Opportunities and Challenges for Indian Data Center Energy Efficiency: Findings from Focus Groups

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Executive Summary

Energy consumption in data centers is growing rapidly. Combined with growth in the IT industry and rising energy prices, energy consumption adds a significant burden on the operating costs, and challenges India's sustainable growth. While the impact of data center energy in India is yet to be quantified, the exponential growth of software and services businesses indicate that the energy challenges to the data center industry and opportunities for energy efficiency need greater attention.

To meet the current and future challenges and identify opportunities, the U.S. Department of Energy's (DOE) Lawrence Berkeley National Laboratory (LBNL), with assistance from the U.S. Agency for International Development (USAID) Energy Conservation and Commercialization (ECO-III) project and Infosys Technologies, hosted two focus group workshops in Delhi and Bangalore. Participants included representatives from the Indian data center industry as well as stakeholder experts. The key objectives of both workshops were to:

- Update on US and India data center research and development (e.g. LBNL work).
- Evaluate and take stock of data center efficiency activities since 2008; what was accomplished, and what remains to be done.
- Reassess current challenges to energy efficiency in Indian data centers.
- Identify potential actions to overcome those challenges.
- Refine data center energy efficiency goals and prioritize plans for going forward.

Key Findings

The workshops identified significant challenges that included:

- Lack of awareness and the need for expertise (e.g., for capacity building).
- Lack of policies, regulations and enforcement of energy standards relating to data centers, as well as a lack of guidelines for voluntary standards and ratings.
- Need for better benchmarking – performance metrics and measurement protocols, and more metering and measured data.
- Need for design and assessment tools, as well as tools to better operate data centers.
- Disconnect between design and operations, and between IT and facilities personnel.
- Need for demonstrative information technology and infrastructure solutions (e.g., virtualization, cooling).

Opportunities and Next Steps

The workshops resulted in the following high-priority recommendations to overcome the challenges. The overarching need was a consultancy "body" or center (a partnership between industry and government) to serve as the focus to develop and disseminate:

- Financial and technical resources aimed at a variety of target audiences (information clearinghouse for existing facility retrofits and new facility design)
- Education and training materials.
- Certification of designers and operators

- Mandatory energy efficiency codes and reporting requirements
- Award and recognition program(s)
- Market analysis and opportunity assessment.
- Expand benchmarking activities.

In addition there were a number of technology and policy related recommendations. Technology demonstrations and case studies would provide industry the confidence to adopt new best practices and emerging technologies such as server virtualization. The sense of both working groups was the need to have the government play a bigger role in improving data center efficiency, for example by establishing standards. The sense was that data centers are falling in the crack between buildings and industrial government programs.

These findings should encourage both US and Indian Government agencies to take appropriate measures to improve data center energy efficiency and foster businesses and public-private partnerships between the two countries. The next steps would include developing a business plan and governance structure for a center of excellence, as well as initiating the additional activities listed above (e.g. developing resource material).

Introduction

The U.S. Department of Energy's (DOE) Lawrence Berkeley National Laboratory (LBNL), with assistance from the U.S. Agency for International Development (USAID) Energy Conservation and Commercialization (ECO-III) project and Infosys Technologies, hosted two full-day focus group workshops with Indian data center industry and stakeholder experts. The key objectives of both these workshops were to:

- Update on current US and India data center research and development at LBNL.
- Evaluate and take stock of data center efficiency activities since 2008, what was accomplished, and what remains to be done.
- Reassess current challenges to energy efficiency in Indian data centers.
- Identify potential actions to overcome those challenges.
- Refine data center energy efficiency goals and prioritize plans for going forward.

The USAID ECO-III hosted the first workshop in New Delhi on September 06, 2010. Infosys in Bangalore hosted the second workshop on September 13, 2010. The industry and stakeholder participants for these focus group workshops combined totaled about 30 experts. The experts represented major Indian and US companies, associations, consultants, and non-governmental organizations. Represented organizations included Intel, Cisco, Network Appliances, American Power Conversion (a division of Schneider Electric), Qualcomm, Infosys, Wipro, Schneider Electric India, Tata Communications, Cognizant Technologies, Schnabel DC Consultants, LSI Logics, National Association of Software and Services Companies (NASSCOM), Alliance for Energy Efficient Economy (AEEE), Sobha Developers Ltd.

