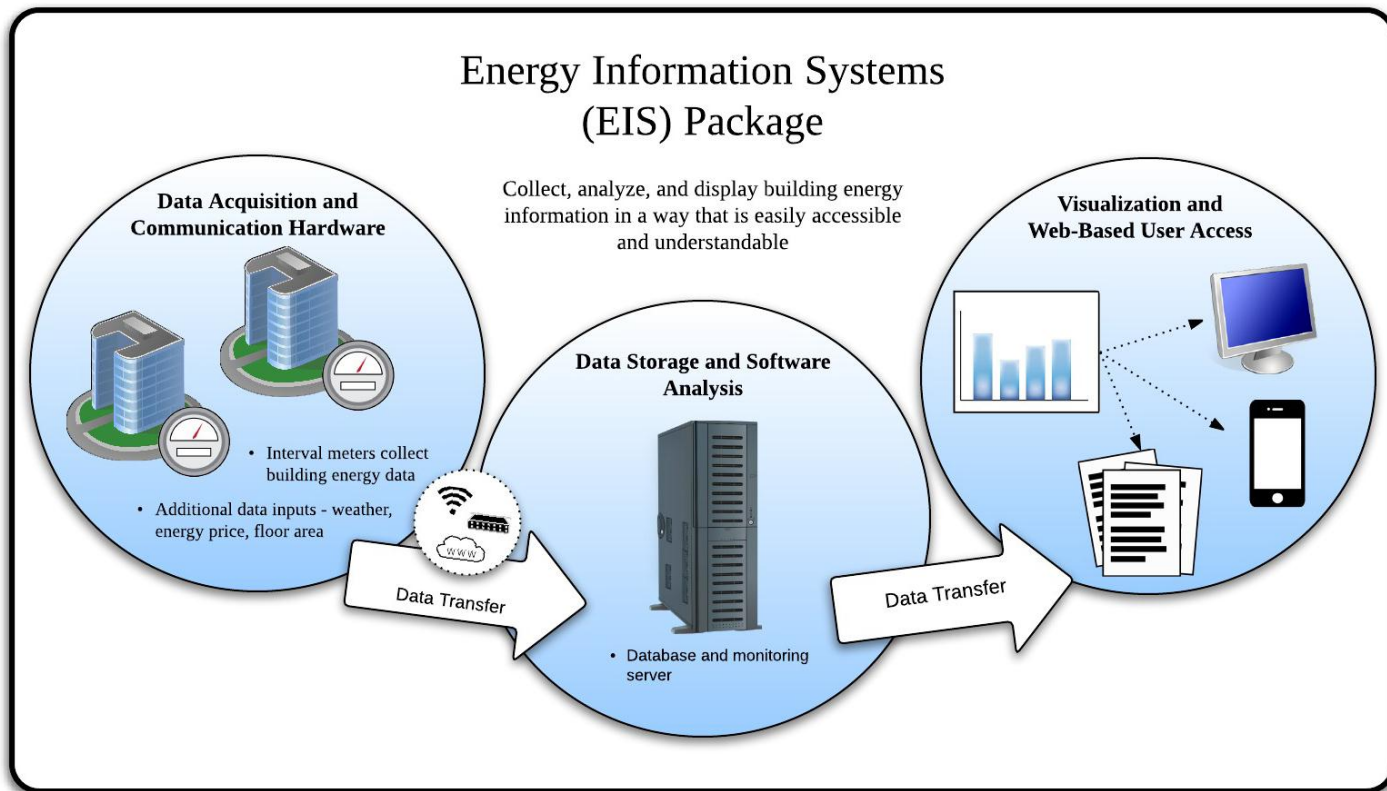


# US-India Center for Building Energy R&D (CBERD) Monitoring and Benchmarking

2015 Building Technologies Office Peer Review



# Project Summary

## Timeline:

Start date: Oct 2012; Planned end date: Sep 2017

## Key Milestones

1. Technical specifications for cost-effective Energy Information Systems packages for hotels and hospitals. (Sep 2015)
2. New techniques to increase flexibility and applicability of whole-building benchmarking needs. (Sep 2015)

## Budget:

Total DOE \$ to date: \$450 K ( FY'13 through FY'15)

Total future DOE \$: \$300 K (FY'16-FY'17)

## Target Market/Audience: Commercial Buildings

- EIS vendors
- Building owners and operators
- Benchmarking programs

## Institutional partners

CEPT University, India

## Industry partners

1. Schneider Electric India
2. Wipro Eco-energy
3. Synapsense

## Project Goals

1. Develop, test and demonstrate cost effective, scalable approaches for Energy Information Systems in commercial buildings which can be integrated into EIS and metering products with broad applicability in the U.S. and Indian markets.
2. Enhance and expand benchmarking methods adapted for India and applicable to US benchmarking

