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Data Center IT Equipment Energy Assessment Tools

Current State of Commercial Tools, Proposal for a Future Set of Assessment Tools

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Disclaimer

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Abstract

Information Technology (IT) equipment (servers, storage, and network) in data centers represents a large component of the total data center energy use. When the data center facility is efficiently designed and operated, the IT equipment energy becomes dominant. Majority of work in the area of energy efficiency has been focused on the data center infrastructure. Metrics are still developing when it comes to effectively defining and measuring IT equipment energy consumption.

This research project, which was conducted during the Summer and Fall of 2011, investigated some commercially available assessment tools with a focus on IT equipment to see if such tools could round out the DC Pro tool suite. In this research, the assessment capabilities of the various tools were compiled to help make "non-biased" information available to the public. This research should not be considered to be exhaustive on all existing vendor tools although a number of vendors were contacted. Large IT equipment OEM's like IBM and Dell provide their proprietary internal automated software which does not work on any other IT equipment. However, found two companies with products that showed promise in performing automated assessments for IT equipment from different OEM vendors.

This report documents the research and provides a list of software products reviewed, contacts and websites, product details, discussions with specific companies, a set of recommendations, and next steps. As a result of this research, a simple 3-level approach to an IT assessment tool is proposed along with an example of an assessment using a simple IT equipment data collection tool (Level 1, spreadsheet). The tool has been reviewed with the Green Grid and LBNL staff. The initial feedback has been positive although further refinement to the tool will be necessary.

Proposed next steps include a field trial of at least two vendors' software in two different data centers with an objective to prove the concept, ascertain the extent of energy and computational assessment, ease of installation and opportunities for continuous improvement. Based on the discussions, field trials (or case studies) are proposed with two vendors – JouleX (expected to be completed in 2012) and Sentilla.

1.0 Introduction

In a data center, IT equipment consisting of servers (for computing), storage devices (for data storage) and network devices (for communication) is supported. It is not uncommon for very large data centers housing tens of thousands of pieces of IT equipment (e.g., Google and Apple). Our current way-of-life depends on immediate access to data over the Internet (e.g streaming video, eCommerce). All of this information is handled by data centers consuming energy 7x24.

Since one of the largest and the fastest growing expenses in data centers is energy, companies need an effective tool to measure and analyze energy usage, and optimize operations through identification, and implementation of energy efficiency (EE) measures using the latest technology.

This research focused on software tools associated with assessing the energy usage and computational work efficiency in order to assist in identifying energy efficiency measures related to the IT equipment. Typically, in a formal assessment, tools monitor and measure, results are analyzed and recommendations are made for energy efficiency and for better utilization IT equipment.

The objectives of this research were:

1. Investigate the availability, functionality, and ease-of-use of commercial tools (manual or software-based system tools) which focus on assessing data center IT equipment for energy use and efficiency for computing, storing, and networking data.
2. Recommend potential commercial data center IT equipment assessment tools for field trial for potential use supporting Federal and private industry data center initiatives.
3. Recommend changes to an IT assessment tool developed by the Green Grid for data centers.
4. Recommend a path forward for developing an IT equipment assessment tool for becoming part of the DOE's DC Pro tools and the DCEP training program.

Background

In a data center with a Power Usage Effectiveness (PUE)[1] of 2.0 for example, fifty percent of the total energy is consumed by the IT equipment. As the industry adopts best practices for infrastructure, PUEs are dropping, leaving IT equipment's energy use as the dominant one for further efficiency reduction.

To stimulate energy efficiency improvement in data centers, Lawrence Berkeley National Laboratory (LBNL) has developed a suite of energy assessment software tools for the U.S. Department of Energy (DOE). These tools are collectively termed the DC Pro Software Tool Suite (DC Pro). These tools mainly address energy efficiency opportunities in typical infrastructure systems in data centers and provide only limited recommendations for improving IT equipment efficiency. To provide more robust recommendations for these systems, the Green Grid (TGG) organization collaborated with DOE in the development of an IT system assessment tool. Early versions of this tool, however, required a considerable amount of manual data collection and data entry. Consequently, it was felt that such a complicated tool would not be used as part of DC Pro.

Furthermore, the DOE Data Center Energy Practitioner (DCEP) program qualifies energy practitioners to perform data center assessments. This training program incorporates DC Pro, which currently focuses on infrastructure systems. This is partly due to the absence of an assessment tool to help determine the efficiency opportunities related to IT equipment. To address this need, the research reported here was initiated to see if commercially available tools could be used to automate data gathering for IT equipment and be utilized for data center energy assessments.

While overall energy use in IT equipment can easily be measured at a few points, getting accurate information about the individual IT equipment to assist in determining efficiency measures is a challenge. There are currently no agreed metrics that combine computational throughput and equipment energy use (e.g. computing/Watt). This fact creates a problem for base-lining and tracking efficiency improvement as well as pinpointing efficiency opportunities.

To identify efficiency measures for IT systems, it is useful to know various characteristics of the IT operation including processor and memory utilization, power management states, age of equipment, etc. Once a clear and complete inventory of the systems is provided, measures to improve overall IT equipment efficiency can be recommended.

