Compiled Presentations from Track 1, Breakout Session 1/Morning

High Performance Buildings Technologies: LEDS and BEYOUND
US – China Clean Energy Research Center
Building Energy Efficiency Consortium
(CERC-BEE)

September 25, 2013

Lawrence Berkeley National Laboratory of the United States and
MoHURD Center of Science and Technology of Construction of China, with:
U.S. – China Collaboration with Real World Impact

- Initiated between U.S. President Obama and Chinese President Hu in 2009
- Over a dozen high visibility, cost-shared, US-China projects in the buildings sector
  - Engaging industry
  - Creating partnerships
  - Government, academia, and private sector
  - Software, tools, guidebooks, early commercialization of technologies, codes, policies

- $50M, five year program funded by U.S. and China:
  - $5M/year from government
  - $5M+/year from private industry (cash, in-kind)
An Ambitious and Pioneering US-China Collaboration

Vision: To Achieve Wide Spread Adoption of Very Low Energy Buildings

Mission: Build partnership, and make real world impact

- Engage industry in R&D and bring technologies to market
- Create a sustainable platform and building partnerships
- Involve various stakeholders such as government, academia, and private sector covering whole business model
- Deliver outputs including software, tools, guidebooks, early commercialization of technologies, codes, policies
Strategic Approach to Achieving Very Low Energy Buildings

Building Design
- **Integrated Design**
  Protocols and design tools for VLEBs
- **Occupant Behavior**
  50-70% reduction in energy use

Policy, Market Promotion
- **Data and Energy Management**
  Energy use reductions
- **Policy Analysis and Incentives**
  New joint policies

Whole Building
- **Building Technology Integration**
  Optimization and evaluation of energy system and operation

Renewable Energy/Distributed Generation
- **Integration and Operation in Real Time**
  Optimized technology selection, real time controls
- **New Heat Pump Design**
  System energy use reductions >30%

Building Envelope
- **Cool Roof/Surface Coatings**
  Long life high solar reflectance
- **Insulation**
  New cost effective air sealing technology
- **Advanced Window/Shading Technologies**
  Perimeter energy reduction of 15% - 30%

Building Equipment
- **Natural Ventilation Design**
  Optimization of efficiency/comfort
- **Lighting Controls**
  New lighting control technologies
- **HVAC Systems**
  Efficiency improvements

US-China Clean Energy Research Center, Buildings Energy Efficiency Consortium (CERC-BEE)
A Sustainable Platform Creating US-China Research & Development Partnerships

### United States

- Lawrence Berkeley National Laboratory
- Oak Ridge National Laboratory
- Natural Resource Defense Council
- ICF International
- Massachusetts Institute of Technology

### China

- MoHURD Center of Science & Technology of Construction
- Tsinghua University
- China Academy of Building Research
- Chongqing University
- Tongji University
- Tianjin University
- China Society for Urban Studies

US-China Clean Energy Research Center, Buildings Energy Efficiency Consortium (CERC-BEE)
Enhanced R&D Industrial Partnerships Bring Technologies to Market

### US Industry Partners

- **Dow**: Roofing Technology, New Insulation
- **Saint-Gobain**: Low-e Window Technology & Design
- **Bentley**: Integrated Design, Modeling
- **ClimateMaster**: Ground Source Heat Pump
- **C3**: Energy Systems for Buildings, Behavior
- **Lutron**: Lighting Control Systems
- **The Energy Foundation**: Policy, Market Promotion

### Chinese Industrial Partners

- CONVERTERGY (Shanghai)
- East-West Control Group (Shenyang)
- ENN Group (Tongji)
- Ever Source Technology Development (Tongji)
- Fullshare Energy (Tongji)
- Guangdong Provincial Academy of Building Research (Guangzhou)
- Huajing Geothermal (Tongji)
- Jiangsu DISMY GSHP (Tongji)
- Lampearl Photoelectric Co., Ltd (Guangzhou)
- LANP Electrical Co. (Zhejiang)
- Leye Energy Service (Beijing)
- LH Technology Co., Ltd
- Liaoning Solar Energy R&D Co., Ltd (Tongji)
- NARI Technology Development (Nanjing)
- National Center for Quality Supervision Test of Building Energy Efficiency (Beijing)
- Persagy (Tsinghua)
- Shanghai Futian air conditioning equipment Co., Ltd (Tongji)
- Shenzhen Institute of Building Research (Shenzhen)
- Singyes Solar (Tongji)
- SOLATUBE Daylight Technology, CECEP (Suzhou)
- Telchina (Beijing)
- Tongguang Construction Group (Shanghai)
- Vanke Building Technology (Tianjin)
- Wall Insulation Committee in China Association of Building Energy Efficiency (Beijing)
- Xinjiang Green Messenger (Urumqi)
- Yingli Energy, Beijing (Tongji)
1. **US and Chinese businesses and research teams match up** to accelerate invention and commercial success.

