U.S. Department of Energy
Office of Inspector General
Office of Audits and Inspections

Audit Report

Efforts by the Department of Energy to Ensure Energy-Efficient Management of Its Data Centers

May 2012

Department of Energy
Washington, DC 20585

May 25, 2012

MEMORANDUM FOR THE SECRETARY

FROM: Gregory H. Friedman
          Inspector General

SUBJECT: INFORMATION: Audit Report on "Efforts by the Department of
                  Energy to Ensure Energy-Efficient Management of its Data Centers"

INTRODUCTION AND OBJECTIVE

In pursuit of its varied set of highly technical missions, the Department of Energy and its prime contractors rely heavily on various forms of information technology (IT) and related support equipment and facilities. This includes numerous data centers and server rooms throughout the Department's complex. Historically, data center operations have been notorious users of massive amounts of energy and, by their very nature, often require specially configured physical space. As demand has increased, the number of data centers has proliferated both within the Department and throughout government – in fact, the Office of Management and Budget (OMB) recently noted that the number of data centers serving the Federal sector has increased by 150 percent in the last decade. To address concerns related to energy efficiency, economy of operations, and cyber security, the Federal government established the Federal Data Center Consolidation Initiative and the President issued Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*.

Prior reviews by the Office of Inspector General identified areas where the Department could improve the management of its IT resources. For example, our audit report on *Management of the Department's Data Centers at Contractor Sites* (DOE/IG-0803, October 2008) found that the Department could save $2.3 million per year through the use of more efficient hardware technologies such as virtualization, which would allow for increased energy efficiency through the consolidation of servers. Based on the significant investment in IT infrastructure, the potential for further savings and the need to improve sustainability, we initiated this audit to determine whether the Department managed its data centers in an energy-efficient manner.

RESULTS OF AUDIT

The Department had taken certain actions designed to improve the management of its data centers. Our review, however, identified a number of opportunities to improve the energy efficiency of its IT operations. In particular, we found that the nine locations we reviewed had not always implemented effective practices for space configuration and utilization designed to improve the energy efficiency of data centers. In addition, the Department continued to operate and maintain excess space within its data centers, a practice that led to energy inefficiencies. Specifically:

- The Department had not always taken advantage of many commonly recommended efficiency measures, many of which could have been implemented at little or no cost.

For instance, IT server racks in 43 of 77 data centers reviewed were not configured using hot/cold rows to maximize energy efficiencies. In addition, organizations and sites had not always implemented many routine, low or no-cost measures designed to enhance efficiencies through better airflow management. For example, improvements such as perforated tiles that direct air flow from the floor to the servers were placed in less than optimal locations, and blanking panels and floor skirting typically used to prevent hot and cold air from mixing within or beneath server racks were not used consistently. Furthermore, occupancy sensors to control energy usage from lighting and separately installed data center electric meters to monitor overall power consumption had not always been utilized; and,

- The Department continued to operate data centers and server rooms that were not fully utilized, further contributing to inefficiencies. Specifically, more than 74,000 square feet (26 percent) of space within 77 data centers at 9 sites was either vacant or was otherwise inappropriately used. In many cases, we determined that this space could have been put to better use.

We found as well that the Department continued to lack visibility over the number of data centers it funds. Although certain efforts had been completed or were in the planning stage, the Department had not fully developed and implemented plans to identify all data centers and server rooms, and, most importantly, consolidate them as appropriate to increase efficiencies and minimize duplicative operating costs. For example, as of July 2011, the Department's Chief Information Officer reported to OMB that the Department operated only 58 Federal unclassified data centers and server rooms encompassing 101,000 square feet. However, we found that this report excluded at least 520 data centers and server rooms accounting for more than 314,000 square feet at just the 6 contractor-managed sites included in our review. In a number of instances, we noted that data centers excluded from the Department's inventory – those operated by contractors on behalf of the Department – were underutilized. We noted that omissions of contractor-operated data centers continued despite OMB's request that the Department resubmit an updated and complete final inventory prior to December 31, 2010. In fact, in support of Executive Order 13514, the Department was to submit a consolidation plan that specifically included all national laboratory and facility assets, including those within the scope of the Department's management and operating contracts.

The problems we identified occurred, in part, because the Department had not always established specific goals or performance metrics, or otherwise incentivized its organizations and sites to attain the energy-efficiency levels outlined in Executive Order 13514 in a timely manner. For instance, organizations and sites had not fully developed and implemented plans to identify all data centers and server rooms and consolidate them, as appropriate, to increase efficiencies and minimize duplicative maintenance costs. In addition, data center resources and IT equipment were not effectively controlled to promote efficiency in energy usage and space utilization. Finally, Department organizations and sites had not effectively coordinated efforts to promote efficiencies through full utilization of data center space. For example, even though the Pacific

Northwest National Laboratory and the Hanford Site were located in close proximity to one another, each site continued to operate data centers with vacant space. Coordination between the sites could have enabled equipment to be co-located, thus reducing the need to lease additional space and secure funding for supporting infrastructure.

