Enabling Efficient, Responsive, and Resilient Buildings: A Collaboration Between the United States and India

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Project Goal

Development of a roadmap of technical collaboration between India and United States to jointly address the R&D and knowledge gaps in enabling efficient, responsive and resilient buildings in both the countries, under the auspices of Center for Building Energy Research and Development (CBERD)

Demand side activities: A story of two countries

Exchange of experience, expertise and use cases fostering mutual growth in smart grid sector

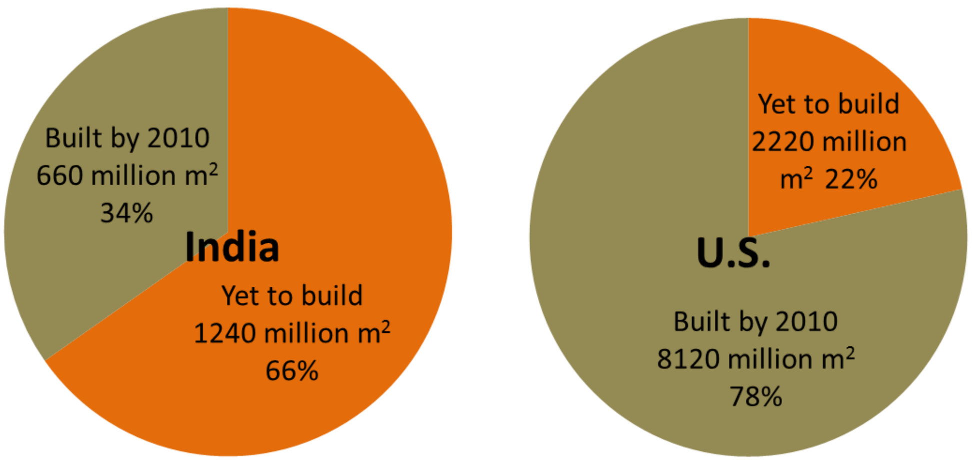

Figure 1. 2030 floor space forecast for the commercial building sector: India 1,900 million square meters (m2) and U.S. 10,340 million m2. India is expected to triple its floor space by 2030. Sources: ECO III and EIA.

Estimated generation capacity in U.S. will be 200 GW by 2030, at a cost of $0.5 trillion to $1 trillion (`22 trillion to 45 trillion) (DOE "business as usual")

Estimated required generation capacity in India will grow 5 folds to 800GW in 2030.

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Why commercial buildings sector?

- **Growing demand in commercial buildings of India:**
  - current consumption 9-10% of total electricity
  - increase in consumption at a rate of 12-14%, attributed to both floor area and energy intensity increase in existing buildings

- **Growing power demand:**
  - Current generation capacity of 160 GW (2006-07)
  - 5 folds increase by 2030-2031, an estimated 800 GW

- **Peak power shortage:** Current estimated shortage is16.6%

- **Experiences from Indian partnership and R&D will benefit U.S. commercial buildings**

Research questions

What is an appropriate building sector for technology intervention in India?

Who are the potential collaborators in India and the U.S. for this research?

How can our work leverage other building-to-grid activities in India undertaken by the above collaborators?

Given the current state of Smart Grid development in India and technology availability, both nationally and internationally, what is an ideal roadmap for pilot demonstration of grid-responsiveness?

