Building Energy Efficiency Consortium
U.S.-CHINA CLEAN ENERGY RESEARCH CENTER (CERC)

14th Quarterly Report for 1Q 2014
(April - June 2014)

Prepared on July 16, 2014 by
Lawrence Berkeley National Laboratory

Dr. Nan Zhou
Director for U.S. CERC BEE

For assistance, contact Brian Heimberg at BSHeimberg@lbl.gov

Table of Contents

Project #1: Human Behavior and Standards to Improve Design and Operation of Very Low Energy Buildings 3

Project #2: Advanced Window and Shading Technologies 6

Project #3: Materials that Improve the Cost-Effectiveness of Air Barrier Systems 9

Project #4: Cool Roofs and Urban Heat Islands (LBNL) 12

Project #4: Cool Roofs and Urban Heat Islands (ORNL) 16

Project #5: Hybrid Ventilation Technology and Product R&D: Natural Ventilation for Commercial Buildings 19

Project #6: Advanced Lighting Controls in New and Existing Buildings 23

Project #7: Research and Demonstration of Integrated Building Energy Technologies 25

Project #8: Advance Ground Source Heat Pump Technology for Very Low Energy Buildings 28

Project #9: Commissioning, Operation, Real Time Monitoring and Evaluation of Pilot 31

Project #10: Research on Very Low-Energy Building Operations and Management Methods 33

Project #11: Wet Bulb Evaporative Chiller 37

Project #12 [NEW]: Analysis of Commercial Building Energy Efficiency Standards 40

Project #1: Human Behavior and Standards to Improve Design and Operation of Very Low Energy Buildings

1.	**Full Project Name**	Human Behavior and Standards to Improve Design and Operation of Very Low Energy Buildings
2.	**Reporting Period**	Q2, 2014
3.	**U.S. Research Team**	Tianzhen Hong, LBNL, US project lead Cheng Li, Simona D'Oca, Qi Zhang, Xiaoxin Ren, LBNL
4.	**U.S. Industry Partners**	Bentley Systems
5.	**China Research Team**	Da Yan, Tsinghua University, China project lead Kaiyu Sun, Xiaohang Feng, Tsinghua Benqiang Li, Center of Building Standards Shan Liu, MoHURD
6.	**China Industry Partners**	CABR, Vanke, CECEP, Swire Properties
7.	**One Sentence Project Highlight**	Continued to make solid progress on all technical tasks.
8.	**2014 Target Outcomes and Progress**	1. Behavior software completed and available for download - a joint deliverable with China side. **Making progress. Collaborated and had periodic calls with the Tsinghua team.** 2. Modified EnergyPlus to integrate the behavior software. **Making progress. Met with Michael Wetter's team and discussed FMI/FMU for the behavior module.** 3. A technical report to support the development of the China design standard for very low energy buildings (the China side is developing the standard with inputs from the U.S. side). **Finished the major review of related standards and studies. In the process of finishing up the technical report.** 4. Application guide for the China building energy consumption standard - a joint deliverable with China side. **Compiled actual building operation practice and occupant behavior from survey data in China. Completed simulations and a draft report.** 5. Public workshop, inviting MoHURD, 5 Universities, and IAB partners - a joint event with China side and IAB partners. **Workshop was scheduled on August 28. Announcement and invitations were sent.** 6. Roadmap with timeline for code adoption/influence - a joint deliverable with China side. **Kicked off, in progress.**
9.	**Quarterly Milestones and**	• Completed the 2013 CERC Integrated Design project; finished the technical report of subTask 3 - building information modeling

	Deliverables (*Notable U.S. Technical Progress, Achievements, Findings)*	results schema • Finished the 2013 CERC integrated design final report. • Made significant progress on the review of existing standards and design guides of low energy buildings in the U.S. and Europe. Started writing the technical report: a review of low energy building standards. • Finished the comparison of the China building energy consumption standard and the design standard for energy efficiency of public buildings. Writing the technical report on the comparison of the two standards. • Completed the data mining of the occupant behavior patterns of windows opening and closing in an office building. A journal article was prepared. • Looked for more data sets for data mining study by talking to Iowa energy center, Fraunhofer, and the LBNL FLEXLAB team.
10.	**Notable U.S. Non-Technical Progress, Achievements**	• Organized an Annex 66 subtask leads call to discuss annex progress and preparation for the coming Nottingham meeting. • Started planning for the annual LBNL behavior workshop • Biweekly conference call with the China team on CERC and Annex 66 • Organized a workshop on human behavior at ASHRAE Seattle conference on June 30, 2014. Presented the occupant behavior framework. • Preparing materials for the CERC annual conference on Aug. 25th and 26th • Presented Annex 66 occupant behavior research to the IBPSA-SF chapter. • Preparing for the 2nd expert meeting of Annex 66
11.	**Notable U.S. Industry Progress**	• Participated in a conference call to discuss project plan and progress • Discussion about contribution to the project by integrating and testing the behavior module
12.	**U.S. Technical Next Steps**	• Host the public behavior workshop at LBNL. Prepare and make presentations on behavior research work. • Complete the report on low energy standards and design guides. • Prepare a journal paper on low energy standards • Submit the journal article on data mining of occupant behavior of windows opening and closing • Continue the development of the behavior software module • Participate in the second Expert Meeting of Annex 66 in August in UK. Make presentation on model development.
13.	**Notable China**	• Participated in the bi-weekly calls on CERC and Annex 66

	Progress *(a) research and technical achievements* *(b) demonstration projects*	• Improved the behavior module and integrated with DeST • Participated in the ExCo meeting in June in Germany and reported progress of Annex 66 • Finished comparison of the two China standards • Published a journal article on overtime occupancy • Presented Annex 66 at the behavior workshop of the ASHRAE conference
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	• April 7 & 8, 2014, San Francisco, $500, CERC project. ASHRAE High Performance Buildings conference. • April 21-24, 2014. Washington DC, $1600, CERC project. BTO Review.
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	• August 2-8, 2014, Nottingham, UK, $3500, CERC project. 2nd Annex 66 meetings. • October, 2014, Beijing, China, TBD, project workshop on building energy standards. • November 4-7, 2014, Finland, TBD, IEA EBC Exco meeting. • December 7-10, 2014, Washington DC, TBD, BECC conference.
	Prepared by:	Tianzhen Hong
	Prepared on:	July 3, 2014

Project #2: Advanced Window and Shading Technologies

1.	**Full Project Name**	Advanced Window and Shading Technologies
2.	**Reporting Period**	Q2 2014 (April – June 2014)
3.	**U.S. Research Team**	Eleanor Lee, LBNL
4.	**U.S. Industry Partners**	Robert Licht, Saint-Gobain / Neil Sbar, Sage Electrochromics; John Mansheim, 3M; Robert Nachtrieb, Lutron Electronics, Inc.
5.	**China Research Team**	Li Hong, Wuhan University of Technology; Wu Jianlin, CABR; Li Zhengrong, Tongji University
6.	**China Industry Partners**	Luo Duo, Zhuhai Singye Green Building Technology Co., Ltd
7.	**One Sentence Project Highlight**	Demonstration of Saint-Gobain/ Sage Electrochromic windows underway in Shanghai.
8.	**2014 Target Outcomes and Progress**	**1. Demonstration of innovative shading and daylighting technologies (Task 1.1 Test A)** The initial evaluation of the Lutron shading system (as designed and commissioned by Lutron) was completed and results were reviewed with Lutron. Under sunny summer solstice conditions, the window sensor based control system was found to yield near acceptable control of glare and daylight; additional tuning is needed to better control sky brightness. Testing of an adjusted system will continue through the next quarter, with outcomes potentially of direct relevance to the Xingye demonstration. **2. Testbed evaluation of integrated electrochromic windows and dimmable lighting (Task 1.1 Test A)** Separately, Sage Electrochromics shipped windows in mid-March so we decided to accommodate them in our field test even though they slipped the go/ no-go milestone in mid-January and resources for testing were allocated instead to Lutron. Sage windows were received in mid-March (equinox), installed by early April, made operational by Sage by late-May, but the controls are not yet operating as intended. We are working with Sage to determine the source of the problem. Testing will continue through next quarter to evaluate performance. **3. Model development to assess dynamic façade technologies with control systems (Task 1.1 Test B; Task 2.1 + Task 3a/ Project D1)** Developed code to generate a look-up table for the three-zone electrochromic (EC) window and dimmable LED daylighting control system which is then read by the DER-CAM engine. Combined, this optimization tool determines the optimal state of the EC windows for