Without improvements, the Department will continue to spend more than necessary operating data centers and server rooms. For instance, as noted in a recent data center assessment at Headquarters, implementing recommended improvements such as those noted in our report could result in a 16 percent reduction in energy consumption. While these reductions were specific to the Headquarters environment, we found that similar efficiency measures could be taken at each of the sites reviewed. Furthermore, a lack of coordination regarding advances in energy efficiency may hinder the Department's progress in meeting Federal and Department energy reduction goals. Also, inadequate progress relating to data center consolidation resulted in missed opportunities for potential cost savings related to energy usage and maintenance costs.

Notably, the Department had taken certain actions to improve energy efficiencies supporting its IT infrastructure. For instance, electricity produced from experimental solar panels at Sandia National Laboratories had been redirected for data center usage. In addition, Los Alamos National Laboratory's Weapons Complex used a software program to help determine the optimal placement of equipment. These are positive actions; however, additional effort is necessary to ensure that all data centers operated by or on behalf of the Department are managed in an energy-efficient manner.

Therefore, we have made several recommendations that, if fully implemented, should improve the Department's ability to reduce energy usage and related costs associated with its computing environment.

MANAGEMENT REACTION

Management concurred with the report's recommendations and indicated that it had initiated actions to address issues identified during our review. Management stated that it would work to conduct assessments of data centers and implement performance metrics for improving energy efficiencies. In addition, management commented that it would improve coordination between organizations and sites to help enhance energy efficiency and consolidation practices. Management stated that our findings were reasonable and that the recommendations provided effective insight to correct discrepancies and improve the energy efficiencies of the Department's data centers. Management's comments are included in Appendix 3.

Attachment

cc: Deputy Secretary
    Associate Deputy Secretary
    Acting Under Secretary of Energy
    Acting Under Secretary for Science

Under Secretary for Nuclear Security
Acting Administrator, Energy Information Administration
Acting Chief Information Officer
Chief Health, Safety and Security Officer
Chief of Staff

REPORT ON EFFORTS BY THE DEPARTMENT OF ENERGY TO ENSURE ENERGY-EFFICIENT MANAGEMENT OF ITS DATA CENTERS

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DATA CENTER MANAGEMENT

The Department of Energy (Department or DOE) had not always managed its data centers and server rooms[1] in an energy-efficient manner. At the locations reviewed, sites reported maintaining over 530 data centers and server rooms with a combined area of more than 343,000 square feet. However, we determined that organizations and sites had not always implemented effective practices for space configuration and utilization designed to improve the energy efficiency of data centers. In addition, the Department continued to operate and maintain excess space within its data centers, a practice that led to further inefficiencies.

Data Center Energy Efficiency

Although certain actions had been taken, we found that the nine locations reviewed, including Headquarters, had not always implemented effective space configuration and utilization practices designed to improve data center energy efficiency and reduce operating expenses. In particular, information technology (IT) equipment was not always configured to maximize efficiencies and reduce costs. In addition, organizations and sites had not implemented many routine measures to enhance efficiencies. Finally, we noted that occupancy sensors to control energy usage from lighting, and separately installed data center electric meters monitoring overall power consumption, had not always been utilized.

IT server racks in 43 of 77 data centers reviewed were not configured using hot/cold rows to maximize energy efficiencies. As noted by industry best practices[2], a significant benefit of using a hot/cold row configuration is increased cooling system efficiencies and the potential to save up to 15 percent of a data center's electricity costs on an annual basis. We found that the National Energy Technology Laboratory (NETL) constructed a new facility in 2009 that housed its data center. At the time of our review, however, the server racks had not been configured in the most energy-efficient manner. Specifically, racks were not placed in hot and cold rows, which prevented adequate segregation of the equipment's hot exhaust air and cooler supply air. In addition, hot or cold row containment, which prevents air from mixing around the rows or allows for the capture and reuse of warm air in

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[1] During the course of our audit, we used the Federal Data Center Consolidation Initiative (FDCCI) definition of a data center, which included rooms/facilities greater than or equal to 500 square feet that housed computer systems (servers) and associated components, while a server room was less than 500 square feet.
[2] Sun Microsystems, *Site Planning Guide of Entry-Level Servers, Version 1.4*; and, *Data Center Energy Efficiency Best Practices*.

other locations, was not used. According to one industry study[3], containment systems could yield energy savings greater than 20 percent. In comments to our report, NETL management stated that subsequent to our review, a partial reconfiguration of the Morgantown data center had taken place. At various other locations, server racks were placed in ad hoc configurations that restricted airflow, which caused air-conditioning units to run less efficiently and at potentially greater costs than if racks were properly configured. In contrast, Sandia National Laboratories (SNL) tested the advantages of a cold-row containment system for use in a high performance computing environment and realized operating efficiencies of nearly $30,000 per year through the reduced use of air-conditioning units.

