



**U.S.- India Joint
Center for Building Energy Research and Development
(CBERD)**

**Goals and Use cases for Indian Benchmarking
Program**

29 June, 2013

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Acknowledgements

The U.S. Department of Energy (DOE) and the Department of Science and Technology (DST), Government of India (GOI) provided joint funding for work under the U.S.–India Partnership to Advance Clean Energy Research (PACE-R) program’s “U.S.–India Joint Center for Building Energy Research and Development” (CBERD) project. The Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State and Community Programs, of the U.S. DOE under Contract No. DE-AC02-05CH11231 supports the U.S. CBERD activity. The DST, GOI, administered by Indo-U.S. Science and Technology Forum, supports the Indian CBERD activity.

The authors acknowledge the assistance and thank all the reviewers, in particular, Mr. Lalit Joshi, Senior Project Engineer CBERD, from MNIT Jaipur, Rajasthan for their advice and continued support.

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**Goals and Use cases for
Indian Benchmarking Program
Q3-M
CBERD : Benchmarking and Monitoring Subtask
29th June' 2013**

Contents	
I. Benchmarking of Commercial Buildings in India	
A. Vision & Goals	
B. Use Cases for Indian Benchmarking Program	
1. Users	
2. Use Cases : Building level System level Portfolio level	
3. Methodology	
4. Summary	
C. Scope & Limitations	
1. Building Types and Subtypes	
2. Challenges and Limitations	
Contents	2

Contents	
I. Benchmarking of Commercial Buildings in India	
A. Vision & Goals	
B. Use Cases for Indian Benchmarking Program	
1. Users	
2. Use Cases : Building level System level Portfolio level	
3. Methodology	
4. Summary	
C. Scope & Limitations	
1. Building Types and Subtypes	
2. Challenges and Limitations	
Contents	3

A. Vision & Goals	
Vision:	
An integrated suite of methods, tools and practices for 'Actionable energy information' to	
a. Prompt energy saving options in design and operation	
b. Rate energy efficiency	
c. Create energy awareness	
d. Inform policy change	
in commercial buildings in a manner that is	
a. Contextually appropriate:	
• Technical environment (design and operation of buildings, indoor air quality, degree of space conditioning), Business model, Policy environment, Geography, Economics, Culture	
b. Market relevant:	
• Interpretation and ease of use, Commercial benefits, Means to claims incentives, Recognition, Documentation, Transparency, Customizability, Graduated approach, Credibility	
c. Technically appropriate:	
• Defensible, Accurate and Rigorous	
Benchmarking : Vision & Goals	4

A. Vision & Goals	
<p>Goals:</p> <ul style="list-style-type: none"> a. Expand and improve the existing whole building benchmarking b. Create building asset and operational benchmarking c. Establish system level metrics and benchmarks 	
Benchmarking : Vision & Goals	5

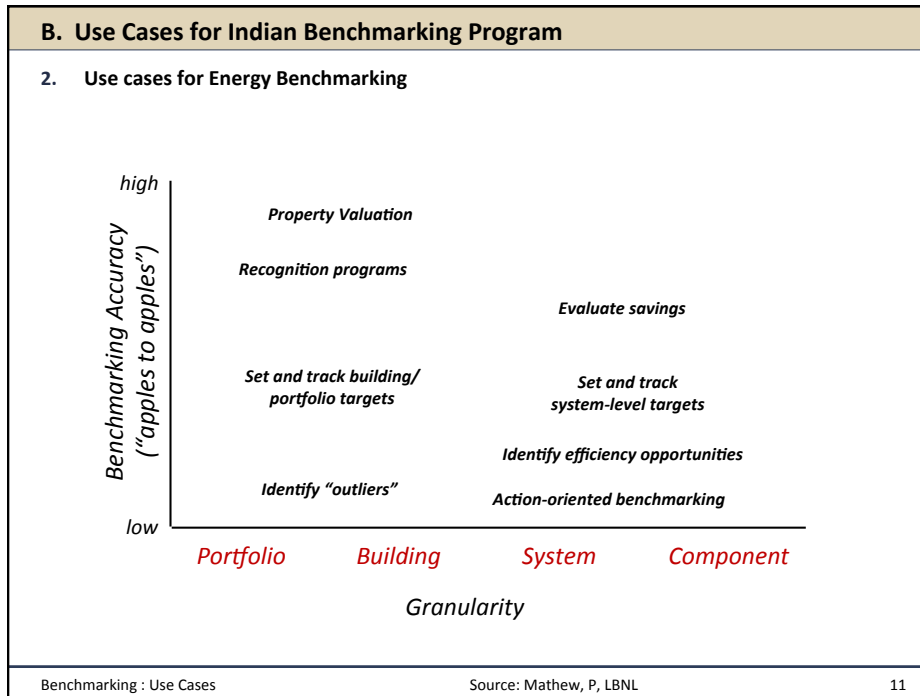
A. Vision & Goals	
<p>Goals:</p> <ul style="list-style-type: none"> a. Expand and improve the existing whole building benchmarking <ul style="list-style-type: none"> • Expand building types <ul style="list-style-type: none"> – Office, Hotels, Hospitals, Retail (given data availability) • Improve methodology <ul style="list-style-type: none"> – Explore alternate approaches, Regression diagnostics, Confidence bands, Subtypes treatment and Special use adjustment, Data definitions and adjustments, Level of service, Data quality and Missing data, Graduated approach • Collect data <ul style="list-style-type: none"> – Create template based on graduated approach, Data definitions, Sub type identification, Quality, Sampling, .. • Create an improved whole building benchmarking model and tool prototype 	
Benchmarking : Vision & Goals	6

