Buildings Energy Efficiency Consortium

US-China Clean Energy Research Center (CERC-BEE)

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Led by **MoHURD Center of Science and Technology of Construction** of China and **Lawrence Berkeley National Laboratory** of the United States with:

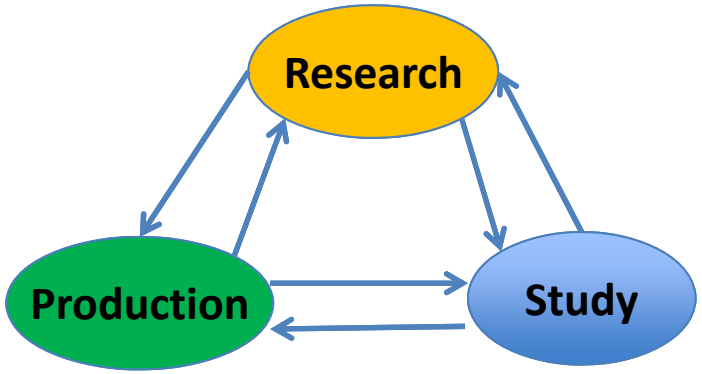
About CERC-BEE

CERC-BEE: US-China Clean Energy Research Center

Ministry of Science and Technology,Ministry of Housing and Urban-Rural Development, U.S Department of Energy

- Initiated in March 2011
- United, Open, Practical

Platform for Research, Production,and Study

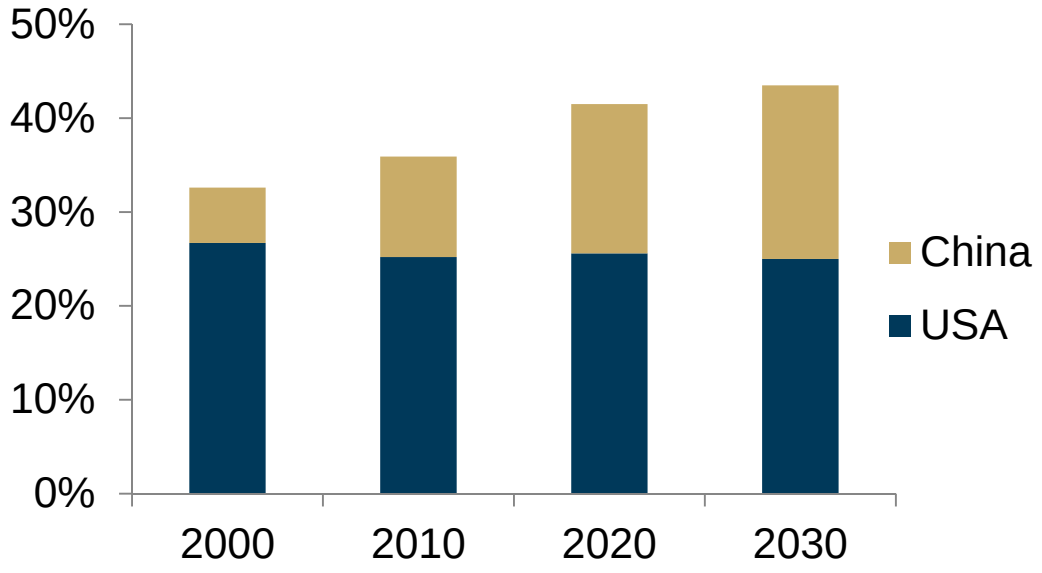


Promote building energy conservation in both counties

- Collaboration in R&D
- Organize Conferences
- Product/Technology Inspection and Demonstration
- Information Platform
- Promotion of Achievements

