Protection Agency Energy Star Partner of the Year award. Its chief executive officer is publicly committed to conserving energy, and its energy consumption has decreased since the base year 2007 despite increased production of aircraft.

The discussion after the presentation explored Boeing’s motivations for reducing energy. Boeing’s 787 aircraft is sold in part for its fuel efficiency. By extension, customers are also looking at the production efficiency. Commercial airlines focus on energy efficiency, which is tracked for each pilot and aircraft tail number. Significant savings have been achieved simply by adjusting the center of mass of the aircraft for optimum efficiency. Bollinger noted that the military does not have the same financial motivation as that of a commercial enterprise. He observed that support for energy conservation comes and goes in the various military services and that officers need to be held accountable for making progress on the energy front. Big fuel savings are possible when equipment is replaced—for example, when the Joint Surveillance Target Attack Radar System program transitioned to the more efficient Boeing 737 aircraft.

Col Douglas Wise, Chief, Civil Engineering Operations and Readiness Division, HQ AFMC/A70

Five of the top 10 energy-consuming installations in the Air Force are within AFMC, including the three air logistics complexes (ALCs): Oklahoma City ALC, Oklahoma (#1), Ogden ALC, Utah (#3), and Warner Robins (ALC), Georgia (#7). Col Douglas Wise, Chief, Civil Engineering Operations and Readiness Division, Headquarters Air Force Materiel Command (AFMC), estimated that for AFMC to reach its energy-reduction goals in FY 2015 would require investing the entire operations and maintenance (O&M) budget of the Air Force. Installations are not able to keep the money that they save with from energy-reduction investments, and so they have less incentive to make these investments. An ongoing point of friction is that of relating energy savings to the mission—for example, how does a 1 percent energy saving affect the mission?

FY 2010 saw the first standardized reporting of energy intensity, in the form of standard spreadsheets that could be shared with all installations. Water use is not currently metered, but the goal is to do so in the 2015-2016 time frame. Several potential sources of money, or "colors of money," are available to fund energy projects. These include O&M ("3400" funds); research, development, testing, and evaluation ("3600" funds); and capital investment funds. These funding sources are not fungible—that is, one cannot use 3400 funds for projects at test facilities. In FY 2009, focus funds (approximately $200 million per year) were set aside in the O&M budget for energy-related projects, and the Major Commands (MAJCOMs) were asked to submit project proposals with estimated returns on investment. In addition, Energy Savings Performance Contracts (ESPCs), which fall under Executive Order,[1] and Utility Energy Service Contracts (UESCs), in which third-party companies come in and do projects to improve a facility for a fixed fee, are options available to the Air Force. In that case, the company owns and maintains the infrastructure and captures any long-term profits. Col Wise estimated that the private sector (e.g., Wal-Mart) invests about 3 to 4 percent of its budget in renewing its infrastructure, whereas the DoD/Air Force invests about 1 percent.[2]

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[1]For additional information, see *Presidential Memorandum -- Implementation of Energy Savings Projects and Performance-Based Contracting for energy savings*. December 2, 2011. Available at http://www.whitehouse.gov/the-press-office/2011/12/02/presidential-memorandum-implementation-energy-savings-projects-and-perfo. Last accessed on December 27, 2012.

[2]The Air Force has historically invested at 2 percent (or less) of plant replacement value on operations and maintenance (O&M) and recapitalization. O&M is the day-to-day maintenance of a facility while recapitalization is the replacement of building subsystems, to include roofs, HVAC, control systems, paving, fire protection apparatus, among other items. Recapitalization may vary as a facility ages; that is, you will likely spend more on recapitalization as subsystems fail. There are differing opinions on a good rule of thumb for O&M and recapitalization. One estimate cites 4 percent (2 percent for O&M and 2 percent for recapitalization). For additional information, see For additional information, see http://www.tradelineinc.com/reports/E81F7036-BECE-11D4-95B9005004022792. Other estimates recommend 29 percent for O&M and 4 percent for recapitalization. For additional information, see http://www.tradelineinc.com/reports/59A81BA1-DB23-11D4-95BA005004022792/0/0/. Either way, the

Civil engineering (CE) personnel manage the installation of meters and other building-related projects, but logistics personnel have responsibility for the industrial processes that go on inside the buildings. The ALCs lack a funding source for conservation programs. The CE side can help, but it cannot drive the process. The CE and sustainment communities need to work together. The AFMC is undergoing a management change in which 12 sustainment centers are being reorganized into 5, with each center overseeing multiple installations. This reorganization provides an opportunity to increase the visibility of process energy efficiency. The ensuing discussion raised several points. One participant noted that it is sometimes difficult to cleanly define “process energy.” In paint hangars, for example, the heating, ventilation, and air conditioning (HVAC) system serves the dual purpose of maintaining a comfortable temperature as well as providing heat for the painting process. This can cause problems when investment is required and funding sources have definite colors. Fifteen years ago, pollution prevention was integrated into the depots. The personnel already exist and could be repurposed to focus on energy reduction—it is not a personnel issue. Indeed, pollution prevention money has been used for energy projects at Tinker AFB.

Col Stephen Wood, Vice Commander, 72nd Air Base Wing, Tinker Air Force Base

Col Stephen Wood, Vice Commander of the 72nd Air Base Wing, Tinker AFB, discussed efforts to reduce process energy at the Air Force Sustainment Center (AFSC), one of the reorganized sustainment centers in AFMC, based at Tinker AFB. He noted that the mandated energy meters have been purchased and that installation at the building level should be completed by the spring of 2013. Submetering, or metering of individual processes inside buildings, at the industrial process level has not yet been accomplished, but it will be needed in order to provide data to process owners. Lt Gen Bruce Litchfield, commander of the AFSC, has set a goal of 5 percent reduction in energy consumption per year, which goes beyond the federal goals. AFSC has identified the major inefficiencies in its industrial processes, and is initiating partnerships with local government, industry, and academia to address them. Challenges include low utility rates across the complexes and changing processes that place limits on the required investment-payback times for energy-reduction investments. The discussion following this presentation focused on opportunities to work with local utilities to reduce electricity costs. Utilities have an incentive to reduce peak loads through demand-side management programs and interruptible power deals that lead to lower rates to customers.

Air Force is below recognized standards. Also, the figures cited by Col Wise include only real property assets, not equipment items, such as dipping tanks, spray booth equipment, among other items. SOURCE: Col Douglas Wise, Chief, CE Operations and Readiness Division, HQ AFMC/A70. Personal communication to Carter Ford on December 19, 2012.

Kirk Rutland, Technical Director, Test Sustainment Division, Arnold Engineering and Development Complex

Kirk Rutland, Technical Director of the Test Sustainment Division, Arnold Engineering and Development Complex, explained how Arnold creates flight-test conditions on the ground; the controlled conditions provide better test data, and ground testing is more cost-effective and efficient than air testing. A huge amount of energy is required to “create the conditions.” The test workload constitutes approximately 93 percent of the power demand, which is 18 megawatts (MW) on average, but can surge to a peak of 400 MW, equivalent to about one-third of the power average demand of Nashville, Tennessee. Customers are generally the acquisition community, who need the test data to help them make decisions. Much of the infrastructure at Arnold is from the 1940s and 1950s, but it still works, and even though it is not the most efficient, its replacement is a low priority. Fighting obsolescence of infrastructure is a much bigger concern than energy efficiency, although there are opportunities for efficiency improvements when infrastructure is replaced.

The metric of performance at Arnold is “more data in less time,” not energy efficiency, Rutland explained. If a test campaign can be shortened by several days, much more money is saved than could be saved by energy efficiency. Process energy use is not metered. Some energy use at Arnold is excluded from the Air Force energy bill, so the question is asked—what is the incentive? Energy-efficiency investment costs cannot be passed on to the customer, so the question is, where to go for money for reducing process energy use? During the discussion, the question was raised as to whether the ideal efficiency of test processes at Arnold is known. The answer was that no studies have been done. Energy use per test data point has not been tracked. A related point is that responsibility for managing energy use at Arnold tends to be placed on civil engineering personnel, who do not have the expertise to address processes in which the bulk of energy is used.

Cameron Stanley, Support Contractor, Advanced Power Technology Office, Air Force Research Laboratory

Cameron Stanley, Support Contractor, Advanced Power Technology Office (APTO), Air Force Research Laboratory (AFRL), indicated that APTO is supporting energy-related projects in five bucket areas: hydrogen, renewable energy integration, waste to energy, advanced energy technologies, and energy storage. There are three crosscutting focus areas: operational energy, process energy, and energy security. Congress recently added $40 million to APTO’s budget to implement new cutting-edge technologies. Stanley stated that technology solutions (e.g., energy storage) must be tailored to specific environments and/or applications. To be successful, AFRL needs better requirements for Air Force energy-related projects and also good technology-transition partners. The metrics also need to be appropriate. For instance, investments in the cyber area often lead to smaller, faster processing, and this investment is desirable; however, the processors also tend to have a higher energy intensity. A point raised in the discussion is the importance of getting young, energetic students involved in these energy technology projects, whether at the Air Force Academy or through the Air Force Institute of Technology (AFIT) at Wright-Patterson AFB, Ohio.

Concluding Discussion

The November 5 session ended with a discussion of the presentations and discussions that the workshop participants had heard. Participants noted that the Air Force had demonstrated progress on energy issues, at least at the MAJCOM level, although less so at higher levels. The Air Force Council has responsibility for achieving efficiency targets and subpanels of the Council are concerned with energy, but some workshop participants argued that a continuing effort will be needed to ensure that the gains are sustainable. Wal-Mart has the slogan “Save Energy, Live Better”; the Air Force needs a slogan such as “Save Energy, Fight Better.” Partnering among the Air Force, government, and industry was viewed by many workshop participants as an important way forward. An example of a potential source of useful information for the Air Force is the Construction Industry Institute (CII) at the University of Texas that brings together key private companies and government agencies. Funding issues are key to progress in this area. Many participants stated that proper incentives for improving energy efficiency are needed. Trade-offs between reducing energy use and meeting readiness objectives need to be explored. The proper approach is one of balance, and identifying when both efficiency and conservation strategies could impact the mission versus just require a change in culture (as conservation frequently does). It was also noted that having the right sensors and meters to measure energy use is important in order to effect change. Proper metrics are also needed. For example, energy intensity measured in British thermal unit per square foot, while a good metric for office space and living quarters, is not a very good metric for process energy use. It was argued that the Air Force has been focused on the low-hanging fruit in facility energy use, whereas technology improvements are needed but not funded. How can a process that has twice the throughput at half the cost be implemented?

TUESDAY, NOVEMBER 6, 2012

Robert Gemmer, Technology Manager, Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy, Department of Energy

Robert Gemmer, Technology Manager from the Advanced Manufacturing Office (AMO) in DOE’s Office of Energy Efficiency and Renewable Energy (EERE), was invited to give an unscheduled presentation on AMO’s outreach to industry in its effort to improve the energy efficiency of industrial processes. There are now industrial assessment centers[3] at 26 land-grant universities aimed at educating students and identifying ways to assess and improve industrial processes such as the following: (1) process heating (which accounts for one-third of all industrial energy use), (2) boilers and steam delivery, (3) compressed air, (4) air movement systems, and (5) motors. AMO has developed a suite of software tools[4] for identifying where the energy savings opportunities are. A group of 200 qualified specialists trained in the use of these tools is available for outreach. A small subset of these specialists, the "energy experts," is able to teach the use of the tools and are available to work with clients.[5] Former Secretary of Energy Samuel Bodman instituted a program in which 200 industrial facilities were checked for opportunities to reduce energy use in steam and process heating. The program identified $500 million in potential savings, of which 40 percent ($200 million) has been realized. A list of participants is available. DOE has also calculated the theoretical energy required to process materials, and has estimated the practical energy minimum for the same processes.[6] During the discussion of this presentation, several workshop participants from industry praised the Industrial Assessment Centers of AMO, noting that they had used these centers as training opportunities for their own employees.

