DATA CENTERS:

AN ACCOUNT OF FEDERAL INITIATIVES AND DATA CENTER ASSESSMENTS FOR FACILITY MANAGERS

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ABOUT THE AUTHOR

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Facility Engineering Associates, P.C. (FEA) is a nationally based consulting engineering firm specializing in resolving the challenges of clients faced with managing and operating their existing facilities. FEA's focus is on facility asset management and involves the organizational structure, dynamics of the FM organization, and the physical assets of the organization. FEA's services provide solutions to help building owners and managers extend the life cycle of their facilities. FEA's mission is to make buildings last by implementing practical and cost-effective strategies. FEA is headquartered near Washington, D.C., and has additional office locations in Boston, MA; Dallas, TX; Denver, CO; and San Francisco, CA. For more information on FEA, visit www.feapc.com.

With the rapid expansion of computer processing power and data storage requirements over the past two decades, data centers have been forced to keep pace. Until recently, energy efficiency of data centers has taken a back seat to functionality and reliability, but with the seemingly constant increasing cost of energy and environmental considerations, efficiency of data centers has become a focus of many engineers, facility managers, and governmental institutions.

Federal Data Center Consolidation Initiative

The United States Government has not been immune to this rapid growth either. According to the US Office of Management and Budget, the number of federal data centers increased from 432 to more than 1,100 between 1998 and 2009 and it is anticipated that electricity consumption could top 12 billion kWh by 2011 (Kundra, 2010). **Figure 1** shows the number of data centers by federal agency as of July 2010 and totals over 2000 data centers across the country (Vivek Kundra, 2010).

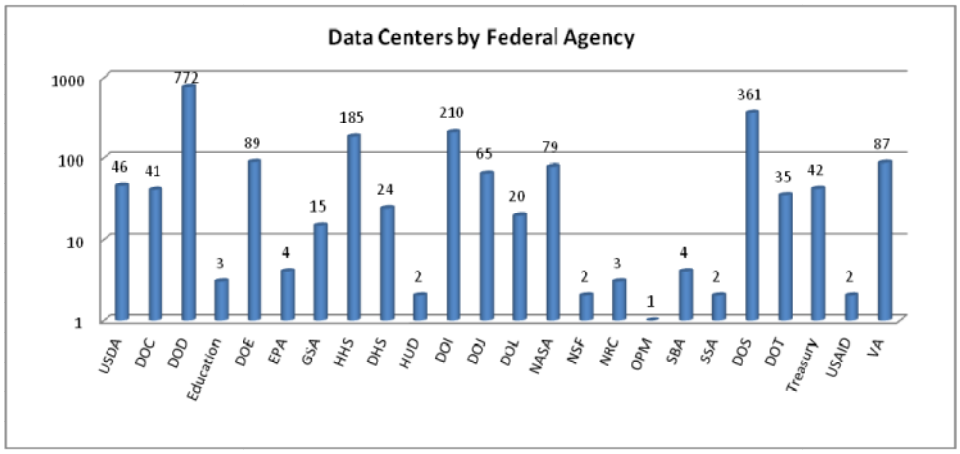

Figure 1: Federal Data Centers Inventory by Agency

As a result, the Office of Management and Budget issued the Federal Data Center Consolidation Initiative in February of 2010. The goal of this initiative is four-fold:

- Promote the use of Green IT by reducing the overall energy and real estate footprint of government data centers,
- Reduce the cost of data center hardware, software and operation,
- Increase the overall IT security posture of the government, and
- Shift IT investments to more efficient computing platforms and technologies.

The initiative is currently in progress and has five distinct milestones, four of which are complete. The Federal Agencies have completed the following phases:

- Initial Data center Asset Inventory (April 30, 2010)
- Initial data Center Consolidation Plan (June 30, 2010)
- Final Data Center Asset Inventory (July 30, 2010)
- Final Data Center Consolidation Plan (August 30, 2010)

The final phase is the approval of final data center consolidation plans and is scheduled to be completed December 31, 2010 with implementation of the plans in 2011.

So, what does this all means for private industry? Rich Miller predicts in his March 1st article relating to the Federal Data Center Consolidation Initiative, that data center service providers, especially those located in northern Virginia, will experience a boom as a result of this initiative (Miller, 2010). This speculative "boom" will predominately benefit data center system integrators and cloud computing platforms, but energy efficiency consultants could also benefit from this federal initiative. Energy efficiency consultants could be contracted to aid in the calculation of data center performance metrics, benchmarking, and data center assessments.

