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Green Energy for Information Technology Data Centers: An Analysis of Energy Procurement Options for the Federal Government

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This analysis takes on the complex but urgent question of how to reduce energy use in a particularly power-hungry sector, information technology data centers. The authors evince an impressive level of expertise in the variety and complexity of data centers and in their increasing energy consumption. Despite a likely preference for "a transformative green policy option," these researchers dissect the issue dispassionately and make a strong case for a more incremental approach. This meticulous analysis is exceptionally well-executed.

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EXECUTIVE SUMMARY

Information technology data centers are facilities that house a vast array of computer systems and equipment. Data centers are pervasive throughout the United States (U.S.) government, and are required to effectively manage the scale and complexity of information technology processes required to deliver various government services. Data centers support a multitude of critical business operations and information processing services for the federal government.

A significant amount of energy is required to power and cool the servers that compose a typical data center. Since 2000, the overall rate of energy consumption for U.S. data centers, sourced primarily from polluting energy, has grown at an average of 14 percent per year. This trend is projected to continue as information technology services become ubiquitous. Moreover, research suggests that government dependency on scarce/vulnerable energy resources may have adverse consequences (i.e., security and aggregate cost concerns). However, a federal procurement guideline for green data center energy is still absent. This is an issue that must be remedied.

This report compares alternatives to current data center service procurement trends based on: (1) total emissions, (2) relative cost, (3) performance, and (4) feasibility. Overall, the research herein suggests that, due to the complexity and variety of data center technology needs, a transformative green policy option is not currently available for data center services. However, it is recommended that the Office of Federal Procurement Policy (OFPP) mandate energy measurement standards and encourage agency procurement officers to incorporate the Energy Star® Program guidance into future data center procurements.

INTRODUCTION

According to the Office of Federal Procurement Policy (OFPP), the federal government is one of the largest buyers of goods and services in the world, procuring $350 billion per annum.[1] The federal government also spends a substantial amount of funds on energy. In the United States (U.S.) alone, the government spends "$293 million to power its PCs and $479.5 million annually to power and cool its data centers.[2] Despite significant spending on energy for data centers, the federal government has yet to establish policy on the acquisition of energy efficient data centers.

In addition to these monetary costs, the operation of data centers incurs numerous life cycle environmental costs. Such costs include, but are not limited to: the environmental consequences of mining operations required to procure the raw materials necessary for manufacturing computer equipment, the impact on the biodiversity of buildings that house data centers, and the polluting emissions of the data center service personnel as they commute to the facility. By far the greatest environmental cost associated with data center operations arises from the emissions of greenhouse gasses during the combustion of low cost and abundant fossil fuels that generates the enormous amount of power used for data center operations. Greenhouse gas emissions are attributed by many scientists as contributors to annually increasing global temperatures that in turn increase long-term risks to society and the world ecology. Given the availability and low cost of fossil fuel sources for power production, there is currently a direct correlation between energy consumption and environmental impact. Standards for designs and processes that reduce these polluting emissions are commonly denoted with the label "green".

Data center operations represent a surprising proportion of total energy consumption by industry in the United States. The independent technology industry analyst firm, The 451 Group

states, "if data centers were classified as a separate industry, they would be the sixth-largest user of electricity."[3] The carbon dioxide (CO_2) emissions produced by the information technology and communications industries are now almost equivalent to CO_2 emissions produced by the aviation industry, almost 2 percent of global total emissions.[4] CO_2 emissions account for approximately 50 percent of the total ecological footprint of the wealthy nations such as the United States, Japan, and western European Union nations.

The United States federal government is a significant operator and procurer of data centers, and therefore has both indirect and direct influence over how these contribute to national emission rates. Presidential executive orders such as Executive Order 13423 and legislative statues such as the Energy Policy Act of 2005 require federal agencies to either reduce total energy consumption or increase the percentage of their energy usage from non-polluting (renewable) sources. Compliance to this policy is required for those data center operations run by the government itself, but is not required when the government purchases data center services from the private sector. This paper examines procurement policy options that may effectively lessen the environmental impact of procured federal data center services.

The proposed client for this project is the Deputy Administrator of the OFPP at the Office of Management and Budget (OMB). This role managed the development of procurement policy and developed green procurement policy in 2007 at the behest of the Office of the Federal Environmental Executive (OFEE). Soon after the development of this green procurement policy, OFPP recognized that data centers were an important area for future inclusion. Other stakeholders for this policy would include the procurement offices of each federal agency, the Environmental Protection Agency (EPA), the Department of Energy (DOE), and the information technology industry.