Thomas Hicks, Deputy Assistant Secretary of the Navy for Energy

The Navy does not promote an energy/environmental agenda per se—like the Air Force, it is explicitly concerned with energy security and combat capability. Deputy Assistant Secretary of the Navy for Energy Thomas Hicks gave a high-level overview of the Navy's energy-related programs, including goals for alternative energy (e.g., waste to energy, biofuels) and renewables, power purchase agreements, and culture change. Incentives are given to commanders to be more efficient, and awareness of energy use has made facilities more efficient. The latter effort led to a 10 percent reduction in energy used in housing. The Navy has made a conscious effort to bring energy guidance as a factor into the acquisition process; Hicks cited an energy-efficient landing ship as an example. Much of the ensuing discussion focused on skepticism regarding the cost-effectiveness of investments in renewables and other energy projects. It was pointed out that it is necessary to take advantage of renewable energy credits and tax incentives to make the investments attractive for third-party power purchase agreements, and "take or pay" guarantees have to be provided so that if a base is closed or another

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[3]Additional information on Industrial Assessment Centers can be found at http://www1.eere.energy.gov/manufacturing/tech_deployment/iacs.html. Accessed November 20, 2012.

[4]Additional information on energy assessment tools can be found at http://www1.eere.energy.gov/manufacturing/tech_deployment/software_ssat.html. Accessed November 20, 2012.

[5]Additional information can be found at http://www1.eere.energy.gov/manufacturing/tech_deployment/assessment_process.html. Accessed November 20, 2012.

[6]Additional information on DOE's Clean Energy Application Centers can be found at http://www1.eere.energy.gov/manufacturing/resources/footprints.html. Accessed November 20, 2012.

energy source is chosen, the third party will be compensated for its investment. Part of the problem is that energy security and mission capability are not monetized. Platforms may use more energy but provide more capability; the Joint Strike Fighter is an example. It is important to have energy metrics but, although they should be a factor, they should not be the only factor.

Sandrine Schultz, Energy Program Manager, Commander, Navy Installations Command

Sandrine Schultz, Energy Program Manager for the Navy Installations Command presented a developing heads-up "dashboard" tool that displays data on energy intensity from building-level meters overlaid on a geospatial map of the facility to promote awareness of energy use and to show improvements for both field personnel and managers (see Figure 2-1). The display is very intuitive, with problem buildings shown in red and satisfactory buildings in green. The data can be rolled up at various levels, from individual units in facilities to entire facilities. The module is updated on a monthly basis (for example, to account for buildups in places such as Guam), and data

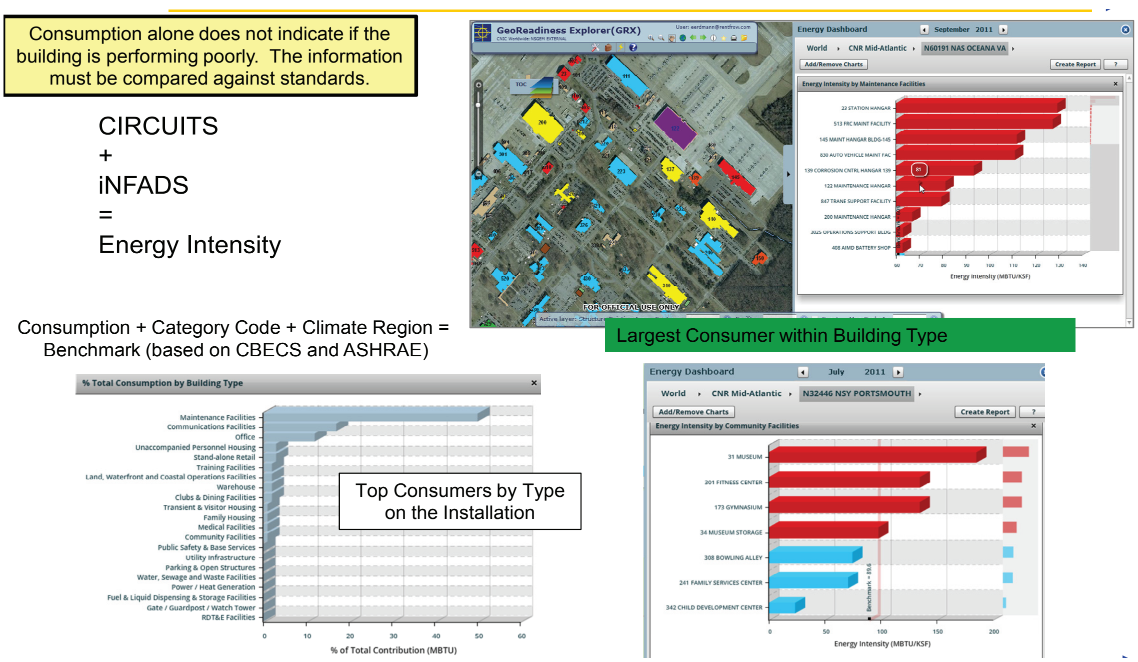

FIGURE 2-1 Example of the energy-intensity dashboard display being developed by the U.S. Navy. Metering data on the intensity of energy use is overlaid on geospatial facility maps, with colors indicating building performance. NOTE: CBECS, Commercial Buildings Energy Consumption Survey; ASHRAE, American Society of Heating, Refrigerating, and Air-Conditioning Engineers. SOURCE: Sandrine Schultz, Energy Program Manager, Commander, Navy Installations Command, presentation to the workshop, November 5, 2012, Washington, D.C.

errors are corrected immediately. The energy dashboard tool is to be made available throughout the Navy on November 17, 2012. The general response of the participants to this presentation was very favorable, and the suggestion was made that the Air Force may wish to adopt a tool like this as a way to monitor and promote its own energy-reduction efforts.

John Dwyer, Deputy Chief of Staff for Logistics, Army Materiel Command

The Army's goals and programs for energy-use reduction, development of renewables, and water conservation are similar to those of the Navy and the Air Force as discussed above, according to John Dwyer, Deputy Chief of Staff for Logistics, Army Materiel Command (AMC). There is a full-time civilian energy manager (GS 12 to GS 14) at 95 percent of Army installations. Savings identified by these managers have yielded a return on investment (ROI) in their salaries by a factor of five. There are weekly installation briefings on energy with high commander visibility. Capital investment program projects require the metering of electricity and are not approved if they are not expected to result in energy savings. The Army also uses the energy-intensity metric, but normalizes it by direct labor hours to account for changes in personnel levels.

Budgets available for funding energy-related projects in AMC are predicted to shrink in coming years. The AMC has identified its most energy-intensive processes through energy audits. It relies heavily on ESPCs with third parties to address these. Equipment used directly on the production line is paid for by Army core funding, and the infrastructure is financed by third parties. About $360 million is estimated to be needed to enable AMC to meet its energy intensity reduction goals—about two to three times its annual energy expenditure. Therefore, private sector financing through various mechanisms is viewed as critical for success. Several participants viewed with favor the normalization of the energy-intensity metric by direct labor hours, noting that further adjustments were needed to account for changes in facility square footage through consolidation, demolitions, or base closures. The question was raised as to whether funds that might materialize from the return of Army facilities in Germany to the German government could be made available to fund energy projects. The answer was that those funds would remain in Germany for use in future construction projects there.

Timothy Unruh, Program Manager, Federal Energy Management Program, Office of Energy Efficiency and Renewable Energy, Department of Energy

The Federal Energy Management Program (FEMP) provides the services, tools, and expertise to federal agencies to help them achieve their energy-use, greenhouse gas, and water-consumption reduction goals as mandated by legislation and Executive Orders. Timothy Unruh, Program Manager for FEMP, in DOE's EERE, noted that the Air Force is ahead of the rest of the federal government in meeting its goals for energy- and water-consumption reduction. FEMP is also working with the military academies to give energy-related awards to students, in categories defined by the academies.

A December 2, 2011, Presidential Memorandum[7] stated that “The Federal Government will enter into a minimum of $2 billion in performance-based contracts in Federal building energy efficiency within 24 months.” FEMP coordinates these contracts, 39 of which have been awarded, with a total value of $427 million. An example is an $80.7 million ESPC signed in August 2012 at Tinker AFB that is expected to reduce energy intensity by 30 percent and save $6.4 million per year. The project decentralizes steam heating so that steam will no longer be sent long distances. These third-party projects typically take about 2 years to develop, then another 2 years to show results. It is not known how the $2 billion goal, which does not require any appropriation, matches the actual need. One comment following this presentation was that there needs to be an understanding of what it is that one wants to meter and of what meters or sensors are most appropriate to the task. A process expert should select the right meter for a particular process. In some cases, a 15-minute meter may be useless and a 30-second meter may be right. A second comment suggested an alternative metric for evaluating project success: dollars invested per British thermal unit saved. A dollar invested should yield a 6,000-8,000 Btu reduction.

Al Hildreth, Company Energy Manager, General Motors North America

General Motors (GM) has an annual energy budget of approximately $1 billion and a robust business process to manage it, according to Al Hildreth, Company Energy Manager for General Motors North America. Goals have been set by top management to reduce energy, greenhouse gases, and water use, and GM participates in the Energy Star program. All plants are ISO 50001-certified. GM uses the metric megawatt-hours (MWh) per vehicle to measure its energy intensity; in North America it currently requires 2.59 MWh to produce a vehicle, equivalent to the electricity used by one household in a year. GM uses a proprietary energy-management dashboard display to track energy intensity that half of its plants currently feed into.

GM estimates that 60 percent of its energy consumption is due to processes and has conducted audits to identify opportunities for reduction. The largest electricity user is the paint shop. Hildreth discussed a series of steps that were taken to improve energy efficiency in painting operations, the most significant of which was increasing the fraction of recirculated air to outside air. Annual energy savings from taking these steps amounted to nearly $3 million. Most participants were favorably impressed by GM’s program and its energy-intensity metric, and thought that the Air Force’s efforts to

[7] For additional information, see “Presidential Memorandum -- Implementation of Energy Savings Projects and Performance-Based Contracting for energy savings.” December 2, 2011. Available at http://www.whitehouse.gov/the-press-office/2011/12/02/presidential-memorandum-implementation-energy-savings-projects-and-perfo. Last accessed on December 27, 2012.

reduce industrial process energy would benefit from a closer collaboration with companies such as GM.