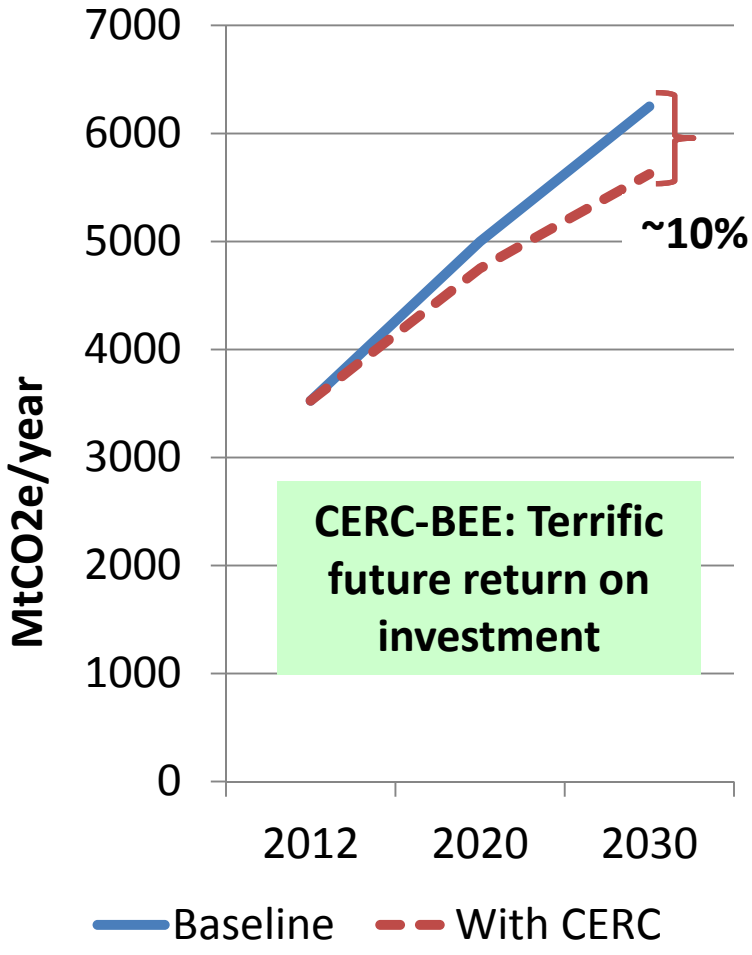
Vision: Widespread Adoption of Very Low Energy Buildings

% Global Building Energy Use



- Building accounts for 40% of the total global CO_2 emissions (trending to 50%)
- U.S. and China account for close to 40% of the global building energy
- U.S. consumes more energy/capita, China is growing fast, and we share the same challenges

US – China Buildings Emissions



Impact and Approaches

100 million tons CO_2 reduction per year by 2025

Pioneering collaboration model with foundational IP protection

Accelerated technology development and deployment benefiting both countries

Development

Demonstration

Deployment

Technology Innovation:

- New state-of-the art products
- Software
- Tools
- Guidebooks

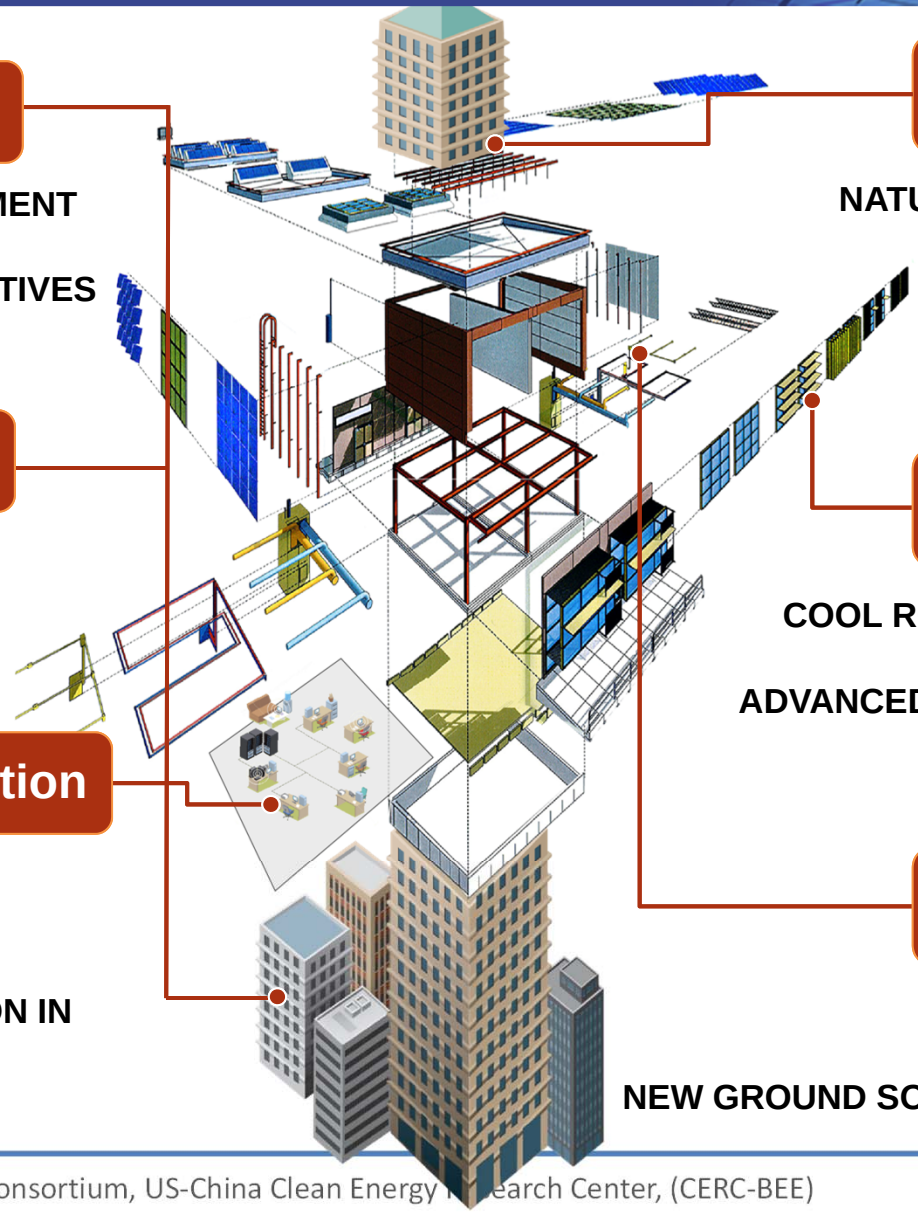
Pilot Buildings:

- Demonstrating value of technologies
- Accelerating development
- Commercial impact

Codes and Market:

- Industry commercialization
- Policies and standards
- Trainings
- Developers as path to market

A Portfolio to Deliver Real World Impact



Policy, Market

DATA & ENERGY MANAGEMENT

POLICY ANALYSIS & INCENTIVES

Demonstrations

BUILDING TECHNOLOGY INTEGRATION

Renewables Integration

BUILDING TECHNOLOGY INTEGRATION

INTEGRATION & OPERATION IN REAL TIME

Design

NATURAL VENTILATION DESIGN

INTEGRATED DESIGN

OCCUPANT BEHAVIOR

Envelope

COOL ROOFS/SURFACE COATINGS

ADVANCED WINDOW TECHNOLOGIES

INSULATION

Equipment

LIGHTING CONTROLS

NEW GROUND SOURCE HEAT PUMP DESIGN

Materials Innovation

Cool Roof and Surface Coatings

High Performance, Superhydrophobic

- Dow, LBNL, ORNL, GABR, CU developed new materials and quantifying impacts
- No or very little incremental cost
- LBNL's accelerated aging protocol speeds prototyping by reducing 3 year wait to 3 days
- 5-20% reduction in annual cooling energy use on top floor of building in hot-summer climate
- 3B m^2 upgradeable by 2025 in the U.S. and China
- Cool roof standards (2015); sales in 2016