Fortunately software assessment tools are becoming available that can automate the data collection process and more fully assess the operation of the IT equipment.

[1] PUE is the ratio of Total Facility Power to the IT equipment Power [Green Grid Data Center Power Efficiency Metrics, 2007, 2008]. There are now up to four categories of PUE definition including using only Energy.

Data center energy efficiency studies have been the center of attention for a number of years. The Environmental Protection Agency (EPA) completed a well-publicized report to congress in 2007 [1] .The report identified then current trends in energy use and energy costs of operating data centers in the U.S. and also outlined emerging opportunities for improving the energy efficiency. In order for data centers to achieve the goals EE set forth in the report, it will be important to have energy assessment and benchmarking tools for the various components of a data center: infrastructure (e.g., HVAC, UPS, PDUs, lighting, power chain, etc.) and all the IT equipment.

EPA has developed and deployed a data center ENERGYSTAR on-line benchmarking tool [2], and Lawrence Berkeley National Laboratory (LBNL) on behalf of the U.S. Department of Energy (DOE) has developed a suite of data center tools collectively called DC Pro. The DOE tools not only analyze the data center, but also make specific recommendations for energy efficiency [3]. In both tool sets, the focus is on the data center infrastructure. Only high-level IT equipment data is used as input to the tools. The total energy used by all the IT equipment is provided by the user along with only minimal information on IT practices. As such, the output and recommendations from these tools provide minimal detail of what can be done to improve the energy performance of the IT equipment.

Most data centers do not have accurate records of their IT equipment: make, model, power consumption, number of each type of equipment, utilization, etc. It is also common that some IT equipment is idling and consuming energy yet performing no useful work. IT equipment electrical load has traditionally not varied significantly whether performing useful work or not.

One can argue that all data center energy consumptions is due to the IT equipment – directly (operation of all IT equipment) or indirectly (infrastructure supporting the operational environment for IT equipment). This argument would lead one to believe that energy efficiency efforts should really be focused on the IT equipment. But in reality, most of our metrics and efficiency focus has been on the infrastructure. There have been recent discussions questioning PUE – is it still a good metric for a data center?

IT equipment consumes a significant amount of energy. Half of the total data center energy use would be contributed by the IT equipment if the Power Usage Effectiveness (PUE) were 2. Further, the focus for efficiency measures is beginning to move toward the IT equipment due to the large number of IT devices. On the high end, a data center could have tens of thousands of servers and storage devices, and a very large network connection (hundreds to thousands). Saving energy at the IT level has a magnifying effect by decreasing losses in power distribution and lowering the cooling requirements. As the efficiency of the infrastructure improves, the major remaining efficiency opportunity is with the IT equipment.

Some research has been conducted on network equipment energy use and savings potential in buildings [4]. Organizations such as the Green Grid have started work on computational efficiency metrics, and they have developed a first generation IT equipment assessment tool for data centers in partnership with DOE [7]. Developing such a tool has been made more difficult and complex with no agreed upon standard metrics or benchmarks for IT equipment energy efficiency. EPA has defined the specifications for ENERGY STAR for Servers [5] and a research paper by Hewlett Packard (HP) has recommended a benchmarking framework for network equipment [6]. Similar work still needs to be completed for storage devices. This work is still far from defining clear energy metrics for all types of IT equipment.

The author of the present research collaborated with several Subject Matter Experts (SME) at LBNL. The general feedback was that IT equipment in data centers is still a difficult subject matter when it comes to collecting detailed data due to the common lack of accurate record keeping (inventory) for servers, storage devices, and network devices, and the lack of metrics to measure computational work.

1.0 Commercially Available Tools – Research

One of the key objectives of this research was to look for commercially available tools for IT equipment assessments and to investigate them for their energy assessment effectiveness. Some of the key tool types that were investigated include:

1. Spreadsheet and web tools. These tools often follow a similar approach to that of EPA (ENERGY STAR) and DOE (DC Pro) tools where data is entered manually, analyzed, and reported but geared towards the IT equipment in the data center.

   A spreadsheet tool records all relevant data and then calculates many of the metrics of the data center along with identifying recommendations for energy savings, cost savings, and best practices. A web application with Graphical User Interface (GUI) collects, assesses, and recommends as mentioned in (a) above.

   It is to be noted here that the Green Grid has been working on a spreadsheet-based assessment tool. This organization developed an initial draft that was tested at LBNL's IT Department, DOE, and Green Grid member companies. The users found the tool to be too detailed and somewhat complex in gathering and entering the required data. It was felt that this would have discouraged its use by the bulk of the data center professionals. Based upon the initial feedback, the Green Grid is continuing to refine the tool.

2. Comprehensive Vendor Products. These are tools that vendors would deploy in a data center using a separate local server or one of the data center servers. The main advantage of this type of tool is that they can electronically collect, analyze and display real-time

data on IT Equipment utilization, energy consumption and any other related data in a user friendly manner (e.g., Dashboards) and also make available different reports which will aid the DC management personnel to make short and long term decisions on several fronts – energy management, asset management, etc. This approach can also save a lot of manual data entry about the IT equipment which may not be available (much that is required in the approach 1 above).