James B. Porter, Jr., Independent Consultant

As indicated by James B. Porter, Jr., retired vice president for engineering and operations at DuPont, DuPont consumes 129 trillion Btu of energy per year, compared with the Air Force's 65 trillion Btu. DuPont's business goal is "sustainable growth" that entails increasing shareholder and societal value while decreasing the footprint of operations. In 1999, DuPont announced the goal of holding energy use at or below the 1990 baseline, with additional goals for greenhouse gases and renewable energy use. In fact, DuPont has achieved a 6 percent reduction in energy consumption since 1990, despite the 40 percent increase in production. The commitment of senior leadership to sustainable growth is the key to DuPont's success; this commitment percolates down through the enterprise. A single site manager at each plant is responsible for all aspects of operations, including meeting energy-savings targets. Energy-use data are aggregated at the site level. The metric is energy dollars spent last year divided by energy dollars spent this year. It is important to keep the value proposition in front of managers and stockholders, Porter noted. DuPont estimates that it has gotten a 60 percent internal rate of return from its investment in energy projects.

DuPont has many subject-matter experts in energy-related issues. They are deployed by means of a leveraged model to maximize effectiveness and efficiency. Peer-to-peer forums of energy champions have been key enablers. Technology is also being used to promote energy savings, with a website that disseminates best practices, downloadable energy engineering assessment tools, and virtual workshops that enable energy training without the necessity of travel. Peer recognition for meeting energy goals is important, perhaps more so than recognition by management. The DuPont culture is that all energy-management projects are good business projects. The notion of "sustainable energy management" seemed to resonate with the Air Force participants in the workshop, as well as the emphasis on the commitment of top leadership. In response to a question, Porter noted that the energy-efficiency culture promoted by DuPont has also spilled over into the energy choices that their employees make in their personal lives.

Roger Weir, Energy Manager, ATK Aerospace Systems

As noted by Roger Weir, Energy Manager for ATK Aerospace Systems, ATK is the world's top producer of solid rocket propulsion systems and military ammunition. Its operations are widely dispersed, with some 24 offices and operating locations in 23 states. Starting in 2009, each location was required to develop an energy plan, but communication among sites and sharing of best practices have proved challenging.

Annual energy spending is $70 million, and 7.3 trillion Btu are consumed. No funds are specifically allocated for energy projects, which must compete for funding with other projects. ATK has a dashboard display system for tracking water, air, gas, electricity, and steam (WAGES) consumption on a monthly basis and comparing it to budget targets, primarily for primary process building owners. Annual pay increases are tied to cost reduction in these areas. Weir cited several projects involving improvements to processes that had significant energy savings, although the motivation for undertaking them was to increase throughput:

- Replacing an electric furnace with a natural gas furnace.
- Replacing a gas-fired continuous line anneal furnace with a cellular electric furnace,
- Replacing an old anneal furnace with a new one that has improved insulation,
- Modernizing steam boiler controls, and
- Installing remote maintenance of an HVAC system with an automatic trouble notification system.

ATK believes that the future sustainable grid will involve much more distributed electricity generation, with energy storage technologies becoming more prevalent. Weir described a 3-year joint project between DOE and ATK to explore several of these technologies and to gather data on their performance.

Kenneth Walters, Chief, Measurement and Analysis Division, Air Force Civil Engineer Center–Energy, Air Force Materiel Command

Kenneth Walters, Chief of the Measurement and Analysis Division of the AFMC's Air Force Civil Engineer Center—Energy, was invited to give an overview of progress in the metering of electricity use in Air Force facilities. The Energy Policy Act of 2005 mandates that federal agencies put meters on all facilities where it is cost-effective. To judge cost-effectiveness, the Air Force uses an algorithm based on the estimated amount of electricity used in a building and the cost of the electricity, and it assumes that at least 2 percent of electricity costs would be saved just from the awareness that an installed meter would provide. Fully burdened, the cost of installing a meter is about $10,000. If savings are calculated to be a few thousand dollars per year, this is judged to be cost-effective. Some 74 percent of the mandated electricity meters have been installed at Air Force facilities, at a cost of $100 million. The remainder are expected to be installed in the next few months. Military construction specifications require meters on all new buildings.

The Air Force has already contracted out the development of an advanced meter-reading system (AMRS) that will provide a dashboard display of electricity use enterprise-wide, similar to the system described above being developed by the Navy. It is expected to be deployed over the next 2 years. Submetering of specific processes has not yet been addressed, but it is not precluded. One problem is that the meters are of different types and they talk to different proprietary systems, so in some cases it is necessary to pull data from alternative sources.

Col Steven Wood, Vice Commander, 72nd Air Base Wing, Tinker Air Force Base

Col Steven Wood was asked to comment on relevant activity at Tinker AFB, which is a joint Air Force and Navy base with good cooperation between the two. The Navy pays for its electricity based on its usage. From the perspective of the Air Force,, electricity use at Tinker AFB is reported as the fenceline electricity minus amounts attributed to other customers and tenants. In 2009, Tinker AFB took over an old GM plant that was only lightly used, and so the energy-intensity metric dropped (due to the increase in the denominator square footage). Tinker AFB has purchased meters to monitor electricity, gas, and water usage, although they are not all installed. Current energy projects do not yet address industrial process energy, but Tinker AFB is ramping up a team to focus on process energy, as are Hill AFB, Utah, and Robins AFB, Georgia.

WEDNESDAY, NOVEMBER 7, 2012

Col Gregory Ottoman, Chief, Environment and Energy Division, Office of the Deputy Chief of Staff for Logistics, Installations, and Mission Support

Col Gregory Ottoman, Chief of the Environment and Energy Division, Office of the Deputy Chief of Staff for Logistics, Installations, and Mission Support, noted that the progress of the Air Force in reducing facility energy intensity (16.8 percent since 2003) leads the other services. The Air Force has three reasons to invest in energy projects: (1) It must try to meet congressional and presidential mandates; (2) the savings in utility costs are considerable, with about $2 dollars saved for every dollar invested; and (3) reducing energy use contributes to national security (although there is no price tag on this benefit). It all boils down to funding, Ottoman said, and finding the dollars to invest will get harder in the future. Restoration and maintenance (R&M) funds for retrofitting facilities that are currently being set aside for energy projects will no longer be set aside in FY 2016, and so energy projects will have to compete with all other projects. These funds can’t be used for improving industrial processes or for laboratories. There are no excess dollars in the infrastructure budget; about $1 billion is available, but the backlog is around $33 billion.

Leadership needs to decide to dedicate funding to energy projects. There is an oversight and resourcing council chaired by Terry Yonkers, Assistant Secretary of the Air Force for Installations, Environment and Logistics, that has energy as part of its purview. The focus of federal mandates and EOs on the relatively small fraction of Air Force energy consumed in facilities rather than the much larger fraction used in aviation appears to be skewed, but this is changing. One stated goal was to reduce aviation fuel use by 10 percent from 2006, but this goal has not been met due to the wars in Iraq and Afghanistan. There are expected to be new initiatives on reducing fuel use in aviation in this Program Objective Memorandum (POM) cycle.

Ottoman argued that the metrics for measuring energy intensity may be appropriate for office buildings but are not appropriate for addressing industrial process energy. Also, base utility bills are in the "must pay" category. Commanders and managers know that they will get the money necessary to pay them—which reduces the incentive for reducing consumption. The Air Force believes that it is in relatively good shape in meeting its goals for reducing water consumption and expanding renewable energy. However, there is a recognition that decisions regarding energy and environmental projects continue to be made on an ad hoc basis, which leads to suboptimization. For example, the Air Force has leased land at Nellis Air Force Base on which a contractor has built a photovoltaic (PV) electricity system, ostensibly to meet renewable energy and energy security goals for the base. However, the PV electricity is not connected to the base, but instead goes directly to the grid, and there does not appear to be funding available or the right incentives to make the connection to the base. Technology tends to be applied where it can be applied, as opposed to where it should be applied. Ottoman stated that there needs to be a macro model that could lead to a more holistic approach to energy and environmental decision making throughout the Air Force.

Much of the discussion following this presentation revolved around the issue of fragmented decision making and suboptimization. One participant commented that DuPont's energy initiatives also started as scattered and ad hoc efforts, and only coalesced into a coherent program over time. The Office of the Deputy Assistant Secretary of the Air Force for Energy has only been in existence for about 2 years, with a small staff and minimal contractor support. The biggest concern may be the lack of visibility of energy issues at headquarters outside of the civil engineering community. There are no "blue-suit" logisticians; leadership is needed to address process energy. Several participants asserted that energy use must be translated into cost in order to influence the acquisition community.

Several workshop participants also commented on issues related to metering. Metering will provide quicker and more accurate data on energy consumption to managers. The Empire State Building in New York City was renovated several years ago and meters were installed. Businesses located in the building competed to reduce their electricity consumption. The lesson was that energy use should not be viewed as an isolated island—there is a whole community involved. Other comments related to funding for submetering, which will be needed in order to tackle industrial process energy. Submetering would have to be funded by maintenance accounts rather than civil engineering accounts. However, meters would not have to remain indefinitely at a single site. It should be possible to save money by moving meters around from site to site in order to verify the value of investments as part of a research and development process.

3

Wrap-Up Discussion

The final day of the workshop was devoted primarily to general discussion and to distilling and considering the main points that had been presented. The discussion involved the following topic areas: (1) management and leadership, (2) budgets and funding, (3) information resources, (4) metrics, (5) culture change, (6) personnel and training, and (7) investment opportunities.

MANAGEMENT AND LEADERSHIP

To most participants who spoke at the workshop, it appeared that the Air Force has a solid overall energy strategy and that the representatives from bases such as Arnold AFB and Tinker AFB have a nuanced and well-thought-out understanding of energy usage in general and of process energy and opportunities for addressing the associated challenges without impact to the mission. With the right vision from leadership and access to resources, the facility managers who addressed the workshop appear to be well positioned to implement improvements. Many participants were impressed with the progress that the Air Force has made on its energy goals. Stimulated at least in part by the successful efforts of civil engineers who have demonstrated that a reduction of energy waste in facilities augments mission capability, most participants seemed to think that everyone is trying to support the energy goals of the Air Force.

The primary criteria on which the Air Force is judged are combat readiness and mission capability; reducing energy use can contribute to energy security and can save money that can be used to improve readiness, but reduction in energy use per se is not a primary objective, especially if it conflicts with maintaining mission capability. Many speakers noted that energy reduction will not stand a chance if it stands alone; it needs to be a part of every operational decision. Energy projects that have a long payback time are particularly hard to fund and sustain, in part because the tenure of any particular commander is typically short compared to the payback time. For example, it was noted that paint hangars are expected to last a long time and should be able to sustain long-term investments.

It was a general view among participants who spoke at the workshop that Air Force leadership has stepped up to spend on reducing energy use in buildings in response to federal mandates, but there have been no comparable goals or mandates addressing the fuel or industrial process aspects of the problem, despite the likelihood that the lower-hanging fruit and biggest potential reductions are on the aviation side. There appears to be no guidance that puts an emphasis on energy efficiency and conservation in decisions related to process energy use. Several speakers asserted that the procurement process needs to be adjusted in order to better reflect total life-cycle O&M costs for equipment purchases. Often, more efficient equipment has a higher upfront cost but can deliver significant energy savings over its useful life. In general, many participants thought that the Air Force has been forced to take an ad hoc approach to energy efficiency and conservation improvements, reacting to available funding or available resources to support a specific effort. Sometimes, projects can counteract each other and cumulatively miss the “big picture” objective. For example, one participant pointed out that process energy needs are not necessarily compatible with the installation of nonfirm renewable power generation.

