



Meeting the Goal

## FEMP Studies Impacts of New Building Performance Standards on Laboratory Design

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The Energy Policy Act of 2005 (EPA 2005) has many energy goals and requirements that affect all federal buildings. This article focuses on Section 109, Federal Building Performance Standards. Section 109 requires new federal buildings to meet American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 90.1-2004. Section 109 also requires new federal buildings to be designed to achieve energy consumption levels that are at least 30 percent below the levels established in the ASHRAE 90.1-2004, if life cycle cost effective.

The energy performance improvements between ASHRAE 90.1-1989 and 90.1-2004 are significant, and a full description is well beyond the scope of this article. As an example, the lighting power density for an office space is 1.0 per square foot in the 2004 version; it was 1.3 watts per square foot in the 1999 version and 1.8 per square foot in the 1989 version.

ASHRAE standard 90.1-2004 has a new “Informative Appendix G Performance Rating Method” intended for use in rating the energy efficiency of building designs that exceed the minimum requirements. The energy performance must be calculated using simulation programs such as DOE-2, BLAST, or EnergyPlus. The improved performance of a proposed building is calculated using the following formula:

$$\% \text{Savings} = 100 * \frac{\text{BaselineBuildingPerformance} - \text{ProposedBuildingPerformance}}{\text{BaselineBuildingPerformance}}$$

Baseline Building Performance = Total Baseline Building Energy Costs (including ALL plug loads)

Proposed Building Performance = Total Proposed Building Energy Costs (including ALL plug loads)



...and more!

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Michael Magee, Regional Energy  
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# EPA Optimizes Controls at its Research Triangle Park Laboratory with Real-Time Commissioning

The Environmental Protection Agency's (EPA's) Research Triangle Park (RTP) facility has more than 1 million square feet of office and laboratory space. The laboratory space contains more than 600 laboratory modules and 200 fume hoods, while the vivarium (animal holding area) contains 73 laboratory modules, 20 animal suites with 5 surgical areas, and 26 fume hoods. In addition, there are numerous biological safety cabinets and local exhaust systems (canopy hoods) throughout the facility to ensure the safe operation of RTP's laboratories.

While the safety of all RTP personnel is of paramount importance, the systems necessary for maintaining that safety have a significant impact on the facility's energy consumption. Improvements in heating, ventilating, and air conditioning technology have provided an incentive for investigating ways to minimize energy use from these systems, while simultaneously maintaining critical safety features. EPA recently implemented two Controls Optimization Projects at RTP: one for laboratory controls (LCOP) and one for vivarium controls (VCOP). These projects have reduced energy use by minimizing airflow during periods of reduced activity.

EPA tested a sampling of the fume hoods installed during the optimization projects to evaluate their ability to control airflow and ensure the safety of laboratory personnel. Using statistical analysis EPA extrapolated the sample data to establish a baseline flow spreadsheet. Following baseline measurements, LCOP and VCOP required 4 major tasks:

Task 1: Determine minimum acceptable criteria for fume hoods and ventilation controls during both occupied and unoccupied periods.

- Identify laboratories that have the ability to be setback during unoccupied periods.
- Re-calculate optimal airflow set points for laboratories, corridors, and atriums.
- Assess the impacts of airflow changes on system operations.

Task 2: Develop a plan for implementing and continuing new set points for laboratory ventilation controls.

- Develop a commissioning protocol to ensure that new set points are achieved.
- Ensure that laboratories meet EPA performance requirements during occupancy.

Task 3: Implement the approved commissioning protocol in all laboratory modules, animal suites, surgical areas, and associated corridors and atriums.

Task 4: Implement a Static Pressure Optimization and Reduction Test (SPORT).

- Determine the minimum static pressure set points for the supply and exhaust systems.
- Determine optimum sequence of exhaust fan and air handler operation.

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**EPA OPTIMIZES CONTROLS AT ITS RESEARCH TRIANGLE PARK LABORATORY WITH REAL-TIME COMMISSIONING**  
(continued from page 2)

The current estimate of airflow savings are shown in the table below:

Building	Estimated Design Occupied to Post LCOP Occupied Supply Reduction cfm	Estimated Design Unoccupied to Post LCOP Unoccupied Supply Reduction cfm	Estimated Maximum Flow Reduction from Task 1 Investigation cfm	Baseline Measured to Post LCOP Supply Flow Reduction cfm	Baseline Building Supply Flow Measured Actual cfm	LCOP/VCOP Flow Reduction as % of Baseline Bldg. Supply Flow	Estimated Supply Flow Reduction Post LCOP in Atrium & Corridors	Baseline Measured to Post LCOP Supply Flow Reduction + Corr./Atriums	Total LCOP/VCOP Flow Reduction as % of Baseline Bldg. Supply Flow
RTP - B	20,725	32,580	32,580	59,960	184,680	32	12,000	71,960	39
RTP - HB	3,805	9,125	9,125	16,150	84,174	19	0	16,150	19
RTP - D	19,650	37,470	37,470	36,500	138,497	26	10,000	46,500	34
RTP - E	20,550	38,305	38,305	38,305	176,171	22	10,000	48,305	27
RTP - A (VCOP)	17,039	30,304	53,952	53,952	189,645	28	5,000	58,952	31
Total	81,769	147,784	171,432	204,867	773,167	26	37,000	241,867	31

EPA has invested \$1.9 million in the laboratory and vivarium control optimization projects. A conservative estimate of energy costs for outside air is \$4 per cubic-foot-per-minute (cfm), obtained from the Lawrence Berkeley National Laboratories cfm calculator. Even applying this conservative estimate to saving 204,867 cfm provides savings of over \$820,000 per year, which equates to a 2.3-year payback period. Expanding the initial project to include ventilation modifications in the corridors and atriums would increase savings to \$967,000 and shorten the payback period to 1.9 years.

In addition to the financial benefits of LCOP and VCOP, these projects have provided EPA with less tangible benefits, including:

- 1) Proving the accuracy, repeatability, and reliability of the entire laboratory ventilation system.
- 2) Extending the life of the equipment by performing preventative maintenance on all components of the

laboratory ventilation system.

- 3) Providing the Operations and Maintenance (O&M) staff with accurate and extensive documentation for preventative maintenance.
- 4) Establishing protocols for O&M staff that will enable them to quickly and efficiently use the Building Automation System (BAS) to verify and continuously commission the laboratory ventilation system.

As a result of the success of these projects at RTP, EPA has decided to extend the same LCOP and VCOP protocols to its entire inventory of laboratory buildings. A project in Denver is already yielding savings and paybacks similar to those seen at RTP. Numerous other projects are in planning stages and will be implemented as part of EPA's strategy to meet the EPAct 2005's (the Energy Policy Act of 2005's) energy reduction requirements.

*For more information, please contact Dan Amon, EPA, at amon.dan@epa.gov.*

# New Best Practice Guides for Laboratories Now Available

The Laboratories for the 21<sup>st</sup> Century program (Labs21) has published several new best practice guides on specific technologies that contribute to energy efficiency and sustainability in laboratories. The guides were developed by the Labs21 technical team, with significant participation from industry experts. Each guide was also peer reviewed for technical accuracy. Each includes a description of the technology and provides specific best-practice strategies along with performance metrics and implementation examples. Since a full description of each guide is beyond the scope of this article, we encourage the reader to download them from the Web site at <http://www.labs21century.gov/toolkit/index.htm> for more detailed information.

## Modeling Exhaust Dispersion

The standard practice for designing exhaust stacks in laboratories involves the use of prescriptive guidelines, which may oversize the system while not necessarily meeting performance requirements. The practice strategies described in the guide include ASHRAE and Environmental Protection Agency (EPA) calculation and graphical methods, plume dispersion calculations, computational fluid dynamics, and wind tunnel modeling. These methods provide a more accurate assessment of exhaust dispersion. They can be used to produce exhaust/intake designs optimized for energy consumption, taking into account stack height, volume flow rate, exit velocity, expected pollutant emission rates, and concentration levels at sensitive locations.

## Water Efficiency in Laboratories

Laboratories offer significant opportunities for water savings. Some of these opportunities, such as increasing the concentration ratio for cooling tower water, rainwater harvesting, etc., are common to other commercial buildings. However, this guide focuses on strategies that are unique to laboratories, such as:

- Elimination of single-pass equipment cooling, which typically consumes more water than any other cooling method in laboratories;
- Use of counter-current rinsing to minimize water used for glass-washing;
- Flow control by using a control or solenoid valve that allows water to flow through a piece of equipment only when it is actually being used;
- Use of reverse-osmosis reject water for non-potable domestic uses; and
- Use of water efficient equipment for sterilization, photography, vacuum systems, dishwashers, and vivariums.