Organizations and sites also had not always implemented many routine low or no-cost measures designed to enhance efficiencies through better airflow management, such as perforated tiles, blanking panels and floor skirting. For instance:

- Perforated tiles, which are used to direct airflow from the cooling units, were placed ad hoc, without regard for energy conservation considerations such as increased airflow uniformity or decreased airflow leakage within data centers and server rooms at eight of nine locations reviewed;

- Panels used to fill empty spaces in server racks and optimize airflow by minimizing the mixing of hot and cold air were not utilized consistently. Industry best practices[4] noted that blanking panels were an inexpensive and integral part of containment systems within data centers that could reduce energy expenses up to 2 percent;

- Only one site reviewed, the Fermi National Accelerator Laboratory (Fermi), had adopted the practice of using skirting along the floor to prevent additional air gaps below the server racks in each of its data centers. This practice can be helpful to prevent cooled air from mixing with warmer air, thus enabling the air-conditioning units to operate more efficiently and lower energy costs;

- Inconsistencies also existed in the row-to-row spacing of server racks in room layouts. For instance, at the

[3] Dell, *The Energy Advantages of Containment Systems.*
[4] Dell, *Rack Blanking Panels – To Fill or Not to Fill*, February 2011; and, *Data Center Energy Efficiency Best Practices.*

Headquarters Germantown data center, spacing ranged from 2 to 16 feet even though industry recommendations[5] generally call for spacing of 3 to 4 feet. As noted by various industry studies, standardizing and minimizing row-to-row spacing in data centers could optimize equipment footprints and limit the amount of space to be cooled, potentially increasing efficiencies and reducing energy costs; and,

- At eight locations, IT equipment cabling was kept below the floor rather than on trays above the server racks, resulting in restricted airflow and increased cooling costs. As noted by the Federal Energy Management Program (FEMP), congested cabling below raised floors can sharply reduce the total airflow and degrade the airflow distribution of perforated floor tiles, promoting the development of hot spots. Certain data center officials commented during the audit that they had begun removing legacy wiring to improve air flow, lower costs and improve maintenance time frames. However, other data center operators explained that they continued to maintain wiring under the floor so that it would not be visible.

Occupancy sensors to control energy usage from lighting and the use of separately installed data center meters monitoring overall power consumption had not been utilized at most of the data centers reviewed. Specifically, occupancy sensors can reduce energy consumption by turning off lights when a room is empty. However, only 1 of 77 data centers reviewed, a room at the Pacific Northwest National Laboratory (PNNL), had sensors installed. In addition, Headquarters, NETL and the Albuquerque Complex had temporarily used metering equipment to establish estimated energy usage baselines, but none had permanently installed meters to separate each data center's electrical usage from the rest of the building or had submetered IT equipment from its supporting infrastructure. Implementing power monitoring mechanisms such as this could allow officials to monitor the energy performance of data centers and IT equipment and set measurable goals for reducing energy usage.

In preliminary comments to our report, the Department stated that it had performed an assessment and became aware of opportunities to reduce energy consumption in its Germantown data center. It noted, however, that improvements were delayed to provide a stronger baseline for a Headquarters Energy Savings Performance

[5] Sun Microsystems, *Site Planning Guide of Entry-Level Servers, Version 1.4.*

Contract (ESPC) pilot project. Although the ESPC may be beneficial when implemented, we noted that Headquarters officials had only recently begun making a determination as to whether an ESPC would be feasible, more than a year after the initial assessment was completed.

<div align="center">Excess Data Center Space</div>

During our review, we also found that the Department continued to operate data centers and server rooms that were not fully utilized, further contributing to inefficiencies in managing space. As noted by the Office of Management and Budget's (OMB) FDCCI, the significant growth in the Federal government's data centers was costly, inefficient and had a significant impact on energy consumption. In addition, agencies reported many underutilized data centers that further contributed to inefficiencies. Furthermore, the June 2010 Presidential Memorandum, *Disposing of Unneeded Federal Real Estate – Increasing Sales Proceeds, Cutting Operating Costs, and Improving Energy Efficiency*, called for agencies to take immediate steps to better use real property as measured by, among other things, utilization and occupancy rates and energy efficiencies.

Our review of 77 data centers at 9 locations, including Headquarters, identified more than 74,000 square feet of space that was either vacant or not being used for its designed purpose. This represented over 26 percent of the total data center space that we reviewed. We found a number of inefficiencies related to maintaining excess space, such as unnecessary cooling expenses and failure to utilize empty space when possible. As noted below, we determined that the excess space could have been put to better use. For example:

- At the time of our review, over 3,000 of approximately 4,500 square feet (68 percent) of usable space at NETL's Morgantown data center was cooled even though it was empty. As highlighted in our *Management Alert on Planned Actions Related to the National Energy Technology Laboratory's Simulation-Based Engineering User Center* (OAS-RA-11-08, April 2011), NETL had planned to install additional data center capacity for a computing effort even though there was existing space. Furthermore, at least one NETL official noted that it would be possible to separate the unused data center space from the occupied space in an effort to help reduce cooling costs; and,

