BUILDINGS ENERGY EFFICIENCY CONSORTIUM

U.S. - CHINA CLEAN ENERGY RESEARCH CENTER (CERC-BEE)

Dr. Nan Zhou,

Lawrence Berkeley National Laboratory of the United States

Professor Liang Junqiang,

MoHURD Center of Science and Technology of Construction of China

July 1, Beijing, China

Tasks for the Remaining CERC 1.0 from Last Steering Committee Meeting

- **Improve CERC-BEE communication and dissemination through BEE Action, coordination with US-China Energy Cooperation Program, Foreign Commercial Service, etc.**
- **Strengthen the technical quality of projects.**
- **Program prioritization to focus on high impact projects.**
- **Drive innovation delivery and commercialization achieving tangible outcomes e.g. IP, license, copyright, standards, product launches.**
- **Ensure enduring and expanded research- industry partnerships.**
- **Working closely with each other's government, expert committee, industry partners and to develop CERC 2.0 implementation plans.**

Recent Promotion of CERC-BEE

CLEAN ENERGY MINISTERIAL
Accelerating the Global Clean Energy Transition

U.S. - CHINA CLIMATE-SMART CITIES INITIATIVE

Clean Energy Ministerial (CEM7) Solutions Showcase, June, San Francisco

Secretary Moniz, Governor Brown, and Zhenjiang Delegation visit CERC-BEE Showcase at CEM7.

CERC-BEE U.S. Director, Nan Zhou, speaks on CERC-BEE at U.S.-China Climate Leaders Summit.

Close Cooperation to Develop CERC 2.0 Plans

* From August 2014 :

* July 2015 in Zhuhai, China discussed plans for CERC 2.0 and also how to complete CERC 1.2 work

* 5 rounds of proposal submission & feedback in the U.S. between BTO/CERC management/PIs/IAB members

*Multiple in-person meetings in China

- Oct. 15, 2015 Joint planning meeting in Beijing with U.S. + Chinese research teams

- Jan. 1, 2016 LBNL joint management meeting w/ MoHURD in Beijing

- Jan. 1, 2016 LBNL management meets with Shenzhen IBR on collaboration

* Feb. 16 IAB Chair (Clay Nesler) planning meeting w/ MoHURD, CABR, CABEE

*DOE/BTO all day long Merit review on March 4, 2016

* March 8th and April 6th 2016 Demonstration projects plan seminars in Fuzhou, Shenzhen, China

MOHURD all day long Merit review July 13, 2016

* Monthly conference calls between BTO + LBNL Management + Advisors; meetings with DOE leadership

CERC-BEE Recent Achievements

- **LIQUIDARMOR, by DOW and ORNL, wins 2016 Gold Edison Award for Building Construction & Lighting Innovations.**
- **CABR' near-zero energy building, wins 2015 Prize for Cities of the Future Honorable Mention**
- **ClimateMaster's next-generation ground source heat pump systems wins *R&D Magazine's* 2015 R&D 100 Award.**
- **LBNL's Cool Roofs wins outstanding research award at 4th International Conference on Countermeasures to Urban Heat Islands (Singapore, 2016)**

	TYPE OF PRODUCT	2011	2012	2013	2014	2015
SUBTOTALS	Products Launched	0	0	3	4	3
	Guidebooks, Reports	7	8	8	8	15
	Software	2	2	3	5	3
TOTALS		9	10	14	17	21

Equipment & Envelope Innovation

Next Generation GSHP Systems

Low-cost, integrated, smart controls

- ClimateMaster, ORNL, CABR, and TU
- Identified new GHX that uses **14%–30%** less drilling and energy
- Developed first-of- its-kind R&D center and test bed for distributed GSHP systems at CABR
- Developed a new analytic tool for cost monitoring and detecting faults in GSHP systems
- Designed an innovative flow-demand-based control to **reduce pumping energy by 20%.**
- ClimateMaster launches Co-axial GHX and the Trilogy integrated heat pump.

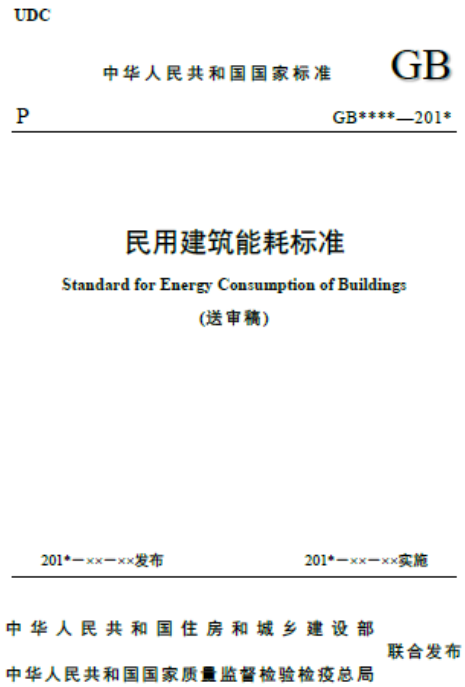
Liquid Flashing

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
- Bridges gaps up to ¼" wide without supporting materials
- Reduces installation time by **50 to 75%** when compared to tape
- Dow launches patented sprayable liquid flashing under LIQUIDARMOR – CM and RS

New Energy Conservation Standards

Civil Building Energy Consumption Standard GB/T 51161-2016


UDC

中华人民共和国国家标准 GB

P GB****—201*

民用建筑能耗标准

Standard for Energy Consumption of Buildings

(送审稿)

201*—××—××发布 201*—××—××实施

中华人民共和国住房和城乡建设部

中华人民共和国国家质量监督检验检疫总局 联合发布

- Planning Stage
- Plan Bidding
- Plan Design
- Drawing Design
- Equipment
- Bidding
- Construction Controlling
- Operation Management
- Diagnosis of Energy Saving

- The first outcome-based standard.
- Constraint value, advanced value for different climates.
- Guide the design, construction, and operation of the whole building.
- Focus on the usage patterns, O&M level of the buildings.
- Implement from Dec. 1st , 2016

Design Specification for Building Energy Conservation GB50189-2015

UDC

中华人民共和国国家标准 GB

P GB 50189－2015

公共建筑节能设计标准

Design standard for energy efficiency of public buildings

2015－02－02 发布 2015－10－01 实施

中华人民共和国住房和城乡建设部

中华人民共和国国家质量监督检验检疫总局 联合发布

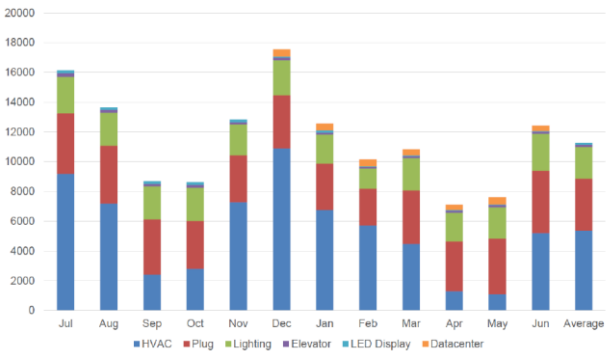
- 30% higher efficiency levels than previous version.
- Establish a typical public building model database;
- Update building envelope thermal performance limit and the source of cold energy efficiency limits;
- Increase the envelope weighed judgment precondition, supplement and refine trade-offs and requirements to weighed judgment precondition software;
- Add water supply, drainage, and electrical system and renewable energy application requirements.

CERC 1.0 Demonstration Projects Yield Meaningful Technological Progress

#1 Beijing, CABR Demo Building

- Office, cold climate zone, 4025m^2
- Energy Intensity 25 kWh/(m2.a) (37kWh/(m^2·a) total energy)
- 0 fossil fuel for space heating
- Uses 50% less energy for cooling
- Uses 75% less energy for lighting
- High actual indoor environment satisfaction level
- After adjustment, the efficiency of various systems is higher

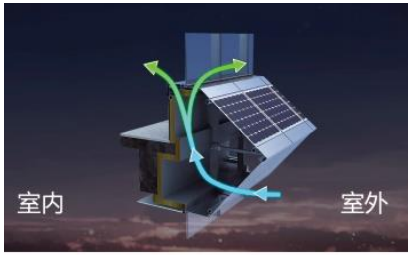
CABR Demo



Annual Energy Consumption Index Value

#2 Zhuhai, Xingye Demo Building

- Office Building, 23,500 m^2, Hot Summer and Warm Winter zone
- Annual Energy Intensity：52.4kWh/m^2·a
- Energy Saving Target：76.7%
- Renewable energy：172,863 kWh
- Percentage of Renewable energy：14.4%

