



Energy Technologies Area

Lawrence Berkeley National Laboratory

# China Energy Group Project Overview

Lawrence Berkeley National Laboratory  
Berkeley, CA

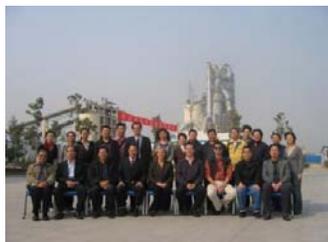
December 2015

# China Energy Group Mission Statement



The China Energy Group works collaboratively with groups in China and elsewhere to:

- Understand the dynamics of energy use, improve energy efficiency, and reduce emissions in China
- Strengthen Chinese capabilities in energy efficiency
- Enhance relationships on energy efficiency among Chinese, U.S., and international institutions.



# China Energy Group Vision



LBNL's China Energy Group aims to continue to:

- Grow as the most authoritative source regarding improving energy efficiency and reducing GHG emissions from China
- Act as a leader helping governments and the private sector to better understand China's energy dynamics
- Influence policy development by offering unbiased, holistic, scientific, innovative, and effective solutions



# China Energy Group Staff



- Lynn Price, Senior Staff Scientist and Group Leader
- Nan Zhou, Staff Scientist and Deputy Group Leader
- Mark Levine, Senior Staff Scientist
- David Fridley, Staff Scientist
- Chris Marnay, Staff Scientist, Lawrence Berkeley National Laboratory
- Ali Hasanbeigi, Research Scientist
- Bo Shen, Principal Scientific Engineering Associate
- Wei Feng, Senior Scientific Engineering Associate
- Carolyn Szum, Program Manager
- Jimmy Tran, Program Manager
- Yao Yuan, Program Manager in China
- Nina Khanna, Principal Research Associate
- Hongyou Lu, Senior Research Associate
- Angela Liu, Senior Research Associate
- Aimee Zhu, Research Associate
- Ping Liu, Postdoctoral Fellow
- Sammi Leung, Administrator
- Deborah Ash, Administrative Assistant

# China Energy Group Visitors



- Stephanie Ohshita, Associate Professor, University of San Francisco
- Joanna Lewis, Associate Professor, Georgetown University
- Valerie Karplus, Assistant Professor, MIT Sloan School of Management, Director, MIT-Tsinghua China Energy and Climate Project
- He Gang, Assistant Professor, Stony Brook University
- Haakon Vennemo, Professor at the School of Business, Oslo and Akershus University College
- ZHOU Yong, Director, Climate Change Research Center, Shandong Academy of Sciences
- WU Yong, Vice Chairman, China Association of Building Energy Efficiency
- ZHANG Qi, Associate Professor, Department of Thermal Engineering, Northeastern University
- ZHAO Ming, Vice director & secretary general of ESCO Committee of China Energy Conservation Association (EMCA)
- DING Yan, Lecturer, Tianjing University
- LIN Jianyi, Associate Professor, Institute of Urban Environment, Chinese Academy of Sciences
- WANG Weidong, Associate Professor, China University of Mining and Technology, Beijing
- ZHAO Lijian, Program Director, Energy Foundation, Beijing Office
- ZHENG Lingwei, Associate Professor, East China University of Science and Technology, Shanghai
- HUANG Xiulin, Lecturer, School of Materials Science and Engineering, Hubei University
- HOU Jing, PhD Student, Beijing Jiaotong University
- LU Meng, PhD Student, China University of Petroleum-Beijing
- ZHU Han, Master Student, Tianjin University
- ZHAO Shanguo, PhD Student, SouthEast University
- YUAN Nan, CECEP Solar Energy Technology Co., Ltd

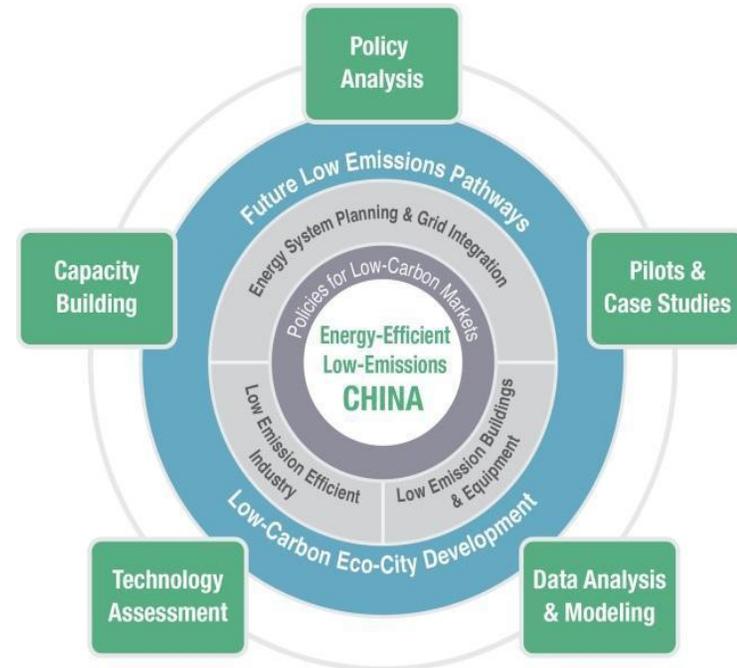
# Research Areas and Common Approaches

## Integrated Research Areas

- Future Low-Emissions Pathways
- Low-Carbon Urban Development
- Policies for Low-Carbon Markets
- Energy System Planning & Grid Integration
- Low Emission & Efficient Industry
- Low Emission & Efficient Buildings and Equipment

## Common Approaches

- Data Analysis and Modeling
- Policy Evaluation
- Technology Assessment
- Capacity Building
- Pilots and Case Studies



## Data Analysis

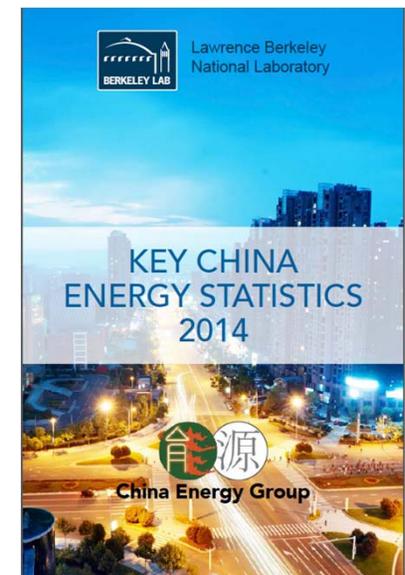
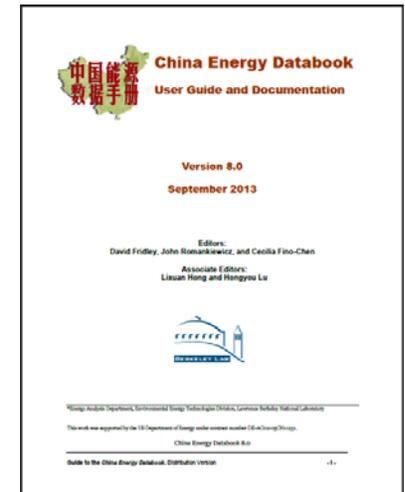
### China Energy Databook 8.0

- Fully relational database of national and provincial energy balances, plus detailed sectoral energy end-use
  - Developed in Microsoft Access
  - Containing over 110,000 data points
- Set of several hundred tables and figures in Microsoft Excel and PDF formats
  - Extracts from the database
  - Standalone spreadsheets containing data that can not be treated on a relational basis
- Data series cover available information from 1949; most data are updated through 2013
- Available for download at <http://china.lbl.gov/research-areas/china-energy-databook>

### Key China Energy Statistics

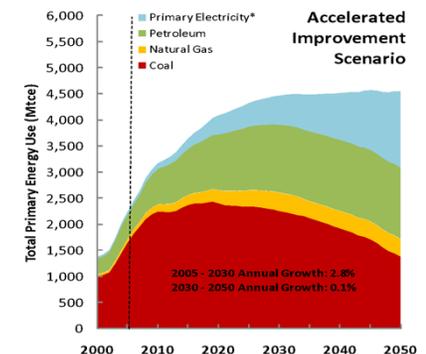
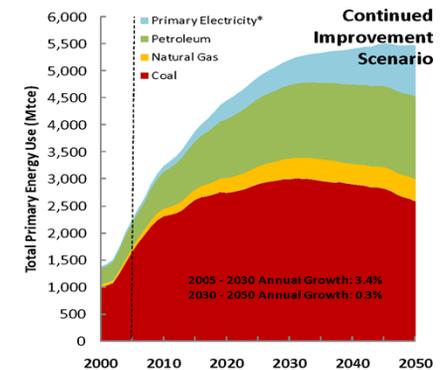
**Publication:** Key China Energy Statistics 2014

**URL:** [http://eetd.lbl.gov/sites/all/files/key\\_china\\_energy\\_statistics\\_2014\\_online.final\\_.pdf](http://eetd.lbl.gov/sites/all/files/key_china_energy_statistics_2014_online.final_.pdf)



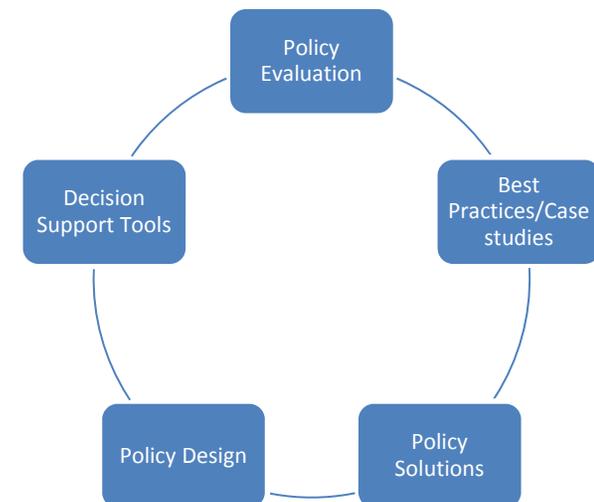
## China End-Use Energy Model

- Current Status (10 years of experience developing the model)
  - Used for evaluating comprehensive energy policies, future scenarios, supply options, energy, emission and pollutants analysis
  - Includes:
    - sectoral patterns of energy consumption
    - change in subsector industrial output
    - trends in saturation and usage of energy-using equipment
    - technological change including efficiency improvements
    - links between economic growth and energy demand
  - Expertise in all energy sectors including demand and supply
  - Long term relationship working with high caliber Chinese researchers and officials
  - Knowledge in energy dynamics and processes (vs. pure economics)
  - Energy data in China and understanding of the data
  - Access to information on international best practices
  - Ability to analyze data and policies
- Future Development
  - Traditional pollutants (SO<sub>x</sub>, NO<sub>x</sub>, PM 2.5, etc.) and CO<sub>2</sub>
  - Optimization scenarios
  - Integrated measures (passive measures, building envelope, integrated design, industry, etc.)



## Types of Policy Analysis Undertaken by China Energy Group

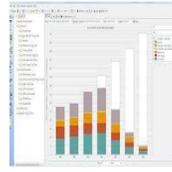
- *Policy evaluation*: assess how specific policy in China has been designed and implemented
- *International best practice policies*: introduce international best practices in policy design and implementation
- *Policy solutions*: identify and recommend practical and suitable policy solutions
- *Policy tools*: develop policy decision tools to assist policy-makers in making informed decisions
- *Policy design*: assist researchers and policy-makers in designing new policies





## Technology Guidebooks

- Identify energy-efficient technologies
- Quantify energy savings
- Quantify implementation and O&M costs
- Determine lifetimes
  - Commercial technologies
  - Emerging technologies
  - Waste co-processing technologies



## Assessment & Modeling

- Life-cycle costing assessment
- Techno-economic analysis
- Decomposition analysis
- Co-benefit analysis
- Benchmarking/comparison analysis
- Life-cycle analysis
- Modeling technologies:
  - LEAP model
  - Conservation Supply Curve model
  - Optimization model
  - Other bottom-up or top-down models



## Technology-based Tools

- EAGER tool
- BEST Cement
- GREAT tool
- COMBAT
- SUCCESS tool
- MASTER tool
- BEST Cities tool

# Capacity Building – *building a collaborative research model*



- Localized energy analysis tools for heavy industries, commercial buildings, etc.
- Benchmarking and modeling tools for low carbon policy actions in China
- Training workshops at various levels in China – disseminate & outreach

- Provides opportunities to work closely with key partners and to “deepen” knowledge in both directions
- From ad hoc to institutionalized selection process
- Establishes a bridge for continuous collaboration

- Joint research project with Chinese research and industry partners (CERC-BEE)
- Joint policy analysis projects with collaborators in China (e.g. ERI)
- Building a joint research model with Chinese research organizations

# China Energy Group Projects



## Future Low-Emissions Pathways

- Mind the Gap: China's Energy Outlook to 2030 and Gap Analysis of Possible Domestic Energy Shortfalls
- Extreme Energy: Unconventional Oil and Gas Resources and Development in China
- Reinventing Fire: China
- Quantitative Evaluation of the Impact of Low Carbon and Energy-Efficient Policies for China
- China Energy Demand and Emission Outlook to 2050

## Low Carbon Urban Development

- The Eco and Low-carbon Indicator Tool for Evaluating Cities (ELITE Cities Tool)
- Integrated and Adaptable Eco-City Guidelines
- Benchmarking and Energy Saving Tool for Low Carbon Cities (BEST-Cities Tool)
- The Green Resources & Energy Appraising Tool (GREAT Tool)
- Urban Form Rapid Assessment Model (URBAN-RAM)
- Development of a Low Carbon Indicator System for China
- Low Carbon Development Guide for Local Government Actions
- "Strategies for Local Low Carbon Development" Booklet

# China Energy Group Projects (cont'd)



## Policies for Low-Carbon Markets

- Bilateral Efficiency Standard for Chinese Data Centers
- Bilateral Efficiency Standard for Chinese Boiler Systems
- Assessing China's Top-10000 Program and Design New Mechanisms for the 13<sup>th</sup> Five-Year-Plan
- Assisting China in Developing a Comprehensive National Boiler Program to Capture the Co-benefits of Emissions Reductions and Energy Improvements
- Increasing Energy Efficiency of Small and Medium Enterprises in China through Developing Manufacturing Energy Performance Labeling System at the National Level
- Development of an Energy-Efficiency Rating and Labeling System for China's Enterprises
- Enhancing U.S.-China Cooperation on Energy Savings Performance Contracting
- Advancing Energy-Efficiency Governance to Improve the Practices of Administering and Implementing Energy-efficiency Policies in China
- Supporting China's Regional Carbon Cap-and-Trade Pilot
- Evaluating China's Design and Implementation of Energy Efficiency Incentive Policies and Making Policy Recommendations for China to Develop More Effective Incentive Policy Informed by International Best Practices
- Identification of Viable Options to Remove Barriers to Financing Energy Efficiency
- Development of an Energy Efficiency Financing and Investment Tool (EE-FIT)

# China Energy Group Projects (cont'd)



## Energy System Planning & Grid Integration

- DER-CAM China Applications – Microgrid Study
- Coal supply study: Recent Trends in Production and Consumption, Resource Constraints and Outlook
- Alternative Energy Study: Analysis of Life-Cycle, Physical Impacts and Barriers to Non-Fossil Energy Development in China
- Policy Issues of Microgrid Deployment in China
- Developing a District Energy Planning Tool to Use in China
- Technical Support to China's National DR Pilot
- International Best Practices in Implementing DR
- Performance-based Power Rationing Tool

# China Energy Group Projects (cont'd)



## Low Emission & Efficient Industry: Policy-related

- Assessment of Opportunities for Efficiency Improvement and Fuel Switch for Industrial Boiler
- International Industrial Energy Efficiency Training and Deployment
- Comprehensive Program to Improve Energy Efficiency, Increase the Use of Alternative Fuels and Raw Materials, and Reduce Emissions in the Cement Sector in China
- Analysis of the Past and Future Trends of Energy Use in Key Medium- and Large-Sized Chinese Steel Enterprises, 2000-2030
- Industrial Energy Assessments: Chinese and International Experience
- Database on China's 11th and 12th Five Year Plan Industrial Sector Policies and Programs
- Henan Province Energy Cap and CO<sub>2</sub> Balance
- International Experience with Monitoring, Measuring, and Quantifying the Co-Benefits of Energy Efficiency and GHG Mitigation Policies
- Retrospective and Prospective Decomposition Analysis of Chinese Manufacturing Energy Use, 1995-2020
- Quantifying the Co-benefits of Energy-Efficiency Programs: A Case Study of the Cement Industry in Shandong Province, China
- Barriers and Drivers of Combined Heat and Power in the Industrial Sector of the United States: Comparison to China's practices and policies

# China Energy Group Projects (cont'd)



## Low Emission & Efficient Industry: Technology-related

- US-China Collaboration on Green Data Center Initiative
- Top Ten Energy Efficiency Best Practices and Best Available Technologies
- Benchmarking Tool Development and Application in China's Cement Industry
- Guidebooks on Commercialized and Emerging Industrial Energy Efficiency Technologies
- International Best Practices in Pre-Treatment and Co-Processing Municipal Solid Waste and Sewage Sludge in the Cement Industry
- MAnufacturing STructure and Energy Research (MASTER) tool
- Comparing the Energy Intensity of the Pulp and Paper Industry in China and the U.S.
- Energy Assessments under the Top 10,000 Program—A Case Study for a Steel Mill in China
- Capturing the Invisible Resource: Analysis of Waste Heat Potential in Chinese Industry and Policy Options for Waste Heat Generation
- Textile Industry Energy Efficiency
- Comparison of Energy Intensity for the Iron and Steel Industry in China and the U.S.
- Development of a Framework for Comparison of Energy-Related CO<sub>2</sub> Emission Intensity of the Iron and Steel Industry in China, Germany, Mexico, and the U.S.
- Best Practices in Energy Efficiency and CO<sub>2</sub> Emissions Reduction Technologies: Cement Industry Database
- Energy Efficiency Assessment and Greenhouse Gas Emission Reduction (EAGER) Tool
- Analysis of Energy-Efficiency Opportunities for the Pulp and Paper Industry in China

# China Energy Group Projects (cont'd)



## Low Emission & Efficient Industry: Other

- Understanding Chinese Industrial Energy Data and its Differences from International Practices
- Capacity Building and Technical Training on Energy Analysis Research Methodologies
- Support for University Alliance for Industrial Energy Efficiency (UAIEE)
- Support for Top-1000 and Top-10,000 Energy-Consuming Enterprises Programs
- Information on Provincial CO<sub>2</sub> Emissions

## Low Emissions & Efficient Buildings and Equipment

- U.S.-China Clean Energy Research Center, Buildings Energy Efficiency Consortium (CERC-BEE)
- Real Time Building Energy Monitoring
- Evaluation of the Contribution of the Building Sector on PM<sub>2.5</sub> Emissions in China
- Building Energy Efficiency Best Practice Policies and Policy Packages
- Commercial Building Analysis Tool for Energy-Efficient Retrofits
- Comparison of Building Simulation Tools
- Technical Assistance to Development of a Guidebook on Estimating Building Energy Consumption and Projecting Energy-savings Potential for Local Governments in China
- Green Building Policies, Standards, Technologies, Performance Evaluation and In-Depth Analysis
- In-depth Analysis of a Green Building Design, Construction and Performance in China
- Potential Energy Saving and CO<sub>2</sub> Emission Reduction of Home Appliances and Commercial Equipment in China
- Appliance Manufacturer and Retailer Award Programs
- Monitoring and Information Systems for Energy Efficiency Labeling Check-Testing Laboratories

