ENERGY STAR® ICT Product Road-Mapping Informing Document

TRACK 3: Data Center Energy Efficiency Best Practices

March 2013

Background/Informing Document Purpose.

An EPA/ITI jointly sponsored ENERGY STAR ICT Product Road-mapping Workshop was held on July 10, 2012 in Washington DC. The Workshop consisted of three tracks focused on ICT products and ICT enabled solutions. Each track engaged in brainstorming dialog in separate breakout sessions and came up with key focus areas, to address in group discussions over the remainder of the year. The focus of Track 3 is on approaches and opportunities to encourage the adoption of data center energy efficiency best practices.

The data center has changed considerably as the evolution of information technology has enabled it to become the economic engine and critical nerve center of today's enterprise. As business demands increase, so do the demands on energy-efficient IT and data center facilities housing a rising amount of powerful IT equipment. Data center managers around the world are running into resource limitations related to power, cooling, and space, making the resource efficiency of data centers an important topic of discussion. At the same time, innovations in ICT hardware and software design enable these systems to greatly increase the quantity of work delivered per each unit of energy and space consumed but only if these systems are properly configured and utilized.

Significant work has been done by various organizations to develop programs and resources to inform and assist data center operators on data center energy efficiency issues including the EU Data Center Code of Conduct[1], the Lawrence Berkeley National Lab High Performance Buildings[2], The Green Grid[3], DOE Saving Energy in Data Centers Program[4] which includes the DC Pro Software Tool Suite and the Data Center Energy Practitioner Program, ENERGY STAR[5], ASHRAE, and others. While there is a diversity of available resources, various studies and reports suggest that there is significant unexploited data center energy efficiency opportunities. The working group deliberations identified 5 potential program elements that could be incorporated into the ENERGY STAR activities to encourage and incentivize implementation of data center energy efficiency initiatives.

1. Data Center Competition to Recognize Energy Efficiency Leadership in the Public and Private Sectors
2. Education Programs
3. Incentive Program Development
4. Data Center reporting initiative
5. Capacity or Utilization Metric

This informing document discusses each of these issues, outlining opportunities that The Green Grid, DOE, the ENERGY STAR program, and other stakeholders can pursue and exploit to increase the uptake of data center energy efficiency initiatives in both the private and public sectors. The discussions also outline opportunities for the working group participants to continue their collaboration to further the outlined work plan in 2013 and beyond. The Track 3 working group believes that a continuing effort by The Green Grid, ITI, DOE, the ENERGY STAR program, and other stakeholders can facilitate the execution of 5 identified program initiatives.

DISCUSSION

1. Data Center Competition: The Track 3 working group is unanimous in its support of the development of a data center efficiency competition to recognize data center operators that have taken concrete, measurable actions to improve the efficiency of their operations. The ENERGY STAR Portfolio Manager tool enables data center operators to assess and benchmark their performance against that of their peers from across the US while the DOE DC Pro tool facilitates a more detailed assessment and identification of efficiency improvements in an operating data center. Assessing performance is the first step, with the true goal being to building on the benchmarking to identify specific actions to drive improvements in energy efficiency in the buildings being benchmarked.

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[1] http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct/data-centres-energy-efficiency

[2] http://hightech.lbl.gov/datacenters

[3] http://www.thegreengrid.org/

[4] http://www1.eere.energy.gov/manufacturing/datacenters/index.html

[5] http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency

For the past 3 years, EPA has used the ENERGY STAR National Building Competition[6] as a platform on which to incentivize improvements in energy efficiency among all types of buildings. The results have been extraordinary, with the winning buildings reducing energy use by well over 30 percent in a single year, and hundreds of other buildings achieving substantial savings as well. Data centers have not been eligible to participate in the competition though, because the competition metric is a reduction in energy per square foot, which differs from the metric used by ENERGY STAR for assessing the performance of data centers (data centers use the PUE metric). Therefore, the working group proposes to initiate a data center energy efficiency competition, modeled after the ENERGY STAR National Building Competition, which recognizes exemplary, energy efficient operation in the various classes of data centers. The competition proposal would be conducted in two stages. The first stage would be designed for simplicity in communication, implementation, and participation and would be based on data center energy use information submitted to the ENERGY STAR Portfolio Manager. Upon completion of the initial competition, the responsible group(s) would review the program outcomes to determine whether to continue or expand the program and consider program modifications based on lessons learned from the initial competition.

