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Data Center Energy Efficiency Standards in India: Preliminary Findings from Global Practices

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Data Center Energy Efficiency Standards in India: Preliminary Findings from Global Practices

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ABSTRACT

Global data center energy consumption is growing rapidly. In India, information technology industry growth, fossil-fuel generation, and rising energy prices add significant operational costs and carbon emissions from energy-intensive data centers. Adoption of energy-efficient practices can improve the global competitiveness and sustainability of data centers in India. Previous studies have concluded that advancement of energy efficiency standards through policy and regulatory mechanisms is the fastest path to accelerate the adoption of energy-efficient practices in the Indian data centers. In this study, we reviewed data center energy efficiency practices in the United States, Europe, and Asia. Using evaluation metrics, we identified an initial set of energy efficiency standards applicable to the Indian context using the existing policy mechanisms. These preliminary findings support next steps to recommend energy efficiency standards and inform policy makers on strategies to adopt energy-efficient technologies and practices in Indian data centers.

Categories and Subject Descriptors

D.2.8 [**Software Engineering**]: Metrics – *Performance measures,* H.3.4 [**Information Storage and Retrieval**]: Systems and Software – *Performance evaluation (efficiency and effectiveness)*

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Design, Documentation, Economics, Measurement, Performance, Standardization, Verification

Keywords

Best Practices; Data Centers; Energy Efficiency; Technologies; Standards and Codes; Evaluation Metrics; Carbon Emissions; Energy Consumption

1. INTRODUCTION

Data centers are energy-intensive facilities that support a diverse set of services such as Web, e-mail, data storage, and processing. They are operated around the clock, and are energy intensive. It has been reported that global data center emissions will grow 7% year-on-year through 2020 [1]. Over the last decade India has witnessed increased demand in data because of explosive growth in smartphones and widespread use of social media apps, banking and e-commerce transactions, and multimedia storage needs, providing an impetus to the large growth in data center markets in India. According to studies, Indian data center spending on storage, server, and network equipment reached $2.2 billion in 2012, and this market is expected to grow at a compound annual growth rate of 8.5% to reach USD 3 billion by 2016 [2]. Energy represents one of the most significant operating costs in data centers. Rising energy costs increase their operational expenses. In India, where coal is the primary source of electricity generation, it is necessary for data centers to adopt sustainable operations. In power-deficit India, energy efficiency offers the following benefits to data centers: (a) increased reliability of electricity supply; (b) reduction in operating costs; and (c) enhanced efficiency in design and operations.

It is estimated that achieving just half of the technologically feasible savings by adopting best practices could cut electric use in data centers by 40% [3]. In India, the increased focus on data center efficiency, reliability, and cost optimization has led to the identification of challenges such as: (a) lack of integrated building design approach; (b) lack of technical awareness, exposure to best practices, and energy-efficient solutions; (c) identification of information technology (IT) infrastructure needs to keep up with evolving technologies; and (d) lack of regulatory measures and an institutional framework to promote energy efficiency. The industry has noted these challenges, and efficiency practices in data centers are high on the agenda. But it is not enough to simply recognize the need to save energy and improve efficiency; one must quantify key benefits associated with energy efficiency practices and prioritize the actions to achieve them. This quantification has been a key outcome from the collaborative U.S.– India activities since 2009 [4].

This paper outlines preliminary findings from a joint study supported by the United States (U.S.) and India. It presents a review of various global practices to provide data center energy efficiency in their respective countries and beyond. We propose energy efficiency evaluation metrics and application of these global practices to the Indian context. We review existing energy efficiency practices in India and show the key similarities that these measures share with global practices. These preliminary findings will aid next steps to recommend energy efficiency standards and inform policy makers on strategies to adopt energy-efficient technologies and practices in Indian data centers. Both public- and private sector stakeholders in India will review the recommendations from this study and specific recommendations for energy efficiency practices will be proposed following this exercise.

