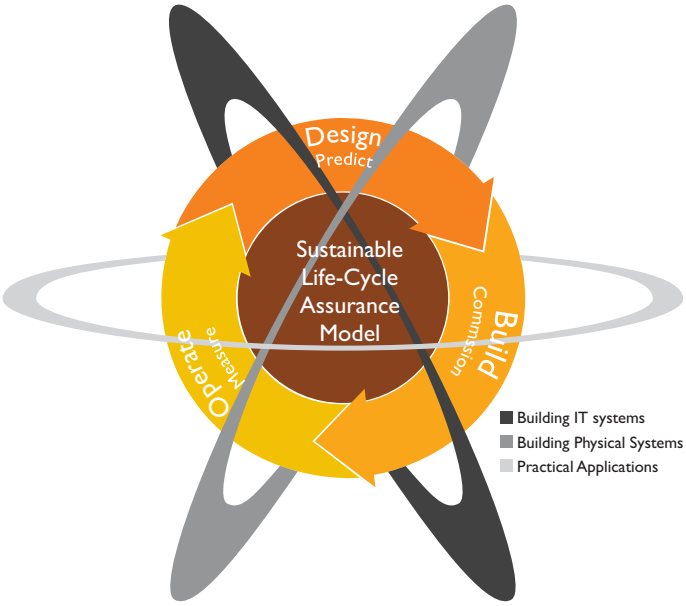
The U.S.-India Joint Center for Building Energy Research & Development (CBERD)

Background

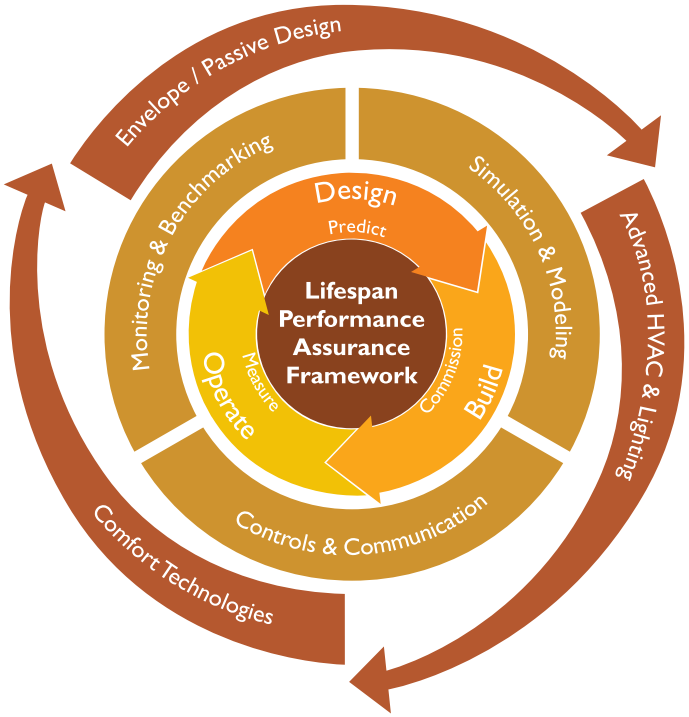
Through the Partnership to Advance Clean Energy (PACE) Research program, a five-year joint U.S. India Center for Building Energy Research and Development (CBERD) was created to advance buildings energy efficiency in both nations. UC Berkeley (USA) and CEPT University (India) jointly proposed the United States–India CBERD program. The main focus of CBERD during the duration of five years (2012-2017) was to conduct collaborative research that results into reduction in energy use in buildings.

To accomplish collaborative research and promote clean energy innovation in energy efficiency with measurable results and contributing to significant reduction in energy use in both nations was an important CBERD focus. The broad spectrum of R&D tasks intended for technology acceleration included:



1. Simulation
2. Monitoring
3. Controls
4. Envelope/Passive Design (insulation, cool roofs)
5. Advanced technologies (HVAC, lighting)
6. Thermal comfort
7. Grid responsiveness
8. Renewable integration
9. Scientific collaboration

This outcome-based R&D resulted in significant energy savings by driving development of cost-effective technologies and their implementation across the buildings.



Objectives

- Optimize the building systems integration using the whole building approach across the building lifecycle to facilitate and advance high-performance
- Formulate building energy efficiency R&D strategies targeted to the diversity of building types
- Develop a suite of R&D strategies customized for U.S. and Indian applications, enabling rapid development of regional and localized low-energy building practices and technologies
- Enhance compliance and development of building standards and codes
- Promote the long-term sustainability of building energy efficiency through collaborative education and training
- Accelerate building efficiency R&D and deployment through a solid, functioning consortium with bilateral public-private partnerships

Tasks

CBERD conducted analyses of how buildings in India and USA used energy through a Lifecycle Performance Assurance Framework (LPAF) that supported building system integration. The main R&D tasks are as under:

Task 1: Simulation an Modelling: Enable commercial buildings to maximize their technical potential in design and achieve that potential in operation.

Task 2: Monitoring and Benchmarking: The broad purpose of this task was to support wider availability and use of energy information by a) developing packaged and scalable technical solutions for Energy Information Systems (EIS) and b) advancing the state of the art of energy benchmarking.