Metrics and Benchmarking

In the United States, the power utilization effectiveness (PUE) is becoming the preferred metric relating to data center energy efficiency. The PUE is the ratio of total data center power to total IT power. Included in the total data center power is the HVAC load, lighting load, and any other consumer of power related to the operation of a data center. The IT power would include server loads and UPS losses. The data center infrastructure efficiency (DCiE) is another metric and is the reciprocal of the PUE. In other words the DCiE is the ratio of total IT power to total data center power and is the percent of IT power compared to total data center power.

Recommendations for measuring and reporting data center efficiency have been made by the Data Center Metrics Coordination Taskforce (The Taskforce) and is represented by the 7x24 Exchange, ASHRAE, The Green Grid, Silicon Valley Leadership Group, U.S. Department of Energy Save Energy Now Program, U.S. Environmental Protection Agency's ENERGY STAR Program, United States Green Building Council, and the Uptime Institute. The Taskforce has recommended that the PUE metric be classified into four categories, based on the metering configuration and how the energy usage is recorded:

- PUE Category 0
- PUE Category 1
- PUE Category 2
- PUE Category 3

PUE Category 0 is a demand based metric. The metric is calculated using the maximum load during a 12-month period with the IT power recorded at the UPS system output. PUE Categories 1 through 3 are consumption based metrics calculated by a 12-month total on kWh readings. Differences between the three categories are where the IT usage is measured and are progressively more specific. PUE Category 1 IT usage is measured at the UPS and is the least specific. PUE Category 2 IT usage is measured at the power distribution (PDU) outputs, and PUE Category 3 IT usage is measured at the individual server components (The Green Grid, 2010).

The Green Grid is a global association promoting data center efficiency by defining data center models and metrics along with promoting energy efficient standards, processes, measurement methods and technologies. Resulting from the Green Grid's dedication to data center efficiency has been benchmarking data in terms of the PUE and DCiE. The Green Grid consortium has also established a rating system for data center energy efficiency. **Table 1** summarizes the Green Grid's criteria for data center performance (Munther Salim, 2009).

Benchmark	DCiE	PUE
Platinum	> 0.8	< 1.25
Gold	0.7 - 0.8	1.25 - 1.43
Silver	0.6 - 0.7	1.43 - 1.67
Bronze	0.5 - 0.6	1.67 - 2.00
Recognized	0.4 - 0.5	2.00 - 2.50
Not recognized	< 0.4	> 2.5

Table 1: Summary of Green Grid Benchmarking Criteria

Data Center Efficiency Assessments

Data center efficiency assessments can be performed with varying levels of detail, not unlike ASHRAE energy audits, and are classified by how the data center energy usage is metered and the interval in which information is recorded. Classifications are Level 1 (L1), Level 2 (L2), and Level 3 (L3). Table 2 provides the level of detail of each classification.

Parameter	Level 1	Level 2	Level 3
IT Equipment Power	UPS	PDU	Server
Total Facility Power	Data Center Input Power	Data Center Input Power less shared HVAC	Data Center input power less shared HVAC plus building lighting security
Measurement Interval	Monthly/Weekly	Daily	Continuous

Table 2: Level of detail for each level of assessment as recommended by the taskforce (The Green Grid, 2010).

The level of assessment is dictated by the extensiveness of metering and monitoring at the facility. An L3 assessment requires comprehensive metering schemes that are continuously

recorded, while an L1 assessment would be a much higher level approach and could be performed at facilities with "typical" metering schemes.

A three-stepped approach in performing data center assessments can be used to provide a client with a well-written, well thought out final report. A three-stepped approach contains the following phases: preparation, execution, and reporting.

Step 1: Preparation

The preparation phase allows for the engineer to collect and peruse important information about the data center's layout, energy usage, and establish a plan of action when in the field. When performing data center energy efficiency assessments, knowing the data center's layout prior to the site visit allows the engineer to establish logical locations to place data loggers and take measurement in the field, thus cutting down on time required in the field. Reviewing energy use would give the assessing engineer an idea as to how the data center is performing and allow him/her to establish utility demand and consumption rates. Lastly, but not unimportant, the preparation phase allows the engineer to determine a reasonable plan of action when entering the field.