2. METHODOLOGY

Adoption practices and success stories from different countries are the stepping-stone to devising appropriate energy efficiency *guidelines* or *standards* (the terms used interchangeably in our study) for Indian data centers. Our effort focuses on a detailed review of energy efficiency guidelines or standards and assessment of their appropriateness for India. The initial step was to identify existing and relevant global energy efficiency practices for data centers. The following step was to list key evaluation metrics for these energy efficiency practices. Finally, energy efficiency practices were proposed and evaluation metrics were identified for each selected energy efficiency mechanism, to determine its relevancy to the India context.

3. EVALUATION OF GLOBAL ENERGY EFFICIENCY PRACTICES

The following global energy efficiency practices for data centers were reviewed for this study: *Energy Star Rating (U.S.)* [5], *Leadership in Energy and Environment Design (U.S)* [6], *American Society of Heating, Refrigerating and Air-Conditioning Engineers (U.S)* [7], *California Title 24 Standards (U.S)* [8], *National Australian Built Environment Rating System (Australia)* [9], *Green Mark (Singapore)* [10], *Green Building Index (Malaysia)* [11], *Certified Energy Efficient Data Center Audit (U.K)* [12], *Building Research Establishment Environmental Assessment Method (U.K)* [13], *European Code of Conduct* [14], *Blue Angel Eco-Label (Germany)* [15], *and International Standards Organization 50001: 2011 (Europe)* [16]. The following section describes these global practices.

- **ENERGY STAR Rating by Environment Protection Agency (EPA):** The score, expressed as a number on a 1-to-100 scale, such that one point represents 1% of the population. Performance ratings given on a percentile basis.
- **Leadership in Energy and Environmental Design (LEED):** The certification recognizes a best-in-class data center based on the score achieved on a scale of 110 points.
- **American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1:** This standard establishes the minimum energy efficiency requirements of buildings, including Data Centers and Telecommunications Buildings, for design, construction, and a plan for operation and maintenance, as well as utilization of on- or off-site renewable energy resources.
- **California Title 24 Standards:** The standard focuses on key areas to improve the energy efficiency of new data centers, additions, and major alterations to existing data centers.
- **National Australian Built Environment Rating System (NABERS):** This is a tool to measure environmental performance on a scale of 1 to 6 stars. Rating is done across three categories.
- **Green Mark:** This Singapore performance-based rating system awards points for green features, energy efficiency, and best practices.
- **Green Building Index (GBI):** This is derived from existing rating tools, including the Green Mark, but extensively modified for relevance to the Malaysian tropical weather, environmental context, and cultural and social needs.

- **Certified Energy Efficient Datacenter Audit (CEEDA):** This U.K-based award assesses the implementation of energy efficiency best practices within a data center.
- **Building Research Establishment Environmental Assessment for Data Centers (BREAM):** This U.K-based rating, also practiced by Hong Kong, is based on the total score achieved by a data center across ten categories.
- **European Code of Conduct by the European Commission:** This promotes data center energy efficiency by setting targets, understanding of energy demand, raising awareness, and recommending energy-efficient best practices.
- **Blue Angel Eco-Label:** This label may be awarded to any resource-conscious company committed to the implementation of a long-term strategy to improve the energy and resource efficiency of its data center with respect to the IT services to be delivered and conducting regular monitoring to optimize its data center operations.
- **International Organization for Standardization (ISO) 50001 Standard for Energy Management Systems (EMS):** This international standard specifies EMS requirements upon which data centers can develop and implement an energy policy, and establish objectives, targets, and action plans which take into account legal requirements and information related to significant energy use.

Additional practices reviewed include: energy efficiency programmes such as *Building Energy Rating (Ireland)* [17], *Green Star Rating System (Australia)* [18], and *German Sustainable Building Certificate* [19]. Two other important mechanisms to determine resource availability are *Uptime Institute (U.S.)* [20] and *Data Center Star Audit (Germany)* [21]. *The Green Grid* has developed the *Data Center Maturity Model* [22].