Background

In 2008, LBNL, with assistance from ECO-III project, kicked off a public-private partnership program with industry and stakeholder focus groups and identified the following challenges or needs for an Indian data center energy efficiency initiative:

- Lack of awareness
- Lack of technical expertise
- Lack of institutional framework to stimulate change
- Lack of benchmarking

Through these needs, the following recommendations were made:

- Create information/awareness framework
- Capacity building/training
- Industry forums for information exchange
- Develop performance metrics and benchmarking
- Develop framework for standards and incentives

Since then, significant progress has been made in the following activities:

Activities (with Organizations)	Progress (with Organizations)
Government and industry forums	• Two LBNL and ECO-III industry workshops • Confederation of Indian Industry workshops (CII) • Working groups formed by NASSCOM and CII. • Continued updates and status briefing to US Department of Energy (DOE) and Indian Ministry of Power's Bureau of Energy Efficiency (BEE)
Develop energy efficiency guides	• Tip Sheet (LBNL/ECO-III).[1] • Best Practices (CII/BEE).
Benchmarking report (LBNL/ECO-III)	• Benchmarking report published and circulated.[2]
Standards and Incentives (BEE)	• **Standards**: Performance based rating program "STAR Labeling " for Data Centers was discussed and recommended. • **Incentives**: Recommendation for BEE's market based scheme "Perform Achieve and Trade (PAT)" to be extended for large energy intensive Data Centers (apart from current nine sectors).
Information dissemination using Websites (LBNL/ECO-III)	• **LBNL High-tech**: http://hightech.lbl.gov/dc-india/india-datacenters.html/ • **LBNL and UC Berkeley India**:

[1] http://hightech.lbl.gov/DC-India/documents/Data-Center-Tip-Sheet.pdf and http://eco3.org/?file_id=13/
[2] http://bijlee.lbl.gov/India-DataCenters-Benchmarking/ and http://eco3.org/?file_id=124/

	http://bijlee.lbl.gov/program/data-center-energy-efficiency-initiative/ • **USAID ECO-III**: http://eco3.org/datacenters/

These activities were updated and re-evaluated with the industry and stakeholder experts to reassess current challenges and identify and prioritize potential actions for a sustainable data center energy efficiency initiative in India.

Findings

The workshop challenges and resulting recommendations identified strategic areas of focus for government and industry and US-India collaborative activities.

Challenges

A facilitated discussion on challenges facing Indian data center industry for energy efficiency improvements was held in both Delhi and Bangalore. The challenges from previous findings were revisited to ascertain their validity for continued focus and identify any new challenges.

Consolidated Challenges

From both New Delhi and Bangalore focus group meetings, the following common challenges emerged. These challenges and their focus areas are listed in the table below.

Focus Area	Challenges
Expertise and Awareness	• Lack of expertise, little or no retrofit industry, and knowledge/advice is fragmented. • Efficiency not on "high priority" list. • Continued lack of focused forums on data center facilities and especially efficiency opportunities. • More experts needed (consultants) and a way to "qualify" those experts. • More awareness needed (but significant improvement – "green" overall) to identify: a. What is the problem? b. What are the solutions? c. Need to convert above to commitment (to change) d. Big enterprises are making progress but next tier lacks basic information.
Regulation and Policies	• Hard to focus on without specific guidance. • Difficult to "sell" to management (e.g. payback) without effective regulations/guidance, partly because downtime is so much more costly. • Large organizations have significant momentum, difficult to change course without larger mandates (e.g., sustainability, carbon emissions). • Data centers fall through crack between buildings and industry government programs.

