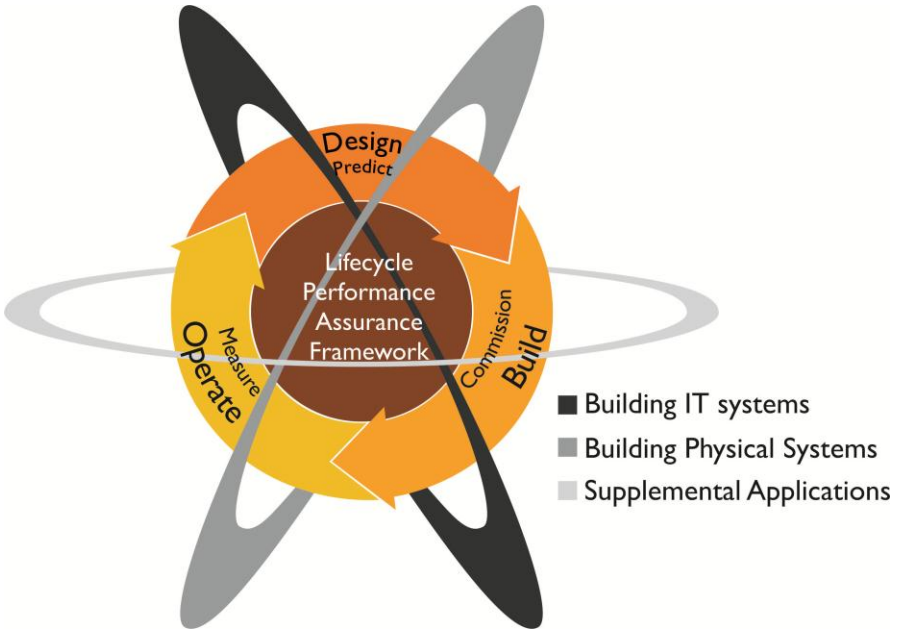
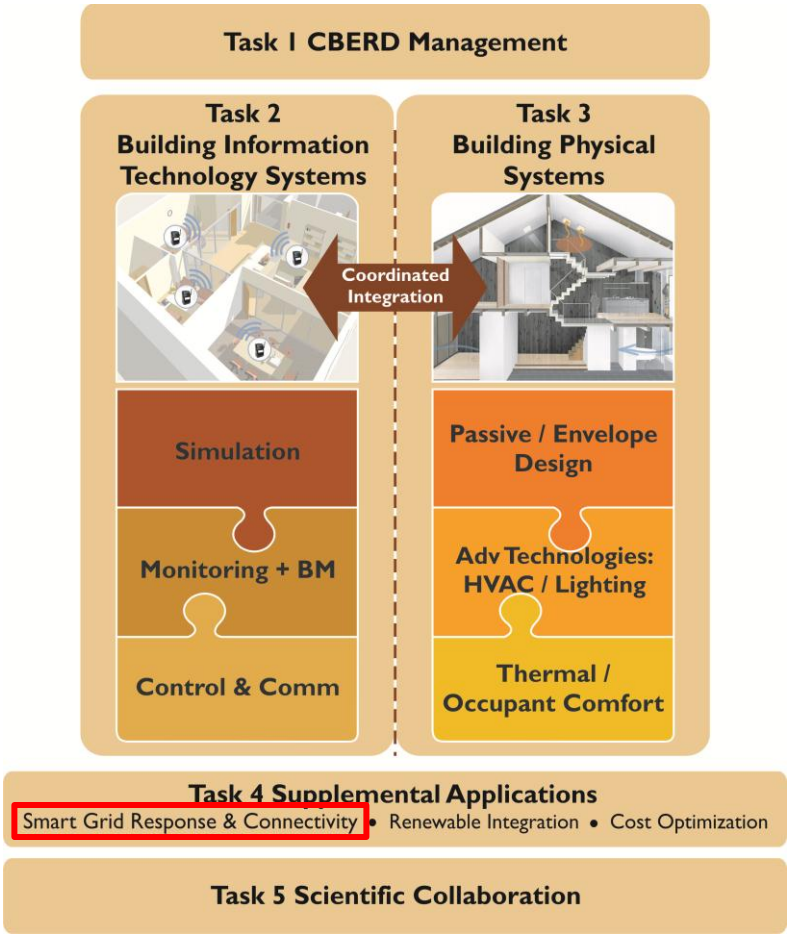
U.S.–India Joint Center for Buildings Energy Research and Development (CBERD):

Grid Responsive Buildings

2014 Building Technologies Office Peer Review

CBERD promotes innovation in energy efficiency through collaborative research, contributing to significant reduction in energy use in both nations.





