

# Building Energy Analysis, Comparison and Benchmarking

## Integrated Building Design & Operation of Very Low Energy, Low Cost Buildings

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### Research Objectives

- Develop and pilot a market-oriented, practical system for benchmarking building energy performance in China and an associated national energy performance database and benchmarking policy that will drive: energy and carbon reductions in Chinese buildings; sale of US energy efficiency technologies in China; and deliver long-term, sustained innovation in Chinese policy, including inclusion of benchmarking in China’s 13<sup>th</sup> Five Year Plan.
- Develop an Evaluation and Energy Reporting Protocol for US-China Energy Research Center (CERC) Demonstration Buildings that provides consistent and transparent performance information to CERC leadership on the performance of the demonstration buildings.
- Conduct research to inform evolution and advancement of US and Chinese building energy policy, with initial focus on application of real-time, on-line, energy monitoring to increase efficiency and reliability of data collection and carbon emissions trading schemes (ETS) that incorporate commercial buildings.

### Technical Approach

- Use nationally representative data sets (when available).
- Compare energy performance in terms of source energy.
- Perform multiple regression analyses to find the combination of statistically significant operating characteristics that explain the greatest amount of variance in building source energy use.
- Use the nationally representative data set to determine the distribution of energy performance across the entire population of hotels and commercial offices. A table is created and the benchmark rating is based on the ratio of actual energy consumption to that predicted by the regression analysis.



Figure 1. The hotel benchmarking tool is complete and available online at <http://www.cabr-cecc.com/>.

## Recent Progress

- Completed a Web-based benchmarking tool for hotels that is housed at China's largest building research institute —the China Academy of Building Research.
- Developed an Excel-based prototype benchmarking tool for commercial offices that automatically normalizes for the key drivers of energy use in Chinese commercial offices (size, location, operating hours, etc.) so office energy performance can be fairly compared
- With CSTC, CABR, and Tsinghua, completed a draft national hotel energy characteristics data set for China, including data points for more than 750 hotels.
- Completed a draft Evaluation and Energy Reporting Protocol that references applicable Chinese standards including: JGJ/T288-2012 China Standard for Building Energy Performance Certification and JG/T 358-2012 Classification and Presentation of Building Energy Use Data.
- Conducted an introductory workshop on the Evaluation and Energy Reporting Protocol for CERC developers in Zhuhai, China on July 18th 2014.
- Provided US DOE with a draft report on Chinese innovations in real-time, on-line building energy monitoring and emissions trading for the commercial buildings sector, and lessons and recommendations to advance US building energy policies.

## Expected Outcomes

- Significant potential energy and CO<sub>2</sub> emission reductions over the short, medium, and long term as a result of the availability of comparative energy benchmarking tool for hotels and commercial offices in China (as detailed in Table 1)

**Table 1. China Energy and CO<sub>2</sub> Impact**

	Total m <sup>2</sup> Benchmarked (2%)	Total Savings from Benchmarked Buildings (kWh)	GHG Emission Reduction (MtCO <sub>2</sub> e)	Wind Turbines Installed
Short-term: 2016-2017 (2yr)	29,400,000	1,169,197,200	949,797	262
Med-term: 2016-2020 (5yr)	78,000,000	6,086,232,000	4,944,151	1,362
Long-term: 2016-2025 (10yr)	171,000,000	23,784,354,000	19,321,220	5,321

- A marked increase in sales of energy-saving technologies and building equipment due to the availability of comparative building benchmarking tools and more buildings obtaining a practical understanding of their energy performance and need for improvement. As the leading suppliers of green building technologies globally, U.S. companies stand to gain a substantial market share of these equipment and technology sales in China. If five percent of all buildings benchmarked invested in advanced lighting; heating, ventilation, and air-conditioning systems; and other equipment and technologies, U.S. companies could generate substantial additional sales and revenue (as detailed in Table 2).

**Table 2. Projected Revenue from Sale of U.S. Green Building Technologies in China**

	Total m <sup>2</sup> Investing in Technology (%)	Estimated Retrofit Cost Per Square Meter (USD)	Total Sales (USD)
Short-term: 2016-2017 (2yr)	1,470,000	\$82.93	\$121,904,883
Med-term: 2016-2020 (5yr)	3,900,000	\$82.93	\$323,427,000
Long-term: 2016-2025 (10yr)	8,550,000	\$82.93	\$709,051,500