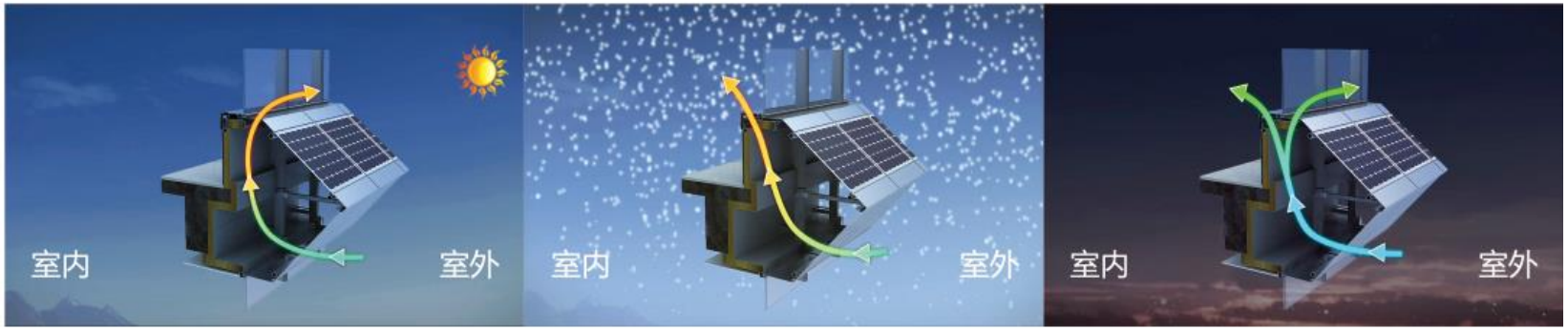


春秋过渡季节及夜晚

CERC 1.0 Demonstration Projects Yield Meaningful Technological Progress

#1 Beijing, CABR Demo Building

有策略的自然通风技术，比机械新风节约30%的用能。



夏季　　冬季　　春秋过渡季节及夜晚

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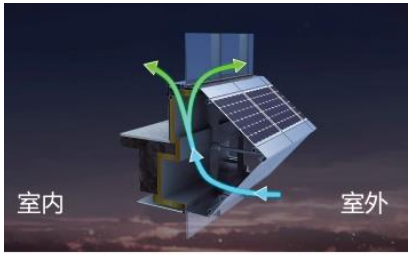

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Program Prioritization to Focus on High Impact Projects

2011-2013 CERC1.0

- 35 projects, 50% joint
- Projects too scattered, disconnected
- Focusing on small incremental improvement in single component
- Producing reports and papers

2013-2015 CERC 1.2

- 14 projects, 100% joint
- Projects more focused and aggregated, but still disconnected
- Demo projects to test integration of technologies
- Shifting investment focusing on innovation
- Independent IP

2015~ CERC 2.0

- 5 large projects, 100% joint
- Integrated technologies to deliver maximum system efficiency
- High impact technology breakthroughs and scalability
- Demo in U.S. and China, includes retrofit, district applications
- Aiming for joint IP
- Increased focus on commercialization

Transitioning from CERC-BEE 1.0 to 2.0 to achieve Net Zero Energy Buildings

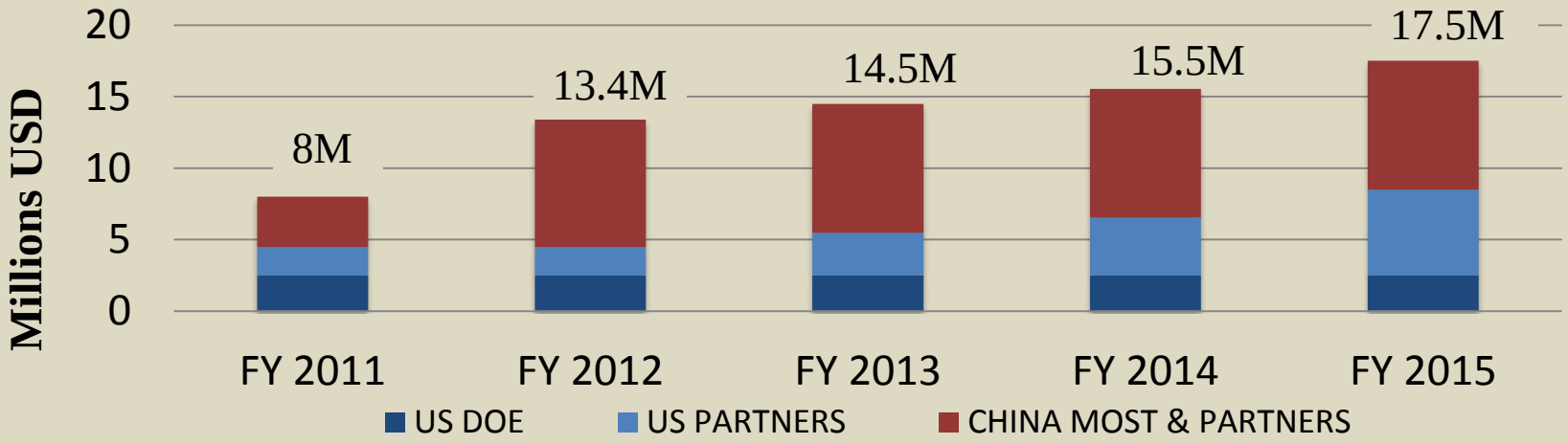
IAB Growing Year After Year Demonstrating Strong Engagement

>59 U.S. & China Industry Partners including:

Johnson Controls
DOW
3M
BASF We create chemistry
LUTRON
PCI Precast/Prestressed Concrete Institute
United Technologies
Lend Lease
SAGE ELECTROCHROMICS, INC.
SAINT-GOBAIN
CLIMATEMASTER
C3 Energy
WattStopper
Walt Disney Imagineering
ENERGY FOUNDATION
legrand
citi CITIBANK
保尔森基金会 PAULSON INSTITUTE
Bentley
FORESTCITY
IMT INSTITUTE FOR MARKET TRANSFORMATION
VICOR The Power Behind Performance
NEXTEK Power Systems
ROCKY MOUNTAIN INSTITUTE
LUMENCACHE
nbi new buildings institute
乐业节能 LEYE ENERGY SERVICE
通广建工集团有限公司 Tong Guang Jian Gong Group Co., Ltd.
NARI 国电南瑞科技股份有限公司 NARI Technology Development Co.,Ltd.
Pelsagy
安徽罗宝 ANHUIROBA
JKELONG
阜泰建设集团 FUTAI CONSTRUCTION GROUP
MCC 中冶赛迪
SY 興業太陽能 SINGYES SOLAR
ENN新奥 用我所能 善待明天
丰盛新能源 FULLSHARE ENERGY
CSCEC
日新科技 RIXIN TECHNOLOGY
CABEE
iBR 深圳市建筑科学研究院 Shenzhen Institute Of Building Research
国家发展和改革委员会能源研究所 Energy Research Institute National Development And Reform Commission
vanke 万科 赞美生命 共筑城市
安徽罗宝 ANHUIROBA
辽宁太阳能研究应用有限公司 LIAONING SOLAR ENERGY R&D CO., LTD
通广建工集团有限公司 Tong Guang Jian Gong Group Co., Ltd.
中华人民共和国财政部 Ministry Of Finance People's Republic Of China

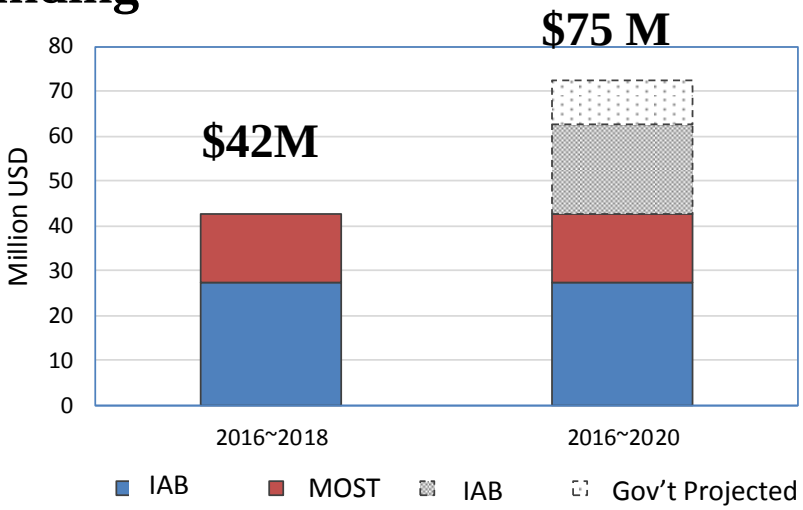
Transitioning to CERC-BEE 2.0 - Total Funding and Cost Share Updates

Annual CERC-BEE 1.0 Funding



CERC-BEE 2.0 Funding

2016 (Million USD)	US	China	Total
IAB COSTSHARE	4.3	4.85	9.15
DOE /MOST REQUEST	2.5	2.5	5
TOTAL	6.8	7.35	14.15



CERC-BEE 2.0
Moving Towards Net Zero Energy Buildings

CERC-BEE 2.0 Target and Approach

Vision

Build on the foundation of knowledge, technologies, human capabilities, and relationships that accelerate and scale up the development and deployment of very low energy buildings in the U.S. and China.