		energy minimization based on the source availability and cost (PV, battery, grid). Implemented a 24 vdc network for LED lighting, HVAC, and window system served by PV panels, a lead acid battery, and ac power (utility). Began setting up data acquisition and control of the sources to match that provided by the optimization tool. 4. **Implement integrated controls in Xingye building (Task 1.3)** Xingye declined demonstration of Sage windows due to aesthetic appearance of exterior facade and cost. They intended to do a small portion of the facade (5-6 windows) instead of an entire floor, but this patchwork appearance was not acceptable to the owner. Lutron will be attempting to demonstrate their automated shading and lighting systems in this building. 5. **Clear value proposition of economics of the electrochromic technology in the U.S. and China markets (Task 1.2)** Electrochromic windows were shipped to Shanghai and received by SGR-Shanghai. Installation and commissioning were completed end of May. Baseline monitoring occurred from February through May. Metering of the Sage system was initiated. Adjustments to the monitoring equipment and protocol were made. The occupant survey and protocol was finalized between LBNL, Tongji University, and Saint-Gobain and testing is scheduled to commence in mid-July. 7. **Present at major conferences (or trade shows) in China and the U.S.** Presented latest results at the DOE Peer Review, Washington DC, April 22-25, 2014. 8. **One patent filed (by Sage) in 2014 and roadmap for an additional patent in 2014-15** No activity.
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	Task 1.1: Test A completed, due 6/1/14. Status: completed. Measured results were indicative but the Lutron control system requires further detailed evaluation for potential improvements. Testing will continue (potentially until winter solstice) as Lutron works out options for adjusting their controls. Task 1.2: SGRS Shanghai demo of Sage electrochromics, ship windows, go/ no-go, due 4/15/14. Status: completed; Sage shipped earlier than 4/15/14. Task 1.2: Sage controls operational at Shanghai, monitoring initiated, due 5/30/14. Status: on schedule. Commissioning was completed 5/21/14.

		Task 2.1: Set up of optimization framework complete, due 5/14/14. Status: completed. Framework is complete and ready for field testing. We set up a "microgrid" system in the Advanced Windows Testbed (PV, battery, ac) on a 24 vdc network for the lighting and shading/ ec window systems. Currently working out details on how to cycle between sources on the 24 vdc network with goal of field test proof of concept testing within the next month. Possible application to Xingye demo, although high risk since early stage pre-commercial system.
10.	**Notable U.S. Non-Technical Progress, Achievements**	None.
11.	**Notable U.S. Industry Progress**	Sage Electrochromics delivered products to both the LBNL and Shanghai sites for field demonstrations.
12.	**U.S. Technical Next Steps**	Complete field assessments of Lutron and Sage systems, coordinate results with China SGRS study and relay findings to other China demonstration project teams.
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	SGRS and Tongji University completed baselining activities in the new building and initiated monitoring of the EC window system.
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	DOE Peer Review, Washington DC, April 22-25, 2014, CERC.
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	SGRS Headquarters (Task 1.2), September 2014 (equinox), CERC-BEE funding, $10K (tentative), CERC.
	Prepared by:	ESLee
	Prepared on:	7/15/14

Project #3: Materials that Improve the Cost-Effectiveness of Air Barrier Systems

1.	**Full Project Name**	Materials that Improve the Cost-Effectiveness of Air Barrier Systems
2.	**Reporting Period**	2014 – Q2
3.	**U.S. Research Team**	Oak Ridge National Laboratory (ORNL)
4.	**U.S. Industry Partners**	Dow Chemical 3M
5.	**China Research Team**	China Academy of Building Research (CABR) China Building Standard Design and Research Institute (CBS)
6.	**China Industry Partners**	CABR Kelong Insulation
7.	**One Sentence Project Highlight**	This project seeks to improve the cost-effectiveness of air barrier systems by reducing their installation time.
8.	**2014 Target Outcomes and Progress**	**Dow: Sprayable Liquid Flashing** 1. Dow will generate a technical product planning road map for the sprayable liquid flashing in 2014. 2. Dow will launch the sprayable liquid flashing in the US in 2014. 3. Dow/ORNL will initiate in 2014 laboratory and field tests to demonstrate adequate performance of the liquid flashing. Evaluations will be completed in 2015. ***Progress:*** • *ORNL successfully conducted tests on a wall where the liquid flashing was used to seal joints and penetrations through THERMAX sheathing. The tests performed are: ASTM E283, ASTM E331, ASTM E1424, ASTM E2357, and AAMA 501.5. ORNL will send Dow an interim report.* • *Dow successfully conducted ASTM E2357 and ASTM E331 on a test wall where the liquid flashing was used to seal joints and penetrations through STYROFOAM boards.* 4. Dow will generate an economic value proposition in 2014. 5. Dow will present benefits from the sprayable liquid flashing at a major trade conference in the US and/or China in either 2014 or 2015. **3M: Primer-less Self-Adhered Membrane** 1. 3M will generate a product planning road map for the primer-less self-adhered membrane in 2015 based on results from laboratory and field tests that are performed in 2014. 2. 3M/ORNL will initiate laboratory and field tests in 2014 that will assess benefits from the primer-less self-adhered membrane. After these tests are completed in 2015, 3M will use results to support the

		economic value proposition of the primer-less self-adhered membrane. ***Progress:*** • 3M *successfully conducted ASTM E2357 on a test wall where the primer-less self-adhered membrane was over concrete masonry blocks.* 3. 3M will launch the primer-less self-adhered membrane in China in 2014. 4. 3M will present benefits from the primer-less self-adhered membrane at a major trade conference in the US and/or China. ***Progress:*** • *Hosted a booth at the 2014 American Institute of Architects Convention.* • *3M gave a presentation on the importance of airtightness in buildings in Korea.*
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	• ORNL: − Completed all the LabView codes to evaluate the air and water penetration performance of large-scale test walls before and after these are aged through pressure and temperature cycles per ASTM and AAMA test standards. − Successfully conducted the following tests on one of the Dow walls: *ASTM E283, ASTM E331, ASTM E1424, ASTM E2357 and AAMA 501.5*. − A second wall should have also been tested in Q2; however, this did not occur because CERC-BEE funds arrived at ORNL on April 2014. Building materials are onsite and the assembly of the wall will begin in mid-July. • Dow/ORNL/CABR: CABR tested the air leakage through two windows that incorporated the liquid flashing and an adjacent control window that was installed using typical construction practices. • 3M/ORNL/CABR: CABR tested the air leakage through a window that incorporated the primer-less self-adhered membrane and an adjacent control window that was installed using typical construction practices. An installation defect was detected during the test. The air leakage test will be repeated after the window installers fix the problem.
10.	**Notable U.S. Non-Technical Progress, Achievements**	• ORNL gave a presentation on this project during the DOE Peer Review meeting held on April, 2014. • ORNL and 3M submitted a proposal to DOE's Emerging Technologies / Commercial Building Integration Lab Call. The team was selected to present the proposal to the review panel. If successful, the team will be able to continue the research that started under CERC-BEE. Awardees will be announced by mid-July.
11.	**Notable U.S. Industry**	• Dow successfully conducted ASTM E2357 and ASTM E331 on a test wall where the liquid flashing was used to seal joints and

	Progress	penetrations through STYROFOAM boards. • 3M successfully conducted ASTM E2357 on a wall where the primer-less self-adhered membrane was applied over concrete masonry blocks.
12.	**U.S. Technical Next Steps**	• ORNL to test the second Dow wall • ORNL and 3M to finalize the wall assembly to be tested • ORNL to test the first 3M wall • Dow and 3M to continue evaluating the performance of their products
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	• CABR performed air leakage tests on the windows with the liquid flashing and the primer-less self-adhered membrane. An installation defect was detected in the 3M window during the test. The air leakage test will be repeated after the window installers have fixed the problem. • CABR has not determined if they will conduct the water penetration tests
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	4/23 – 4/24: DOE peer review meeting in Washington, DC. 6/30: proposal presentation in Washington, DC, to review panel for the Emerging Technologies / Commercial Building Integration Lab Call
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	8/25 – 8/26: CERC-BEE annual meeting in Berkeley, CA.
	Prepared by:	Diana Hun
	Prepared on:	7/10/14