- At Headquarters, we found that the Department was paying to cool 7,530 square feet of space in the Forrestal data center maintained by the Office of Energy Efficiency and Renewable Energy (EERE) and the Energy Information Administration (EIA) that was vacant or could have been put to better use. Although the Department's 2011 Strategic Sustainability Performance Plan (Sustainability Plan) and the July 2011 FDCCI inventory included the future consolidation of data centers managed by EERE and EIA into the Department's data center in Germantown, Office of the Chief Information Officer (OCIO) officials had not coordinated with the organizations regarding consolidation. EIA had previously expressed concerns with housing its equipment within the Department's data center, but we noted that the Sustainability Plan was submitted to OMB prior to addressing those concerns. In preliminary comments on our report, EERE and EIA officials indicated that they were working with the Office of Management and OCIO to consolidate existing data center space by relocating within the Forrestal facility. Officials commented that the new space will be designed to implement various best practices in energy efficiencies, while also reducing the overall square footage. Specifically, EIA agreed with our conclusion that the existing facility was much larger than necessary for current and projected requirements, not energy efficient and had many other drawbacks. EIA officials noted that our findings supported the need to reduce existing data center space and improve energy efficiencies and that the Forrestal data center project has been fast tracked and will soon enter the second phase of construction.

Metrics, Resources and Coordination

The problems we identified occurred, in part, because the Department had not always established specific goals and performance metrics for organizations and sites to identify, share and implement energy-efficient practices designed to lower energy usage and related costs of data centers in a timely manner. In addition, data center resources and IT equipment were not effectively controlled to promote efficiency in energy usage and space utilization. Finally, organizations and sites had not effectively coordinated efforts to promote efficiencies through full utilization of data center space.

<u>Goals, Performance Measures and Incentives</u>

The Department had not always established specific goals or performance metrics, or otherwise incentivized its organizations

and sites to attain the energy-efficiency levels outlined in Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance,* in a timely manner. Officials noted in preliminary comments on our report that, subsequent to our audit work, the Department had outlined performance metrics to be achieved through Fiscal Year (FY) 2015 related to managing data centers as part of its 2011 Sustainability Plan. Targets were related to separately metering data centers, utilization rates of equipment and completion of energy assessments using Data Center Profiler (DC Pro), a software program funded by EERE at a cost of approximately $1.1 million and designed to identify potential energy-efficiency improvements for both government and commercial data centers. However, none of the field sites reviewed had established similar measures that could have been used to support the Sustainability Plan. Such measures should be included in planning documentation to help increase visibility over data center efficiencies that could result in reduced costs over a period of time.

Although certain efforts had been completed or were in the planning stage, the Department had not fully developed and implemented plans to identify all data centers and server rooms and consolidate them, as appropriate, to increase efficiencies and minimize duplicative operating costs. Implementation of such plans could have been used to incentivize sites to enhance efficiencies and reduce operating costs. For example, as of July 2011, the OCIO identified for the FDCCI that the Department operated only 58 Federal unclassified data centers and server rooms encompassing 101,000 square feet. However, we found that it excluded at least 520 data centers and server rooms accounting for more than 314,000 square feet at the 6 contractor-managed sites reviewed. In a number of instances, we noted that data centers excluded from the Department's inventory were underutilized. As noted by FEMP, consolidating underutilized data centers into a centralized location could improve the cost-effectiveness of energy-efficiency measures by implementing them at one location rather than across several. We noted that omissions of contractor data centers continued despite OMB's request that the Department resubmit its updated and final inventory prior to December 31, 2010. In fact, in support of Executive Order 13514, the Department was to submit a consolidation plan that included all national laboratory and facility assets, including those within the scope of the Department's management and operating contracts.

Data center resources were not effectively controlled to reduce energy consumption and ensure successful implementation of Federal guidelines. In particular, site-level funding was often provided based on a specific project rather than allowing for a centralized pooling of technology resources to ensure more efficient operations and placement of IT equipment within data centers or server rooms designed to house such equipment. Officials at SNL, Los Alamos National Laboratory and Argonne National Laboratory (ANL) indicated that researchers frequently purchased and installed equipment with project-specific funding, which resulted in the creation of new data centers and server rooms that required additional resources to support the infrastructure. Utilization of a central fund for IT resources could have helped ensure acquisitions were conducted in a manner that minimized duplication and maximized the benefit from investments in technology.

In addition, central IT functions were generally funded through an overhead rate charged to the sites' various projects. At some sites, officials noted that efforts to consolidate resources into more efficient facilities specifically designed to house data center equipment were met with resistance from project officials unwilling to cede control of equipment purchased using project resources. Further, while PNNL charged a higher overhead rate for data center space compared to general office space, overhead rates may not have appropriately reflected the true cost of data center operations throughout the Department. For example, beginning in FY 2011, Headquarters standardized the rate charged for square footage in its facilities rather than associate unique costs to space dependent on its purpose, as had been done in the past. Spreading the cost of data center space, including electricity consumption, equally across organizations did not provide an incentive to increase the efficiency of space managed.