Toward Net Zero Energy Building

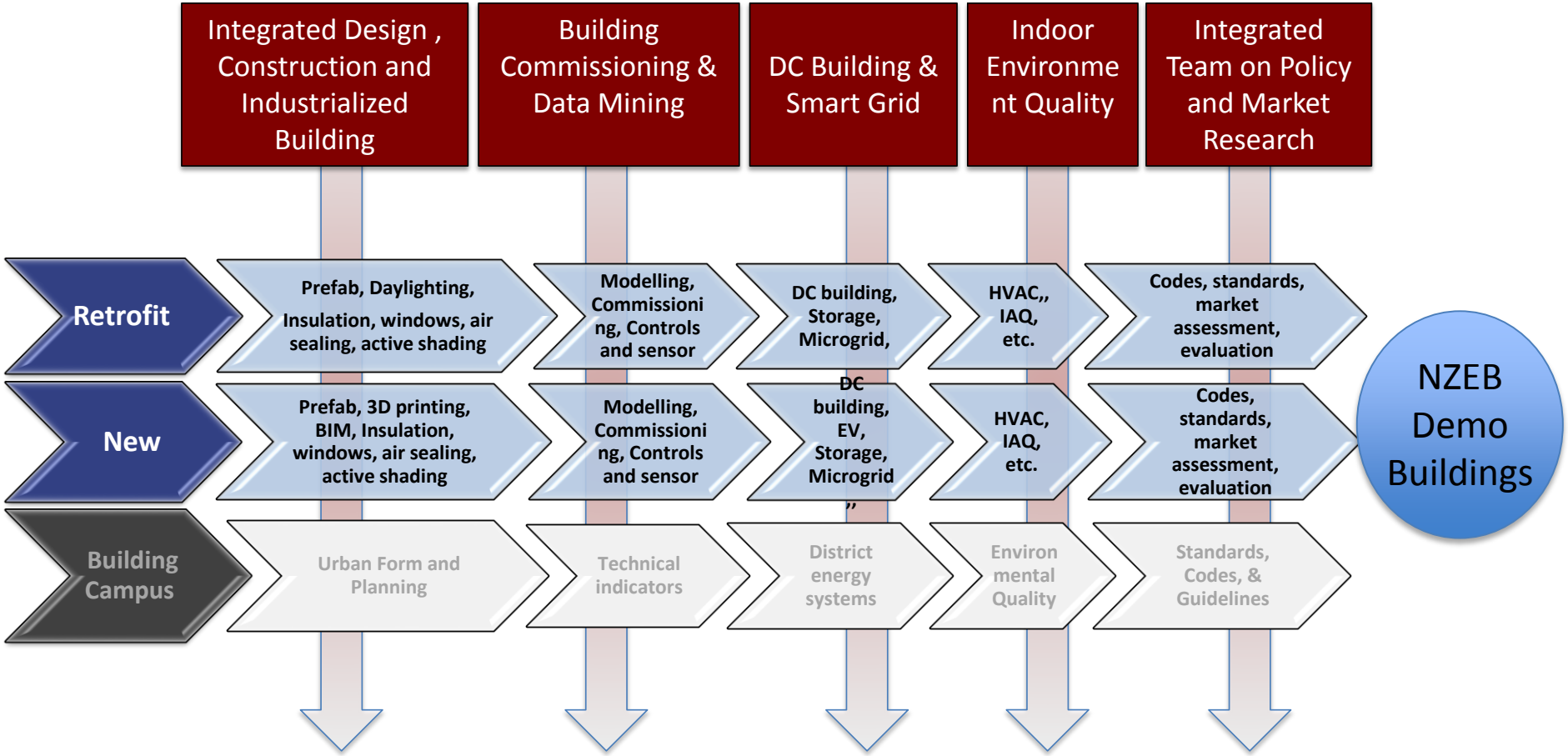
IAB partner led | R&D and Demonstration Project | Systems integration

Demonstration in China + Demonstration in U.S.

Cooperation basis | Technology & product achievements | Demonstration projects

CERC BEE 1.0 Success

Original Pathways for Integrated Technology Development



Demonstration of NZEB in China

- Construction of 5-8 "net-zero energy buildings" to promote technology application and engineering development in different climatic zones.
- Establishment of demonstration project program with participation from both China and U.S. to promote close cooperation between two parties.
- Implementation of all the technologies to be developed, highlighting the integrity and integration.

Demonstration project sites include: Beijing, Tianjin, Shanghai, Chengdu, Fuzhou, Shenzhen and others, to be completed before the end of 2018.

Demonstration of NZEB in United States

– **Heller-Manus Corporation** has five projects zero-energy projects in California .

350 Bush

505 Brannan

1510 Webster

Menlo Gateway

181 Fremont

– **American Modern Green** has 48.5 acres of mixed use types of buildings, including townhouses, multi-family units, apartments, commercial and retail and hotels in Texas.

Proposed Plan Site

Architect Rendition

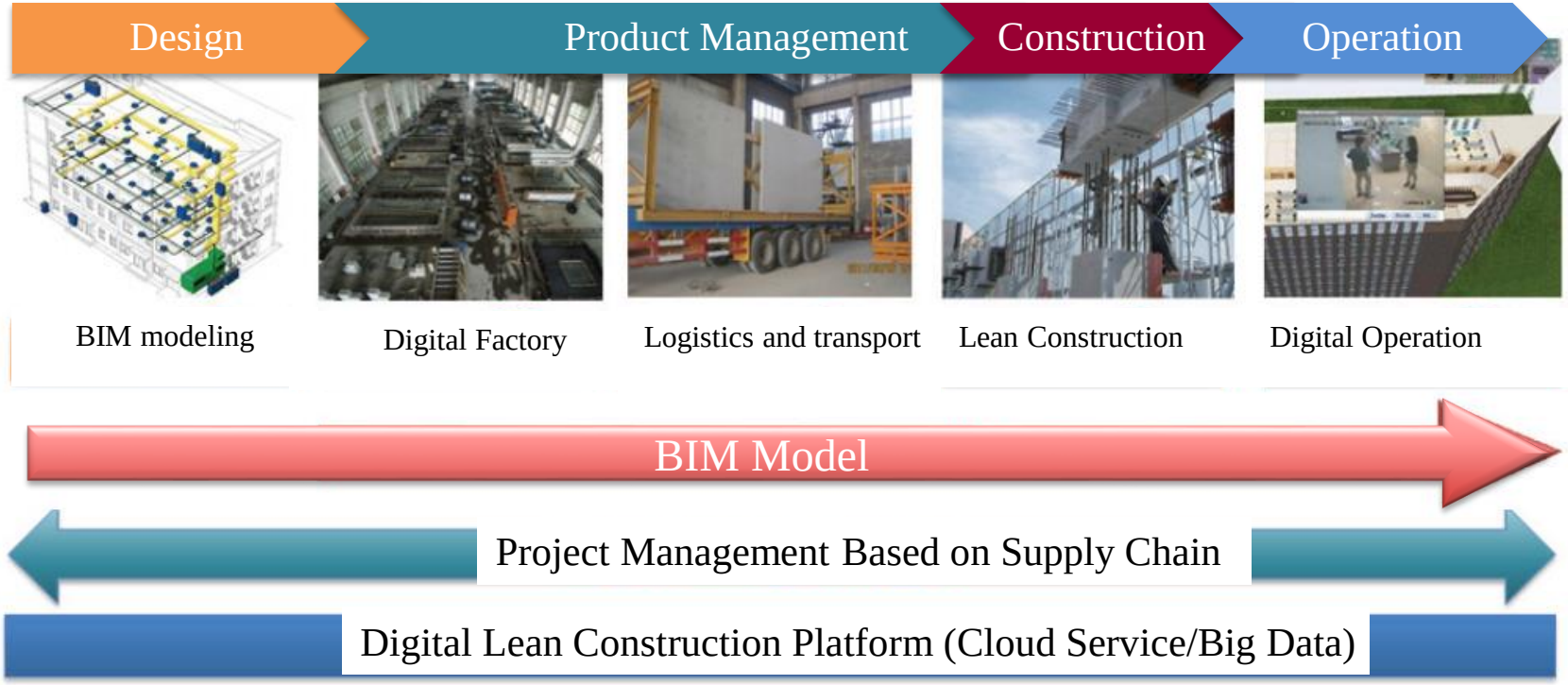
Integrated Design, Construction, and Industrialized Building

Problems:

- Information is disconnected during all stages of design, construction and operations
- Rough technology during construction process

Solution: Integrated design and construction information platform

- Digital production, transportation, and construction management
- Improve construction quality and operational management level



Integrated Design, Construction and Industrialized Building

To promote the modernization of the construction industry:

- Research prefabricated concrete and steel construction solutions to promote the building industrialization, standardization, information technology, and integration and innovative applications.