A. Vision & Goals	
Goals:	
b. Create building asset and operational benchmarking	
<ul style="list-style-type: none"> • Identifying key asset and operational parameters • Explore appropriate methodology. Some potential methods include: <ul style="list-style-type: none"> – DOE's Asset Rating Tool / ASHRAE BEQ / EcoNirman – Simulation / Parametric – Empirical / Modifier approach / Decomposition – Technical: Expert opinion based – Hybrid • Identify key data requirements, Collect data • Create a model for asset and operational rating program 	
Benchmarking : Vision & Goals	7

A. Vision & Goals	
Goals:	
c. Establish system level metrics and benchmarks (Action oriented benchmarking)	
<ul style="list-style-type: none"> • Identify the potential areas for improvement & define a list of system level metrics • Assess methodology options: <ul style="list-style-type: none"> – Actual measurement – Simulation – Expert opinion – Hybrid • Rate / Evaluate system performance <ul style="list-style-type: none"> – Develop effective way to obtain data for system level benchmarks • Create a model for system level benchmarks 	
Benchmarking : Vision & Goals	8

Contents
<p>I. Benchmarking of Commercial Buildings in India</p> <p>A. Vision & Goals</p> <p>B. Use Cases for Indian Benchmarking Program</p> <ol style="list-style-type: none"> 1. Users 2. Use Cases : Building level System level Portfolio level 3. Methodology 4. Summary <p>C. Scope & Limitations</p> <ol style="list-style-type: none"> 1. Building Types and Subtypes 2. Challenges and Limitations
Contents

B. Use Cases for Indian Benchmarking Program
<p>1. Users</p> <ul style="list-style-type: none"> • Architects and Engineers • Owner and Developer • Facilities Manager/Operator • Portfolio/Enterprise Resource Manager • Financier and Appraiser • Energy Auditor and Service Provider • Green Rating Systems • Utility and Service Provider • Government and Local bodies
Benchmarking : Use Cases
10



B. Use Cases for Indian Benchmarking Program

2. Use Cases (Building Level)

Use Cases	Key Performance Indicators
Screen buildings based on overall Energy Efficiency	- total site/source Energy Performance Intensity (EPI)
Rate/label overall building EE	- overall score - total site/source EPI
Evaluate building asset EE	- asset score - total EPI with normalized options
Evaluate building operations EE	- operations score
Set and track overall building EE targets	- total site/source EPI
Evaluate demand response potential	- annual Peak W/m ² - seasonal Peak W/m ²

Benchmarking : Use Cases 12

B. Use Cases for Indian Benchmarking Program

2. Use Cases (Building Level): Technical Metrics

Whole Building Metrics	Units
Annual Energy Consumption, EPI	KWh/ m ² .a
Plug Energy Use	W/ m ²
Annual Energy Consumption/FTE occupant	kWh/a/person

Benchmarking : Use Cases 13

B. Use Cases for Indian Benchmarking Program

2. Use Cases (System Level)

Action Oriented Benchmarking: A hierarchy of metrics can help identify potential actions

Example of system level benchmarking

Site kWh/sq.m-yr -----> Overall potential for building-wide energy efficiency

Ventilation kWh/sq.m-yr -----> Potential for energy efficiency in ventilation system

Air change (l/s)/sq.m -----> Potential to reduce energy use through operational practices e.g. by optimizing ventilation rates

Vent. Efficiency W/(l/s) -----> Potential to reduce energy use through ventilation system efficiency improvements