CRITERIA

In nearly all cases, the most significant environmental impact of data centers is extensive energy consumption resulting in greenhouse gas emissions. Therefore, the primary policy performance criterion used herein compares total emission reductions over a period of time with a base case of no policy change.

Total Emissions

The computation of total emissions resulting from electric energy consumption is relatively straightforward. Total emissions (T) equals the energy consumed (E) multiplied by the greenhouse gas emission Intensity (I) of that energy use, or ($T = E \times I$). The measurement of energy consumption (E) can be sourced directly from the electricity meter of the data center itself, while the emissions intensity (I) can be calculated by the energy supplier (the power company) as an average value based on the sources of fuel providing energy to that data center. A particular policy might reduce the total emissions by improving energy efficiency, thereby reducing the rate of energy consumption while remaining at a fixed emissions intensity. Alternately, a policy approach might focus exclusively on the use of lower-emission clean fuels such as wind, solar, biomass, or hydroelectric, which would reduce total emissions by reducing emissions intensity while maintaining its rate of energy consumption. Some policies may reduce total emissions by targeting both energy consumption and emissions intensity.

Relative Cost

Another important criterion is the relative cost of implementing an alternative policy. This value would include, over the period of assessment, the cost of emissions improvement

investments (energy efficiency or clean energy) less any savings resulting from these investments.

Performance

Although one approach to reducing data center energy consumption would be to reduce performance by using low power, low performance computers, this would also have a deleterious effect on the business operations of the agency procuring the service. Therefore, the best criterion would be one that measures the performance-to-energy ratio of a data center and would thus evaluate the best value per environmental cost for the government. This would be the equivalent of the fuel economy standard of 'miles per gallon.' Unfortunately, there is not currently an agreed upon industry method for calculating a standard unit of performance for the output of a data center (equivalent to 'miles' for vehicles). Therefore, the best criterion presently available to assess procurement options is the total greenhouse gas emissions criterion discussed previously.

Feasibility

Feasibility of policy implementation is important in any assessment of projected benefits. Each alternative must be assessed in terms of political feasibility, administrative feasibility, and adoption incentives. Highly feasible alternatives with strong incentives for adoption convey greater confidence in the realization of emissions reduction projections rather than infeasible alternatives with disincentives for adoption.

ALTERNATIVE APPROACHES

Current Trends

The information technology industry is already responding to the call for green data centers resulting from a variety of drivers. Relatively recent changes in public sentiment and emerging investor perceptions of the value of corporate environmental responsibility have spurred a number of large companies such as IBM and General Electric to competitively differentiate themselves through "being green." Further, exponential increases in annual data center energy consumption combined with increases in power prices (see Figure 1), compels corporate actors to focus on improving energy efficiency as a means of reducing costs.[5] As the DOE anticipates continued increases in energy prices, it is expected the normal operation of the market will bring some corporate investments in energy efficiency that improve the total emissions performance. Conversely, efforts to reduce costs could also concentrate on locating data centers in regions with the lowest energy prices, which are typically coal power plants which have some of the highest greenhouse gas emissions intensity.

Renewable Energy Mitigation Program

A broad spectrum of green procurement initiatives are being developed and adopted at the state, local, and university levels. Many of these sustainability programs have displayed tangible results with regards to increased energy efficiency, energy sustainability, cost benefits, and secondary environmental benefits. Practical and theoretical aspects of the non-federal model described hereinafter are applicable in the realm of data center energy procurement. However, the efficiency of policy experiments at the state and local levels can often be hard to replicate at the federal level due to its political polarity.

Many non-federal sustainability programs offer economic incentives, including loans, grants, credits, and tax benefits for green procurement, which, according to Paul Epstein, can help "erect the scaffolding for the [new] low carbon economy."[6] This is a worthy notion given the fact that non-federal entities spend more than $1 trillion on goods and services annually.[7]

Colorado is at the forefront of progressive and efficient state energy initiatives, relying on rebates and incentives to harness renewable and clean energy (Colorado's Clean Energy Choices [CCEC]). For example, the city of Aspen in Colorado sponsors a successful sustainable energy program. The economically-inspired Renewable Energy Mitigation Program (REMP) attaches fees of up to $10,000 for homeowners who exceed an allotted amount of energy for powering their houses. The energy budgets for homes are further calculated based on home size. The funds collected from the fees are then rerouted into energy efficiency programs and/or are used for purchasing alternative energy sources. Since 2000, the REMP has raised $8 million for such programs.