# China Energy Group Projects (cont'd)



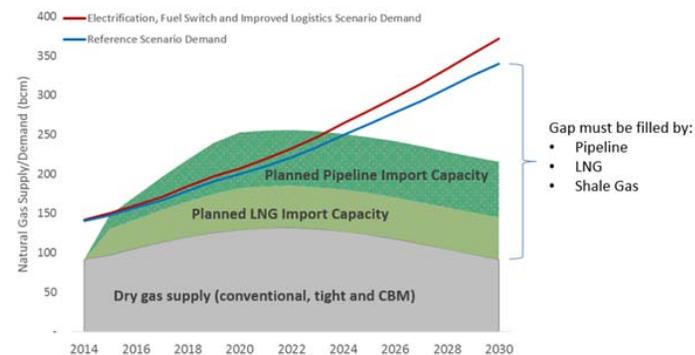
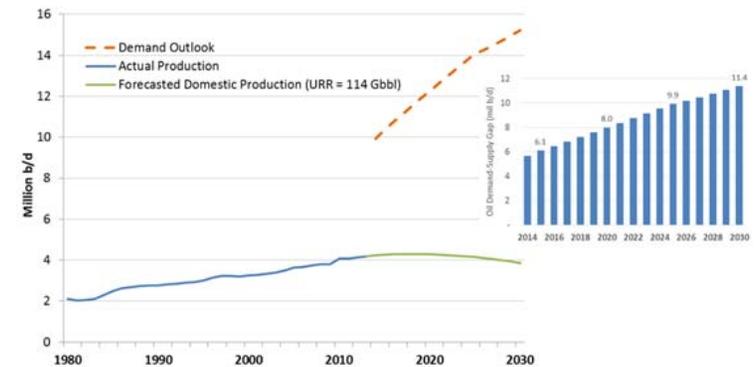
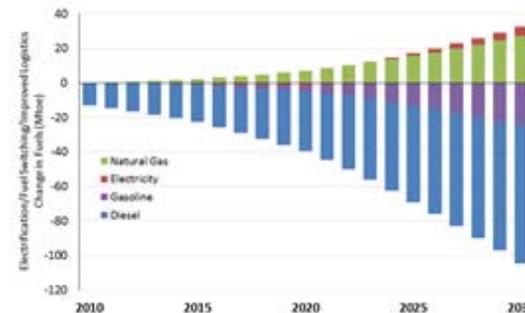
## Low Emissions & Efficient Buildings and Equipment

- Status of Local Enforcement of Energy Efficiency Standards & Labeling Programs in China
- International Review of Standards & Labeling Programs – Implications and Gap Analysis for China Standards & Labels in the 12th Five Year Plan
- Technical Assistance on Appliance Efficiency Standards Development
- Frameworks for Standards Setting and Labeling Development
- Frameworks for Standards, Labeling, and Incentive Program Evaluation
- Continued Framework Development for S&L Program Development and Evaluation with Data Availability Assessment (2012-2013)

# Future Low-Emissions Pathways

## Project: Mind the Gap: China's Energy Outlook to 2030 and Gap Analysis of Possible Domestic Energy Shortfalls

- Comprehensive review of recent transport sector energy trends and policy developments
- Developed energy supply and demand outlook to 2030 with updated buildings, industry, transport and power sector drivers
- Analyzed energy and CO2 emissions impact of alternative transport scenario with accelerated electrification, fuel switching and improved freight logistics
- Gap analysis for coal, oil, natural gas and uranium of:
  - China's energy and supply demand gap from 2014 to 2030
  - Planned vs. needed infrastructure expansions to accommodate imports and estimated costs
  - China's net import dependency and global trade implications

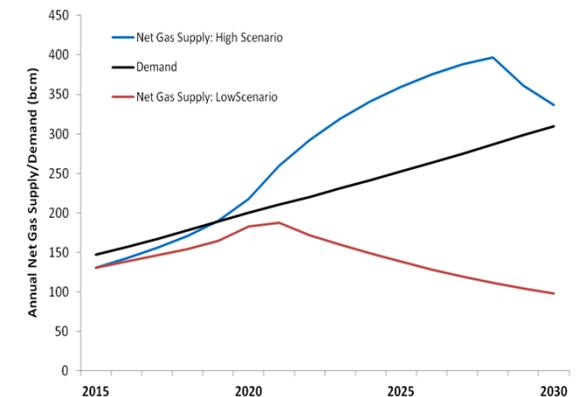
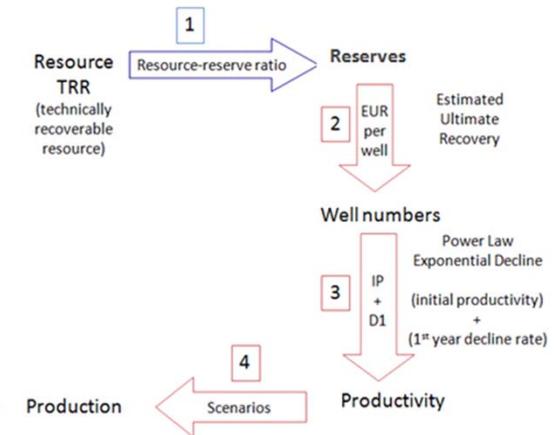
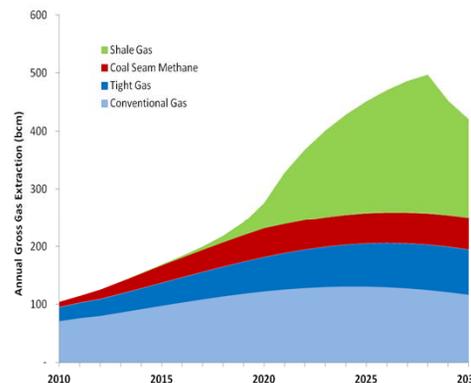


# Future Low-Emissions Pathways

## Project: Extreme Energy: Unconventional Oil and Gas Resources and Development in China

Collaborator: Sinopec

- Study of the resource base and technology conditions for unconventional energy development in China including:
  - Shale gas
  - Tight oil
  - Oil shale
  - Tar sands
  - Heavy oil
  - Coal-seam methane
  - In-situ coal gasification
  - Methane hydrates
- For shale gas, development of a model to estimate the number of wells needed to achieve China's target output (6.5 bcm by 2015) and scenarios of production to 2030
- Overall assessment of the potential contribution of unconventional resources to China's energy mix to 2030



# Future Low-Emissions Pathways

## Project: Reinventing Fire: China

Collaborators: China's Energy Research Institute, Rocky Mountain Institute, Energy Foundation China

*The Reinventing Fire scenario is a pathway for China to economically meet its energy needs and improve its energy security and environmental quality using the maximum feasible share of efficiency and renewable supply through 2050*

### BUILDINGS 2050 VISION

By 2050, buildings and communities will be self sustained and resilient with increased comfort levels



| Integrative Design   | Passive Buildings   | Renewable and Clean Energy   | Super efficient appliances   | Microgrids and Demand Response   | Prefabricated buildings   |
|--|---|--|--|--|---|
| <ul style="list-style-type: none"> <li>Standard and optimized measures</li> <li>Maximum whole building system energy efficiency in a cost effective way</li> </ul> | <ul style="list-style-type: none"> <li>Passive House for Northern residential building</li> <li>Natural ventilation and shading for Southern buildings</li> <li>Day lighting</li> </ul> | <ul style="list-style-type: none"> <li>Onsite generation</li> <li>PV, solar thermal, geothermal</li> <li>From coal to natural gas and electricity</li> </ul> | <ul style="list-style-type: none"> <li>Higher penetration of super efficient appliances</li> <li>Super efficient AC, refrigerator, clothes washer, LED, and other equipment</li> </ul> | <ul style="list-style-type: none"> <li>Microgrid with distributed generation</li> <li>Storage such as battery, EV, fuel cells</li> <li>Demand response</li> <li>Smart control</li> </ul> | <ul style="list-style-type: none"> <li>Longer building lifetime</li> <li>Durable, recyclable material</li> <li>Less material intensity</li> <li>Speedy and high quality construction</li> </ul> |

### TRANSPORTATION 2050 VISION

By 2050, China's transportation system will provide increased mobility, but more efficiently, with fewer emissions, and lower costs



| Passenger Transportation  | Trucking   | Other Modes  |
|---|--|--|
| Smart growth and integrated transport planning to reduce the need for private vehicles.   | Lightweight, plug-in electric delivery vans, improved aero, low rolling resistance, advanced powertrain tech, etc. | Mode shifting from road to rail/sea and passenger air to high speed rail |
| Parking pricing, vehicle quotas and public transit investment to encourage mode shift.  | Software and data to improve routes, loads and operations, even across companies                                   | Best practices and emerging tech for plane, train, and boat efficiency   |
| Increased vehicle efficiency through lightweighting, electrification, hybridization, aerodynamics and low rolling resistance tires. | Biofuels for remaining demand  | Biofuels for remaining demand  |

### INDUSTRY 2050 VISION

By 2050, China's industry is world-class in terms of energy efficiency and has moved away from carbon-intensive fuels



| Production/Energy Demand Reduction      | Energy Efficiency Improvement                         | Fuel Switching/CCS                                 | Structural Shift                                      |
|---|---|--|---|
| Higher quality products and materials   | Integrative design/system optimization                | Lower carbon fuels                                 | Less energy intensive processes within industries     |
| Material recycling, material efficiency | Energy-efficient commercial and emerging technologies | Electrification and on-site electricity generation | Increase high value added, lower intensity industries |
| By-product synergy/industrial parks     | Energy management                                     | CCS  | Move from industry to service sector                  |

### TRANSFORMATION SECTOR 2050 VISION

Primary energy demand reduced dramatically allows large-scale shift to renewable supplies



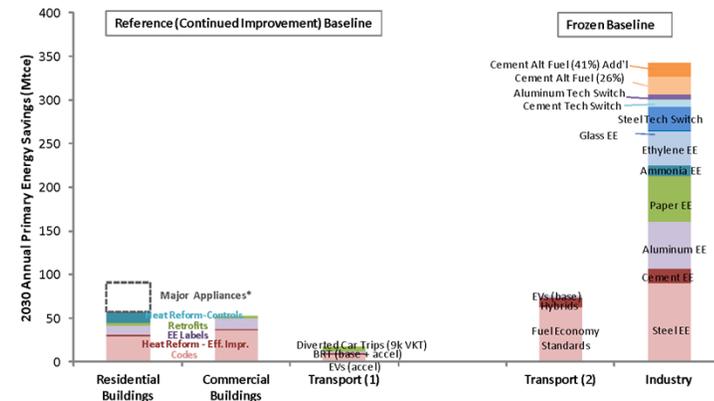
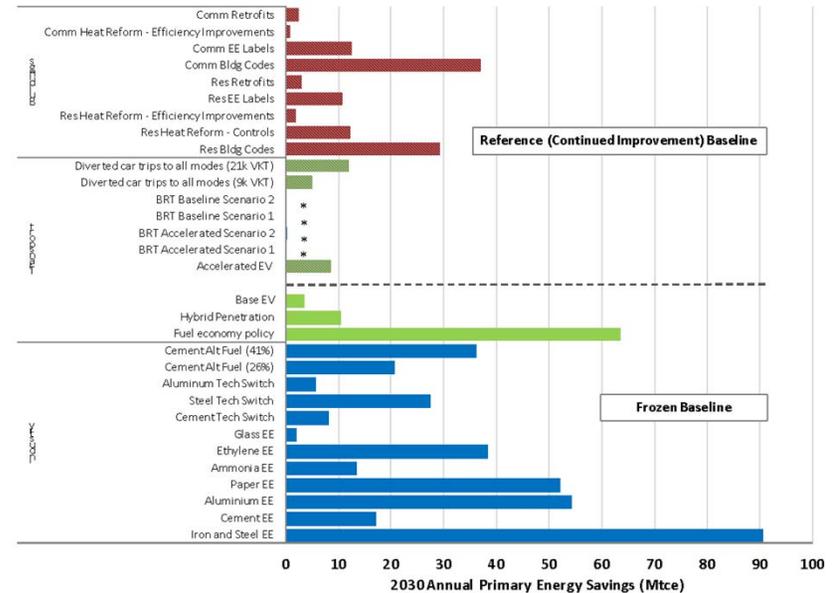
| Electricity   | Mining and refining                                       | Combined heat and power                                  |
|---|---|--|
| Hybrid grid structure with partial decentralization   | Coal and petroleum use significantly reduced              | Proliferation of Zero Net Energy systems                 |
| Robust 2-way distribution network (significant demand response, EVs, storage, ZNE buildings)            | Local gas resources developed (CBM, unconventional shale) | Integrated district heating designed into compact cities |
| Decarbonized generation sources (i.e., hydro, wind, solar, nuclear); CCS for remaining coal and new gas | Biodiesel and biogas                                      |  |



# Future Low-Emissions Pathways

## Project: Quantitative Evaluation of the Impact of Low Carbon and Energy Efficient Policies for China

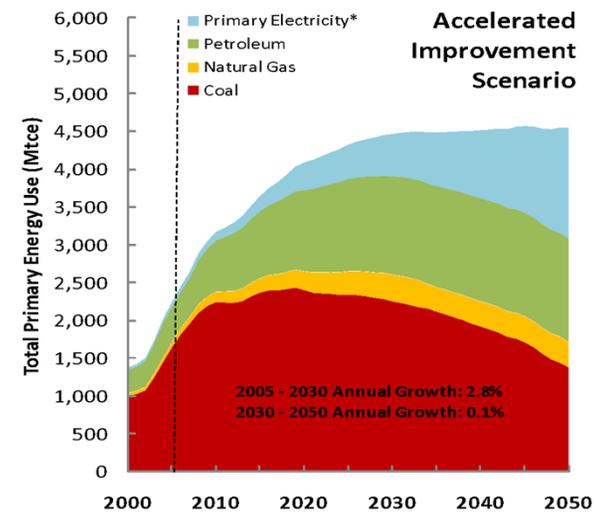
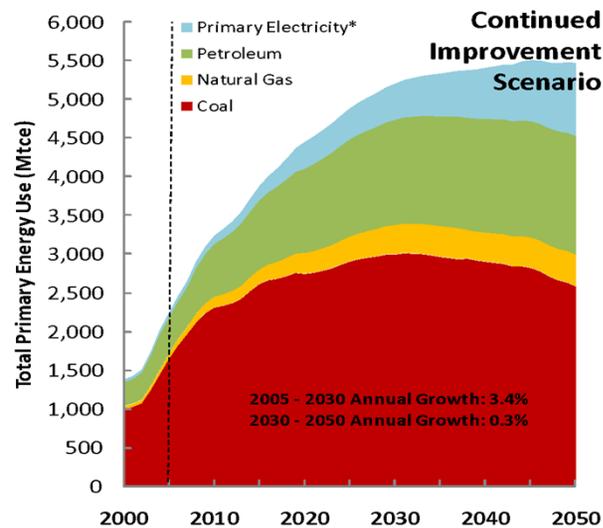
- LBNL used the China Energy End Use Model to quantify the potential savings and emission reductions of a comprehensive set of policies being adopted or considered by China
- Sector-specific and cross-cutting policy evaluation for residential and commercial buildings, industry, transport and power sectors
- Relative magnitude of savings potential from individual policies identified, can help prioritize policies needed to meet China's energy and CO<sub>2</sub> intensity reduction targets
- Paper presented at 2013 European Council for an Energy-Efficient Economy (ECEEE) Summer Study on Energy Efficiency



# Future Low-Emissions Pathways

**Project:** China Energy Demand and Emission Outlook to 2050

**Collaborator:** China's Energy Research Institute



\*Primary Electricity includes nuclear, hydropower, wind, solar and other renewable power and uses calorific equivalent for conversion.

**Publication:** China's Energy and Carbon Emissions Outlook to 2050  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-4472e-energy-2050april-2011.pdf>



# Low Carbon Eco-City Development

**Project:** The Eco and Low-carbon Indicator Tool for Evaluating Cities (ELITE Cities Tool)

**Collaborator:** Shandong Academy of Science/Chinese Society for Urban Studies of MoHURD

- Goal is to calculate an overall score by which cities' performance can be compared against benchmark performance goals as well as ranked against other cities in China
- ELITE Cities measures progress on 33 key indicators chosen to represent priority issues within 8 primary categories
- ELITE Cities could be a useful and effective tool for local city government in defining the broad outlines of a low carbon eco-city and assessing the progress of cities efforts towards this goal
- ELITE Cities can also be used by higher-level government to assess city performance and discern best practices
- Tested in Jinan and will be disseminated to Laiwu, Weifang, Shenzhen other Chinese cities in 2014
- Technology database is under development to meet local demand for low carbon technology
- The tool can be downloaded at <http://china.lbl.gov/tools-guidebooks/elite-cities>



The Eco and Low-carbon Indicator Tool for Evaluating Cities (ELITE Cities)

**Basic Info**

|                    |  |
|--------------------|--|
| City Name          |  |
| Province Name      |  |
| User               |  |
| Position           |  |
| Approver           |  |
| Date of last entry |  |

**Key Features**

|                                  |  |
|----------------------------------|--|
| Population                       |  |
| Urban land area(m <sup>2</sup> ) |  |
| Climate                          |  |
| Water scarcity index             |  |
| Service as % of GDP              |  |
| Industry as % of GDP             |  |

Start

About



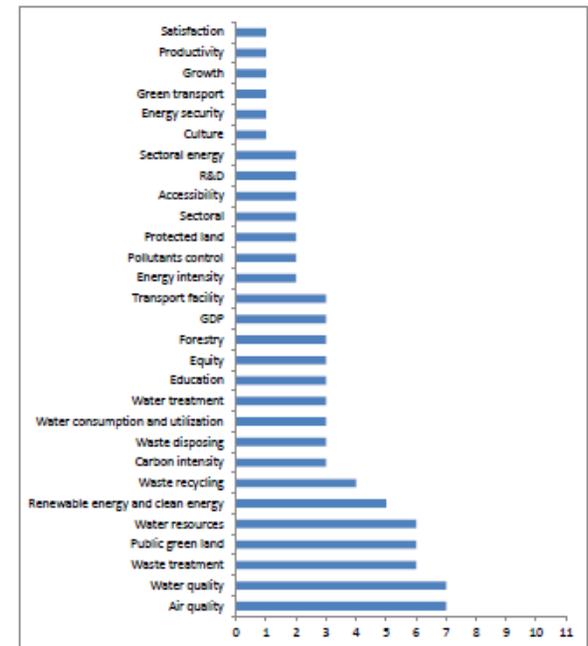
**Publication:** ELITE Cities: A Low Carbon Eco-City Evaluation Tool for China (ECEEE Summer Study Paper)  
URL: <http://proceedings.eceee.org/visabstrakt.php?event=3&doc=3-399-13>