Project start  
Oct 2012

NOW

Project end  
Sep 2017

Oct 2012

Oct 2013

Oct 2014

Oct 2015

Oct 2016

Oct 2017

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

# Purpose and Objectives: Problem Statement

## Problem Statement:

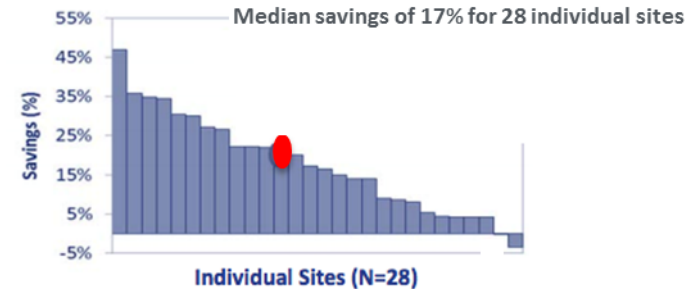
Benchmarking and Energy Information Systems (EIS) can enable significant energy savings. However, technical challenges exist to their wider application:

**1. Energy Information Systems** are commercially available (> 90 US products) and growing in technical capability....

*.....but high transaction costs – skill and time required to configure, install and use EIS – limit their market reach.*

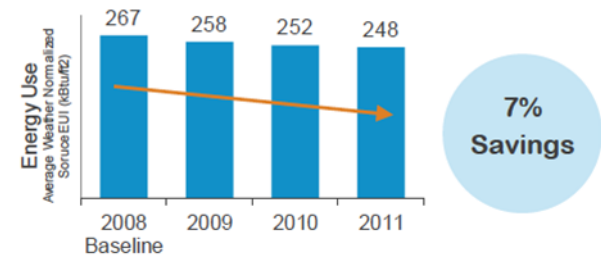
**2. Energy Benchmarking** tools are well established....

*.....but they lack flexibility in required data inputs vs. desired accuracy.*



Energy savings reported by EIS users in Better Buildings Alliance Study

## Energy Savings in Portfolio Manager



Source: ENERGY STAR Data Trends factsheet

# Purpose and Objectives: Target Market

- Broad applicability to commercial buildings sector, primarily retrofit in the US and new construction India. In US, potential savings ~2 Quads primary energy (~10% savings x ~20Q commercial sector energy use)
- Applicable to all sectors. CBERD focusing on target segments - hotels, hospitals, offices

## Audience:

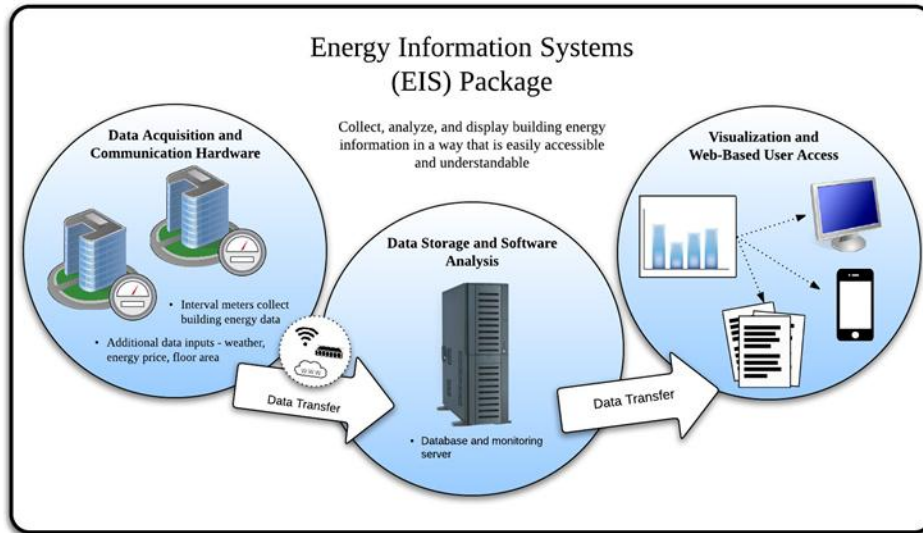
- EIS vendors
- Owners, operators of commercial buildings
- Benchmarking programs

# Purpose and Objectives: Project Outputs - EIS

## HELP SCALE APPLICABILITY AND USE OF EIS:

Technical requirements for **packaged, scalable, cost effective “EIS in a box”** for the US (underserved building sectors) and India (emerging market);

- Supports set of use cases in initial target segments: hotels, hospitals, offices
  - Based on market segmentation analysis.
- Includes meters, gateways, software.
  - Drawn from existing technologies
- 3-level EIS package offerings
  - Basic, Advanced, Custom for each segment