For either type of tool, the following were some key criteria investigated.

a) Types of data and completeness of data collected, including utilization, number and types of IT equipment, power supply ratings, peak power, energy consumption, virtualization, age of the equipment, etc.
b) Types of charts and reports produced that emphasize energy efficiency measures that are easily understood by data center management, including next steps for further energy efficiency measures.

3.1 Comprehensive Vendor Products and Other Research

A number of vendors were contacted to discover any existing data center IT equipment assessment tools. Vendors that had equipment utilization monitoring tools were also contacted to explore their future plans which might include the ability to support assessments. Initial contact with the vendors was mostly made through emails and phone contacts. Additional follow-up phone conversations were held with vendors who responded to the emails. With some vendors, the follow-up resulted in demonstrations of their offerings via WebEx.

The following two lists includes the vendors that were discovered during this research.

These vendors had a tool that had the capability to do energy assessment of data center's IT equipment or they had a tool for which they were planning to add the capability to measure energy and do assessments. These companies (in no particular order) are:

1. JouleX, Atlanta, GA
2. Uptime Software, Toronto, ON
3. Sentilla Corporation, Redwood City, CA
4. IBM, Rochester, MN
5. Dell
6. VMware.

These vendors have offerings that automatically collect data for a period of time for enabling an energy assessment as opposed to a more manual approach with a spreadsheet tool or a

web-based application such as the DC Pro Profiling Tool) where the data center manager enters all relevant data.

Research on the Internet also found the following companies with product offerings – although their main focus was not on IT equipment.

1. OSIsoft (Industrial process monitoring, including oil and gas. Data centers were not specifically mentioned in the portfolio but they do have some exposure in data center market)
2. Wonderware (Industrial process and power management software, but not in the data center space yet)
3. Puppetlabs (Server management)
4. CF Engine (IT infrastructure engineering)
5. Romonet (Predictive model tool for data centers)
6. Schneider Electric (Power management and physical data center infrastructure)

This set of companies did not offer any single tool for IT equipment assessment but they claim that they can install a full enterprise system to do "all" that is required to manage a data center including infrastructure energy. They tended to have focus in one specific area in a data center like servers or physical infrastructure.

3.2 Specific Vendor Product Details

3.2.1 JouleX

JouleX (Atlanta, GA) was founded in 2009 and is privately held with capital investments from Target Partners, TechOperators, Sigma Partners, Flybridge Capital Partners and Intel Capital. The company is headquartered in Atlanta with offices in Tokyo, Paris, Munich, and Kassel, Germany. JouleX is expanding its staff in sales, marketing, and engineering teams.
Their product called JouleX Energy Manager (JEM) claims to automatically monitor, analyze, and control the energy consumed by ***all devices connected to the network.***

Among the vendors that were investigated, JouleX capabilities were the most comprehensive. They had already started working with DOE and had taken the first steps to integrate JEM with the DC Pro Profiling Tool. JEM claims the ability to include all the IT equipment in their energy measurement.

Here are some highlights of JEM per their presentation and website.

- No need for agents, hardware, or changes to the network or security

- Measure utilization and energy usage by device or application without installing software agents on each device and system in the data center

- Identify virtualization opportunities and optimize existing virtualization/cloud computing environments

- Provide business and energy context to power capacity planning.

JEM gets access to the devices through their IP addresses, and use standard protocols (e.g., SNMP) to get energy and other information directly from the device. Most IT equipment devices installed in the last 3 years have the ability to provide this information through the IT network. For older devices, JEM makes an estimate based on the make and model and maintain a data base of this information. This approach is very significant in data centers with a lot of older equipment - especially servers – which do not have this capability. JEM produces various reports directly related to energy and utilization – this combined chart is important to manage a data center. JouleX also claims their product is an "Agentless" software (meaning no software needs to be installed in the IT equipment).

JouleX already has a relationship with Cisco, and JEM interfaces to Cisco's energy software. LBNL has completed a pilot test of the Joulex software (study results to be published in 2012).

3.2.2 Uptime Software

This Toronto, ON, based company offers software specialized in data center monitoring in the areas of performance and availability with a user-friendly dashboard (their website has a demo). They claim over 1,000 customers. At the time of the research, they do not monitor and display any energy usage information specifically for IT equipment. But, they claim they are working with a partner to include energy monitoring of IT equipment.

The software is available for free for 30 days.

3.2.3 Sentilla Corporation

Sentilla is based in Redwood City (2003), CA. It claims to have an enterprise-wide energy management system. Their focus includes data centers at a detailed level as well. Sentilla's energy management platform is an enterprise-grade system now in its sixth generation. With patent-pending Virtual Meters, no agents or physical meters are required. Sentilla enables enterprises to track energy use, cost, and utilization of each data center application and correlate this activity back to its business value.

They view the data center as a factory (as it relates to production of computing services delivered to customers) and they claim their platform to be an "integrator" gathering information from various different tools already used in data centers (Cisco's EnergyWise, IBM's Tivoli for energy, and VMware for virtualization.). Power and energy hierarchy is displayed in a graphical manner showing energy details down to a rack or to a server. With their integration with Cisco's EnergyWise, they claim they cover much of the networking equipment in data centers. They also claim to have built a database of older IT equipment (e.g., servers) and based on the make and model they can look up the manufacturer's information for energy consumption. . On a feature-

by-feature comparison, Sentilla and JouleX have similar capabilities with slightly different dashboard display types.