(1) Problem

- Actual savings from energy-efficient building envelope technologies depend on quality of onsite workmanship
- Quality control is difficult at construction sites

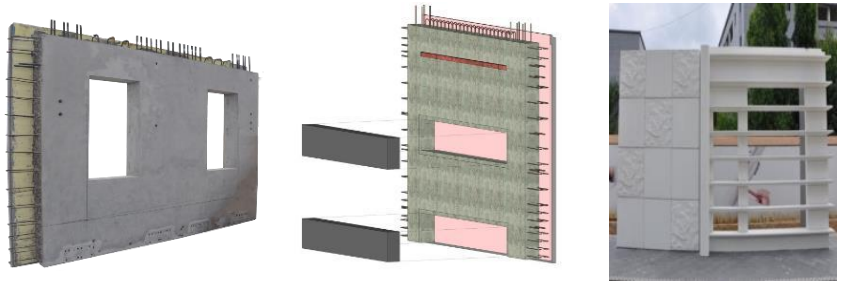
Solution: offsite construction of precast insulated wall panels

- Factory quality control of energy-saving features
- Faster construction in the field
- Less construction waste

Next generation of precast concrete panels:

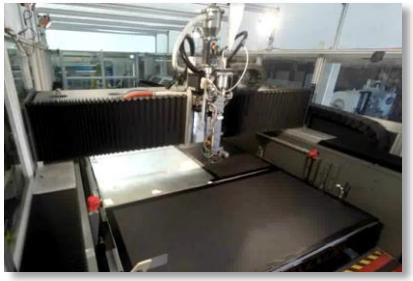
- Cost-neutral
- 40% decrease in wall-transmitted HVAC load
- Thinner and lighter concrete wythes (3” → 1-3/4”)
- Non-corroding composite connectors and lifters
- 3D printed formwork
- Lower CO_2 emissions
  - 20 to 40% cement replacement, less concrete due to thinner wythes, integrates emerging low-GWP insulation

External wallboard research



Formwork

vs.



Manual assembly 3D printing

Energy Savings and CO_2 Reductions

2030 Estimates	US	China
Energy savings (quads)	0.04	0.32
CO_2 reductions (M tons)	0.6	7.13

Integrated Design, Construction and Industrialized Building

(2) Problem:

- Opaque walls are responsible for about 14% of the energy consumed in existing US commercial buildings
- Owners reluctant to retrofit because of scarcity of data on energy savings and payback period

Solution: retrofit case studies

- 3rd party assessment
- Hygrothermal analysis of proposed retrofit
- Improvements in airtightness and/or thermal insulation
- Data collection before and after retrofit
- Simulations to estimate energy savings and payback time

Retrofit types to be evaluated:

- Recladding
- Overcladding
- Interior retrofits

Energy Savings and CO_2 Reductions

2030 Estimates	Total
Energy savings (quads)	0.26
CO_2 reductions (M tons)	18.4

Technologies

Dow FROTH-PAK ULTRA
Refillable cylinders

Dow LIQUIDARMOR
Sprayable liquid flashing

3M 3015VP air and water barrier primer-less self-adhered membrane

Dow THERMAX (ci)
Polyiso board insulation

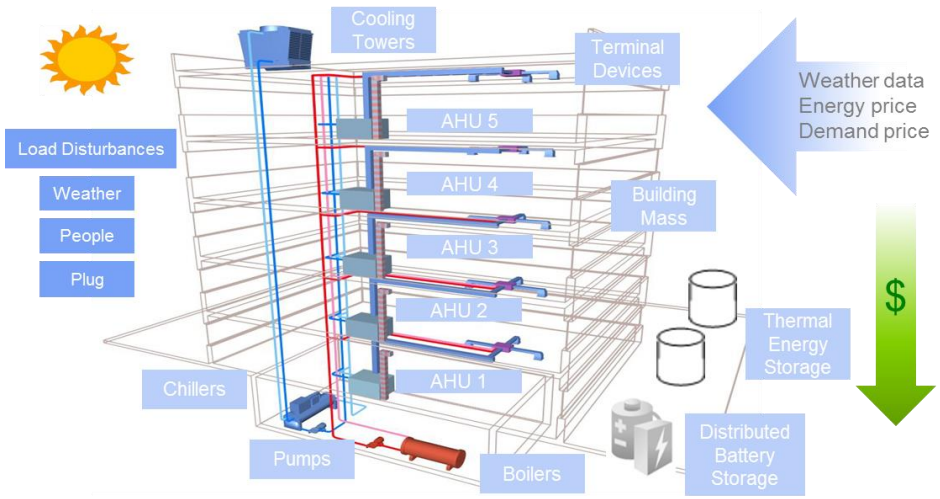
3M 3015 air, water and vapor barrier
primer-less self-adhered membrane

3M 8067 flashing tape

Integrated Sensors, Controls and Commissioning

Problem: Building operation needs to become elastic, energy-optimized, grid-aware and occupancy responsive.

Impact: Wide-scale occupancy-responsive model predictive control (MPC) commercialization to transform the built environment to be zero-net energy, smart-grid, and IoT ready.



Energy Savings and CO_2 Reductions

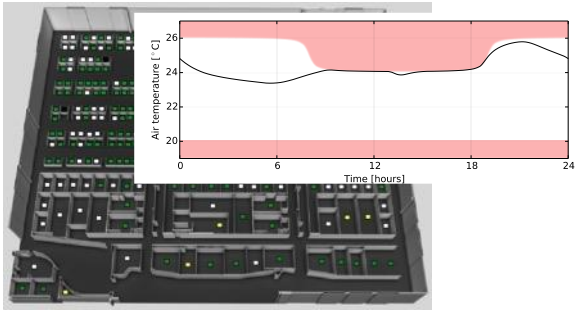
2025 Estimates	Total
Energy savings (quads)	2.9
CO_2 reductions (M tons)	695

Integrated Sensors, Controls and Commissioning

Approach: Develop and demonstrate open-source, hierarchical occupancy responsive MPC at room, building, and campus levels, built on open standards, consisting of:

Machine learning
for system identification

Energy/Comfort
Dashboards



Occupancy-responsive MPC

Hierarchical distributed, occupancy- and grid-aware operation

Outputs:

- Building and district energy systems that:
  - Optimize their operation across end-uses
  - Learn about energy system dynamics and user's preferences
  - Inform building occupants and operator about how to reduce energy consumption
- On-site demo within open infrastructure that allows start-up to also test and integrate their technologies.

DC Buildings and Microgrids

Goal

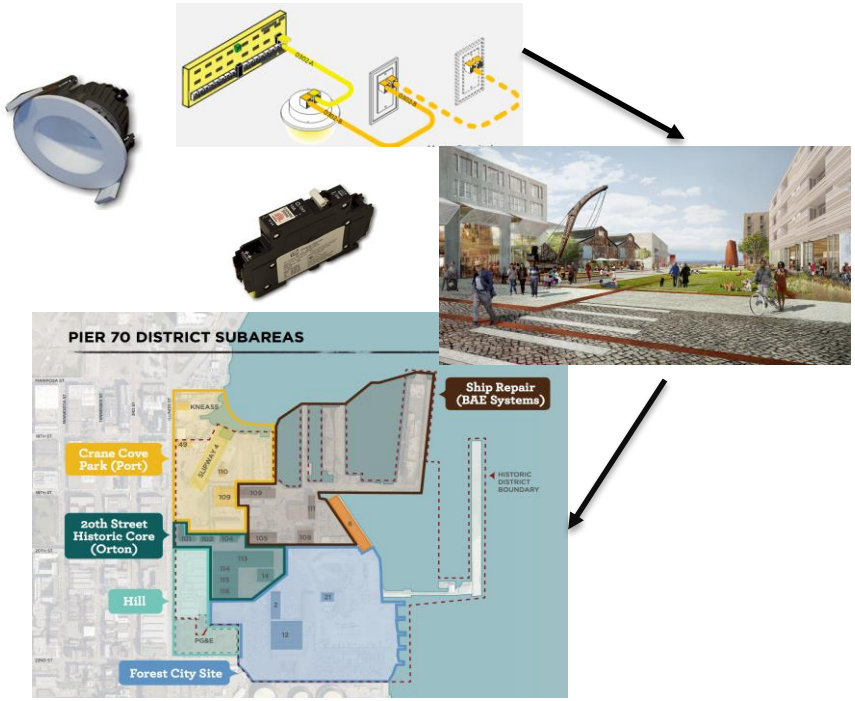
- Provide research platform for testing, demonstration, and installation of all electric appliances of DC buildings.
  - Provide test-beds for power supply standards for DC buildings.
  - Conduct testing for safety and reliability of all DC products.
  - Prepare operational rules and technological methods.
  - Verify energy saving volume and power utilization rate (reliability, power energy quality, etc.)

Approach

- Review existing studies of building DC system and savings in comparison with AC.
- Cost-benefit analysis of DC power distribution system.
- Model DC system and simulate system efficiency.
- Measure DC system in pilot projects and demo buildings and validate efficiency.
- Develop standard and control algorithm for DC system.