The effectiveness of the REMP has been profound in Aspen, with residents opting to install renewable energy systems rather than exposing themselves to the REMP fees.[8] Furthermore, the REMP also attaches rebates and credits for residents who purchase energy efficient appliances. The REMP model is an efficient means for reducing CO_2 emissions at the local level. The economic strategies, such as fees and incentives, found in the REMP may be useful in the broader realm of data center energy procurement.

Institutional Action Plan: European Model of Green Public Procurement

When assessing the options to mitigate the negative environmental impact of data centers procured by the government, consideration should be given to a comprehensive green procurement strategy, developed and applied by leaders within an organization. Although the

following represents a model based on the development of a plan at the national level, there is considerable room to adjust the model for use at the institutional level.

Beginning in 2000, the European Union (EU) began taking steps to create unified policies aimed at the growth of a sustainable economy. Over the next several years, EU leaders considered the use of Green Public Procurement (GPP) to aid in achieving their emission reduction goals.[9] In January of 2006, the European Parliament called on member states to adopt national action plans that create rules governing the use of GPP. Currently, ten countries have adopted draft national action plans and ten others are in the development phase.[10] Nearly all national action plans include the use of targets aimed at the reduction of CO_2 emissions[11], some based on the Kyoto Protocol.

Austria, Denmark, Finland, Germany, Netherlands, Sweden, and the UK (the 'Green-7'), rank the highest in their use of GPP within the EU. [12] These countries have taken steps to mitigate the barriers — lack of knowledge in the development of environmental criteria, lack of political and managerial support, and the belief that green products cost more — commonly identified by procurement professionals.[13] Not surprisingly, all countries in the Green-7 have adopted draft national action plans. This appears to be the most important common factor across countries with high success rates. The plans help address each one of the commonly cited barriers to GPP, perhaps most importantly by addressing the issue of political and managerial support. The support of high-level government officials and legislators (whether by a plan that compels or recommends) provides the foundation needed to address the other perceived barriers. Without the political and managerial support, purchasers are inclined to focus solely on traditional best-price criteria, rather than taking environmental considerations into account.[14]

The lack of knowledge to create environmental criteria, and the perception of increased prices can be lumped into one category: lack of information. Once the plans have been developed and enacted, training and GPP workshops provide the information required by purchasers to make informed purchasing decisions that take into account environmental considerations. In addition to the training and workshops, public procurement professionals often have access to inventories of identified eco-friendly products. By accessing an inventory of eco-friendly products, purchasers can see that the cost is often less than what they expected, sometimes less than what the currently-used product would cost. Information about specific products and cost are not the only benefit to the inventory websites. The technical specifications provided by the eco-friendly products can also be used to develop appropriate environmental criteria, by copying the standards used for eco-friendly labels into the tender documents.[15]

Institutional strategies for successful procurement of green data centers hinges on the ability to overcome the previously cited barriers, which on the surface, the Institutional Action Plan (IAP) seems to accomplish. The adoption of an IAP would establish the needed managerial support for the inclusion of environmental considerations into the data center procurement process. Further, the identification of clear emission reduction targets (for the entire organization) provides procurement officials and potential contractors a clear statement of the overall goal of the IAP. The inclusion of green criteria into data center procurement is required to achieve the IAP target. To support the adoption of an IAP, the implementing institution would need to establish education and training programs, so procurement officials have the knowledge and resources available to develop green criteria for the procurement of data centers.

LEED Green Building Certification

The U.S. Green Building Council maintains the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, which has been widely and successfully adopted as a standard for building environmental performance across the United States and within government. This standard evaluates a wide variety of design features for buildings ranging from energy impacts of lighting and Heating Ventilation, and Air Conditioning systems, to water reuse systems and onsite renewable energy generation, to building placement and employee alternative commuting opportunities. These standards use a point system to rate buildings based on assessments conducted through third party audits by civil engineers certified by the U.S. Green Building Council (itself a non-profit organization).

This approach is popular, easily understood, and has been endorsed by numerous prominent environmental groups. It also has a logical and standardized means of assessing the environmental design of buildings.

This certification process has been used to confer a green rating in some US government data centers, indicating an improved environmental performance of the data center facility. However, the LEED rating system is exclusively used to assess the building (structure) environmental performance, and does not assess the environmental performance of the computer systems *inside* the building. In the case of data centers, the environmental burden of the computer operations housed within the facility produce by far the greatest impact to society in terms of polluting energy consumption. Therefore, utilization of the LEED rating system may yield improvements in data center energy efficiency and emissions reductions through improved facility operations, but does not address the core issues unique to data centers.