Fan Efficiency % -----> Potential to improve fan efficiency

Pressure drop Pa -----> Potential to reduce system pressure drop

Fume hood density -----> Impact of fume hoods on ventilation energy use

Sash Closure ratio -----> Effectiveness of VAV fume hood sash management

Cooling kW/ton

Benchmarking : Use Cases 14

Source: Mathews, P, LBNL

B. Use Cases for Indian Benchmarking Program

2. Use Cases (System Level)

Use cases	Key Performance Indicators
Set and track system level EE targets	- system EPI (e.g. kWh/m ²) - system efficiency (e.g. kW/ton)
Identify potential EE measures	- N/A
Assess potential savings from EE measures	- savings % - savings EPI
Cross-check results from engineering models	- total site/source EPI - system EPI (e.g. kWh/m ²) - system efficiency (e.g. kW/ton)

B. Use Cases for Indian Benchmarking Program

2. Use Cases (System Level): Technical Metrics

HVAC Metrics	Units
HVAC Annual Energy Consumption	kWh/m ² .a
HVAC Peak	W/m ²
Chiller Plant Peak	kW/TR*
Cooling Load (Building) Efficiency	m ² /TR

Lighting Metrics	
Lighting Annual Energy Consumption	kWh/m ² .a
Lighting Peak Energy Use	W/m ²

Plug Metrics (includes UPS and Raw Power)	
Plug Annual Energy Consumption	kWh/ m ² .a
Plug Peak Load	W/ m ²

B. Use Cases for Indian Benchmarking Program	
2. Use Cases (System Level): Technical Metrics	
Internal Lighting Metrics	Units
Lighting Annual Energy Consumption	kWh / m ² .a
Lighting Peak Load Use (Installed, Operational)	W / m ²
Plug and Process Metrics (includes UPS & Raw Power)	
Plug Annual Energy Consumption	KWh / m ² .a
Plug Peak Load (Operational)	W / m ²
Benchmarking : Use Cases	
17	

B. Use Cases for Indian Benchmarking Program	
2. Use Cases (Portfolio Level)	
Use cases	Key Performance Indicators
Track EE trends in building stock. Influence performance-based codes	- stock site/source EUI
Set and track portfolio EE targets	- portfolio site/source EUI
Benchmarking : Use Cases	
18	

B. Use Cases for Indian Benchmarking Program	
3. Methodology	
a. Peer comparison using simple filtering of dataset	
b. Peer comparison using multi- variate regression model	
c. Comparison to model-based technical benchmarks	
d. Comparison to expert-based technical benchmarks	
e. Nested regression models	
f. Features-based benchmarking	
Benchmarking : Use Cases	19

B. Use Cases for Indian Benchmarking Program				
4. Summary				
Priority	Use cases	Granularity	Key Performance Indicators	Methodology options/ considerations
**	Screen buildings based on overall EE	Building	- total site/source EUI	A: Peer comparison using simple filtering of dataset B: Peer comparison using multi- variate regression model (<i>optional</i>)
****	Rate/label overall building EE	Building	- overall score - total site/source EUI	B: Peer comparison using multi- variate regression model C: Comparison to model-based technical benchmarks
****	Evaluate building asset EE	Building	- asset score - total EUI w/ normalized ops	C: Comparison to model-based technical benchmarks F: Features-based benchmarking (<i>optional</i>)
****	Evaluate building operations EE	Building	- operations score	X: TBD
*	Set and track overall building EE targets	Building	- total site/source EUI	B: Peer comparison using multi-variate regression model C: Comparison to model-based technical benchmarks
*	Evaluate demand response potential	Building	- annual Peak W/m2 - seasonal Peak W/m2	A: Peer comparison using simple filtering of dataset
****	Set and track system level EE targets	System	- system EUI (e.g. kWh/m2) - system efficiency (e.g. kW/ton)	C: Comparison to model-based technical benchmarks D: Comparison to expert-based technical benchmarks E: Nested regression models
****	Identify potential EE measures	System	N/A	C: Comparison to model-based technical benchmarks F: Features-based benchmarking
*	Assess potential savings from EE measures	System	- savings % - savings EUI	C: Comparison to model-based technical benchmarks
****	Cross-check results from engineering models	Building System	- total site/source EUI - system EUI (e.g. kWh/m2) - system efficiency (e.g. kW/ton)	A: Peer comparison using simple filtering of dataset B: Peer comparison using multi- variate regression model E: Nested regression models
****	Track EE trends in building stock. Influence performance-based codes	Portfolio	- stock site/source EUI	A: Peer comparison using simple filtering of dataset B: Peer comparison using multi- variate regression model
**	Set and track portfolio EE targets	Portfolio	- portfolio site/source EUI	B: Peer comparison using multi- variate regression model C: Comparison to model-based technical benchmarks
Benchmarking : Use Cases				20