Energy Savings and CO_2 Reductions

2025 Estimates	Total
Energy savings (quads)	0.7 – 3.8
CO_2 reductions (M tons)	128 – 719



U.S. Pilot: Pier 70, San Francisco

Indoor Environment Quality (IEQ)

Technologies Needed	Project Activities
Improved Air Cleaning Materials	Air Cleaning Material Development & Testing
Reliable AQ & Environmental Data	Identify Technologies to Measure IEQ
Integrated Air Cleaning and Ventilation Systems	Demonstrations in US and Chinese Bldgs
Simulation Tools	Develop & Demonstrate Simulation Tools

Planned Outcomes

- Metrics and test conditions for air cleaning materials
- Advanced materials to remove CO_2, formaldehyde, VOCs
- Simulation tools to advance deployment of air cleaning technologies for energy savings
- Integrated filtration & air cleaning with sensor-based controls
- Air quality module integrated into Energy Plus

Energy Savings and CO_2 Reductions

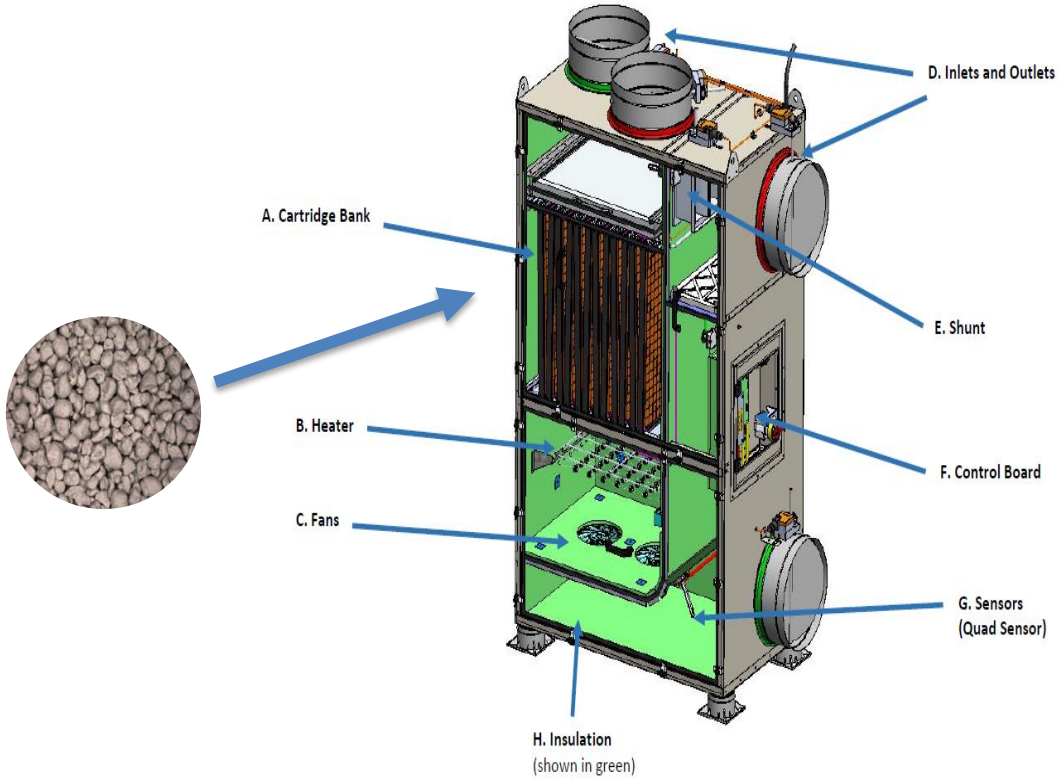
2030 Estimates	Total
Energy savings (quads)	0.56
CO_2 reductions (tons)	68

Indoor Environment Quality (IEQ)

Problem: Commercial buildings ventilate with outdoor air (OA) to manage indoor pollutants. Substantial energy is required to condition ventilation air. Additional energy and O&M costs to clean polluted OA.

Impact: Reduced energy burden of conditioning OA and improve IEQ using integrated, sensor-controlled air cleaning and ventilation.

Disney Research China



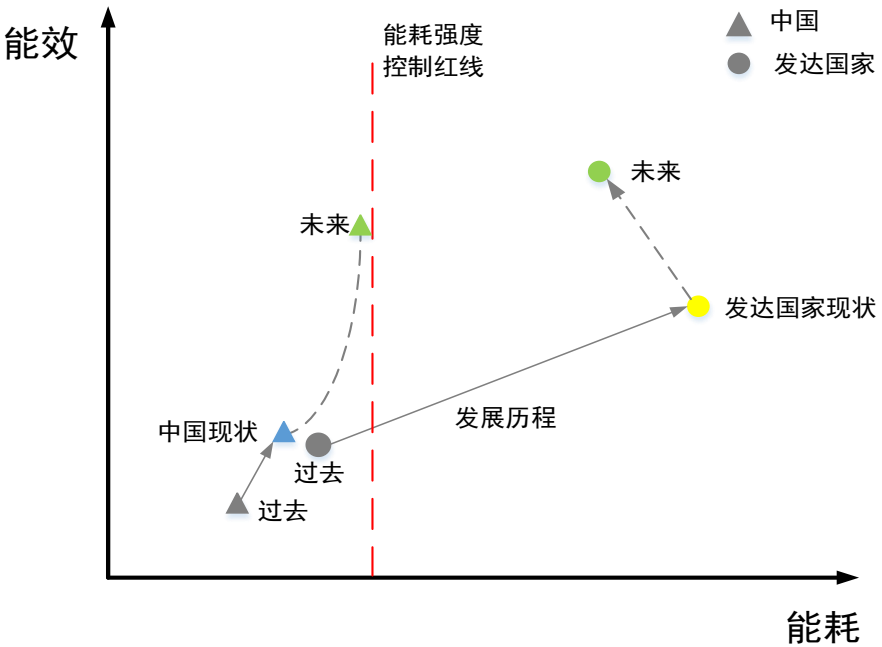
BASF materials and Johnson Controls scrubber unit

Policy & Markets Initiative

Problem:

- Targets and roadmap for building energy conservation are unclear in the US and China.
- Codes based on prescriptive measures do not regulate all factors that impact building energy performance (plug and process loads).
- Lack of data transparency, inadequate tools to identify retrofits at scale, and lack of energy saving investment and financing models which can be scaled up.

US-China Building Energy Usage and Efficiency Comparison



Policy & Markets Initiative

Approach:

- **2016: Research and data aggregation**
- **2018: Prototype audit tool**
- **2019-20: Pilot demos**
- **2020: Quantify impact**
- **2021: Launch new codes, software, and policies**

Outcome: Outcome-based code models, energy disclosure policies, open-source audit tools, financing mechanisms, and building energy conservation roadmap that can expand the global market for energy efficiency technologies by $60 billion annually by 2025.

Open-Source Audit Tool

Outcome-based Codes

National

Provincial/City

Building Sectors

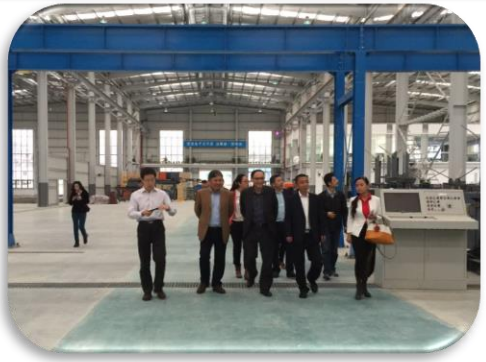
Changning District Pilot Project

BEE Action

Build a cooperation platform of technical and policy research that results in the spirit of “high efficiency, innovation and deep integration” in building energy saving field to realize the idea of “participation, research and communication together.”

Technology promotion

Project visit



Training and seminar

On-line analysis and case study

Demonstration project and all studies design the honeycomb action plan together.

Integrated Design, Construction and Industrialized Building Team Members

US

Patrick Hughes
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Uday Vaidya, PhD
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Da Yan
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Di Zeng

Duo Luo
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CHEN Zhixin

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Wu Ying
Fabien Rioult

Murilo Bonilha

Clay Nesler

Ming Liu

Kevin Chen

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Jinhan Mo
Da Yan
Bin Zhao

Bin Lu
Xin Feng
Zhichao Wang

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Guodong Ye
Zhenjian Du

Policy & Markets Initiative Team Members

US

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Kevin Mo

China

Chen Peng, Liu Shan

Xu Wei, Zhang Shicong, Chen Xi, Wei Zheng

Jiang Yi, Yan Da

Sun Peng Cheng

Qi Ye, Hao Bin

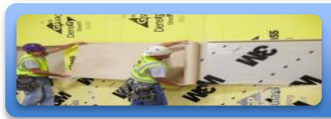
Wu Yong, Jing Hou

CERC-BEE Outputs

Using CERC-BEE's established portfolio management process, joint project teams will deliver additional:

Patents, new tools & software

New Codes and policy solutions



New products and licenses

Technology cost reductions

Integrated building energy solutions

New business model

Demonstration of Zero Net Energy Buildings

CERC 2.0 Preliminary Roadmaps and Outcomes -Net Zero Energy Building

- **Feasibility study and research for deployment**
- **New IP, product prototype**
- **Implementation of demonstration projects**