Liquid Flashing

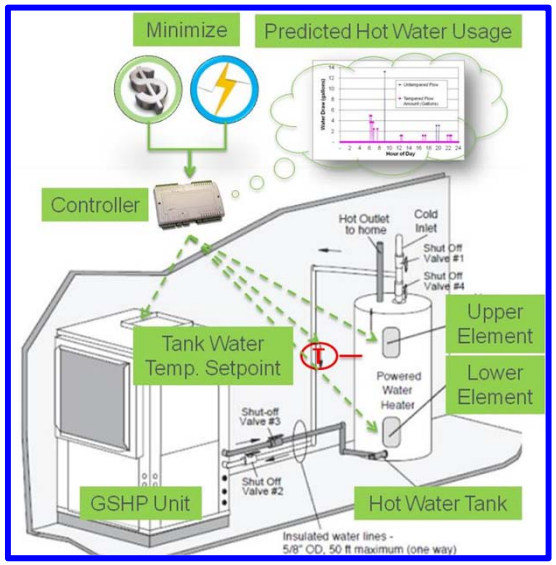
Easy to Apply, Low-toxicity

- Dow, ORNL, and CABR created materials and testing procedures
- ~10% decrease in heating loads in commercial buildings in the U.S.
- Low cost
- Reduces installation time by 50 to 75% when compared to tape
- Patent awarded to liquid flashing for residential buildings

Equipment and Envelope Innovation

Ground Source Heat Pumps (GSHP)

Improved Energy Efficiency and Cost



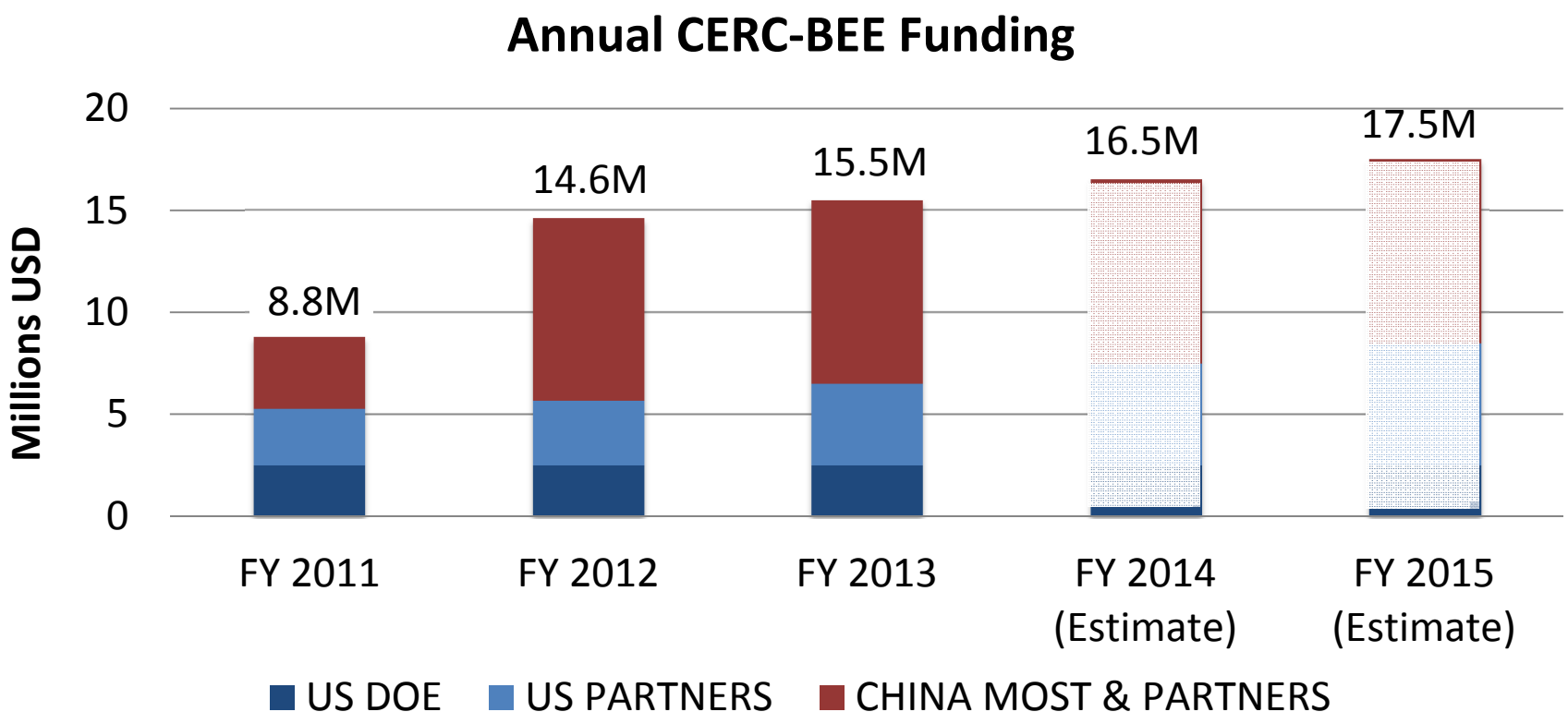
- ClimateMaster, ORNL, CABR, and TU
- Developing control strategies that improve system operational efficiency by 10 -20%
- Smart hot water tank controls that has potential to improve hot water generation efficiency by at least 10%
- 20 to 30% reduction in drilling depth