### Labs21 Best Practice Guides

- On-Site Power Systems
- Daylighting
- Energy Recovery
- Low-Pressure Drop HVAC Design
- Modeling Exhaust Dispersion
- Water Efficiency
- Minimizing Reheat Energy Use
- Right-Sizing Laboratory Equipment Loads
- Optimizing Ventilation Rates

## Right-Sizing Laboratory Equipment Loads

Peak equipment loads in laboratories are frequently overestimated because designers often use estimates based on “nameplate” rated data, or design assumptions from prior projects. These estimates result in oversized heating, ventilation, and air conditioning HVAC systems, increased initial construction costs, and increased energy use due to inefficiencies at low part-load operation. This best-practice guide presents a case study of over-sizing, and then describes best practice strategies to obtain better estimates of equipment loads and right-sized HVAC systems. Some of these strategies include:

- Measuring equipment loads in a comparable laboratory during peak activity, and then sizing HVAC and electrical systems based on this data;
- Use of a probability-based “bottom-up” approach to more accurately assess load diversity in a structured, methodical manner;
- Configuring equipment for high part-load efficiency; and
- Negotiating risk management between owners and designers.

## Minimizing Reheat in Laboratories

Load variation across different laboratory spaces can significantly increase simultaneous heating and cooling, particularly for systems that use zone reheat for temperature control. This best practice guide describes the problem of simultaneous heating and cooling resulting from load variations, and presents several technological and design process strategies to minimize it:

- Properly assess load variation during the design process and design HVAC systems taking these variations into account – do not assume uniform loads across the labs.
- Consider alternative HVAC systems that can mitigate reheat energy use by separating the thermal and ventilation systems.

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# NREL Builds New High-Performing, Low-Energy Laboratory

The National Renewable Energy Laboratory (NREL)'s 71,300 square-foot Science and Technology Facility (S&TF) is one of eight federal Laboratory for the 21<sup>st</sup> Century (Labs21) pilot projects. Sponsored by the Department of Energy's Federal Energy Management Program and the Environmental Protection Agency, the Labs21 pilot projects incorporate sustainable and low-energy features into laboratory design and construction in order to showcase strategies to achieve high performing laboratories. The S&TF houses laboratories designed to accelerate renewable energy process and manufacturing research for both near-term technologies, such as thin-film solar cells, and next-generation technologies, such as organic and nano-structured solar cells.

Laboratories use 5 to 10 times more energy per square foot than office buildings, so there is a large opportunity for energy savings. It is estimated that the S&TF will use 38 percent less energy than a conventional laboratory designed to the ASHRAE Standard 90.1-1999. The largest energy load in laboratory buildings is for conditioning and moving large volumes of ventilation air; the most significant and cost-effective energy savings features focus on reducing the quantity of air that needs to be conditioned while still maintaining a safe working environment for the occupants.

The state-of-the-art facility is the first federal laboratory building to achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) "Platinum" rating—the highest in the LEED rating system. Energy savings strategies

include the use of variable air volume supply and exhaust systems for all laboratory, low flow chemical, and laminar flow fume hoods, indirect/direct evaporative cooling, and energy recovery from both the exhaust air stream and process cooling water. S&TF also uses fan coil units to provide heating and cooling directly to the laboratory spaces, nearly eliminating the use of inefficient reheating systems. Finally, staged exhaust fans are brought on according to building exhaust needs, so fans will not run at 100 percent capacity when they are not needed.

Offices are located in a separate module of the building from laboratories, and were designed so that 100 percent of ambient light is provided by daylighting between the hours of 10:00 am and 2:00 pm. The offices are conditioned by an underfloor air distribution variable air volume system.

NREL recently completed extensive computer modeling to determine the building energy performance. Building energy use was simulated and compared against three base case buildings – the *LEED™ Application Guide for Laboratory Facilities* base case; ASHRAE 90.1- 1999; and ASHRAE 90.1- 2004. NREL also calculated the simple payback for a series of 11 individual energy savings strategies used in the building. This project will be documented as a Labs21 case study, and will be available in 2007 on the Labs21 Web site at [http://www.labs21century.gov/toolkit/case\\_studies.htm](http://www.labs21century.gov/toolkit/case_studies.htm).

*For more information, please contact Otto Van Geet of NREL at 303-384-7369.*

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## **NEW BEST PRACTICE GUIDES FOR LABORATORIES NOW AVAILABLE** (continued from page 4)

For example, a dedicated ventilation air stream can provide tempered air while thermal conditioning is done in the zone with fan coils or radiant panels.

- Continuous commissioning and diagnostics can help to identify zones with excessive reheat and adjust system control and operation accordingly.

### **Optimizing Laboratory Ventilation Rates**

Ventilation is often the largest component of energy use in a laboratory. Various codes and standards recommend a wide range of minimum ventilation rates—from 4 to 12 air changes per hour. In many laboratories, these minimum ventilation rates are set at excessively high levels even though more air changes do not necessarily improve safety. The challenge is to determine an optimal ventilation rate that handles both the worst scenario (possible) safely and manages routine scenarios (probable) efficiently. This guide describes a detailed deliberate decision-

making process to optimize ventilation rates, with techniques such as:

- Controlling banding, i.e. classifying hazards in each lab and customizing the ventilation rate accordingly;
- Using lower ventilation rates during unoccupied periods;
- Using emergency overrides with higher ventilation rates during a spill, but reduced ventilation rates during normal operation; and
- Using computational fluid dynamics (CFD) modeling or tracer gas evaluations to optimize the configuration of the ventilation system components.

Labs21 will continue to develop best practice guides on various efficiency opportunities in laboratories, and welcomes input from interested stakeholders for developing these guides.

*For more information, please contact Otto Van Geet of the National Renewable Energy Laboratory at [otto\\_vangeet@nrel.gov](mailto:otto_vangeet@nrel.gov) or 303-384-7369.*

## Sustainability in the Low Country – Labs21 Goes to Charleston, South Carolina

This October 2-4 in Charleston, South Carolina Laboratories for the 21<sup>st</sup> Century (Labs21®) will hold the Labs21 2007 Annual Conference, co-sponsored by the Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE), as well as the International Institute for Sustainable Laboratories (I<sup>2</sup>SL).

The conference will provide technical sessions for addressing the issues of sustainability, as well as up-and-coming challenges to laboratory energy use, including the impact of laboratories on climate change. This year's event also has many new opportunities for participants. Five professional development courses from the National Biosafety and Biocontainment Training Program will run on Sunday, September 31 and Monday, October 1. Attendees can earn continuing education units through the International Association for Continuing Education and Training that count toward a biosafety and biocontainment certificate. Labs21 will also offer its Introductory, Advanced, Operations and Maintenance, and Environmental Performance Criteria workshops. Attendees in

these courses can receive professional development hours for professional engineers or continuing education credits from the American Institute of Architects for registered architects.

In addition, the specialized symposia from last year's pre-conference events were such a success that Labs21 has incorporated these panel-based sessions into the main conference agenda. Topics will cover the realities of laboratory construction, goals for hospital design and efficiency, cross-contamination and international laboratory issues.

Early registration is now open at \$650, and late registration will be available after August 3, 2007 for \$700. Labs21 is also now offering full-time student discounts of \$350 (early registration) and \$400 (late registration). Learn more about the Labs21 2007 Annual Conference, including how to register, by visiting the Labs21 Web site at <http://www.labs21century.gov/conf>.

*For more information, please contact Will Lintner of FEMP at [william.lintner@ee.doe.gov](mailto:william.lintner@ee.doe.gov) or 202-586-3120.*

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## FEMP Staff Wins 2007 White House Closing the Circle Award

Congratulations to Federal Energy Management Program staff Anne Crawley, Matthew Gray, and Beverly Dyer (formerly with FEMP) for winning a 2007 Closing the Circle award under the new Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*.

FEMP staff received the award as chairs of DOE's Interagency Sustainability Working Group (ISWG), which serves as a forum for the exchange of information within the federal government on sustainable design activities. The workgroup consists of about 250 members from 20 Federal departments and agencies and 35 selected members from the private sector, industry, and academia.

The ISWG was instrumental in developing an interagency Memorandum of Understanding (MOU) on Federal Leadership in High-Performance and Sustainable Buildings. The MOU committed signatory agencies to meet five specific sustainable Guiding Principles for integrated design, energy performance, water conservation, indoor environmental quality, and materials. The ISWG also developed technical guidance for the implementing the Guiding Principles of the MOU.

The significance of the MOU was demonstrated in the recent presidential Executive Order 13423, which made mandatory the five Guiding Principles of the MOU for all new construction and major renovations, and set an aggressive goal for applying these practices to existing capital assets over the next decade.