Several participants believed that the Air Force should consider taking a more holistic approach to developing a long-term strategy for addressing the energy cost and delivery of buildings and facilities for a particular base or depot, regardless of current funding sources. They noted that this could also be done within the context of local and regional energy issues and opportunities. In that way, a base could collaborate with local groups to implement an overarching strategy when and if it became appropriate to pull in other non-Air Force resources, and simultaneously the base could apply available Air Force resources to projects within a larger strategic plan for the facility as they become available. Energy efficiency is likely an area that would provide a significant ROI. Moreover, DuPont has found that there are ways to save money by streamlining the project-management process itself. Thus the problem may be related less to a lack of funds and more to insufficient focus on energy by the allocation process. Several speakers noted that the way in which energy plays into the Air Force base decision process needs to be codified.

BUDGETS AND FUNDING

A budget is an expression of values and priorities at a given time. A variety of government budget authorities and of public and private mechanisms are available to fund energy-reduction projects. These include the following:

- *Operations and maintenance (“3400”) funds, used to recapitalize infrastructure.* The Air Force has historically funded this at less than 2 percent of plant replacement value, compared with a typical private-industry investment of 6 to 8 percent.

- *Research, development, test, and evaluation ("3600") funds, controlled by A3 (Operations) of which approximately $300 million is to sustain the test program infrastructure.* It does not appear that energy- and water-conservation projects have received support from this community. Also, energy and water conservation are not included as part of the discussion in test infrastructure/equipment construction, restoration/modernization, sustainment and demolition.
- *Milcon ("3300") funds for new construction and major renovation and Working Capital Fund Capital Investment Program (WCF CIP), controlled by A4 (Installations and Logistics).* The U.S. Army Materiel Command has designated 6 percent of its CIP for infrastructure renewal projects, in compliance with guidance from the National Defense Authorization Act of 2007 (Public Law No. 109-364). The Air Force does not appear to have interpreted this as a "hard and fast" requirement. Although there are recent successes of including energy and water conservation in some infrastructure/equipment upgrades, the concept is not fully integrated into the Depot Maintenance Activity Group framework—which consists of infrastructure/equipment construction, restoration/modernization, and sustainment and demolition.
- *Third-party funding, a financial contract in which a company saves the Air Force energy and/or water over a period of years, and for payment over the term, keeps the savings.* These include Energy Savings Performance Contracts and Utility Energy Savings Contracts. The Air Force expects to rely more heavily on third-party funding for energy projects in the future as internal funding sources shrink.

No Air Force budget line is specifically devoted to energy. Several workshop participants expressed the idea that these diverse sources tend to lead to a fragmented, ad hoc approach to energy projects that lacks a long-term vision, is suboptimized, and can lead to "color-of-money" constraints. Most participants felt that the Air Force's use of ESPCs, as required by presidential order, is a good mechanism for providing funding for infrastructure and efficiency improvements in the absence of other funding sources. ESPCs accomplish the goal of reducing energy usage (intensity), although they do not result in cost savings to the Air Force over the near term and may actually result in cost increases if a contract needs to be "bought out" due to base closure or shifting priorities. Nonetheless, absent other funding sources, they appear to be a valid mechanism and worth implementing.

INFORMATION RESOURCES

Several workshop participants noted that Air Force personnel should look for opportunities to identify the processes that offer the largest potential ROI for energy-reduction and also should seek opportunities to leverage what they know and how they do what they do through collaboration and networking with subject-matter experts and consortia of organizations concerned with making processes better, faster, cheaper, safer, and more energy-efficient. This collaboration could be institutionalized. Examples include the Construction Industry Institute at the University of Texas at Austin, which brings together experts from many major companies, academia, and government to discuss technical concerns. The Air Force could consider stimulating an analogous interaction with industry, academia, and other agencies on a continuing basis. The key to the success of such collaborations is a continuing interaction, with a focus on accomplishment. In this environment, all participants can receive benefits that far exceed participation costs. Networking can also be done remotely. Many participants agreed that there is a reservoir of goodwill and desire to help the country in many major companies, especially if the information provided will be used on a noncompetitive basis.

The technical underpinnings for such an interaction are in place. For example, DuPont has a list of best practices that it used when it increased output while decreasing energy input. Robins AFB started an energy and conservation forum in 2008 to discuss energy-reduction efforts in the AFMC, and further forums are planned. But many participants noted that the primary emphasis of such efforts has been on the civil engineering (CE) side rather than on the process side. These efforts can be folded into—and serve as foundation for—Air Force participation. Finally, the Advanced Manufacturing Office within DOE’s EERE has been working with companies to improve processes for 30 years. All of the resulting documents are free and available on the web. The Federal Energy Management Program in DOE’s EERE offers consulting services, with experts in various process technologies, and evaluation software tools.

Since energy, water, and waste issues often scale beyond the installation perimeter, several participants stressed that it is important for base commanders to get involved with the broader community—for example, by participating in energy-use groups. Such participation has already saved money at Tinker AFB. The larger the set of parameters over which a solution is optimized, the less likely one is to have a suboptimized, inefficient solution. However, participants noted that it also should be recognized that each Air Force installation is unique and may have its own special requirements. Awareness of new technologies and ways of doing things is important. Training and software tools are available, but they must be adapted to local procedures. It is becoming increasingly feasible to develop computer-based models of a facility that provide the information needed to plan and assess the impact of emerging energy, water, and waste technologies.

Energy efficiency, water conservation, process improvement, smart grid, smart buildings, facilities, and cities are all major engineering research topics today. Thus it was not surprising to hear from industry speakers that their research staff is intimately involved in improving energy productivity. Several participants noted that the Air Force Research Laboratory is well positioned to help the Air Force improve its energy usage and has published a description of its energy focus. However, it appeared to several participants that the relationship between the depots and AFRL is limited. They thought that AFRL could be tasked with helping the depots. This tasking would be consistent with a focus on next-generation technologies. Improvement of industrial processes is a fertile field for innovative engineering research. For example, an AFRL-funded industry partnership developed improved high-speed drill bits that lasted longer and saved water.

Some participants noted that a second tasking for AFRL could be to serve as the primary interface between the Air Force and the DOE national laboratories. The Air Force could take advantage of these resources, but the various DOE laboratories compete with each other for funding. Choosing the right avenue of collaboration requires that the users of the technology be knowledgeable about the strengths and weaknesses of the various programs. The staff members of AFRL are the technical peers of the DOE scientists and engineers and are likely in the best position in the Air Force to provide the interface needed to use the national laboratories' capabilities effectively.

Several participants were of the opinion that a third tasking for AFRL could be to form a closer relationship with Air Force energy managers. Much of the ad hoc approach to energy at Air Force installations is due to the fact that installations do not have the technical capability to assess technologies and systems with existing staff and often rely on open-source information without due diligence to the overall Air Force approach. For example, an industry provider may approach the CE lead at an installation with a valid technology for battery storage on a site, but the local CE lead might not have the capability to assess this across all battery technologies or similar technologies (e.g., flywheels).[1] There are many best practices to identify and share, such as Arnold AFB, Tennessee, managing its workload by moving high-energy-use testing to off-peak hours (nighttime) to reduce costs. One suggestion was to compile examples from both the Air Force and industry into a best-practices handbook that could be useful in sharing those experiences. Other participants indicated that there are likely opportunities to install energy saving measures such as soft starts and variable frequency drives on equipment, and that an inventory of such opportunities should be conducted on a facility-by-facility basis.

METRICS

Many workshop participants agreed with the idea that data—and therefore appropriate metrics—are critical for various purposes such as the following: for raising awareness of energy use, driving culture change, making the business case for investments, and presenting the value proposition to commanders that energy use can be reduced while improving mission capability at the same time. However, as metering and data collection are improved in order to understand energy usage, it is important to understand what will be done with the resulting information in order to avoid

[1]The three taskings may require some restructuring of how AFRL operates since energy issues cut across AFRL directorates.

”collecting data for data’s sake.” One participant noted that developing a data-collection and data-management plan to inform the overall objectives can avoid the challenge of swimming in data that are not meaningfully used.

Data are also important in order to understand actual performance versus projected performance. Often, systems underperform compared to expectations, and documenting why this occurs is important for improving future projects. Also, one participant stated that people involved in a specific project can become “project champions” and at times can lack objectivity. Having a process to go back and assess actual performance to inform future project and funding decisions is important. Several participants were of the opinion that in the next 10 years, metering of energy use—at least at the building level—will indicate new ways to improve and will “break the waves” for more detailed energy analyses at the individual process level. Many stated that the Air Force should consider adopting the Navy Geospatial Energy Module/Energy Dashboard, which can roll energy usage from a building to the facility level and provide clear energy information to users compared to an established baseline. The Air Force’s advanced meter reading system as presented at the workshop may perform a similar function, but participants commented that it would be worth comparing best practices with the Navy so as to avoid re-creating a system that already exists.

A frequently expressed view by the participants was that the Air Force needs better energy-use metrics that measure the right things. The most commonly used metric for energy intensity is British thermal units per square foot (which should be reported in joules per square meter, since the U.S. government has committed to the use of the metric system). This metric is driven by the externally mandated goals. It is obviously a metric that focuses on building shells and personnel habits. As such, it has stimulated the DoD to invest in energy efficiency in order to meet mandated improvements in that metric. Largely, the investments appear to have been made in ways that enhance both energy security and mission effectiveness. But one participant noted that this metric is flawed in three important ways:

- *It rewards lightly used and lightly serviced buildings.* In the extreme, it could serve as an impediment to the destruction of obsolete and unsafe buildings. More importantly, however, it rewards light rather than optimal use of a facility. It counts the consolidation of activities and/or surges in personnel or mission activities as an increase in energy intensity, whereas these are actually actions that can reduce the energy required to meet the mission effectively.
- *The DoD maintains industrial facilities that produce products.* An example is the Air Force depots that refurbish the nation’s military aircraft. Industrial experience suggests that there is significant energy and cost savings that could be achieved by a serious look at these processes. The metric used, however, stimulated a funding focus on facilities, thereby limiting the funding available to address energy-intensive processes and the equipment that leads to that inefficiency.

- *Finally, a key responsibility of the military is to project military force.* This activity requires fuel. The energy-intensity metric is obviously irrelevant to effective fuel use.

Several participants agreed that the important issue raised in this discussion is that the Air Force would benefit if it had a coherent and transparent set of metrics that related energy use to the accomplishment of the mission—the desired metric for making a value proposition to decision makers and commanders. For industrial processes, this might be energy used per unit of product (for example, General Motors uses megawatt-hours per vehicle). One way of accounting for surges in activity might be to normalize the existing energy-intensity metric to the number of direct labor hours. The current energy-intensity metric, albeit flawed, demonstrates that metrics can stimulate beneficial behavior. Many participants believed that the Air Force should consider concentrating more effort on developing a set of metrics that permit it to improve its mission capability while lowering energy use and cost.

Another view stated that it is also important to recognize that in some areas in which process energy is central to the mission, opportunities for large-scale reductions in energy usage or savings are not feasible. This consideration needs to be reconciled with established metrics such as energy intensity. Energy intensity as a singular metric is probably not appropriately applied to facilities with high process energy needs required to meet their mission.