3.2.4 IBM

IBM is big player in data center services. In fact, one of IBM's IT architects wrote a book titled "The Greening of IT" which discusses data centers in detail and talk about the full physical infrastructure and also energy-saving opportunities and solutions —from virtualization and consolidation to cloud and grid computing—that will improve business flexibility as they reduce environmental impact [7].

The IT equipment assessment tool availability from IBM was discussed with their monitoring software architect in Rochester, MN. He also confirmed that there are no standards for IT equipment energy measurement or assessment. IBM has their own monitoring platform called Director and all their energy and other performance-related software tools runs on this platform. These tools are specifically designed to run on only IBM equipment. This puts a limitation on further exploring this tool for general availability.

Their IT equipment measurement and assessment tool is called Active Energy Manager (AEM). He also said that these tools are free downloads from their websites for IBM customers with their equipment. AEM has several special energy management features in addition to measuring energy: Power capping and other power savings features which allow servers to self-regulate its energy usage according to data center energy management practices.

3.2.5 Dell

IT equipment assessment tools from Dell was discussed with their Principal Environmental Strategist in Austin, TX. He is also the author of a technical white paper published by Dell [8] who was the Green Grid's chair for four years. He pointed out that there is a lack of industry standards and metrics for IT equipment. The white paper concluded that for an energy analysis of IT equipment the ability to collect meaningful data is key and the tools to help collect the data are not yet available. They deployed BMC's software in their data center for their white paper analysis. BMC's website claims the following: Application Performance Management and Capacity Optimization – focused on cloud computing. They do not seem to have a specific product that claimed to be an energy performance monitor.

3.2.6 VMware

No discussions where held with VMware although email connections were made with individuals at VMware (referenced from within LBL). VMware vSphere software is the market leader when it comes to virtualization. It should be noted that VMware software does not do any energy monitoring or reporting directly. Implementing virtualization in a data center is one of the highly recommended energy management best practices since it reduces the number of servers required by running multiple applications on each server, thus reducing the overall IT energy consumption.

It is to be noted that VMware software does not report any specific IT monitoring/ measurement data or IT equipment management.

VMware has a new Total Cost of Ownership (TCO) calculator (web tool) which is free to use from VMware website (This tool asks for fairly simple data on the current server configurations (see Figure 1). It asks for only two pieces of data on the existing servers: CPU's/Server, and Cores/CPU.

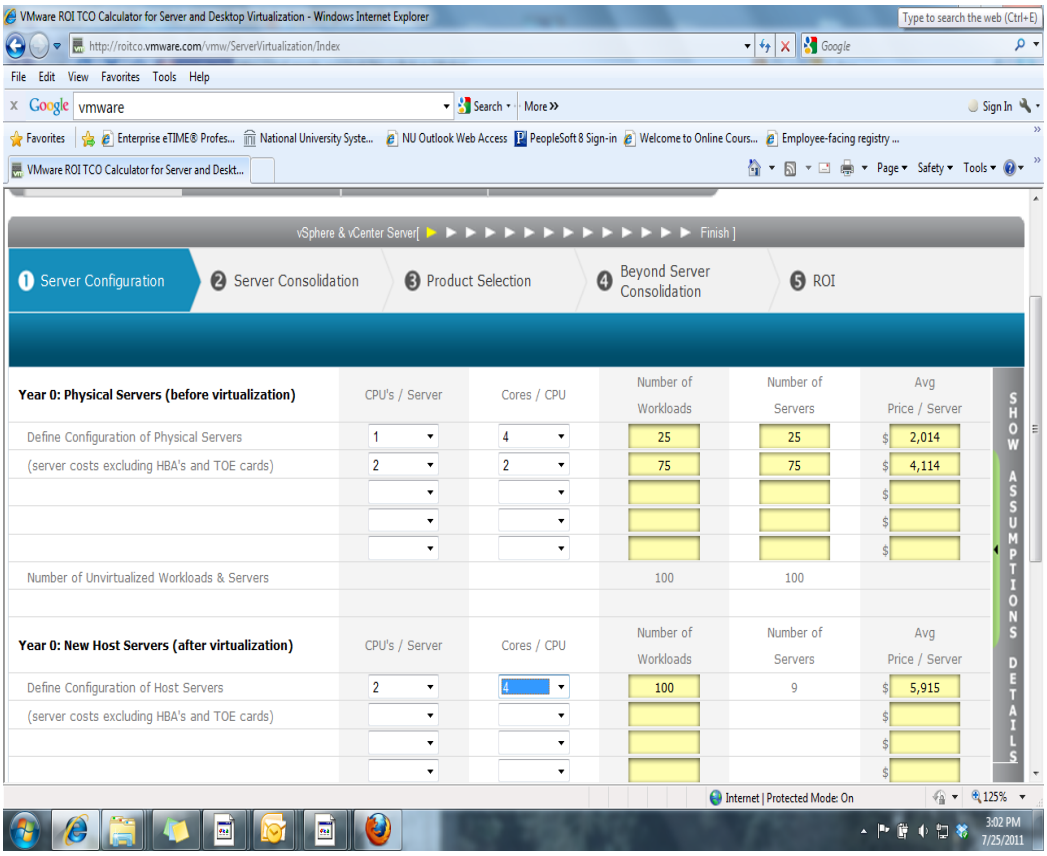

Figure 1 –VMware online tool

It does extensive calculations on all aspects of the benefits of the virtualization including energy cost savings. The calculation does include additional savings due to reduced storage and network equipment needed. For these calculations, the tool assumes a lot of data that is not visible to the user.