B. Use Cases for Indian Benchmarking Program				
4. Summary				
Priority	Use cases	Granularity	Current state of the art	New developments needed
**	Screen buildings based on overall EE	Building	A: Well established. Tool available for a few building types. B: Basic methodology is well established.	A: Collect new data and cover more bldg types. B: Identifying significant variables and developing more robust models. May require additional parameters and more buildings.
****	Rate/label overall building EE	Building	B: See #1. C: Limited use for benchmarking (e.g. UK), but modeling is well established.	B: see #1 C: Will need detailed data on a few buildings to calibrate the scale. Normalization could be via simulation model or pre-calculated factors.
****	Evaluate building asset EE	Building	C: Prototype tool developed in US (DOE asset score). Some EU benchmarks have developed method? F: Not developed for benchmarking	C: Define asset and operational variables; Assess methodology used in US and adaptation or further development needed for India. F: First need to explore feasibility of this approach.
****	Evaluate building operations EE	Building	Not developed	Explore methods
*	Set and track overall building EE targets	Building	C: Generally not done using benchmarking. F: Implicitly covered in some audit tools.	C: Develop model-based approach for system level benchmarks; Need to collect limited measured audit-type data to calibrate models. F: Adapt existing audit tools methods.
*	Evaluate demand response potential	Building	C: Generally not done using benchmarking	C: See #5; Need to assess robustness of benchmark based savings calc to conventional parametric simulation.
****	Set and track system level EE targets	System	B: See #2 and C: See #2	B: see #2 and C: see #2
****	Identify potential EE measures	System	C: See #5 D: Generally not done using benchmarking E: Not developed	C: See #5 D: Need to adapt expert system methods and list of experts. E: Need to develop methods
*	Assess potential savings from EE measures	System	See #7	See #7
****	Cross-check results from engineering models	Building System	A: See Energy IQ and high tech benchmarks B : E: See #8	A: Need to expand system metrics and building types B,E: See #8
****	Track EE trends in building stock. Influence performance-based codes	Portfolio	A: Unclear if benchmarking has been used	A: need to collect demand data; need definitions for seasonal peaks
**	Set and track portfolio EE targets	Portfolio	A, B: Several tools using CBECS, RECS, etc.	A, B: See #1
Benchmarking : Use Cases				21

Contents	
I. Benchmarking of Commercial Buildings in India	
A. Vision & Goals	
B. Use Cases for Indian Benchmarking Program	
1. Users	
2. Use Cases : Building level System level Portfolio level	
3. Methodology	
4. Summary	
C. Scope & Limitations	
1. Building Types and Subtypes	
2. Challenges and Limitations	
Contents	
22	

C. Scope & Limitations					
1. Building Types & Subtypes					
Included sub-types	Use	Office	Hospital	Hotels	Retail
		Administrative/professional office	One Specialty	Resort / Heritage	Single store
		Bank/other financial	Multi specialty	Business	Mall
		Government office			
		Other office			
		Software Development			
		Assorted/Multi-tenant			
	Users	single organization			
		multi organization			
	Level of service	Class A	NABH accreditation	5 star	
		Class B		4 star	
		Class C		3 star	
				1 and 2 star	
	Ownership	Owned	Government	Owned	Owned
		Leased	Private	Leased	Leased
	Operator	Single	Single		Single
		Multiple	Multiple		Multiple
Inclusion criteria			In patient		
Excluded sub-types			Clinics		Strip Malls
Special use		Data centers / MSC	Cafeteria	In house laundry	Refrigeration
			In house laundry	Restaurant	Electronics
				Heated swimming pool	Multiplex
				Conference facility	Restaurants
Benchmarking : Scope & Limitations					23

B. Use Cases for Indian Benchmarking Program	
Building Type Specific Metrics	
Hotels	Units
Annual energy use intensity	kWh / room or room nights
Hot water energy use intensity	kWh/..
Hospitals	
Annual energy use intensity	kWh / bed
Hot water / Steam energy use intensity	kWh /..
Offices	
Annual energy use intensity	FTE - hr, / m ² - hr
Retail	
Annual energy use intensity	kWh / m ² -hr
Benchmarking : Scope & Limitations	
24	

C. Scope & Limitations	
2. Challenges & Limitations to arrive at credible benchmarks	
a. Indoor Environment Quality	
b. Level of service	
c. Definition of area (built up, super built-up, service areas.)	
d. Occupancy schedules: Weekend occupancy / Part occupancy	
e. Multi use (related) building: e.g. Hospital may have medical facilities + College and Hostel, etc.	
f. Multi use (unrelated) buildings: e.g. Retail + Office	
g. Multi tenant building	
h. Impact of city: Tier, Climate	
i. Special use allowances: Outsourced services, extra amenities, parking	
Benchmarking : Scope & Limitations	25