Project #4: Cool Roofs and Urban Heat Islands (LBNL)

1.	**Full Project Name**	Cool roofs & urban heat islands
2.	**Reporting Period**	2014 Q2
3.	**U.S. Research Team**	Ronnen Levinson, LBNL, U.S. Team Lead Dev Millstein, LBNL Tim Xu, LBNL Hugo Destaillats, LBNL Mohamad Sleiman, LBNL Scott Hunter, ORNL (Scott's work reported separately)
4.	**U.S. Industry Partners**	Dow Chemical
5.	**China Research Team**	Dr. GAO Yafeng, Chongqing University (CU), China Team Lead Prof. YANG Shichao, Guangdong Provincial Academy of Building Research (GPABR) Dr. Meichun CAO, Chinese Academy of Sciences (CAS) Changqing LIN, MOHURD Research Institute of Standards and Norms (RISN)
6.	**China Industry Partners**	China-Icepower Energy Technology Co., Ltd
7.	**One Sentence Project Highlight**	Started black/white/garden roof experiment in Chongqing, modeled potential for urban heat island mitigation by cool roofs in Guangzhou, and had major paper on cool roofs in China accepted by *Energy Policy*.
8.	**2014 Target Outcomes and Progress**	*Conference paper describing natural exposure campaign.* In June, Xu (LBNL) met with Lin (RISN) and Yang (GPABR) in Shanghai to review the natural exposure campaign and discuss the exposure and measurement protocol developed for China by LBNL. *Journal article describing urban and global cooling by cool surfaces in Guangzhou.* Millstein and Levinson (LBNL) hosted Meichun Cao (CAS) for one month at LBNL to continue collaboration between LBNL and IAP/CAS on regional climate modeling of cool roofs in China. All Guangzhou simulations have been performed and the analysis has begun. *Conference paper/presentations describing upgrades to cool surface credits/requirements in China. Participate in special workshop to engage and educate the people/organizations drafting such standards.* Our review of cool roof/cool wall standards is included in an article at press in *Energy Policy*. Green building standards reviewed. *Conference paper describing designs of black/white/garden roof demonstrations at GPABR/CU.* The CU black/white/garden is underway; instrumentation has been installed, the modular garden roof

		has been assembled, and the white coating will be applied in early July. CU data collection expected to begin in late July. *Conference paper describing design and instrumentation of cool wall demonstration in Wuhan.* No activity. *Conference paper describing the ongoing testing methods, results and conclusions of accelerated tests of the SH extended cool roof coatings*. Paper submitted to the Third International Conference on Countermeasures to Urban Heat Islands, to be held in Venice, Italy, October 2014. (Title: Aging of Cool Roof Materials: New Accelerated Laboratory Test Method for Mimicking the Change in Solar Reflectance. Authors: M. Sleiman, T. Kirchstetter, P. Berdahl, H. Gilbert, S. Chen, R. Levinson, H. Destaillats and H. Akbari)
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	*Task A-1, Q2: Collect representative Chinese roofing products, measure initial properties, and begin coupon exposure at identified sites.* Lin (RISN), Yang (GPABR), and Xu (LBNL) have made substantial progress in identifying sites (5 so far), establishing measurement protocols, and adding new Chinese partners (universities) to the team for this activity. Lin and Yang will hold a workshop for Chinese researchers in mid-July to review the protocols and identify another 5 test sites. Coupon measurement and exposure rescheduled to Q3/Q4. *Task A-3, Q2: Initiate modeling of urban/global cooling in Guangzhou.* Millstein and Levinson (LBNL) hosted Meichun Cao (CAS) for one month to continue collaboration between LBNL and CAS on regional climate modeling of cool roofs in China. Millstein worked closely with Cao to develop predictions of potential changes to urban air temperature from the adoption of cool roofs in cities throughout China. They used the newest version of the regional climate model, WRF, on the NERSC supercomputer (a Department of Energy supercomputing cluster). All model runs were finished and initial analysis of the modeling output begun. *Task A-4, Q2: Develop strategy to advance cool surface credits/requirements in Guangdong Province.* Joint manuscript (CU, GPABR, LBNL) detailing our cool roof simulations, experiments, and policy analysis to date was accepted by *Energy Policy*. LBNL also reviewed green building standards from nine southern provinces with hot summers. *Task B-1, Q2: Instrument black/white/garden roof demonstration at GPABR.* With guidance from LBNL, a black/white/garden roof demonstration at CU was instrumented this quarter, and its garden roof installed. GPABR has started to commission three rooms for concurrent testing. *Task C-2, Q2: Evaluate the self-cleaning ability of SH coatings.* Completed assembly of goniometer to measure water contact angles to quantify hydrophobicity before and after accelerated aging. The system

		includes a setup to determine the self-cleaning performance of superhydrophobic surfaces by measuring the dynamic rolling of water droplets on the surface (prior and after aging). Preliminary experiments to optimize the setup are currently being carried out. *Tasks C-1 & C-2, Q2: Complete formulation and SH and optical testing of pigmented acrylic based coatings.* LBNL identified specimens of superhydrophobic materials from ORNL to be tested with LBNL simulated field exposure (accelerated aging) appartus. LBNL also reached out to Dow Chemical to identify reference samples (non-superhydrophobic) to test.
10.	**Notable U.S. Non-Technical Progress, Achievements**	-
11.	**Notable U.S. Industry Progress**	(Collaboration with Dow Chemical on anti-soiling coatings is detailed in Scott's report.)
12.	**U.S. Technical Next Steps**	LBNL will review and help RISN & GPABR to finalize natural exposure test protocol in support of cool roof rating in China. LBNL will provide guidance and training for RISN/GPABR and their partners in the natural exposure tests. Levinson (LBNL) will help CU analyze early results from its black/white/garden roof experiment, and help GPABR instrument its black/white/garden roof experiment. Test rooms for the GPABR black/white/garden roof experiment will be vacated and fully equipped for the testing in Q3/Q4. Millstein (LBNL) and Cao (CAS) will continue to collaborate to analyze the results of the regional climate modeling performed in Q2, and begin to write a manuscript describing these results. Analysis to be done includes comparison of base case results to observations, comparison of the base and cool scenarios to each other, and comparisons of the effects of cool roofs averaged over the summer season to the effects of cool roofs during various heat wave episodes. Destaillats and Sleiman (LBNL) will begin to test the soil resistance and water resistance of samples of the SH white roof coating as they are made available by ORNL and Dow.
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	Please see Section 9, above.
14.	**Completed Travel in 2014** *(Dates, location,*	22 – 24 April 2014; BTO Peer Review in Arlington, VA; $1K; CERC

	cost, source of funds)	
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	-
	Prepared by:	Ronnen Levinson
	Prepared on:	7 July 2014

Project #4: Cool Roofs and Urban Heat Islands (ORNL)

1.	**Full Project Name**	Cool roofs & urban heat islands (Dow-ORNL-LBNL Advanced White Roof CRADA)
2.	**Reporting Period**	2014 Q2
3.	**U.S. Research Team**	Ronnen Levinson, LBNL, U.S. Team Lead Scott Hunter, ORNL - this report documents the ORNL contribution
4.	**U.S. Industry Partners**	Joe Rokowski, Dow Chemical
5.	**China Research Team**	This activity is US only
6.	**China Industry Partners**	This activity is US only
7.	**One Sentence Project Highlight**	Anti-soiling and anti-microbial testing of ORNL provided SH silica particle containing coatings have been performed at ORNL and are underway at LBNL, and a paper describing the SH diatomaceous earth anti-soiling coatings was published in the journal *Applied Surface Sciences*.
8.	**2014 Target Outcomes and Progress**	Complete formulation and SH testing of basic acrylic formulations and coatings: - work has been delayed at Dow due to relocation of their R&D facilities. Evaluate the anti-soiling ability of SH coatings: - these tests are being performed at ORNL, LBNL and Dow. UV weathering, water repellency and accelerated durability testing of new cool roof coatings: - anti-soiling coated coupons are under evaluation at ORNL and LBNL. Complete formulation and SH and optical testing of pigmented acrylic based coatings: - presently being performed at Dow. Microbial growth testing of anti-soiling coatings: - presently being evaluated at ORNL. Characterize surface roughness and topographical features, perform depth profiling measurement of water retention and coating oxidation: - these studies are under way at ORNL and LBNL.
9.	**Quarterly Milestones and Deliverables** (*Notable U.S. Technical Progress, Achievements, Findings)*	ORNL has initiated anti biofouling studies using surface modified SH coatings that are expected to have enhanced anti biofouling properties. ORNL has characterized microbial-aged SH coupons in a preliminary trail run. Biofilm growth was confirmed within two weeks. Reduction in solar reflectance (measured by D&S reflectometer) varied widely from a few percent to 19% at the end of two months of exposure. SH silica particle coated surfaces were found to be microscopically transformed by microbial mixture similar to other coated surfaces.