Task 3: Integrated Sensors and Controls: Can there be integration between control of HVAC, lighting, and plug loads into one, easy to use platform? To understand application of transaction-based controls at the level of the individual workstation, using personalized controls? Can integrated controls platform be used to manage energy and load in grid-islanded, "resource constrained"

buildings? Is the Volttron system robust enough to handle the intermittency and instability of the Indian grid? Can task-ambient lighting systems reduce their power use in a way that maintains occupant comfort and productivity? This task demonstrates the control of a group of office workstations that can have a measurable energy savings and load reduction effect on a building zone.

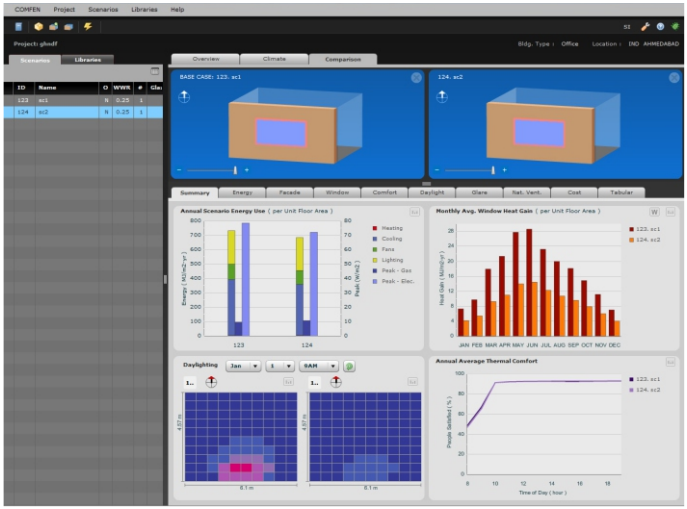
Task 4: Advanced HVAC Systems: Develop and test energy efficient HVAC systems

Task 5: Building Envelopes

5.1 Advanced Building Materials – Developed experimental protocols and data on the benefits of adding Phase-Change Materials (PCM) to building envelopes, which helped to operate buildings in mixed mode operation.

5.2 Cool Roofs – Demonstrated and quantified the energy-saving impacts of cool roof technology and enhanced the cool roof market in India through rigorous demonstration and quantification of cool roof benefits.

5.3 Windows and Daylighting – To achieve greater penetration of energy efficient windows, window attachments and overhead daylighting technologies in US and India through the utilization of enhanced modeling tools and test facilities, open source software solutions,



characterization and demonstration of energy efficient fenestration technologies and supported the development of a rating system.

Task 6: Climate Responsive Design: The broad purpose of this task was to understand the performance of climate responsive buildings, and thus advance the state of the knowledge, of well-designed climate-responsive architecture in terms of their indoor thermal environments, occupant's response to the indoor conditions, the role of air movement in achieving thermal comfort for elevated temperatures, and the opportunities to judiciously combine both natural ventilation and low-energy mechanical systems in well-designed "mixed mode" buildings that can improve both energy and comfort performance.

Cross cutting task on cost optimization of energy efficiency: The development of Triple Bottom Line (TBL) life cycle justifications (economic, environmental and human) for building decision makers is critical to overcome, first-least-cost decision making patterns that prevented investments in high performance, energy efficient building solutions.

Benefits and Outcomes of the Research

Enhanced ties between U.S. and India building energy researchers and industry; integrated, proven, marketable building technologies; a public-private collaboration to identify deployment pathways; leveraged research funding; improved capabilities for both nations to leapfrog development of building technologies and markets.

Deployable Outcomes

Tools, Methods, Evidences

- Climate Responsive Design
- COMFEN India
- Dedicated Outdoor Air System
- Early Design Optimization Tool (eDOT)
- Energy Information Package for Hotels and Hospitals

- Grid Responsive Building Web tool
- Indirect Evaporative Space Cooling
- Integrated Workstation Controls Hub
- Laser Cut Panels (LCP)
- Low Power Wireless Motion Sensor
- Non Coplanar Shading Calculator
- Phase Change Material Tiles and Masonry Units

Infrastructure established

- Accelerated Ageing Lab for Cool Roof Materials
- Buiding Material Characterization Laboratory (Upgrade)
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- Daylighting Laboratory
- Fault Detection and Diagnostics (FDD) Laboratory
- Hygrothermal Characterization Laboratory
- Lighting Test Laboratory
- MCHX_Evaporator & Modular DOAS Test Facility
- Radiant Cooling Laboratory
- Solution Heat Exchanger Performance Test Facility
- Testing Facility of DOAS Systems
- Thermal Comfort Chamber
- Window Characterization Facility (Upgrade)

R&D Partners

Berkeley Lab · CEPT University · Carnegie Mellon University · CSR Auroville Centre for Scientific Research · IIIT-H · IIM Ahmedabad · IIT Kanpur · MNIT Jaipur · Oak Ridge National Laboratory · Rensselaer · The University of California Berkeley

Organizational Partners

Glazing Society of India · Indian Green Building Council · ISHRAE · REIL · City of San Jose Capital of Silicon Valley · h+k · NRDC

Industry Partners

AIS Asahi India Glass Ltd. · BCIL be the change · Infosys · NeoSilica smartgrid solutions company · Oorja energy engineering · Paharpur A Group Company greenspaces · PLUSS® · Philips · Schneider Electric · Sintex Active Thinking · Skyshade™ Innovation in Daylighting & Shades · Wipro Applying Thought · Autodesk · Delphi · enLighted · Honeywell · LightingScience Welcome to the Light Ages · Nexant · Saint-Gobain · Synapsense Wireless Instrumentation Solutions