Environmental Management Systems

The EPA defines an environmental management system (EMS) as "a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency."[16] EMSs represent a potentially powerful and innovative federal acquisition tool that could aid in the procurement of energy efficient data centers. Many organizations around the world have already adopted EMSs in accordance with the international standards outlined in ISO 14001. By the end of 1998, almost two thousand organizations and corporations around the world had adopted ISO 14001 certified EMSs; of these organizations, 330 were located in the United States.[17] ISO 14001 guidelines facilitate the creation of EMSs that are organization and industry specific by identifying legislative requirements, fostering employee commitment, and ensuring organizational compliance through third party audits.[18] ISO 14001 does not provide specific environmental performance standards, but instead presents a firm with a framework for developing its own environmental objectives that can potentially lead to increased environmental performance.[19]

The small business subcontracting program, as described in the Federal Acquisition Regulation (FAR) part 19, provides a potential framework that the government could emulate in the implementation of an EMS requirement. The government requires that all contractors participating in a negotiated federal contract develop a small business subcontracting plan for contracts exceeding $550 million.[20] Subcontracting plans, like ISO 14001 certified EMSs, are developed by individual firms who set their own performance standards. Subcontracting plans are subject to government audits and firms are required to make a good faith effort to comply with their proposed plans.

EMSs provide federal acquisition professionals with a tool that is both regulatory and incentive-based. It is regulatory because it mandates that all companies have some type of EMS and it is incentive-based because the contractor who develops the most innovative EMS would likely win the contract award. A government EMS mandate would require contractors to make a substantial upfront investment in environmental performance in order to remain competitive in the federal contracts marketplace; however, this investment has the potential to benefit the firm, the government, and society in terms of reducing costs and increasing energy efficiency in the long run. Matthew Potoski, an associate professor of political science at Iowa State University, and Aseem Prakash, an associate professor of political science at the University of Washington – Seattle, succinctly describe the use of EMSs as viable tools of federal procurement: "It is a classic 'Third Way' approach that seeks to pursue the goals of the left – cleaner environment – through the means of the right – harnessing private profit motives for public ends."[21]

Energy Star® Program

The FAR provides a potential framework for energy efficient data center procurement. FAR part 23 requires federal agencies to use the Energy Star® Program to obtain energy efficient products and technologies. In fact, federal agencies are required to use the Energy Star® Program on almost all procurements. However, this regulation is weak considering agencies can forgo the Energy Star® requirement if it does not meet agency functional requirements or provide effective cost savings, which are determinations made at the behest of senior agency officials.[22] This program does not specifically address data centers, but it does provide a potential avenue for procuring energy efficient data centers.

The Energy Star® Program was established by the EPA in 1992 and provides businesses and consumers with energy performance information and measurement tools that aid in their

decisions to make long term investments in energy efficient products.[23] The EPA and the DOE work with industry and various energy stakeholders to label products that meet the energy performance measures developed by the agencies.[24] Currently, the Energy Star® Program provides information on 40,000 individual product models across 50 different product categories.[25] Some of these categories have the potential to be applicable to data centers, such as, air conditioning systems, but most products found in data centers, for example, computer servers, are not found in the Energy Star® Program list of product procurement recommendations.[26]

Energy Star® server certifications have experienced slow development because of the complexities inherent in the evaluation of server electrical efficiency. Personal computers contain standardized technologies and configurations whereas server technologies often vary widely across companies. Server technologies are extremely divergent and require different types of energy efficiency performance metrics. One feasible solution is to focus solely on performance metrics for server power supplies. Joe Loper and Sara Parr of the Alliance to Save Energy, a non-profit entity co-chaired by democratic Senator Mark Pryor and Duke Energy CEO James Rogers, state, "power supply performance is relatively straightforward – i.e., unit of energy output per unit of energy input – compared to measuring server energy performance."[27] The 80plus performance specification, testing methods and energy efficiency standards for server power supplies developed by electric utilities, could be incorporated into the Energy Star® Program as a minimum set of performance metrics that servers must meet in order to be suitable for government procurement. Servers frequently do not run at full rated capacity and the 80plus program "requires…server power supplies to operate at 80-percent efficiency at 20, 50, and 100 percent of rated capacity."[28]

The adoption of servers and other data center components into the Energy Star® Program product listings and categories would be a significant step towards the procurement of more energy efficient data centers. However, more collaboration is required of industry, the EPA, and the DOE to determine standardized performance metrics that ensure effective cost savings and measurable decreases in energy consumption.

ALTERNATIVE COMPARISON

Table 1 summarizes the assessment of each solution alternative in terms of the criteria identified earlier. The criteria for feasibility are summarized as a 'Risk' criterion that estimates the probability of success (or proportion of realizable benefits) for a given solution.

Table 1 – Alternative Comparison Matrix.