		Characterization of these and other anti-soiling coupons is ongoing in Q3. A second trial of the anti-microbial properties of a batch of SH-coated and other types of coupons is underway at ORNL. Anti-soiling coated coupons containing various formulations of SH particles were sent to LBNL for evaluation of their anti-soiling properties. The journal article by ORNL researchers has been published in the Applied Surface Sciences journal: G. Polizos, Kyle Winter, D. A. Schaeffer, J. T. Simpson, S. R. Hunter, "Scalable superhydrophobic coatings based on fluorinated diatomaceous earth: Abrasion resistance versus particle geometry," *Appl. Surf. Sci.*, **292**, 563-569 (2014).
10.	**Notable U.S. Non-Technical Progress, Achievements**	
11.	**Notable U.S. Industry Progress**	Dow moved their R&D facility from Spring Hill, PA to Collegeville, PA during late Q4 of CY13. This activity took considerably longer than originally anticipated and Dow's new R&D facility has only recently become fully operational. This delay has had considerable impact on the timing of the anti-soiling coating development work being performed at Dow. Dow continues to study the best methods for the incorporation of the functionalized silica particles in the acrylic based mixtures to reduce the water permeability of the anti-soiling coatings.
12.	**U.S. Technical Next Steps**	ORNL will provide additional milled and SH functionalized diatomaceous earth powders with different functionalization groups to enhance SH particle-polymer binding to reduce coating porosity and improve particle retention during mechanical abrasion of anti-soiling acrylic coatings. ORNL will continue to provide anti-soiling coated coupons to LBNL to test soiling resistance of the coatings ORNL will continue internal development work on the coating optimization and testing of panels with SH coatings impregnated with anti-biofouling media. Dow will continue to develop low solvent and VOC techniques and processes to disperse and incorporate the SH materials into non-pigmented and pigmented acrylic emulsions and coatings. Dow, ORNL and LBNL will characterize coupons coated with these acrylic resins for water repellency, optical, anti-biofouling and anti-soiling properties in comparison with standard solvent based coatings.
13.	**Notable China Progress** *(a) research and*	This activity is US only

	technical achievements (b) demonstration projects	
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	22–24 April 2014; BTO Peer Review in Arlington, VA; $1.5K; CERC
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	Aug. 25-27 - CERC-BEE Annual Meeting, Berkeley, CA; $1,500 from CERC-BEE
	Prepared by:	Scott Hunter
	Prepared on:	2014-07-11

Project #5: Hybrid Ventilation Technology and Product R&D: Natural Ventilation for Commercial Buildings

1.	**Full Project Name**	Hybrid ventilation technology and product R&D: Natural ventilation for commercial buildings
2.	**Reporting Period**	Q2 2014: April 2014 – June 2014
3.	**U.S. Research Team**	US project leader: Leon R. Glicksman, Massachusetts Institute of Technology Support: Alonso Dominguez, Massachusetts Institute of Technology
4.	**U.S. Industry Partners**	---
5.	**China Research Team**	Chongqing project • Leader: Li Baizhan, Chongqing University • Support: Li Nan, Chongqing University Zhuhai project • Leader: Zhu Neng, Tianjin University
6.	**China Industry Partners**	Chongqing project: Chongqing Jinxi Cultural Center • Project developer: Chongqing Fu Tai Construction Group Heishishan Integrated Tourism development LLC • Contact: Zou Wei, Chongqing Fu Tai Construction Group Heishishan integrated tourism development LLC Zhuhai project: Zhuhai Singyes R & D Building, the 2nd Zhuhai Singyes Renewable Energy Industrial Park • Project developer: Zhuhai Singyes Green Building Technology Co.Ltd • Contact: Deng Xin, Zhuhai Singyes Green Building Technology Co.Ltd
7.	**One Sentence Project Highlight**	Develop natural ventilation design tools, guidelines, and controls and use them in building demonstrations to highlight the efficiency and practicality of natural ventilation
8.	**2014 Target Outcomes and Progress**	2014 targets Continue the development of control algorithms for night ventilation and dual mode operation of natural ventilation Extend current air thermal stratification model in naturally ventilated offices Continue work with Chinese developers: fenestration elements, façade elements and ventilation strategies Prepare and carry out workshops to promote the widespread application of natural ventilation and to reach new users of our design tool, CoolVent *(See section 8 for detailed progress report)*
9.	**Quarterly Milestones and Deliverables (***Notable U.S.*	Improvement of design tool, CoolVent Achieved: New control strategies based on predictor, which keeps track of the thermal mass temperature. In an actual building system, no

	Technical Progress, Achievements, Findings)	measurement of the thermal mass temperature is available, thus, it is important to be able to predict it in an accurate and fast way. Taking account of the thermal mass temperature allows for better control of windows, fan and air conditioning. Predictor has been shown to be accurate in many situations and is still being tested and debugged for other cases. Share information with Chinese developers, analysis of impact of façade element on natural ventilation assist on the design and control of natural ventilation systems Achieved: Submitted a second report regarding weather conditions suitable for natural ventilation to the research team and industrial partners for the Zhuhai Singyes R & D Building. Report included evaluation of buoyancy-driven ventilation for the first floor and cross ventilation for the rest of the floors as first suggested by Singyes. Additionally, we explored the possibility of buoyancy ventilation for all of the floors and a combined buoyancy-wind driven ventilation for all the floors. Studied the impact of an exhaust fan at the outlet of the ventilation shaft, as well as the impact of the photovoltaic panels, which surround the façade of the building, on the performance of natural ventilation. Fan + water spray strategy, as proposed by Singyes, was found to be inadequate for the very humid months of the summer, but could be effective during the shoulder seasons. Currently, we are looking at a night cooling strategy for the summer and the effect of the geometry of the panels' mounting system on natural ventilation. Third report including these last items is in preparation and will be finished soon. Improvement of thermal stratification model Achieved: Studied the effect of inlet height, total temperature rise in the room and inlet area on the temperature stratification of the space. It was found that previous model is still valid to determine the temperature stratification of the air in the room, even for cases that were not investigated by previous researcher. However, it was not effective for the surrounding surfaces (floor, ceiling and walls). Dimensionless temperature of these surfaces was found to increase as the inlet area increased, and to increase as the inlet speed decreased. This also means that these dimensionless temperatures decrease as the total temperature rise increases. However, non-dimensional temperatures are not monotonically decreasing (or increasing) functions of the inlet height, rather they increase first and then decrease as the inlet height decreases. Thus, previous model strategy was not successful to determine these temperatures. Operative temperature was calculated for many room configurations, which include tables, vertical separations and different lighting configurations. Although mean air temperature at

		occupant level was found to be similar for all these cases (and generally below the exhaust – or well-mixed – temperature), the mean radiant temperature for them is different. Therefore, the operative temperature is indeed different and was found to be the lowest for the cases with larger area for convection. In all the cases the operative temperature was found to be higher than the exhaust temperature. Operative temperature follows a linear trend in the dimensionless temperature vs dimensionless convection area plane. Currently trying to define the parameters that define such linear trend. Additionally, the effect of a second floor on the thermal stratification of the space was also investigated. When the temperature rise in the second floor is higher than in the first floor, it was found that virtually all of the air from the first floor enters the second floor. The air leaving the first floor is not warm enough for buoyant forces to push it out of the ventilations shaft, instead, it enters the second floor. The temperature profile in the first floor is also different than in the single-floor case. However, the mechanism by which the temperature stratification changes in the first floor was found to be heat transfer in the ventilation chimney, given that no air from the second floor reaches the first floor. The temperature stratification of the second floor was found to be independent of the stratification of the first floor. The stratification in the first floor was changed by changing the height of the inlet and the momentum of the jet entering the first floor, while keeping the temperature rise in the floor constant. This is consistent with the fact that all of the air of the first floor gets into the second floor, so its stratification in the first floor is somewhat irrelevant. When the temperature rise of the first floor is higher than in the second floor, it was found that no air from the first floor enters the second floor, and that no air from the second floor enters the first floor. The mechanism by which the stratification changes in both floors is by heat transfer in the ventilation chimney. The effect of thermal mass on the stratification in both floors was assessed. It was found that in steady state, the stratification in the rooms, as well as the temperatures in the floor and the ceiling of both floors, was not significantly altered by the presence of the thermal mass.
10.	**Notable U.S. Non-Technical Progress, Achievements**	Preparing for the Natural Ventilation Workshop @ MIT in August. This day-long workshop features speakers from SOM, Payette, Transsolar and MIT. It will include hands-on workshops on CoolVent and Archsim. Intended for architects, designers and engineers as well as educators; its goal is to disseminate our work on natural ventilation and to reach new CoolVent users to promote the use of natural ventilation that will reduce energy use for cooling.