U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Project Summary

Timeline:

Start date: Oct 2012;

Planned end date: Sep 2017

Key Milestones

1. Scoping study to link building technologies to Smart Grid needs and integration of building control systems to supply-side; Yrs. 1-2
2. Testing of framework through development of prototype technologies and products; Yrs. 3-4
3. Identification and tests of technologies (such as EMCS) in test-beds; Yrs. 4-5

Budget:

Total DOE $ to date: $100 K (FY'13 and FY'14)

Total future DOE $: $150 K (FY'15 - FY'17)

Target Market/Audience:

Building and Grid operators, technology vendors, regulators.

Key Partners:

Institutional	Industry
Indian Institute of Management, Ahmedabad (IIM-A)	Honeywell (U.S.)
	Neosilica
	Schneider Electric

Goals (and Objectives)

- Framework to integrate building technologies to the Smart Grid through collaborative knowledge and industry partnerships.
- Propose framework for building technologies that require consideration of Smart Grid communication, responsiveness, and transactions.

Research Subtasks

- Link building technologies to the Smart Grid
- Integrate building control systems to supply-side systems
- Develop prototype technologies
- Identify and test technologies in test-beds

Purpose and Objectives

Problem Statement: Lack of cost-effective and integrated technologies for energy efficiency and grid transactions to achieve reliability and operational efficiencies.

Target Market and Audience: Technology vendors, building and grid owners/operators, regulators; business potential of building systems to be approximately $939 million by 2016 (market size of grid-integrated technologies is likely larger) [1]; ~5 percent of the buildings, have energy management and control systems.[2]

Impact of Project: Joint R&D will transfer the knowledge and motivate electricity markets by disseminating the collective experiences and technologies for uptake of Smart Grid and cost-effective integrated building technologies.

a. Near-term (up to 1yr): Identify appropriate building sector/end-uses for technology intervention; collaboration and areas of focus of technology integration for grid-responsiveness/transactions.
b. Intermediate-term (1-3yr): Technical roadmap with public-private stakeholders; accelerate technology development through pilot studies.
c. Long-term (3-5yr): Evaluate prototypes within test-beds.

[1] *Ghatikar G., V. Ganti, and C. Basu; Expanding Buildings-to-Grid (B2G) Objectives in India. Lawrence Berkeley National Laboratory and University of California Berkeley. 2013. LBNL-6369E*
[2] *DOE/EIA Commercial Building Energy Consumption Survey 2003, released 2006*

Approach

Through collaborative knowledge and industry partnerships, link CBERD technologies to Smart Grid, test an integrated framework to enable building systems for communication, responsiveness, and transactions.

Key Issues: Impact of energy efficiency buildings technologies and their integration for supply- and demand-side management (e.g., demand response or DR transactions); interoperability, cost efficiencies.

Distinctive Characteristics: Leverage joint work to address unique challenges in new buildings and DOE/BTO plans.

Year 1 Sub-task Activities for CBERD	Relevance to DOE/BTO (or other) Objectives
Identification of building technologies for Grid-Responsiveness	Grid and building systems integration activities
Integrated framework and collaboration – IEEE paper: "Enabling Efficient, Responsive, and Resilient Buildings: A Collaboration between the United States and India."	Collaborative avenues to enable integrated buildings-to-grid R&D, market transformation, and deployment pathways.
Identification of loads areas of focus: Indian buildings survey to identify building types, monitoring, and technology intervention.	International activities for gird integration of demand-responsive building technologies.