*For more information on the 2007 Closing the Circle award winners, please visit [http://www.ofee.gov/ctc\\_winners.html](http://www.ofee.gov/ctc_winners.html).*



*Michael Kilpatrick, DOE's Deputy Chief for Operations, Health, Safety, and Security; Anne Crawley; Matthew Gray; Beverly Dyer; and Edwin Piñero, Federal Environmental Executive*

# BLM Awarded LEED Gold for Escalante National Monument Science Center

The Bureau of Land Management's (BLM) new visitor and science center at the Grand Staircase-Escalante National Monument has received Gold Certification in the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) green building rating program. The 13,000 square foot Escalante Science Center is earning recognition for its elegant design and healthy and comfortable indoor environment, as well as its energy efficiency, environmental sensitivity, and sustainability features.

Among the 42 green construction features that earned the building its distinction are rooftop swamp coolers that collect rainwater, recycled materials used in construction, daylighting, and a solar photovoltaic system that supplies 11 percent of the building's power. The center uses 40 percent less energy than a similar building of conventional construction.

BLM's goals for this facility from the beginning of the planning process were extraordinary energy efficiency and achieving a LEED rating. Trent Duncan of the Utah State BLM office requested design assistance for the project from FEMP in 2001, and the architecture and engineering firm Gillies Stransky Brems and Smith was chosen based on its ability to design buildings that are elegant and energy efficient.

FEMP-supported staff from Oak Ridge National Laboratory (ORNL) worked with the design team to identify energy conservation strategies and equipment options, and later

reviewed the firm's design and specifications. ORNL staff also constructed building simulation models based on American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) normal standards and the design to establish the center's LEED points for energy efficiency. Staff from the National Renewable Energy Laboratory provided technical assistance with the photovoltaic systems.

Skylights and interior and exterior light shelves in the Escalante Science Center reduce electrical lighting needs, and the interior lights adjust to the sunlight. Natural ventilation, operable windows, and materials low in volatile organic compounds contribute to a healthy indoor environment. Water-saving and reuse technologies reduce wastewater volume by 50 percent. A 7.5-kilowatt, grid-connected photovoltaic system generates 11 percent of annual energy needs; the remaining 89 percent is met through a green power purchase. These features, along with increased insulation, evaporative cooling, and high-efficiency boilers, account for the building's energy efficiency. Special care was taken at the Escalante site to use a previously disturbed area, and native vegetation is used for landscaping.

*For more information, please contact Ed Pierce at 865-574-6369 or piercefejr@ornl.gov, or Kirby Wilcher at 865-574-0429 or wilcherkl@ornl.gov.*



*The Escalante Science Center, which is two structures separated by a patio and trellis, was designated a Federal Energy Saver Showcase in 2005.*

## GSA's Cool Coup at the Philadelphia Custom House

As reported in the Summer 2005 edition of *FEMP Focus*, FEMP performed a study of prospective load management and demand response approaches for the General Services Administration's (GSA) Philadelphia Custom House in early 2005. GSA adopted the key recommendation and, through a few targeted operational changes and almost no capital cost, saved nearly \$70,000 in demand payments in 2005-2006 and more than \$100,000 (almost 15 percent of the facility's annual electricity bill) in 2006-2007.

GSA pays more than \$28 per kilowatt (kW)—two to three times the national norm—in demand charges for the 570,000 square foot Custom House, and is also subject to a demand “ratchet” such that 80 percent of its summer peak power draw (i.e., its highest single 30-minute interval reading between June and September) becomes its minimum billed demand for each of the next eight months (October through May).

Since the Custom House generally experiences a summer peak of about 2,000 kW, this means that GSA is obligated to pay for at least 1,600 kW during these off-peak months. However, the facility is a conventional federal office building with a low load factor, and barely reaches peaks of 1,000 kW from December to March. At more than \$28 per kW, the Custom House regularly pays its utility (PECO Energy) over \$15,000 per month during those four months (as well as additional sums in the “shoulder” months of October, November, April, and May) for power it does not even draw.

With this in mind, GSA commissioned FEMP to conduct a study on the potential to cost-effectively reduce its peak demand. The central component of FEMP's recommendation was a “pre-cooling” strategy where GSA would turn on its chilled water plant very early in the morning (as opposed to the usual 6 A.M.) on hot summer days. In addition, FEMP recommended that the chilled water valves in the building's roughly one thousand perimeter induction units be tripped to a “fail-open” position during these early morning hours so that the facility would actually be somewhat over-cooled. The idea was to utilize the circa 1934 building's substantial mass as a thermal storage medium, which could then absorb heat and provide cool-temperature radiation throughout the day, mitigating the customary afternoon power peak.

GSA adopted this strategy, and working with their operations and maintenance contractor, Brooks Range Contract Services, they developed a multi-part plan to reduce the building's peak through early morning pre-cooling and afternoon “demand-limiting.” The key elements are:

- If the outside air exceeds 70°F at 2 A.M., one of the facility's two 650-ton chillers is turned on and programmed to produce 42°F chilled water;
- All induction unit chilled water valves are set to a full-open position during the early morning;

- At 9 A.M., the chilled water temperature is raised to 46°F and induction unit control reverts to the tenants (the units have no re-heat coils but the unit controls can be set towards “warmer” to reduce or eliminate the flow of chilled water through them);
- If demand reaches 1,500 kW and is still rising by 12 noon, the chilled water temperature is raised again, to 48°F;
- Only one of the two 650-ton chillers is allowed to operate at any given time.

In the beginning of summer 2005, the Brooks Range team executed the strategy manually, using control system overrides for chiller operation and bleeding the air out of the pneumatic lines to open the induction unit valves. Once the team gained confidence in this strategy, the building's controls contractor was called in to help automate it within the energy management control system (installed in 2003 as part of a Super Energy Savings Performance Contract).

As a result, the operations team was able to keep the facility's peak demand down to 1,766 kW over the summer (defined by the PECO tariff as June through September), as opposed to the 2,050 kW or higher that would likely have been reached. GSA benefited directly from the reduced demand in the summer, saving an estimated \$26,000 (see Figure 1, below) in those four months alone.

GSA reaped even greater savings from the reduced ratchet charges during the winter months. The ratchet clause set the minimum demand charge for the October through May bills at 1,413 kW (80 percent of the 1,766 kW summer peak). While the previous four summers' average peak was 2,080 kW, FEMP conservatively estimated that 2,050 kW would have been 2005's peak draw (this is a conservative estimate because the summer of 2005 was an unusually hot one in the mid-Atlantic). Since 80 percent of 2,050 is 1,640, this figure was used to estimate the ratchet savings – i.e., to represent what the billed peak would have been without the pre-cooling. The 227 kW reduction (1640 – 1413) translated to more than \$30,000 in savings for the five months of December through April; additional ratchet relief in October, November, and May made for a total (including the \$26,000 in direct summer months' savings) of roughly \$68,000.

FEMP's preliminary sense was that there would be a slight – perhaps 5 percent – energy (kilowatt-hour) penalty for implementing the pre-cooling, since some of the “coolth” generated by the chiller and HVAC system in the early mornings would escape from the building envelope without generating comfort cooling. Unquestionably, this effect took place. However, the building's summer electricity usage does not seem to have gone up. Next to the most comparable recent summer (2002),

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**GSA'S COOL COUP AT THE PHILADELPHIA CUSTOM HOUSE**  
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**Figure 1. Custom House Demand Reduction and Savings - 2005-2006.**

Month	Expected Peak (kW)*	Actual Peak (kW)	Billed Peak (kW) **	Peak Rdctn. (kW)	kW Value
June, '05	1900	1766	1766	134	\$ 3,410
July, '05	2050	1692	1692	358	\$ 9,109
August, '05	2050	1692	1697	353	\$ 8,982
September, '05	1900	1711	1711	189	\$ 4,809
October, '05	1640	1604	1604	36	\$ 916
November, '05	1640	1448	1448	192	\$ 4,885
December, '05	1640	1015	1413	227	\$ 5,776
January, '06	1640	992	1413	227	\$ 6,134
February, '06	1640	961	1413	227	\$ 6,134
March, '06	1640	953	1413	227	\$ 6,134
April, '06	1640	1393	1413	227	\$ 6,134
May, '06	1850	1646	1646	204	\$ 5,512
<b>Total Savings</b>					<b>\$ 67,934</b>

\* June - Sept., '05 and May, '06 figures are projected, w/out pre-cooling; October through April numbers represent 80% of projected summer peak maximum (see light gray-shaded cells)

\*\* Dec., '05 - April, '06 figures represent 80% of actual summer peak maximum (see dark gray-shaded cells)

summer 2005's usage was only 0.5 percent higher, despite the fact that it had 4.3 percent more cooling degree days. Moreover, a regression plotting the four previous summers' kWh consumption against the number of cooling degree days in each revealed that summer 2005's actual consumption was 2 percent less than what the model predicted. The facility's summer 2006 usage fell a remarkable 7.5 percent below the regression's prediction.