*Components of EIS Packages*

## Outputs

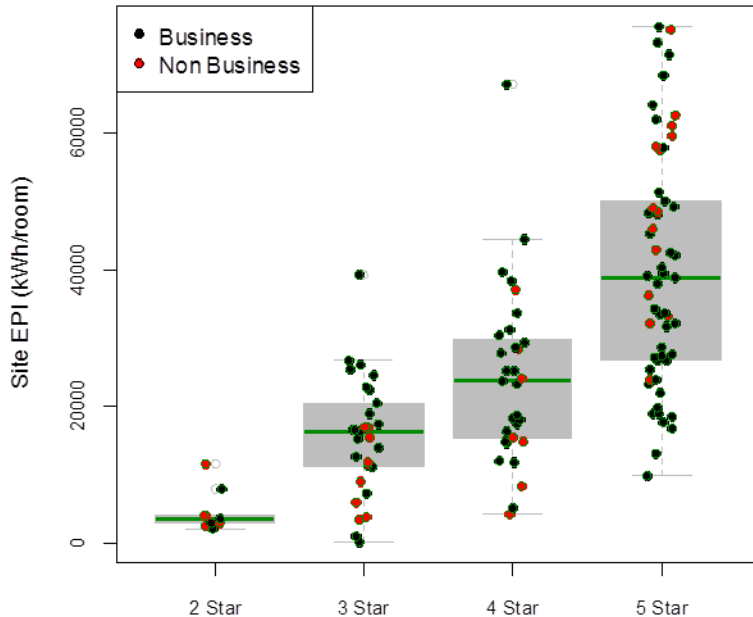
**Near Term** (during project duration):

- EIS guides for specific building types
- Technical Requirements for EIS packages for specific market segments
- EIS Package demonstrations in real buildings

**Intermediate-to-long term** (after project):

- EIS packages routinely offered by vendors.
- Scaling up of EIS installations in commercial buildings.

# Purpose and Objectives: Project outputs - Benchmarking



*Example - Analysis of Eco-III hotels dataset used to identify variables for graduated benchmarking*

**Benchmarking methods that enable broader use** of benchmarking tools within market-facing deployment programs and policies.

- “Graduated” benchmarking model that allows tradeoff between data inputs and accuracy.
- Benchmark scores with error bars allow users to apply them appropriately.

## Outputs

**Near Term** (during project duration):

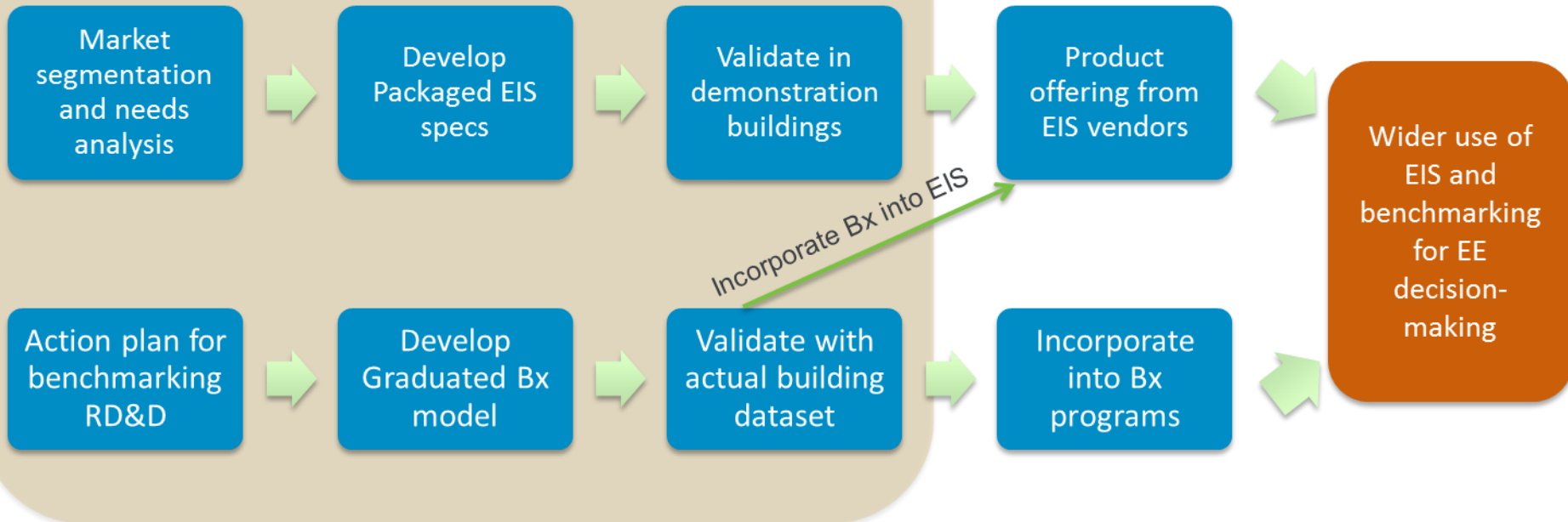
- Benchmarking analysis of hotel and hospital datasets using univariate, bivariate and regression analysis
- Graduated Benchmarking models and methods for hotels and hospitals

**Intermediate-to-long term** (after project duration):

- Uptake of Graduated Benchmarking by programs in India and the US.