There is a lesson to be learned from VMware calculator: It only asks for a minimal amount of data, but delivers extensive output including ROI based on a lot of internal assumptions. Such results have to be taken as a first estimate of potential savings especially if the assumptions are unknown. When a company embarks on server virtualization, VMware would collect a lot more information to come up with a specific dollar savings.

The goal of VMware calculator is financial ROI and not energy. One would say the bigger picture of all IT equipment energy seems to get lost in this approach.

4.0 Spreadsheet Based Tool Proposal

As indicated earlier, the Green Grid developed a spreadsheet tool for energy assessments of IT equipment (servers only initially). This tool was found to be too time consuming and complicated which would have limited its adoption. The tool asks for very detailed information about the IT equipment and some questions on its management practices. The idea was get the most accurate data so appropriate calculations on metrics could be made along with providing best management practices. Data centers do not necessarily have a very formal and accurate record keeping of all their equipment. This could be due the volume, complexity of the different devices and the rate of change in technology.

Again from discussions with staff at LBNL and with other SMEs, it is clear that a spreadsheet based IT equipment assessment tool needs to be user friendly, simple, and yet be effective in its presentation of results so it can stand on its own. A spreadsheet tool can be extended to interface with other DC Pro tools so that data can be exchanged between the tools.

This researcher's recommendation is to develop an IT equipment assessment tool which can be used by data center managers at different levels of complexity – up to 3 – depending upon their skill and interest for achieving different levels of EE.

The strategy of this approach is as follows:

1. **Simplicity:** The three-level approach makes it easier for the data center manager to obtain the necessary data, and he/she does not have to be put in a position to come up with every detail about the IT equipment. Initially, a basic tool could be available for use while work continues on the more detailed levels.
   One of the recommendations from the tool would be for the data center to consider implementing a continuous monitoring system
2. **Tool Scaling**: The input (IT equipment information) and the output (energy efficiency, cost savings, and management practices) can be scaled up in complexity through the three levels.
3. **Flexibility:** Some data center managers may decide to stop at the first or the second level depending on their needs. Pushing for data that may not exist could result in incorrect data and incorrect results. This tool will also serve data center owners who have not utilized the DC Pro Profiling Tool but still want to get a handle on their IT equipment energy.

A first version of this spreadsheet tool is part of this research report and is included here as an attachment. This tool was developed and reviewed at LBNL and also reviewed by the Green Grid. The tool needs to be further developed and reviewed.

5.0 Conclusion: Findings and Recommendations

The results of this research which is based on published material, discussions with SMEs/researchers (including LBNL experts), and discussions with vendors reflect the continued challenges associated with managing all aspects of IT equipment: inventory, asset management, utilization tracking, and energy management.

The following are highlights of the findings of this research, including recommendations and next steps:

1. There are no accepted standards and/or metrics for measuring the performance of IT equipment that would help assess them for computational and energy efficiency. An industry agreement on computational metrics should be given high priority.
2. There are no generally accepted tools on the market from vendors or from research and professional organizations – manual or automatic – for data center IT assessments with a focus on energy efficiency. Large equipment manufacturers often have their own tools.
3. Several DCIM vendors have automated software tools with the claim of easy integration with data center management software. They are mostly focused on measuring utilization of servers. Some tools also claim energy measurement capabilities which could help to assess IT equipment energy efficiency. One vendor claims the ability to estimate energy consumption of legacy equipment.
4. LBNL to make an objective evaluation of different monitoring and management systems and claims by vendors as mentioned above need to be verified through field trials. The initial recommendation is to conduct field trials on two vendor systems: JouleX and Sentilla in two different data centers.
5. For a spreadsheet-based assessment tool, based on the feedback on the initial Green Grid tool, the tool has to be simple both in content (data collection items) and presentation.
6. It is strongly recommended that the spreadsheet based approach be done in phases or levels – up to 3 levels. First level of assessment would involve collecting IT equipment data at a very high level. The output from this first level, in addition to appropriate energy efficiency calculations and recommendations, should also have information about the potential for better energy efficiency with additional data which would entice the data center owners to go to the next level.
   With this approach, data center owners can decide how detailed of an energy assessment they want or need depending on the resources available to collect the data and their own

strategy to improve the overall efficiency. There is some initial positive feedback to this multi-level approach from LBNL and the Green Grid.