11.	**Notable U.S. Industry Progress**	---
12.	**U.S. Technical Next Steps**	• Monitoring of buildings in China • Continue research regarding "Model-Predictive Control" (MPC) in hybrid ventilation systems. • Implementation of MPC algorithms in CoolVent • Continuing work towards a better thermal stratification model, not only in a single-room building, but in multistory spaces and to include it as part of thermal comfort evaluation in CoolVent • Finish report for Chinese Zhuhai team regarding night cooling potential and the effect of the geometry of the pv mounting system.
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	April 23rd to April 24th, Washington DC, for the BTO review meeting
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	August 25th to August 26th, Berkeley, CA, for the US-China CERC-BEE Annual Meeting October 19th to October 22nd, Sao Paulo, Brazil for Roomvent conference. Two papers accepted for this conference.
	Prepared by:	Alonso Dominguez, Leon Glicksman and Kathleen Ross
	Prepared on:	July 1st, 2014

Project #6: Advanced Lighting Controls in New and Existing Buildings

1.	**Full Project Name**	Advanced Lighting Controls in New and Existing Buildings
2.	**Reporting Period**	Q2 2014
3.	**U.S. Research Team**	Lawrence Berkeley National Laboratory. Francis Rubinstein, Erik Page
4.	**U.S. Industry Partners**	Lutron Electronics. Robert Nachtrieb
5.	**China Research Team**	National Low-Carbon Lighting Research Center. Huang Yuehui
6.	**China Industry Partners**	Lutron Electronics. Matt Blakeley
7.	**One Sentence Project Highlight**	Lutron lighting controls systems were installed and commissioned at the CARB field test site in Beijing; experimental plans for FLEXLAB test were refined.
8.	**2014 Target Outcomes and Progress**	1. *Demonstrated launch of control system in U.S. and China markets by end of 2014* This target outcome is no longer relevant as the system installed in CABR and tested in FLEXLAB is an existing (not newly developed) Lutron product. 2. *Clear road map and progress to establishing codes in 2014* Limited Progress in Q2 2014. 3. *Economic value proposition including field data and modeling against the real cost to demonstrate technology's viability in market/application* The experimental design refined this quarter explicitly addresses this target. 4. *Code language and plan for which partners need to be engaged in both US and China to have the code adopted and implemented* Limited Progress in Q2 2014. 5. *FY2014 goal: Tool for analyzing lighting data collected by manufacturer's control system.* The experimental design refined this quarter explicitly addresses this target. 6. *Stretch goal (FY15): Embed analysis into developed code language to verify compliance* Limited Progress in Q2 2014.
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical*	Milestones: • *Installation of lighting controls systems in FLEXLAB - June 2014* Milestone not yet completed as we are: • still refining the experimental design

	Progress, Achievements, Findings)	• awaiting arrival of Lutron lighting controls systems • waiting for FLEXLAB to be fully operational This milestone is now anticipated for October 2014 Deliverables: • *Experimental plan for evaluating lighting controls system in FLEXLAB – April 2014* In Q1 we completed the conceptual design of experimental plan at FLEXLAB and field test at CARB (Beijing). In Q2, in discussions between LBNL and Lutron, we continued to refine the experimental plan but it has not yet been finalized. We anticipate this will be completed in August 2014
10.	**Notable U.S. Non-Technical Progress, Achievements**	LBNL has hired a Program Manager to manage this project, who will start July 21.
11.	**Notable U.S. Industry Progress**	Lutron commissioned the controls for the CARB field test site. Lutron also participated in discussions with US researchers related to the FLEXLAB test plans.
12.	**U.S. Technical Next Steps**	We continue to develop a detailed experimental plan for the FLEXLAB experiment. We also anticipate we will receive sample controls equipment from Lutron. This will also LBNL to conduct benchtop testing of the equipment so that we can more quickly install within the FLEXLAB when it is available.
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	The installation of Lutron's lighting controls equipment was completed and commissioned in CARB in Q2 2014.
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	N/A
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	Erik Page will likely visit the field test site in 2014 though dates have not yet been set.
	Prepared by:	Erik Page
	Prepared on:	July 8, 2014

Project #7: Research and Demonstration of Integrated Building Energy Technologies

1.	**Full Project Name**	**Research and Demonstration of Integrated Building Energy Technologies**
2.	**Reporting Period**	2014 Q2
3.	**U.S. Research Team**	Nan Zhou, Berkeley Lab, Co-PI Michael Stadler, Berkeley Lab, Co-PI Wei Feng, Berkeley Lab, Sr. Scientific Engineering Associate Salman Mashayekh, Berkeley, Postdoc Tyler Yan, Berkeley Lab, Student Research Assistant Shi Wang, Affiliate Kuixing Liu, Affiliate Gonçalo Cardoso, Berkeley Lab, Post-doc
4.	**U.S. Industry Partners**	C3 Energy
5.	**China Research Team**	Neng ZHU, Tianjin University, PI Hongwei TAN, Tongi University, PI Shilei LV, Tianjin University & Berkeley Lab Affiliate Jing Zhao, Tianjin University & LBNL Affiliate Yan Ding, Tianjin University & LBNL Affiliate Zhixin Chen, Beijing University of Construction and Architecture Jia Wang, Beijing University of Construction and Architecture Sheng Li, XingYe Solar Jin Li, XingYe Solar
6.	**China Industry Partners**	XingYe Solar, Wuhan Rixin
7.	**One Sentence Project Highlight**	Create an open-access web service that permits optimization of building equipment selection and operation for building-scale microgrids.
8.	**2014 Target Outcomes and Progress**	Develop real-time control methods for distributed energy system in buildings
9.	**Quarterly Milestones and Deliverables** (*Notable U.S. Technical Progress, Achievements, Findings)*	■ Worked with XingYe on its demo building microgrid design. Provided technical comments on DC microgrid construction in XingYe demonstration building ■ Refined Building 26 EnergyPlus model and calibrated it with real-time measurement data ■ Developed a program using Python language to acquire weather forecast data and saved for operation optimization ■ Developed an algorithm to forecast building load profiles based on forecasted weather data and historical load data. ■ Developed closed loop data exchange for conduct real-time

		operation optimization for University of New Mexico M.E. Building ■ Executed a test week of DER-CAM control at M.E. Building ■ Developed secure SQL-based data exchange design for larger scale deployment ■ Continued development of models for control of One Sun Plaza and Hyatt Regency Buildings in Albuquerque ■ Developed electrochromic window operation optimization scheme. Coupled electrochromic window control with battery charging and discharging schedules ■ Set up interface between DER-CAM and controllable shading model
10.	**Notable U.S. Non-Technical Progress, Achievements**	■ Approached Automated Logic and Johnson Controls Inc. as a potential controls vendor partner (both are promising partners) ■ Kickoff meeting of microgrid system and research in XingYe demonstration building ■ Maintained conference calls and reports with Chinese industrial partners
11.	**Notable U.S. Industry Progress**	■ JCI is trying to identify opportunity to work with Xingye, and potentially another building in Shanghai using Xingye's technology ■ C3 is proceeding with licensing DER-CAM
12.	**U.S. Technical Next Steps**	■ Work with XingYe to develop an EnergyPlus model for the demo building ■ Assist XingYe with building design, amending DER-CAM as necessary. ■ Develop methods to forecast building load at Blg. 26 ■ Identify controls vendor partner. ■ Build interface for Operations DER-CAM to selected vendor's control system ■ Deploy electrochromic windows optimal operation strategy to B71 testbed ■ Provide DER-CAM training to researchers in Beijing University of Civil Engineering and Architecture (BUCEA)
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	■ Initial design for XingYe building developed ■ Preliminary BIM model for XingYe building is developed ■ Tianjin U. is deploying sensor on top of Blg. 26 to verify the accuracy of weather forecast program developed by LBNL. ■ BCAU is developing a PV electricity generation forecast model
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	■ April 2014, C Marnay, W Feng traveled to China to participate the XingYe demo building kickoff meeting ■ Mashayekh travelled to Albuquerque, Jun 14
15.	**Anticipated Travel in 2014**	August, 2014, Beijing, CERC Nov 2014, U.S. DOE OE, Beijing/Tianjin