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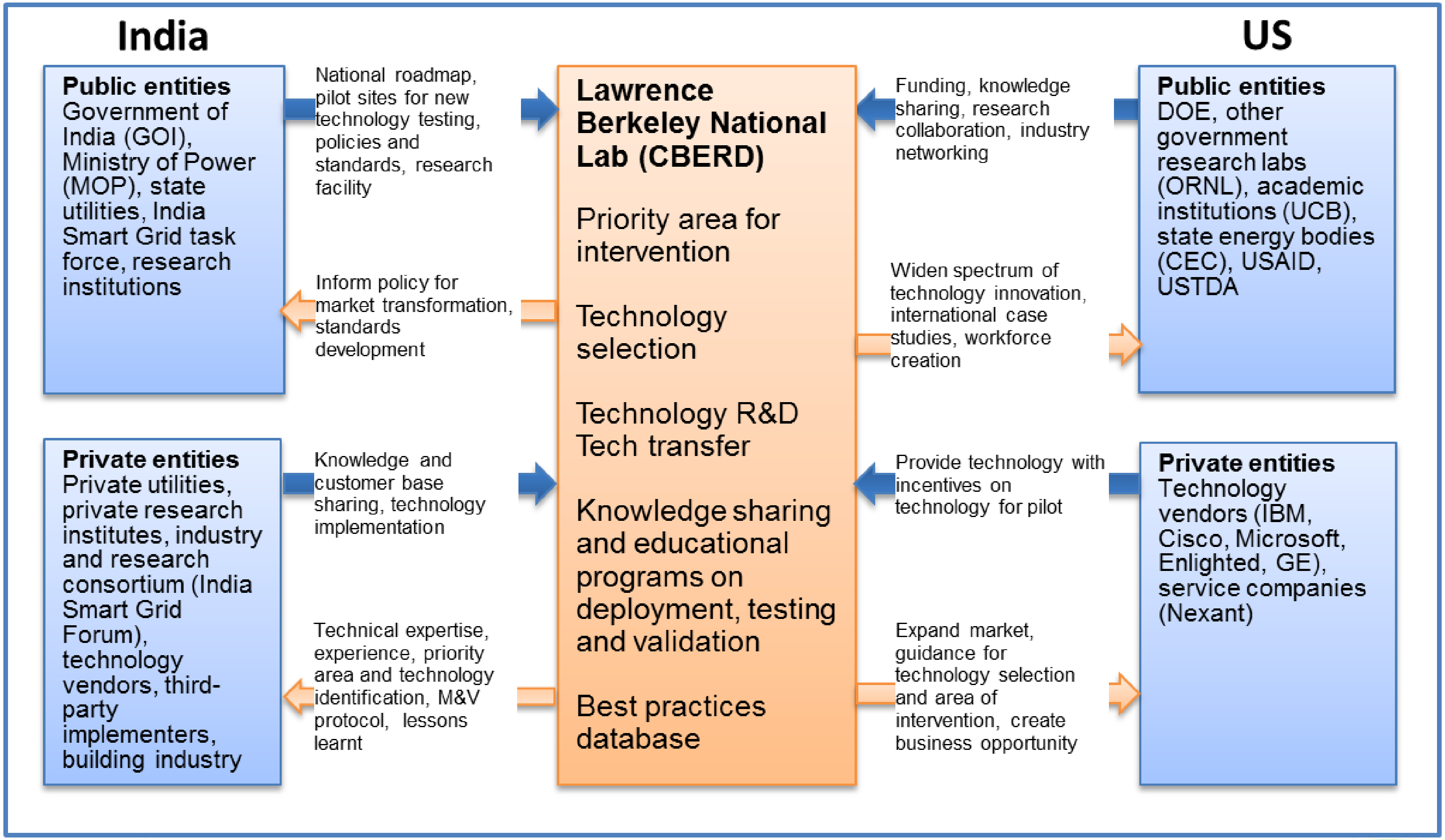
Interaction map of CBERD in India