7. It is important to have an IT equipment assessment tool as part of the DC Pro tool suite. It is also important to have the IT equipment tool stand on its own so that data center owners have the ability to pursue IT equipment energy efficiency improvement independent of DC Pro. It is recommended that the spreadsheet assessment tool stand fully on its own in its initial development stages and only after some trial be integrated into DC Pro.
8. Among the three components of data center IT equipment, the network equipment data might be the most difficult to collect for an energy assessment. It might be a candidate for a second phase or level 2 type of assessment. There was positive feedback from the Green Grid on this recommendation. The sample Level-1 spreadsheet developed as a part of this research does include network data at a high level, but this can change with more review and feedback.
9. Every data center is unique and thus the recommendations will be different for different data centers when it comes to steps and best practices for IT equipment energy efficiency
10. Recommendations and Next Steps Summary:
    a. A strategic plan for the data center IT assessment tool should be developed, with a short-term plan and a long-term plan, including for DC Pro and DCEP
    b. Conduct additional field trials with vendor's software systems for energy assessment, preferably with a participating Federal agency.
       (Note – details of the first field trial done with JouleX software at LBNL will be published in 2012).
    c. Pursue the 3-level tool (spreadsheet) approach with the Green Grid, and lay out the details of the three levels with examples
       Longer term, pursue a methodology for integration of the tool with DC Pro and the course material for the DCEP Program based on the trials as mentioned above.
    d. Further research of available solutions. Since this industry is rapidly evolving, the offerings are likely to rapidly evolve too.

Attachment

Level -1 Assessment Tool Sample

Data Center IT Equipment Energy Assessment Tool

Objective:

Identify potential areas in the data center - IT devices (servers, storage devices and network) for energy saving improvements and best practices.
Recommend actions to realize and maximize these energy savings based on the given data.

Process

Due to the complexity of information gathering about IT devices - this process can be broken down in to three levels of information gathering, analysis and feedback.

The assessment process will analyze the data collected, and recommendations will include energy management process, estimate of potential energy savings, conservation, industry best practices and the overall data center readiness to implement the recommendations.

First level data collection will be at a high level and a corresponding assessment and recommendation.

Depending on the need and desire by the customer additional detailed information will be gathered at each succeeding level. More detailed data gathering at each higher level will result in more analysis, feedback and recommendation.

Data Input Process:

Level 1:

Power and Energy Input Data:

1	We would like both the Design (or capacity) Power and the Peak power (ion KW). If both are not readily available, one of the two will be a good start (leave the other blank and enter a comment). If you have peaks from different times, input the highest peak power.
2	For both power and energy - if you have multiple meters , you need to add them up for the correct input
3	See additional information and comments on data entry also in the IT Equipment Inputs -Level 1 tab

Data to be entered in the green cells only

Conatact Information about the person entering the Data

Date:		Date of this data entry
Name:		Person entering the data
Contact:		email
		Phone number
Data Center Tier Level		Tier 1 through Tier 4

		Orgn Name	
		Name, ID or Address of the Data Center	

DATA CENTER INFORMATION TO ASSESS IT EQUIPMENT ENERGY USAGE : Level -1 Data Collection

Data to be entered in the green cells only

Your Comments

Data Center Info	Attribute	Detail	Data Input	Units	Notes, Comments	Commets from the Person entering Data
	Floor Area	Date center IT Equipment Floor Area	**2,500**	**sq. ft**		
		Number of Racks	**100**	**#**		
		Area per Rack	**8**	**sq. ft**	A standard rack is 2 x 4 = 8 sq.ft	
	Current Energy Consumption	Energy consumed for the total Data Center *per year*	**17,520,000**	**kWh**	See 'Data center energy diagram' tab - this energy is at point X. Same as DCPro input. Sum of the last 12 months would be good data (it may be an addition of several energy meters).	
		Energy consumed for IT equipment only for *per year*	**40**	**% of Total**	See 'Data center energy diagram' tab for a data center layout diagram - this energy is at point Y. Same as DCPro input. Sum of the last 12 months would be good data. You can enter the kWh or an est of % of the total data center energy consumption, and select the your chosen unit.	
		Energy Cost	**0.12**	**$**	Average cost per kWh over the year; in $ (e.g; 0.12; or 0.15)	
	Design or Capacity Power	Total Data Center Design or Capacity Power	**2500**	**KW**	See 'Data center energy diagram' tab for a data center layout diagram - this power is at point X	
		IT Only Design or Capacity Power	**1000**	**IT KW**	See 'Data center energy diagram' tab - this power is at point Y. It is also the UPS rated. You can enter KW (if known) or an est. % of the total data center power design power, and select your chosen unit.	
		Max. Design or Capacity Power per Rack	**25**	**KW**		
		Or				
	Peak Power	Total Data Center Peak Power		**KW**	See 'Data center energy diagram' tab for a data center layout diagram - this power is at point X	
		IT Only Peak Power			See 'Data center energy diagram' tab - this power is at point Y. It is also the UPS rated. You can enter KW (if known) or an est. % of the total data center power design power, and select your chosen unit.	
		Peak Power per Rack		**KW**		
	Air Temperature	Rack Inlet Air Temperature	**55**	**Deg F**	Will tell us about the potential opportunity to raise the inlet temperate and save energy	
	Future Computing Growth Rate	Ave Growth rate for the next 5 years - computing and storage	**10**	**%**	This is the average projected growth of the data center - servers, storage, network. This data can help project metrics for the next few years including energy savings.	
IT Equipment	**Servers**	Total numbers of servers in the data center	2000	**#**	Include all different servers that are in the data center	
		Power per server	300	**Watts**	Max server power	
		Server Utilization	35%	**%**	Overall average utilization from your monitoring systems or OS outputs or your best estimate or users' input, if monitored data is not available	
	Storage Devices	Total storage devices in the data center	1,000	**#**	Pure disk storage (or JBODs)	
		Power per Storage device	250	**Watts**	Max power per storage device	
		Data Storage Utilization	30	**%**	Overall average utilization(used capacity) from your monitoring systems. OR your best estimate, if monitored data is not available	
	Network	Low end switches	50	**#**	Smaller switches - 48 ports or less	
		Power per switch	350	**Watts**		
		High-end core or edge switches	10	**#**		
		Power per High end switch	1,200	**Watts**	These are switches with line cards and higher speed (1GB) switches	
	Misc Equipment	Other Misc Equipment within IT floor area	10	**#**	This could PCs, monitors, etc.	
		Power per 'other Misc' equipment	125	**Watts**	Average Power per Misc equipment	
	Servers' Age	< 1 year	15	**%**	For this initial input - a good estiamte of these should be ok	
		Greater than 1 & Less than 3 yrs	50	**%**		
		Greater than 3 & Less than 6 yrs	20	**%**		
		Greater than 6 years	15	**%**		
	Storage Devices' Age	< 1 year	5	**%**	For this initial input - a good estiamte of these should be ok	
		Greater than 1 & Less than 3 yrs	25	**%**		
		Greater than 3 & Less than 6 yrs	50	**%**		
		Greater than 6 years	15	**%**		