	(Dates, location, cost, source of funds)	
	Prepared by:	Wei Feng, Nan Zhou, and Salman Mashayekh
	Prepared on:	07/10/2014

Project #8: Advance Ground Source Heat Pump Technology for Very Low Energy Buildings

1.	**Full Project Name**	Advance ground source heat pump technology for very low energy buildings
2.	**Reporting Period**	Q2_2014
3.	**U.S. Research Team**	Xiaobing Liu, Oak Ridge National Laboratory (ORNL)
4.	**U.S. Industry Partners**	ClimateMaster
5.	**China Research Team**	WU Jianlin, LI Wang, and other researchers at China Academy of Building Research (CABR) will lead GSHP related studies at the joint US-China CABR demonstration project
6.	**China Industry Partners**	Unknown
7.	**One Sentence Project Highlight**	Improve GSHP systems' operational efficiency by optimizing controls of major equipment and the entire system
8.	**2014 Target Outcomes and Progress**	1. Improved efficiency of hot water generation by smart tank or distributed GSHP system by smart controls (ongoing, see following technical progress) 2. At least one invention disclosure on the smart tank or system smart controls (**Three invention disclosures on the smart tank control, virtual sensing for measuring performance of distributed GSHP systems, and intelligent pumping control for distributed GSHP systems have been prepared**) 3. IEA heat pump conference paper on the field test and evaluation of alternative vertical bore GHXs (**This paper has been presented at the 11th IEA heat pump conference in May 22-25 at Montreal, Canada**) 4. Invited ASHRAE Journal paper on ASHRAE HQ HVAC system analysis: distributed GSHP vs. VRF (**The first paper from this study has been submitted to ASHRAE Journal** and two more papers are underway and will be submitted in next quarter) 5. Conduct lab tests to verify performance of the smart tank (**A CRADA with ClimateMaster has been officially signed and lab tests are ongoing,** see following technical progress) 6. Assist in the design of the first-of-a-kind GSHP test bed (ongoing, see following technical progress) 7. ClimateMaster heat pump will be installed at other demonstration sites (ongoing, see following industry progress) 8. Technical support for the VLEB demonstration projects in China (**A distributed GSHP system using ClimateMaster's**

		heat pump has been commissioned at CABR's VLEB, see following industry progress)
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	• Prepared three invention disclosures for (1) a self-adaptive control for the hot water tank tied with a GSHP unit, (2) an intelligent pumping control for distributed GSHP system, and (3) a virtual sensing algorithm for measuring the performance of distributed GSHP systems. • Specified test plan and instrumentation for the initial lab tests for the hot water tank. This lab tests will characterize the thermal stratification in the tank at various hot water draws and circulate flow rates of the heat pump water heater. In addition, another set of lab test will quantify the heat loss from the dip tube in the tank and the connected city water supply line. • Investigated a couple of options for the heat sink and source for the experimental distributed GSHP system to be installed at ORNL's 2-store flexible research platform (FRP). A close-loop design that uses an air-cooled chiller and a gas-fired water heater to emulate various ground sources has been determined. The interior piping layout and the heat pump selection for the experimental GSHP system have been finalized. The selected heat pump units and other accessories have been ordered by ClimateMaster. Currently, the PI is working with ClimateMaster and ORNL facility management team to implement the experimental GSHP system. • Co-authored a paper for ASHRAE Journal on the performance comparison between a VRF system and a distributed GSHP system installed at the ASHRAE HQ. Two more papers are underway: one is for building load analysis and the other is for monitoring and evaluation of the GSHP system performance. • Presented the progress of this project at DOE BTO's Peer review meeting • Presented the paper on the field test and evaluation of alternative vertical bore GHXs at the 11th IEA heat pump conference in May 22-25 at Montreal, Canada
10.	**Notable U.S. Non-Technical Progress, Achievements**	• A new CRADA for developing the smart controls for hot water tank and distributed GSHP systems has been officially signed by ORNL and ClimateMaster
11.	**Notable U.S. Industry Progress**	• Provided technical support for the VLEB demo at CABR and replaced a failed compressor in one of the heat pump units installed at the demo • ClimateMaster is in negotiation with other demonstration sites for demonstrating its advanced GSHP units
12.	**U.S. Technical Next Steps**	• Analyze initial lab test results and calibrate/improve tank model • Implement the experimental GSHP system at ORNL's two-

		story FRP • Conduct computer simulations to optimize controls for the hot water tank tied with GSHP units • Perform field test with the experimental GSHP system to verify the effectiveness of the optimized control for the hot water tank
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	The CABR demo is completed. Both the Secretary of US DOE and the Secretary of DoST of China will visit CABR demo on 11, July and cut the ribbon for the opening ceremony of the demo building.
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	• 11th IEA Heat Pump Conference, May 12-16th, Montreal, Canada • BTO Peer review (travel cost is shared with another DOE funded project): April 22-24th, Washington, DC
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	• CERC-BEE Annual Review, August 25-27th, Berkeley, California
	Prepared by:	Xiaobing Liu
	Prepared on:	7/10/2014

Project #9: Commissioning, Operation, Real Time Monitoring and Evaluation of Pilot

1.	**Full Project Name**	Commissioning, Operation, Real Time Monitoring and Evaluation of Pilot
2.	**Reporting Period**	Apr. 2014 to Jun. 2014
3.	**U.S. Research Team**	Xiufeng Pang, LBNL
4.	**U.S. Industry Partners**	Interface Engineering, PG&E
5.	**China Research Team**	Bin Hao, CSTC, MoHURD
6.	**China Industry Partners**	China Academy of Building Research (CABR), Environmental Market Solutions Inc. (EMSI)
7.	**One Sentence Project Highlight**	Compare the Cx practice between US and China, and ensure the proper installation and operation of demonstrated technologies.
8.	**2014 Target Outcomes and Progress**	• Organize a two-day seminar in China to promote the US Cx standard and industry practice. *Progress*: The seminar will be held on July 18th and squeezed into one day due to the challenges of scheduling. Four Cx experts have been confirmed and will present in the seminar • Compare Cx practice between US and China. Provide the technical report for US companies that are interested in starting business in China. *Progress:* Three candidate buildings have been identified to be included in this study. One building in Beijing, one in Shanghai, and one in Guangzhou, which covers three different climate zones in China. • Develop integrated functional testing protocol to ensure the proper installation and operation of demonstrated technologies.
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	• Identify seminar speakers. *Progress:* completed. • Develop seminar curriculum *Progress:* completed. • Complete the seminar *Progress:* the seminar is schedule on July 18 • Demonstrate the benefits of the seminar *Progress:* will complete right after the seminar • Provide technical support to commissioning the demo buildings. *Progress:* technical support has been provided to the demo buildings as needed.