2. **Industry partners assume central roles** in research, development, deployment, and commercialization.

3. **“Technology Management Plan” enhances protection for IP rights;** endorsed by both governments, it establishes rights to own or license IP for commercial purposes, leverages complete research portfolio, and facilitates demonstration and introduction of products to large new markets.

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**U.S. Industrial Partner Contribution**

+40% Annual Average Growth Rate

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**Graph: U.S. Industrial Partner Contributions**

- **2011**: $2.5M
- **2012**: $3.5M
- **2013**: $5.0M

- **Legend**:
  - Industrial Partners
  - Other Funders

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Research Portfolio Outcomes

Technologies

Demonstration Buildings

Software

Commercial Impact

Tools and Guidebooks

Wide Adoption of Cost Effective VLEBs

New Patent Applications

Market

Policy

US-China Clean Energy Research Center, Buildings Energy Efficiency Consortium (CERC-BEE)
| Monitoring and Simulation | • On-line comparative energy benchmarking tool  
  • Energy data model and analysis of measured data from real-time monitoring  
  • Occupant behavioral impacts integrated into simulation models |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Envelope                  | • Patent filed by Dow for liquid flashing, “method for sealing fenestration openings”  
  • Cool Roof provisions for Chinese national BEE standards, 2 invention disclosures  
  • New designs for fenestration systems, advanced standards, and demonstrations |
| Equipment                 | • Integrated control strategies for natural ventilation  
  • Advanced algorithms and demonstration programs for lighting  
  • New advanced evaporative cooling systems |
| Renewables                | • Cloud tool for microgrids based on technologies, load and tariffs  
  • Evaluation and competitiveness of renewable energy systems  
  • 10% GSHP system efficiency improvement, 20-30% cost savings, R&D100 award, patent in 2014 |
| Whole Buildings           | • Real time strategies for cost & peak load reduction  
  • Comparative research on energy use of U.S. and Chinese high efficiency buildings |
| Policy                    | • Methodologies for energy cap and trade system in buildings and quota system for public buildings  
  • Policy recommendations to promote EE, renewable energy, and green buildings |
**Example: Low-cost, Superhydrophobic Roof Coatings for Energy Savings and Roof Lifetime**

**Objectives**

- **Quantify** the energy and environmental benefits of cool surfaces
- **Create white roof coatings** with superior reflectance and durability for U.S. and China markets
- **Demonstration** of cool roofs in China

**Market Size:** 3B m² upgradeable by 2025 (U.S. + China)

**Key milestones:**

- China cool-roof simulations (completed)
- China cool-roof demonstrations (ongoing)
- New coating product yields IP (2013)
- New coating product achieves sales in China and the United States (2016)
Pilot Demonstration and Joint R&D Collaboration – Delivering Technology to Market

- China planning 5 demonstration buildings
- Multiple CERC-BEE technologies included in each pilot
- Strong support and involvement from the US Industrial Advisory Board

US Engagement:
- Design Review
- Simulation
- IAB’s Technologies
- Evaluation

US-China Clean Energy Research Center, Buildings Energy Efficiency Consortium (CERC-BEE)
Importance of Collaboration

• **Pioneering R&D Consortium**
  – Governments, researchers, and industry
  – Involves key government policy makers

• **Huge Potential Impact**
  – CO₂ emissions reductions
    ~100 MtCO₂/year by 2025
  – Cost savings of $2B/year by 2025
  – U.S. / China construction market ~ 2B square meters (~ $50B/year)

• **Long Term Platform**
  – Creating opportunities for sustainable
    U.S. - China R&D on building energy efficiency

**Fundamental Criteria** adopted by U.S. & China:

1. Benefits to both countries
2. Innovative
3. Impact on market
4. Significant reduction of energy demand and carbon dioxide emissions
Energy Savings Opportunities

Presented by
Dr. Robert Nachtrieb
Lead Scientist, Lutron
Chair, CERC-BEE Industrial Advisory Board (US)

Presented at
4th US-China Energy Efficiency Forum

25 September 2013
50 Years in Light Control

1961
• Introduced the first electronic dimmer

Today
• 15,000 products
• Energy-saving solutions for residential and commercial applications
• Light, shade, temperature, and small appliance control for a single room or throughout a whole home or building
• Convenient control from keypads, wireless controls, tablets, and mobile devices
• Projects in more than 80 countries
Global Presence
Global Project Solutions – United States

New York Times Building
United States Capitol
NASA, Cape Canaveral
Global Project Solutions – China