Progress and Accomplishments

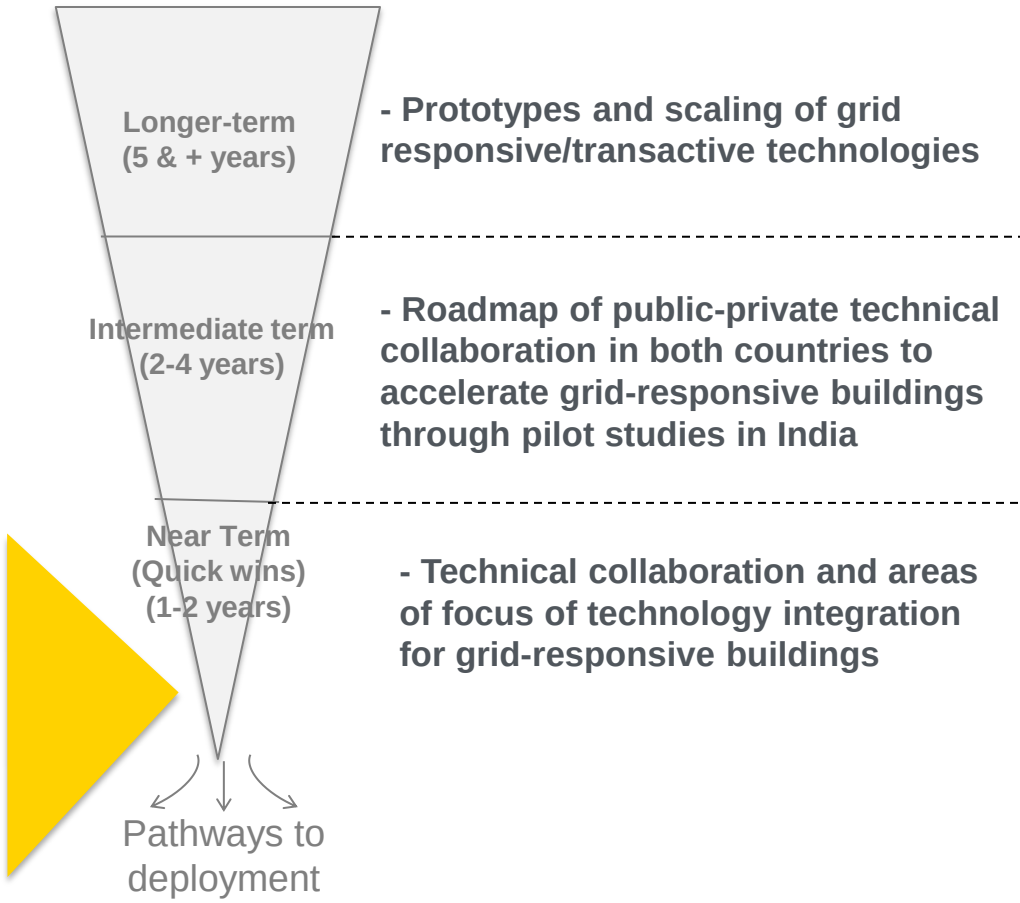
Lessons Learned: Technology opportunities and challenges in both countries, cost-efficiencies, country-specific technology applications, and joint collaboration.

Accomplishments:

- **Milestones:** Link building technologies to enable efficient, responsive, and resilient buildings.
- **Deliverables:** Paper to proceedings of IEEE Smart Grid and the New Energy Economy (U.S); Draft Grid-responsive buildings focus (India, U.S)
- **Metrics:** Two publications[1], briefings, and presentations.

Market Impact:

- Results transferred key stakeholders and deployments/policies in U.S. and India;
- In next 10yr, Asia Pacific continue or start pilots for Automated DR.[2]