	Outcome Criteria		Risk	Feasibility Critertia 1 = low, 5 = high		
Solution Alternatives	Total emissions 1 = worst, 3 = best	Relative Cost 1 = Low, 3 = High	Likelihood 1 = Most probable, 0 = least probable	Political Feasibility	Administrative Feasibility	Incentives for Adoption
Current Trends	1	1	1.0	5	5	5
Renewable Energy Mitigation Program	3	2	0.3	2	2	1
Institutional Action Plan	3	2	0.5	2	4	2
Energy Star Program	2	1	0.8	4	4	4
LEED Buildings	1.5	2	0.8	4	4	4
Environmental Management Systems	1.5	1	0.7	4	3	4

Current Trends

Some small near-term incremental improvements in total emissions are expected, with greater improvements as projected trends in energy prices draws greater corporate investment towards improving energy efficiency of data centers. The current trends present a benchmark to contrast the other policy alternatives, which are anticipated to improve environmental performance at some increased cost.

Renewable Energy Mitigation Program

The fundamental goal of the REMP is long term reduction of carbon dioxide emissions via fees and incentives for data center service providers. As such, this model performs well in terms of total emissions per annum, and surpasses the current trends outlook in this criterion. Moreover, the relative cost of the REMP is marginally higher than the base case, and would certainly measure better in terms of cost if the funds collected from the energy budget fees were not rerouted into separate programs. However, the REMP appears to be an appropriate model for smaller, non-federal arenas, because many of its aspects (e.g., the rerouting of funds into alternative energy programs, and the attachment of fees based solely on size) are more politically and administratively feasible when levied on constituencies whose values are more directly aligned with these policies.

Institutional Action Plan

The IAP is designed to ensure an organization is working towards the reduction of emissions; IAP is best suited for an overall green public procurement strategy for an entire organization. Due to the flexibility in target setting, there is significant potential for the large reduction of emissions per annum (assuming target is set high). If the IAP were developed to

include only the procurement of data centers, there would be significant cost in the development and administration for a single product based plan. The IAP benefits from economies of scale, or widespread application. The success of emission reduction goals depends upon the adopted level of the target. Targets can be defined as, for example, 10 percent reduction of emissions for all procured services by the year 2020. The higher the emission reductions target, the further away from the status quo the IAP becomes, and the less politically feasible it becomes. Absent pressure from outside the government agency, there is little likelihood of the adoption of an IAP.

LEED Green Building Certification

The LEED Green Building rating confers a marginal improvement in total emissions at some cost. Due to the fact that this rating assesses the components of the data center with the least relative impact, this alternative offers some improvement over the base case but relatively small advantages when compared to many of the other alternatives. It is deemed to be broadly feasible in terms of political acceptance and administrative feasibility given the widespread current adoption of this assessment system.

Environmental Management Systems

The central tenet of an ISO 14001 certified EMS based policy solution is the incentive it creates for firms to innovate. If a firm is required to submit an EMS plan as part of the competitive source selection process for government contracts, then the firm will seek to develop and adopt an innovative plan in order to beat out its competitors. However, evaluating a plan could prove to be politically and administratively risky for government agencies. Without some sort of standardized measurement of energy efficiency, total emissions per annum of a data center could not be assessed or quantified. The procuring agency and the EPA would have to

spend significant amounts of capital building the organizational and administrative capacity just to be able to assess and audit individual EMSs. Prakash and Potoski point out that, "some EMS-based programs have turned out to be greenwashes either because their sponsors have willfully designed them that way or because their weak institutional architecture does not provide for monitoring and sanctioning to ensure that having joined the program, firms do not shirk."[29]

Energy Star® Program

The single greatest impediment to procuring energy efficient data centers is the lack of minimum performance efficiency standards for servers. According to Kenneth Brill, the executive director of the Uptime Institute, "the widening delta between the faster rate of increase in server computational performance and the slower rate of increase in energy efficiency growth results in a dramatic increase in user engineering and costs burdens of providing power and cooling."[30] The Energy Star® Program's high level of political and administrative feasibility places it in a unique position to increase the rate of energy efficiency in data centers while simultaneously reducing the costs associated with power and cooling.

The institutional and regulatory framework for the Energy Star® Program already exists, and the federal government currently requires all energy consuming items to be procured from the Energy Star® Program's product listings. The Energy Star® Program has also produced measurable increases in energy savings and reductions in CO_2 emissions. A report produced jointly by members of the Lawrence Berkeley Laboratory and KEMA Consulting estimates that, "Through 2006, US EPA's ENERGY STAR labeled products saved…$47 billion dollars in energy bills (discounted at 4 percent)…through its voluntary program efforts."[31] In addition, the buildings that house government data centers and the air conditioners cooling data centers are already required to possess Energy Star® labels.