CULTURE CHANGE

Many workshop participants were of the opinion that the Air Force is making good progress toward metering individual facilities; however, it is imperative that the information get back to the individual users of that facility, who are in the best position to enact small, incremental changes. The Air Force estimates that behavior change can result in a 2 percent improvement in energy usage for buildings. However, one participant stressed that the overarching goal should be toward a culture shift at all levels of the organization—"culture" being defined as behaviors that individuals engage in even when no one is looking.

Another participant noted that it is critical that Air Force uniformed personnel in the field participate in shaping the specifics of strategies to reduce energy use, and that procedures not be simply dictated from headquarters by people who have no experience in the field. Several speakers noted that two possible paradigms for how to integrate energy awareness into corporate-wide thinking are illustrated by efforts already made to promote pollution prevention and safety. Air Force instructions mention pollution prevention and safety, but not energy use. There could be a reward system for personnel in the field who come up with good ideas for saving energy. Several participants noted that considering improvements in energy management as a criterion for promotion for facility managers could also help drive cultural change.

Culture change needs to occur throughout the organization, and must be supported by the upper level of leadership. Blindly working toward achieving metrics and milestones does not necessarily meet the underlying goals.

PERSONNEL AND TRAINING

Many participants expressed the idea that it is important for individuals in the Air Force at all levels of management and responsibility to be aware of the importance of addressing energy-security/-surety and costs, and that, at times, improving efficiency and reliability can result in enhancement to the mission. Some participants suggested that having mandated energy training throughout the Air Force might be a driver toward greater understanding of the problem. Classes in energy-related topics are already offered by the Air Education and Training Command. Another suggestion was to have energy efficiency written into the job description (and performance evaluation) of process managers and that they receive appropriate training. Yet another suggestion discussed by participants was a graduate degree or certificate that could be offered by the Air Force Academy or the Air Force Institute of Technology with a focus on energy.

It was demonstrated in several presentations that the acquisition of new technologies and infrastructure provides a great opportunity for improvements in energy efficiency and long-term energy reduction. A key target for improving energy awareness is the acquisition community, to get life-cycle energy use to be one of the criteria on which acquisition decisions are made. One participant noted that an example target group is the Logistics Officers Association. There is no codified knowledge base for process equipment at depots. An example is the lack of maintenance manuals written to support test facilities at Arnold AFB. One suggestion was that progress might be made through working with the Society of Maintenance and Reliability Professionals.

INVESTMENT OPPORTUNITIES

Several speakers noted that the civil engineering community has shown the Air Force that energy-reduction projects are a good investment—typically returning $2 in savings for every $1 invested. One speaker noted that specific processes such as painting offer opportunities for improvement (as the General Motors presentation showed), but there is no budget for it. The CE community typically does not own either the industrial process or the budget. Participants noted that other processes that are good candidates for efficiencies are those that generate or transfer heat or involve rotating equipment. One participant noted several potential areas for future Air Force investment:

- Work process design and associated training and audit protocols focused on business effective energy management.

- Standardization of all common, repetitive processes such as machining, parts/equipment cleaning, painting, etc. across all sites.
- Engineering evaluation of rotating and heat exchange equipment to establish life cycle energy use and operating costs.
- Formal assessments of current operations vs. standard protocol to identify short and long-term improvement actions and projects (see Appendix E for possible areas to consider).

Appendix A

Biographical Sketches of Committee Members

Kenneth E. Eickmann is the deputy director of the University of Texas Center for Energy Security and senior research fellow for all energy related matters at the University. In December 2009, he facilitated a national forum to identify strategic energy goals for the U. S. Air Force and the nation. In 2010, Lt. Gen. Eickmann chaired an Air Force Installation Energy Study designed to determine how best to ensure military installations have energy for mission critical capabilities. Eickmann currently serves on the Military Advisory Board for the Center for Naval Analyses, which completed and published a study in October 2011, laying out the national security imperative to reduce U.S. oil dependence. General Eickmann is a Registered Professional Engineer and is certified as an Acquisition Professional in Acquisition Logistics, Program Management and Systems Planning, Research, Development & Engineering. He is also a recognized expert in propulsion technology and has published several papers in technical journals in the United States and overseas. Following his retirement from the United States Air Force in 1998, he served as the director of the Construction Industry Institute (CII) at The University of Texas (UT) at Austin, where he led a collaborative effort by engineering and construction owners, contractors, and academia to improve one of the nation's largest industries. General Eickmann's accomplishments include selection as a Distinguished Engineering Graduate of the University of Texas; selection for membership in the National Academy of Construction; and selection as chairman of a general officer red team formed to review logistics transformation efforts of the U.S. Air Force. He was also a member of a National Research Council committee formed to provide an independent evaluation of the feasibility of achieving the science and technology requirements implied in the National Aerospace Initiative. Eickmann currently serves as the state vice chairman of the Texas Engineers Task Force for Homeland Security. Lt. Gen. Eickmann (ret) is a past member of the Air Force Studies Board and past chair of several NRC studies, including *A Review of United States Air Force and Department of Defense Aerospace Propulsion Needs* (2006) and *Improving the Efficiency of Engines for Large Nonfighter Aircraft* (2007).

Robert E. Hebner, Jr., is the director of the Center for Electromechanics and associate director for technology of the Center for Energy Security, both at the University of Texas at Austin. Throughout his career, Hebner has served on numerous technical committees that develop voluntary standards for the electric utility industry. His personal research focuses on smart grid technologies, microgrids, renewable energy, and energy storage. He is an active contributor to the Pecan Street program that is helping to gather the information needed to design a smart grid architecture that is attractive to both consumers and industry. Hebner has had extensive experience in technical collaborations, being former chair of the Board of the Center for Transportation and the Environment and chair of the Electric Ship Research and Development Consortium. He is also a past member of the Board of Directors of the IEEE. He has been selected as vice president elect for the IEEE with responsibility for all of the IEEE's technical activities. The combination of the Pecan Street and IEEE activities has provided opportunities for unique insight into smart grid and smart city activities in the United States, Europe, and Asia. He has applied this knowledge to military energy activities. He was a founding member of the Electric Ship Research and Development Consortium. He has made significant contributions to the design and operations of ship power systems, which are isolated microgrids. Research in the two centers has led to modeling techniques for power systems for ships, forward bases, and military bases in the United States. In addition, he has been a member of an Air Force study team that assessed the energy security of Air Force bases. Before joining the University of Texas, he spent many years at the National Institute of Standards and Technology (NIST), culminating his time there as acting director. He also worked in the Office of Management and Budget and at the Defense Advanced Research Projects Agency. Throughout his career, Hebner has been active technically, having received a Ph.D. in physics and having authored or coauthored more than 150 technical papers and reports. He is a fellow of the IEEE.

Thom J. Hodgson is the James T. Ryan Distinguished University Professor, an Alumni Distinguished Research Professor, co-director of the Operations Research Program, and director of Graduate Programs of Engineering-On-Line at North Carolina State University (NCSU). He served as director of the Integrated Manufacturing Systems Engineering Institute at NCSU ('95-'11); director of the Division of Design and Manufacturing Systems at the National Science Foundation ('91-'93); head of the Industrial Engineering Department at NCSU ('83-'90); professor of Industrial & Systems Engineering at the University of Florida ('70-'83); operations research analyst at Ford Motor Company ('66-'70); and an officer in the U.S. Army ('61-'63). He is a fellow of IIE and INFORMS, and a member of the National Academy of Engineering. He is the author or co-author of over 80 journal articles and book chapters. He served as associate editor, departmental editor ('81-'84, '88-'91), and editor-in-chief ('84-'88) of *IIE Transactions*. He served as a member of the U.S. Army Science Board ('94-'00).

Gwen P. Holdmann is the director of the Alaska Center for Energy and Power (ACEP), which is an applied energy research program based at the University of Alaska Fairbanks emphasizing both fossil and renewable/alternative energy technologies. ACEP is a highly interdisciplinary program with over 30 affiliated faculty, spanning a wide range of energy-related disciplines. Prior to joining the University of Alaska, Holdmann served as the vice president of new development at Chena Hot Springs Resort near Fairbanks. While at Chena, Holdmann oversaw the construction of the first geothermal power plant in the state, in addition to numerous other innovative energy projects ranging from hydrogen production to cooling a 10,000 ft^2 ice museum year-round using 150°F hot water. Holdmann moved to Alaska in 1994, shortly after graduating from Bradley University with an M.S. in physics and mechanical engineering. Holdmann has been the recipient of several awards throughout her career, including an R&D 100 award, Project of the Year from Power Engineering Magazine, and the Alaska Top 40 Under 40 Award.

Carroll N. LeTellier, a member of the National Academy of Engineering (NAE), was involved in the early design phases for the new Cooper River Bridge. Other significant projects he helped lead include the design and building of the Tennessee Tombigbee Waterway, the Fort McHenry Tunnel in Baltimore, Locks and Dam 26 on the Mississippi, and multimillion dollar improvements to the physical and technical security of 44 U.S. embassies worldwide. A 1949 graduate of the Citadel, LeTellier served for 27 years with the U.S. Army Corps of Engineers. He then joined Sverdrup Corporation as vice president, where he served for 25 years until his retirement in 2001. The NAE cited LeTellier for "leadership in the planning, design and construction of major infrastructure and military facilities that meet and serve the highest societal values." LeTellier has had a lifelong connection with engineering and the Citadel. His father, Louis S. LeTellier, was head of the Citadel's civil engineering department for many years and served as acting president of the college after the retirement of General Charles P. Summerall in 1953 until the arrival of General Mark Clark in 1954.

James B. Porter, Jr., was chief engineer and vice president of engineering and operations for DuPont until his retirement in September 2008. He joined the company in 1966 as a chemical engineer in the Engineering Service Division (ESD) field program at the Engineering Test Center in Newark, Delaware. He left the same year for a tour in the United States Army and returned in April 1968 as a technical services engineer at DuPont's Chattanooga, Tennessee, fibers plant. Porter was named vice president of engineering on November 1, 1996. He then became vice president of Safety, Health & Environment and Engineering on February 1, 2004. Porter assumed the position of chief engineer and vice president, DuPont Engineering and Operations on July 1, 2006. He has served as chair for the Construction Industry Institute (CII) and he was the 2004 recipient of CII's Carroll H. Dunn Award of Excellence. In 2005 he received the Engineering and Construction Contracting Association Achievement Award and in 2007 he was honored with the Society of Women Engineers Rodney D. Chipp Memorial Award. In 2008 he was the first recipient of FIATECH's "James B. Porter, Jr. Award for

Technology Leadership." He is a member of several boards of directors and is on the Argonne National Laboratory Board of Governors. Today, Porter is the founder and president of Sustainable Operations Solutions, LLC, which provides consulting services to help companies make significant and sustainable improvements in workplace safety, process safety management, capital effectiveness, and operations productivity. He received a B.S. in chemical engineering from the University of Tennessee. Porter is a current member of the Board on Infrastructure and Constructed Environment.