Why was consumption lower than expected? One reason might be that, since only one chiller was run at a time, average chiller operation was at much higher load conditions than in previous summers – this raises efficiency. Another small effect might be from the cooling towers, which purge their heat into 70 degree night air more efficiently than in 95 degree sunny conditions.

Despite the impressive savings, GSA was adamant from the start of the pre-cooling experiment that any decrement in occupant comfort would not be acceptable. Both FEMP and GSA were concerned that the pre-cooling would generate cold complaints in the mornings as tenants arrived at work, and hot complaints during the hottest afternoons while GSA held to only one chiller as part of the “demand-limiting” strategy. However, this was not the case. “Thermal complaints went down,” asserts John Kleaver, the GSA building manager. “The tenants have never been happier,” agreed Brooks Range's Rich Ponticelli, head of the operations team that implemented the pre-cooling. Corroborating these accounts were GSA's complaint logs, which showed that hot complaints went down from 41 in 2004 to 26 in 2005 (despite the much hotter summer of '05). Interestingly, cold complaints went down slightly also, from 10 in 2004 to 6 in 2005.

In previous summers, the fact that the facility's chilled water system was shut off at 5 P.M. and did not resume operation until

6 A.M. the following morning meant that some tenants, particularly the early birds, found the building too warm and humid upon arriving for work on the hottest summer days. The pre-cooling strategy appears to have resolved this problem – and without over-compensating. The 2 A.M. start time seems to have been an excellent choice by the operations team.

In sum, the Custom House's pre-cooling thermal storage experiment has been an enormous success. The GSA avoided almost \$70,000 in demand charges during the first year (2005-6), all for the cost of a visit from their controls contractor and two solenoid valves. GSA manager Tom McGarry concluded at a “lessons learned” meeting that the GSA should “declare victory” and commit to repeating the

strategy in the summer of 2006. Indeed, GSA was able to suppress demand even further in the summer 2006, from an expected 2,100 kW to 1,684 kW. This 20 percent reduction generated savings of roughly \$103,000, along with approximately \$6,000 in kWh savings from the 7.5 percent energy consumption reduction. Needless to say, GSA is implementing the strategy once again in 2007 and plans to continue it in future years.

For more information, please contact Phil Coleman, Lawrence Berkeley National Laboratory, 610-604-0170 or [pcoleman@lbl.gov](mailto:pcoleman@lbl.gov).



General Service Administration's Custom House, Philadelphia, Pennsylvania

# Enhancing Maintenance Programs with Advanced Metering

Imagine that a major auto manufacturer decides to roll out a car with no dashboard gages, reasoning that the gages cost extra money and do not really contribute to the performance of the car. There is no fuel gage, no speedometer, no oil or temperature indicators, no odometer or tachometer, but a consumer can save money on the purchase price of the car without all of these “extras.” So you decide to buy the car and save money up front, but you have no idea how fast you are going at any given moment, until, of course, you get a speeding ticket and the policeman tells you. You have no idea how much gas you have left, until your car gets stranded on a dark, lonely stretch of highway. You do not have a clue about engine temperature or oil pressure until that cloud of white steam or black smoke erupts from under the hood or out of the tailpipe. Would anyone opt to save money on dashboard gages? Of course not—you would have to be crazy to buy a car without them. In fact, auto manufacturers are constantly adding *more* gages to our cars to give us information about every aspect of their performance.

A car without dashboard gages is analogous to the existing situation in many, if not the majority, of federal buildings. Often we do not have the right information about how they are operating because we do not meter their energy consumption, even at the whole building level in many cases. We cannot determine if the buildings are performing well, how they compare with similar buildings, or when things are starting to go bad. We continue paying bills from the utility company without having the means to verify them. We regularly exceed demand limits and pay exorbitant costs because we have no way of knowing when we are approaching the limits.

For the most part, federal building operators are like the consumer who got a price break on a car without gages, and the first sign of any trouble is when the engine blows. In the building operations and maintenance world, this is known as “run to failure” or “reactive maintenance.” This has been the dominant form of building maintenance for a long time, and its costs are relatively high because of energy inefficiencies, unplanned downtime, damaged machinery, and overtime expenditures. In this mode, management and the maintenance department are controlled by the vagaries of their machines, and the actual status of the overall plant machinery is only vaguely known. This makes it nearly impossible to plan for maintenance needs, and worse, impossible to predict the state of overall system readiness (<http://www.dliengineering.com/vibman/runtofailuremaintenance.htm>).

In some cases, run to failure is considered acceptable if cheap and quick repair is possible and failure is not critical to the overall performance of the building and its occupants. From there, however, failures can progress to areas where they have significant impacts on the occupants of the building and their

ability to carry out their missions. Repair and/or replacement costs can become significant as well.

To avoid this situation, building operators practice something called “preventive maintenance,” which usually consists of regularly scheduled activities such as oil or filter changes, inspections, calibrations, and cleanings. It is not known if this is the most effective means of maintaining mechanical equipment, since scheduled maintenance also assumes that similar pieces of equipment are operated in identical ways under identical conditions and therefore, “what is good for one is good for all.” We could very well be doing too much or too little maintenance if we stray from the average operating conditions. However, if we cannot measure fuel consumption and continuously monitor the condition of our equipment, preventive maintenance is considered the best fallback position.

The missing link between reactive and predictive maintenance is our ability to obtain accurate and timely information about our buildings’ energy performance and the means to analyze and act upon that information. This is where advanced metering concepts come into play. Advanced metering is defined as:

Meters with the capability to measure and record interval data (at least hourly for electricity), and communicate the data to a remote location in a format that can be easily integrated into an advanced metering system.

An advanced metering system collects time-differentiated energy usage data from advanced meters via a network system on either an on-request or defined schedule basis. The system is capable of providing usage information on at least a daily basis and can support desired features and functionality related to energy use management, procurement, and operations.

When advanced metering systems are introduced into the operations and maintenance picture, buildings operators can begin to practice what is known as “predictive maintenance.” Predictive maintenance takes information on energy consumption and equipment conditions and uses that information to develop maintenance procedures based on actual operating conditions, not an overall average for a given equipment type. Without some means to measure, monitor, analyze, and act on information, predictive maintenance is virtually impossible.

Past studies have estimated that a properly functioning predictive maintenance program can provide a savings of 8 to 12 percent over a program utilizing preventive maintenance strategies alone. Depending on a facility’s reliance on a reactive maintenance approach and material condition, savings

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**ENHANCING MAINTENANCE PROGRAMS WITH ADVANCED METERING***(continued from page 10)*

opportunities of 30 to 40 percent could easily be realized. In fact, independent surveys indicate the following average savings resulted from initiation of a functional predictive maintenance program (see [http://www.eere.energy.gov/femp/operations\\_maintenance/strategies/strat\\_predictive.cfm](http://www.eere.energy.gov/femp/operations_maintenance/strategies/strat_predictive.cfm)):

- Return on investment: 10 times
- Reduction in maintenance costs: 25 to 30 percent
- Elimination of breakdowns: 70 to 75 percent
- Reduction in downtime: 35 to 45 percent
- Increase in production: 20 to 25 percent

The Energy Policy Act of 2005 (EPA 2005), Sec. 103 requires installation of advanced electric metering on all federal buildings by the year 2012, according to guidelines set forth by the Department of Energy, in consultation with other federal agencies and stakeholder groups. A document providing this guidance is available on FEMP's Operations and Maintenance Web page ([http://www.eere.energy.gov/femp/operations\\_maintenance/](http://www.eere.energy.gov/femp/operations_maintenance/)

[om\\_resources.html](#)) and should be applied to each agency's approach to metering as appropriate. The guidelines sort out the requirements of EPA 2005 by addressing:

- The many ways to use metered data;
- Different metering approaches and technologies;
- Methods of determining metering cost effectiveness;
- Methods for prioritizing metering opportunities;
- Alternative financing possibilities; and
- An outline for developing agency metering plans.

In addition to these guidelines, FEMP will provide periodic training on advanced metering applications for federal facility managers, energy managers, and building operators.

FEMP encourages all federal energy managers and building operators to stop driving without dashboard gauges, and look for opportunities to use advanced metering systems wherever practicable. The benefits are real, proven, and there for the taking.

