Status Report on Accelerating Energy Efficiency in Indian Data Centers and Developing Core IT Metric to Report Energy Performance of Data Centers

February 2016

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Introduction

Objective of Presentation:

- To share a comparative matrix on different energy performance metrics for data centers with the Core-IT Stakeholder Consultative Working Group (Slide 9,10 &11).

- To gather inputs and arrive at a consensus on IT-specific energy performance metric to be considered for reporting energy performance of data center to enable PAT-type scheme.

Introduction

Project Overview:

The "Accelerating Energy Efficiency in Indian Data Centers" initiative aims to develop an energy efficiency policy framework for Indian data centers involving key stakeholders.

The study is being led by the Confederation of Indian Industry (CII), in collaboration with Lawrence Berkeley National Laboratory (LBNL)-U.S. Department of Energy, and under the guidance of Bureau of Energy Efficiency (BEE).

Phase 1 (November 2014 – September 2015)

Phase 2 (December 2015 – September 2016)

Introduction (Contd.)

Phase 1 Activities

- Comprehensive review of existing data center standards from around the world.
- Comprehensive review of existing energy efficiency policy in India.
- Analysis of international standards to the Indian context.
- Stakeholder engagement through a primary survey.
- Stakeholder engagement through an in-person workshop (July 13, 2015).
- Meeting with Bureau of Energy Efficiency (BEE) to share results (July 21, 2015).

Introduction (Contd.)

Key Recommendations from Phase 1:

1) Development of a "Composite Policy Framework" for Indian data centers that encompasses all the components of a data center (e.g., IT and Infrastructure) and is based on existing Indian energy efficiency standards such as Perform, Achieve & Trade (PAT) and Energy Conservation Building Code (ECBC).

2) Formulation of a Core-IT Stakeholder Consultative Group to focus on the IT performance metric and a Large Stakeholder Consultative Group to focus on synchronizing the standard with existing ECBC and PAT frameworks to make the standard easily adoptable by BEE.

3) Factors to be considered in the new standard: variation in size of data centers; variation in type of data centers (e.g., captive, colocation), their implication on energy use; reliability; and air and environmental quality.

Phase 2 Activities

1) Develop short- and long-term strategies/mechanisms to implement energy efficiency standards for Indian data centers using ECBC and PAT-type scheme.

2) Develop technical and administrative procedures for ECBC (short term) and PAT (long term) energy efficient data center standards.

3) Organize consultative stakeholder meetings for outreach and plans to implement the procedures developed.

A PAT-Type Mechanism for Data Centers

- PAT is designed to accelerate energy efficiency in energy- intensive large industries and facilities. It is a market based mechanism to enhance cost effectiveness of improvements in energy efficiency, through certification of energy savings that could be traded.

- Under PAT, different energy intensive sectors are evaluated on the basis of Specific Energy Consumption (SEC) and a baseline SEC is defined. Targets for reduction are set based on the baseline.

- LBNL and CII technical teams are currently working on developing one or more energy performance metric/s for data centers in India that can be used to report energy performance of data centers and enable a PAT-type program for data centers.

Comparative Matrix- Energy Performance Metrics

S.NO.	Energy Performance Metrics	Brief Description	Metric Calculation	Parameter 1	Parameter 2	Parameter 3
1	**Power Usage Effectiveness (PUE)**	PUE is defined as the ratio of total facilities energy to IT equipment energy. Total facility energy is defined as the energy dedicated solely to the data center. The IT equipment energy is defined as the energy consumed by equipment that is used to manage, process, store, or route data within the compute space.	**PUE** = Total Facility Energy/ IT Equipment Energy	Total Facility Energy (Infrastructure + IT Energy)	IT Equipment Energy	
2	**Data Center Infrastructure Efficiency (DCiE)**	DCiE is defined as the fraction of the IT equipment energy divided by the total facility energy. **It is the reciprocal of PUE.** The total facility power is defined as the power measured at the incoming utility meter of data center. The IT equipment power is defined as the power consumed by the IT equipment supported by the data center as opposed to the power delivery and cooling components and other miscellaneous loads.	**DCIE =** IT Equipment Energy/ Total Facility Energy	IT Equipment Energy	Total Facility Energy (Infrastructure + IT Energy)	
3	**IT Power Usage Effectiveness (ITUE)**	ITUE is intended to be a "PUE-type" metric for IT equipment rather than for the data center. PUE is total energy divided by IT energy, analogously, ITUE is defined as total IT energy divided by computational energy.	**ITUE =** IT Equipment Energy/ Total Energy into the Compute Components	Total Energy into IT Equipment (Including internal fans, power supplies, and voltage regulators (VRs), etc.)	Total Energy into the compute Components (The Compute components can be defined as the CPU, memory, and storage, etc.)	
4	**Total Power Usage Effectiveness (TUE)**	TUE is the total energy into the data center divided by the total energy to the computational components inside the IT equipment	**TUE =** ITUE * PUE OR Total Facility Energy/ Total Energy into the Compute Components	Total Energy into Data Center	Total Energy into the Compute Components	
5	**Compute Power Efficiency (CPE)**	CPE measures how efficiently the power is being used for computing. It is calculated by dividing the PUE into the utilization percentage of the computing equipment.	**CPE =** Computer Equipment utilization rate / PUE OR Computer Equipment Utilization (IT Productivity) * IT Equipment Energy/ Total Facility Energy	Computer Equipment Utilization is synonym to IT Productivity [IT service output of the datacenter (includes network transactions, storage or computing cycle)]	Total Facility Energy (Infrastructure + IT Energy)	IT Equipment Energy

Comparative Matrix- Energy Performance Metrics (Contd.)