Design Requirements and Standards	• Indian data centers may not involve expert consultants in design (vendors fill the gap). • Difficult to define design requirements early in project (including projecting growth). • Need for real data on load and need to have modular design to accommodate changes. • Misalignment of design and operation. • Capacity underutilization of some facilities (designed for higher capacity). • Lack of design standards (voluntary and mandatory).
Information Technology (IT) and Infrastructure	• Optimized environmental limits of server operation not clear or well defined (e.g. how hot can you go in a hot and cold isle containment – 28 or 31 degree C?) • Large growth expected (e.g. 60-70%), need for infrastructure consolidation rather than random growth. Existing infrastructure limits (capacity constraints). • Need designs for flexibility of higher density loads (e.g. blades) • Virtualization technologies are not "here" but coming and will impact facility energy use significantly.
Performance Metrics	• No measurement and verification including "baselining" to determine opportunities and actual performance. • Data not being converted to information. • No feedback on utilization rates (e.g. kW/rack). Designers don't go back and check. • Difficult to keep up, efficiency is low priority and often done late. Need service-level metric for efficiency. • Little good data from manufacturers regarding temperature requirements, actual power draw, etc. • Manufacturer representatives quote tighter ranges than specification sheets or ASHRAE ranges. • Difficult to determine PUE (lack of sub-metering).

Additional Challenges

Other than the challenges listed above, the following activities also need attention:

- Need for demonstrations to identify estimated versus actual savings and wide-scale adoption of resulting findings. Practices in existing/legacy data centers are hard to change – can't shut them down. Legacy centers often not designed to be data centers – many compromises have to be made and it is hard to change them live.
- Difficult to approach in an integrated fashion over the entire lifecycle and difficult to often coordinate IT and facility/site infrastructure. Lack of integrated automation capabilities (application, IT, Facilities).
- Lack of integration of personnel and systems for IT and facility/site infrastructure. IT staff don't know energy use/cost (or carbon savings). There is also a desire for servers to be close to the person/organization responsible (want control of equipment). This leads to a lack of use of virtualization and cloud computing technologies.

- Unreliable power with several power failures per day. In some cases Diesel Generators (DG) set running all-day (very expensive) with costs of $0.15/kWh (3-4 times more than other facilities.)

Recommended Opportunities

Based on the challenges identified in the earlier exercise, a facilitated discussion identified recommended opportunities moving forward. These recommendations are based on prioritization of activities with High (H), Medium (M), and Low (L) indicating immediate and long-term needs of the data center community.

Consolidated Opportunities and Priorities

The table below lists prioritized opportunities for focus area activities:

Focus Areas Activity	Priority
1. Expertise and awareness, regulation and policies, design requirements and standards	
○ Develop data center design and operation consultant body ○ Create **center(s)** for education and training. ○ **Center(s)** to provide certification of professionals. ○ Include training curriculum and certification (design, operation). ○ Illustrative business plan to demonstrate integration of efficiency into the data center design and operation. ○ Initial start up partnership with NASSCOM, CII, BEE, and technology providers.	H
○ Form a "body" that can coordinate training, certification, and standards. Governance body for potential **center** creation and other activities – steering committee for the **center(s)** ○ Start by creating a business plan.	H
○ Develop data center energy efficiency code ○ Define minimum PUE (based on climate). ○ Look at existing standards and take best to suit Indian context. ○ Establish standards and requirements for existing Data Centers (over a certain size) ○ Recognize that smaller data centers often have largest opportunity.	H
○ BEE could make data centers a designated consumer ○ Regulatory reform to require efficiency measures ○ Required disclosure of data for larger data centers ○ Collaborate with Ministry of Corporate Affairs for mandatory disclosure of PUE.	H
○ Establish zoning (or incentive) for data centers (to encourage efficiency and clean supplies). ○ Encourage cool, clean locations, available natural gas (clean generation and co-gen) ○ Focus would be large IT data centers ○ State government may use this as economic stimuli.	H (Long term)