Bank of China, Beijing
中国银行总部大楼

China Mobile HQ, Beijing
北京中国移动总部大楼

Agriculture Bank of China HQ, Beijing
北京中国农业银行总部大楼
US-China CERC-BEE

• Joint Research Activities
  – Quantify Energy Savings from different Lighting Control strategies in demonstration facilities
  – Options for Low-Cost installation

• Anticipated Benefits/Outcomes
  – Motivation for development of new technologies
  – Access to China market
  – Future and strengthened collaboration with China
  – Regular joint US-China IAB meetings (First joint IAB mtg. held in Zhuhai, December 2012)
Expandable Solutions

Basic standalone solutions
Single-space solutions
Small area solutions
Multi-room or entire floor solutions
Whole building solutions
Expandable Solutions

**Basic standalone solutions**
Single-space solutions
Small area solutions
Multi-room or entire floor solutions
Whole building solutions
Expandable Solutions

Basic standalone solutions

**Single-space solutions**

Small area solutions

Multi-room or entire floor solutions

Whole building solutions
Expandable Solutions

Basic standalone solutions
Single-space solutions
**Small area solutions**
Multi-room or entire floor solutions
Whole building solutions
Expandable Solutions

- Basic standalone solutions
- Single-space solutions
- Small area solutions
- Multi-room or entire floor solutions
- Whole building solutions
Expandable Solutions

Basic standalone solutions
Single-space solutions
Small area solutions
Multi-room or entire floor solutions

Whole building solutions
Stand-alone & Single-Space Solutions

**switches, sensors, modules**

- Maestro Wireless® switch
- Radio Powr Savr™ wireless occupancy/vacancy sensor
- **NEW** PowPak® dimming module with EcoSystem®

**Energy-saving strategies** that can be used in the space:
- Occupancy or vacancy sensing
- Daylight harvesting
- Appliance control

Potential lighting energy savings:

<table>
<thead>
<tr>
<th>15% lighting</th>
<th>15% lighting</th>
<th>15% plug load</th>
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<td>(1)</td>
<td>(2)</td>
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30%
Small Area Solutions

controls, sensors, drivers, shades

- GRAFIK Eye® Wireless with EcoSystem™
- Hi-lume® A-Series LED driver
- Sivoia® QS Wireless shades

Energy-saving strategies that can be used in the space
- High-end trim
- Occupancy/vacancy sensing
- Daylight harvesting
- Personal dimming control
- Controllable window shades
- Timeclock scheduling

Potential lighting energy savings

60%
Multi-Room and Entire Floor Systems

**controls, sensors, ballasts, shades**

- Radio Powr Savr™ wireless daylight sensor
- Energi Savr Node™ with EcoSystem™
- EcoSystem H-Series digital dimming ballasts

**Energy-saving strategies** that can be used in the space:
- High-end trim
- Occupancy/vacancy sensing
- Daylight harvesting
- Personal dimming control
- Controllable window shades
- Timeclock scheduling

**Potential lighting energy savings**

60%
Whole-Building Solutions

controls, sensors, ballasts, shades, and systems

- Quantum® hub and Green Glance®
- Q-Manager™ server
- Hyperion™ solar-adaptive shading with Sivoia® QS shades

Energy-saving strategies that can be used in the space:
- High-end trim
- Occupancy or vacancy sensing
- Daylight harvesting
- Personal dimming control
- Controllable window shades
- Timeclock scheduling
- Demand response

Potential lighting energy savings:

60% +
New York Times, New York

纽约时报总部大楼

Lighting Savings: 3.9 kWh/sqft/yr (56%)  
HVAC Savings: 2.6 kWh/sqft/yr (51%)  
Occupied: 628,000 sqft

Reference: Lee et al, LBNL, 2013  
http://buildings.lbl.gov/sites/all/files/lbnl-6023e.pdf
Thank You
rnachtrieb@lutron.com
Industrialized Green Building
A State-of-Art Precast Concrete Building

September 25, 2013

Dr. Hongxi Yin, Ph.D.
Chief Technology Officer, Broad Homes Industrial Co.
Director, Digital Laboratory, Broad Homes Industrial Co.
What does Broad Homes Produce?

We produce the following products:
- precast concrete building and component;
- prefabricated indoor components, such as bathroom, kitchen, and MEP system
- automated precast concrete manufacturing lines;

We provide the following services:
- urban planning, architectural and engineering design
- Design Build / General Contractor
- construction management
- green building consultancy
Maximize efficiency in

- Energy
- Material
- Water
- Time
- Labor
- Cash Flow

绿色施工实例
为普通人造世界级的家
High Performance Building

**Building Operation Performance**
- 70% Energy Efficiency
- 80% Water Saving
- 20% Material Saving

**Indoor Environmental Quality**
- 20% Land Saving

**Production & Construction Performance**
- Labor Saving—90% of the work done by robots and automation manufacturing lines
- Time Saving - 70%
- Construction Cost Saving—100% to 200%
- First Cost Saving—30%
- Industrial Product Quality