*For more information, please contact Ab Ream, FEMP's Operations and Maintenance manager, at [ab.ream@ee.doe.gov](mailto:ab.ream@ee.doe.gov).*

**FEMP STUDIES IMPACTS OF NEW BUILDING PERFORMANCE STANDARDS ON LABORATORY DESIGN**  
*(continued from page 1)*

Including all end-use loads (such as receptacle and process loads) is a significant change from previous standards. Including all end-use loads will effect all calculations, but it is especially important for buildings with high process loads such as laboratories. For example it is not unusual to see laboratory buildings designed for process loads of 5 to 15 watts per square foot.

There are also many new heating, ventilation, and air conditioning (HVAC)-related requirements in ASHRAE 90.1-2004 such as air economizers and energy recovery for most buildings and most climate zones. ASHRAE 90.1-2004 also clarifies the requirements for laboratory buildings. Per Section 6.3.7.2 - Fume Hoods, buildings with design supply flow rates of 15,000 cubic feet per minute (cfm) or greater and fume hood systems shall include at least one of the following features:

- Variable air volume (VAV) system capable of reducing exhaust air and make-up air volume to individual space by at least 50 percent of design values.
- Direct makeup air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2° Fahrenheit below room set point, cooled to no lower than 3° Fahrenheit above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control. (Note that this option is rarely used in laboratory design.)

- Energy recovery systems to precondition makeup air from fume hood exhaust in accordance with 6.3.6.1 (Exhaust Air Energy Recovery) without using any exception.

The Laboratories for the 21<sup>st</sup> Century program (Labs21) has published draft Laboratory Modeling Guidelines using ASHRAE 90.1-1999 as well as Guidelines using ASHRAE 90.1-2004 (Visit [http://www.labs21century.gov/toolkit/bp\\_guide.htm](http://www.labs21century.gov/toolkit/bp_guide.htm)). These guidelines clarify and modify some of the requirements in ASHRAE 90.1 in order to make them more applicable to laboratory buildings.

In addition, the Department of Energy's (DOE) Departmental Energy Management Program funded a study at the National Renewable Energy Laboratory (NREL) to determine the impact of the EPA 2005 building standards on new laboratory designs and major renovations. The recently completed NREL study modeled a laboratory building under ASHRAE 90.1-1999 and 2004 versions. The building incorporates many energy conservation measures (ECMs) beyond the baseline requirements of each standard, including daylighting with lighting controls, energy recovery (lab variable air volume was in the baseline), fan coils for each lab, high efficiency boilers and chillers, office under-floor air distribution, and several other ECMs. The laboratory is designed for a process load of 9 watts per square foot. Compared to the ASHRAE 90.1-1999 baseline, the proposed design had an expected savings of 38 percent (calculated *excluding* process loads). Compared to the ASHRAE

*continued on page 13*

# Building Operator Certification Training Helps Federal Agencies Implement Energy Saving Strategies

Variables affecting a building's energy use are often complex and interdependent. Understanding facility operation as a whole is key to determining how to achieve optimum operating efficiency. This is where the Building Operator Certification (BOC) program comes in. This nationally-recognized program presents a comprehensive series of energy-use training sessions for building operators, from lighting fundamentals to indoor air quality to heating, ventilation, and air conditioning (HVAC) systems and more.

Both private sector companies and governmental agencies have found BOC training to be invaluable as a means to trim energy costs. It also benefits employees as a standard of professional certification. Evaluation research conducted by the Northwest Energy Efficiency Alliance (NEEA) and the Northeast Energy Efficiency Partnerships (NEEP) found that BOC certified operators are saving money for their companies to the tune of \$20,000 annually per participant. Annual energy savings for participating facilities were, per square foot, .50 kWh for electricity and .74 MMBtu for natural gas.

Recent federal agency graduates of the BOC program in the Pacific Northwest region all agree that the training is a plus for facilities managers at any level of experience. An electronics technician by training, Dale Brigham was part of a project to develop an HVAC controls system at the Fort Lewis Army Base near Tacoma, Washington. The project integrated control systems in individual buildings into a networked system for monitoring operations across the base.

At the Public Works Department, teams composed of electrical, plumbing, and HVAC specialists maintain the base facilities. Brigham decided to attend BOC as a way to "get out of the tunnel vision mode" of his own trade, and found that BOC training gave him "the competence and confidence to step out of [his] boundaries" to operate effectively within the team framework to explore energy efficiency opportunities. "BOC helps you see how the systems you work on overlap with others, and how it ties in with energy efficiency," said Brigham.

Brigham was one of five Public Works Department staff to attend BOC training. Upon completion he and his supervisor, John Timmers, lobbied base command to bring BOC training to Fort Lewis. With financial help from FEMP, the Public Works Department hosted a Level I course series on site for 25 federal public works employees.

Even with 24 years experience in facilities management, Darcy Sullivan thought she could learn something from BOC training. Since earning her certification, she has had many opportunities to apply lessons from training to real work on the job at the

Public Works Department at Whidbey Naval Air Station on Whidbey Island, Washington.

Working with their Resource Energy Manager, Kevin Evans, to fulfill the energy efficiency mandates of Executive Order 13123, Sullivan's multi-faceted BOC training became a major asset to the project. Her primary responsibility is to oversee work performed by the base's maintenance contractors. "Darcy is my go-to person for resolving energy efficiency issues with contractors," said Evans. Her understanding of the big picture now allows her to act effectively as a liaison among disparate groups.

In addition to supporting Evans' resource efficiency initiatives, Sullivan continues to look at other projects through the efficiency lens. "We have a continuous maintenance inspection program that includes cyclical and planned maintenance activities, and the energy component is important," said Sullivan.

Veteran building operator Chuck Eddington found the BOC series valuable from a professional perspective and as a helpful review. "To persons that are entering the operation or building engineering field, it covers a broad base of information," said Eddington, a General Services Administration building operation manager at the new Seattle Federal Courthouse in downtown Seattle.

Eddington gained some specific benefits from BOC training. One assignment required him to complete a schematic drawing of the facility, giving him a clearer understanding of the building's electrical system. Eddington stated that a project on power load calculations "forced me to become more familiar with the building," and he gained "a different perspective" on such HVAC issues as filter changes. BOC certification also gives him a professional advantage. "I won't say it has a tangible value as far as salary, but it does have a tangible value as far as potential promotions," he said. "Credentials and experience—that's what it's all about."

Eddington also gave the following advice. "If you are entering this field or entering in a position, take [BOC] just to get acquainted with what is involved in running a building. There's a lot...it's a good course to take for somebody who is contemplating entering the field or somebody who is looking at a promotion for entering that position, or for a good refresher course."

In other words, BOC training will provide great benefits to just about anybody who operates a building.

*For more information on BOC training topics and class schedules, please visit <http://www.theboc.info/>.*

# New On-line Tool Available for Saving Energy at Federal Data Centers

Data centers are among the most energy-intensive facilities in the federal sector (as well as among local and state governmental facilities), having energy use and intensity typically orders of magnitude greater than other buildings. Data centers are also becoming increasingly common across numerous agencies, including the Departments of Homeland Security, Defense, and Energy, the Environmental Protection Agency, the Internal Revenue Service, National Institutes of Health, and others, as they cope with the increasing demands of having to handle enormous amounts of data. Previously exempt from Executive Orders for energy reduction, federal data centers now must meet federal requirements under the Energy Policy Act of 2005 (EPAct) for 2 percent energy reductions per year.

As an indication of the importance of public sector computing, many of the top 500 “supercomputer” centers are federal or other public facilities. To meet this challenge, FEMP’s Technical Assistance program supported the development of a Web-based guide to assist federal energy managers—and others—in identifying the best solutions for controlling energy use in these facilities. The reality is that in the near term, energy use is likely to increase in these buildings as demands for more computing power increases. Steps taken now can minimize these increases, and help show that facility managers are addressing the goals of EPAct.

Resources such as this new Web-based tool are particularly important for federal agencies, which are mandated under EPAct to measure and report their facility consumption. FEMP offers extensive support for energy management at federal facilities, including many items specifically relevant to data centers.

The Data Center Energy Management Web site allows a user to:

- Diagnose Energy Inefficiencies and Rate a Data Center’s “Energy IQ” — by comparing your data center to the benchmarking results for top performers
- Specify State-of-the-art Solutions — using detailed guides to 67 best practices
- Generate Clear Design Intent Documents — using a pre-defined design intent tool “template” for recording data center energy efficiency objectives, strategies
- Evaluate Cost-Effectiveness — by considering both the “straight economics” of energy efficiency improvements, as well as non-energy benefits that are central to making the business case for investing in improved efficiency
- Explore Real World Examples — that show the application of best practices and the magnitude of savings that can result
- Calculate Impacts and Savings — using practical software tools to help users achieve energy savings and make the economic case to decision makers and managers at the data centers and management
- Stay on the Cutting Edge — with information on leading-edge research and new technologies just emerging in the marketplace
- Apply the Information — by following a series of exercises to evaluate real data centers
- Learn More — using links to an extensive body of resources from the trade press and research institutions

Visit the tool online at <http://hightech.lbl.gov/DCTraining>. For more information, please contact Rick Diamond of Lawrence Berkeley National Laboratory at [rcdiamond@lbl.gov](mailto:rcdiamond@lbl.gov) or 510 486-4459.