Finally, alternative funding sources had not been fully evaluated by the Department to improve the energy efficiency of its data centers. For instance, ESPCs can allow Federal agencies to accomplish energy savings projects without significant up-front capital costs. Although Headquarters had initiated an ESPC to review its data centers, we found that sites reviewed had not fully evaluated the use of ESPCs when planning to secure funding for energy-efficient improvements to data centers. For example, during our review, an SNL official indicated that limited funding resources had prevented the expansion of the solar array supporting its data center operations; yet, an ESPC had not been

considered. In comments on our report, the National Nuclear Security Administration noted that funding for IT organizations was decreasing while demand for IT services continued to increase and believed that organizations must balance investments in major energy saving improvements with those needed for IT infrastructure improvements to support the mission. We agree that such a balance is necessary and continue to encourage the Department to explore all possible funding alternatives to improve its IT infrastructure.

Coordination

Organizations and sites had not effectively coordinated efforts to ensure efficient utilization of data center space. For instance, site-level organizations had not consistently worked together to determine how data center space should be utilized in the most efficient manner. As reported in our *Management Alert on Planned Actions Related to the National Energy Technology Laboratory's Simulation-Based Engineering User Center*, NETL's Site Operations Division had not been informed of the Office of Research and Development's plan to implement the Simulation-Based Engineering User Center project until nearly 3 months after the project charter was approved. In preliminary comments to our report, the Office of Science noted ongoing projects to coordinate and consolidate functions within its Advanced Scientific Computing Research program. In addition, EIA commented that cooperation at Headquarters among various organizations helped to accelerate the Forrestal data center consolidation project. As noted in our report, however, additional coordination efforts are necessary throughout the Department.

Finally, the Department did not always minimize duplicative infrastructure due to a lack of coordination among and between organizations and sites. For example, even though PNNL and the Hanford Site are located in close proximity to one another, each site continued to operate data centers with vacant space. Coordination between the sites may have enabled equipment to be co-located, thus reducing the need to lease additional space and secure funding for supporting infrastructure. Specifically, one of Hanford's contractors maintained a 1,500 square foot backup data center, but utilized less than 300 square feet of the space. This equipment could have fit within PNNL's newest data center, which had nearly 8,000 square feet of vacant space, and eliminated the need to lease the space for the backup data center. To its credit, Hanford housed equipment for two other Federal agencies, helping to reduce the overall Federal IT footprint. We identified, however, a similar lack of coordination within the Department in co-locating

data centers between the Albuquerque Complex and SNL. Notably, ANL and Fermi had demonstrated that co-location among facilities was possible as each maintained a limited amount of the other's equipment.

Impact and Path Forward

Without improvements, the Department will continue to spend more than necessary operating inefficient data centers and server rooms. While organizations and sites were unaware of, and could not calculate, the amount of energy used by data centers and the resulting levels of efficiency that could be achieved, we believe the savings could be significant. For instance, as noted in a recent data center assessment, implementing recommended improvements to air management and cooling systems could result in a 16 percent reduction in energy consumption, saving an estimated $81,600 per year at just the Headquarters Germantown facility. We found that similar efficiency measures could be taken at each of the sites reviewed. Furthermore, as previously identified in our audit on *Management of the Department's Data Centers at Contractor Sites* (DOE/IG-0803, October 2008), a continued lack of coordination regarding advances in energy efficiency may hinder the Department's progress in meeting Federal energy reduction goals.

In addition, the Department continued to maintain over 74,000 square feet of conditioned data center space that was either vacant or not being used for its designed purpose. As the Department moves to newer technologies that require a smaller footprint, such as virtualization and cloud computing, the need for data center space will likely decrease, resulting in increased vacant space. Excess data center space could be used for consolidating existing or planned data centers and server rooms, thus preventing future costs associated with constructing or converting other areas into data center space. For example, our review noted that NETL planned to acquire additional computing space at a cost of $3 million while over 3,000 square feet of space remained vacant at its Morgantown site. Although officials commented that the new space will be more efficient than that being replaced, we noted that the opportunity still existed to better utilize the existing vacant data center space. While we realize there may be costs associated with moving additional equipment into data centers and converting data center space into areas suitable for other conditions such as offices, we believe there are significant net savings that could be realized in this area. Finally, inadequate progress related to data center consolidation could result in missed opportunities for potential cost savings related to energy usage and maintenance costs.

Furthermore, while we commend the Department for establishing efficiency goals as part of its Sustainability Plan, we believe these targets should be revisited in light of the issues identified in our report. In particular, our findings indicated that the Department may be unable to meet its long-term energy conservations goals. For example, while the Department targeted that 40 percent of data centers would be independently metered in FY 2011, we noted that only 15 of 77 (less than 20 percent) data centers included in our review were separately metered. In addition, only 11 of 77 data centers at 6 of 9 locations reviewed had utilized DC Pro even though the Department's FY 2011 target was 50 percent. Absent sufficient performance metrics, the Department's organizations and sites will be unable to measure progress towards enhancing the energy efficiency of its data centers.