All these countries have varied approaches for data center energy efficiency practices. To normalize these global practices against the existing energy efficiency mechanisms in India, we classify them under four broad categories and provide descriptions.

i. *Point-Based (Whole-Building) Ratings*
ii. *Best Practices/Guidelines-Oriented Ratings*
iii. *Comparative-Scale Ratings*
iv. *Performance-Based Relative Benchmarking*

A few basic common characteristics are described to establish the similarities in approach and other basic characteristics between existing energy efficiency mechanisms in India and some of the global energy efficiency methods.

i. Point-Based (Whole-Building) Rating systems reward design excellence through specifications of building components, systems, and processes in a quantifiable fashion by allocating credits or points to achieve different levels of environmental performance. Points are awarded against each of these parameters, and the cumulative sum of these points is categorized to define the level of energy efficiency achieved. These awards are usually time bound and need reassessment after fixed time tenures. Most of them also address other aspects of sustainable design and operation (such as water use, energy and water sources, materials, and indoor environment) in an attempt to achieve a holistic rating for environmental sustainability. Energy efficiency mechanisms that follow this approach are *Leadership in Energy and Environmental Design (LEED), Certified Energy Efficient Data Center Audit (CEEDA), Building Research Establishment Environmental Assessment Method (BREEAM), Green Building Index (GBI),* and *Green Mark.*

ii. Best Practices/Guidelines-Oriented Ratings define energy efficiency targets, which must be achieved through a defined action plan, based on the guidelines defined in the policy document. The successful achievement of these targets leads to the certification of the data center as an "Energy Efficient Data Center." Standards/Policies based on this approach are the *European Code of Conduct, ISO 50001,* and *Blue Angel Eco-Label*.

iii. Comparative-Scale Ratings emphasize a relative rating system, wherein a peer group of buildings with similar characteristics and services are defined, and the rating is awarded based on a relative percentile. Energy efficiency data center mechanisms based on this rating are the *ENERGY STAR* rating and the *National Australian Built Environment Rating System (NABERS)*.

iv. Performance-Based Relative Benchmarking focuses on energy efficiency related to building envelope; heating, ventilation, and air-conditioning (HVAC); lighting; water; gas; etc. It offers compliance through a prescriptive whole-building performance method using a simulation model to assess energy performance. Standards based on this approach include American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 and California Title 24 standards. The standard ASHRAE 90.4, *Energy Standard for Data Centers and Telecommunication Buildings*, is proposed and under review.

Most of the short-listed energy efficiency data center practices have adopted *Power Usage Effectiveness (PUE)* and *Data Center Infrastructure Efficiency (DCiE)*, introduced by The Green Grid [23], as an evaluation metric or criteria to rate data center energy efficiency. While PUE is the ratio of a facility's total power drawn to the amount of power used solely by the data center's IT equipment, DCiE is its inverse. The PUE and DCiE gauge the efficiency of a data center by focusing mostly on the support infrastructure (e.g., cooling).

4. EVALUATION AND METRICS FOR ENERGY EFFICIENCY PRACTICES

Evaluation metrics for energy efficiency are the instruments used to accurately capture the efficiency of a data center or its components. Evaluation metrics can be used to capture unique requirements for the Indian data centers. For e.g., data centers in India operate in hot and humid weather, and poor outdoor air quality conditions with less opportunity for water and airside free cooling technologies. Poor power quality and reliability also leads to increased use of power systems and backups. Many such metrics have evolved over the years to simplify the evaluation procedure and increase the efficiency of data capture for calculations. Attempts have been made to categorize and summarize the evaluation metrics. The evaluation metrics have been grouped into two categories: (a) ***Basic Metrics:*** *Cooling System Efficiency (CSE), Airflow Efficiency (AE), Cooling System Sizing (CSS), Air Economizer Utilization (AEU), Water Economizer Utilization (WEU), Data Center Infrastructure Efficiency (DCiE)* [23], *Power Usage Effectiveness (PUE)* [24] [23] [25] [26], *HVAC Effectiveness, Data Center Energy Productivity (DCeP)* [27] [23], and *Space, Watts and Performance (SWaP),* and (b) ***Extended Metrics:*** *Storage Utilization (Storage-U), Network Utilization (Network-U), and Server Utilization (Server-U)* [28]. The basic metrics define the level of efficiency of a data center and extended metrics are defined as functions of basic metrics that give an in-depth efficiency practices. There are many other metrics used around the world, typically to characterize sub-systems. For example, for infrastructure, cooling plant overall and component efficiencies, power distribution efficiency, and fan-specific power are used. For IT, utilization, virtualization, and power management are used. Several such metrics are covered in [26] and [27]. Others include: *Data Center Energy Efficiency and Productivity (DC-EEP)* [29], *Carbon* [27] [26], *Water Usage Effectiveness (Site) (WUE)* [30], and *Electronics Disposal Efficiency (EDE)* [31]. These evaluation metrics are also defined as "Green Performance Indicators" (GPIs) to assess a data center's environmental performance; in particular energy, greenhouse gas emissions, and resource efficiency. Further, the GPIs or metrics are classified as Data Center Level GPIs, SI system Level GPIs, IT system Level GPIs, and IT Benchmarks [32]. Among the standards/policies considered in this paper, seven standards/policies use PUE to provide a scoring or rating. The Green Mark rating system has benchmarked PUE in the range of 2.2–1.5 for existing data centers and 2.0–1.4 for new constructions. Malaysia's Green Building Index rating system [11] has benchmarked PUE in the range of 1.3–1.9. The PUE metric drives the need to minimize power used by anything other than IT. However, there are concerns that the metric does not consider the actual productivity or efficiency of the IT equipment [23]. Metrics that evaluate energy use by the generation sources are, Energy Reuse Effectiveness (ERE) and Green Energy Coefficient (GEC). The ERE [33] quantifies the amount of energy reused outside of the data center, and GEC looks at the amount of renewable energy used. SI-EER is similar to PUE. The DCeP is the ratio of work produced in the data center to the energy used in producing it [34].