Despite the Energy Star® Program's current measurable successes and energy performance requirements for buildings and air conditioners, it has yet to implement minimum energy performance standards for servers. Although this represents a significant drawback to the efficacy of the Energy Star® Program, the EPA, due in part to the high visibility and entrenched institutional framework of the program, has begun working with industry to develop standardized server performance metrics. Standard energy performance metrics adopted by the Energy Star® Program are crucial to any policy intended to promote energy efficient data centers because results must be measurable in order to track the performance of federal agencies and to accurately quantify financial incentives that could be provided to industry stakeholders to promote regulatory compliance and innovation.[32] The Energy Star® Program's current regulatory status will be advantageous to any new policy which focuses solely on progressing and implementing the technology necessary to develop energy efficient performance metrics.

Recently, the EPA initiated an Energy Star® Program which focused on the entire energy performance of the data center, in addition to its constituent components described above. This approach should be monitored for feasibility, industry input, and realization of objectives.

CONCLUSION AND RECOMMENDATION

For data center outsourcing, the cost-conscious market will continue to accelerate investment in energy efficiency as long as rising electricity prices create a positive return for those investments. Federal green procurement policy, then, would be warranted if the government sought to use this as a tool to accelerate the adoption of energy-efficient technologies at a faster pace than would otherwise occur in the market. The benefits for this could include: reducing US government risks and costs due to increasing dependence on energy,

foreign or otherwise; accelerating the environmental benefits of reduced emissions; and further stimulating the development of innovative green technology.

Agencies are able to select from a variety of green data center procurement approaches, and may choose based on the specific strategy and political climate of each agency. Based on this analysis, no particular approach stood out as possessing distinct advantages over the others, though the Energy Star® Program is perhaps the most feasible and is expected to further reduce total emissions at a marginal incremental cost when compared to the current trend projection.

Giandomenico Majone defines the policy core as the stable aspect of the policy and the periphery as the flexible part.[33] No matter which green procurement options emerge or become popular at the periphery, measurement of the total energy consumption and emission intensity of those data centers would be needed to assess the performance of that option. The empirical methodology to assess these measures already exists within the Energy Star® Program and is relatively easy to calculate at negligible increased cost. Therefore, the core recommendation of this report is for these measures to be reported annually as a mandatory requirement for all future federal data center service contracts, regardless of which green procurement option is preferred by an agency. The estimated advantages of this policy recommendation include:

- greatest administrative and political feasibility;
- improved information to estimate agency and total government energy consumption and greenhouse gas emissions;
- ability for data center service competitors to consistently differentiate their services in terms of energy efficiency or reduced emissions;
- incremental organizational change in both data center service providers and government agencies by bringing greater awareness on these metrics; and

- allows the US government to identify relatively high-performing, energy-efficient data centers so that these best practices might be encouraged at lower-performing data centers elsewhere.

In addition, by introducing government wide energy consumption and greenhouse gas emission measures, OFPP can also provide a stronger quantitative basis for future policy analyses seeking to improve the environmental performance of the federal government.

IMPLEMENTATION EVALUATION

If implemented, the OFPP can systematically assess the net results of the present policy recommendation by conducting periodic summative impact evaluations. These evaluations will measure the rate of energy consumption for both the components and entire collective data center. The performance metrics can then be measured against energy efficiency standards developed and set forth by the Energy Star® Program. Over fixed time periods, summative impact evaluations can provide empirical information regarding whether the policy implementation (as a whole) has met its objectives. The OFPP can analyze the outcomes – including unanticipated consequences – in terms of what was expected of the policy recommendation in its initial stage, the actual outcomes of the policy recommendation, and the relative costs in connection with policy implementation. Furthermore, descriptive analyses prepared from these assessments can provide support regarding whether to continue or modify the policy. To be successful, this policy must ultimately narrow the energy-reporting gap that exists between standard performance metrics for data centers and minimum energy performance standards mandated by the federal government.