Scott E. Sanders is the current vice president for strategic innovation for Wyle Laboratories, Inc. He is responsible for the cultivation and infusion of innovative science, technology, and processes that overlap energy, environmental, infrastructure, and business considerations. His focus is on solutions that support the DoD marketplace and that facilitate rapid and agile responses to the changing national security environment and the associated culture change methodologies. Sanders has been with Wyle for over 25 years and he previously led a $2 billion contract effort supporting the Defense Technology Information Center, where “operational energy” was infused into the construct of the contract in response to national level emphasis and focus on this critical area. He was responsible for the technical evaluation of rapid responses to deployed forces and the analysis of their merit for distribution to all services. He has worked with several non-profit associations on energy and water issues, such as the American Council on Renewable Energy (ACORE) and the International Renewable Energy Agency (IRENA), as well as several major universities. Sanders is a drilling reservist and holds the rank of Rear Admiral in the United States Navy. He served as Vice Commander of U.S. Naval Forces in Bahrain for 3 years and was the first drilling reservist since WWII to command an at-sea task force (CTF-151 Counter Piracy). He also has served as the Deputy Commander for the largest U.S. Navy Fleet (2nd Fleet) and is currently assigned to the Joint Staff. He has a broad perspective on energy, water usage, and energy- and water-reduction technologies and their application to forward deployed as well as CONUS-based forces. Sanders also has a solid understanding of what partner nations (Middle East and East Africa) are developing and their associated energy security approaches that relate to reduced energy usage and/or reduced dependency on petroleum sources.

Appendix B

Workshop Agenda

Energy Reduction at U.S. Air Force Facilities Using Industrial Processes:
A Workshop

November 5-7, 2012
The Keck Center of the National Academies
Room 110
500 Fifth Street, NW
Washington, DC 20001

MONDAY, NOVEMBER 5

0900 **Welcome and Introductions**

- Lt Gen (ret) Ken Eickmann, Workshop Committee Chair

0930 **Vision for the Workshop**

- Kevin Geiss, Deputy Assistant Secretary of the Air Force for Energy, Office of the Assistant Secretary of the Air Force for Installations, Environment and Logistics

1000 **Break**

1015 **OSD Initiatives**

- Joseph Sikes, Director of Facilities Energy Privatization, Office of the Deputy Under Secretary of Defense for Installations and Environment

1115 **Manufacturing Industry Initiatives**

- Paul Bollinger, Director, Boeing Energy

1215 **Continue Discussions *with Lunch Available***

1300 **Air Force Materiel Command Initiatives**

- Col Douglas Wise, Chief, CE Operations and Readiness Division, HQ AFMC/A7O
- Col Stephen Wood, Vice Commander, Air Force Sustainment Center
- Kirk Rutland, Technical Director, Test Sustainment Division, Arnold Engineering and Development Complex
- Cameron Stanley, Advanced Power Technology Office, Air Force Research Laboratory

1600 **Break**

1615 **Workshop Committee Feedback to Day 1 Presentations**

- All

1700 **Adjourn**

TUESDAY, NOVEMBER 6

0900 **Navy Initiatives**

- Thomas Hicks, Deputy Assistant Secretary of the Navy for Energy
- Sandrine Schultz, Energy Program Manager, Commander, Navy Installations Command

1000 **Break**

1015 **Army Initiatives**

- John Dwyer, Deputy Chief of Staff for Logistics (G4), Army Materiel Command

1115 **DOE Initiatives**

- Timothy Unruh, Program Manager, Federal Energy Management Program, Office of Energy Efficiency and Renewable Energy

1215 **Continue Discussions *with Lunch Available***

1315 **Manufacturing Industry Initiatives**

- Al Hildreth, General Motors
- James Porter, Jr., Independent Consultant
- Roger Weir, Energy Manager, ATK Aerospace Systems

1600 **Workshop Committee Feedback to Day 2 Presentations**

- All

1700 **Adjourn**

WEDNESDAY, NOVEMBER 7

0900 **HAF Initiatives**

- Col Gregory Ottoman, Chief, Environment and Energy Division, Office of the Deputy Chief of Staff for Logistics, Installations, and Mission Support

1000 **Break**

1015	**General Discussion with Participants to Include Next Steps** ➢ All
1200	**Continue Discussions *with Lunch Available***
1300	**Adjourn**

Appendix C

Workshop Participants

Energy Reduction at U.S. Air Force Facilities Using Industrial Processes:
A Workshop

November 5-7, 2012

The Keck Center of the National Academies
Room 110
500 Fifth Street, NW
Washington, DC 20001

COMMITTEE MEMBERS

Lt Gen (ret) Kenneth E. Eickmann, *Chair*
Robert E. Hebner, Jr.
Thom J. Hodgson
Gwen P. Holdmann
MG (ret) Carroll N. LeTellier
James B. Porter, Jr.
RADM Scott E. Sanders

NRC STAFF

Terry Jaggers, *AFSB Director*
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Gregory Eyring, *Rapporteur*
Dionna Ali, *Senior Program Assistant*
Marguerite Schneider, *Administrative Coordinator*

SPEAKERS

Kevin Geiss
Deputy Assistant Secretary of the Air Force for Energy
Office of the Assistant Secretary of the Air Force for
Installations, Environment and Logistics

Paul Bollinger
Director
Boeing Energy

John Dwyer (via VTC)
Deputy Chief of Staff for Logistics (G4)
Army Materiel Command

Robert Gemmer
Technology Manager
U.S. Department of Energy

Thomas Hicks
Deputy Assistant Secretary for the Navy for Energy

Al Hildreth
Company Energy Manager
General Motors

Col Gregory Ottoman
Chief, Environment and Energy Division
Office of the Deputy Chief of Staff for Logistics,
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Kirk Rutland
Technical Director, Test Sustainment Division
Arnold Engineering and Development Complex

Sandrine Schultz
Energy Program Manager
Commander, Navy Installations Command

Joseph Sikes
Director of Facilities Energy Privatization
Office of the Deputy Under Secretary of Defense
for Installations and Environment

Cameron Stanley
Support Contractor
AFRL/RXS-APTO

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Col Douglas Wise
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HQ AFMC/A70

Col Stephen Wood
Vice Commander
Air Force Sustainment Center
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GUESTS

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Chief, Energy Branch
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Facility Engineer
USAF AFMC 76th Propulsion Maintenance Group

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Elisa Shyu
Senior Consultant
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Appendix D

Presentation Abstracts

Speaker: Kevin Geiss, Deputy Assistant Secretary of the Air Force for Energy
Presentation Title: Vision for the Workshop

The U.S. Air Force is a leader in energy security with a history of innovation in identifying ways to reduce demand and increase the supply of energy. In the area of alternative fuels, the Air Force has worked for six years to certify aircraft on a range of alternative fuels including Fischer-Tropsch, Hydroprocessed Renewable Jet and Alcohol to Jet fuel types. Along the way the Air Force accomplished a number of “firsts” including the first aerial refueling, first supersonic flight, and first flight by an aerial demonstration team (the Thunderbirds). This certification has been shared with the aviation industry through the Commercial Aviation Alternative Fuels Initiative (CAAFI) and leveraged by airlines that now fly select routes on biofuel blends. Dr. Geiss’ presentation reviews the Air Force’s alternative fuel accomplishments and highlight areas of current and future research, testing and application. This includes on-going certification of aircraft on alternative fuels, months-long field testing of drone aircraft on biofuels and analysis of the long-term impacts of biofuels on engine components. Dr. Geiss will also discuss partnerships with other U.S. government and military entities, foreign countries and industry. These partnerships allow the Air Force to share its knowledge and expertise with the fuel-engine interface with outside organizations who can then bring their own knowledge and perspectives to the issue.

Speaker: Joseph Sikes, Director of Facilities Energy Privatization, Office of the Deputy Under Secretary of Defense for Instillations and Environment
Presentation Title: OSD Initiatives

This talk will highlight the following OSD initiatives:

- DoD Goals and Objectives
- 2011 Annual Energy Management Report (AEMR)--Status of Performance Metrics
- Validity of Performance Metrics
- What to expect in the Next Administration

Speaker: Paul Bollinger, Director, Boeing Energy, Boeing Defense, Space and Security
Presentation Title: Boeing Internal Resources Reduction Initiative

The Boeing Company is the world's largest and most diversified aerospace company with Commercial and Defense, Space & Security partners and customers in more than 90 countries. We have more than 172,000 employees and 86 million square feet of floor space. While Boeing is aggressively driving toward greater sustainability in all aspects of our business, this presentation focuses on our internal operations, manufacturing and office conservation initiatives. Boeing is on track to meet externally communicated five-year Environmental Targets for reductions in energy consumption, greenhouse gas, hazardous waste generation and water use, as well as an increase in recycling rate. In addition, Boeing has established a LEED Silver standard for all new construction and building refurbishments and utilizes industry tools and best practices like EPA ENERGY STAR programs to continuously improve the efficiency of sites and buildings. To ensure meeting Company goals, the enterprise Conservation Initiative is comprised of eight focus areas that are driven by specific strategies, goals, communications and monthly metrics at all levels from individual sites up to the headquarters in Chicago. Conservation Focus Areas include: Energy Conservation, Renewable Energy, Sustainable Site & Building Design, Solid Waste & Recycling, Hazardous Waste, Water Conservation, Fleet Management and Alternative Commuting. Conservation strategies have also been incorporated into our Lean practices and workshops across the enterprise. Other programs that help drive greater sustainability include empowering more than 6,000 Employee Involvement Teams across the company to improve efficiency and eliminate waste. The annual internal Conservation Awards Program recognizes excellence in ten sustainability categories. Boeing also competes for external awards and recognition and has been named an EPA ENERGY STAR Industrial Partner of the Year for the past two consecutive years. Boeing's commitment to environmental stewardship starts at the top. Jim McNerney, President and Chief Executive Officer, in response to Boeing being awarded the 2012 Partner of the Year Award, stated "This ongoing achievement showcases our employees' commitment to champion the environment in everything we do – from developing and building our products to improving the efficiency of the infrastructure that supports them. This recognition is a reminder that all of us need to do our part to reduce consumption and conserve energy."

Speaker: Col Douglas Wise, Chief, CE Operations and Readiness Division, HQ AFMC/A70
Presentation Title: AFMC Facility Energy Program

The DoD is the largest single user of energy in the US. In 2011, the DoD spent almost $20B on energy and the Air Force made up almost half of that amount. The vast majority of the Air Force's energy use is for aviation fuels with smaller amounts consumed in facilities/utilities and transportation energy. For AFMC, the figures for aviation and facilities/utilities energy are reversed. AFMC therefore is focusing on facilities/utilities energy. In addition, AFMC is falling short of Executive Order goals for energy and water intensity reduction. By 2015, it is estimated that AFMC will fall 10% short of the energy intensity goal. To close this gap, AFMC needs to look at loads not associated with the facility envelope. This type of energy is defined as Process Energy, which includes IT, labs, medical, and industrial energy. For AFMC, we are currently focusing on our large industrial complexes as they consume a significant portion of our energy. This energy is currently being termed Industrial Process Energy (IPE). In 2012, AFMC/A6/7 partnered with AFMC/A4 to initiate an IPE IPT. AFMC/A4 subsequently took the lead to develop an IPE action plan, which is currently under development.

Speaker: Col Stephen Wood, Vice Commander, Air Force Sustainment Center
Presentation Title: Air Force Sustainment Center: Process Energy Update

Col Steve Wood will discuss key aspects of Air Force Sustainment Center process energy. The discussion framework is provided so the audience can understand the Air Force and Air Force Material Command energy environment, and then AFSC’s Energy & infrastructure portfolio supported by detailed data associated with AFSC installations; Tinker, Hill, and Robins AFBs. Follow-on emphasis is provided regarding AFSC/CC Energy Philosophy as well as accomplishment, challenges, enablers, and future focus for process energy reductions.