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## **FEMP STUDIES IMPACTS OF NEW BUILDING PERFORMANCE STANDARDS ON LABORATORY DESIGN** (continued from page 11)

90.1-2004 baseline, the expected savings are 23 percent (calculated including process loads). Some of the difference is because 90.1-2004 will require more efficient heating, ventilation, and air conditioning equipment and heat recovery in the baseline building, but most of the difference is because process loads are included in the baseline for ASHRAE 90.1-2004.

ASHRAE 90.1-2004 is the energy standard that must be used for all new federal buildings. If the building owner chooses to

pursue Leadership in Energy and Environmental Design (LEED™) certification, the latest version, LEED 2.2, uses ASHRAE 90.1-2004. It is a good goal to exceed the requirements of ASHRAE 90.1-2004. However, for buildings with high process or receptacle loads such as laboratory buildings, achieving consumption levels that are at least 30 percent below 90.1-2004 may not be practical or life-cycle cost effective.

For more information about Federal Building Performance Standards under EPAct 2005, please contact Otto Van Geet of the National Renewable Energy Laboratory at [otto\\_vangeet@nrel.gov](mailto:otto_vangeet@nrel.gov).

# Lower Interest Rates Reduce Average Super ESPC Payments by Agencies

The data on Department of Energy’s Super energy savings performance contract (ESPC) projects as of April 2007 shows significant change in some average project characteristics and constancy in others. The averages and trends discussed here are based on data from the financial schedules of all awarded Super ESPCs. We draw a number of comparisons between two sets of projects: (1) projects awarded from program inception in FY 1998 through FY 2004, before the 2004 modifications in the Super ESPC contract went into effect (including six project modifications implemented during the temporary lapse in federal ESPC authority) and (2) projects awarded from FY 2005 through April 2007, after the contract modifications went into effect and federal ESPC authority was restored.

## Financing Costs Reduced Significantly

After 2004, Super ESPC energy service companies (ESCOs) were required to obtain competitive financing offers for Super ESPC delivery orders. Since then, as shown by the graph below, lenders’ premiums on Super ESPC projects have dropped by more than 50 percent.

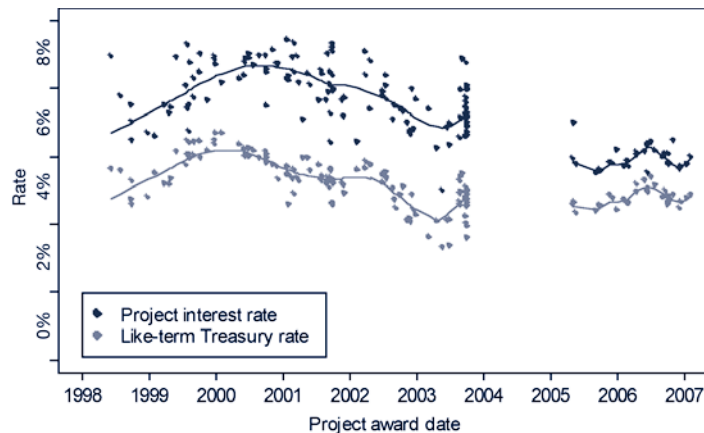


Figure 1. The total interest rates (“project interest rate”) for all awarded Super ESPC projects are shown in the upper clusters of data points on the graph. The lower data points show the index rates – interest rates on U.S. Treasury Securities for terms corresponding to the represented projects (“like-term Treasury rate”). The difference between the index and total interest rates represents the premiums added by the lenders.

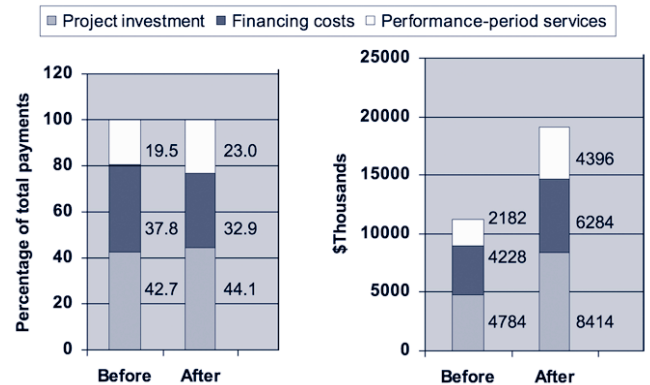
During 1998 through FY 2004, ESPC customers paid average premiums of 242 basis points (bp) and total interest rates averaged 7.63 percent. After competition was implemented, from FY 2005 through April 2007, premiums averaged 116 bp and total interest rates averaged 5.96 percent.

## What to Expect for Project Interest Rates

An estimate of the interest rate that can be expected for ESPC projects in development can be based on the trend illustrated above. The rule of thumb: take the yield of a 20-year constant maturity Treasury Security and add 116 basis points. For example, if the yield of a 20-year T-bill is 4.5 percent, the project interest rate should probably be in the neighborhood of 4.5 + 1.16, or 5.66 percent.

## More Project, Less Finance Cost

Reduced financing costs allow for increases in project scope and services. The figures below compare the percentages and dollars respectively going to project investment, financing costs, and performance-period services in the average Super ESPC project before and after competition in financing was required.



Characteristics of the Average Super ESPC Project Before Competition in Financing (1998 – 2004) and After (2005 – April 2007)

Figure 2. Averages for the set of 125 projects awarded before competition in Super ESPC financing was required and the set of 31 projects awarded after the reforms were implemented. The amount of Super ESPC payments going toward project investment (or implementation price, including one-time payments); financing costs (interest and financing procurement price); and performance-period services, including measurement and verification (M&V), in the average project for each set. Percentages of total payments over term are shown in the chart at left; dollar amounts (thousand) at right.

## Project Term

Although the average project size has increased, average project term has changed very little, from 17.36 years before FY 2004 to 17.51 years after 2004.

**LOWER INTEREST RATES AVERAGE SUPER ESPC PAYMENTS BY AGENCIES**  
(continued from page 14)

**A More Detailed View**

Figures 3 and 4 give a more detailed view of the “cost stack” for Super ESPC projects.

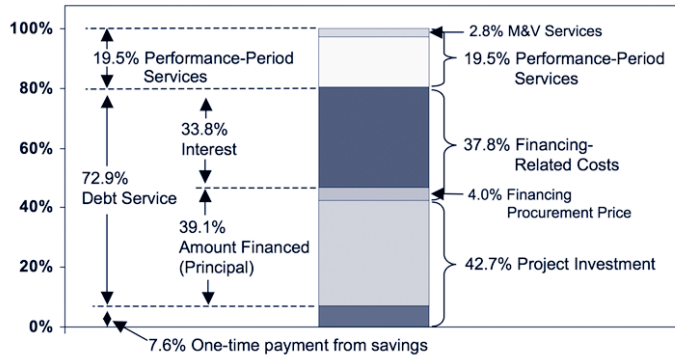


Figure 3. Breakdown of costs paid on the average Super ESPC project, based on 125 projects awarded before competition in financing was required and before the federal ESPC authority lapsed. Average sum of payments over term is \$11.19 million.

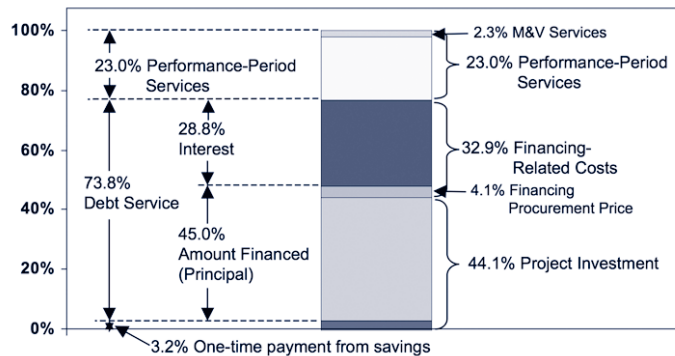


Figure 4. Breakdown of costs paid on the average Super ESPC project, based on 31 projects awarded after competition in financing was required and after the federal ESPC authority was reinstated. Average sum of payments over term is \$19.1 million.