RECOMMENDATIONS

To improve the management of data centers, we recommend that the Under Secretary for Nuclear Security, the Acting Under Secretary of Energy and the Acting Under Secretary for Science, in coordination with the Department's and National Nuclear Security Administration's Chief Information Officers:

1. Review existing and planned data center configurations and update them, as appropriate, to take advantage of energy efficiency best practices, including the use of energy assessments;

2. Establish and implement effective performance measures for enhancing data center energy efficiency and reducing operating costs, including identification of all existing Federal and contractor data centers and server rooms and development of plans to consolidate them, as appropriate;

3. Review and modify, as appropriate, IT funding and resource practices to enable the Department to further realize efficiency improvements and achieve associated Federal goals; and,

4. Ensure coordination between organizations and sites, including IT, facilities and scientific personnel, to help enhance energy efficiency and consolidation practices within the Department.

MANAGEMENT REACTION

Management concurred with each of the report's recommendations and stated that it had initiated action to address issues identified during our review. For instance, management stated that it will conduct assessments of data centers to determine which ones are

worthy of further investment and which are candidates for closure. In addition, management stated that it will work to identify compliance with Sustainability Plan goals and performance metrics and will address performance results, as appropriate. Furthermore, management commented that it had aligned site-level environmental, energy and real property planning systems to elevate sustainability in site management and budgeting. Management also noted that it was exploring the use of performance contract vehicles to accelerate transformation of IT infrastructure services that will include significant energy efficiency and data center optimization/consolidation practices. Additionally, management commented that it was enhancing coordination between organizations and sites to address and implement data center energy efficiency, optimization and consolidation projects.

AUDITOR COMMENTS   Management's comments and planned corrective actions were generally responsive to our recommendations. We commend the Department for establishing performance goals as part of its Sustainability Plan and continue to believe that development and implementation of supporting metrics at field sites will be critical to the success of management's stated performance goals. In addition, while management's stated actions related to IT funding and resource practices are supportive of Recommendation 3, the Department may be able to achieve further savings by revisiting how funding is provided for data centers, including evaluation of the need to centralize funding at sites and/or how overhead rates are used to support data center operations. We believe that this recommendation should remain open until potential actions are fully evaluated. Management's comments are included in their entirety in Appendix 3.

OBJECTIVE

To determine whether the Department of Energy (Department) is managing its data centers in an energy-efficient manner.

SCOPE

The audit was performed between November 2010 and May 2012, at Department Headquarters in Washington, DC and Germantown, MD; the National Energy Technology Laboratory in Pittsburgh, PA, and Morgantown, WV; Los Alamos National Laboratory in Los Alamos, NM; the Albuquerque Complex (formerly the National Nuclear Security Administration Service Center) and Sandia National Laboratories in Albuquerque, NM; the Pacific Northwest National Laboratory and Hanford Site in Richland, WA; the Chicago Office and Argonne National Laboratory in Argonne, IL; and, the Fermi National Accelerator Laboratory in Batavia, IL.

METHODOLOGY

To accomplish our objective, we:

- Reviewed applicable laws and directives pertaining to information technology management, including Executive Order 13514; Presidential Memorandum – *Disposing of Unneeded Federal Real Estate,* dated June 10, 2010; and Departmental Order 430.2B;

- Reviewed related reports issued by the Office of Inspector General and the U.S. Government Accountability Office;

- Reviewed best practices pertaining to energy-efficiency practices within data centers;

- Reviewed an inventory of site-identified classified and unclassified data centers and server rooms housing equipment supporting business, scientific and high performance computing applications; and,

- Held discussions with field site officials and officials from various Departmental offices.

We conducted this performance audit in accordance with generally accepted Government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective. Accordingly, we assessed significant internal controls and compliance with laws and regulations to the extent necessary to satisfy the audit objective.

In particular, we assessed the Department's implementation of the *GPRA Modernization Act of 2010.* Although the Department had established certain overarching performance goals subsequent to our audit work, none of the sites evaluated had established performance metrics specific to data center energy efficiency or space utilization in site performance evaluation plans. Because our review was limited, it would not necessarily have disclosed all internal control deficiencies that may have existed at the time of our audit. We did not rely on computer-processed data to satisfy our audit objective.

Management waived an exit conference.

PRIOR REPORTS

- Audit Report on *Management Alert on Planned Actions Related to the National Energy Technology Laboratory's Simulation-Based Engineering User Center* (OAS-RA-11-08, April 2011). The National Energy Technology Laboratory (NETL) initiated plans to use $20 million of American Recovery and Reinvestment Act of 2009 (Recovery Act) funds to support a computing project, including $3 million for acquiring and installing a Performance Optimized Data Center. Aside from a number of analytical flaws and unsupported assumptions within project planning documentation, the audit identified that the existing NETL data center contained over 3,000 square feet of usable space with no plans on future use.