10.	**Notable U.S. Non-Technical Progress, Achievements**	The Cx seminar attracts many attentions from the Industry in China. Many companies ask about the seminar and express their interest in attending the seminar.
11.	**Notable U.S. Industry Progress**	The industry partner is preparing the training materials for the upcoming Cx seminar in China.
12.	**U.S. Technical Next Steps**	• Review the Cx plan for the two demo buildings • Develop integrated functional testing protocols • Provide technical support to commissioning the demo buildings • Identify candidate buildings for comparison
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	• CSTC, MoHURD will co-host the Cx seminar in July 18th. • Xingyes is completing the mechanical drawings and will start the commissioning-focused design review soon. The US team is helping Xingyes with the design review process. • CABR demo building has been completed and the owner decided to commission the building as the occupants move in. The US team is working with CABR team to develop the Cx plan.
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	Apr 22nd to Apr 30th, Beijing and Zhuhai, $1,939, 60% CERC fund, 40% paid by others.
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	July 11th to July 23rd, Beijing, Zhuhai and Shenzhen, $4,500, 100% paid by CERC fund.
	Prepared by:	Xiufeng Pang
	Prepared on:	7/8/2014

Project #10: Research on Very Low-Energy Building Operations and Management Methods

1.	**Full Project Name**	**Research on Very Low-Energy Building Operations and Management Methods**
2.	**Reporting Period**	Q2 2014 (submitted July 10, 2014)
3.	**U.S. Research Team**	ICF International (ICF), Sustainable Energy Partnerships (SEP), and Lawrence Berkley National Laboratory (LBNL)
4.	**U.S. Industry Partners**	US-China Energy Cooperation Program (ECP) – Xu Haihong, Ma Li
5.	**China Research Team**	Research Counterparts: Center of Science and Technology of Construction (CSTC), Ministry of Housing and Urban-Rural Development (MOHURD), China Academy of Building Research (CABR) Advisors and Collaborators: Tsinghua University and Natural Resources Defense Council (NRDC)
6.	**China Industry Partners**	N/A
7.	**One Sentence Project Highlight**	***Task 1 – Building Energy Performance Database, Rating System, and Policy/Program Framework Development*** • Drawing on US and international experience, develop a policy/program framework, and supporting database and prototype benchmarking tool, to deliver widespread very low-energy buildings in China, thereby advancing the market for US energy-efficient building technologies and providing lessons to advance US building energy policies, databases, and rating systems. ***Task 2 – Evaluation and Energy Reporting Protocol for CERC Demonstration Buildings*** • An Evaluation and Energy Reporting Protocol for the five very low-energy demonstration buildings in China that ensures performance of the demonstration buildings can be consistently, fairly, and accurately evaluated and communicated. ***Task 3 – Collaboration on Building Energy Performance Monitoring and Standards*** • Summary of the innovative building energy data collection and regulatory policy being piloted in China, and identification of relevant lessons to advance building energy data collection methodologies, codes/standards, and policies in the US.
8.	**2014 Target Outcomes and Progress**	***Task 1 – Building Energy Performance Database, Rating System, and Policy/Program Framework Development*** • Final commercial (public) building energy performance database taxonomy for China which has been implemented on a pilot basis

		in one city or region. • Final prototype Excel-based tool(s) to rate (including normalization) commercial building energy performance in China following the ENERGY STAR methodology (with appropriate customizations for China). • Final report describing China's current situation related to building energy data and benchmarking and which proposes a program/policy framework that integrates a national building energy performance database and building energy performance rating system to drive very low-energy buildings in China. ***Task 2 – Evaluation and Energy Reporting Protocol for CERC Demonstration Buildings*** • An Evaluation and Energy Reporting Protocol, approved by MOHURD and DOE, for the five very low-energy demonstration buildings in China. • Template and training materials to support the implementation of the Evaluation and Energy Reporting Protocol. • Workshop to introduce and train demonstration project developers on the Evaluation and Energy Reporting Protocol. ***Task 3 – Collaboration on Building Energy Performance Monitoring and Standards*** • Technical/policy paper about real-time, on-line energy monitoring; innovations in building energy codes, standards, and policy; and the China quota standard for US DOE and publication.

9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	***Task 1 – Building Energy Performance Database, Rating System, and Policy/Program Framework Development***
		• Shared the following materials with CSTC associated with energy performance benchmarking tool development:
		  o Overview of "Building Energy Data Exchange Specification (BEDES);" "The Standard Energy Efficiency Data (SEED) Platform;" and "The Building Performance Database (BPD)"
		  o Sample, draft Excel-based building energy performance database taxonomy (Excel)
		  o DOE BPD, SEED, and BEDES Materials
		• With CSTC, initiated second draft of commercial (public) building energy performance database taxonomy for China. Per request of CSTC, ICF provided input regarding what hotel energy performance data we have (2010, 2011, 2012).
		• **Finalizing revised hotel benchmarking tool.**
		
		Task 2 – Evaluation and Energy Reporting Protocol for CERC Demonstration Buildings
		• Submitted first draft of Evaluation and Energy Reporting Protocol

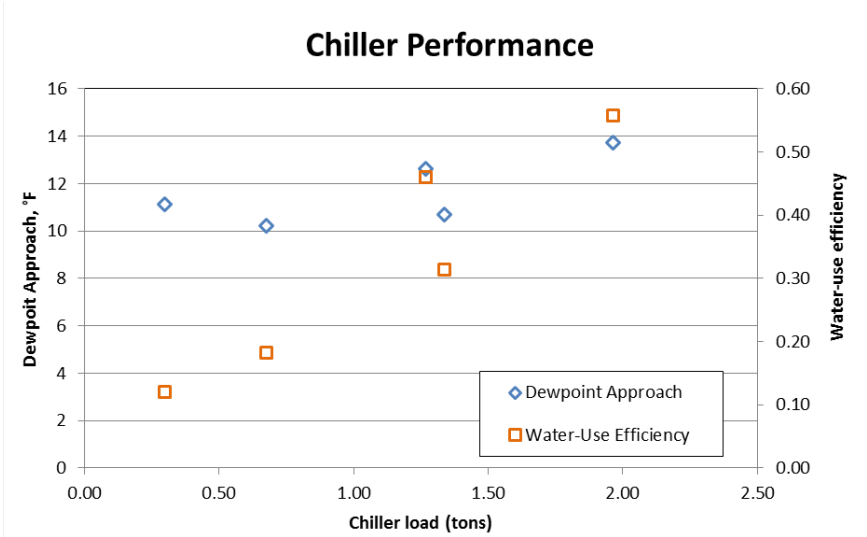
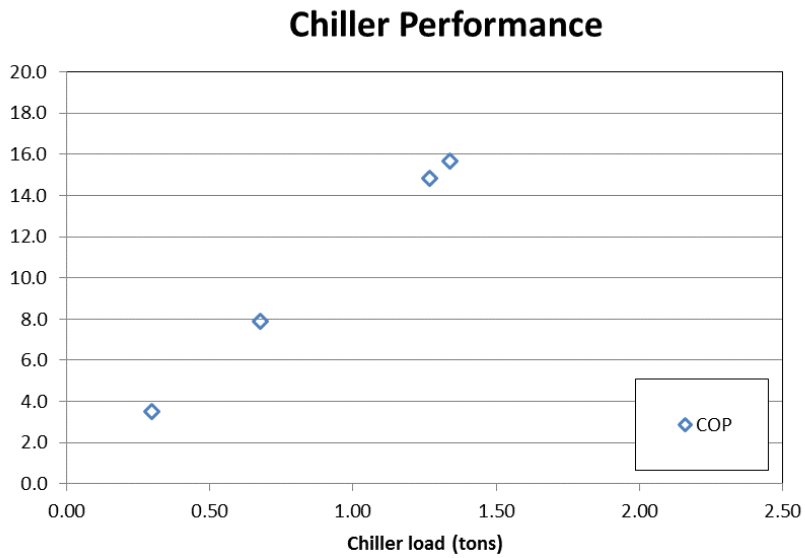
		and data collection template to CSTC for comments.
		• Developed revised Evaluation and Energy Reporting Protocol and data collection template based on feedback from CSTC. Revised Protocol references applicable Chinese standards and associated metric conversions, including: JGJ/T288-2012 China Standard for Building Energy Performance Certification and JG/T 358-2012 Classification and Presentation of Building Energy Use Data.
		• Prepared for Zhuhai workshop on July 18th where ICF will provide a brief introduction (10-15 minutes) on the Energy Reporting Protocol covering:
		  o Introduction to protocol (what it is, etc.)
		  o Purpose of protocol development under CERC
		  o What type of data will be collected
		  o How data will be collected
		  o How data will be utilized
		
		Task 3 – Collaboration on Building Energy Performance Monitoring and Standards
		• Held discussions and obtained feedback from Tsinghua University, CSTC, and CABR application of real-time building energy monitoring in China.
		• Conducted research on emissions trading scheme (ETS) pilots and how they incorporate public buildings in China.