# Low Carbon Eco-City Development

*Project:* Integrated and Adaptable Eco-City Guidelines

*Collaborator:* Chinese Society for Urban Studies of MoHURD

- LBNL defined “low carbon eco-city” based upon existing academic and professional theory
- Evaluated state of official city index systems in China
- Compared international and Chinese indicator systems to find commonalities and best practices through:
  - Comparison of 30+ indicator systems from governments, NGOs, academics and private organizations worldwide
  - Over 300 individual indicators
  - Over 100 identified eco-city projects worldwide
- Defined best practice indicators for MOHURD national low carbon eco-city rating program
- Detail measures for performance improvement in each indicator category



Numbers of Indicator Systems that Contain Various Subcategories

**Publication:** China’s Development of Low-Carbon Eco-Cities and Associated Indicator Systems  
**URL:** [http://china.lbl.gov/sites/all/files/china\\_eco-cities\\_indicator\\_systems.pdf](http://china.lbl.gov/sites/all/files/china_eco-cities_indicator_systems.pdf)

# Low Carbon Eco-City Development

**Project:** Benchmarking and Energy Saving Tool for Low Carbon Cities (BEST Cities Tool)

**Collaborator:** China's Energy Research Institute

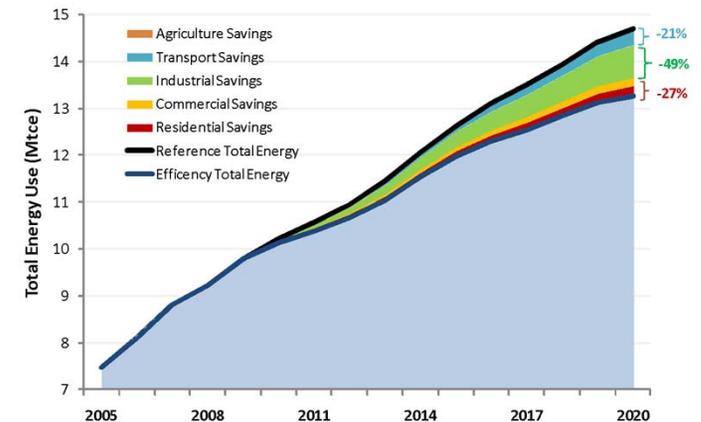
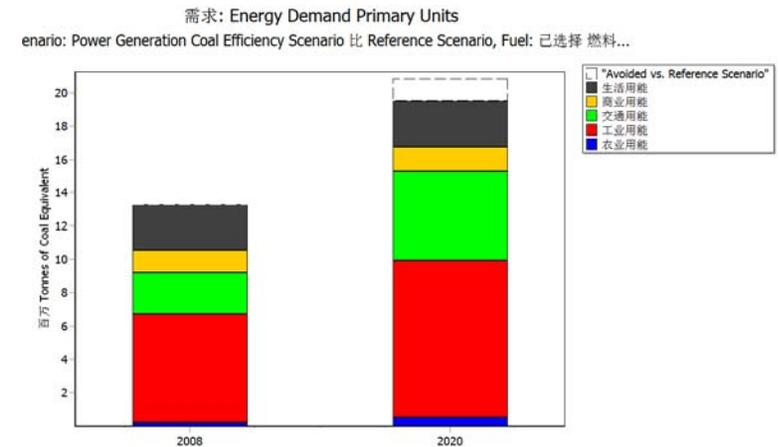
- Designed to provide city authorities with strategies they can follow to reduce city-wide carbon dioxide (CO<sub>2</sub>) and methane emissions.
- Offers a quick assessment of a city's local energy use and energy-related CO<sub>2</sub> emissions across nine sectors (i.e., industry, public and commercial buildings, residential buildings, transportation, power and heat, street lighting, water & wastewater, solid waste, and urban green space).
- Energy and carbon inventory values can then be benchmarked against those of cities inside and outside China in order to identify sectors with greatest potential in energy savings and CO<sub>2</sub> emissions reduction.
- To realize the potential, 72 sector-specific strategies are provided in this tool that the city can use based on filtered results to reduce energy use and CO<sub>2</sub> emissions.
- More information about the tool:  
<http://china.lbl.gov/tools-guidebooks/best-cities>



# Low Carbon Eco-City Development

## Project: The Green Resources & Energy Appraising Tool (GREAT Tool)

- Develop a city's GHG inventory
- Future energy and emission projection baseline generation
- Scenarios generation
- Evaluate the impact of different policies
- Help to set targets, develop action plans, and establish target allocations
- The tool can be downloaded at <http://china.lbl.gov/tools-guidebooks/great>

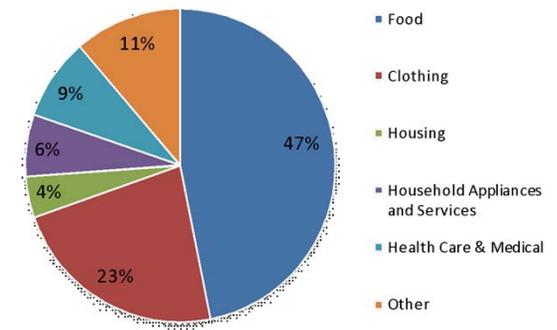


# Low Carbon Eco-City Development



## Project: Urban Form Rapid Assessment Model (URBAN-RAM)

- Quick assessment tool to shed light on the magnitude and sources of a city’s energy and carbon “footprints”
- Provides insights into the relative contributions and key driving factors related to the direct and embodied energy and carbon impacts of people in a city:
  - Buildings—for people to live, work, educate, be sick, and buy goods
  - Transportation—to move people around
  - Infrastructure systems (e.g., pavements, water provision)—to provide services to people
  - Personal expenditures—what people consume
  - Waste disposal—what people throw away
- Allows for scenario playing to assess areas of opportunity for reducing energy and carbon footprints
- Based on a synthesis of data and life-cycle modeling approaches from both U.S. and Chinese sources
- The tool can be downloaded at <http://china.lbl.gov/tools-guidebooks/urban-ram>



The embodied energy in food accounts for nearly half of household embodied energy consumption in Suzhou

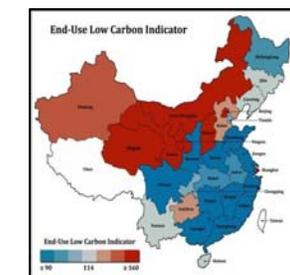
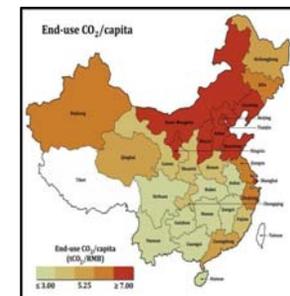
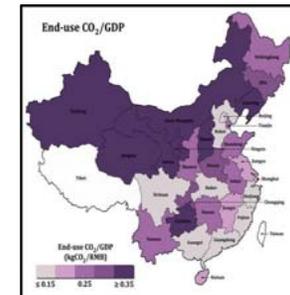
| Income Range (Year)               | < ¥20000 | ¥20001 < ¥40000 | ¥40001 < ¥60000 | ¥60001 < ¥100000 | > ¥100000 |
|-----------------------------------|----------|-----------------|-----------------|------------------|-----------|
| % of Households                   | 15.51    | 42.02           | 23.81           | 14.17            | 4.49      |
| Expenditures                      | 5378.00  | 7676.25         | 10840.25        | 15813.38         | 25172.00  |
| Food                              | 48.55    | 41.20           | 36.59           | 31.57            | 25.70     |
| Clothing                          | 8.39     | 10.65           | 11.30           | 10.33            | 8.58      |
| Housing                           | 4.17     | 5.62            | 6.42            | 6.22             | 6.58      |
| Household Appliances and Services | 8.15     | 7.58            | 7.29            | 6.55             | 5.12      |
| Health Care & Medical Services    | 7.04     | 9.90            | 11.77           | 17.38            | 23.77     |
| Other                             | 23.70    | 25.05           | 26.64           | 27.96            | 30.25     |

**Publication:** Urban RAM: Assessing the Energy Impact of Having People in Cities  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5740e-urban-ram-aceeejune-2012.pdf>

# Low Carbon Eco-City Development

## Project: Development of a Low Carbon Indicator System for China

- Macro-level indicators of low carbon development (e.g. energy use or CO<sub>2</sub> emissions per unit of GDP or per capita) are too aggregated to be meaningful measurements of whether a city or province is “low carbon”
- LBNL developed and tested a methodology for a low carbon indicator system at the provincial and city level
- Based on energy end-use sectors: industry, residential, commercial, transport, electric power
- Improved approach for defining “low carbon” and for taking action to reduce energy-related carbon emissions
- Report provides initial results for an end-use low carbon indicator system, based on data available at the provincial and municipal levels
- Paper presented at ACEEE 2012 Buildings Summer Study



**Publication:** Development of a Low-Carbon Indicator System for China

**URL:** <http://china.lbl.gov/sites/all/files/lbl-low-carbon-indicatorsnov-2011.pdf> (English)

[http://china.lbl.gov/sites/all/files/low-carbon-indicator.system.cn\\_.pdf](http://china.lbl.gov/sites/all/files/low-carbon-indicator.system.cn_.pdf) (Chinese)

# Low Carbon Eco-City Development

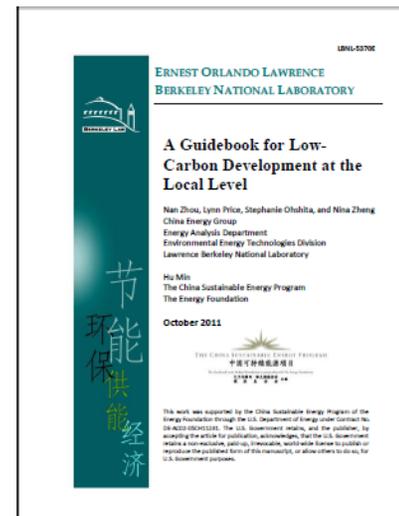


## Project: Low Carbon Development Guide for Local Government Actions

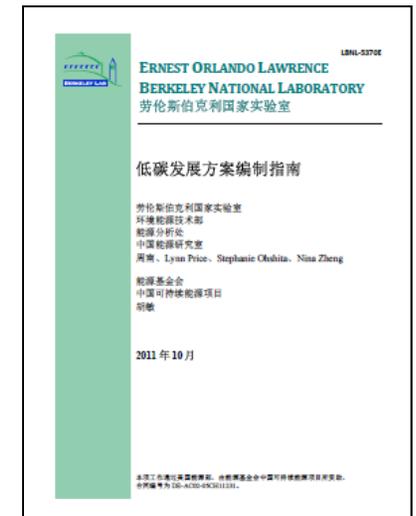
- Development of a indicator system for low carbon development for China
- Simple step-by-step description of how action plans could be established
- Comprehensive list of successful policies and best practices found internationally and in China by sector
- Can also be used in other developing countries

### Accomplishments:

- Bilingual report completed
- Trainings:
  - Total of 8 training workshops
  - 180 person-time
  - 6 pilot provinces and cities



English version



Chinese version

**Publication:** A Guidebook for Low-Carbon Development at the Local Level  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5370e-low-carbon-guidebookoct-2011.pdf> (English)  
[http://china.lbl.gov/sites/all/files/lbl\\_5370e\\_low\\_carbon\\_guidebook\\_cn.oct\\_2011.pdf](http://china.lbl.gov/sites/all/files/lbl_5370e_low_carbon_guidebook_cn.oct_2011.pdf) (Chinese)

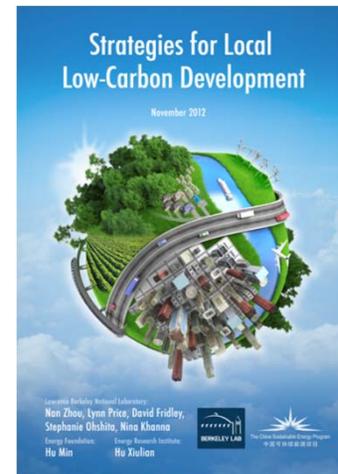
# Low Carbon Eco-City Development



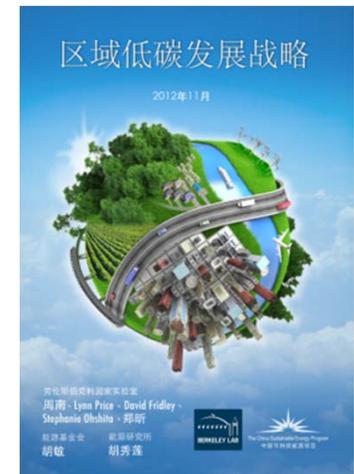
**Project:** Strategies for Local Low-Carbon Development Booklet

**Collaborator:** Energy Foundation, China's Energy Research Institute

- LBNL compiled 23 policy recommendations across six sectors (industry, building & appliances, electric power, consumption & waste management, transportation & urban form, agriculture & forestry).
- Each policy recommendation provides a policy description, stakeholders, conditions for implementation, energy & CO<sub>2</sub> emissions reduction impact, cost effectiveness, barriers and challenges, as well as case studies



English version



Chinese version

**Booklet:** Strategies for Local Low Carbon Development  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-6004e-low-carbon-booklet-nov-2012.pdf> (English)  
[http://china.lbl.gov/sites/all/files/lcd\\_booklet\\_cn\\_0.pdf](http://china.lbl.gov/sites/all/files/lcd_booklet_cn_0.pdf) (Chinese)

# Policies for Low-Carbon Markets



**Project:** Bilateral Efficiency Standard for Chinese Data Centers (BEST-Data)

**Collaborators:** MIT, China Institute Electronics (CIE)

- Data centers are an energy-intensive segment of the new digital economy
- Project addresses the lack of energy efficiency standards governing the design or operation of data centers and the associated devices and systems in the U.S. and China
- Project is working with stakeholders in both countries to promote open standards, test procedures, specifications, and evaluation metrics for data centers
- Create a bilateral industry consortium consisting of technology providers, internet companies, data center developers, associations, and research institutions from both countries to form an open community to achieve harmonized standards and specifications

# Policies for Low-Carbon Markets



*Project:* Bilateral Efficiency Standard for Chinese Industrial Boiler (BEST-Boiler)

*Collaborators:* AQSIQ, ASME

- Industrial boilers are one of the largest energy consumers in China, contributing significantly to air pollution
- Project will create an effective platform for stakeholders to exchange information on boiler efficiency standards, equipment efficiency test procedures, system efficiency assessment methodology, operational/maintenance protocols, and/or emission standards relevant for Chinese boiler and steam systems
- Project will develop a work plan and identify ways to link this work with related opportunities and resources in both China and the U.S.

# Policies for Low-Carbon Markets



***Project:* Assessing China's Top-10,000 Program and Design New Mechanisms for the 13th FYP**

***Collaborators:* Energy Research Institute, National Energy Conservation Center**

- Through the Top-10,000 Program, policies and programs have been carried out in China during the 12<sup>th</sup> FYP targeting energy efficiency in large industrial enterprises
- Project is to conduct a comprehensive evaluation of the Top-10,000 Program to identify its success factors and outstanding issues
- Project will collect and examine international leading experiences in promoting energy efficiency in large energy users
- Project will design new policy instruments and market mechanisms in order to make effective recommendations for the Chinese government to encourage large energy users to improve energy efficiency

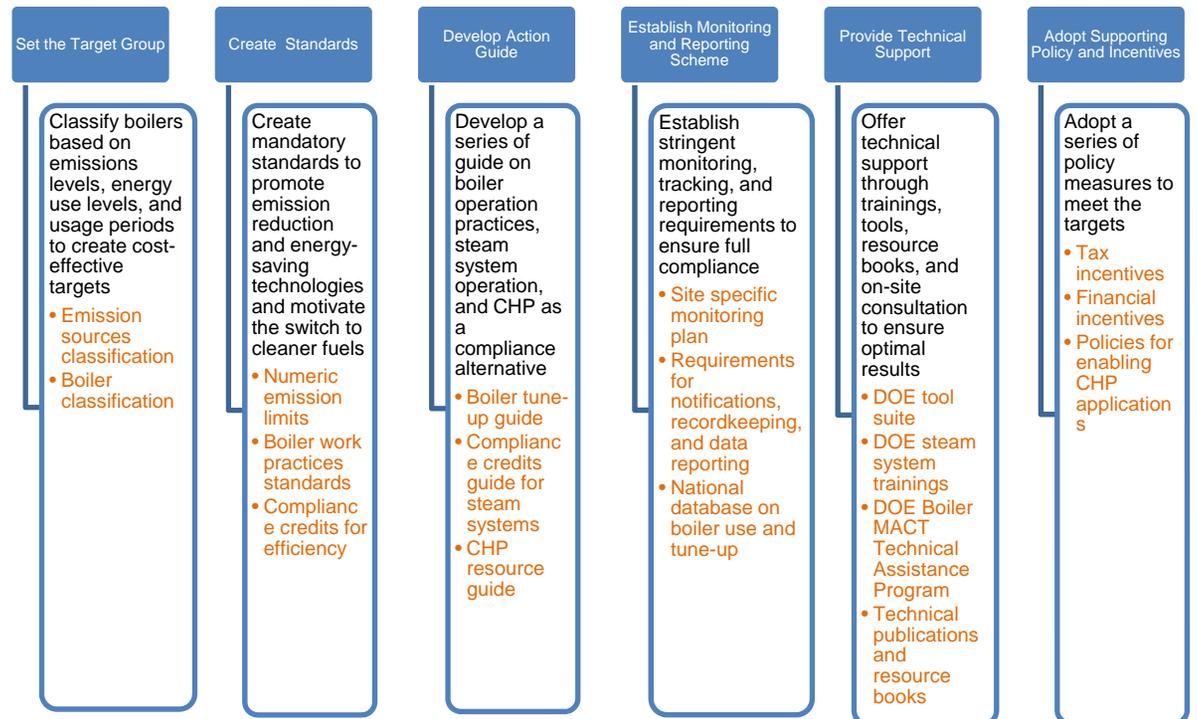
# Policies for Low-Carbon Markets

**Project:** Assisting China in Developing a Comprehensive National Boiler Program to Capture the Co-benefits of Emissions Reductions and Energy Improvements

**Collaborator:** China's Ministry of Industry and Information Technology, China Machinery Industry Energy Conservation Center



- Reforming China's extensive use of coal-burning boilers through policy development and technology improvement is a vital measure to address the nation's worsening air pollution that is also the root cause of carbon emissions
- China's Ministry of Industry and Information Technology (MIIT) is developing a national action plan to develop enabling policies, launch new programs, and adopt advanced technologies and best practices to minimize the environmental impacts of coal-burning boiler.
- LBNL is assisting MIIT by providing recommendations for China's action plan based on relevant U.S. and international experiences



# Policies for Low-Carbon Markets



**Project:** Increasing Energy Efficiency of Small and Medium Enterprises in China through Developing Manufacturing Energy Performance Labeling System at the National Level