- Audit Report on *Management of Energy Savings Performance Contract Delivery Orders at the Department of Energy* (DOE/IG-0822, September 2009). One goal of the Recovery Act was to improve the energy efficiency of Federal facilities that could be funded using Energy Savings Performance Contracts (ESPC). ESPCs would allow private-sector energy services companies to develop and install energy improvements in exchange for a share of the future savings. The audit determined that the Department of Energy (Department) had not always effectively used ESPC orders to achieve energy savings, nor ensured that the Government's interests were adequately protected in this process. As a result, the Department may risk spending up to $17.3 million more than it would realize in energy savings.

- Audit Report on *Department of Energy Efforts to Manage Information Technology Resources in an Energy-Efficient and Environmentally Responsible Manner* (OAS-RA-09-03, May 2009). The Department did not take adequate steps to ensure energy efficiency through management of information technology resources. Specifically, the sites visited had not implemented the recommended time for standby mode, many computers did not have the hibernation feature enabled and energy saving desktop devices were not purchased. The Department had not taken important steps to reduce energy consumption and properly monitor performance to realize energy savings, and it was estimated the Department spent $1.6 million more than necessary on energy costs for Fiscal Year 2008 by not adequately addressing the opportunity for savings.

- Audit Report on *Management of the Department's Data Centers at Contractor Sites* (DOE/IG-0803, October 2008). The Department had not always taken advantage of opportunities to improve the efficiency of its data centers. In particular, as many as 140 data centers were found at the 6 sites reviewed that duplicated common services such as e-mail, data storage and libraries. Furthermore, four of the six sites made only limited use of more efficient hardware technologies that conserve energy and reduce operational costs. The Office of Inspector General estimated that $2.3 million per year for these 6 sites could be saved through the use of more efficient hardware technologies.

MANAGEMENT COMMENTS

Department of Energy
Washington, DC 20585

April 9, 2012

MEMORANDUM FOR GREGORY H. FRIEDMAN
                           INSPECTOR GENERAL

FROM: MICHAEL W. LOCATIS, III
                   CHIEF INFORMATION OFFICER

SUBJECT: IG Draft Report, "Efforts by the Department of Energy to
                   Ensure Energy Efficient Management of its Data Centers"

Thank you for the opportunity to comment on the draft report, "Efforts by the
Department of Energy to Ensure Energy Efficient Management of its Data Centers." The
Department of Energy (DOE) Office of the Inspector General (IG) provided a thorough
and concise review of the Department's implementation of energy efficiency best
practices at its data centers. In reviewing the draft, we agree that the majority of the IG
findings are reasonable. While the contributing comments from DOE organizations
uniformly agree that the recommendations provide effective insight to correct
discrepancies and improve the energy efficiency of the Department's data centers, NNSA
raises concerns associated with funding data center energy efficiency projects. The
information provided in the report will enable the Office of the Chief Information Officer
(OCIO), the Sustainability Performance Office (SPO), and program offices to take
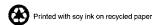appropriate follow-up actions on specific findings.

Detailed comments from the U.S. Energy Information Administration (EIA), Office of
Environmental Management (EM), Office of Health, Safety and Security (HSS), National
Nuclear Security Administration (NNSA), Office of Science (SC), and National Energy
Technology Laboratory (NETL) are contained in Appendix A.

With respect to the specific recommendations in the draft report:

Recommendation 1: *Review planned and existing data center configurations and*
update them, as appropriate, to take advantage of energy efficiency best practices,
including the use of energy assessments.

Management Response: Concur.

DOE's approach for data center optimization and consolidation is integrated with the
Department's Strategic Sustainability Performance Plan (SSPP), which is required by
Executive Order (EO) 13514. Using the DOE Green IT (DOEGRIT) Data Center
Profiling tool, developed by DOE and deployed in early FY2012, DOE has identified as a
best practice that Sites conduct an annual energy assessment of each data center using a

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and identify facility infrastructure improvements that are possible to improve Power Utilization Effectiveness with the goal of improving DOE's average to 1.4, as outlined in DOE's SSPP. During this approach DOE sites will identify which data centers are worthy of further investment and which are candidates for closure. This implementation methodology ensures that a complete business assessment is conducted for each data center where cost effective and that consolidation and optimization activities are properly aligned and prioritized with other sustainability projects.

Recommendation 2: *Establish and implement effective performance measures for enhancing data center energy efficiency and reducing operating costs, including identification of all existing Federal and contractor data centers and server rooms and development of plans to consolidate them, as appropriate.*

Management Response: Concur.