10.	**Notable U.S. Non-Technical Progress, Achievements**	• Held ½-day meeting with CSTC on May 28th to provide overview of DOE BPD, SEED, and BEDES as well as to discuss the Energy Reporting Protocol.
11.	**Notable U.S. Industry Progress**	N/A
12.	**U.S. Technical Next Steps**	***Task 1 – Building Energy Performance Database, Rating System, and Policy/Program Framework Development*** • Continue sharing technical information with CSTC, CABR, and Tsinghua on building energy performance databases and methodology for development, including US DOE BPD, SEED platform, and BEDES. • Finalize second draft commercial (public) building energy performance database taxonomy for China. • Finalize prototype Excel-based tool(s) to rate (including normalization) commercial building energy performance in China following the ENERGY STAR methodology (with appropriate adaptations/customizations for China.) ***Task 2 – Evaluation and Energy Reporting Protocol for CERC Demonstration Buildings*** • Finalize draft Evaluation and Energy Reporting Protocol and Template.

		• Provide introduction to the Evaluation and Energy Reporting Protocol to CERC Demo Buildings in Zhuhai on July 18th. • Share final draft Evaluation and Energy Reporting Protocol with MOHURD. ***Task 3 – Collaboration on Building Energy Performance Monitoring and Standards*** • Obtain updates on real-time building energy monitoring; innovations in building energy performance codes, standards, and policies in China. • Develop initial draft of full paper. • Submit initial draft technical/policy paper to US DOE.
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	• Held ½-day meeting with CSTC on May 28th to provide overview of DOE BPD, SEED, and BEDES as well as to discuss the Energy Reporting Protocol. • CSTC taking lead role on development of a national building energy performance database based on US DOE BPD model. CSTC is in coordination with ICF, Tsinghua, and CABR on this. • CSTC, Tsinghua, and CABR provided information on on-line building energy performance monitoring to ICF for report to US DOE.
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	None.
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	ICF: • CERC Mid-Term Review August 25th -27th, San Francisco, CA, $3,500 US DOE CERC. SEP: • Meetings in China with experts/collaborators, likely June or September: $3,500
	Prepared by:	Carolyn Szum and Adam Hinge
	Prepared on:	July 10, 2014

Project #11: Wet Bulb Evaporative Chiller

1.	**Full Project Name**	CERC-BEE Sub Wet Bulb Evaporative Chiller
2.	**Reporting Period**	Quarter 2 – April 10th 2014 – July 10th 2014
3.	**U.S. Research Team**	Western Cooling Efficiency Center, University of California , Davis
4.	**U.S. Industry Partners**	Nexajoule LLC
5.	**China Research Team**	Building Energy Research Center, Tsinghua University
6.	**China Industry Partners**	Xinjiang Refreshing Angle Air Environment and Technology Company
7.	**One Sentence Project Highlight**	This quarter WCEC lab-tested the Nexajoule prototype and recorded a dewpoint approach between 10-14°F, water-use efficiency of 10-56%, and a COP between 3-15.
8.	**2014 Target Outcomes and Progress**	1) Lab performance characterization of two dew point fluid cooler prototypes documented in a technical paper. *Progress: One chiller was tested. Currently data is being analyzed and reported. Finalized design for second chiller with Tsinghua University, estimated delivery timeframe is Oct. 2014.* 2) Improved fluid cooler with redesign documented in a letter report *Progress: A literature search and modeling of the components of the systems are underway including plate-to-plate heat exchangers, evaporative media, and tube-and-fin heat exchangers. A working model of each system will allow for system optimization.* 3) File one invention disclosure in 2014 *Progress: No invention disclosures have been filed.* 4) Secure industrial partner *Progress: A Chinese manufacturer exists for production of the Chinese technology. An industrial partner has not been secured in the US.*
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	This quarter the WCEC lab-tested the Nexjoule prototype and measured several performance parameters including water-use efficiency, dewpoint approach, and COP. The results are plotted as a function of applied load (below). The water-use efficiency is a measure of the amount of water evaporated for chilling the water divided by the total water consumption. The dewpoint approach is a measure of how close the chilled water temperature is to the dewpoint temperature of the outdoor air. As shown in the figures, WCEC recorded a dewpoint approach between 10-14°F, water-use efficiency of 10-56%, and a COP

		of between 3-15. Performance of the system generally increased with load, which was expected. The system evaporates a significant amount of water into the air when no load is present, cooling the air stream instead of cooling the water. In addition, the fan power for the system is fixed, so the COP is unfavorable at low loads.  
10.	**Notable U.S. Non-Technical Progress, Achievements**	This quarter WCEC made arrangements for testing the Chinese technology. This includes contract negotiation between the Universities involved, sizing the chiller for the test chamber, and planning for interfacing the chiller with the test chamber. In addition, plans have been made for a student from Tsinghua to visit during August 2014.
11.	**Notable U.S. Industry Progress**	Nexajoule delivered the test unit to WCEC for testing and provided technical assistance as needed.
12.	**U.S. Technical Next Steps**	This quarter, WCEC will begin development of computers models to simulate performance of both sub-wet bulb chillers (US and Chinese). These models, after they have been verified using actual laboratory test

		data, will be used to optimize the chiller technologies. For example, the models can be used to investigate how the system performance will change as a function of parameter (i.e. effect of airflow and water flow rates on COP).
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	The Chinese sub-wet bulb chiller has installed in the Xinjiang province of Western China applied to building covering over 200,000m^2. The technology is described in this journal article: Y. Jiang, X.Y. Xie, Theoretical and testing performance of an innovative indirect evaporative chiller, Sol Energy, 84 (2010), pp. 2041–2055
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	None.
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	CERC-BEE Meeting August 25th and 26th in Berkeley, CA. Costs charged to Southern California Edison contract (cost share).
	Prepared by:	Theresa Pistochini
	Prepared on:	7/9/2014

Project #12 [NEW]: Analysis of Commercial Building Energy Efficiency Standards

1.	**Full Project Name**	**Analysis of commercial building energy efficiency standards**
2.	**Reporting Period**	2014 Q2
3.	**U.S. Research Team**	Mark Levine, Berkeley Lab, PI Wei Feng, Berkeley Lab, CO-PI Ke Huang, Affiliate
4.	**U.S. Industry Partners**	Dow, SIEMENS, Carrier UTC
5.	**China Research Team**	Xu Wei, CABR, PI Zhang Shicong, CABR, Co-PI Sun Deyu, CABR Xi Chen, CABR
6.	**China Industry Partners**	CABR
7.	**One Sentence Project Highlight**	Evaluate energy and cost-effective performance the new Chinese commercial building energy standard
8.	**2014 Target Outcomes and Progress**	Develop Chinese reference buildings and evaluate the new commercial building energy standard in China. Contrast ASHRAE 90.1 performance and understand the gap of commercial building energy standard between China and the U.S.
9.	**Quarterly Milestones and Deliverables (***Notable U.S. Technical Progress, Achievements, Findings)*	■ Developed an office reference building model in compliance with Chinese commercial building energy standard GB50189-2014, and GB50189-2005 ■ Simulated the office reference building model energy performance and contrast the performance with ASRHAE 90.1-2004 and ASHRAE90.1-2013 ■ Published results in a paper accepted by ACEEE summer conference
10.	**Notable U.S. Non-Technical Progress, Achievements**	■ Work with CABR to discuss code future trend and net zero energy buildings in China ■ Prepare writeup on NZE building U.S. and California experience and how it drives code development
11.	**Notable U.S. Industry Progress**	■ Carrier, UTC work on evaluating the market penetration of different chiller types in Chinese market
12.	**U.S. Technical Next Steps**	■ Develop shopping mall reference building energyplus model ■ Collect measure cost ■ Model the impact of new commercial building energy code in the

		social scale
13.	**Notable China Progress** *(a) research and technical achievements* *(b) demonstration projects*	■ The commercial building code draft has been reported to MOHURD for final approval ■ Development of building code energy saving roadmap and future trend
14.	**Completed Travel in 2014** *(Dates, location, cost, source of funds)*	■ W. Feng, Beijing, June 2014, the 5th U.S. China Energy Efficiency Forum
15.	**Anticipated Travel in 2014** *(Dates, location, cost, source of funds)*	■ W. Feng, Beijing, Nov 2014, APEC-Net Zero Energy Form
	Prepared by:	Wei Feng, Mark Levine
	Prepared on:	07/10/2014