**Better Interest Rates Reduce Average Super ESPC Payments by 16 Percent**

Premiums in Super ESPC interest rates have decreased by 50 percent since the requirements for competition and transparency in Super ESPC financing were incorporated into the contracts. The decrease in interest rates has lowered agencies’ total payments for their projects by 16 percent, based on the average Super ESPC project.

For more information, please contact Erica Atkin, Oak Ridge National Laboratory, at 865-574-4829 or atkine@ornl.gov.

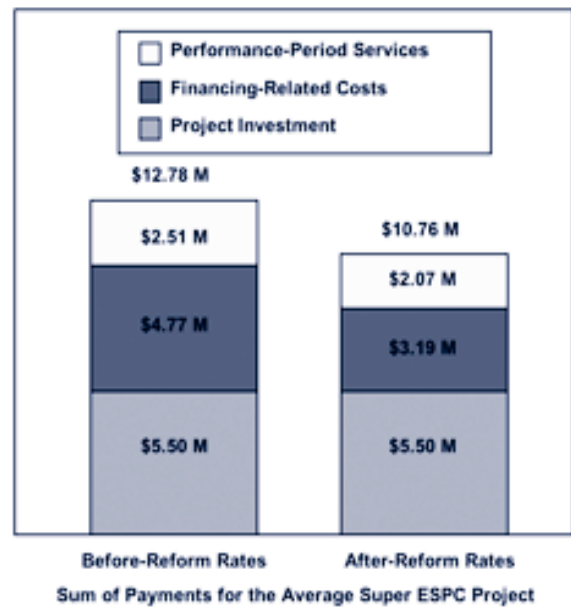


Figure 5. This figure represents two versions of the average Super ESPC project with a project investment (or implementation price) of \$5.50 million. With average interest rate premiums from before competition and transparency were required, financing-related costs were \$4.77 million, as compared to \$3.19 million after the reforms were implemented. Payments for performance-period services are greater for the project before reforms because the term is longer and ESCO services are delivered for a longer period. The average project is based on all Super ESPC awards as of April 2007.

## Implementing On-Site Renewable Energy Projects with Innovative Private Financing

Are you looking for funding to complete renewable energy projects at your site? Several federal agencies are in the process of developing on-site photovoltaic (PV) projects utilizing an innovative business model that may offer a solution. Under this model, a private entity finances the PV equipment and installation and provides operations and maintenance (O&M) for the term of the contract. The PV system is privately owned, and the federal site purchases the electricity through a long-term power purchase agreement (PPA). While the examples in this article involve PV systems, this contractual arrangement may also be used for other types of renewable projects.

This is an attractive business model for several reasons. The primary benefit is that a private entity is eligible for various tax and other incentives that may not be available to a federal agency. In addition, the site does not have to provide up-front capital for the system. Finally, the long-term electricity contract helps federal agencies stabilize a portion of their electricity costs – an important benefit given energy market volatility.

There are several important issues to consider during initial project development; including contract length, contracting methodology and land use agreement. There are three example projects in various phases of development – Nellis Air Force Base (AFB), a General Services Administration (GSA) facility in Sacramento, and Fort Carson. Each uses a slightly different contractual methodology.

SunPower Corporation is developing a 15 megawatt (MW) PV project on Nellis AFB that will be the largest PV system in North America. Nellis will purchase the electricity from SunPower Corporation using a FAR 41 (Acquisition of Utility Services) utility contract with an indefinite term and a 12-month termination provision. SunPower Corporation was granted access to the land through a 20-year ground lease, in conjunction with an operating agreement with security and other site access provisions. The leasing authority is 10 USC 2667. The groundbreaking ceremony was held on April 23, 2007 and construction is expected to be complete by the end of 2007. The PV project will supply over 25 percent of Nellis' electricity requirements and will save approximately \$1 million per year, even after accounting for standby charges. The renewable energy certificates (RECs) are being sold to Nevada Power for the state renewable portfolio standard solar set-aside requirement.

In November 2006, GSA awarded a 10-year contract for electricity from a 1 MW PV project to Deliddo & Associates dba DEERS, from Ripon, California. The PV system will be installed on the roof of the Federal Building at 2800 Cottage Way in Sacramento. GSA utilized modified FAR Part 41 clauses, as well as Part 12 (Acquisition of Commercial Items), for the contract. DEERS was granted a license for use of the roof for the PV



*Nellis Air Force Base PV project*

system. A utility rebate and federal incentives (30 percent investment tax credit and accelerated depreciation) will offset approximately half the cost of the system. Electricity production is expected to be approximately 1,350 megawatt-hours per year, supplying an estimated one-third of the building's annual power use. Installation is expected to begin this fall. DEERS retains rights to the RECs.

3-Phases Energy Services is developing a 2 MW PV project on Fort Carson land. Western Area Power Administration (Western) is the contracting agent and will purchase the electricity, estimated at 3,200 MWh/year, on behalf of Fort Carson through a 17-year contract (this is the remaining time under the current Western-Fort Carson power allocation contract). The RECs will be sold to Xcel Energy and used to meet the solar requirement of the state renewable energy standard. The ground-mounted, thin film PV system will cover nearly 15 acres on an old Fort Carson landfill. Construction is expected to be completed in November 2007. SunTechnics Inc. will design and construct the project. The PV panels carry a 25-year warranty.

FEMP is exploring the possibility of utilizing Western as the contracting agent for other on-site renewable projects at federal sites within Western's service territory (see <http://www.wapa.gov/regions/default.htm>). The short-term focus will be on the California market due to the attractive PV incentives that allow the site to retain the RECs.

*continued on page 17*



# The Food and Drug Administration's Jefferson Labs Realizes Great Success with UESC

The Jefferson Laboratories Engineering Team at the Department of Health and Human Services, Food and Drug Administration's (FDA) Jefferson Laboratories has reduced energy consumption by 32 percent on a square foot basis when compared to a FY 1990 baseline, and by 17 percent on a square foot basis when compared to a 2003 baseline. Carbon emissions were reduced by 28 percent from FY 2003 to FY 2006. Much of these savings are attributable to a utility energy services contract (UESC) that has installed \$10.1 million of energy and water efficiency projects between 2004 and 2007, with another \$2.4 million planned for the future.

Jefferson Laboratories (JL) includes the National Center for Toxicological Research (NCTR) and the Arkansas Regional Laboratory (ARL) Office of Regulatory Affairs, and resides on a 500-acre campus in Jefferson, Arkansas thirty miles south of Little Rock. The facility was a military installation until 1971 when it was deeded to the FDA. It consists of approximately 870,000 square feet of space in 38 buildings. There are more than 250,000 square feet of laboratory or animal holding areas requiring 100 percent outside air with stringent temperature and humidity control. As a fifty year old renovated facility, there have been many opportunities to implement energy saving projects and incorporate energy conservation into new construction and renovation projects.

In 1999, with the approval and support of the JL management, a UESC was initiated with Entergy Arkansas, Inc., the electricity provider. Between 1998 and 2003 the team initiated eight task orders with a total cost of \$2.2 million and estimated annual energy savings of 90,500 Btu per square foot and \$490,000. The projects included a comprehensive energy audit, cooling tower construction, enhanced energy procurement strategies, power factor correction, district cooling system design, heat recovery, high efficiency lighting, and energy management control system upgrades.

From 2004 to 2007, the JL Team continued with their UESC to accumulate additional annual savings of \$621,000 and 57,450 Btu per square foot with projects such as extensive heating,

ventilation, and air conditioning (HVAC) renovations of large laboratories, district cooling system construction, variable air volume system installation in large office areas, and automated lighting controls.

The implementation of the UESC with the local utility began a whole new institutionalization of energy efficiency. The Team presented large scale project ideas to the top-level management that included life cycle cost analyses with strong economic and investment information. This high level of exposure to the Team's energy and water efficiency efforts and the partnership motivated the team to look closer at how space is managed and has enabled the team to complete a broader range of energy conservation opportunities.

In fact, the JL Team plans to implement additional task orders with projected annual savings of \$256,691 and 35,500 Btu per square foot. These savings will result in a projected energy rate reduction of 25 percent from the 2003 baseline. The future projects include installation of high efficiency boilers, upgrade to overhead and underground utilities and piping, completion of a new comprehensive energy audit, and use of grey water strategies.

The results achieved by the JL Team can be attributed to alternative financing, strategic planning, implementing a comprehensive district energy system, and using a sophisticated environmental management control system to its fullest potential. Not only has the JL Team saved valuable dollars for the Jefferson Labs, they have created a new atmosphere on campus as all projects are now viewed with an eye toward energy or water efficiency. The priority of energy efficiency has come to the forefront in engineering and operations management, and the publicity that JL personnel has received for their efforts through awareness campaigns and award programs has further instilled this consciousness for efficiency and savings.