The next step for this action is the identification or creation of an organizing body to develop and run the competition, with guidance provided by ENERGY STAR staff. The Track 3 working group recommends that The Green Grid be asked to take the lead role to manage this competition.

The competitions will highlight the availability of the ENERGY STAR resources for Data Center operators, the Portfolio Manager tool, and the cost saving results that data centers can achieve through the application of energy efficiency best practices. It can also serve as a launch vehicle for some of the education and incentive activities discussed below.

2. Education Programs/Data Center Summit: As discussed above, there is a wealth of educational materials, cases studies, and other information detailing the cost effective opportunities to improve the energy efficiency and workload delivered per unit of energy from the range of types of data center operations. At the same time, various studies and reports[7,8,9] have noted that there continue to be significant opportunities to improve data center efficiency through the application of data center best practices, thermal monitoring and optimization systems, and IT equipment virtualization/consolidation technologies. The group identified several factors which they believe have contributed to the sub-optimal pace of implementation of these systems in data center environments:

a. Concerns on the part of IT professionals regarding the inherent risks in service continuity and uptime associated with implementing virtualization technologies and managing and increasing data center thermal balance and temperatures.
b. The divide that exists in many data center organizations in which the IT professionals that consume the energy are not integrated or collaborating with the facilities professionals that pay the energy bills.
c. The fact that close to 40-50% of IT systems exist in small server closets with limited technical support.

The group believes that there are continued opportunities for outreach to disseminate information on best practice activities and inform and encourage IT and facility professionals to capture available energy efficiency and IT operations and space reduction savings offered by these activities. There are several actions that the group believes can facilitate and improve the dissemination of information on these opportunities:

a. Development and promotion of an internet based central repository or library of data center energy efficiency resources. This repository would organize current resources and provide a vehicle to capture and provide updates and notices on new activities and opportunities. The repository could be supported by an industry group such as The Green Grid; though it will require a commitment of resource for development and maintenance of the site.
b. Presentation of a regular data center education module, perhaps on a quarterly basis, in collaboration with the various webinars sponsored by the ENERGY STAR buildings program, the DOE commercial buildings program, and others. The modules could be developed by a working group comprised of DOE, ENERGY STAR and The Green Grid professionals.

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[6] http://www.energystar.gov/index.cfm?fuseaction=buildingcontest.index

[7] http://www.nytimes.com/2012/09/23/technology/data-centers-waste-vast-amounts-of-energy-belying-industry-image.html?pagewanted=all&_r=0
[8] http://www.forbes.com/sites/danwoods/2012/09/23/why-the-new-york-times-story-power-pollution-and-the-internet-is-a-sloppy-failure/2/
[9] http://www.koomey.com/post/8323374335

c. Consider alignment with an existing data center conference/summit such as that sponsored by the Silicon Valley Leadership Group or use of The Green Grid Forum and technical programs as a venue to promote existing educational materials and assessment tools to enhance data center efficiency. The Green Grid would have the option of including the announcement of the winners of the Data Center competition discussed above at this event.

d. Initiate research and issue a report on the state of server and data center efficiency to update the 2007 "Report to Congress on Server and Data Center Server Efficiency Public Law 109-431". There have been substantial improvements in server and data center energy efficiency since the 2007 report and those improvements should be recognized and the next steps of the data center efficiency roadmap detailed to stakeholders. Various groups, including TGG, EPA, and DOE should contribute to the development of this report by providing summary data on ENERGY STAR product purchases, and other relevant data collected by groups active in this area. An entity and resource needs to be identified to sponsor and/or generate this update.

The group recognizes that all four of these activities will require resource commitments. One of the work items would be identification of supporting resources and development of the systems, programs, and activities discussed in this section.