**Collaborators:** China National Energy Conservation Center

- Review of international programs in rating and/or scoring enterprises' use of energy and resources
- A comprehensive set of metrics, indicators and rating criteria for rating enterprises' practices and performance in managing energy consumption
- Metrics has three focus areas including energy policy and planning, energy practices, and energy performance with 13 indicators
- Metrics and rating scheme will be applied in China's National Energy Conservation Center's pilot of the China Energy Efficiency Star program

中国“能效之星”行动计划的设计和实施方案（思路和架构）  
（征求意见稿）



LBNL/苏州节能技术服务中心

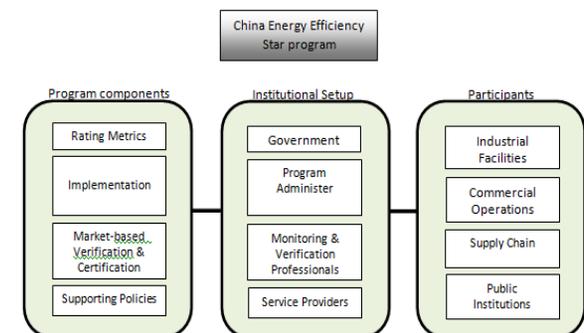


# Policies for Low-Carbon Markets

**Project:** Development of an Energy-Efficiency Rating and Labeling System for China’s Enterprises

**Collaborators:** Suzhou Energy Conservation Center, China’s Energy Research Institute, Azure International

- Suzhou’s Energy Efficiency Star: China’s first comprehensive labeling for manufacturers
- Evaluates and rates an industrial facility’s energy practices and performance including energy and resource utilization, environmental performance, technology application, and energy management.
- Integrated approach to help a business achieve an overall improvement from all aspects of its operations. Provides government with a yardstick for policy.
- Adopted in Suzhou and Jiangsu with extensive implementation
- Leveraged participation of multinationals and global brands
- Assisted NECC to design a framework of a possible national program



# Policies for Low-Carbon Markets



**Project:** Enhancing U.S.-China Cooperation on Energy Savings Performance Contracting

**Collaborator:** China's Development and Reform Commission, ESCO Association of China (EMCA)

- Develop a White Paper to compile information on the energy service company (ESCO) landscape in the U.S. and China as a basis for recommended activities to accelerate ESCO markets in both countries
- Develop policy recommendations and toolkits to promote greater use of energy performance contracting (EPC) for deep retrofits
- Toolkits to support for EPC activities
- Identify and implement high-profile, innovative pilots in both countries of capturing deep-savings opportunities

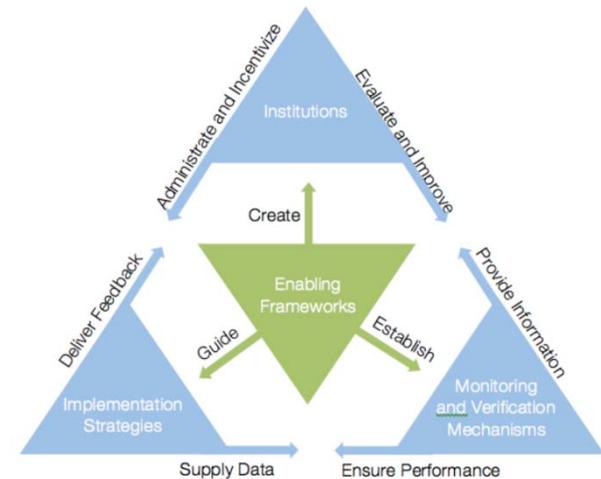


# Policies for Low-Carbon Markets

**Project:** Advancing Energy-Efficiency Governance to Improve the Practices of Administering and Implementing Energy-efficiency Policies in China

**Collaborator:** China's Energy Research Institute (ERI)

- Optimizing governance solutions is crucial in addressing the inefficiencies in the policy chain and ensures that policies are fully implemented and sustainable with optimal results.
- This joint project between LBNL and ERI aims to provide key policy-makers in China with a complete set of recommendations for strengthening energy efficiency administration and implementation based on a domestic study of existing gaps and international study of best practices
- This project will have cross-cutting impacts: improved governance structures and practices in energy efficiency will create a model for governance practices related to implementing climate policy, and environmental protection policy.
- Results of the project highly praised by both Energy Conservation Department and Climate Department of NDRC and recommendations are considered of being incorporated in China's 13th Five-Year Plan (2016-2020).



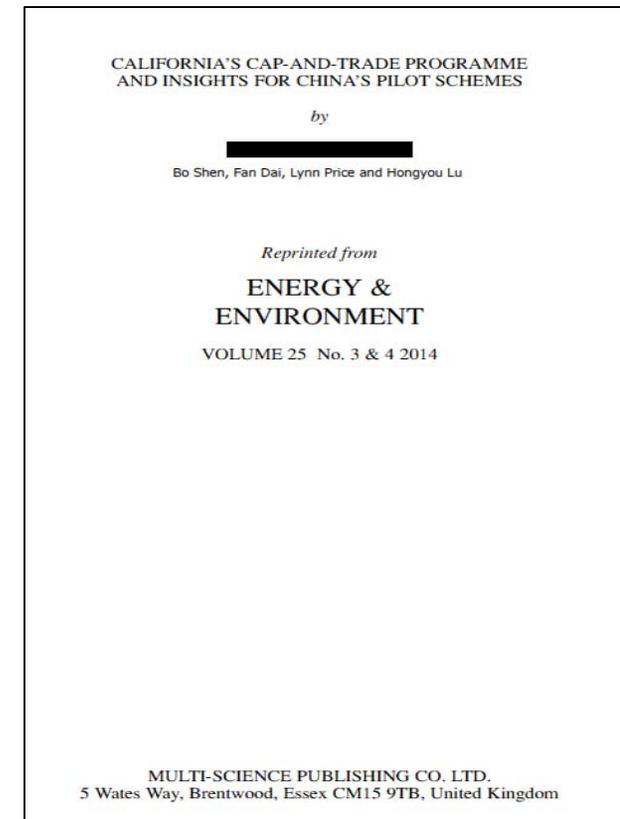
# Policies for Low-Carbon Markets



**Project:** Supporting China's Regional Carbon Cap-and-Trade Pilot

**Collaborator:** Wuhan University

- LBNL works with one of China's 7 carbon cap-and-trade pilots to:
  - o Share California's overall experiences in developing its GHG cap-and-trade program
  - o Conduct joint research with the piloting province on optimal allocation strategy.



# Policies for Low-Carbon Markets

## **Project:** Evaluating China’s Design and Implementation of Energy Efficiency Incentive Policies and Making Policy Recommendations for China to Develop More Effective Incentive Policy Informed by International Best Practices

### **Collaborator:** China’s Energy Research Institute

- Extensive survey to understand how energy efficiency incentive policies were designed and implemented in China during the 11<sup>th</sup> FYP
- Review of international leading examples in developing and implementing effective incentive policies for energy efficiency
- Joint recommendations drawn upon lessons learned from China’s activities as well as international best practices, helping China improve its incentive policies and programs
- Dissemination of research findings and policy recommendations to key policy-makers in China
- Project as well as the ERI/LBNL collaboration model of conducting high-impact policy research was highly praised by China’s key decision-makers at NDRC for its usefulness and relevance
- Findings and recommendations well received by NDRC
- NDRC requested more work in more specific topics be carried out using this approach



**Publication:** Addressing the effectiveness of industrial energy efficiency incentives in overcoming investment barriers in China  
**URL:** <http://proceedings.eceee.org/visabstrakt.php?event=2&doc=6-156-12>

# Policies for Low-Carbon Markets

## Project: Identification of Viable Options to Remove Barriers to Financing Energy Efficiency

### Collaborator: China's Energy Research Institute

- Review the policies, programs, and activities pursued in China during the 11<sup>th</sup> FYP on green financing  
Report available at:  
[http://china.lbl.gov/sites/china.lbl.gov/files/Green\\_Finance\\_WIREs.pdf](http://china.lbl.gov/sites/china.lbl.gov/files/Green_Finance_WIREs.pdf)
- Identify issues and barriers to energy efficiency financing in China
- Develop domestic and international case studies on financing strategies and ways to reduce risks associated with energy efficiency financing
- Make specific recommendation on finding solutions to remove financing barriers



**Publication:** China's approach to financing sustainable development: policies, practices, and issues  
**URL:** <http://onlinelibrary.wiley.com/doi/10.1002/wene.66/abstract>

# Policies for Low-Carbon Markets

## Project: Development of an Energy Efficiency Financing and Investment Tool (EE-FIT)

- Tool to help determine the cost-effectiveness of an energy-efficiency project
- Necessary for the host, ESCOs, and investors to make informed investment decisions
- Valuable to the development of energy performance contracts
- Helps to address questions related to EE financing such as: what to invest, investing in EE vs. in production, timing of the investment, financing structure, decisions on EPC terms and length, and the impacts of policy changes



# Energy System Planning & Grid Integration

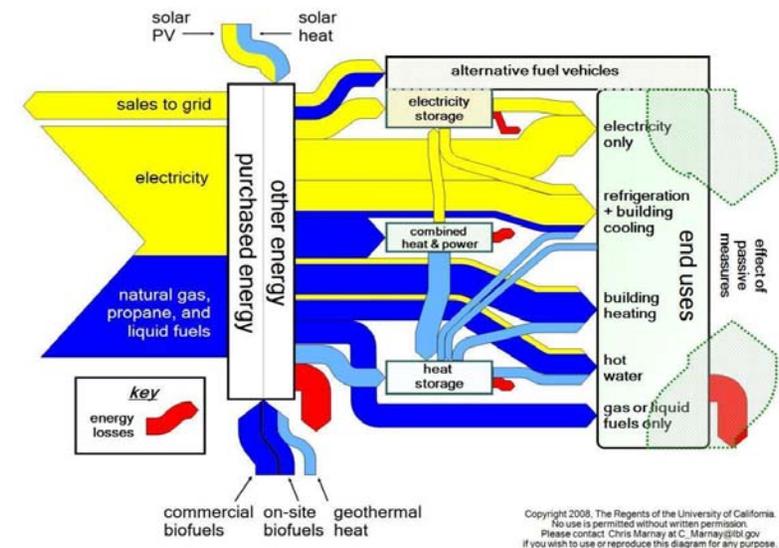
**Project :** DER-CAM China Applications – Microgrid Study

**Collaborators:** Tongji University, Tianjin University (CERC), China Academy of Science – IEE, Shanghai Changning Low Carbon Office, Shenzhen IBR

Distributed energy resource system study for buildings in China

DER-CAM:

- A multiple energy resources, supply, and energy conversion optimization tool for energy cost and CO<sub>2</sub> minimization
- Integrated building energy technologies: CHP, absorption chiller, heat/cool storage, electricity storage, PV, solar thermal, ground source heat pump, etc.
- Support design based optimization and building operation optimization
- Renewable energy system building integration evaluation

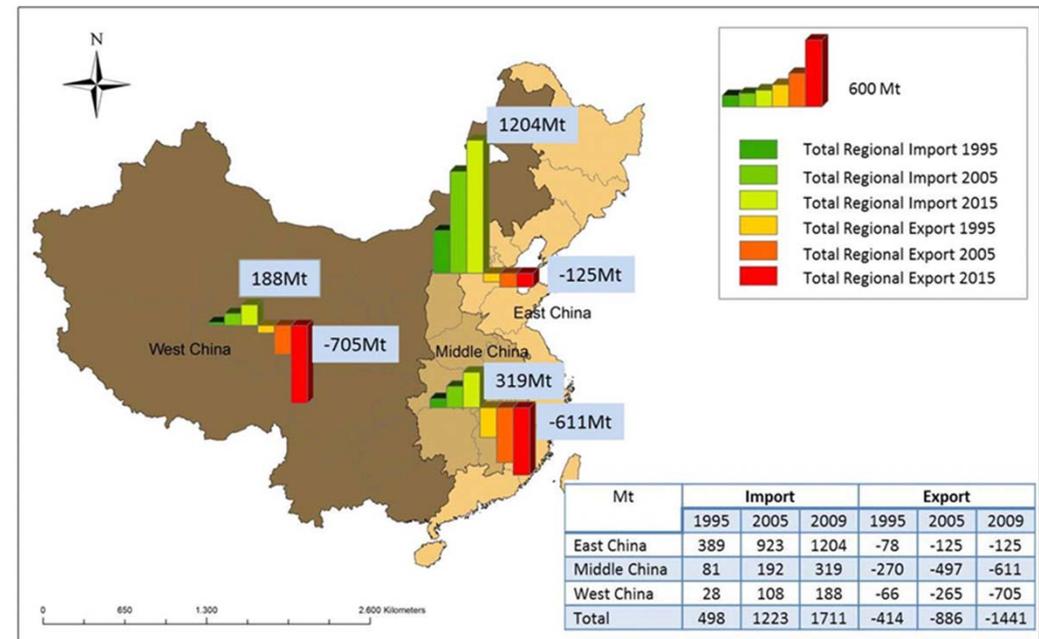


Website: [der.lbl.gov](http://der.lbl.gov)

# Energy System Planning & Grid Integration

## Project: Coal Supply Study: Recent Trends in Production and Consumption, Resource Constraints and Outlook

- Assessment of recent trends and outlook for China's coal industry focusing on:
  - Production
  - Mine ownership and scale
  - Performance indicators for mining
  - Geographical distribution
  - Transportation bottlenecks and trade
  - Consumption drivers
  - Coal-power conflict
  - Coal-based polygeneration
  - Coal-bed methane
- The study found that China faces increasing challenges to further expand output as coal quality and mining productivity decline and production centers move West, leading to serious transportation bottlenecks
- Power sector decarbonization and efficiency gains in key coal-consuming industries are key to reaching a coal consumption plateau

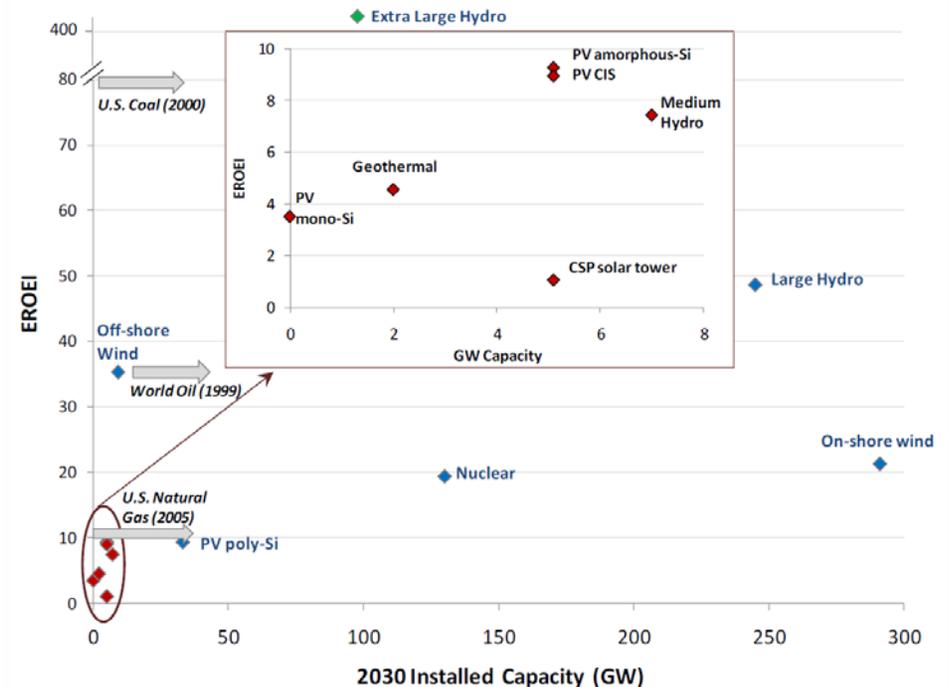


# Energy System Planning & Grid Integration

## Project: Alternative Energy Study: Analysis of Life-Cycle, Physical Impacts and Barriers to Non-Fossil Energy Development in China

- Examined China's targets and goals for non-fossil energy development (including nuclear power) to assess the material and resource requirements over the lifecycle of the technologies, the EROEI (Energy Returned on Energy Invested), and potential contribution to reduction of CO<sub>2</sub> emissions to 2030.
- Non-fossil energy plans emphasize technologies with high energy returns (large hydro, onshore wind) with lower expectations for low energy-return processes (PV, CSP, geothermal)
- Water and land are the two resources most critical as potential barriers to expansion
- Successful deployment could result in a peak in power sector CO<sub>2</sub> emissions by 2020

Figure 24. EROEIs and 2030 Installed Capacity by Alternative Energy Technology



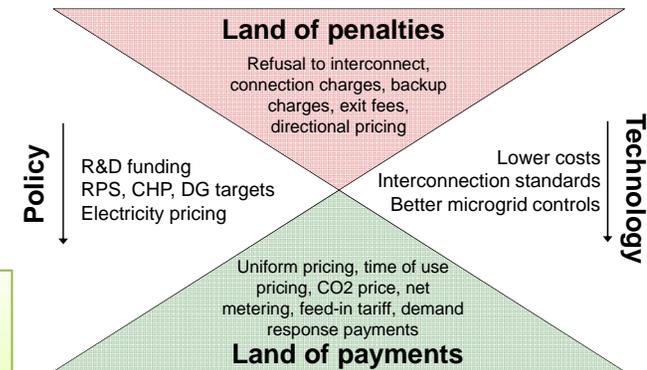
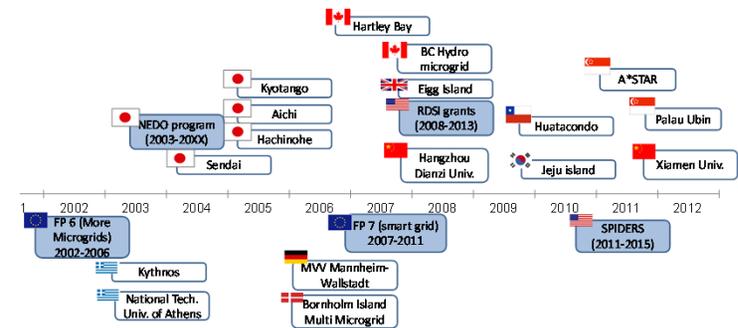
# Energy System Planning & Grid Integration



## Project: Policy Issues of Microgrid Deployment in China

### Collaborator: China Academy of Science - Institute of Electrical Engineers

- Microgrid deployment drivers
- Microgrid programs to date – international review
- Current state of technology – improvements, cost reductions, further needs
- Basic microgrid policy questions and economic barriers: From the land of penalties to the land of payments
- Case studies (Santa Rita Jail Project and Sendai project)
- Recommendations for China
  - RD&D program recommendations
  - Project recommendations
  - Deployment policy recommendations