Advanced Windows and Shading

Modeling Tools and Design

- Sage Glass, Lutron, Dow, 3M, LBNL, CU, TU
- Field testing dynamic window, shading, and daylight-redirecting systems in US and China
- 20-30% perimeter zone energy savings
- Developed modeling tools and trained users
- Reductions of ~1 quad/year, 26 Mtons/year CO_2 by 2025

Year Over Year Funding Increase



- Industrial partners see value, demonstrated by +30% annual average growth rate for cash and in-kind contributions to date
- Anticipated 5-year total program funding of $73M vs. $50M planned (+46%)

CERC 1.0 Milestones

2010

- >50 founding partners

2011

- Technology Management Plan signed

2012

- 8 codes and standards adopted
- 5 demonstration buildings
- >150 research publications

2013

- >6 product launches
- >25 patents filed
- 2 new industry partners (Disney, Lend Lease)

2014

- Develop additional codes and standards
- Ensure enduring and expanded research- industry partnerships
- More patents and product launches

2015

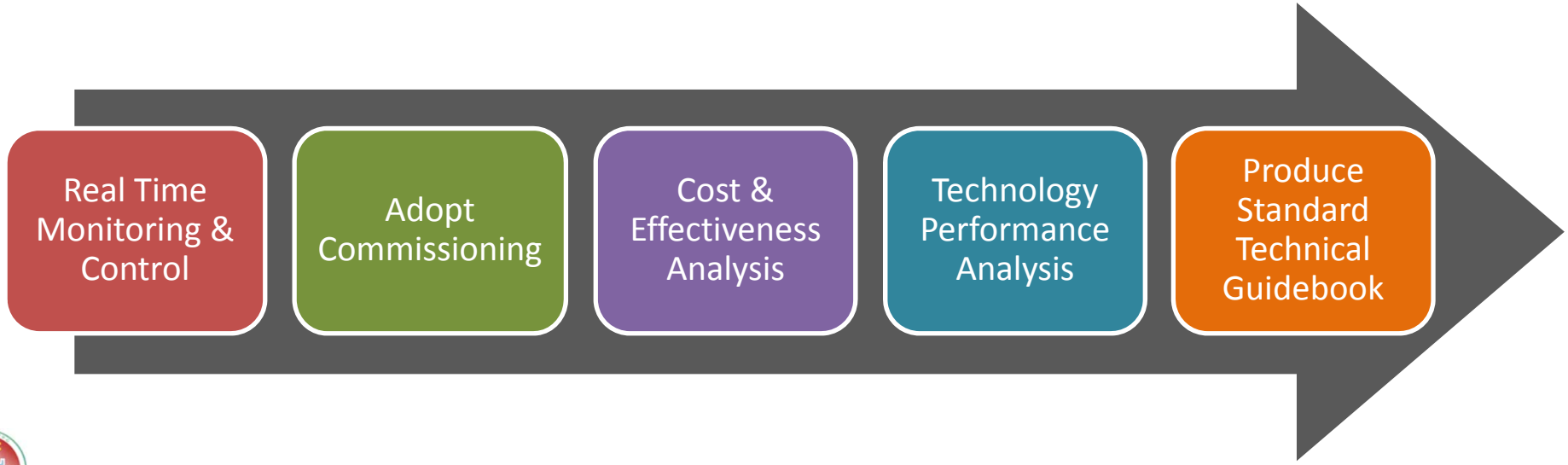
CERC 2.0

Net Zero

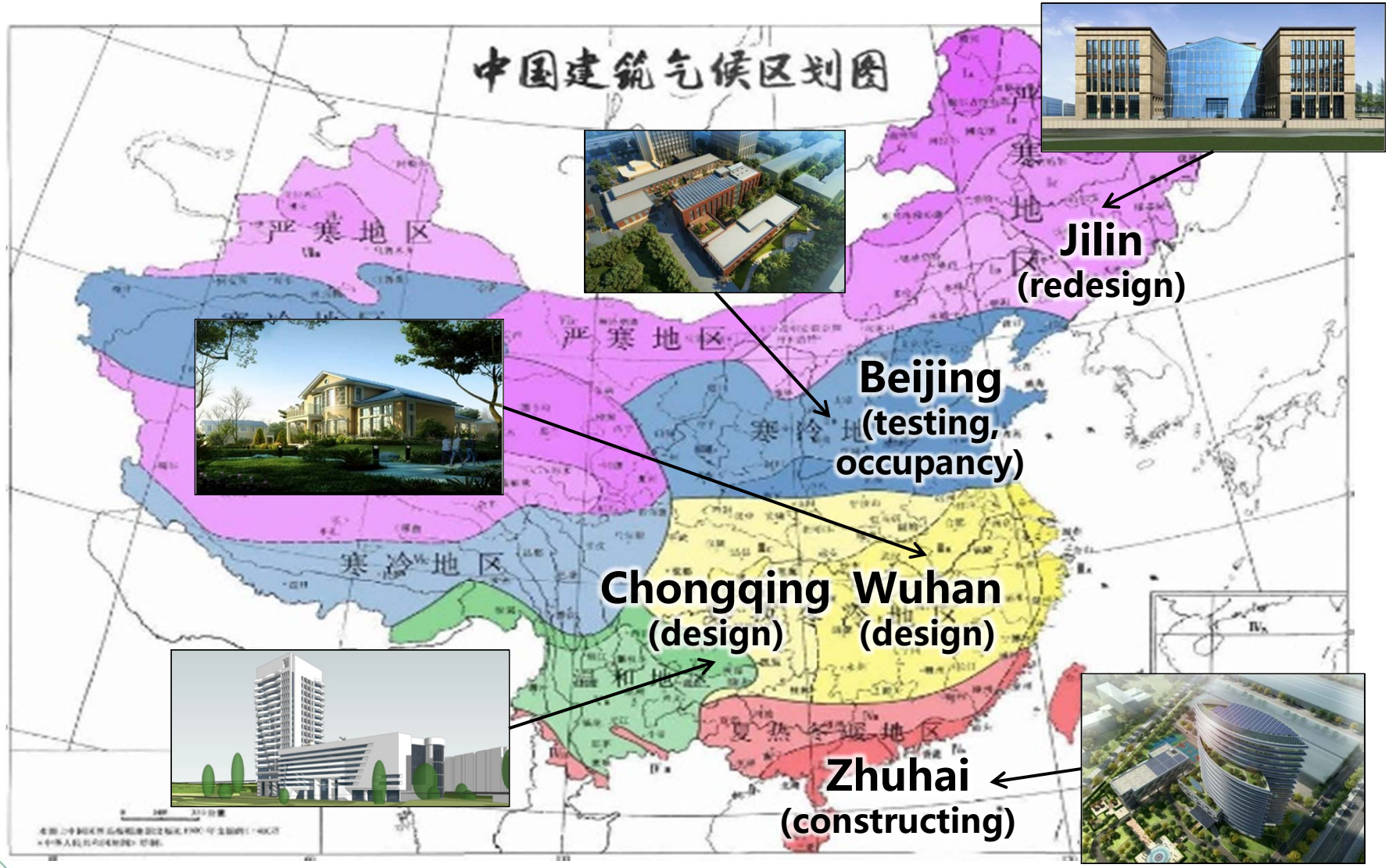
Very Low Energy Demonstration Buildings

1. Joint demonstrations catalyze adoption