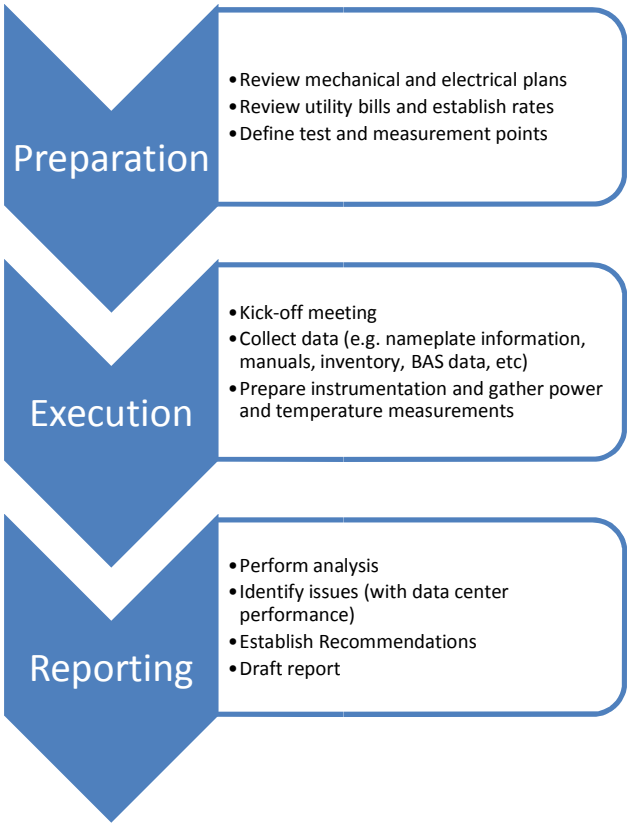

Figure 2: Data Center Energy Efficiency Assessment Process

Step 2: Execution

The execution phase is exactly what it sounds like. It's the actual process of executing the plan developed in the preparation phase. During this phase, the site visit is carried out, including a kick-off meeting and data collection exercises. Required data collection includes nameplate information, operation manuals, inventories of equipment, BAS data. At this time instrumentation is prepared and placed, and power and temperature measurements are recorded.

Step 3: Reporting

The reporting phase consists of compiling and organizing the collected information, and performing the energy analysis based on visual observation made during the execution phase.

Issues with data center performance as well as energy conservation measures are summarized and provided in a written report.

Many online tools are available for use to aid in the analysis of data center energy efficiency. Examples of online tools are ENERGY STAR Portfolio Manager and the Save Energy Now's Data Center Energy Profiler.

In 2010, ENERGY STAR Portfolio Manager released a new feature for the online benchmarking and baselining tool for data centers. Adopting the PUE as its metric; ENERGY STAR Portfolio Manager has integrated the metric into its 0-100 rating scale. The new feature is based on a regression model that includes factors outside of the control of the owner/operator as well as factors for adjustment by the owners/operators. The PUE calculated by the ENERGY STAR Portfolio Manager tool is based on source energy and not site energy. Additionally, its important to recognize that the PUE in Portfolio Manager is using consumption and not demand power in its model at either the UPS or individual PDU in the data center (Sullivan, 2010).

The Save Energy Now's Data Center Energy Profiler is a separate tool developed by the U..S. Department of Energy to identify how energy is being consumed in data centers. The tool also identifies specific energy conservation measures (ECMs) to reduce the energy consumption. The tool requires some specific inputs that need to be collected in the field as well as obtained through interviews with data center staff. Outputs generated by the tool include supplied energy information, annual energy consumption, potential annual energy savings resulting from implementation of recommended ECMs, and suggested next steps. Based upon the inputs, the tool generates a DCiE and predicts what the DCiE could be if ECMs are implemented (U.S. Department of Energy, 2010).

Energy engineers and data center operators are entering an exciting new dimension of energy efficiency. Between the Federal initiatives and the continuous rise in energy costs, data center efficiency is experiencing rapid growth and extensive research is going into developing metrics and methods of assessment. A lot of work has been done, but much more is needed in the future to ensure standardized assessments and metrics.

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