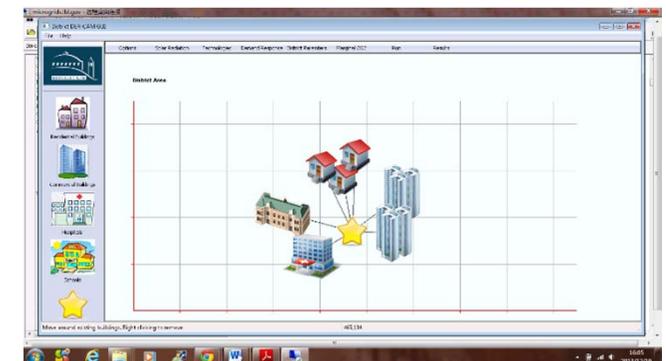
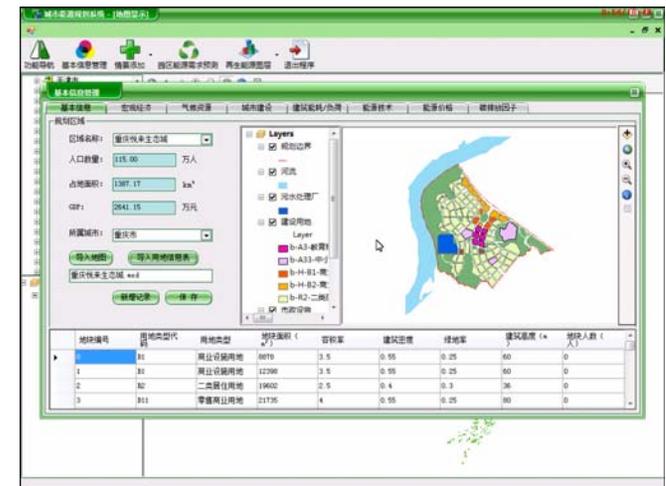
**Publication:** International Microgrid Assessment: Governance, Incentives, and Experience (IMAGINE)  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5914e-imagine-microgridsjune-2012.pdf>  
**Energy Policy URL:** <http://www.sciencedirect.com/science/article/pii/S0301421513011890>

# Energy System Planning & Grid Integration

**Project :** Developing a District Energy Planning Tool to Use in China

**Collaborators:** Shenzhen Institute for Buildings Research

- Develop a new district energy system planning tool for China
- Consider different types of district energy system, including but not limited to centralized chiller and boiler, CHP, GSHP, renewable energy
- Consider multiple building types in a district with different load profiles
- Modify DER-CAM engine to conduct district level energy system optimization and equipment selection
- Integrate with a GIS front-end
- Compare district energy system with building energy system



# Energy Planning and Grid Integration



***Project:*** Technical support to China's National Demand Response Pilot

***Collaborators:*** Economic & Information Commissions of Shanghai and Zhejiang

- Demand response (DR) as a viable demand-side resource is increasingly gaining attention in China.
- Several cities are exploring DR in varying degrees with DR pilots
- Project aims to better understand how DR could play a role beyond as merely a solution to power shortage under the new normal in China
- Through analysis of DR opportunities, project offers technical support to assist DR-related activities in pilot cities

# Energy System Planning & Grid Integration



**Project:** International Best Practices in Implementing Demand Response

**Collaborators:** Suzhou Economic & Information Commission, EnerNOC, Inc., Azure International

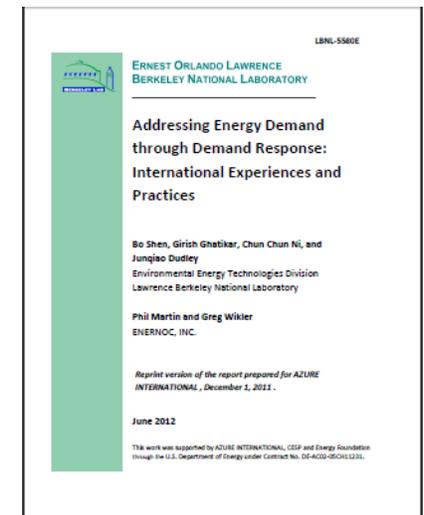
- A comprehensive review of international leading examples in managing electricity peak load through demand response
  - Regulatory and policy framework
  - Enabling technology
  - Implementation strategies
- Study on China's current practices in managing electricity peak
  - Challenges China faces in managing load shortfall
  - Factors affecting China's load needs
  - China's approach to dealing with power shortage: administrative, technical and economic measures
  - What can China learn from international practices

**Publication:** Addressing Energy Demand through Demand Response: International Experiences and Practices

**URL:** <http://china.lbl.gov/sites/all/files/lbl-5580e-deman-response-azurejune-2012.pdf>

**Publication:** What China Can Learn from International Experiences in Developing a Demand Response Program

**URL:** <http://china.lbl.gov/sites/all/files/lbl-5578e-demand-response-eceeejune-2012.pdf>



## Project: Performance-based Power Rationing Tool

### Collaborators: Suzhou Economic & Information Commission, State Grid Demand-Side Management Guidance Center

- To tackle electricity shortfall, China has adopted a mandatory power rationing program with every factory taking a turn
- Power rationing has resulted in load reduction achieved at the cost of unwilling enterprises with production/services interruption and lost economic output
- A tool is being developed to assist utility companies and government regulators in making curtailment decision based on the rank of electricity-consuming enterprises in terms of their over performance
- Better performed enterprises will less likely be curtailed
- Performance is compared systematically based on a comprehensive set of criteria, mainly enterprise's contribution to: economic output, economic structural improvement, energy efficiency, environmental quality, and electricity management
- Tool will be applied in a national DSM pilot conducted in Suzhou



# Low Emission & Efficient Industry: Policy-related



## ***Project:* Assessment of Opportunities for Efficiency Improvement and Fuel Switch for Industrial Boiler**

### ***Collaborators:* National Development & Reform Commission**

- Industrial boiler becomes a key area for close collaboration between the U.S. and China on climate change
- Great opportunities exist for efficiency improvement and switch to cleaner fuels in industrial boiler
- Project conducts detailed assessment in two pilot cities, highlighting the energy-saving and emission reduction potential of boiler programs for broad application to other regions in China
- Suggest the legal, regulatory, infrastructural, and financial policies, programs, and engagement necessary to capture the potential
- Provide a roadmap for strengthening the collaboration between the U.S. and China in industrial boiler efficiency improvement and fuel switch

# Low Emission & Efficient Industry: Policy-related



## Project: International Industrial Energy Efficiency Training and Deployment

Collaborators: see the table below

| U.S. Collaborators   | Chinese Collaborators   |   |
|--|---|---|
| <ul style="list-style-type: none"> <li>Institute for Sustainable Communities</li> <li>Oak Ridge National Laboratory</li> </ul> | <ul style="list-style-type: none"> <li>National Energy Conservation Center</li> <li>CenterUniversity Alliance for Industrial Energy Efficiency</li> <li>Zhengzhou University</li> <li>University of Science and Technology – Beijing</li> </ul> | <ul style="list-style-type: none"> <li>EHS Academy Jiangsu</li> <li>EHS Academy Guangzhou</li> <li>Suzhou Energy Conservation Center</li> <li>Shandong Energy Conservation Office</li> <li>Shandong University</li> <li>Sun Yat-sen University</li> </ul> |

- Developing and Deploying Trainings in Energy Assessment and Management
  - Industry-Focused System-Specific Assessments: Four 5-day training workshops conducted by world-leading experts for 40-50 trainees
    - Process heating system assessment workshop held in Zhengzhou, Henan Province in October 2011: on-site visit to an alumina plant
    - Process heating system assessment workshops in for Guangzhou and Jinan in May 2012
    - Steam system assessment workshops in Suzhou and Beijing in January 2013
  - Implementation of Energy Management Solutions and ISO 50001
- Accelerating the Growth of China’s Industrial Energy Efficiency Market
  - Candidates for Qualified Process Specialists
  - Webinars and Self-Assessment Tools
- Developed Chinese version of the Process Heating Assessment and Survey Tool (PHAST), and localized the Steam System Assessment Tool and the Steam System Scoping Tool
- Joined by U.S. companies, including Dow Chemical, GE, 3M, Alcoa, Honeywell, Bloom, Eclipse, Maxon, Arc Pacific, and ICF.
- Project report: “Energy Assessments under the Top 10,000 Program: A Case Study for a Steel Mill in China” presented at the European Council for an Energy-Efficient Economy’s 2014 Industrial Summer Study



**Website:** Steam Calculator  
**URL:** [http://www4.eere.energy.gov/manufacturing/tech\\_deployment/amo\\_steam\\_tool/](http://www4.eere.energy.gov/manufacturing/tech_deployment/amo_steam_tool/)

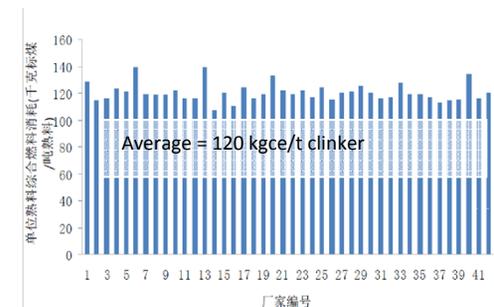
# Low Emission & Efficient Industry: Policy-related



**Project:** Comprehensive Program to Improve Energy Efficiency, Increase the Use of Alternative Fuels and Raw Materials, and Reduce Emissions in the Cement Sector in China

**Collaborators:** China Building Materials Academy, Cement Industry Energy Efficiency and Environmental Protection Evaluation and Test Center of China Building Material Industry, China Cement Association, E3M, Inc., World Resources Institute

- Enhanced the capacity of 42 key representative cement companies
  - o Conducted on-site energy and GHG emissions assessments
  - o Identified energy-saving measures and potentials
- Demonstrated the substantial environmental and economic benefits for co-processing of alternative fuels and raw materials
  - o Six demonstration plants
  - o Four technical guidelines
  - o One sewage sludge techno-economic tool
- Document and disseminate the results of the project throughout China to build up the capacity of entire cement sector
  - o Public online database
  - o Containing summary reports and assessment results



Fuel Consumption Per Unit of Clinker (kgce/t of Clinker)



APP Cement Project Database - Interface

**Website:** <http://www.dcement.com/cemdatabase/>

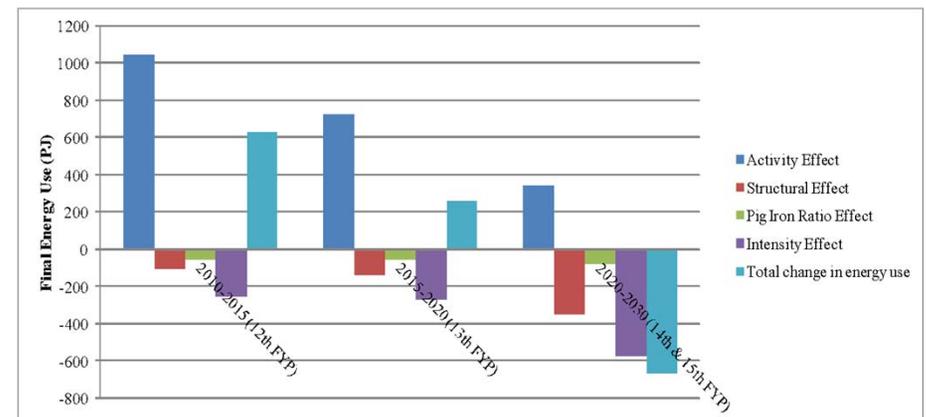
# Low Emission & Efficient Industry: Policy-related



**Project:** Analysis of the Past and Future Trends of Energy Use in Key Medium- and Large-Sized Chinese Steel Enterprises, 2000-2030

**Collaborator:** University of Science and Technology Beijing

- Analysis energy use trends since 2000 of China's key medium- and large-sized steel enterprises and also makes projections for energy use and production up to 2030 for the key medium- and large enterprises.
- Using a refined decomposition analysis to quantify the effects of various factors in shaping energy consumption trends in the past and in the near future.
- The total final energy use of the key Chinese steel enterprises peaks in year 2020 under scenario 1 and scenario 2 and in 2015 under scenario 3.
- The structural effect is expected to be negative (i.e. reducing final energy use) during 2010-2030 because of increases in the EAF share of steel production in this period.

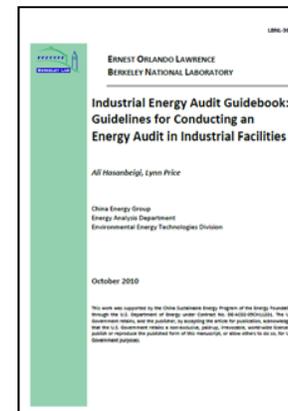
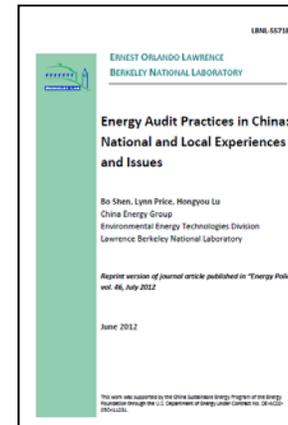


# Low Emission & Efficient Industry: Policy-related

## Project: Industrial Energy Assessments: Chinese and International Experience

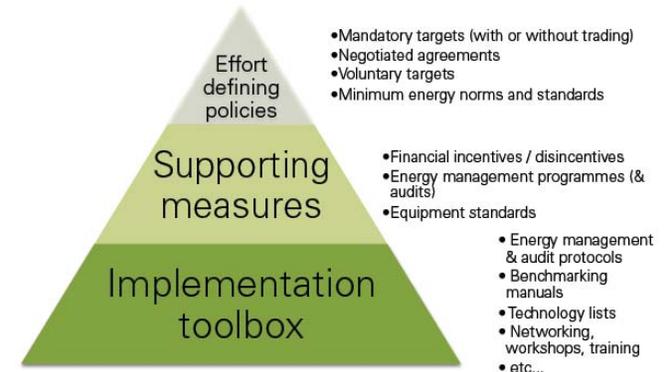
- Examined international best practices related to national-level energy auditing/assessment programs
- Assessed China's energy auditing practices and found that although large-scale energy audits have been performed in industrial facilities throughout China, there is potential for improvement based on international experience
- Developed a guidebook and tools for industrial energy auditing

**Publication:** Energy Audit Practices in China: National and Local Experiences and Issues  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5571e-energy-audit-issue-epjune-2012.pdf> (English)  
[http://china.lbl.gov/sites/all/files/energy\\_audit\\_practices\\_in\\_china\\_cn.pdf](http://china.lbl.gov/sites/all/files/energy_audit_practices_in_china_cn.pdf) (Chinese)  
**Publication:** Industrial Energy Audit Guidebook  
**URL:** <http://china.lbl.gov/publications/industrial-energy-audit-guidebook-gui>



## *Project:* Database on China's 11<sup>th</sup> and 12<sup>th</sup> Five Year Plan Industrial Sector Policies and Programs

- Provides information on industrial energy efficiency and greenhouse gas (GHG) mitigation policies
- Divides policies into:
  - o Effort-Defining Policies
  - o Supporting Measures
  - o Implementation Toolbox
- Includes information on the main industry characteristics, such as national-level GDP, energy consumption, and CO<sub>2</sub> emissions



**Website:** <http://iepd.iipnetwork.org/>

# Low Emission & Efficient Industry: Policy-related



## *Project:* Henan Province Energy Cap and CO<sub>2</sub> Balance

## *Collaborator:* Zhengzhou University

- Assists Zhengzhou University in designing policies and programs to realize the provincial 2015 energy cap
  - LBNL's Low Carbon Development Guidebook for an inventory of energy efficiency policies and programs
  - LBNL's research on structural transition from industrial sector to service sector
- Assists Zhengzhou University in undertaking a CO<sub>2</sub> inventory for Henan Province
- Assisted the development of Henan's energy target allocation system, and allocated targets to local cities and key industrial sectors.
- Presentations on energy and carbon targets allocation methods and modeling using LEAP model

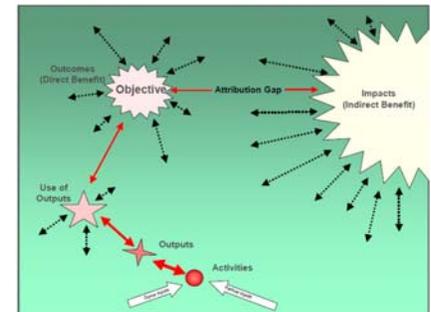


# Low Emission & Efficient Industry: Policy-related

## *Project:* International Experience with Monitoring, Measuring, and Quantifying the Co-Benefits of Energy Efficiency and GHG Mitigation Policies

### *Collaborator:* UC Berkeley

- Documentation of experiences related to the co-benefits or ancillary benefits of energy efficiency and GHG mitigation policies in countries around the world
- Four general steps for quantifying the co-benefits of energy efficiency and GHG emissions reduction policies discussed in this report:
  - Calculating emissions differences between base case and alternative policy scenarios
  - Applying air dispersion modeling or simplifications to characterize and compare concentrations of pollutants.
  - Estimating impacts for each scenario and comparing them against each other (using, for example, population-adjusted C-R functions to find health impacts)
  - Monetizing or otherwise quantifying those impacts in relation to the costs of the alternative policy scenario



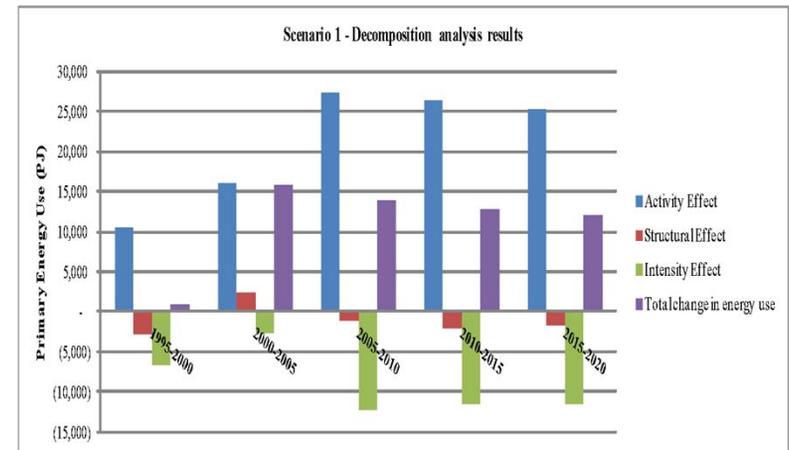
**Publication:** International Experience with Quantifying the Co-Benefits of Energy Efficiency and Greenhouse Gas Mitigation Programs and Policies

**URL:** <http://china.lbl.gov/publications/international-experience-quantifying->

# Low Emission & Efficient Industry: Policy-related

## *Project:* Retrospective and Prospective Decomposition Analysis of Chinese Manufacturing Energy Use, 1995-2020

- Analyzes industrial energy use and economic structure of Chinese manufacturing sector in detail
  - Analyzes the energy use of and output from 18 industry sub-sectors.
  - Retrospective (1995-2010) and prospective (2010-2020) decomposition analyses conducted to show how different factors influence industrial energy use trends in China
    - o Production growth
    - o Structural change
    - o Energy intensity change



**Publication:** Retrospective and Prospective Decomposition Analysis of Chinese Manufacturing Energy Use, 1995-2020

**URL:** [http://china.lbl.gov/sites/all/files/6028e\\_decom\\_analysis.060313.pdf](http://china.lbl.gov/sites/all/files/6028e_decom_analysis.060313.pdf)

# Low Emission & Efficient Industry: Policy-related



**Project:** Quantifying the Co-benefits of Energy-Efficiency Programs: A Case Study of the Cement Industry in Shandong Province, China

**Collaborator:** Air quality modeling group of LBNL

- Studied several collateral health and environmental benefits (co-benefits) of energy-saving measures in the cement industry and shows that including co-benefits can significantly affect the cost effectiveness of some energy-efficiency measures.
- Applied a modified cost of conserved energy (CCE) calculation to determine the monetary value of the co-benefits of reduced damage to human health that results from reduced air pollutant emissions.



