U.S.-China Clean Energy Research Center (CERC) 2.0

Joint Work Plan for Research Projects on Building Energy Efficiency (BEE)

1. Introduction

In November 2009, the President of the United States, Barack Obama, and the President of People's Republic of China, Hu Jintao, jointly announced the establishment of the U.S.-China Clean Energy Research Center (CERC). In its first phase from 2010 to 2015, CERC-BEE has advanced breakthroughs that improve energy efficiency in new and existing buildings and reduce greenhouse gas emissions. Key achievements include development of: a low-cost, high-efficiency air sealant that won the 2016 Gold Edison Award for Building Construction and Lighting Innovations; a next-generation ground source heat pump system that obtained an R&D 100 Award; tools for optimized renewable and distributed energy integration in buildings; advanced lighting controls; and new codes in China that reduce energy consumption by at least 20% against current levels.

In November 2014, the United States and China made a renewed and expanded commitment to CERC by extending its mandate for an additional five years from 2016-2020. Under the second phase of CERC-BEE (2016 to 2020), the expert teams will make further contributions to reduction in building energy consumption in both countries through the dedicated implementation of this Joint Work Plan.

2. Vision of CERC-BEE 2.0

Build on the foundation of knowledge, technologies, human capabilities, and relationships that accelerate and scale up the development and deployment of net-zero energy buildings in the United States and China.

3. Organizational Structure of the CERC-BEE

The Chinese and the U.S. organizational structure for management of CERC-BEE is shown in Figure 1.0 below. In the United States, the U.S. Department of Energy will be the highest level of organization that supervises the work of CERC-BEE. In China,

the Ministry of Housing and Urban-Rural Development will take the responsibility of supervising the work of CERC-BEE.

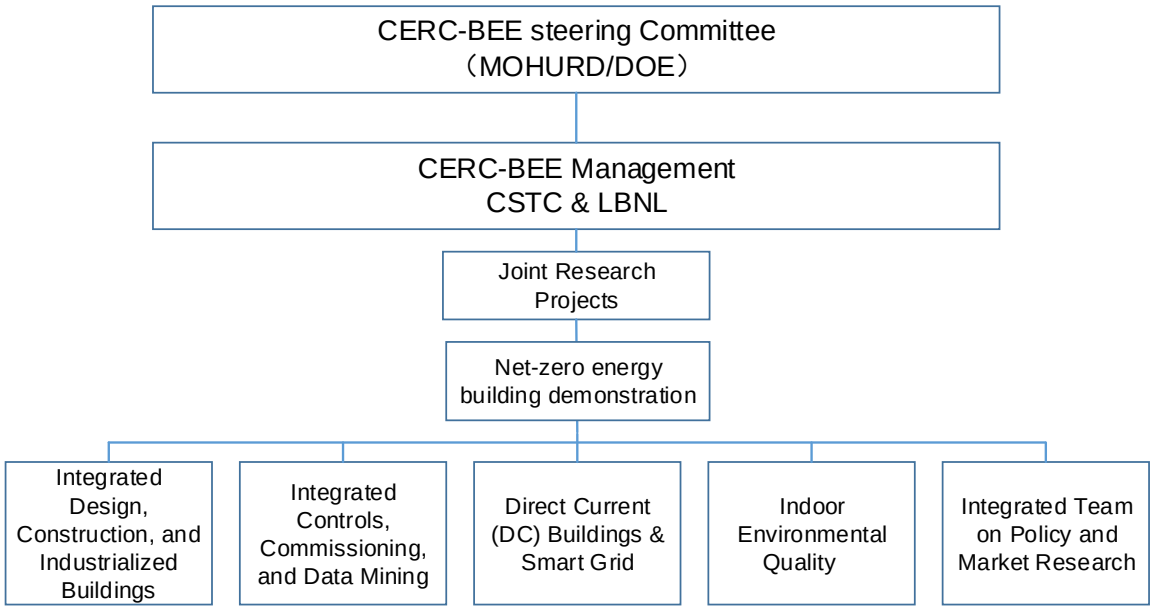

Figure 1.0 CERC-BEE 2.0 U.S. and China Organizational Structure

4. Research Areas

United States and China will conduct research jointly in the six areas identified in the figure above. Under the CERC's U.S.-China Protocol and its Intellectual Property Annex, no work on any cooperative activity between the two countries can begin without a mutually agreed upon Technology Management Plan.