# Overall Approach & Impact Model

## *CBERD project scope*



# Approach: Key Issues and Distinctive Characteristics

## EIS

- How to engineer packages that accommodate heterogeneity across buildings.
- Engineering for simplicity – how to minimize expertise and time needed for installation and use of EIS packages.

### *Distinctive characteristics:*

- “Commoditizing” EIS – not just features, but also ease of installation and use. Field tested.
- Eases sales cycle for vendors for new markets that previously were hard to access or had difficult sales cycle.

## Benchmarking

- Identifying variables for each tier considering statistical significance and ease of data collection.
- Modeling approach – independent models for each tier vs. Constrained regression vs. other ....

### *Distinctive characteristics:*

- Uncertainty information for benchmark scores.
- “Apples-to-apples” rigor can be tailored to programmatic needs.
  - e.g. Screening vs. incentive programs



# Approach: EIS tiered configuration

Drivers Tiers	1. Monitor Energy Performance	2. Benchmark Performance	3. Track Cost and Manage Demand	4. Identify and Track Project Performance	5. Track Emissions
Tier 1 Basic EIS package	●	○	○	—	—
Tier 2 Advanced EIS package	●	●	●	●	●
Custom EIS Solution	●	●	●	●	●



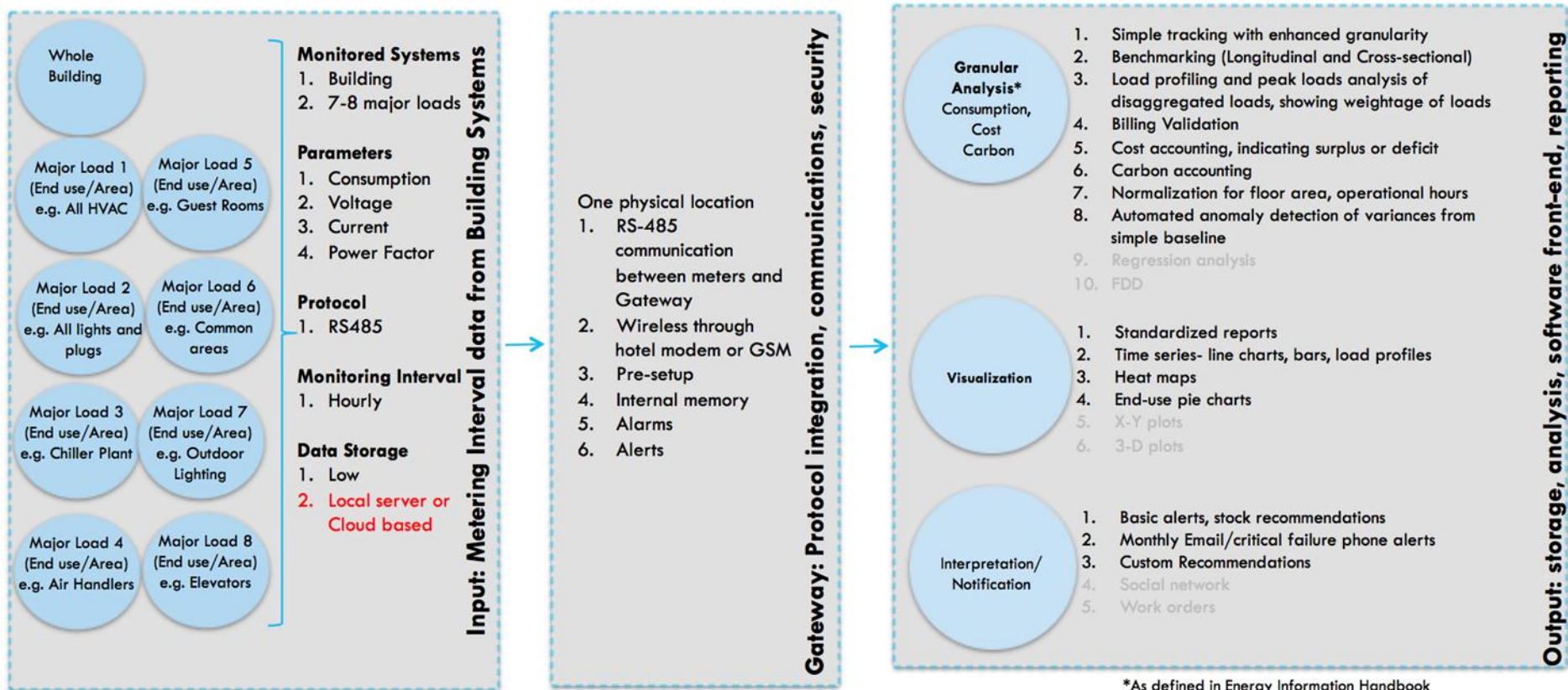
*Prioritized support for business drivers*