Zero

2020

- **Product commercialized and deployed at a scale**
- **Possible joint IP**
- **Huge energy and emission reduction in buildings**

2016

- **Joint Development of key Integrated EE technologies**
- **Joint design and development of demo projects in the U.S. and China**

BUILDINGS ENERGY EFFICIENCY CONSORTIUM

U.S. - CHINA CLEAN ENERGY RESEARCH CENTER (CERC-BEE)

A Deep Dive – CERC 2.0 Integrated Design, Construction and Industrialized Building Research and Demo

Log Ravisanker, Dow Chemical

Guo Haishan, China Construction Engineering Corporation

Beijing, China
July 1st, 2016

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

Integrated Design, Construction and Industrialized Building

Main Research Contents

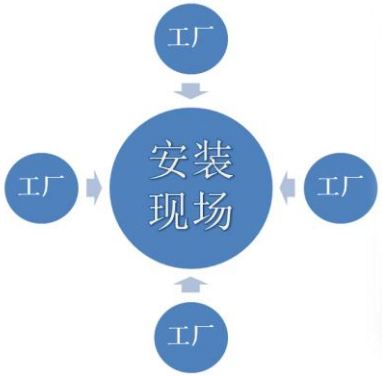
- BIM-based information management system for the whole process of construction
- New high efficiency prefabricated construction system
- New cladding wall system and air sealing material
- Demonstration Projects for new technologies in different climate zone

Team members

BIM-based information management system for the whole process of construction

Compared to traditional construction:

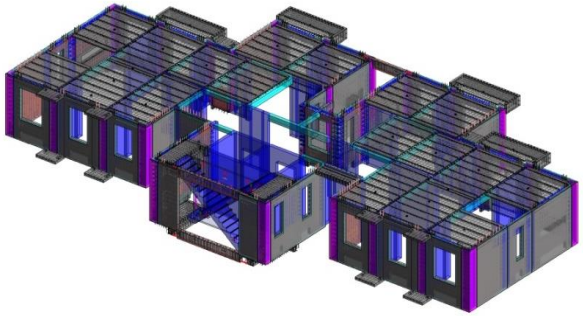
- prefabricated building components are being produced in different factory at the same time, and assembled at the construction site. In this case, higher requirement for overall management of the project.
- Construction period would be severely affected even if a little mistake of prefabricated units happened, sometimes it is difficult to accept
- Prefabricated buildings in the design stage and the production preparation stage need more time. More complex for design changes. Information technologies is necessary for improving Work efficiency

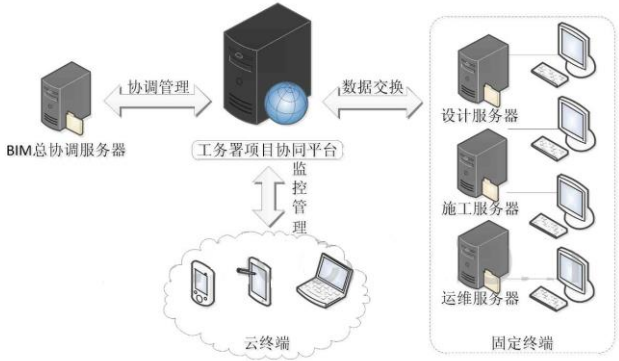


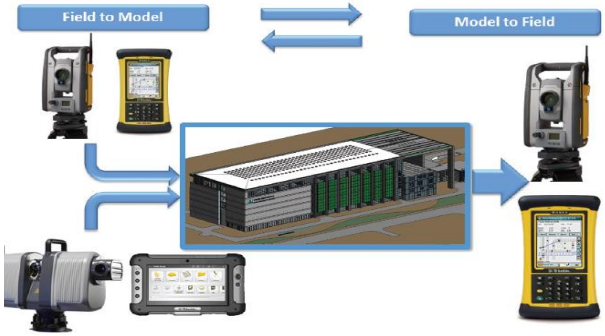
BIM-based information management system for the whole process of construction

Main task:

- Establishment of three-dimensional parametric database for prefabricated beams, plates, columns, walls, doors and windows, pieces of equipment and prefabricated templates. Improving design and production efficiency.
- Establish collaborative design and design management platform based on BIM
- Build Prefabricated units production, logistics and installation management system. Based on RFID (Radio Frequency tag) technique
- Establish Prefabricated buildings project management standards and information management systems







New cladding wall system and air sealing material

Building facades are the most complex part

Insulation ⟷ **fire prevention and durable**

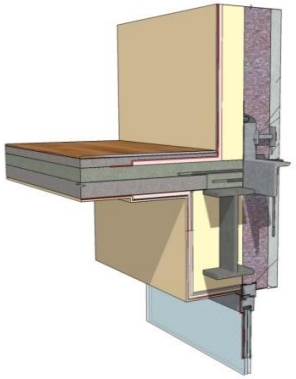
Aesthetics ⟷ **Industrial manufacturing**

stringency ⟷ **Transport and Lifting**

（ Load-bearing, wind, earthquake ）

waterproof
deafening ⟷ **prefabricated**
Airtightness

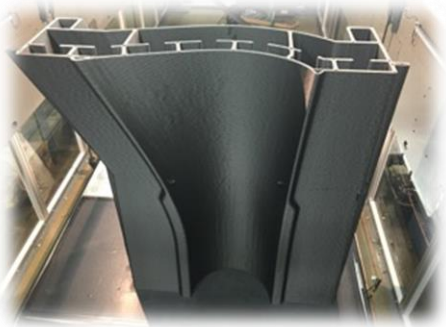
R & D target: Multi-functional integrated precast facades
(Prefabricated composite sandwich wall)



New cladding wall system and air sealing material

Main tasks:

- Porous concrete technology - Long-life, anti-fire inorganic insulation composite wall panels
- Super High Strength Concrete Technology -Long-life thermal insulation sandwich composite wall panels, exterior wall lighter
- 3D printing technology template -Flexible manufacturing, complex modeling precast facades (aesthetics)
- High-performance sealing materials - Tightness and durability better, easier construction quality assurance



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Thank you for your attention!

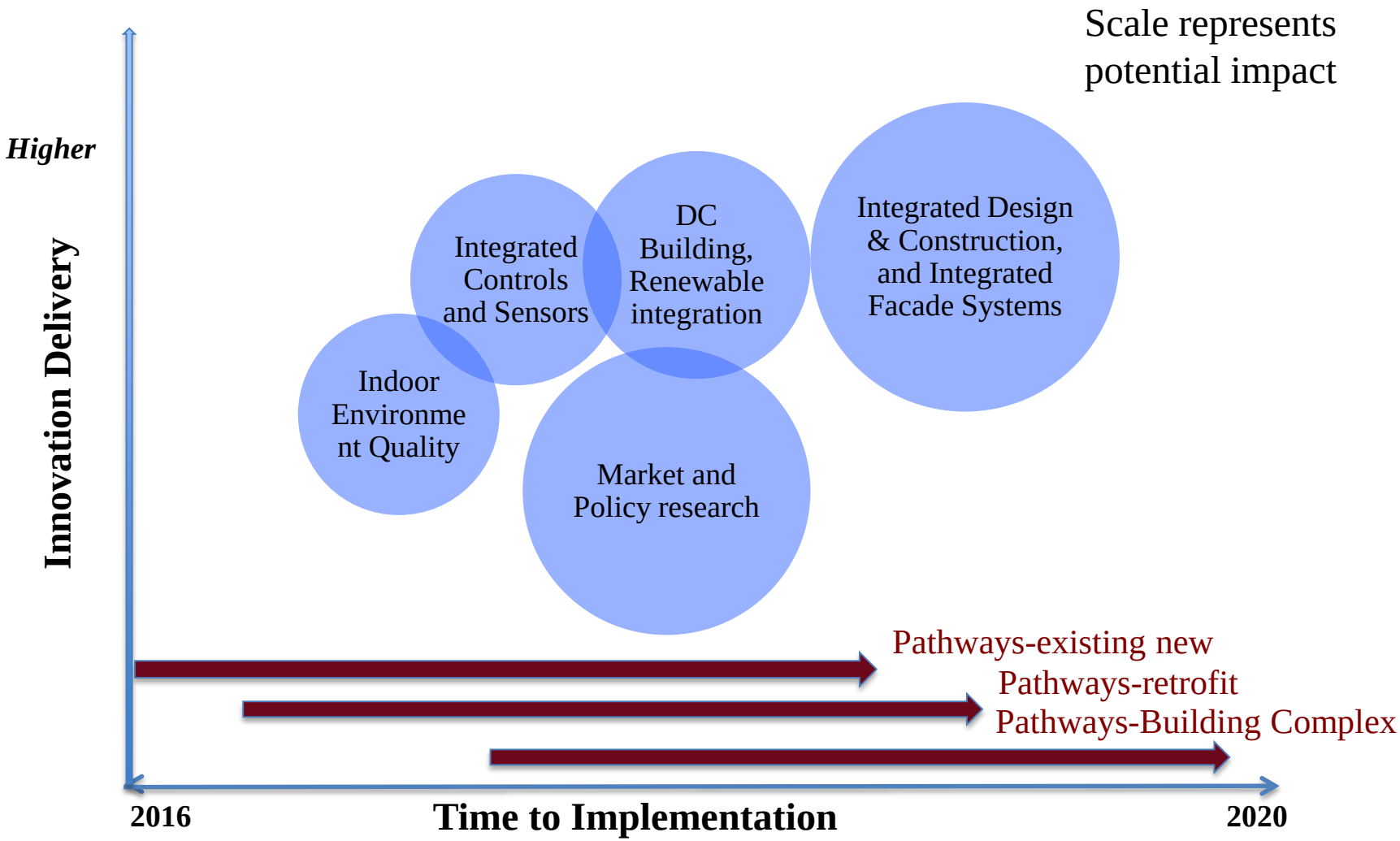
Led by **MoHURD Center of Science and Technology of Construction** of China and **Lawrence Berkeley National Laboratory** of the United States with:

- Extra Slides for reference

Potential CERC 2.0 China Demonstration Sites

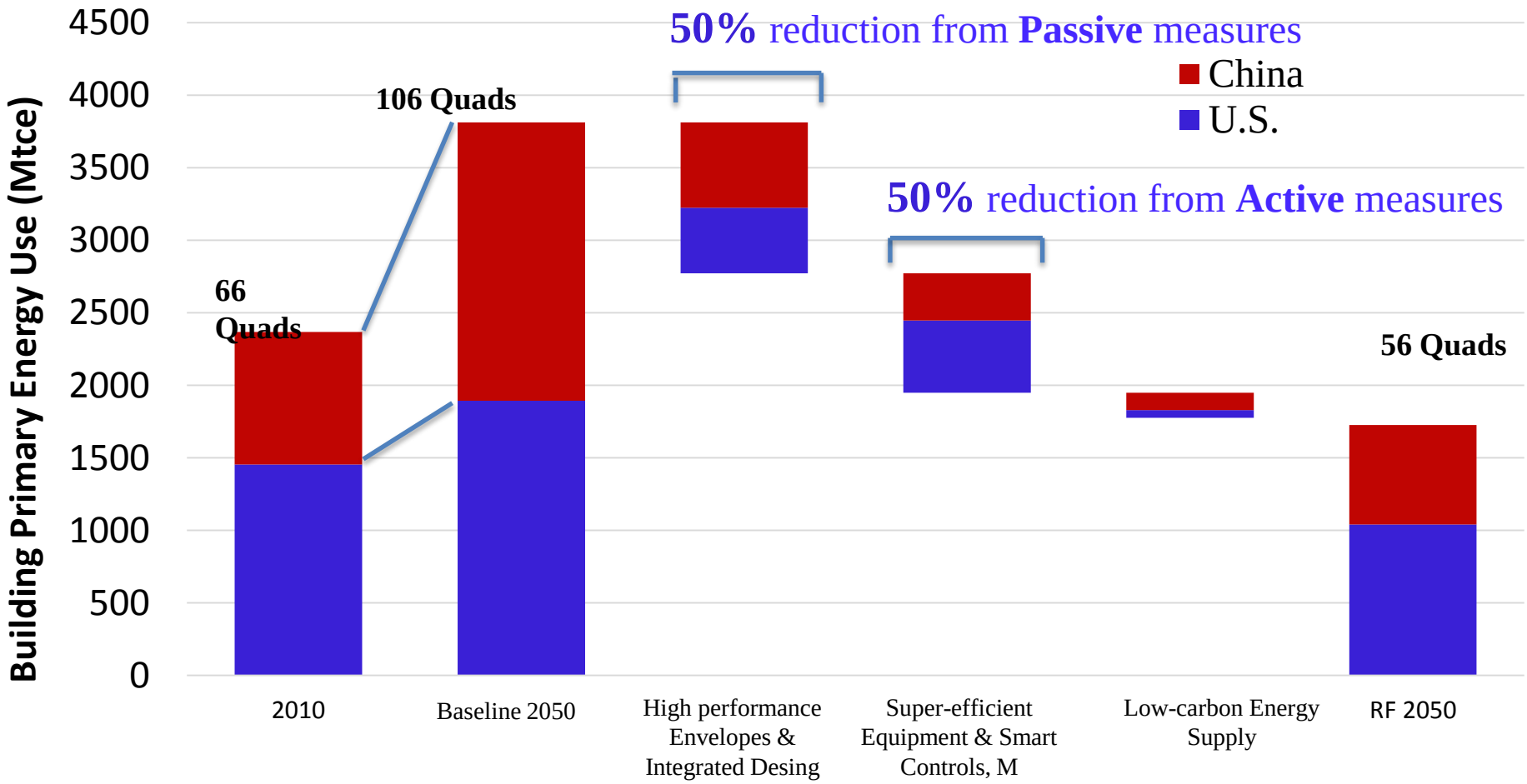
Shenzhen's International Low Carbon City

CERC-BEE 2.0 Portfolio Management Plan



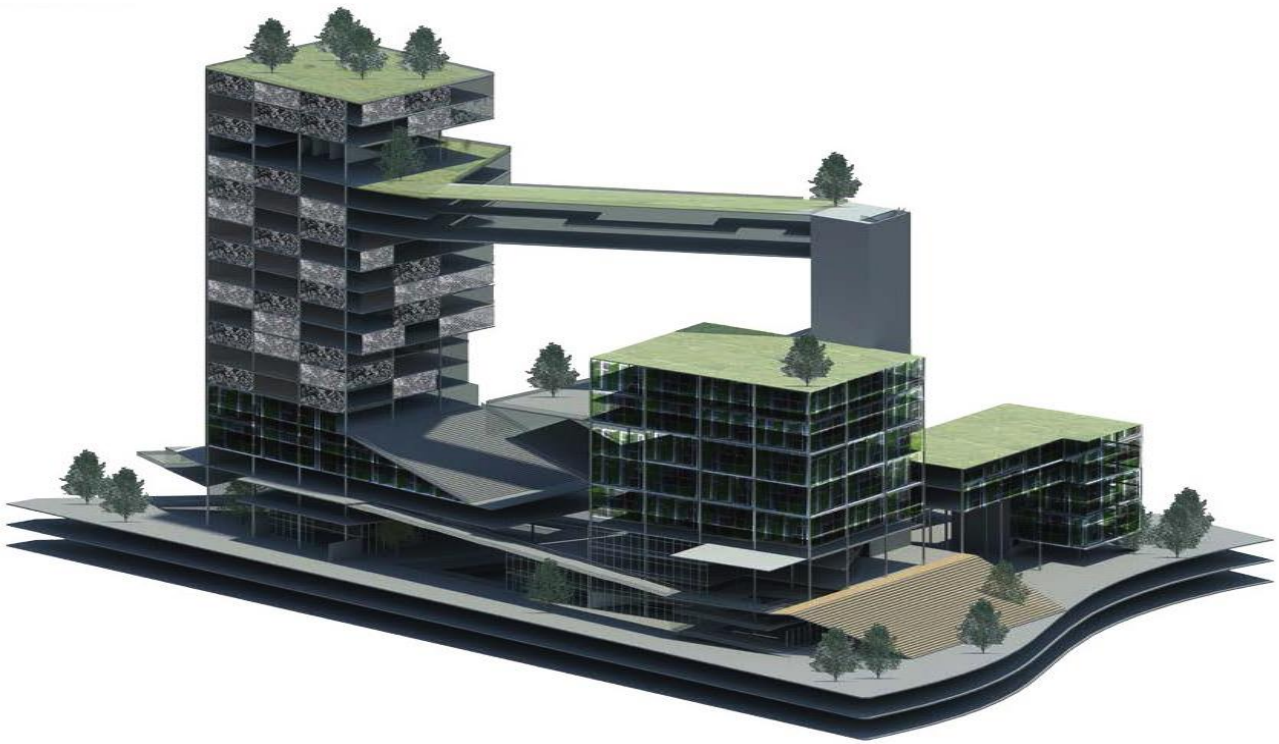
Pathways to Achieving Net Zero Energy Buildings