Incremental Building to Grid (B2G) integration

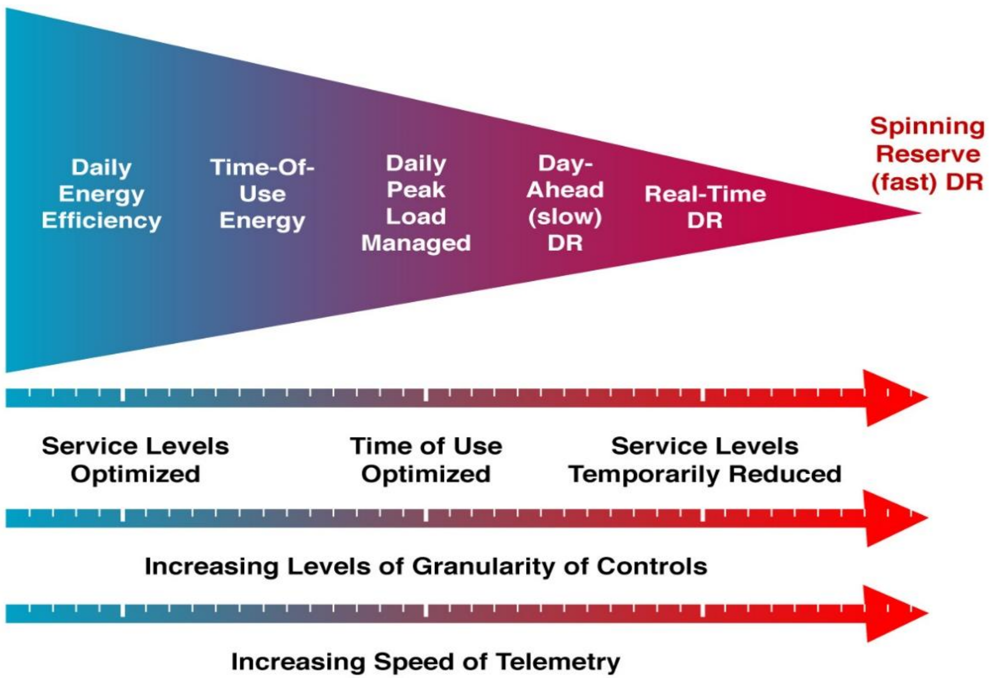


Figure 2. Incremental Demand Response, emerging from Energy efficiency paradigm and transitioning to ascending orders of B2G integration through increased granularity of controls and faster telemetry

B2G Integration Roadmap

Demand-Side Activities	Building-to-Grid Requirements: Basic	Building-to-Grid Requirements: Advanced
Energy Efficiency	• Energy Efficiency (EE) with higher investment for retrofits.	• Energy-efficiency improvements with integrated control and automation.
Demand Response	• Link DR with standard EE practices, semi-automated DR, day-ahead notification (e.g., time of day). • Apply well-studied DR strategies.	• AutoDR and advanced telemetry to communicate price or grid reliability information in "day-of" or ancillary services markets. • Aid ISGF goals for a 5% peak-load reduction target using DR by 2017.
Building System Behavior	• Continuous energy management. • Semi-automated DR strategies.	• Fully automated dynamic building response to DR signals through BMS-based controls. • Pre-programmed responses (e.g., global temperature adjustment for HVAC).
Building Controls	• Building management systems (BMS) in commercial buildings programmed to manage HVAC and lighting loads for DR. • DR signals sent manually to building managers.	• Grid-integrated BMS with advanced control and automation technologies. • Potential of increased and reliable BMS response to DR and OpenADR integration. • Facilitate benchmarking and standardized report formats such as Green Button .

B2G Integration Roadmap

Grid-Integrated Intermittent Renewables Resources (IRR)	• Use on-site renewable generation and electric grid reliability.	• Buildings enabled to feed excess generation from renewable resources to the grid and benefit from credits (e.g., net metering) to meet 33% renewable generation by 2027.
Distributed Energy Resources and Storage	• Use distributed generation and storage resources for DR and daily peak load management. • Provide pre-cooling or load shifting in buildings.	• Intelligent coordination to use/feed excess generation to electric grid during DR events. • Grid integration of advanced storage technologies (e.g., batteries, thermal energy).
Micro-grids	• Metering technologies for accountability and local or grid reliability.	• Develop advanced and community-scale micro-grids with grid-integrated distributed energy resources. • Enable flexible DR and islanding capabilities in response to grid signals.
Electric Vehicles (EV)	• Enable charging integration with time-of-day rate schedules.	• Full electric grid integration of EVs for vehicle-to-grid (V2G) capabilities to meet 10% EV penetration goals by 2027.
Transactions and Market Design	• Facilitate buildings to access price information from open markets using standardized platforms.	• Standards-based market/price transactions integrated with BMS and optimization.

Key Conclusions and Next Steps

- Enhanced ties between U.S. and Indian building energy researchers and industry.
- Integrate proven, marketable building technologies for energy efficiency and grid responsive and resilient loads.
- Improved cost-effectiveness of technology development through enhanced joint collaborations that utilize the strength of both nations.
- Improved capabilities for both nations to leapfrog development of technologies and markets.

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Thank you!