5. OPPORTUNITIES FOR INDIA

With the introduction of the Energy Conservation Act 2001, the Government of India (GOI) started the efforts to institutionalize and mainstream energy efficiency, starting with the formation of the Bureau of Energy Efficiency (BEE) under the Ministry of Power. There are no dedicated energy efficiency data center standards/policies in India. However, there are a few mechanisms available for rating the energy efficiency of buildings (such as the *Indian Green Building Council* [35], *Energy Conservation Building Code (ECBC)* [36], *Star Rating – Standards and Labeling* [37], *Green Rating for*

Integrated Habitat Assessment [38], and Star Rating for equipment. Additionally the Perform, Achieve and Trade (PAT) scheme of the GOI assigns mandatory emission reduction targets for the high energy-consuming industries, known as *Designated Consumers* [39]. Due to the page limit for this paper, Appendix A summarizes these energy efficiency initiatives, including the assessment criteria, compliance criteria, and award criteria.

These identified energy efficiency programmes have also been categorized across each of the four categories mentioned above in Section 3. This categorization shows that although India has no standards or policies specifically for energy efficiency in Indian data centers, it does have overall energy efficiency mechanisms that share a similar approach and the basic characteristics as some of the international standards/policies. The IGBC Rating System is based on a framework similar to other international point-based rating systems (e.g., LEED, BREEAM, GBI, Green Mark), which evaluates building performance against set criteria and points are assigned accordingly. Star Labeling of buildings by the BEE demonstrates certain similarities with the EPA ENERGY STAR rating scheme in terms of evaluation of energy performance. It is based on actual performance (metered data), and it provides a peer-group-based comparison (applicable to offices, hotels, retail malls, IT parks, and hospitals) that accounts operational characteristics of the building such as climatic zone, hours of operation, etc. It also provides a simple metric to evaluate energy performance of the building—i.e., Energy Performance Index (EPI). ECBC by BEE follows the same structure as the ASHRAE 90.1 standard and California T-24, and it covers building envelope, HVAC, service hot water and pumping, lighting, electric power, etc. Similar to ASHRAE 90.1 and California Title 24, there are three compliance options: Prescriptive, Trade-Off, and Whole-Building Performance Method. Due to the page limit for this paper, Appendix B compares the key characteristics of global energy efficiency practices with the Indian standards.