3. Incentive Program Development: Many energy efficiency activities, such as energy-efficient lighting installations and purchases of ENERGY STAR appliances and high efficiency motors, have benefited from the energy efficiency incentive programs administered by energy efficiency utilities or utility incentive programs. While individual energy efficiency incentive programs have been implemented for IT equipment virtualization and consolidation activities and data center thermal management and air flow monitoring programs, these programs have not achieved wide acceptance across the energy efficiency program community. The working group believes that there are opportunities to develop energy efficiency incentives which can be used to facilitate interactions between IT and facility operations groups at data centers and reduce efficiency project payback periods to the two to three years typically required at commercial facilities.

The Consortium for Energy Efficiency (CEE)[10], a consortium of local and regional energy efficiency program administrators from across the U.S. and Canada who work together on common approaches to advancing efficiency, has a Data Centers and Servers Initiative and Committee within its Commercial Programs group. They have been exploring opportunities to work with government and industry stakeholders to inform program approaches that local programs can promote to address common and persistent barriers to data center efficiency. CEE is pursuing development of a reporting template to collect data on data center air flow and thermal management projects to help inform rules of thumb about thermal management approaches, costs and benefits, Monitoring & Verification methods, results, and lessons learned. The intent is to inform incentive program design efforts by either individual programs or potential for harmonized program approaches that CEE could define to address barriers and enable credible, verifiable data center savings.

The Track 3 working group believes there is an opportunity for ENERGY STAR, The Green Grid and CEE to collaborate to design data center specific incentive program(s) by combining the data collection and benchmarking capabilities of the ENERGY STAR program, the combined industry knowledge regarding measurement and monitoring and verification requirements offered by the Green Grid, and CEE member's understanding of the specific criteria an incentive program is required to meet to satisfy utility industry regulatory requirements. While the specific elements of a workable program are not clear at this time, the working group believes this item is worthy of further study and collaboration, as a well designed program could become a major driver to improving the implementation of specific, targeted data center energy efficiency improvements.

4. Utilization/Capacity Metrics:

The data center industry has made strides in developing efficiency metrics, specifically in the area of measuring infrastructure efficiency through The Green Grid's development and publication of the Power Usage Effectiveness (PUE) metric and supporting educational material.[11] Further efforts have been undertaken to establish companion metrics that describe other aspects of data center efficiency, including Corporate Average Data center Efficiency (CADE)[12], Data Center Energy Productivity (DCeP)[13], and Data center Performance per Energy (DPPE)[14].

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[10] The CEE Initiative Description describes the purpose, goals and objectives of the work and can be downloaded at: http://www.cee1.org/com/dcs/dcs-main.php3
[11] http://www.thegreengrid.org/en/Global/Content/Reports/RecommendationsForMeasuringandReportingOverallDataCenterEfficiencyVersion2
[12] http://searchdatacenter.techtarget.com/definition/CADE-Corporate-Average-Data-center-Efficiency

The industry has long desired a metric that would describe the "productivity" of the data center; that is, how much productive work is derived as a function of the investment in energy and currency. As the ultimate purpose of each data center is generally distinct and different equipment may offer different approaches to measuring productivity characteristics, a single, simple and universally applicable metric has proven elusive. The Track 3 working group recognizes, however, that there are likely useful and more broadly applicable metrics that can shed light on the efficiency of the design and operation of the entire data center, IT equipment included, by focusing on one or both of:

- "Capacity" - The amount of computing, storage, and networking potential provided by the data center for a given investment in energy
- "Utilization" - The amount of computing, storage, and networking capacity that is actually in use, versus that which is available but idle.

While these proposed metrics make logical sense, there is as yet no accepted, universal method by which productivity, capacity, or utilization can be measured. A global Task Force comprised of representatives from U.S. Department of Energy's Advanced Manufacturing Office and Federal Energy Management Programs, U.S. Environmental Protection Agency's ENERGY STAR Program, European Commission Joint Research Center Data Centers Code of Conduct, Japan's Ministry of Economy, Trade and Industry, Japan's Green IT Promotion Council, and The Green Grid has been working over the past 2 years to provide guidance to the industry aimed at harmonizing global standards for data center metrics. One of the Task Force's current objectives is the development of a metric which "Measures the actual IT work output of the data center compared to actual energy consumption", with a focus on "Measuring the potential IT work output compared to expected energy consumption; and measure operational utilization of IT Equipment" [15].