The DOE 2011 SSPP Goal 7 provides six specific performance measures and associated annual targets for improving data center infrastructure and operations efficiency. These measures are:

- Percentage of agency data centers independently metered, advanced metered, or sub-metered to determine monthly (or more frequently) Power Utilization Effectiveness (PUE) - (FY15 target 100%)
- Reduction in the number of agency data centers – (FY15 target 6 data center closures)
- Percentage of agency data centers operating with an average CPU utilization greater than 65% - (FY15 target 100%)
- Maximum annual weighted average Power Utilization Effectiveness (PUE) for agency – (FY15 target 1.4 PUE)
- Percentage of agency data center assigned a certified Data Center Energy Practitioner - (FY15 target 100%)
- Percentage of agency data centers that have conducted annual DC-Pro energy assessment – (FY15 target 100%)

As required by the annual Site Sustainability Plan Guidance, DOE sites will report their inventory of data centers and associate performance in their annual Site Sustainability Plan (SSP) and will conduct an annual energy profile using the DOEGRIT website. While verification of inventory accuracy is the responsibility of the DOE sites, the OCIO, in collaboration with the SPO, will review data submitted in SSPs and the DOEGRIT website. The 2011 SSP and Comprehensive Epidemiologic Data Resource (CEDR) data are now under review by the OCIO and a compliance report is being prepared. This report will be provided to the DOE SPO who will then provide it to the program offices for any necessary program/site follow-up. Estimated completion date is April 2012.

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Recommendation 3: *Review and modify, as appropriate, IT funding and resource practices to enable the Department to further realize efficiency improvements and achieve associated Federal goals.*

Management Response: Concur.

While we concur with this recommendation, it fails to recognize that data centers are funded in various ways in the Department based on mission relatedness of the data center and operated by two separate lines of business: Facilities & IT. However, by including the data center energy efficiency performance goals in the SSPP, DOE is integrating the principles of sustainability into its decision-making and budget development processes. The annual budget process will be informed by the goals of the SSPP, starting at the Under Secretary level and progressing through the Program Secretarial Offices (PSO) to the sites. DOE has aligned its site-level environmental, energy, and real property planning systems to elevate sustainability in site management and budgeting. By adopting this holistic approach, DOE Sites will identify energy efficiency improvement opportunities by viewing energy management for both IT systems and facility infrastructure. DOE sites can make informed decisions as to which data centers are worthy of energy efficiency improvements and which are candidates for closure. To assist DOE sites, Federal Energy Management Program (FEMP) is providing quarterly DC Pro web training and Lawrence Berkeley National Laboratory (LBNL) is available to conduct data center technical assessments and identify potential energy efficiency opportunities, as requested by DOE sites.

Additionally, DOE is exploring the use of performance contract vehicles, such as the Energy Savings Performance Contract (ESPC), to accelerate transformation of IT infrastructure services that include significant energy efficiency and data center optimization / consolidation practices. It is expected that with the HQ Data Center ESPC project, DOE will reduce its data center footprint and achieve a PUE of 1.4 (or less) for the Forrestal and Germantown data centers.

These mechanisms will further realize efficiency improvements and achieve associated Federal goals at the Department. Therefore, the Department considers this recommendation closed.

Recommendation 4: *Ensure coordination between organizations and sites, including IT, facilities and scientific personnel, to help enhance energy efficiency and consolidation practices within the Department.*

Management Response: Concur.

The OCIO is working with the SPO to identify compliance with SSPP goals and performance measures. Based on performance reported in DOE site SSPs, the SPO (working with the OCIO) will work with PSOs to address performance results. It is the responsibility of DOE sites and PSOs to establish effective policies to address and implement data center energy efficiency, optimization, and consolidation projects.

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In partnership with the DOE National Laboratories CIOs, the OCIO also serves as a coordination, collaboration and communications conduit between the DOE IT organizations in program offices, as it pertains to IT sustainability and data center optimization.. As an example; in August 2011, the DOE National Laboratories published a report titled Leadership in Green IT, which highlighted examples of best practices, plans, and successes in the following areas.

- Sustainable management of IT devices
- Virtual and high performance computing environments
- Planning and implementation best practices
- Partnering with nature for "free cooling"
- Power using renewable resources
- Waste reuse and recycling
- Energy efficient data center practices
- Leadership through partnering with industry and each other.

This report was distributed to all DOE IT organizations and made available for distribution to other federal agencies and industry leaders.

The SPO will host monthly sustainability teleconference meetings with the Energy Facilities Contractors Group (EFCOG) to raise awareness of common data center issues and promote the sharing of successes and best practices throughout DOE. The monthly teleconferences will include Federal representation from DOE's program offices in addition to DOE laboratory and site contractors that work on a variety of sustainability activities including facilities and IT. Once several meetings have occurred, SPO will report on progress and planned actions. DOE also promotes the sharing of data center best practices and guidance through the SPO's monthly newsletter (SPOtlight). The DOE SPOtlight is widely distributed to DOE employees and contractors throughout the complex. Program offices also identify best practices in their Composite Sustainability Plans (CSP), the first of which is due April 2012. The CSPs are required by DOE Order 436.1 Departmental Sustainability. Program offices also have sustainability coordination activities, e.g., monthly teleconferences.

Attachment

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