FIGURE 1 – SHORT-TERM ENERGY USE

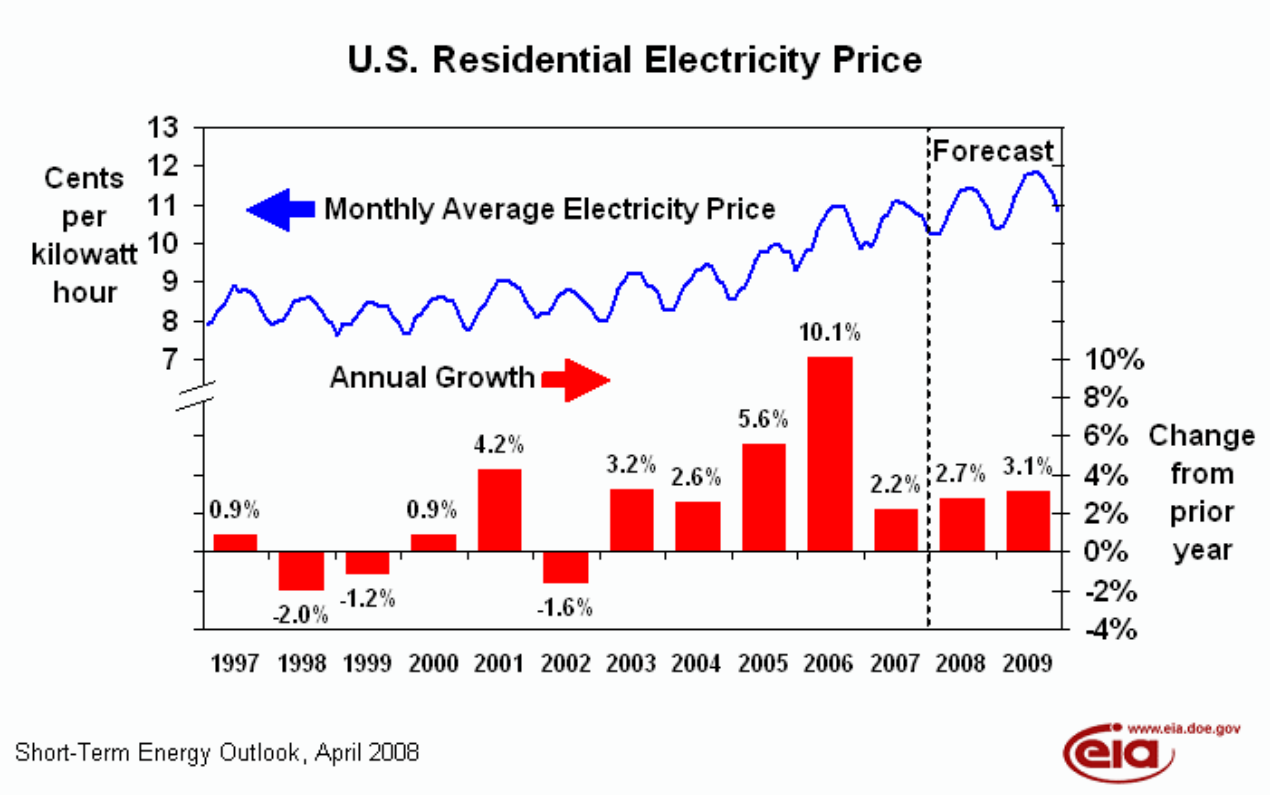

Figure 1 –Trend and short term outlook for US Electricity Prices

This figure depicts recent trends and short-term projections of US electricity prices in the residential sector. These trends and forecasts are expected to be consistent in relative terms to the US industrial sector covering data center power consumption.

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[8] H Black, "Conservation: A Luxury Tax on Energy." *Environmental Health Perspectives* 111, no. 2 (2003): A85.

[9] The European Sustainable Growth Strategy, or Lisbon Strategy, marked the EU's first effort towards becoming a world leader in environmental technology and sustainable practices. Since then, the EU has held several conferences in which the commitment to sustainable growth continued to develop, and European leaders adopted several measures to help realize their ambitious collective goal.

[10] Commission, "National Gpp Policies and Guidelines" (2006).

[11] For example, France's legislation requires that 20 percent of all government vehicles purchased annually must be "clean" (Commission, 2006). Italy's plan, by contrast, is a bit more ambitious. The government has required that 30 percent of all purchases comply with ecological standards, and 30 to 40 percent have reduced energy consumption (Commission, 2006).

[12] Across the EU, 67 percent use some green criteria in the purchasing process (Bouwer M, 2006). Within this group, approximately 28 percent use green criteria nearly all the time. There are two classifications for the extent of which green criteria are used in the tendering process: "Light and Solid Green." A tendering process that is classified as "light green" includes one to three clear environmental criteria; "solid green" tendering documents contain three or more clear and well defined environmental criteria (Bouwer M, 2006). For example, clear, well-defined criteria might include the requirement that all light bulbs used by the business have EU

eco-labels—this constitutes one environmental specification. Despite this seemingly positive numbers, only 37 percent are actually classified as being either "solid or light green (Bouwer M, 2006).