6. CONCLUSIONS AND NEXT STEPS

Enhancing energy efficiency through standards has been recognized as an appropriate strategy to reduce energy consumption in Indian data centers. Though India has well-established energy efficiency standards and practices in its non-data center sectors—commercial and industrial facilities—there are no dedicated standards for data centers. In this context, the review of global practices can aid the development of a “composite policy structure” for data center energy efficiency and help leapfrog India to embrace the concept of “Green IT” for sustained growth. This study established that existing energy efficiency programmes in India share certain similarities with some of the international policies/mechanisms reviewed in this study. The new policy framework for data centers can be a blend of existing energy efficiency programmes rather than a single mechanism to encompass the holistic rating of data centers in India. Indian policy makers can use the review of global practices to develop energy efficiency standards/guidelines specific to the Indian data centers and not reinvent the wheel.

Due to the necessity to engage both public- and private sector stakeholders when determining sustainability practices for the Indian context, specific recommendations will follow this process. The next steps includes consultative discussions with relevant public-private stakeholders in India, a survey capturing the views of various categories of data center stakeholders—technology providers, data center owners, hosting providers, policy makers, and academic and industry experts—on different energy efficiency practices, metrics, and technologies. The collaboration between the U.S. and India should lead to the formulation and implementation of a robust and impactful energy efficiency policy for the Indian data centers.

7. ACKNOWLEDGMENTS

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Appendix A: Assessment and Certification Criteria of India's Energy Efficiency Practices

EXISTING STANDARDS	ASSESSMENT and CERTIFICATION CRITERIA
Indian Green Building Council (IGBC) Green Rating System	This tool enables the designer to apply green concepts and criteria, so as to reduce the environmental impacts, which are measurable. **Assessment Criteria:** The assessment is carried out through certain credit points using a prescriptive approach and other credits on a performance-based approach. The credit points are awarded for the following parameters: Site Preservation and Restoration (16 Points), Site Planning and Design (25 Points), Water Efficiency (15 Points), Energy Efficiency (30 Points), Materials and Resources (10 Points), and Innovation and Design (4 Points). **Award Criteria:** The certifications received are Certified (51–60), Silver (61–70), Gold (71–80), and Platinum (81–100).
Energy Conservation Building Code (ECBC) by the Bureau of Energy Efficiency (BEE)	The ECBC by the Indian Bureau of Energy Efficiency aims to provide minimum requirements for energy-efficient design and construction of buildings and their systems. ECBC encourages energy-efficient design or retrofit of buildings so that it does not constrain the building function, comfort, health, or the productivity of the occupants, and has appropriate regard for economic considerations. **Assessment Criteria:** ECBC follows the same structure as the ASHRAE 90.1 standard and covers the following areas: Building Envelope, HVAC, Service Hot Water and Pumping, Lighting, Electric Power, and more. The code allows a Prescriptive path or Simulated (baseline building) Calculation to show compliance. **Compliance Criteria:** Energy performance is regulated through prescriptive requirements for the thermal envelope and performance requirements for HVAC, hot water and pumping, lighting, and auxiliary systems.
GRIHA – Green Rating for Integrated Habitat Assessment National Green Building Rating System	GRIHA is a guiding and performance-oriented system where points are earned for meeting the design and performance intent of the criteria. Each criterion has a number of points assigned to it, and a maximum of 100 points can be achieved regarding the building's environmental performance in each category. **Assessment Criteria:** The rating is given on the basis of the total score achieved by the building across 34 criteria categorized under various sections such as Site Selection and Site Planning, Conservation and Efficient Utilization of Resources, Building Operation and Maintenance, and Innovation points. Eight of these 34 criteria are mandatory; four are partly mandatory; the rest are optional. **Award Criteria:** 1 star: 50–60 points; 2 stars: 61–70 points; 3 stars: 71–80 points; 4 stars: 81–90 points; 5 stars: 91–100 points.
Perform, Achieve and Trade (PAT) by Bureau of Energy Efficiency (BEE)	PAT is a market-based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy-intensive large industries and facilities, through certification of energy savings that could be traded. **Assessment Criteria:** The scheme imposes mandatory Specific Energy Consumption (SEC) targets on the covered facilities with less-energy-efficient facilities having a greater reduction target than the more-energy-efficient ones. A facility's baseline is determined by its historic specific energy consumption. **Compliance Criteria:** Facilities making greater reductions than their targets receive "EsCerts" or "energy saving certificates" which can be traded with facilities that have trouble meeting their targets. Facilities can also bank them for future use.
Standards and Labeling Program by Bureau of Energy Efficiency (BEE)	The Objectives of Standards and Labelling Program is to provide the consumer an informed choice about the energy-saving and thereby the cost-saving potential of the marketed energy-consuming equipment. **Assessment Criteria:** The amount of electricity consumed per unit amount of appropriate service delivered by the equipment over a period of time. **Award Criteria:** The energy performance of the equipment is rated on a 1- to 5-star scale. A higher star rating means better energy efficiency.
Star Rating for Buildings by Bureau of Energy Efficiency	This standard is based on the actual performance of a building in terms of its specific energy usage in kWh/m^2/year. Buildings have been categorized into two categories: (1) having air-conditioned area greater than 50% of built up area or (2) less than 50% of built-up area. **Assessment Criteria:** Rating is given on the basis of Energy Performance Index (EPI) in kWh/m^2/year. Only those buildings having a connected load of 100 kW and above are considered for assessment. **Award Criteria:** This programme rates office buildings on a 1- to 5-star scale, with 5-star labelled buildings being the most efficient.