2. Technology solution packages
3. Accelerating technology deployment
4. Utilizing CERC-BEE platform and partnerships
5. Technology research, design system, energy-saving operation management and market mechanisms

Prioritize passive technology and optimize by active technology



Five Pre-selected Demonstration Buildings in China's Distinct Climate Zones



Xingye R&D Center

- **GFA:** 23,471 m^2 , 17 Floors
- **Time of Completion : Oct,** 2015
- **Est. Energy Density :** 51 kWh / m^2 · a **(70 kWh/(m^2·a))**
  - 76.7% Energy consumption reduction
  - Local code requires 50% reduction
- **Certification Goal:**
  - GBL-Three Stars: Design and Operation
  - LEED-NC Platinum

Building Design

- Natural Ventilation (MIT)
- Daylighting in basement, green roof

Envelope and Mechanical Design

- Double LOW-E Glass
- Heat Recovery
- Carbon Dioxide Monitoring
- Rainwater Harvest
- Energy-feedback Elevators

Renewable Energy

- PV: 238.56kw, Solar thermal: 800L/d
- PV for sun shading

Integrated Building

- Life cycle commissioning (Lawrence-Berkeley Lab)
- Building Energy Management System
- Smart Lighting (Lutron)

Others

- Shower facilities, alternative transport
- SmartGrid (Lawrence-Berkeley Lab)
- Sustainable Data Center

China Academy of Building Research

- **GFA:** 4 Flloors, 3800 m^2
- **Time of Completion: Aug,** 2014
- **Est. Energy Desity:** 25 kWh / (m^2 · a) (80 kWh/(m2·a)
  - 80% Energy consumption reduction
- **Certification Goal:**
  - GBL-Three Stars: Design and Operation
  - LEED-NC Platinum
  - Energy Start Score of 95

Building Design

- Heat-bridge free design
- Human activity recognition
- Natural ventilation
- Green roof and facade

Envelope and Mechanical Design

- Rainwater reclamation
- Air Quality control system
- Flash distillation air-tightness spray (Dow Chemical)
- Air-tight materials (3M)

Renewable and Distributed Energy

- Renewable energy
- PV and solar thermals
- Ground source heat pumps (ClimateMaster)

Integrated Building

- Building Energy Management System
- Intelligent Lighting Control (Lutron)

Policy Research Results and Application

Establish *ISO/FDIS 12655: International Standard for Presentation of Measured Energy Use of Buildings*

- Unify the presentation methods of energy consumption,facilitate the energy study in different countries
- Provide solid foundation for energy consumption limits