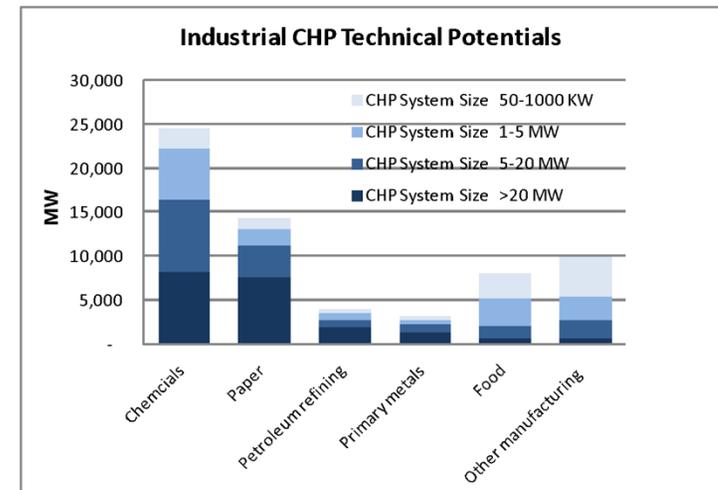
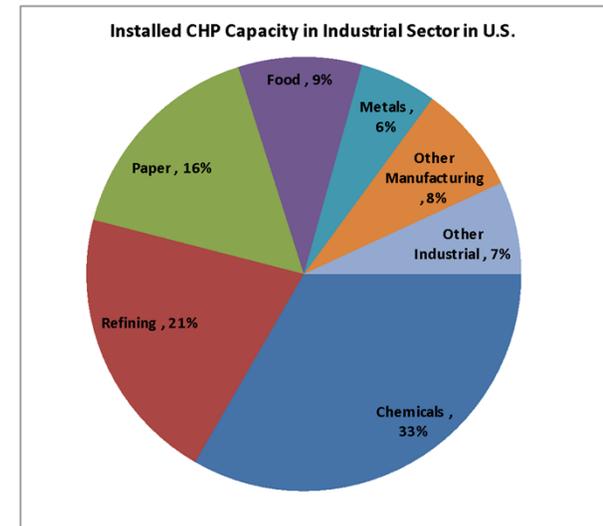
**Publication:** Quantifying the Co-benefits of Energy-Efficiency Programs: A Case Study of the Cement Industry in Shandong Province, China  
**URL:** <http://china.lbl.gov/publications/quantifying-co-benefits-energy-effici>

# Low Emission & Efficient Industry: Policy-related

**Project: Barriers and Drivers of Combined Heat and Power in the Industrial Sector of the United States: Comparison to China's Practices and Policies**

**Collaborator: China Cement Association**

- Described the main types of CHP application in industrial sector
- Identified the key factors of CHP implementation in the U.S. industrial sector
- Compared the supporting policies of industrial CHP in U.S. and China
- Case studies of CHP application in industrial sub-sectors (pulp and paper, steel and cement, metal manufacturing, oil refining, and industrial parks)



# Low Emission & Efficient Industry: Technology-related

**Project:** US-China Green Data Center Initiative

**Collaborators:** China Institute Electronics (CIE) and China Electronics Standardization Institute (CESI)

## Why are data centers an important area of focus in China?

- Fast growth fueled by China's effort in developing a new economy based on information consumption
- The sector consuming more power than produced by the Three Gorges Dam (2.4% of China total)
- High growth rate of 15% annually
- Less efficient – large opportunity for savings and for adoption of advanced technologies

## Activities:

- Training and awareness building of efficiency methods/technologies
- MOU with CIE and CESI with support from the China Ministry of Industry and Information Technology (MIIT)
- Data center energy efficiency standards and international harmonization
- Demonstration project featuring US technologies & companies

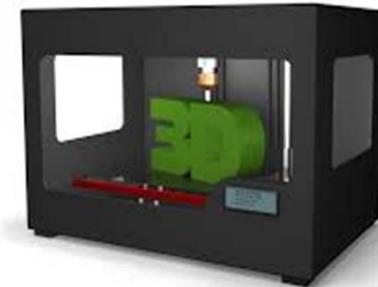


# Low Emission & Efficient Industry: Technology-related

## *Project: Top Ten Energy Efficiency Best Practices and Best Available Technologies*

### *Collaborators: IPEEC members (China, Australia, Japan, etc.)*

- Goal of the study: to identify, evaluate, and disseminate best available technologies (BATs) and best practices to improve energy efficiency within IPEEC member and non-member economies.
- Information on BATs will be collected through task group member contributions, industry associations, institutes, and experts.
- Technologies will be evaluated against the following criteria: environmental protection and public health, energy saving potentials, technical characteristics, economic characteristics, and social characteristics.
- Detailed evaluation indicators are being developed by the expert panel.
- The preliminary list of top 10 best practices and best available technologies for each member country is set to be available for review by the expert panel and other stakeholders by November 2014.



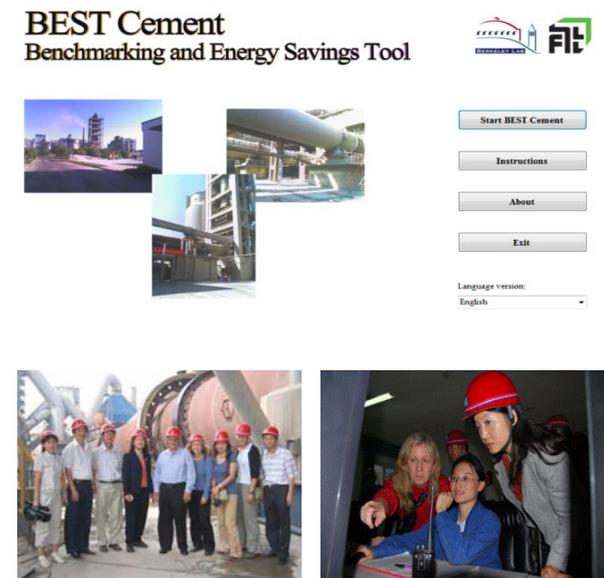
# Low Emission & Efficient Industry: Technology-related



## *Project:* Benchmarking Tool Development and Application in China's Cement Industry

## *Collaborators:* China's Energy Research Institute, China Building Materials Academy, China Cement Association

- Benchmarks a cement plant to world and Chinese best practice by process step
- Menu of ~50 energy-efficiency measures
- Provides information (typical energy savings, costs, and simple payback period) on each measure
- Trained about 300 cement plant staff from over 200 cement facilities
- Used BEST-Cement to evaluate 16 relatively modern cement plants in Shandong Province
- Using BEST-Cement, DOE energy auditing tool, and WRI/WBCSD GHG Protocol tool for cement industry to undertake energy audits of 42 cement plants
- The tool can be downloaded at <http://china.lbl.gov/tools-guidebooks/best-cement>



**Publication:** Analysis of Energy-Efficiency Opportunities for the Cement Industry in Shandong Province, China

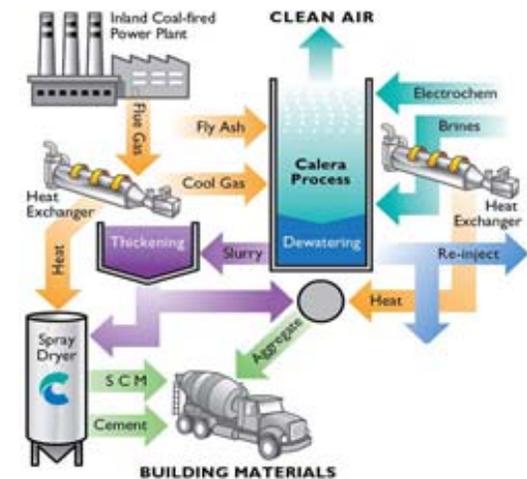
**URL:** <http://china.lbl.gov/sites/all/files/lbl-2751e-shandong-cementoct-2009.pdf>

# Low Emission & Efficient Industry: Technology-related

**Project:** Guidebooks on Commercialized and Emerging Industrial Energy-Efficiency Opportunities

**Collaborator:** International Energy Studies Group of LBNL, Utrecht University

- Guidebooks on commercialized energy efficiency technologies in both English and Chinese
  - Cement – Pulp and paper – Iron and Steel – Breweries
  - Textiles – Petrochemicals – Petroleum refining – Pharmaceuticals
- Emerging energy efficiency technologies:
  - Cement
  - Iron and steel
  - Textile
  - Pulp and paper
  - Glass (forthcoming)
  - Aluminum (forthcoming)
- Information presented for each emerging technology:
  - Short description of the technology
  - Energy, environment, and other benefits of the technology and costs
  - Block diagram or a photo of the technology
  - Commercialization status and resources for further information



**Publication:** all the energy-efficiency guidebooks (English & Chinese version)

**URL:** <http://china.lbl.gov/guidebooks>

# Low Emission & Efficient Industry : Technology-related



**Project:** International Best Practices in Pre-Treatment and Co-Processing Municipal Solid Waste and Sewage Sludge in the Cement Industry

**Collaborators:** WBCSD/CSI, US EPA, Holcim, China Building Materials Academy, China Cement Association, Sinoma Research Institute, China Ministry of Environmental Protection

- This project provides international best practices and influence the operating mode of cement kilns engaged or that will be engaged in MSW or sewage sludge co-processing, thereby ensuring an environmentally-sound treatment of those waste streams
- The report includes:
  - legislation/regulatory framework in other countries for the proper and controlled co-processing of sewage sludge and municipal solid waste in cement kilns
  - best practice technologies for the pre-treatment and co-processing of sewage sludge and municipal solid waste in cement plants
- Findings presented at the WBCSD/CSI international conference in September 2012 in Beijing
- LBNL has also developed a sophisticated techno-economic analysis tool for the use of sewage sludge in the cement industry: *Sewage Sludge Use in Cement Companies as an Energy Source (SUCCESS) Tool*. The tool can be downloaded at <http://china.lbl.gov/tools-guidebooks/success>

**Publication:** International Best Practices for Pre- Processing and Co-Processing Municipal Solid Waste and Sewage Sludge in the Cement Industry

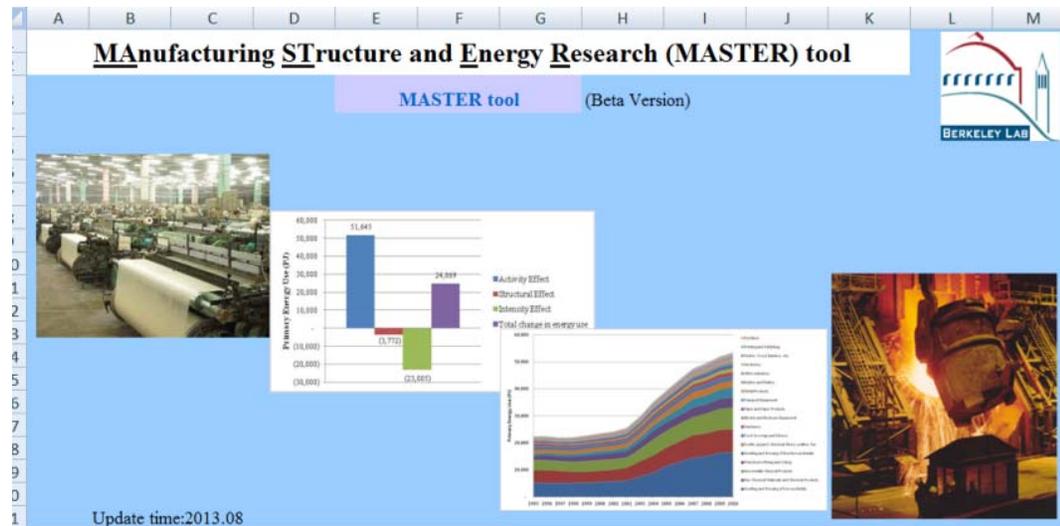
**URL:** [http://china.lbl.gov/sites/all/files/co-processing\\_2.pdf](http://china.lbl.gov/sites/all/files/co-processing_2.pdf) (English)

[http://china.lbl.gov/sites/all/files/co-processing\\_cn.final\\_.pdf](http://china.lbl.gov/sites/all/files/co-processing_cn.final_.pdf) (Chinese)



# Low Emission & Efficient Industry: Technology-related

## Project: MAnufacturing STructure and Energy Research (MASTER) tool



- MASTER tool is a spreadsheet-based tool that can help provincial governments assess the historical energy use and structural change in the manufacturing sector in their province and also to forecast what will be the share of structural change in the future energy use trend.
- The tool will use a decomposition analysis method to conduct such an assessment.
- The tool will be made user-friendly as much as possible, so that the users in the provincial government can use it easily.
- The tool can be download at <http://china.lbl.gov/tools-guidebooks/master>

# Low Emission & Efficient Industry: Technology-related



**Project:** Energy Assessments under the Top 10,000 Program—A Case Study for a Steel Mill in China

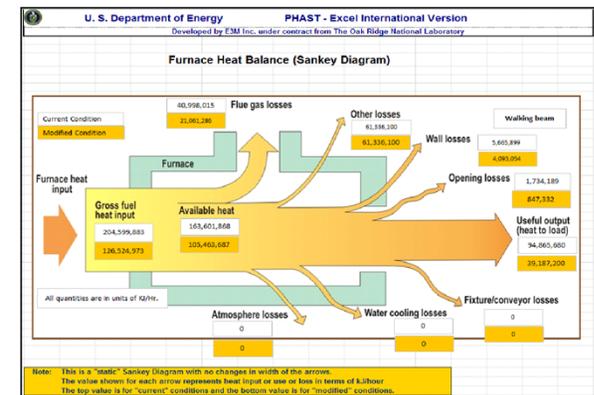
**Collaborators:** Institute for Sustainable Communities, Oak Ridge National Laboratory, E3M Inc., Shandong University, Shaanxi Energy Conservation and Supervision Center

- Update on the performance of China’s Top 10,000 program
- Case study on one process heating energy efficiency assessment in one Chinese steel mills
- Present the results of the process heating assessment on steel reheating furnaces
  - Including overall energy efficiency levels
  - Areas of heat losses
  - Potentials for energy savings
- Provide energy-saving recommendations that were identified
  - potential energy savings estimates
  - Potential cost savings
  - Simply payback period

PEER-REVIEWED PAPER  
 Energy assessments under the Top 10,000 Program – a case study for a steel mill in China

Authors: Li, G. & Yan, D.  
 Title: Energy assessments under the Top 10,000 Program – a case study for a steel mill in China

Abstract: This paper reports on the results of energy assessments under the Top 10,000 Program for a steel mill in China. The paper describes the methodology used for the energy assessments, including the use of Sankey diagrams to visualize energy flows and losses. The paper also discusses the potential for energy savings and the impact of the assessments on the mill's energy management.



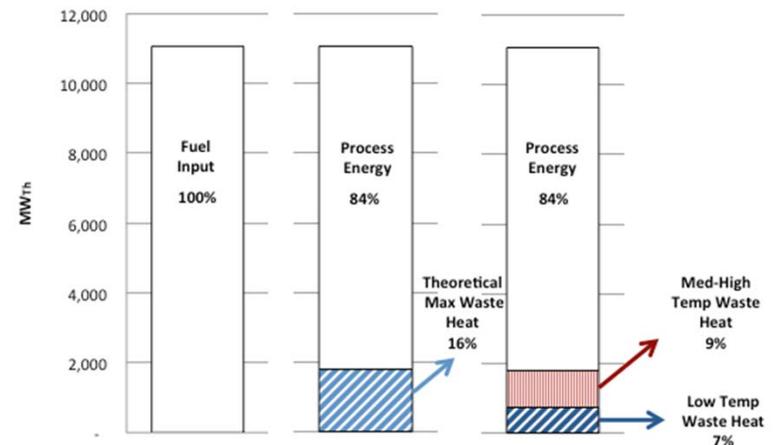
**Publication:** Proceedings of the 2014 European Council for an Energy-Efficient Economy’s Industrial Summer Study, Papendal, Arnhem, the Netherlands, June 2-5, 2014.