○ Encourage carbon footprint reporting of data centers ○ Require reporting separately ○ Need better utility reporting of power plant impacts ○ Consider regional numbers	M
○ Provide training (best if hosted by the center). ○ Train and certify data center energy efficiency professionals (existing data center assessments and new construction designers)	M
2. IT and Infrastructure	
○ Maximize data center utilization – right sizing ○ Encourage modular data centers ○ Publish guidelines on the refresh rates of all parts of a data center (including infrastructure) ○ Identify methods to maximize utilization ○ Develop framework for integrated capacity planning and encourage continued improvement/optimizations.	H
○ Close the gap between HVAC, IT, and building control systems ○ Audit existing data centers and require integrated metering/information systems to be installed	H
○ Promote metering and financial connection (case study, CII guide)	M
○ Develop intermediate metric for capacity and cost of IT as well as infrastructure (looking at avoided cost of infrastructure)	M
○ Improve efficiency at the rack level (IT and infrastructure) ○ Set server rack design standards ○ Rack or row cooling (get the cooling closer to the heat source and more responsive to load) ○ Possibly ID local manufacturers to lower cost (certify products)	M
3. Performance metrics	
○ Expand Indian benchmarking activity (ongoing) ○ Tie to participant award program (performance, improvement). ○ Identify further opportunities to simplify the participation process. ○ Guided to collect data (in the real world) see Green Grid	H
○ Measure Performance Metrics (e.g., PUE) ○ Improve data collection and tools methodology ○ Clarify measurement protocols (apples to apples, cost/benefit) ○ Show how information can be of value to corporate management ○ BEE should set target PUEs	H
○ Benchmarking tool (allow for estimate without detailed monitoring).	L
4. New construction and design information (leads to significant opportunities)	

○ Include a centralized portal for information (website) ○ Possible host: NASSCOM until the **center** is established	H
○ Design information resources or guides for Indian market ○ Inventory existing and identify gaps ○ Best practices design and operations, case studies, and handbooks.	M
○ Provide standards (minimum and voluntary government driven)	L
5. Need market analysis and opportunity assessment ○ Billions of dollars in annual infrastructure investment in India (APC) ○ Needed by industry and government policy makers	H
6. Establish Incentives ○ Go beyond manufacturer incentives ○ Institute an award/recognition program ○ Require benchmark data for awards program ○ Sponsors: NASSCOM and BEE. ○ Ratings – performance-based awards (e.g., LEED) – start with IGBC based on US experience (wait until available from USGBC). ○ India should adopt EPC (LEED) or EU code of conduct for data centers (LBNL has developed NC, EB under development) ○ Extend STAR-rating program to data centers. ○ Promote internal incentive structures via Guide ○ People management – stick and carrot	H-M
7. Smart grid interface important and related forums are good for data center discussions ○ Tie into existing smart grid forum (includes ministry of IT) ○ Seven working groups – more related to IT for grid	M
8. Establish competition between companies	M
9. Encourage variable speed fans and systems to respond to variable IT loads (temperature) ○ Provide information and standards	L

Additional Opportunities and Priorities

Other than prioritized list above, a few other recommended opportunities included:

- Conduct workshops and forums for data center efficiency outreach activities to discuss these ideas and US experiences (involve participation of larger groups). The US experience would include demonstrations of free cooling strategies (increase operating temperature, identify/address air-quality issues).
- Movement towards Cloud Computing tends to increase consolidation and size of data centers. There are good opportunities to do it right with new large data centers by taking advantage and shifting to virtualization and cloud computing. Consolidation and larger data centers tend to be more efficient.
- Beyond the benchmarking tools, data center assessment tools may be needed.

- The standards or certification process may include LEED for data centers and data center efficiency practitioners program. The TIA-942 is a US-based standard used for infrastructure (best practice), which needs efficiency input.[3]

Next Steps

The Indian data center efficiency program goals include improving energy efficiency and fostering businesses and public-private partnerships between two countries and strategic allies. LBNL and USAID ECO-III will engage both US and Indian Government agencies (US DOE and BEE) and participating industry and stakeholders for discussion and prioritization of activities. This activity will lead to:

- Identification of policies, regulations, and guidelines for Indian data center energy efficiency programs.
- Foster bi-lateral inter-governmental international programs focused on sustainability and clean energy programs (e.g., PACE-R and PACE-D).
- Discuss findings with data center experts and work with industry and stakeholders to define a roadmap that outlines implementation guidelines (e.g., conferences, panels, workshops, presentations, meetings).
- Establish US-India industry partnerships that will foster clean energy developments with data center businesses.

[3] TIA-942 standard was developed by the Telecommunications Industry Association (TIA) to define guidelines for planning and building data centers with regard to cabling systems and network design.