*For more information, please contact Ted Kozak, Chief, Design and Construction at Jefferson Laboratories, at Theodore.Kozak@fda.hhs.gov or 870-543-7356.*

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## **IMPLEMENTING ON-SITE RENEWABLE ENERGY PROJECTS WITH INNOVATIVE PRIVATE FINANCING** (continued from page 16)

Cost-effective renewable opportunities depend upon a number of factors, including the utility rate and rate structure, available incentives, and whether there is a solar set-aside as part of the state renewable portfolio standard (thus creating a solar REC market). A site will need to consult with their serving utility to determine if the PPA model is allowable. While a federal agency can also utilize appropriations, when available, to develop a renewable project, third-party financing will facilitate the

widespread development of renewable energy throughout the federal government.

*Federal agencies interested in developing an on-site renewable project utilizing this innovative business model should contact Chandra Shah at 303-384-7557 or chandra\_shah@nrel.gov. Project-specific questions may be directed to Jim Snook (850-283-6295, jim.snook@tyndall.af.mil) or Steve Dumont (757-764-2569, steve.dumont@langley.af.mil) for Nellis AFB, Mark Levi (415-522-3374, mark.levi@gsa.gov) for GSA Sacramento and Vince Guthrie (719-526-2927, vincent.guthrie@us.army.mil) for Fort Carson.*

# Navy Applies Emission Reduction Credits Savings to UESC

The Naval Facilities Engineering Command-Southwest (NAVFAC-SW) Energy Team initiated an unprecedented effort in January 2002 to realize the value of nitrogen oxide (NOx) emission reduction credits (ERCs) into the salvage value of equipment removed as part of a utility energy services contract (UESC). The total value of the credit was finally realized in June 2007 when the local utility, San Diego Gas and Electric, presented the Navy with a check for over \$1 million. While the proceeds from this effort are substantial, the precedence established by the effort is invaluable to other federal agencies. Utilizing a similar approach and citing the enabling contracting authority referenced in this article, other agencies may be able to realize the significant value of ERCs into their contracts.

The SW Division Energy Team leading the effort on a \$16 million UESC cogeneration upgrade project at the Naval Medical Center San Diego (NMCS D) recognized an opportunity for the Navy to benefit from ERCs generated from replacing three 1985 vintage turbines with one cleaner and more efficient unit and two standby diesel emergency generators, resulting in nitrous oxide pollution reduction of 14.7 tons per year. ERCs are bankable and tradable and can be used to offset emissions reduction requirements elsewhere within the same air basin. As such, the ERCs have value and are often bought and sold on the open market. Given that the ERCs hold value, the team developed a strategy to have the project, its customer at the time, Navy Public Works Center San Diego (PWCS D), and ultimately the installation, NMCS D, receive this financial benefit.

By establishing precedent, the overall impact of this effort Department-wide is even larger. The project is likely to affect Navy policy relative to OPNAVINST 5090B and ultimately save installations millions of dollars. Navy installations now have the ability to immediately realize ERCs available from equipment replacements and apply ERC revenue against project costs. The process also allows the Navy to obtain market value of the ERCs, demonstrating that the Navy can leverage its assets to take full advantage of these emerging markets and be a competitive force in business approaches and issues.

The Energy Team, with input from legal counsel, defined their goal as, "Realize the value of the ERCs into the value of the existing construction contract." Authority to do so can be found in 40 U.S.C. 486(c) and its implementing regulations in 41 CFR Part 101-46, which allow for the sale of old turbines where the

proceeds are used to buy a new turbine, or to exchange old turbines to get an allowance to save money on a new turbine. The consideration the contractor includes in the contract for the salvage value of the turbines can reflect the value of the ERCs.

Several other options were available, including the Navy ERC pilot program that allowed for sale of the ERCs on the open market (limited to \$500,000 per year, DOD-wide) and the option to have the Region apply for and bank the ERCs. However, both these options were limited and did not take immediate advantage of the full value of the credits or a direct reduction in the financed amount of the UESC contract. With business acumen and input from counsel, the Energy Team developed a multi-step process and flowchart for the salvage value approach. The process as outlined determined the appropriate salvage value of the turbines and, more importantly, minimized the risk to both the government and the contractor. The steps included:

- Defining the approach, including appropriate legal review and briefing the parties involved. Support and approval from the PWCS D and the NMCS D were critical to the success of this endeavor.
- Determining quantity of potentially available emission credits, a function of the government, the UESC contractor (San Diego Gas and Electric) and the San Diego Air Pollution Control District (SDAPCD). This included an application to SDAPCD and source testing of the equipment in a manner approved by the SDAPCD.
- Estimating market value of the potential ERCs to be recovered, and negotiation of this value with the contractor to be applied against the construction cost.
- Applying for ERCs and issuing to the contractor for sale on the open market.

Faced with numerous legal, environmental, and interagency challenges, the team demonstrated diligence, creativity, and dedication over a five year period to see this effort through and to provide its customers with the best possible service and expertise. The benefit of this initial effort certainly will be extended to other government agencies, with potential for enormous contract savings within the Navy and DOD.

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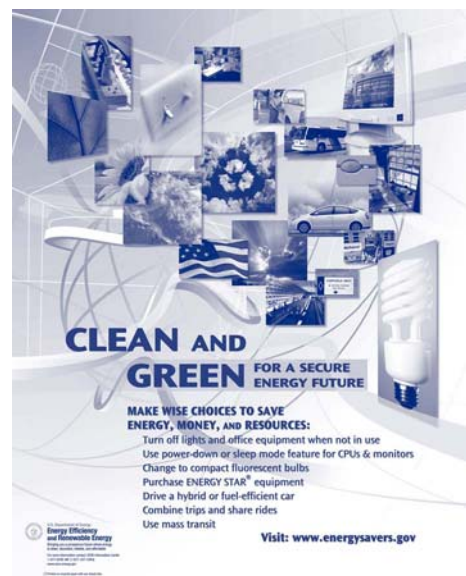
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## October is Energy Awareness Month—Be Clean and Green

The Department of Energy's theme for Energy Awareness Month 2007 is *Clean and Green . . . For a Secure Energy Future*. By showing the energy and money saving technologies and practices that we can choose at home, at work, and in our daily commutes, the theme underscores the message that clean energy choices work together with energy efficiency and awareness. By choosing and using energy wisely, we improve our quality of life, and we secure our future with diverse, reliable, and affordable energy sources.

This poster and accompanying handout materials, including sticky note pads, room temperature cards, and computer monitor calendars, are available in limited quantities after September 25. To create your own printed materials, high-resolution graphics are supplied on *A Power Kit: Awareness Resources* on CD ROM. To order, please call the EERE Information Center at 1-877-337-3463. To learn more about the *You Have the Power* campaign, please visit the FEMP Web site at <http://www.eere.energy.gov/femp/services/yhtp/>.



# Three New Technology Publications Available on the FEMP Web Site

The Federal Energy Management Program recently published three New Technologies publications, now available on the FEMP Web site.

**Coolerado Cooler Helps to Save Energy and Dollars.** The Technology Installation Review describes the operating principles, measured performance, and energy savings potential of a new evaporative cooling technology, the Coolerado Cooler™. This technology uses a water-fueled cooling system powered solely with fan energy, delivering cooler supply air temperatures than direct or indirect evaporative cooling systems without increasing humidity. Because this technology significantly reduces electric demand for cooling over the course of a cooling season, it can provide energy and cost savings and help federal energy managers meet their energy-reduction goals.

**Hybrid Solar Lighting Illuminates Energy Savings at Government Facilities.** This Technology Focus on hybrid solar lighting discusses an exciting near-term solution for energy managers to reduce energy consumption while maintaining or

exceeding lighting quality requirements. Hybrid solar lighting offers an energy-efficient, higher quality, economically viable alternative to incandescent lamps. The publication reviews the operation, benefits, costs, and projected savings of this technology, as well as new developments, availability, and potential candidates for commercial application.

**Strategic Energy and Water Resource Planning for Federal Facilities.** This document provides a detailed look at the strategic planning process based on advice from planning experts, as well as real-world experience in developing planning documents for federal sites and agencies. The publication can help a manager adapt a plan for his or her unique organization, facility needs, goals, and requirements. While it focuses on strategic planning for energy and water resource management, the principles may be applied to all types of strategic plans.

*These and many other technology publications are available on the FEMP Web site at [http://www.eere.energy.gov/femp/new\\_technology/techdemo\\_publications.html](http://www.eere.energy.gov/femp/new_technology/techdemo_publications.html).*



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