Appendix B: Comparing Global Practices With Indian Standards

<table>
<tr><th colspan="4">POINT-BASED (WHOLE BUILDING) RATING APPROACH</th></tr>
<tr><th>COUNTRY</th><th>STANDARD</th><th>BROAD KEY CHARACTERISTICS</th><th>CURRENT INDIAN STANDARDS</th></tr>
<tr><td>USA</td><td>LEED (Leadership in Energy and Environmental Design) for Data Centers</td><td rowspan="4">1. Point-based rating process usually considers energy and environmental performance criteria. It highly emphasizes energy efficiency but also considers other factors such as environment, reliability, water efficiency, etc.
2. Each section includes credit points for a set of minimum requirements, which are mandatory.
3. This type of rating is mostly applicable to all data centers.
4. The assessment identifies the specific energy-efficient and environment-friendly features and practices that have been incorporated in the projects.
5. Additional innovation points are awarded for incorporating environment-friendly features, which are better than normal practices.
6. The rating achieved for a facility in its design phase may not be reflected in its actual performance.
7. In a point-based rating system, an applicant seeking a certification is more concerned about scoring higher points than actually improving building performance.
8. Though it gives more weight to energy efficiency, it does not focus on specific technologies, which impact overall efficiency.
9. It focuses only on reducing the environmental effects of the building and does not consider criticality of operation/performance of data centers.</td><td rowspan="4">1. The BEE Star Rating for Office Buildings determines the Energy Performance Index (EPI) but it only focuses on $kWh/m^2/year$.
2. The Indian Green Building Council (IGBC) Green SEZ Rating System is based on a framework similar to other point-based rating systems addressing various important factors such as sustainable sites, water efficiency, energy efficiency, materials resources, innovation, and design.</td></tr>
<tr><td>UK</td><td>BREAM (Building Research Establishment Environmental Assessment) For Data Centers</td></tr>
<tr><td>Malaysia</td><td>Green Building Index (GBI) for Data Centers</td></tr>
<tr><td>Singapore</td><td>Green Mark for Data Centers</td></tr>
<tr><th colspan="4">BEST PRACTICES/GUIDELINES-ORIENTED APPROACH</th></tr>
<tr><th>COUNTRY</th><th>STANDARD</th><th>BROAD KEY CHARACTERISTICS</th><th>CURRENT INDIAN STANDARDS</th></tr>
<tr><td>GLOBAL STANDARD (Across 44 ISO member countries)</td><td>IS/ ISO 50001 Standard: Energy Management Systems</td><td rowspan="3">1. Key performance parameters such as DCiE, IT Productivity, and Total Data Center Energy Consumption are the basis on which energy efficiency is measured for any data center.
2. Percentage targets for yearly energy efficiency improvements (which are voluntary) are set, depending on type and services of the data centers.
3. It involves a continual improvement process through an energy management program.
4. It includes assessment and implementation of best practices and new technologies.
5. In most cases it involves third-party validation and certification.
6. This type of approach offers too much of flexibility to data center owners/operators in terms of setting their own targets for improving energy efficiency.
7. Being a purely voluntary programme, there are no penalties incurred if compliance with these standards are not achieved, and resignation from the programme is permitted at any time.</td><td rowspan="3">The Perform, Achieve, and Trade (PAT) Mechanism, an initiative by BEE to improve energy efficiency of energy-intensive industries in India, shares some similarities with this approach. Energy-saving targets (mandatory) and subsequently the compliance period to achieve the targets are set on the basis of specific energy consumption for any industry. A third party authorized by BEE conducts the validation. Non-compliance to the given targets will attract penalties.</td></tr>
<tr><td rowspan="2">Europe</td><td>European Code of Conduct by The European Commission for Data Centers</td></tr>
<tr><td>The Blue Angel eco-label for Data Centers - Germany</td></tr>
</table>