[13] The variability of GPP practices across the EU can be attributed to many factors. In a recent study presented to the European Commission, the Take-5 Consortium examined the current status of GPP in 25 EU countries (Bouwer M, 2006). Through the use of surveys and the examination of tendering documents, the report highlighted factors that inhibit and spur GPP.

According to the results of the survey, 44 percent of all respondents indicated that they believed that green products cost more than standard products; 35 percent believed that their lack of knowledge in creating environmental criteria was an obstacle; 33 percent believed that there was a lack of managerial/ political support for GPP (Bouwer M, 2006). These responses represent perceptions that have a negative impact on the use of GPP practices. Presumably, systematically addressing each of the perceived barriers will contribute to the increased use of GPP across the EU.

[14] Stephan Brammer and Helen Walker, "Sustainable Procurement Practice in the Public Sector: An International Comparative Study." *University of Bath, School of Management, Working Paper Series*, no. 16 (2007): 39.

[15] For an example, consider electricity. Because purchasers are seeking eco-friendly products and services, many producers of electricity have sought eco-friendly accreditation through labels such as the European Green Electricity Network, or Eugene Standard. The Eugene Standard is widely recognized in the EU as being a trustworthy seal of approval. In order for the producer to obtain the seal, they must meet a series of requirements. One basic requirement is that the energy is produced from renewable sources such as wind, water, or biomass, which produce negligible carbon dioxide emissions. The benefit of labels such as the Eugene Standard is that it simplifies the complicated environmental criteria for the consumer, so that it is easily understood as being eco-friendly. The Eugene Standard recommends purchasers simply copy the criteria used for the label into tendering documents. In other words, purchasers don't have to require that electricity producers have the label, merely that they produce according to the same standards. For example, one U.S. based label has developed criteria that require producers interested in obtaining a label to have at least 50 percent of their electricity produced by renewable sources (Bürger, 2006). Third party accreditation organizations can offer valuable information into the creation of green public procurement criteria.

[16] "Environmental Management Systems: Your Business Advantage," 8. Washington, DC: United States Environmental Protection Agency, 2002.

[17] Dennis Rondinelli and Gyula Vastag, "Panacea, Common Sense, or Just a Label?: The Value of Iso 14001 Environmental Management Systems." *European Management Journal* 18, no. 5 (2000): 499-510.

[18] Steven A. Melnyk, Robert P. Sroufe, and Roger Calantone, "Assessing the Impact of Environmental Management Systems on Corporate and Environmental Performance." *Journal of Operations Management* 21, no. 3 (2003): 329-51.

[19] Ibid.

[20] "Federal Acquisition Regulation" edited by Department of Defense General Services Administration, and National Aeronautics and Space Administration, 1915, 2008.

[21] Matthew Potoski and Aseem Prakash, "Institutional Design for Ems-Based Government Procurement Policies." *Global Environmental Politics* 6, no. 4 (2006): 13-22.

[22] "Federal Acquisition Regulation" edited by Department of Defense General Services Administration, and National Aeronautics and Space Administration, 1915, 2008.

[23] "Energy Star®— the Power to Protect the Environment through Energy Efficiency." United States Environmental Protection Agency http://energystar.gov/ia/partners/downloads/energy_star_report_aug_2003.pdf.

[24] Marla C. Sanchez, Richard E. Brown, Carrie Webber and Gregory K. Homan, "Savings Estimates for the United States Environmental Protection Agency's Energy Star Voluntary Product Labeling Program." *Energy Policy* In Press, Corrected Proof.

[25] "Energy Star® and Other Climate Protection Partnerships 2006 Annual Report." 76. Washington, DC: United States Environmental Protection Agency, 2007.

[26] Andrew Fanara, "Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431." 133: US Environmental Protection Agency, 2007.

[27]J. Loper and S.Parr, "Energy Efficiency in Data Centers: A New Policy Frontier." 20: Alliance to Save Energy, 2007.

[28] Ibid.

[29] Matthew Potoski and Aseem Prakash, "Institutional Design for Ems-Based Government Procurement Policies." *Global Environmental Politics* 6, no. 4 (2006): 13-22.

[30] Kenneth G. Brill, "Data Center Energy Efficiency and Productivity." 10. Santa Fe: The Uptime Institute, 2007.

[31] Marla C. Sanchez et al. "Savings Estimates for the United States Environmental Protection Agency's Energy Star Voluntary Product Labeling Program."

[32] Andrew Fanara, "Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431." 133: US Environmental Protection Agency, 2007.

[33] G. Majone, *Evidence, Argument, and Persuasion in the Policy Process*. New Haven: Yale University Press, 1989.