*Tradeoff on cost  
functionality,  
flexibility*



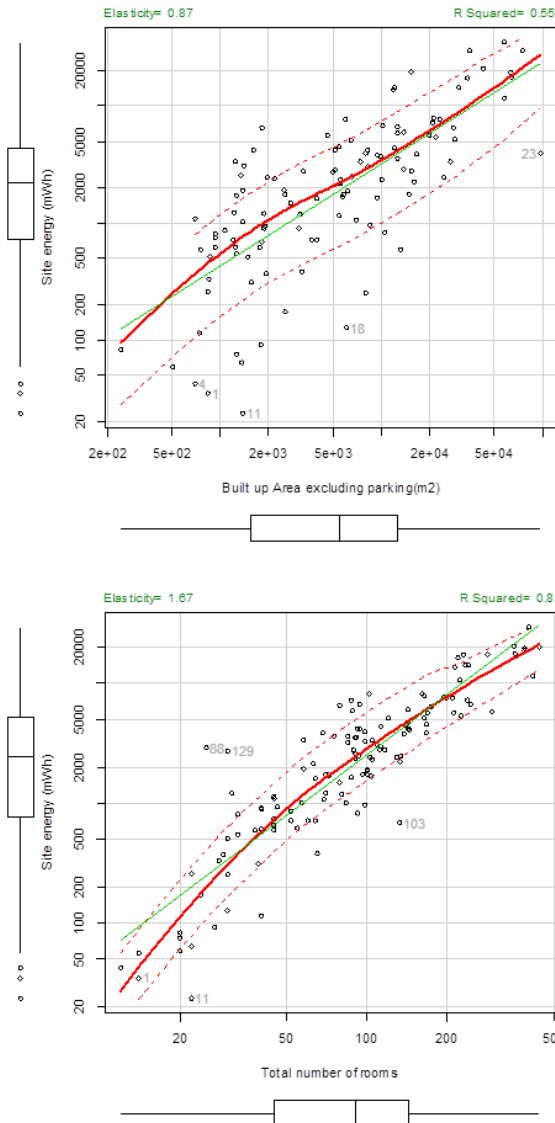
# Approach: EIS packages

## EIS Package Tier 2 (Advanced)- High level sample



High level sample of Hotels EIS Package elements

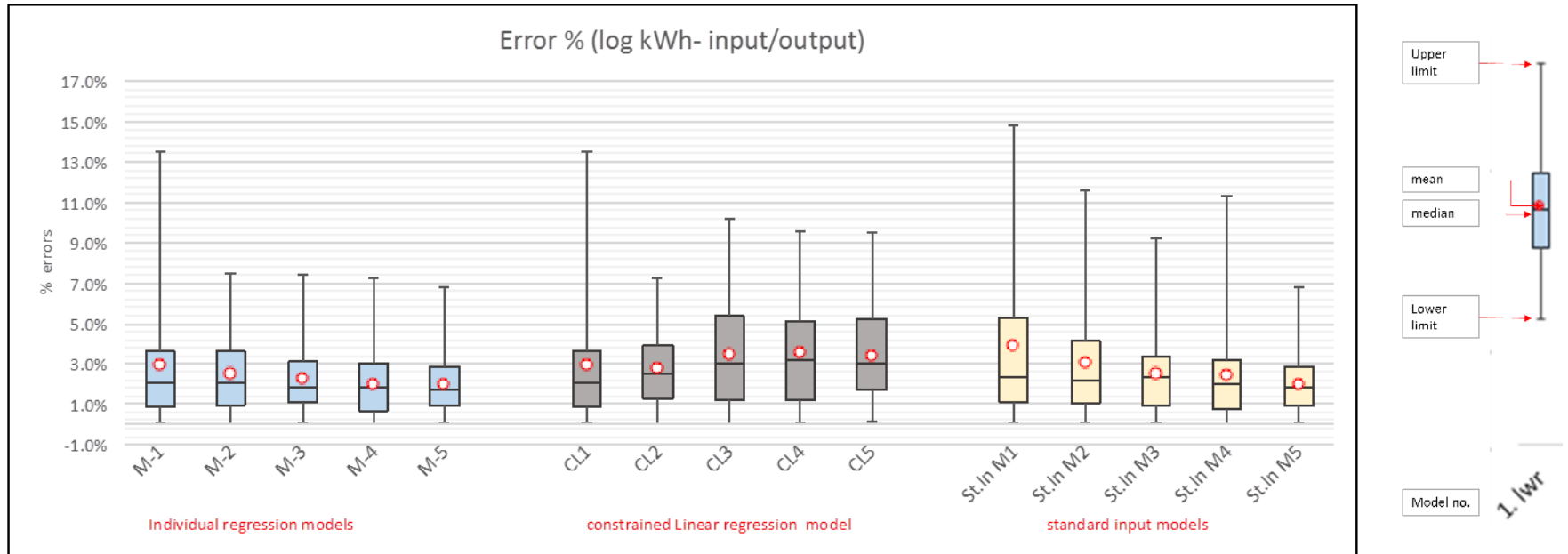
# Approach: Benchmarking



Site energy more correlated to number of rooms  
( $R^2 = 0.8$ ) than built up area ( $R^2 = 0.56$ )

- Univariate analysis
  - Analyze basic data trends; diagnostics and cleansing.
- Bivariate analysis
  - Screen and prioritize variables for inclusion in model.
- Multivariate analysis
  - Assess impact on model accuracy with inclusion/exclusion of different variables.
- Graduated benchmarking model
  - Develop graduated model(s) based on prior analysis
  - Test and validate with real buildings.