PERFORMANCE-BASED RELATIVE BENCHMARKING APPROACH			
COUNTRY	**STANDARD**	**KEY CHARACTERISTICS**	**CURRENT INDIAN STANDARDS**
USA	**California T-24: Building Energy Efficiency Standards for Data Centers**	1. Provides flexibility in choosing a compliance method: Prescriptive, Trade-Off, Performance or Energy Cost Budgeting Method. 2. After fulfillment of the minimum requirements, in some sections (e.g., HVAC, Infrastructure Designing, etc.), excess credit points may be extended to the other sections to achieve a trade-off to achieve an overall rating/compliance. 3. These standards focus on energy efficiency related to building HVAC, lighting, water, etc., and do not consider energy efficiency of equipment in the facility (e.g., energy-efficient IT technologies in data centers).	The **Energy Conservation Building Code** by BEE follows a similar structure as the ASHRAE 90.1 standard and covers the following areas: building envelope, HVAC, service hot water and pumping, lighting, electric power, etc. Similar to **ASHRAE 90.1 and California T-24** there are three compliance options: **Prescriptive, Trade-Off and Whole-Building Performance Method.**
	ASHRAE-90.1 for Data Centers		

COMPARATIVE SCALE RATING APPROACH			
COUNTRY	**STANDARD**	**KEY CHARACTERISTICS**	**CURRENT INDIAN STANDARDS**
USA	**ENERGY STAR Rating for Data Centers by the U.S. Environmental Protection Agency (EPA)**	1. The EPA star rating allow users to compare the energy performance of one data center with others and also enables them to compare energy performance with the national average. (The peer group used for comparison is identified through nationally representative survey data.) 2. It is based on "actual as-billed" energy data. 3. It involves tracking, measurement, and improving energy consumption on a regular basis. 4. Unit of analysis is being carried out in terms of (Total Energy / IT Energy). It measures infrastructure efficiency (i.e., it captures impact of cooling and support systems but does not capture IT equipment efficiency). 5. This certification process requires data for 11 months of continuous operation of the facility before the rating can be evaluated. 6. The rating determines the rank of a data center in its peer group of data centers, which essentially does not reflect the implementation of best practices and new energy-efficient technologies in that data center.	**Star Labeling of Buildings** by BEE demonstrates following similarities to this standard: 1. Evaluation of energy performance of a building is based on **Actual Performance** in terms of specific energy use (kWh/m^2/year) 2. Provides **Peer Group-Based Energy Performance Comparison Mechanism** (applicable to offices, hotels, retail malls, IT parks, and hospitals). 3. Accounts for **Operational Characteristics** of the building (e.g., climatic zone, hours of operation). 4. Provides a simple metric to evaluate energy performance of the building (i.e., **Energy Performance Index (EPI)** measured in kWh/m^2/year).
AUSTRALIA	**National Australian Built Environment Rating System (NABERS) for Data Centers**	1. It offers the ability to separately rate the building infrastructure, whole building, and tenancy of a data center and gives flexibility to the applicants to choose rating for any one of the three in form of an Infrastructure Rating, IT Equipment Rating, and Whole Facility Rating. 2. It measures actual performance of the data center as it uses metered data of actual energy consumption. 3. The number of stars is calculated by benchmarking the energy consumption and by comparing it against a list of data centers with similar attributes. 4. It requires 12 months of building operation before the rating can be evaluated.	

DISCLAIMER