Recognizing the complexities inherent in developing a metric for datacenter productivity, the Task 3 work group believes that it is appropriate for the IT industry to facilitate and expedite current efforts to develop a utilization/capacity metric, with input provided by DOE, EPA, and other interested stakeholders. As a member of the Global Harmonization Task Force, and an industry thought leader in its own right, The Green Grid is well positioned to lead efforts in this regard, while involving other key US and international stakeholders in the initiative. It is expected that this metric development will take 2 to 3 additional years.

When the metric is validated as being a meaningful, representative measure of data center activity, the Task 3 work group recommends that EPA should then evaluate the metric to determine if it can become the basis of the ENERGY STAR energy performance scale for data centers, replacing the current metric of PUE. This will necessitate execution of the following activities:

a. Collection of utilization/capacity, PUE, and other appropriate metric results from operating data centers.
b. Analysis of the data collected to develop a rating algorithm.
c. Incorporation of the new algorithm into the ENERGY STAR Portfolio Manager tool.

These activities will likely take an additional 2-3 years after the metric is agreed upon by industry.

5. Data Center Reporting Initiative:

Delivery of energy efficiency improvement across a broad portfolio of data centers requires the development of key indicators and metrics, commonly defined and universally employed, that enable methodical evaluations and comparisons. The purpose of a data center reporting initiative would be to provide strategy, direction and recommendations on measuring and publishing key performance indicators and metrics for data center efficiency improvements and reduction of energy consumption. The effort would create or establish a current federal data center portfolio baseline, project potential with possible efficiency improvements, and provide, once projects have been completed, a comparison of actual results to expected outcomes. One area of concern with metrics reporting, business confidentiality and competition issues, currently limits the extent of information that data center owner/ operators are willing to make publicly available. This information can be anonymized, occluded or identified in a coded manner to shield location and identity in The Green Grid's data Center Maturity Model.

[13] http://www.thegreengrid.org/~/media/TechForumPresentations2011/TheLatestonTheGreenGridsProductivityResearch_2011.pdf?lang=en

[14] http://www.greenit-pc.jp/topics/release/pdf/dppe_e_20100315.pdf

[15] http://www.energystar.gov/ia/partners/prod_development/downloads/Harmonizing_Global_Metrics_for_Data_Center_Energy_Efficiency_2012.pdf?5237-f817

The working group recommends that The Green Grid consider beginning a process to assess the maturity of the current, U.S. data center portfolio through a program to encourage submission of data center energy efficiency attributes to the The Green Grid Data Center Maturity Model (DCMM) Tool[16]. DCCM assesses the implementation of best practice activities in four operating categories, Power, Cooling, Compute, and Storage, against 6 levels of "maturity". The DCMM tool provides an anonymized system that can collect and report the current level of maturity of individual and groups of data centers against the best practices of a "typical" data center. Assessment of the maturity of the current data center inventory against the expectation of a typical data center can provide information to develop a roadmap of key activities and recommended milestones to promote improvement of data center efficiencies and reduce data center energy consumption over time. The WG recommends that the effort begin by submission of data from the Federal Government data center portfolio, focusing on data centers that serve as consolidation centers for the Federal Data Center Consolidation Initiative[17], to generate a critical mass of data center information followed by an effort to capture data centers operated by The Green Grid members to expand the information. The final result would be that reporting organizations should be able to compare themselves and contribute to the body of knowledge about data center energy efficiency without any data center unique information being made public.

The group recognizes this activity will require resource commitments and coordination with federal agencies before it can be formally initiated. A critical work item, either for this group or for The Green Grid, is to determine whether resources are available to develop and implement this program and the appetite of the federal agencies to participate in the program outlined above.

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[16] http://www.thegreengrid.org/en/Global/Content/white-papers/DataCenterMaturityModel
[17] http://archive.opm.gov/cio/newsandevents/OPM%20FDCCI%20Plan.pdf