# Approach: Graduated Benchmarking – early results



Variable inclusion order:

Model 1: No. of rooms

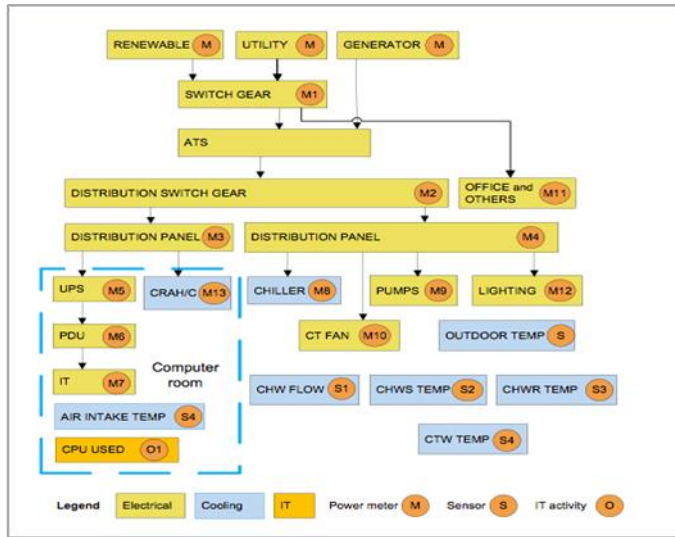
Model 2: + Star Rating

Model 3: + Area ex. parking /room

Model 4: + No. of restaurants /room

Model 5: + Climate zone

# Progress and Accomplishments – EIS



*Metering schema indicating the depth of metering for a specific Datacenter EIS package*

## Lessons Learned

1. Technical simplification of products and their usability is a real need and route towards deployment scalability.
2. R&D should consider the range of opinions and interests across and within industry partners.

## Accomplishments

- Joint report on Datacenter EIS guidelines
  - Advanced by US industry partner Synapsense for use by their potential clients.
- Joint report on Market Segmentation for EIS
  - Specific target market segments identified for development of EIS packages.
- Joint report on Technical Requirements for 3-tier EIS packages for hotels
- Sites identified for EIS demonstration in Indian buildings
- 2 journal papers are in progress

## Impacts

- Broader market applicability of EIS to various building types, regions.
- Demo in India to validate efficacy of packages.
- Engagement in US via allied projects. Packages being informed by pain points identified by US EIS market.

# Progress and Accomplishments - Benchmarking

## Accomplishments

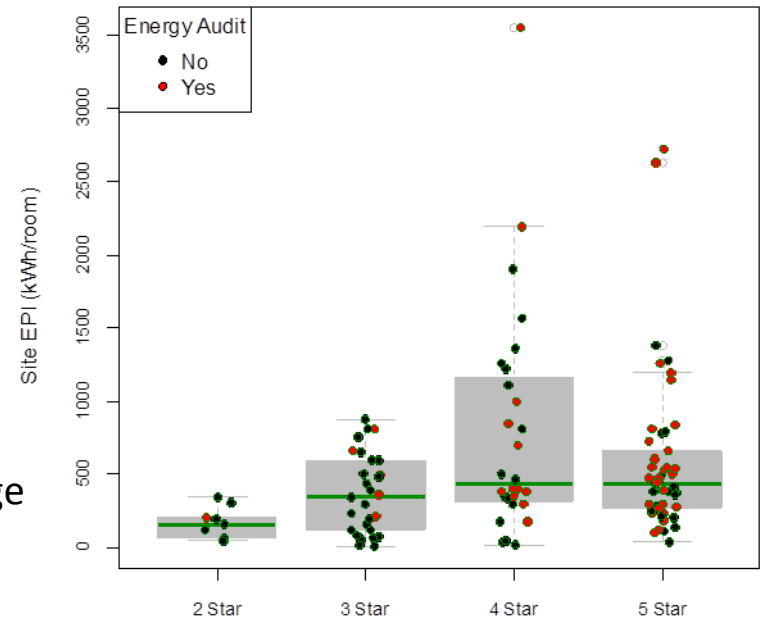
- Action Plan on Benchmarking for India
- Extensive analysis of ECO-III hotels dataset with expanded asset and operational variables
- Initial results of graduated Benchmarking approach.