**Construction Cost Saving—100% to 200%**
High-rise Structure

Non-structure part: pre-cast component wall panel

Horizontal structure part: pre-cast concrete composite floor

vertical structure part: on-site cast concrete for shear wall

Meet all three National Building Standards:
- "Structural Load Specification" GB 50009
- "Buildings Seismic Design Specification " GB 50011
- “High-rise building concrete structural design Specification” JGJ 3
- All PCI Design Standards and Guidelines (North America)
Green Interior Finishing
Design Automation
Streamlined Production Line
Dow Chemical Company
CERC-BEE Research Program
Overview

Overview by Greg Bergtold
Dow Building & Construction
Advantages to Industrial Partners Working within CERC-BEE Program

- Access to World Class Researchers within Lawrence Berkeley and Oak Ridge National Laboratories in a cost share model.
- Access to cross section of Research areas within Building Energy Efficiency market segment.
- Access to China Researchers.
- Access to China Developers for demonstration projects to showcase our technologies.
CERC-BEE Task B-3/3-6
Superhydrophobic Elastomeric Roof Coatings CRADA

Dow Chemical: Joe Rokowski, Jeff Hansbro, Ligeng Yin
ORNL: Scott Hunter
LBNL: Ronen Levinson

September 4th, 2013
Superhydrophobic Technology for Cool Roofs Project

Objective
Maintain high reflectance of roof coating materials and their integrity over prolonged exposures (>10 years), giving an increased energy savings (up to 2x) and service life.

Issues
- Asphalt roof products are water resistance but deficient due to low albedo and poor exterior durability.
- Acrylic coatings have excellent reflectance and UV resistance but are only water resistant and not waterproof.
- Reduced reflectance and retained moisture in roof surface coatings due to:
  - Soiling due to dust, dirt, bird droppings, etc.
  - Microbial growth (fungi, moss, bacteria, etc.)

Solution
- Coatings made from Superhydrophobic Extenders (SHE) can prevent roof surfaces from wetting, inhibiting soiling and microbial growth.
- Development of environmentally friendly water based SH coatings.
Technical Development within CERC

• ORNL will continue to provide technical support to Dow in the development and production of SH materials for the company’s latex based cool roof paint development effort.

• ORNL will develop an accelerated microbial testing protocol and test facility to test proposed new modified SH materials and coatings.

• ORNL will continue internal development work on the coating optimization and testing of panels with SH coatings

• Dow will substantially increase S.H. in aqueous coatings by direct blending or through reformulation to achieve higher water resistance properties.

• Dow, ORNL and LBNL will characterize coupons coated with these acrylic resins for water repellency and optical properties
Commercial Impact Expected

Quantification & demonstration of cool roof benefits in the US and China.

Widespread use of cool roofs in China and the US

– About 50% of the population in both countries live in hot-summer climates.
– Could upgrade 3B m$^2$ of roofs by 2025 at no cost (end-of-service-life replacement).
– Saving 120 TBTU/y source energy and with a reduction of 10 Mt/y CO$_2$.

• The estimated global market size for roof coatings is estimated to be $800M with an annual growth rate of 3-5%.
Accomplishments to Date

• Dispersability of ORNL SH Extenders into aqueous acrylic roof coatings can be achieved using dispersants and high shear mixing.

• Significant improvement in dirt resistance, a surface property, was demonstrated
CERC-BEE Liquid Flashing Project Update

Jeff Hansbro, Katherine Faber, Diana Hun
September 4th, 2013
Progress in Development of IP and Commercial Impact Achieved for Liquid Flashing

• Residential launch for window flashing has occurred in U.S. Market in 2013
• The estimated market size for flashing materials used around the rough window openings and over board joints in the commercial construction market is $143MM.
• Next development phase is in Commercial Weather Resistive Barrier markets and flashing markets
Planned Participation in China Demonstration Projects

• Proposals have been submitted to participate in the CABR (Beijing), Rixin Tech (Wuhan) and Kelong Insulation (Jilin) demonstration buildings.

• The partnership is subject to Dow and ORNL deciding after we get construction details, sequencing and timing, if the demo building is appropriate for the proposed Liquid Flashing.
Accomplishments To Date and By End of CERC-BEE

• The team has conducted voice of the customer, refined the scope of the project and defined application CTQ’s for the Liquid Flashing coating for both the US and China.

• By the end of CERC-BEE, a sprayable, waterborne Liquid Flashing will be sold into the US residential and commercial construction markets. Features of this flashing include competitive cost, ease of installation and durability. The flashing has the potential to greatly decrease energy consumption by improving air tightness and durability of US homes and buildings.
Questions?