Speaker: Kirk Rutland, Technical Director, Test Sustainment Division, Arnold Engineering and Development Complex
Presentation Title: Energy Reduction: AEDC Perspective

AEDC is a primary ground test component within DoD’s Major Range and Test Facility Base (MRTFB). As part of the MRTFB, AEDC’s mission is to provide decision quality data for acquisition programs. It’s extensive suite of test facilities are operated and maintained using Air Force RDT&E funding. Historically, approximately 92% of the energy consumed at AEDC is directly related to the test mission. Annual fluctuations in total energy demand are a product of the type and level of test workload. The majority of AEDC’s test infrastructure was designed and constructed prior to 1980 and is heavily dependent on electrical power to create the required test environment. Energy efficiency was not a critical design component. While the Air Force has made significant AEDC infrastructure investments over the last decade, the focus was on developing and sustaining critical test capabilities driven by acquisition program requirements. Marginal improvements in energy consumption have been made but not tracked. AEDC is currently evaluating 14 different energy reduction proposals, but the RDT&E funding pressures prevent major investments for energy reduction initiatives. Since the AEDC test facilities are coded RDT&E, they are prevented from competing for USAF Energy funding.

Speaker: Cameron Stanley, Support Contractor, Air Force Research Laboratory
Presentation Title: Environmental and Energy (E2) Technology Programs

The Advanced Power Technology Office (APTO) is AFRL's post S&T RDT&E focus on facility power and energy demonstrations. APTO has performed several technology demonstrations at large facilities across the Air Force. Primarily, demonstrations have highlighted technologies in the following 5 technology focus areas: Renewable Energy Integration, Energy Storage, Hydrogen, Waste to Energy, and Advanced Energy Technologies. The APTO technology development process, which includes requirements gathering, technology selection, solution development, operational validation, and transition planning, provides energy technology solutions that meet the needs of the operational Air Force and demonstrates enhanced capability while reducing energy consumption and environmental impact. The lessons learned from testing and demonstrating these technologies can be leveraged to address process energy issues at Air Force depots.

Speaker: Thomas Hicks, Deputy Assistant Secretary of the Navy for Energy
Presentation Title: Department of the Navy Energy Program

No abstract submitted.

Speaker: Sandrine Schultz, Energy Program Manager, Navy Installations Command
Presentation Title: Commander, Navy Installations Command Navy Shore Energy Program Brief

No abstract submitted.

Speaker: John Dwyer, Deputy Chief of Staff for Logistics (G4), Army Materiel Command
Presentation Title: AMC Facilities Energy Program

AMC's Energy Program used four basic tenants: Planning - Put plans in place to drive down demand and costs; Commander Visibility and Emphasis - Commanders must have a good handle on their energy requirements and associated costs; Technology -include energy considerations in construction and renovation projects by applying technology solutions; Communication: Share successes and challenges. AMC uses opportunities to increase productivity and energy efficiency through the use of Sustainment, Restoration and Modernization (SRM) funds at installations such as Tobyhanna, AD, Adaptive re-use of older facilities at installations such as Anniston AD, and new construction to consolidated facilities with reduced energy footprint at Corpus Christi AD. AMC's estimates a total investment of $360M is required (~ 2-3 times AMC's annual energy expenditure) to meet its 30% energy intensity reductions goal by FY15. AMC will leverage available authorities to establish long-term public/private partnerships (Energy Savings Performance Contracts (ESPC), Utility Energy Services Contracts (UESC), Enhanced Use Lease (EUL), Power Purchase Agreements (PPA) to provide sources for private sector financing for AMC energy projects. AMC currently has six active ESPCs with total third-party investment > $88M and is actively pursuing third-party financing at four AMC Installations and one UESC execution at another. AMC's approach to third party financing will conduct detailed energy audits and evaluate industrial process efficiency as part of ESPCs and other third party financing opportunities to provide detailed evaluations of energy using systems. The systems include compressed air and the associated distribution system, motors, lighting, HVAC/building pressurization, boiler/steam system decentralization and other energy using systems such as refrigeration, melting furnaces, process ovens, cracking towers, welding operations. Measurement and verification (M&V) of energy performance through utility metering is paramount to provide an indicator of success for the third party financed projects.

Speaker: Timothy Unruh, Program Manager, Federal Energy Management Program, Office of Energy Efficiency and Renewable Energy
Presentation Title: Federal Energy Management Program Overview

No abstract submitted.

Speaker: Al Hildreth, PE, CEM, Company Energy Manager, General Motors
Presentation Title: GM's Robust Energy Management System

Energy use is a large, but mandatory, expense incurred by manufacturers or facility operators and contributes to Greenhouse Gas (GHG) emissions. At General Motors (GM), although our expenditure for energy is not a large percentage of our total cost, we do spend in excess of $1 Billion USD annually. GHG emissions from energy use represent over 7 million metric tons per year of GM's carbon footprint. Hence, a robust Energy Management business process is needed to meet the challenge for industry. Management of energy and carbon to reduce environmental impact has become important enough to be included in our business plan, similar to safety, people, quality, responsiveness, and cost. Following a model similar to EPA Energy Star's seven step approach, energy as an environmental element has been integrated into GM's business policy and model. Based on top level commitment and public goals to reduce energy and GHG by 20% from 2010 to 2020, GM uses its standardized Global Manufacturing System (GMS) to ensure that energy efficiency and conservation is properly managed through performance assessment, action plans, evaluating progress, and recognizing achievements. The methods used to integrate energy management into our business plan include dedicated resources at all levels in the organization. With people as one of our most important resources, having qualified energy leaders at the corporate, global, regional and site levels is key to our success. To implement initiatives a dedicated budget for systems and projects is required, similar to other areas of the business. Forecasting energy, establishing targets, implementing projects and processes, regular monitoring, and corrective action when required ensures timely adherence to meeting our energy and carbon goals. GM recognizes achievements internally with various processes – Plant energy performance recognition, employee suggestions, employee compensation tied to business results, and others. Also, GM's recognition of our energy performance externally includes many awards and recognitions – EPA Energy Star labels for 2 facilities, meeting Energy Star's Challenge for Industry for 54 plants globally over the past year avoiding $90 Million USD and 1.2 million metric tons of GHG emissions, and winning a 2012 Energy Star Partner of the year award in Energy Management, along with many global, regional, and local awards for protecting the environment.

Speaker: James Porter, Jr., Chief Engineer and Vice President Engineering and Operations, DuPont(Retired); Founder and President, Sustainable Operations Solutions, LLC
Presentation Title: Sustainable Energy Management-"An Industrial Perspective"

The primary focus of the presentation was what is an effective leadership model to embed energy management in an organization so they can *"Make Energy a Consideration In All We Do"*? The model currently practiced in DuPont was highlighted and an energy management Tool Box was outlined. Focus areas for dealing with process energy management as well as core considerations to lead a culture change were discussed.

Speaker: Roger Weir, Energy Manager, ATK Aerospace Systems
Presentation Title: ATK Energy Efficiency Initiatives

ATK is a Fortune 500 aerospace, defense, and commercial products company with operations in 21 states, the Dominican Republic, Puerto Rico, and internationally. World's top producer of solid rocket propulsion systems. World's largest producer of military ammunition. Leader in affordable precision weapons, propellants, and energetic. Leading brands in law enforcement and sporting ammunition. Leading brands in soldier systems, sporting, and hunting accessories. Provider of advanced composite structures, satellite components, and subsystems. ATK operates in 3 business units; Aerospace, Defense and Sporting. Enterprise-wide Energy Team formed in 2003, 24 locations participate on the corporate team. Emphasis is on communication and sharing of best practices and lessons learned. The Team has four "working groups" centered on: Lighting, Compressed Air, Steam, and Natural Gas. Working groups meet monthly to discuss issues impacting energy costs and efficiency. Team Mission: Manage Energy Costs and Consumption – Not just pay bills. Work with providers and regulators to control costs and maximize savings. Develop meaningful measures of energy performance. Facilitate implementation of cost effective energy projects. Encourage Communication, within locations and across all locations. Provide Forum to share Best Practices as well as Lessons Learned. Be a single source for all energy and energy related information. Track Green-House-Gas emissions and minimize carbon footprint. Cultivate increased energy awareness across all ATK employees. Team projects generate more than $2M in annual energy savings and total actual energy usage has been decreasing consistently for the past 3 years. Focus of many of the projects has been to identify waste, make use of it or eliminate it. Efficiency improvements have been included in many process improvement projects. Measuring energy usage and providing data and usage goals to operating areas has been a focus at several locations ATK has also been actively engaged with DOE to help develop new energy technologies to put wasted energy to use and optimize operation of renewable resources and electric storage.

Speaker: Col Gregory Ottoman, Chief, Environment and Energy Division, Office of the Deputy Chief of Staff for Logistics, Installations, and Mission Support
Presentation Title: Air Force Facility Energy Initiatives

The Air Force Facility Energy Program is focused on making sound fiscal investments, meeting Air Force mission requirements, and complying with numerous statutory goals and executive orders. The Air Force has made significant investments in energy and water conservations projects over the last 18 years that have reduced energy consumption by 35%. This translates into annual cost avoidance in FY11 estimated at $579M. While great progress has been made, the Air Force, along with the other Services, is challenged in meeting the aggressive mandates and goals. The Air Force is executing an investment strategy that combines direct appropriated funds investment along with third-party financed projects to conserve energy and water as well as increase production of renewable energy. Another initiative is significantly increased use of facility meters along with an advance meter reading IT system. While, this is mandated under EPACT 05 and EISA 07, it is also a key enabler in the Air Force energy program, helping to identify energy efficiencies and provide measurement and validation of previous efforts. The Air Force is in the early stages of establishing a "Net Zero" energy, water, and waste implementation strategy that integrates the on-going efforts in all three areas, while seeking to maximize conservation results, improve energy security, and minimize long-term environmental liabilities.

Appendix E

Energy Management Checklist

This document is intended to be used as a checklist for walk-through energy efficiency audits and assessments.