## Impacts

- BEE committed to incorporating these outputs in their benchmarking programs in India

## Lessons Learned

1. Data collection and accuracy continues to be a challenge for development and use of benchmarking tools
2. Important to get buy-in and confidence of owner/operators that key characteristics such as star rating, no. of rooms, no. of overnight guests are appropriately addressed in benchmark model
3. Think big, start small. Advanced benchmarking (system level, asset vs. operational) viable only after basic whole-building benchmarking is standard practice.



*Example from hotels dataset analysis - Audits more prevalent in higher star-rated hotels*

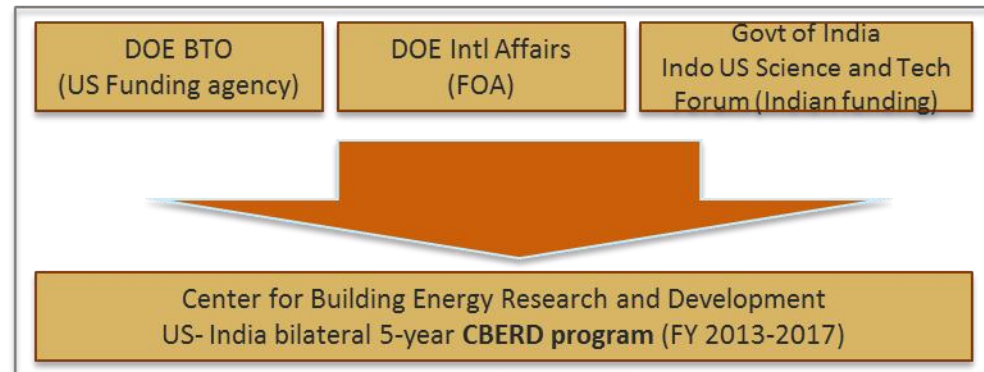
# Project Integration and Collaboration

## Alignment with DOE BTO Objectives

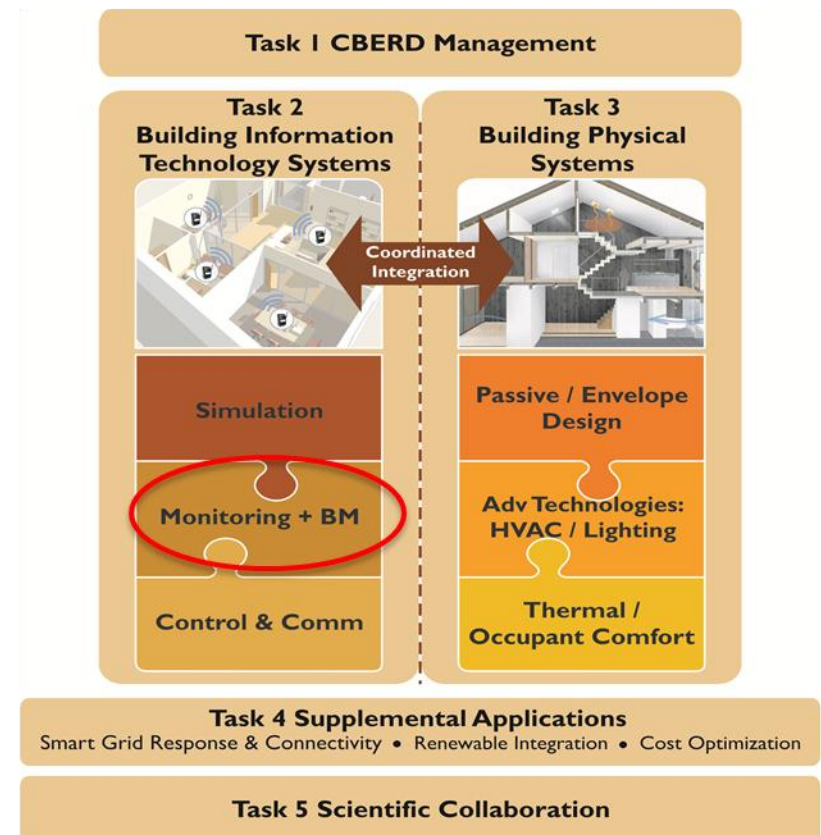
- The Better Buildings Alliance (BBA) seeks to encourage widespread adoption of EIS
- BBA could serve as a key audience for the work, and future deployment channel for the EIS results.

## Project Integration, Partners

- 3 US Project R&D Staff (LBNL)
  - focus is on EIS work
- 3 Indian R&D Project Staff (CEPT University, India)
  - focus is on Bx work (with LBNL input)
- Schneider Electric India and Wipro Eco-Energy are very actively engaged on EIS.
  - Provide ongoing input and feedback on tech design.
  - Engaged in upcoming pilot demonstrations.