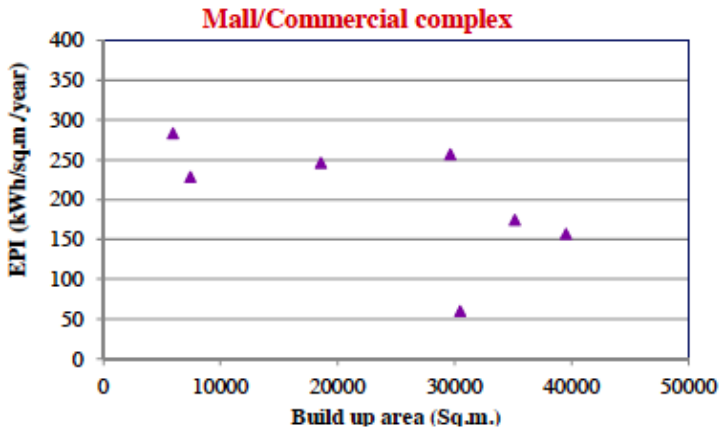


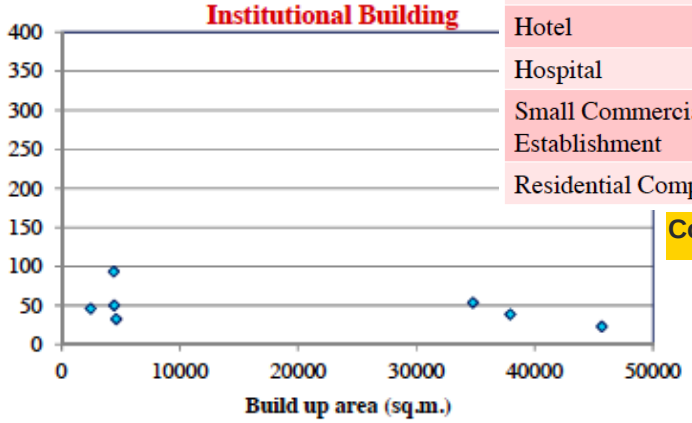
1 Basu C., G. Ghatikar, and P. Bansal; Enabling Efficient, Responsive, and Resilient Buildings: A Collaboration Between the United States and India; Proceedings of the IEEE Great Lakes Symposium on Smart Grid and the New Energy Economy, Chicago, 2013
Garg A, P. R Shukla, J. Maheshwari, and J Upadhyay; An Assessment of Household Electricity Load Curves and Corresponding CO2 Marginal Abatement Costs Curves for Gujarat State, India; Elsevier Journal, 2013
2 Automated Demand Response: Global Market Analysis and Forecasts; Pike Research, 1Q 2014

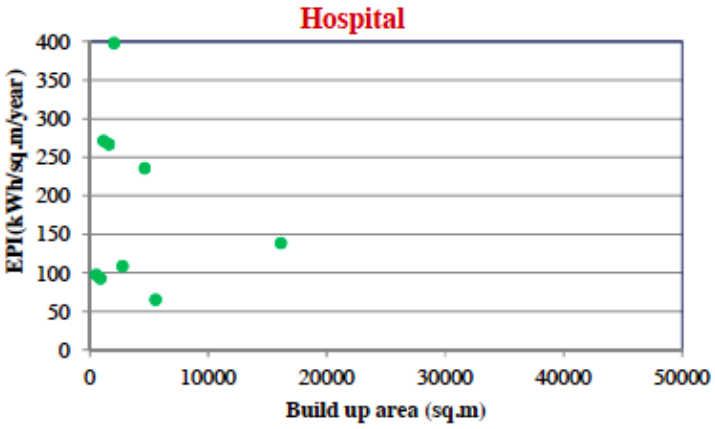
Accomplishments: Load Survey in Indian Buildings

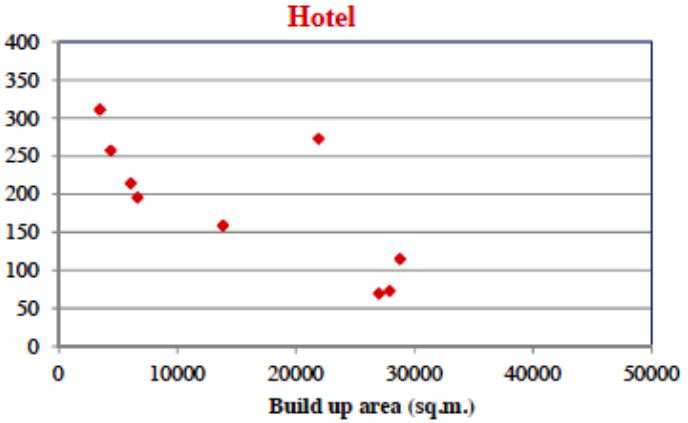
Building Type	No. of Buildings Surveyed
Commercial Complex/Mall	10
Institutional	13
Hotel	100+
Hospital	100+
Small Commercial Establishment	200
Residential Complex	1

Conversion: 1 Sq.m. = ~11 Sq.Ft.