Assumptions:

1. Data Center runs 24x365 = 8760 hrs per year

	Management Practices	Y (Yes) or N (no)	Additional Data	Commets from the Person entering Data
1a	Do you have formal energy managemnet or energy efficiency document plan for the data cetner?	N		No
1b	If yes, for 1a, it is periodicially reviewed and updated			
2	Hav you used DCPro tool and received their overall assessment of the Data Center?			No
3a	Are you using sever virtualization in the data cener?			some
3b	If Yes for 3a, what % of your applications were virtualized ?			12%
3c	If Yes for 3a, what % of servers were removed from service ?			5%
4a	Do you track your data center production output -transactions, queries, etc. - in any form?			no
4b	If yes for 4a, eneter the types of production metrics you track			
5	Have you replaced power supply units for devices (by replacing older power supply units) in the last year or two?			some
6	Are you using variable speed fans for your coooling system?			no
7	Do you have the practice of turning off servers not used in the night			no
8a	Does the date center have an asset inventory recoding system?			no
8b	If yes for 8a, does it reflect the correct set of IT assets in the data center?			
9a	Do you measure and record energy consumption in the data center - for the total data center and separately for IT only?			no
9b	If yes, for 9a, do you review the data for energy management purposes?			
10	Has there been any formal energy management training for the operators and management of the data center?			some
11a	Are all your high end swithces (with line cards) fully populated and utilized?			do not know
11b	If yes for 11a, please enter what % of your high end switches are populated and utilized?			
12a	Does the data center gets its energy supply from other other sources - natrual gas, solar.			yes
12b	If yes, for 12a, enter other forms of energy you use			gas