S.NO.	Energy Performance Metrics	Brief Description	Metric Calculation	Parameter 1	Parameter 2	Parameter 3
6	**Power to Performance Effectiveness (PPE)**	PPE can be defined as actual power performance to optimal power performance. PPE is used to analyze the effective use of power by existing IT equipment, relative to the performance of that equipment	Performance of IT Equipment (Actual)/ Watt Consumed ÷ Performance of IT Equipment (Optimal) / Watt Consumed	Performance of IT Equipment is synonym to IT Productivity	Watt Consumed (same as IT Equipment Energy)	
7	**Space, Watts & Performance (SWaP)**	SWaP is an objective, three-dimensional metric characterizes a data center's energy efficiency by introducing three parameters of space, energy and performance together.	**SWaP** = Performance/ (Space * Power Consumption)	*Performance* : Information about the level of performance or throughput a server maintains can come from any industry-standard.	*Space* : The space a server occupies can be measured by the rack unit height of the system.	*Power* : Determining the watts consumed by the system (synonym to IT Equipment Energy)
8	**Compute Units Per Second (CUPS)**	CUPS represents a universal measure of computing output. CUPS can be defined as the amount of work done by the IT equipment per second. CUPS can serve as the numerator in the equation that determines Compute Efficiency.	**CUPS =** IT Productivity / Second	IT Productivity is the IT service output of the datacenter (includes network transactions, storage or computing cycle)	Second (Unit of Time)	
9	**Data Center Compute Efficiency (DCcE)**	DCcE is calculated by simply averaging the ScE values from all servers during the same time period.	**DCcE =** Summation (Σ) of all values of ScE taken from all server in a given time period/ Total Number of server (m)	All values of SCE taken from all server in a given time period	Total Number of server (m)	

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Comparative Matrix- Energy Performance Metrics (Contd.)

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S.NO.	Energy Performance Metrics	Brief Description	Metric Calculation	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5
10	**Server Compute Efficiency (ScE)**	ScE is a time-based metric; it measures the proportion of time the server spent providing primary services and is expressed as a percentage value. Primary service include: -Average amount of CPU utilization attributable to primary services. - The amount of I/O attributable to primary services. -A primary services process (not a secondary or tertiary service) has received an incoming session based connection request. - There has been an interactive logon to the server.	**ScE =** Summation (Σ) of number of samples where the server is found to be providing primary services i.e **(Parameter 1 + Parameter 2 + Parameter 3 + Parameter 4**)/ The total number of samples taken over that time period. **(Parameter 5)** X 100	Total average CPU utilization minus average CPU utilization from secondary and tertiary services	Total I/O minus I/O from secondary and tertiary services	A primary services process has received an incoming session based connection request	Interactive Logon to servers	The total number of samples taken over that time period (i.e. the measurement of primary service taken at given time period)
11	**Data Center Energy Efficiency & Productivity (DC-EEP)**	The DC-EEP Index can be defined as the delivered IT Productivity "out" to information users per watt of site infrastructure energy "in."	**DC-EEP** = IT Productivity / Total Facility Energy	IT Productivity is the IT service output of the datacenter (includes network transactions, storage or computing cycle)	Total Facility Energy (Infrastructure + IT Energy)			
12	**IT Productivity per Embedded Watt (IT-PEW)**	IT- PEW measures the operating/ power efficiency (bytes processed/ W) of IT equipment or captures the power efficiency of the IT equipment	**IT-PEW** = IT Productivity / Embedded Watt	IT Productivity is the IT service output of the datacenter (includes network transactions, storage or computing cycle)	Embedded Watt is a synonym of IT Equipment Power			
13	**Site Infrastructure Energy Efficiency Ratio (SI-EER)**	The SI-EER ratio can be defined as power "in" to the data center as measured at the utility electric meter divided by the conditioned power "out" to run the IT equipment for computing. **It is same as PUE.**	**SI-EER** = Total Facility Energy / IT Equipment Energy	Total Facility Energy (Infrastructure + IT Energy)	IT Equipment Energy			
14	**Server Utilisation Effectiveness (SUE)**	Effectiveness of servers performance is measured. The efficiency of the number of servers present considering its age factor is measured. Higher SUE indicates, facility is using more server to deliver same work-output (hence more energy consumption in using more server)	SUE = No of Servers / Summation (Σ) of Servers *0.707^age	Total No of Servers in Facility	Total no of server age wise multiplied by 0.707 raise to the power of age of the server			

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Questions for Core-IT Consultative Working Group

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Q.1- Taking in to consideration factors such as variation in data center size, type, etc., do you think it is possible to generalize a specific energy performance metric for a data center specific, PAT-type program in India?

Q.2- Which metric(s) presented here do you think are most appropriate for measuring the energy performance of data centers in India, in your specific organization, and why? If you can think of an IT compute metric that is not included in the list and is more appropriate for our purposes, please include.

Q.3- What challenges do you foresee in regards to implementation, data collection, and reporting of the metric(s) you selected?

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THANK YOU