# Low Emission & Efficient Industry: Technology-related

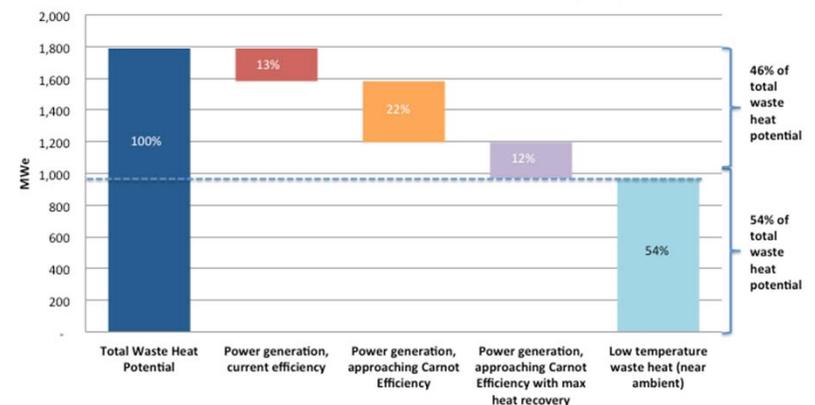
## Project: Capturing the Invisible Resource: Analysis of Waste Heat Potential in Chinese Industry and Policy Options for Waste Heat Generation

- Analyzed technical potential of waste heat in China's cement, iron and steel, and glass sectors
- Identified theoretical maximum potential and practical potential of waste heat to power generation in the studied three sectors
- Surveyed industry professionals and experts on the use of waste heat generation in Chinese industries
- Identified key barriers to waste heat generation in China
- Developed policy solutions to promote greater use of waste heat generation in industry
- Conducted benefit-cost analysis to determine the level of incentive for waste heat generation projects
- Provided technical and policy recommendations on waste heat to power generation

Waste Heat Potential in Glass Sector (2012)



Potential of Waste Heat to Power Generation in Glass Sector (2012)



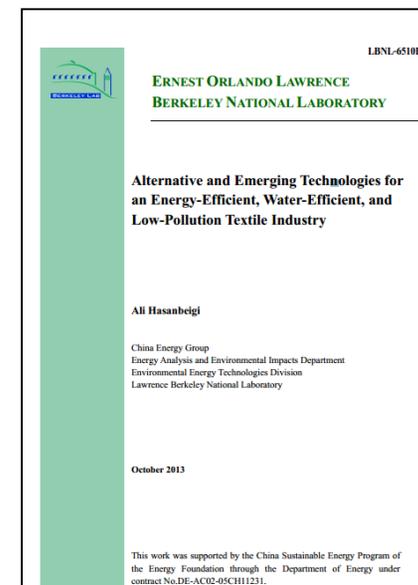
# Low Emission & Efficient Industry: Technology-related



## *Project: Textile Industry Energy Efficiency*

## *Collaborators: Azure International, Suzhou Energy Conservation Center*

- Developed an energy-efficiency technologies guidebook for the textile industry
  - Includes about 190 energy-efficiency measures
  - Available in English and Chinese
- Developed the Energy Efficiency Assessment and Greenhouse Gas Emission Reduction (EAGER) Tool for the textile Industry, which can be downloaded at
- Conducted two training workshops in Suzhou in October 2012
  - More than 150 Chinese textile engineers as well as academia and provincial ECCs were trained on energy efficiency technologies and the use of EAGER-Textile tool



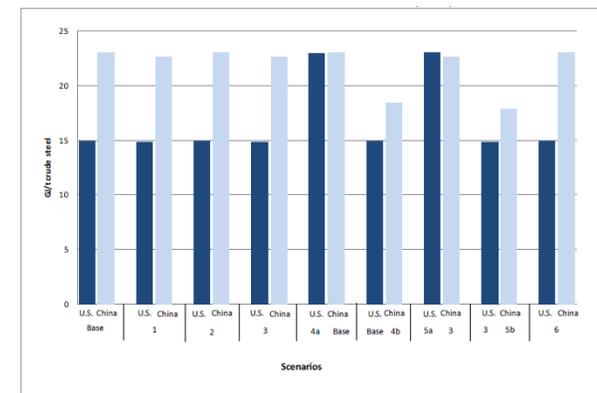
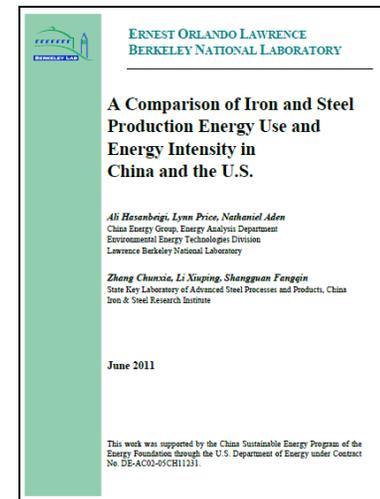
**Publication:** Energy-Efficiency Improvement Opportunities for the Textile Industry  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-3970e-ee-textilesep2010.pdf> (English)  
[http://china.lbl.gov/sites/all/files/textile\\_guidebook\\_cn.pdf](http://china.lbl.gov/sites/all/files/textile_guidebook_cn.pdf) (Chinese)

# Low Emission & Efficient Industry: Technology-related

**Project:** Comparison of Energy Intensity for the Iron and Steel Industry in China and the U.S.

**Collaborator:** China Iron and Steel Research Institute

- Goal of the study: to develop a methodology for making an accurate comparison of the energy intensity of steel production in China and the U.S. by addressing issues related to boundary definitions, conversion factors, etc.
- In a scenario that assumed the Chinese share of electric arc furnace production in 2006 (i.e. 10.5%) in the U.S., the energy intensity of steel production in the U.S. increased by 54% to 22.96 GJ/tonne crude steel
- Thus, when comparing the energy intensity of the U.S and Chinese steel industry, the structure of the industry should be taken into account



**Publication :** A Comparison of Iron and Steel Production Energy Use and Energy Intensity in China and the U.S.

**URL:** <http://china.lbl.gov/sites/all/files/lbl-4836e-us-china-steeljune-2011.pdf>

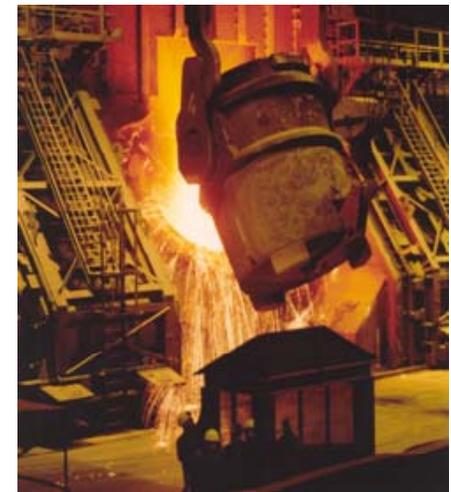
# Low Emission & Efficient Industry: Technology-related



**Project:** Development of a Framework for Comparison of Energy-Related CO<sub>2</sub> Emission Intensity of the Iron and Steel Industry in China, Germany, Mexico, and the U.S.

**Collaborators:** ISI Fraunhofer, Germany, China Iron and Steel Research Institute

- Goal of the study: to develop a methodology for making an accurate comparison of the CO<sub>2</sub> intensity of steel production in China, Germany, Mexico, and the U.S. by addressing issues related to boundary definitions, conversion factors, etc.
- The results show that low EAF steel production share and high grid CO<sub>2</sub> emission factors are two important reasons why Chinese steel CO<sub>2</sub> intensity is substantially higher than that in other 3 countries studied.



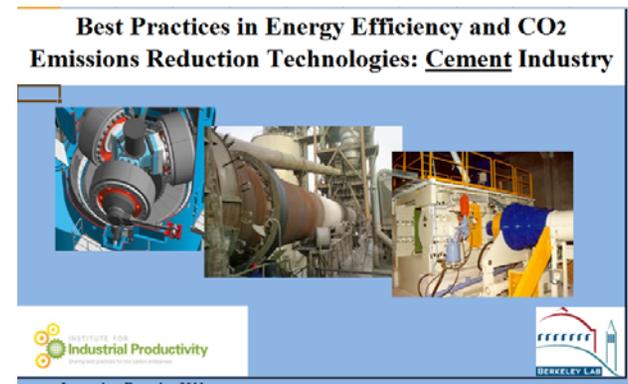
**Publication:** Hasanbeigi, A., Price, L., Arens, M, 2013. Development of a Framework for Comparison of Energy-Related CO<sub>2</sub> Emission Intensity of the Iron and Steel Industry in China, Germany, Mexico, and the U.S. (forthcoming)

# Low Emission & Efficient Industry: Technology-related

## *Project* : Best Practices in Energy Efficiency and CO<sub>2</sub> Emissions Reduction Technologies: Cement Industry Database

### *Collaborator*: Institute for Industrial Productivity

- Database of energy-efficiency technologies for the cement industry
- Includes both commercialized and emerging technologies
- Information on 123 energy-efficiency technologies
- Brief description as well as information on energy savings, costs, and process-related CO<sub>2</sub> emission reduction is presented.
- An accompanying report, *Resources for Energy Efficiency and Other Information for the Cement Industry*, is also compiled and will be published soon. The information in this report is the content of the technology database published by IIP



**Website:** Industrial Energy Technology Database  
**URL:** <http://ietd.iipnetwork.org/content/cement>

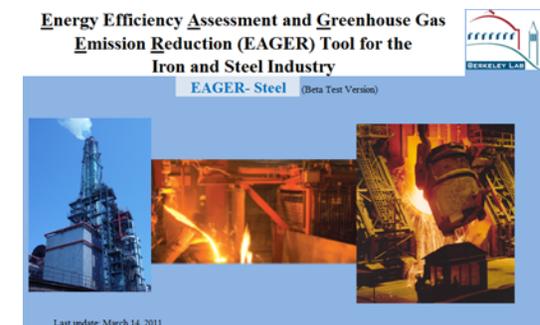
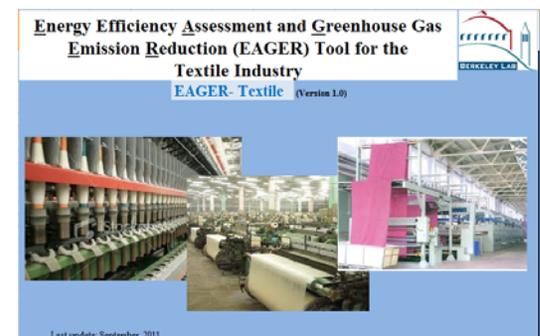
# Low Emission & Efficient Industry: Technology-related



**Project:** Energy Efficiency Assessment and Greenhouse Gas Emission Reduction (EAGER) Tool

**Collaborator:** China Iron and Steel Research Institute, State Key Laboratory of Pulp and Paper Engineering, South China University of Technology, Guangzhou

- EAGER-Textile, EAGER-Steel, and EAGER Pulp & Paper tools are simple techno-economic analysis tools
- Allow the user to evaluate the impact of selected energy efficiency measures in their plants
- 48 energy efficiency technologies are included in EAGER-Textile, 46 are included in EAGER-Steel, and 46 are included in EAGER-Pulp & Paper
- Simple and user-friendly spreadsheet-base tool
- More than 150 Chinese textile engineers and academia and local ECC in Suzhou were trained on the use of the EAGER-Textile tool in October 2011
- Translated into Chinese
- The EAGER-Textile tool can be downloaded at <http://china.lbl.gov/tools-guidebooks/eager-textile>; EAGER-Steel tool at <http://china.lbl.gov/tools-guidebooks/eager-steel>; EAGER-Pulp & Paper tool at <http://china.lbl.gov/tools-guidebooks/eager-pulp-paper>



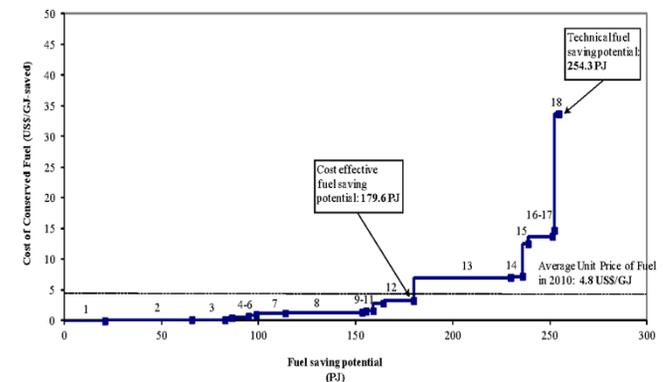
# Low Emission & Efficient Industry: Technology-related



**Project:** Analysis of Energy-Efficiency Opportunities for the Pulp and Paper Industry in China

**Collaborator:** State Key Laboratory of Pulp and Paper Engineering, South China University of Technology, Guangzhou

- Assessed impact of 23 energy-efficiency measures that could be applied in China's pulp and paper industry
- Analyzed fuel- and electricity-efficiency improvement potential of these technologies for the year 2010 using a bottom-up conservation supply curve (CSC) model
- the cost-effective fuel efficiency improvement potential for China's pulp and paper industry is 179.6 PJ, and the total technical fuel-savings potential is 254.3 PJ.
- total technical electricity-efficiency potential to 2,316 GWh

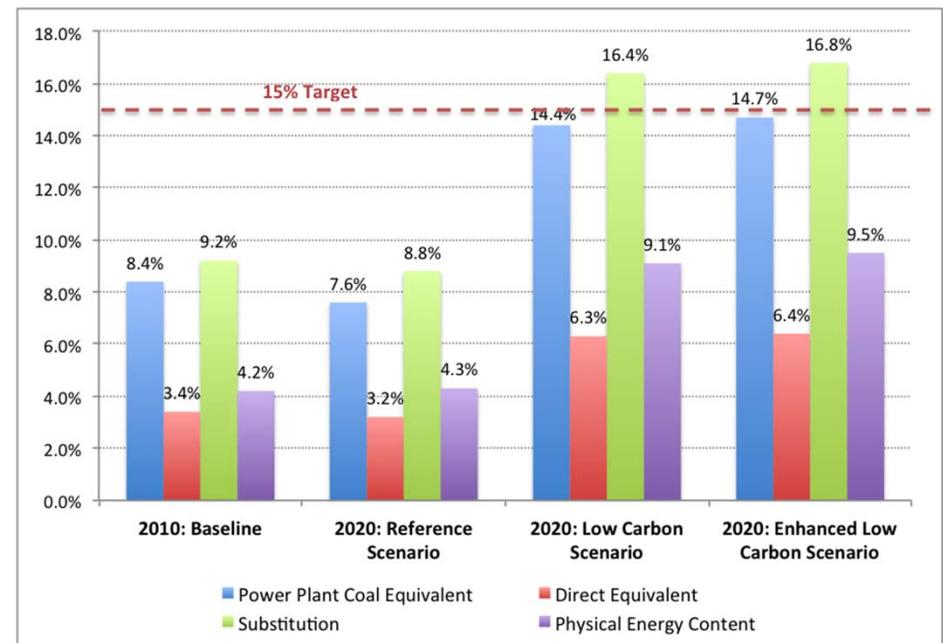


**Publication:** Analysis of Energy-Efficiency Opportunities for the Pulp and Paper Industry in China  
**URL:** <http://china.lbl.gov/publications/analysis-energy-efficiency-opportun-0>

# Low Emission & Efficient Industry: Other

## Project: Understanding Chinese Industrial Energy Data and its Differences from International Practices

- China's energy data reporting has important differences from international practices.
- Most of China's data practices are still unfamiliar to international energy analysts and experts.
- Review China's industrial energy data to understand how China reports its primary energy data
- How China calculates its primary energy equivalents, what energy conversion factors are used in China
- How that differs from international practices
- How these differences would impact the evaluation of policy accomplishments (e.g., energy savings and China's energy intensity targets)



# Low Emission & Efficient Industry: Other

**Project:** Capacity Building and Technical Training on Energy Analysis Research Methodologies

**Collaborators:** China Industrial Energy Efficiency University Alliance, Provincial Energy Conservation Alliance

- This project will undertake to transfer some key energy analysis methodologies to researchers in China's universities and research institutions to support their research work
- Share LBNL experiences in conducting decomposition analysis, energy efficiency supply curves, field surveys, financial and investment analyses, energy data conversions, greenhouse gas emissions calculations, etc



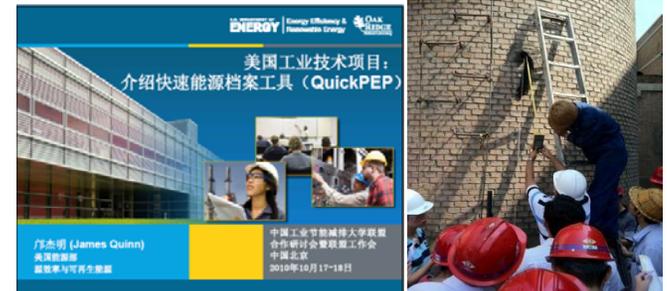
# Low Emission & Efficient Industry: Other



**Project:** Support for University Alliance for Industrial Energy Efficiency (UAIEE)

**Collaborators:** National Energy Conservation Center, University Alliance for Industrial Energy Efficiency, Local energy conservation centers

- Brought the U.S. model and experiences in establishing and management of University-based Industrial Assessment Centers (IACs) to China
- Signed MOU with UAIEE at the First U.S.- China Energy Efficiency Forum in May 2010
- Organized 3-day conference to introduce U.S. DOE industrial energy assessment tools, standardized guidelines, standards, and IAC database
- Demonstrated industrial energy assessments for process-heating (in 2011) and steam system (January 2013)
- Conducted training on QuickPEP tool and translated ePEP tool into Chinese
- Developed Chinese version of the Process Heating Assessment and Survey Tool (PHAST), and localized the Steam System Assessment Tool and the Steam System Scoping Tool



**Website:** Steam Calculators

**URL:** [http://www4.eere.energy.gov/manufacturing/tech\\_deployment/amo\\_steam\\_tool/](http://www4.eere.energy.gov/manufacturing/tech_deployment/amo_steam_tool/)

# Low Emission & Efficient Industry: Other



**Project:** Support for Top-1000 and Top-10,000 Energy-Consuming Enterprises Programs

**Collaborators:** University Alliance for Industrial Energy Efficiency, National Energy Conservation Center, Zhengzhou University, University of Science and Technology, Beijing

- Presentation on US-China energy efficiency collaboration at the Energy Conservation Training and UAIEE Leadership Meeting
- Provided information and reports related to international experience in voluntary agreements programs and energy auditing programs to the National Energy Conservation Center in China
- Working with Zhengzhou University to provide technical assistance on forecasting energy-savings for Top-10,000 enterprises in Henan Province by using LEAP model



**Publication 1:** Evaluation of Efficiency Activities in the Industrial Sector Undertaken in Response to Greenhouse Gas Emission Reduction Targets

**URL:** <http://china.lbl.gov/sites/all/files/lbl-3551e-efficiency-activitiesapril-2010.pdf>

**Publication 2:** Voluntary Energy Efficiency Agreements in China: History, Impact, and Future

**URL:** <http://china.lbl.gov/sites/all/files/ecee-ee-vajune-2011.pdf>

# Low Emission & Efficient Industry: Other



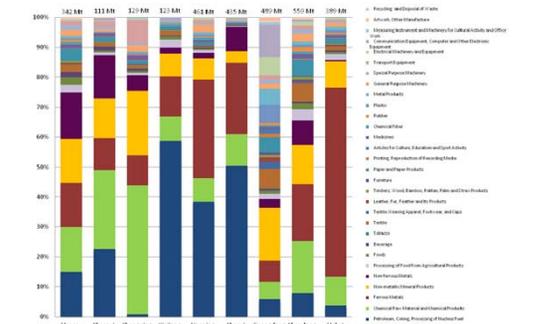
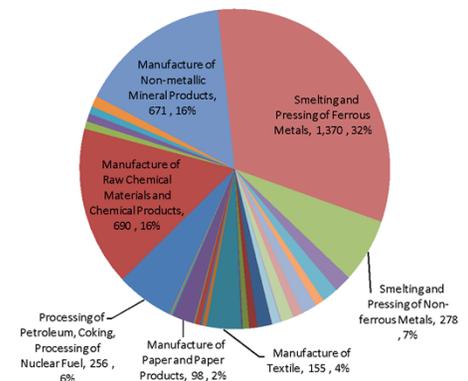
**Project:** Information on Provincial CO<sub>2</sub> Emissions

**Collaborator:** Zhengzhou University

- Provided information on carbon dioxide (CO<sub>2</sub>) emissions for industrial subsectors in 12 selected provinces:
  - o Chongqing, Guangdong, Hebei, Henan, Jiangsu, Liaoning, Shaanxi, Shandong, Shanghai, Shanxi, Sichuan, and Xinjiang
- Based on public-available statistics, and discussed current data limitation on CO<sub>2</sub> emissions calculation for provinces
- Provided technical support to Zhengzhou University to help them establish provincial emissions inventory

**Publication:** China's Industrial Carbon Dioxide Emissions in Manufacturing Subsectors and in Selected Provinces . (Conference Processing of the 2012 ECEEE Industrial Summer Study)  
 URL: <http://china.lbl.gov/sites/all/files/lbl-5575e-industrial-co2-emissionsjune-2012.pdf>

**CO<sub>2</sub> Emissions by Subsector in China (2008)**  
 (Mt of CO<sub>2</sub> Emissions, % of Total Manufacturing Emissions, without T&D losses)