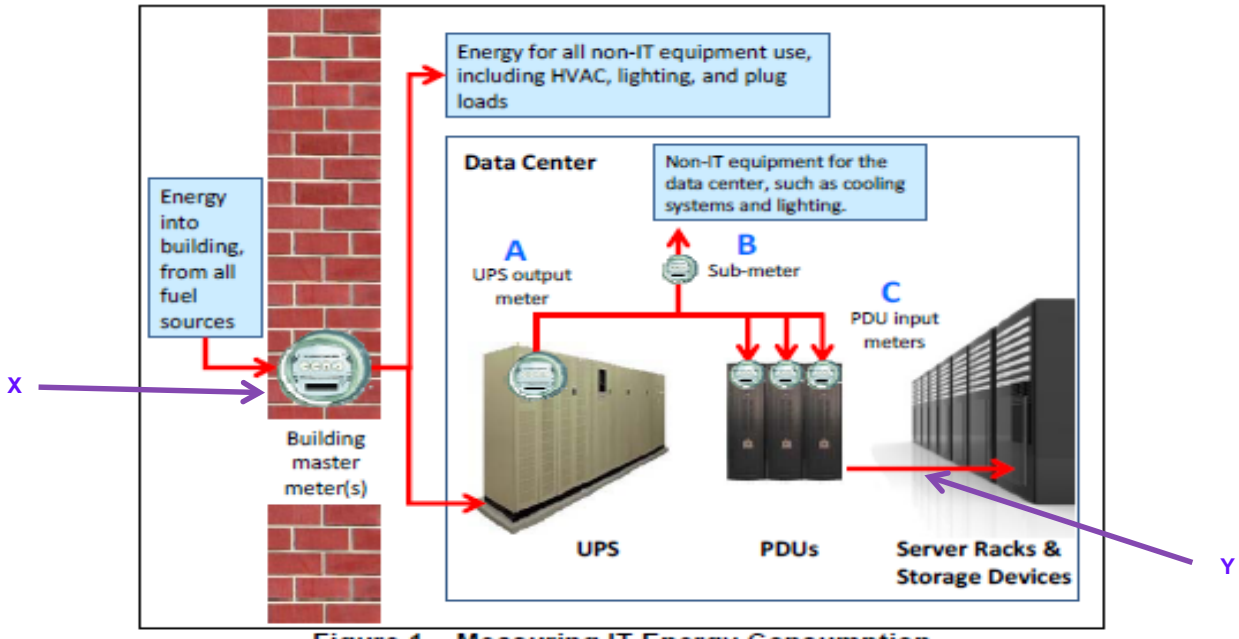

Figure 1 – Measuring IT Energy Consumption

http://www.energystar.gov/ia/partners/prod_development/downloads/Data_Center_Metrics_Task_Force_Recommendations_V2.pdf

Table 1: PUE measurement categories recommended by this task force.

	PUE Category 0*	PUE Category 1	PUE Category 2	PUE Category 3
IT energy measurement location	UPS output	UPS output	PDU output	IT equipment input
Definition of IT energy	Peak IT electric demand	IT annual energy	IT annual energy	IT annual energy
Definition of Total energy	Peak Total electric demand	Total annual energy	Total annual energy	Total annual energy

*For PUE Category 0 the measurements are electric demand (kW).

Notes PUE categories:
1. Category 0 is based on 12 month period peak power load (KW) for' total' and 'IT'
2. Category 1 is based on 12 month kWh consumption for IT at UPS output (or sum of outputs)
3. Categry 2 is based on 12 month kWh consumption for IT at PDU output (or sum of output)
4. Category 3 is based on 12 month kWh consumption at all IT devices connection point to the electrical system

(This is just a sample of calcualtions. More will be added after review/feedback)

	Metric		Units	Time Frame		Industry Norm	Comments
	Current PUE	2.5		NA			Category 0 PUE - purely based on power
	Current DCiP	0.4					
	DC's Total Energy Density	1	KW/sq ft				
	Rack Energy Use Intensity						
	Total Data Center Energy Bill	$2,522,880	$	per year			Includes all infrastrastruce; added 20% for all taxes and charges
	Total Data Center Energy Bill for IT only	$10,092	$	per year			
	Ratio of IT Rack to total Data center area	0.32	%	NA			

Appendix

All Website Links: All links were accessed and operational as of June 30, 2012

1. JouleX, Altanta, GA - http://www.joulex.net/
2. Uptime Software, Toronto, ON. - http://www.uptimesoftware.com/
3. Sentilla Corporation, Redwood City, CA - http://www.sentilla.com/
4. IBM – Active Energy Manager(AEM): http://www-03.ibm.com/systems/software/director/index.html
5. BMC Software - http://www.bmc.com/
6. VMware TCO calculator - http://www.vmware.com/company/news/releases/TCOcalculator.html).
7. OSI Soft - http://www.osisoft.com
8. Wonderware - http://global.wonderware.com/EN/Pages/default.aspx
9. Puppetlabs (Server management, http://www.puppetlabs.com/)
10. CF Engine (IT infrastructure engineering, http://cfengine.com/)
11. Romonet (Predictive model tool for data centers ; http://www.romonet.com/)
12. Schneider Electric (Power management and physical data center infrastructure ; http://www.schneider-electric.com/site/home/index.cfm/ww/)

References

1. EPA, 2007, "Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431"
2. ENERGY STAR Data Center Energy Efficiency Initiatives: http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency
3. Data Center Energy Profiler: http://dcpro.ppc.com/
4. S. Lanzisera, B. Nordman, R. Brown, 2010, "Data Network Equipment Energy Use and Savings Potential in Buildings"; In ACEEE Summer Study on Energy Efficiency Buildings,2010
5. ENERGY STAR Computer Servers: http://www.energystar.gov/index.cfm?c=revisions.computer_servers
6. P. Mahadevan, P. Sharma, S. Banerjee, P. Ranganathan, " A Power Benchmarking Framework for Network Devices"; In Networking 2009
7. J. Lamb, "The Greening of IT", 2009, IBM Press, ISBN: 978-0-13-715083-0
8. J. Pflueger, August 2010, Dell Technical White Paper, "Understanding Data Center Energy Intensity"
9. E.Masanet, R. Brown, A. Shehabi, 2011 IEEE, " Estimating the Energy Use and Efficiency Potential of U.S. Data Centers
10. Green Grid White Paper #17 –"Proxy Proposals For Measuring Data Center Productivity" http://www.thegreengrid.org/~/media/WhitePapers/White%20Paper%2017%20-%20Proxies%20Proposals%20for%20Measuring%20Data%20Center%20Efficiencyv2.pdf?lang=en