Building Energy Consumption Limits Standards Development and Application

- Shenzhen,Shanghai, and Beijing have established public building energy consumption limits proposal and criteria
- All the public buildings such as commercial offices, retails, hotels will gradually reach the energy reduction requirement by comparing to the standard
- Create a market for building energy trading

Revise *Design Standard for Energy Efficiency of Public Buildings*

UDC

中华人民共和国国家标准

P

GB 50189-2005

公共建筑节能设计标准

Design standard for energy efficiency of public buildings

- Mandatory buildings can reduce energy by 30% more
- Public building GFA, , increasing at 0.5 billion m^2 annually, will reach 10 billion m^2 by 2015
- Expected to release in 2015

Case for CERC 2.0: Affordable Net Zero

1. Strong collaborative foundation, but adoption takes time
2. Moving from components to systems, from buildings to communities and cities
3. Great momentum in industry participation, needs to be maintained and increased.
4. Global recognition - CERC model proliferated, U.S-China leading in climate change combat
5. Innovative research for lower cost, better NZEB operations
6. Bring new products to U.S. and China markets
7. More jobs and return on investment

Need for continuing CERC more compelling than ever

Conclusion and Q&A

Supported by U.S. Department of Energy and China Ministry of Science Technology, with:

U.S. Project Lead:
- Lawrence Berkeley National Laboratory (LBNL)

China Project Lead
- Center of Science and Technology of Construction, Ministry of Housing and Urban-Rural Development (MOHURD)

U.S. Partners:
- 3M, Inc.
- Bentley Systems Inc.
- C3 Energy
- ClimateMaster
- Disney*
- DOW Chemical Company
- Energy Foundation China
- ICF International (ICF)
- Lend Lease*
- Lutron Electronics
- Massachusetts Institute of Technology (MIT)
- Natural Resources Defense Council (NRDC)
- Oak Ridge National Laboratory (ORNL)
- Saint-Gobain
- UC Davis

* Denotes new partners

China Partners:
- Anhui Roba Energy Saving Technology
- Beijing Ever Source Science & Technology
- Beijing Huaqing Geothermal Development
- Beijing Huayi Leye Energy Service
- Beijing Lampower Photoelectric
- Beijing Persagy Energy Saving Technology
- Beijing Zhongchengke Green Building Tech
- China Academy of Building Research
- China Lamp Electrical Co
- China Society for Urban Studies
- Chint Solar (Zhejiang) Co.
- Chongqing University
- Chongqing Zhonghai Industry
- CISDI Engineering
- CSUS Green Lighting Science & Technology
- Dasheng Roller Shutters (Shanghai)
- Dongguan Vanke Building Technology
- East-West Control Group (Shenyang)
- ENN Group
- Guangzhou Zhengli General Electric
- Himin Solar Energy Group
- Jiangsu Aide Solar Energy Technology
- Jiangsu Disimai GSHP Air Control
- Jiangsu Refrigeration & Heating Equipment
- Jiangxi Lattice Lighting
- Jilin Kelong Building Energy-Saving Tech
- Landsea Group
- LH Technology
- Liaoning Solar Energy R & D
- Nanjing Fullshare Energy Technology
- Nari Technology Development
- Shanghai Convertergy Energy Tech
- Shanghai Fuka Const. & Engineering
- Shanghai Futian AC Equipment
- Shanghai Qingying Industrial Shares
- Solatube CECIC Daylight Tech
- TelChina (Shandong)
- Tianjin University
- Tongguang Jiangong Group
- Tongji University
- Tsinghua University
- Wuhan Rixin
- Wuxi Suntech Power
- Xinghua Green Industry International
- Xinjiang Green Refreshing Angel Environment Technology
- Yingli Energy (Beijing)
- Zhejiang Dun'an Artificial Environmental Equipment
- Zhongji Yuanxiong Energy Storage Tech
- Zhuhai Singyes Green Building Tech