Steam Generators and Heat Transfer Fluid Heaters and Vaporizers

- Use Fuel Flow/Air Flow Control with Oxygen Trim
- Maintain Excess Oxygen Below 5%, Below 8% for Stokers
- Reduce Stack Temperature to 330°F for Sulfur Bearing Fuels
- Minimize Combustibles in Stack Gas and Ash
- Burn the Lowest Cost Fuel
- Apply the "Utilized Cost" of Coal
- Minimize the Use of Stabilizing Fuel If It Is Expensive
- Burn Non-hazardous Wastes in Boilers or Vaporizers
- Check Casing and Flue Gas Ducts for Air In-leakage
- Optimize the Soot Blowing Schedule
- Keep Internal Tube Surfaces Free From Deposits
- Check Boiler/Vaporizer Efficiency Regularly
- Recycle Wastewater Streams for Ash Sluicing
- Split Range Control of Fan Speed and Dampers
- Control Oil Tank Temperature at Minimum
- Automate Boiler Blowdown
- Install Blowdown Heat Exchanger
- Optimize Load Sharing Between Boilers and Vaporizers
- Operate Boiler Feed Pumps at Minimum Discharge Pressure
- Check Feedwater Heaters for Efficient Heat Transfer
- Reduce Deaerator Vent to <O.1% Water Flow or <0.5% Steam Flow
- Keep Steam Pressure and Temperature at Maximum If System Has Turbines
- Lower Steam Header Pressure If There Are No Turbines

Steam Users

- Eliminate or Find a Use for Vented Steam
- Install Jet Compressor to Make Low Pressure Steam Useful
- Shift Users to Lowest Header Pressure Possible
- Optimize Steam Balance with the Right Combination of Motors and Turbines
- Install Condensate Flash Tanks to Recover Low Pressure Steam
- Reduce Pressure of Heating Steam During Warmer Weather
- Use Turbines Instead of PRV's to Reduce Steam Pressure
- Adjust Steam Header Pressures to Maximize Turbine Work
- Close Turbine Hand Valves
- If Turbine Exhaust Must Be Vented, Vent Those Turbines to Atmosphere
- Install Smaller Turbine Nozzles
- Repair Steam Leaks
- Isolate Unused Steam Lines
- Eliminate Long Steam Lines with Low Flow
- Establish an Effective Steam Trap Maintenance Program
- Reduce Failed Steam Traps to <5% of Total
- Ensure Bypass Valve Around PRV's Is Not Leaking
- Return All Condensate
- Recover Waste Heat Wherever Possible
- Replace Steam Vacuum Jets with Mechanical Vacuum Pumps
- Be Sure Vacuum Jets Have the Correct Nozzle Size
- Operate the Minimum Number of Vacuum Jets
- Be Sure Vacuum Jets Have the Correct Steam Supply and Exhaust
- Check Actual Steam Consumption Against Design
- Check Turbine and Condenser Performance Regularly
- Keep All Steam, Dowtherm, and Condensate Lines Properly Insulated
- Provide New Heat Tracing as Electric, Not Steam
- Conduct a PINCH Technology Survey

Electrical Loads

- Buy New High Efficiency Motors Instead of Rewinding Failed Motors
- Install High Efficiency Motors for New Applications
- Change to Smaller Motors on Lightly Loaded Drives
- Challenge the Need for Every Motor Running
- Use Variable Frequency Drives If Flow Rate/Load Varies Widely
- Use Daylighting Where Possible
- Remove Lamps Where Illumination Is More Than Is Needed
- Promote Turning Off Lights and PCs When Not In Use
- Use Photocells, Timers, or Motion Detectors to Operate Lights

- Replace Incandescent Lamps with Fluorescent, Sodium Vapor, or Metal Halide Fixtures
- Replace Safety Shower and Fire Alarm Incandescent Lamps with Compact Fluorescent Lamps
- Replace Fluorescent Ballasts and Lamps with High Efficiency Electronic Type Ballasts and T8 Lamps
- Request a Lighting Survey
- Clean Light Fixtures to Improve Efficiency/Light Levels
- Provide Electric Tracing Rather Than Steam Tracing
- Provide Controls on Self-Limiting Electrical Tracing
- Maintain Heat Tracing Thermostats and Controls
- Do Not Provide Heat Tracing For Freeze Protection on Lines 6" or Larger
- Keep Electrical Equipment Cool

Electrical Power Distribution

- Buy All Electricity Under One Contract
- Take Advantage of Utility Incentives for Demand Side Management
- Request an Interruptible Electrical Contract
- Have a Load Reduction Plan to Avoid Setting New Electrical Peaks
- Take Advantage of Utility Incentives for Demand Peak Shaving
- Use Diesel Generators to Shave Peaks
- Increase Turbine Generator Load to Shave Peaks
- Transfer Loads from Motors to Turbines to Shave Peaks
- Avoid Setting Peaks by Cycling Nonessential Equipment
- Run Nonessential Equipment and Batch Processes During Off Peak Hours
- Delay Starting Motors Until a New Peak Can Be Avoided
- Switch Large Motors Quickly to Avoid Setting a New Peak
- Install a Power Monitoring System to Enable Load Management
- Trend Plant Loads to Avoid Adding Unnecessary Distribution Equipment
- Analyze Power Usage to Identify Energy Reduction Opportunities
- Install Capacitors to Increase Power Factor
- Install Solar Photovoltaic Systems for Small Remote Loads
- Specify High Efficiency for New Power Transformers

Refrigeration

- Allow Condenser Pressure to Drop With Reduced Cooling Water Temperature
- Control Condenser Pressure to Reduce Horsepower
- Vary the Hot Gas Bypass Control Set Point With Condenser Pressure
- Monitor Energy Consumption Per Ton to Detect Poor Machine Performance
- Increase Chilled Water Delta T Across Machines to Design Or Greater Values
- Maintain Proper Amounts of Refrigerant Charge

- Keep Condensers Clean
- Avoid Liquid Refrigerant Carryover Into Compressor
- Operate the Refrigeration Evaporator at the Highest Practical Temperature (Pressure)
- Minimize or Eliminate Air In-Leakage to Refrigeration Machines
- Operate the Minimum Number of Refrigeration Machines for the Load
- Install Refrigeration Optimization Control System
- Optimize Brine System Concentration
- Install Thermal Storage to Shift Load Off-Peak
- Use Absorption Refrigeration Driven by Low Level Heat
- Shift Loads From Chilled Water to Cooling Tower Water When Feasible
- Precool With Cooling Tower Water Before Applying Chilled Water

Cooling Towers

- Run Minimum Number of Pumps
- Throttle Flow in Plant to Get the Design Delta T Across the Tower
- Select Fan Speed for Ambient Conditions
- Install Adjustable Pitch Fan Blades
- Maintain Correct Cycles of Concentration
- Maintain Tower Equipment to Run at Design Conditions

Heating, Ventilating, and Air Conditioning (HVAC)

- Heating, Ventilating, and Air Conditioning (HVAC) Control Systems
- Use Exhaust Air to Heat or Cool Other Areas
- Balance Air Flows to Meet Actual Loads
- Ensure That Exhaust Flow Matches or Balances Conditioned Air Supply
- Ensure That Duct Work is Free of Obstructions
- Ensure That Terminal Diffusers and Ducts are Clean
- Keep Coils Clean
- Keep Air Filters Clean
- Keep Fans Clean
- Control Flow Through Air Washers Where Possible to Adiabatic Operation
- Repair or Replace Air Washer Nozzles That Do Not Atomize Properly
- Trim Impellers on Air Washer Pumps When Oversized or Install Smaller Impeller
- Make Sure Control Valves to Coils Completely Shut Off When Not in Use
- Make Sure Steam Traps on Heating Coils Function
- Make Sure Dampers on Coil or Air Washer Systems Close Completely
- Maximize Supply Air Temperature During Cooling Season and Minimize During Heating Season
- Minimize Control of Humidity Consistent with Personnel and Product Needs

- Minimize or Eliminate Heating and Cooling in Unoccupied Areas
- Install Thermostats on Interior Walls
- Calibrate and Eliminate Poor or Non-performing Controls
- Install DDC Controls to Replace Pneumatic Controls
- Install HVAC Management System
- Utilize Water-Side Cooling Tower Economizer Systems in Winter Where Possible to Replace Chilled Water
- Reduce Preheater Set Point
- Install Adequate Insulation on Chilled Water Systems
- Use Primary-Secondary Circuits and Variable Flow Chilled Water Systems Where Applicable
- Replace Worn or Loose Belts on Fans
- Install Waste Heat Recovery Where Applicable
- Install or Switch to Variable Air Volume Air Distribution System
- Use an Infrared Survey to Locate Heat Loss

Building Envelope

- Install Tight Sealing Doors and Windows to Minimize Infiltration
- Install Hanging Door Seals in High Traffic Areas
- Use Ceiling Fans to Eliminate Stratification of Air in High Ceiling Areas
- Install Adequate Building Insulation
- Install Roof Spray Systems to Minimize Heat Gain
- Utilize Advanced Window Treatments to Minimize Heat Gain
- Where Appropriate, Re-Roof with Light Colored Roofing Materials
- Ventilate Attic Space
- Install Adequate Wall Insulation
- Insulate Partition Walls Between Conditioned and Unconditioned Spaces
- Keep Garage and Warehouse Doors Closed
- Use Self Closing Doors
- Recaulk Doors and Windows and Install Weather-Stripping
- Replace Broken Windows
- Install Vestibules to Prevent Excessive Air Infiltration
- Close Abandoned Stacks

Compressed Air

- kW/100 scfm Should Be <19 for 100 psi and <24 for 160 psi
- Intercool Between Compressor Stages
- Keep Intake Filters Clean
- Cool Air Intake Where Possible
- Monitor Stage Temperatures and Pressures to Detect Problems
- Use Inlet Guide Vanes for Control of Centrifugal Compressor Output

- Control Antisurge Valves with Flow Rather than Pressure
- Keep Antisurge Valves Closed
- Base Load Centrifugals and Carry Swings on Reciprocating Compressors
- Optimize Load Sharing Between Compressors
- Reduce the System Pressure to the Minimum Needed
- Use a Booster Compressor for Small High Pressure Loads
- Use Air Blower Instead of Compressed Air
- Do Not Use Compressed Air for Cleaning or Agitation
- Eliminate Air Trap Leakage
- Repair Air Leaks
- Shut Off Compressed Air to Equipment That Is Down
- Replace "Heatless" Air Dryers with "Heated
- Eliminate Pressure Regulators That Bleed Air
- Monitor Compressed Air Use to Detect Abnormal Changes

Fans

- Use Adjustable Speed Drives
- Reduce Speed with Sheave-Change to Minimize Damper Throttling
- Control Fan Output with Inlet Guide Vane Control to Reduce Throttling Loss
- Keep Fan Belts From Slipping
- Size Ductwork to Give Minimum Static Pressure Loss
- Minimize Duct Leakage

Pumps

- Reduce System Pressure to Minimum Needed by the Users
- Substitute Gravity Flow Where Possible
- Use a Booster Pump for a Small High Pressure Demand
- Connect Heat Exchangers in Series to Reduce Cooling Water Flow
- Operate the Minimum Number of Pumps for the Load
- Install Smaller Impellers to Avoid Throttling Loss
- Maintain Pumps to Produce Design No-Load Discharge Pressure
- Use a Variable Frequency Drive To Control Discharge Pressure

General

- Reuse Water Wherever Possible
- Use Untreated Water Instead of Filtered Water
- Control Water Flow to Coolers and Condensers at Optimum Rate
- Keep All Instrumentation Calibrated
- Measure and Record All Utility Consumption and Analyze Performance and Trends

- Operate the Minimum Amount of Equipment to Satisfy System Loads
- Use DCS and Energy Optimization Systems to Control Efficiently
- Use All Utilities at the Most Economical Temperature and Pressure
- Optimize Piping Systems for Minimum Life Cycle Cost
- Isolate All Unused Energy Consuming Equipment
- Insulate Heated Tanks
- Use Suction Heaters Instead of Heating Entire Tanks
- Repair Hot Water Leaks
- Run Hot Water Heaters at Minimum Temperature Required
- Keep Heat Exchanger Surfaces Clean
- Purchase Only Energy Efficient Equipment
- Use Heat Pumps to Supply Hot Water and Refrigeration
- Operate Internal Combustion (I/C) Engines Only When Necessary