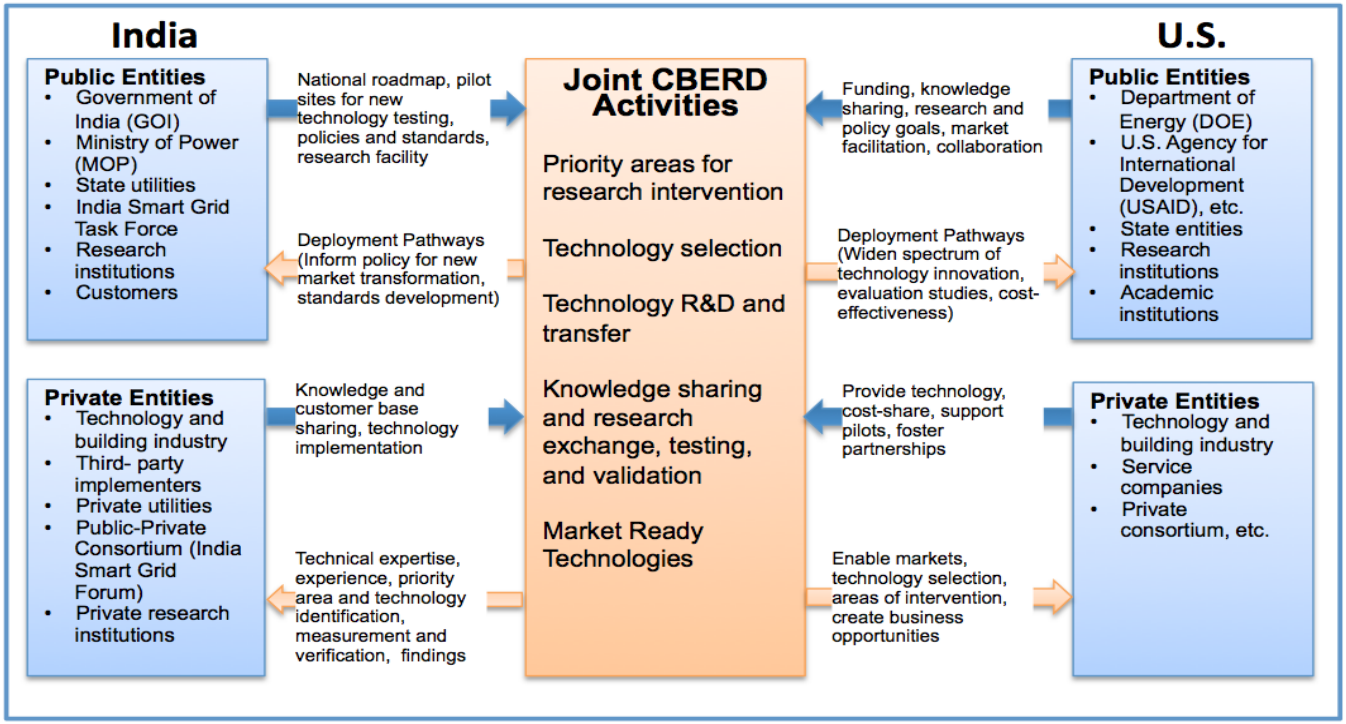




U.S. large Commercial & Industrial facilities can provide an average of 11% AutoDR peak load reduction.

Project Integration and Collaboration

Project Integration: Good coordination with public-private stakeholders in both countries to accelerate impact and improve bilateral ties.



** Basu C., G. Ghatikar, and P. Bansal; Enabling Efficient, Responsive, and Resilient Buildings: A Collaboration Between the United States and India; Proceedings of the IEEE Great Lakes Symposium on Smart Grid and the New Energy Economy, Chicago, 2013*

Partners, Subcontractors, and Collaborators:

R&D PIs and performers:

LBNL: Girish Ghatikar (U.S. Lead)

IIM-A: Amit Garg (India Lead)

Cost-Share Partners: *Honeywell, Neosilica, Schneider Electric*

Communications: Regular calls with DOE, R&D partners and industry, briefings, presentations at U.S.-India Energy Dialogue, and annual reviews.

Next Steps and Future Plans

Next Steps and Future Plans:

1. Improved joint coordination with the Indian R&D lead, IIM-A and leveraging team support.
   - Joint publications (Joint paper on "Scoping study of grid-responsive buildings")
   - Monitor Indian building loads (HVAC, lighting, water pumping), evaluate CBERD technologies
2. Integration with other CBERD R&D sub-tasks and PACE-D activities.
3. Improved industry engagement, Honeywell (U.S.), Neosilica, and Schneider Electric (India), understand cost efficiencies
4. Identify potential benefits to the U.S. buildings through joint activities
   - Technologies to integrate buildings energy efficiency for grid-responsiveness.
   - Technical feasibility of grid-integrated technologies and standards in buildings.

Honeywell

ComfortPoint Open
CP-REM-UP

- Complies to OpenADR 2.0 Standard
- Flexible and easy configuration with ComfortPoint Open Online tool
- Supports one BACnet IP interface and 3 independent RS485 interface MSTP channels for Modbus interface

REFERENCE SLIDES

Project Budget

Project Budget: $100K ($50K/year)
Variances: None.
Cost to Date: $32K
Additional Funding: $160K (in-kind cost-share $80K/year)

Budget History					
Oct 2012– FY2013 ($k past)		FY2014 ($k current)		FY2015 – Sept 2017 ($k planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
50	80	50	80	150	240

Project Plan and Schedule