Projected Energy Consumption of Buildings in 2050 in the U.S. and China



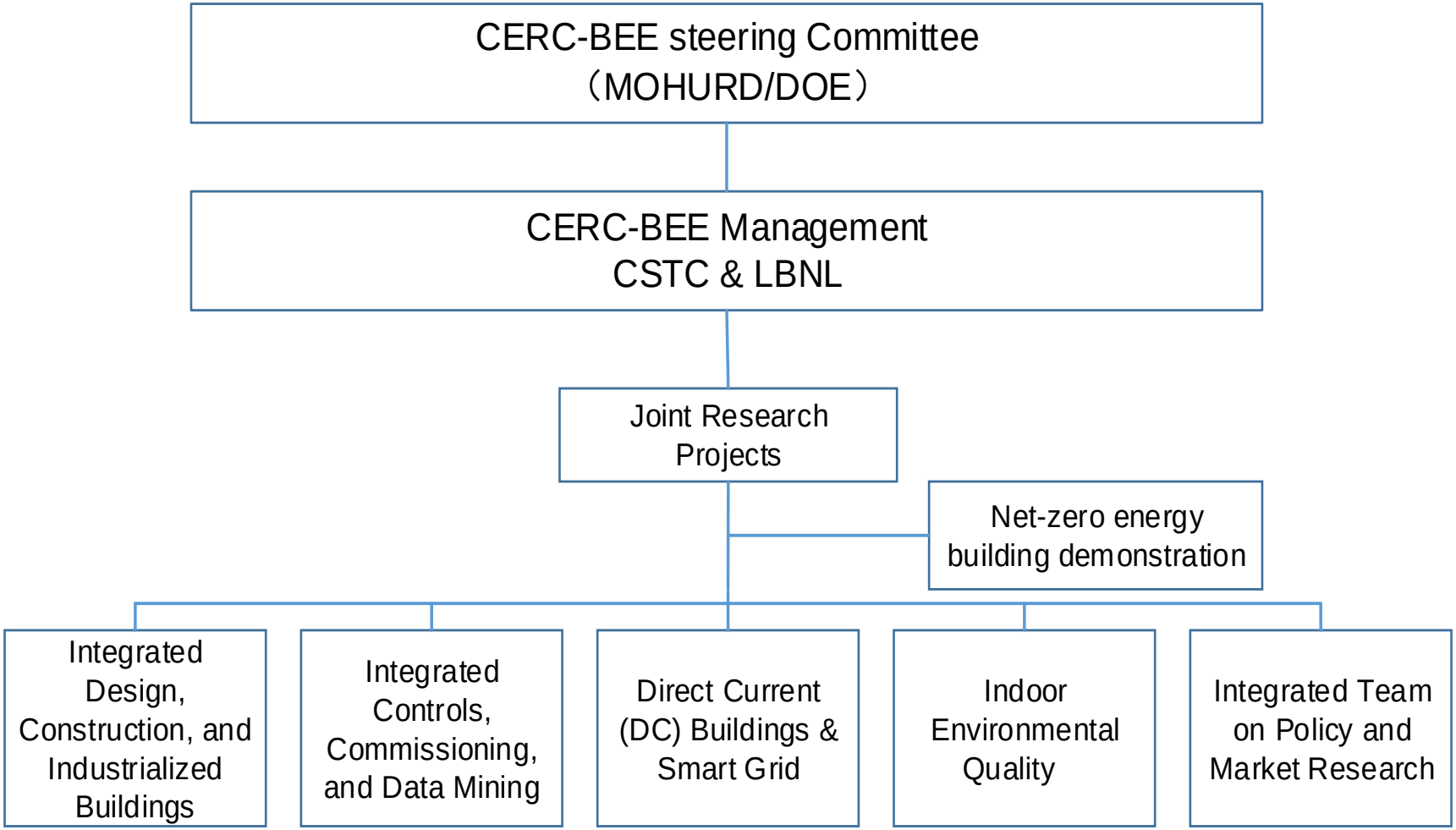
Note: U.S. numbers *based* on RMI Reinventing Fire, China numbers based on LBNL 2050 DREAM model

Potential CERC 2.0 Demonstration Sites



Schematic of potential demonstration buildings in Shenzhen

CERC-BEE 2.0 Organizational Structure



CERC 1.0 Demonstration projects yield meaningful technological progress

#1 Beijing, China, CABR Near Zero Energy

- Office, R&D facility, 4025m^2, cold climate zone
- Energy Intensity **25 kWh/(m^2.a)** (37kWh/(m^2·a) total energy)
- **0 fossil fuel** for space heating
- Cooling energy ⬇ **50%**
- Lighting energy ⬇ **75%**
- Led to development of China's NZEB standard.

#2 Zhu Hai, China, Xingye Research and Office Building, expected completion by year-end 2015

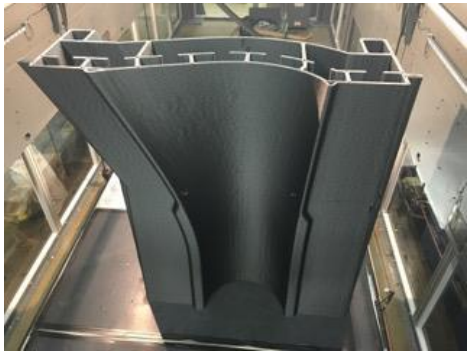
- Office Building，23,500 m^2, Hot Summer and Warm Winter zone
- Annual Energy Intensity：**52.4kWh/m^2·a**
- Energy Saving Target：**76.7%**
- Renewable energy：172,863 kWh
- Percentage of Renewable energy：**14.4%**

Dow 2016 CERC-BEE

DOW B&C PROGRAMS

- Dow's Role in the Second Five Year CERC Program
  - Material Science Partner for CERC ORNL team
  - Insulation Expert for wall assembly systems
  - Connector / Ad Mixture partner for concrete systems
  - Industrial Principle Investigator for high efficiency modular wall systems
  - Industrial Principle Investigator for Flashing and Weather Sealing on U.S. and China demonstration projects

CERC-BEE 2.0 Passive Envelope Advancement Research Program



Precast

Retrofit

Air-sealing

CERC-BEE: New Products and Standards

Products Launched

- 3M 3015 primer-less self-adhered membrane and 3015VP vapor permeable primer-less self-adhered membrane
- DOW LIQUIDARMOR – RS and LIQUIDARMOR – CM
- A first-of-a-kind research facility for DGSHP systems
- Sage and Lutron: modified control systems for lighting
- Several Chinese waterproofing companies have started formulating high reflectance PVC waterproofing products
- 3M: daylight redirecting window launch in China
- ClimateMaster launched the Trilogy™ 40 Q-Mode™ series GS-IHP
- A new co-axial GHX developed by GroenHolland B.V. was launched after the field evaluation by ORNL and other organizations in 2012.

Standards, Codes, Policies

- ISO 15099 for standardized characterization of window and fenestration products
- MOHURD issued in November of 2015 technical guidelines for passive housing where the use of a continuous air barrier is recommended
- New Chinese standards and credits for the use of cool roofs in some climates (JGJ75-2012, JGJ/T 359-2015, GB/T 50378-2014 and 14 provincial standards)
- Adaptation to China of LBNL's lab aging practice for roofing materials (ASTM D7897-15)
- ASHRAE 90.1 for GB 50189-2014(5)
- ISO 12655-2013 for presentation of measured energy use of buildings
- China Design Standard for Very Low Energy Buildings (GB 50189-2015)
- China Building Energy Consumption Standard (GB/T-51161-2016)
- National Certification Standard for Ground Source Heat Pump Personnel, developed by Geothermal Heat Pump Consortium in collaboration with ORNL and other organizations (published in 2013)
- Design Standard for Energy Efficiency of Residential Buildings in Hot Summer and Warm Winter Zones (2012), JGJ75-2012
- Standardized MRV protocol incorporating building tools and database developed
- MOHURD national energy performance benchmarking and disclosure (EPB&PD) policy
- Design handbook on natural ventilation being written as part of EIA Annex 62 program
- Requirements for lighting of commercial buildings

CERC-BEE: New Patents and Software

Patents & Invention Disclosures

- DOW Air sealing - US 8,641,846 B2
- Flow-demand-based control for DGGSHP, Invention Disclosure #: 201403380, DOE S-number: S-138,004)
- Method to cost effectively monitor performance and detecting faults of DGSHP systems, Invention Disclosure #: 201403381, DOE S-number: S-138,005
- Webopt DER-CAM
- Smart Pumping Control for Hydronic Distribution Systems
- Virtual-Sensing-Enabled Low-Cost Monitoring System for Distributed Ground Source Heat Pump Systems
- Incorporation of SH powders in water based acrylic coatings
- Patent applications:

- US 2014/0090578 A1 “Method of making superhydrophobic/ superoleophilic paints, epoxies and composites”
- US 2014/0155522 A1 ”Durable superhydrophobic coatings”
- US 2014/0094540 A1 "Superhydrophobic powder coatings”

- Ventilation and shading combined with PV
- Use PV to make hydrogen combined with fuel cell for domestic use

Copyrights Software

- Three occupant behavior modeling tools: (1) Occupancy Simulator, (2) obXML, and (3) obFMU
- Online Airtightness Savings Calculator for the US, Canada and China
- A protocol and software tool for analyzing the performance of DGSHP systems
- CoolVent for natural ventilation
- WINDOW 7, IGDB, THERM for use on architectural projects in China
- Enhancement to EnergyPlus, behavior software module
- DER-CAM, webopt and operation of DER-CAM
- China Building Energy Benchmarking Tool for commercial offices, hotels, hospitals, and shopping malls
- Traffic lighting control system
- Traffic lighting supervisory control

中美清洁能源联合研究中心指导委员会第八次会议

The 8th China-US Clean Energy Research Centre Steering Committee Meeting

2016 年 7 月 1 日　中国 · 北京　　July 1, 2016 Beijing, China