A. Demonstrations

- Construction of "net-zero energy buildings" to promote technology application and engineering development in the U.S. and China.
- Establishment of demonstration project program with participation from both U.S. and China to promote close cooperation between the two parties.
- Implementation of CERC-BEE technologies, highlighting the integrity and integration.

B. Integrated Design, Construction, and Industrialized Buildings

- Develop one or more licensable packages of technology advancements for energy-efficient precast concrete wall systems that will enable licensees to reduce the contribution from the opaque part of walls to heating and cooling loads by 40% when compared to current practice, and to achieve this goal in a cost-neutral manner. By virtue of 3D printing of custom formwork, the package will enable architects a level of facade design flexibility not previously available to the precast industry in a cost-effective basis and will remove barriers to precast market share expansion and associated energy savings.
- Provide the construction industry with case studies that supply information on energy savings and payback periods from building envelope retrofits.
- Conduct further testing and evaluation of the performance and applicability of the two air sealing products developed under CERC-BEE 1.0. Both products are cost effective and easy to install. Tests will support further refinements and commercial deployment of these products when installed at below freezing temperatures.

C. Integrated Controls, Commissioning, and Data Mining

- Develop an open source framework, software, and algorithm that enable occupancy responsive model predictive controls (MPC) for the room, building, and campus levels. Have it implemented and tested on real buildings, for a) occupancy prediction, b) system identification based on machine learning, and c) model predictive control.
- Carry out an assessment of the energy benefits of occupancy responsive MPC at three levels for office buildings across typical U.S. and China climate zones.
- Establish an open test-bed at a demonstration building in Shanghai, China where industry and academia can develop and demonstrate their building control solutions.

D. Direct Current (DC) Buildings and Smart Grid

- Demonstrate the technical viability of direct DC distribution in buildings, and evaluate its potential energy saving and other non-energy costs and benefits (capital cost reduction, renewable energy integration, reliability, resilience, power quality, etc.).
- Enhance DC building benefits through communication and control, using *low (<600 V) voltage* DC directly integrated with renewable energy technologies and storage in buildings to achieve energy efficiency improvement and peak demand shift.

E. Indoor Environmental Quality (IEQ)

- Conduct a survey on indoor air pollutants (PM2.5, formaldehyde, VOCs and SVOCs) in commercial buildings.
- Develop and demonstrate air cleaning systems and air quality sensors to reduce energy consumption in commercial buildings. This will include integration of outdoor and indoor filtration and air cleaning with sensor-based controls and demonstrating energy savings and IEQ in varied climate zones and building types.
- Customize sorbents to capture carbon dioxide and indoor air pollutants with a focus on formaldehyde. Evaluate air cleaning material performance information for design.
- Develop simulation tools to advance development, design and deployment of air cleaning technologies for energy savings. This will include an air quality module integrated into Energy Plus.

F. Integrated Team on Policy and Market Research

- Establish targets and roadmap for building energy conservation and CO_2 emissions reductions for 2020, 2030, and 2050, assuming maximum cost-effective adoption of efficient technology and advancements in building energy policies (e.g., outcome-based codes, disclosure, and financing).

- Evaluate U.S. and Chinese buildings markets to determine similarities and differences in policymaking; market structure; financing models; and available technology to determine further areas of collaboration.
- Establish a methodology for outcome-based code development that harmonizes prescriptive measures with outcome-based performance.
- Develop and pilot building data transparency policies to improve retrofit identification, monitoring and verification (M&V), and program evaluation.
- Develop and pilot an open-source audit tool that quantifies energy and cost-savings potential and specifies energy efficiency measures for commercial buildings and portfolios.
- Identify and pilot building energy efficiency financing mechanisms and energy service delivery models that better leverage capital markets.
- Develop and launch "BEE Action," a market transformation program to drive very low energy buildings through market uptake of CERC-BEE technologies, software, etc. BEE Action will offer a website with informational resources, provide technical training, and conduct site visits to demonstration buildings.

5. Approvals

The above Joint Work Plan has been jointly developed and reviewed and is hereby approved by the respective authorities in each country, as indicated by the signatures of the appointed CERC-BEE Directors, below, made this date of July 1st, 2016

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