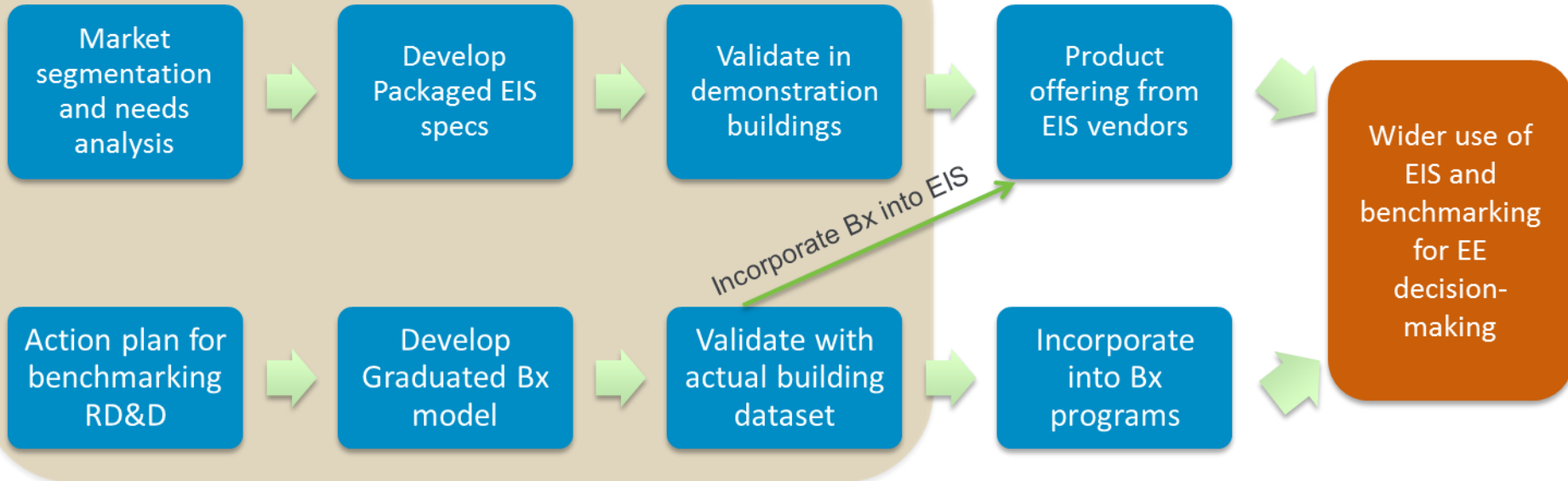


*This project is part of the bilateral CBERD program*



# Next Steps and Future Plans

## *CBERD project scope*



### NEXT STEPS

- Packaged EIS demo in Hotels (Sep 2015)
- Packaged EIS demo in Hospitals (Sep 2016)
- Packaged EIS demo in Offices (Mar 2017)
- Packaged EIS demo results analysis and revised version (Sep 2017)
- Graduated Benchmarking for Hospitals (Sep 2015)
- Spec for national “BPD” for India (Mar 2016)



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# REFERENCE SLIDES

# Project Budget

**Project Budget:** Through DOE funding for CBERD: \$150K per year for 5 years

**Variances:** None

**Cost to Date:** \$220K

**Additional Funding:** In kind- cost share from U.S. industry partner Syfansense (\$450K per year) for Year FY13

## Budget History

FY2014 (past)		FY2015 (current)		FY2016 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$150K	\$450K	\$150K	\$0	\$150K	\$0

# Project Plan and Schedule

Project Schedule												
Project Start: 10/1/12	Completed Work											
Projected End: 9/30/17	Active Task (in progress work)											
	◆ Milestone/Deliverable (Originally Planned)											
	◆ Milestone/Deliverable (Actual)											
	FY2013				FY2014				FY2015			
Task 2.2: CBERD Monitoring and Benchmarking	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
<b>Past Work</b>												
FY2013 Q1 Milestone: Development of a detailed scope of work	◆											
FY2013 Q2 Milestone: Summary of current state of the art in India		◆										
FY2013 Q3 Milestone: Goals and use cases for Indian benchmarking program			◆									
FY2013 Q4 Milestone: Gap analysis relative to current state of the art in India				◆								
FY2014 Q1 Milestone: Sample specification and selection guide for energy monitoring tools tailored to Indian products and market place- Datacenters					◆							
FY2014 Q2 Milestone: Market segmentation for EIS solutions						◆						
FY2014 Q4 Milestone: Benchmarking analysis for Hotels and Hospitals; Development of Graduated Benchmarking Approach.							◆					
<b>Current/Future Work</b>												
FY2015 Q1 Milestone: Technical requirements /specifications for packaged EIS for Hotels									◆			
FY2015 Q2 Milestone: Develop and publish graduated benchmarking approach for Hotels										◆	◆	
FY2015 Q4 Milestone: Installation of Hotel EIS package in 2 buildings												◆
FY2015 Q4 Milestone: Technical requirements for packaged EIS for Hospitals												◆