CO<sub>2</sub> Emissions of Industrial Subsectors in Selected Provinces (without T&D losses, 2008)

# Low Emission & Efficient Buildings and Equipment



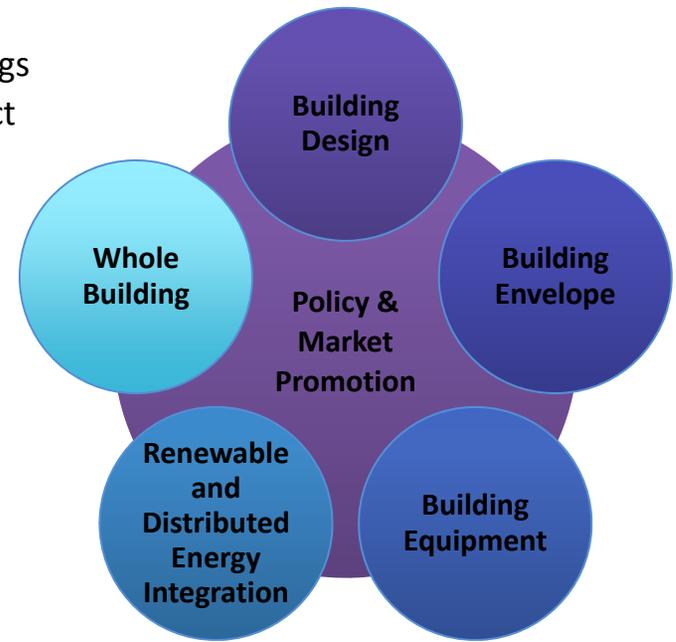
**Project :** U.S.-China Clean Energy Research Center, Buildings Energy Efficiency Consortium (CERC-BEE)

**Collaborators:** Ministry of Science & Technology/National Energy Administration and Ministry of Housing and Urban-Rural Development



Website <http://cercee.lbl.gov>

- Vision:** To Achieve Widespread Adoption of Very Low Energy Buildings  
**Mission:** Build partnership and collaborate to deliver real world impact
- ✓ U.S./China construction market ~ 2B m2
  - ✓ CO<sup>2</sup> savings ~ 100Mt/year by 2025



*U.S./China Research Performers & U.S. Industrial Partners:*

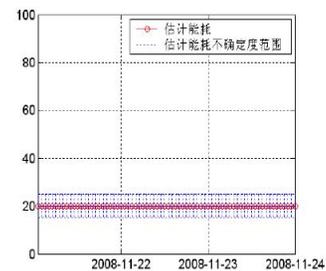
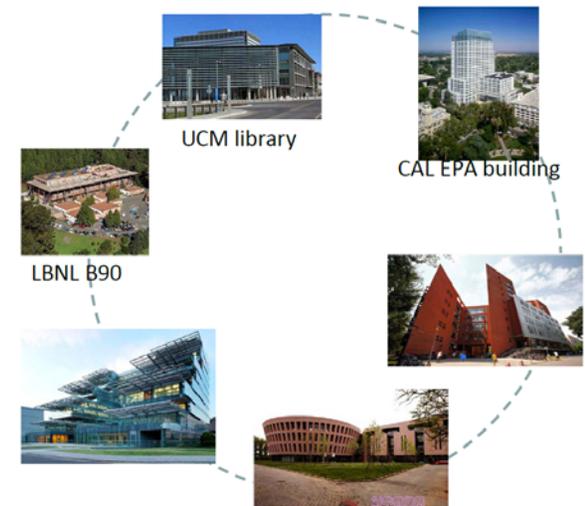


# Low Emission & Efficient Buildings and Equipment

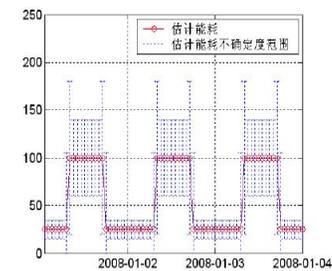
## Project: Real Time Building Energy Monitoring

### Collaborator: Tsinghua University

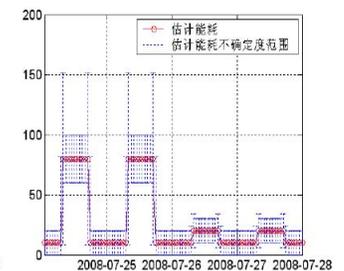
- Understand key drivers of large discrepancies in energy use between buildings
- Detailed case studies by employing a standard platform for collecting, monitoring, and analyzing building energy use data
- Contribute to the development of ISO 12655, Presentation of real energy use of buildings
- Provide guidelines to improve operation and retrofit of buildings
- Project team includes LBL, ORNL, Tsinghua University



• Constant



• Day/Night



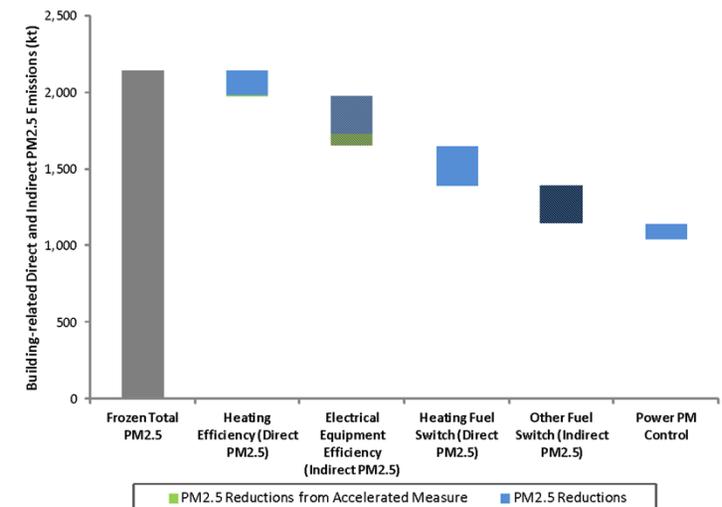
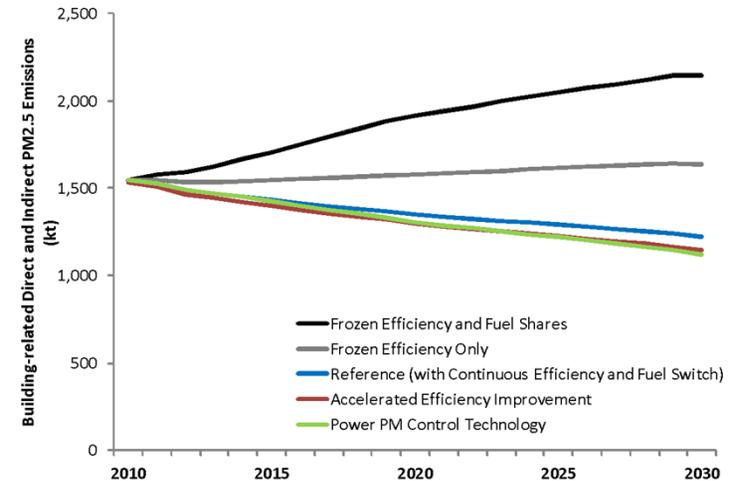
• Weekday/Weekend

# Low Emission & Efficient Buildings and Equipment



## Project: Evaluation of the Contribution of the Building Sector on PM2.5 Emissions in China

- LBNL used the China Energy End-Use Model to evaluate the direct PM2.5 emissions from heating and indirect PM2.5 emissions from electricity consumed by buildings
- Identified and quantified the major sources of direct and indirect primary PM2.5 emissions for residential and commercial buildings in different climate zones
- Evaluated the PM2.5 emissions reduction potential and co-benefits of key strategies:
  - Building energy efficiency improvement
  - Fuel switching for heating and electricity generation
  - Post-combustion PM control technologies for power sector
- Efficiency improvements found to have the greatest co-benefit in reducing PM2.5, without increasing cost or other pollutants, followed by fuel switching
- Paper on study accepted for 2014 ACEEE Summer Study on Energy Efficiency in Buildings



# Low Emission & Efficient Buildings and Equipment



**Project:** Building Energy Efficiency Best Practice Policies and Policy Packages

**Collaborators:** American Council for an Energy-Efficient Economy, Central European University

- **Scope:**
  - o **Policies:** building energy codes, building energy labels, and financial incentives
  - o **Geography:** U.S., E.U., China, and India at the regional, national, state, and sub-state levels
  - o **Sectors:** new construction and existing building retrofits, urban and rural, residential and commercial buildings
  - o **Load types:** focusing on HVAC and water heating
- **Outputs:** Provided policies and policy packages that are considered effective in CO<sub>2</sub> emissions reduction



Global Buildings  
Performance Network



**Publication:** Building Energy-Efficiency Best Practice Policies and Policy Packages  
**URL:** <http://china.lbl.gov/publications/building-energy-efficiency-best-pract>

# Low Emission & Efficient Buildings and Equipment



**Project:** Commercial Building Analysis Tool for Energy-Efficient Retrofits

**Collaborators:** Tongji University, Shanghai Energy Conservation Supervision Center, Schneider-Electric, China, US-China Energy Cooperation Program (ECP)

- Support facility owners and decision makers in estimating energy saving and cost-effectiveness for commercial building retrofit
- Building prototypes: Shopping malls, hotels
- Consider 90+ energy conservation measures (ECMs)
- Calculate building before and after retrofit energy usage, retrofit energy saving, cost, and payback period
- Provide training to Chinese government entities, ESCOs and building owners
- The tool can be downloaded at <http://china.lbl.gov/tools-guidebooks/combat>





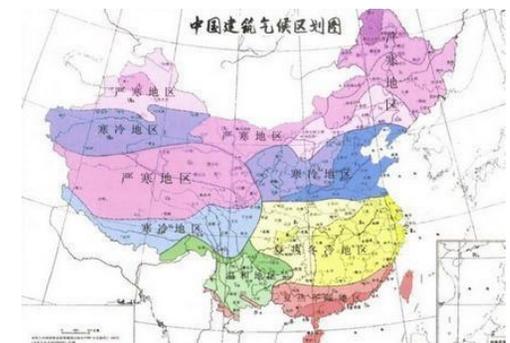
# Low Emission & Efficient Buildings and Equipment



**Project:** Technical Assistance to Development of a Guidebook on Estimating Building Energy Consumption and Projecting Energy-savings Potential for Local Governments in China

**Collaborator:** Chongqing University

- Evaluate key building energy efficiency policies including: heat reform, commercial (public) buildings energy monitoring platform, public building energy efficiency retrofit, renewable energy building integration, green building promotion, rural energy efficiency
- Provide technical assistance to China regarding international experience on building energy consumption statistics, estimating building energy use, and forecasting building energy demand as well as energy-savings potential at local level
- Help China develop a guidebook on forecasting building energy demand and projection of energy-saving potential for local governments

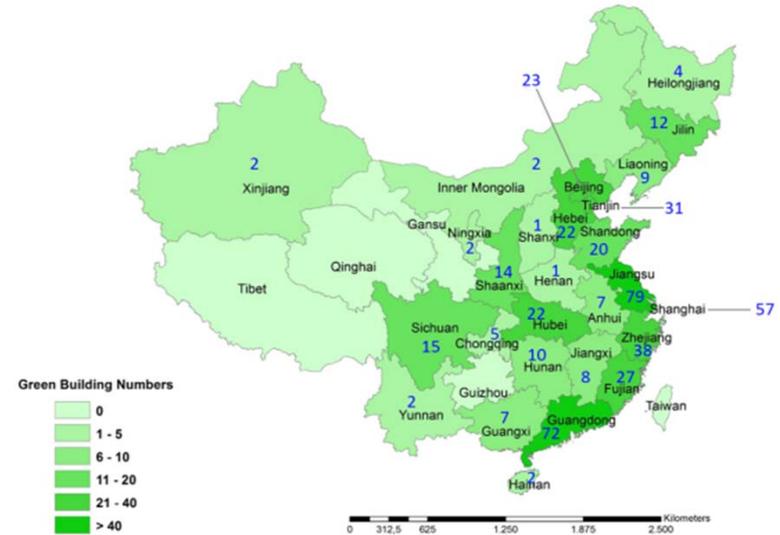


# Low Emission & Efficient Buildings and Equipment

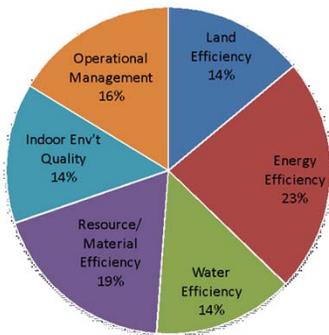
**Project: Green Building Policies, Standards, Technologies, Performance Evaluation and In-Depth Analysis**

**Collaborator: Shenzhen Institute of Building Research**

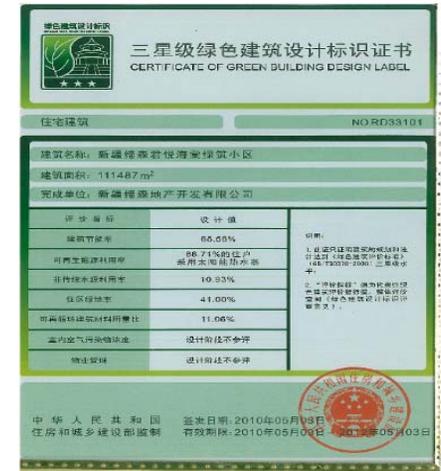
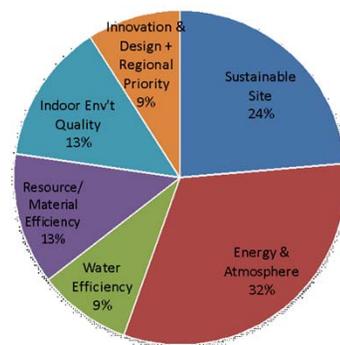
- Published “Comparative Policy Study for Green Buildings in U.S. and China” study on:
  - Green building labeling programs: administrative and programmatic differences
  - Green building policy promotion: how codes, targets, education, fiscal incentives differ between U.S. and China
- Upcoming in 2014: Contrast green building energy use, indoor environment quality, water usage performance, and assess key drivers for building performance difference in the two countries



**China's Three Star Green Building Rating Criteria and Weighting**



**LEED Rating Criteria and Weighting**

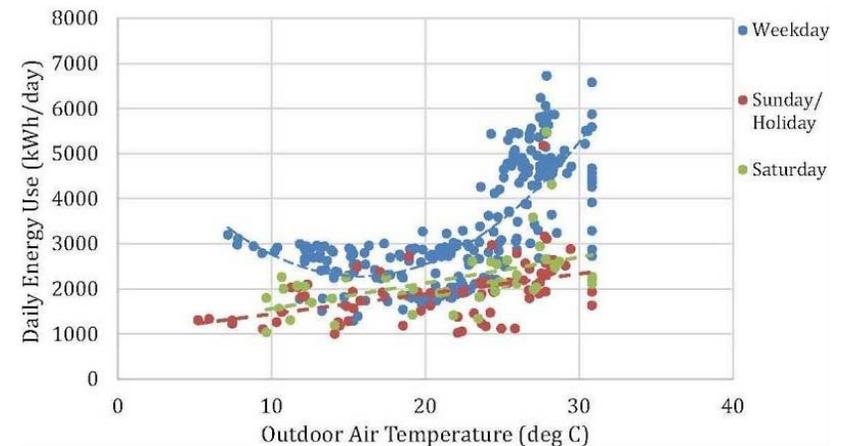
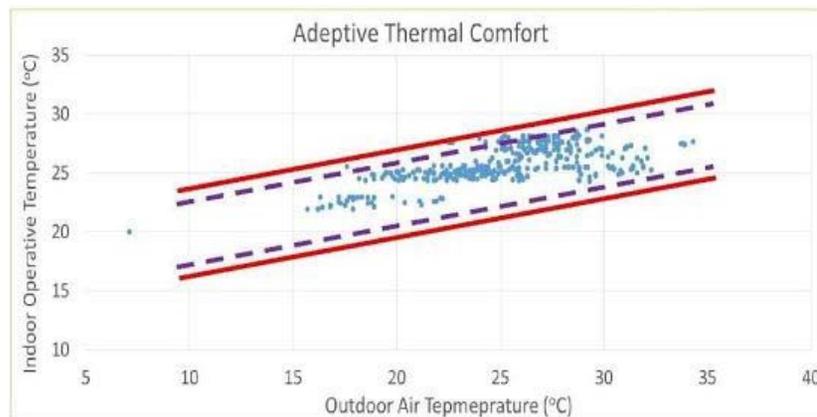


# Low Emission & Efficient Buildings and Equipment

**Project:** In-depth Analysis of a Green Building Design, Construction and Performance in China

**Collaborator:** Shenzhen Institute of Building Research

- Analyze the Shenzhen Institute of Building Research green building's design-building-operation methods
- In depth analysis of performance, including, energy, indoor environmental quality, water and so on
- Understand occupants satisfaction
- Learn how to apply the successful experience in other parts of China/world.



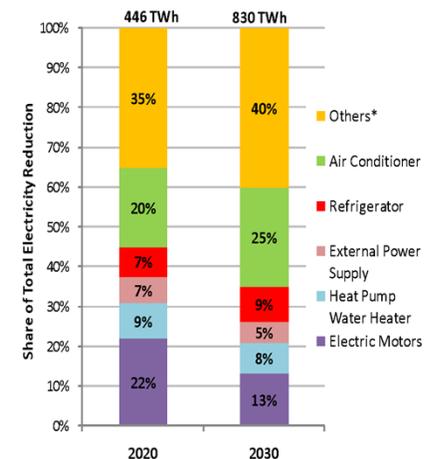
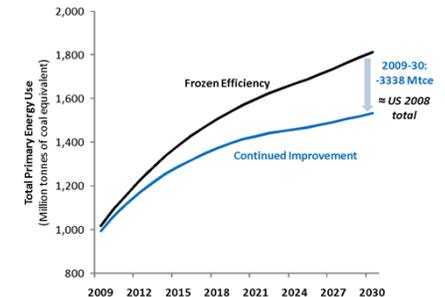
# Low Emission & Efficient Buildings and Equipment



**Project:** Potential Energy Saving and CO<sub>2</sub> Emission Reduction of Home Appliances and Commercial Equipment in China

**Collaborator:** China National Institute of Standardization (CNIS)

- LBNL study used 2 stock turnover analysis models (spreadsheet and LEAP) to evaluate the potential energy and CO<sub>2</sub> emission reductions from 31 product standards thru 2030
- Quantified the potential impact of China’s existing and planned appliance standards, emphasized the important role of China’s S&L
- Highlighted continual need for strengthening standards program since continued improvements with regularly scheduled revisions can achieve most of energy savings potential



**Publication:** Analysis of potential energy saving and CO<sub>2</sub> emission reduction of home appliances and commercial equipments in China  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-4607e-appliance-co2may-2011.pdf>



# Low Emission & Efficient Buildings and Equipment

## Project: Appliance Manufacturer and Retailer Award Programs

## Collaborator: China National Institute of Standardization

- Overview of government, manufacturer, and retailer influence on appliance purchases by consumers
- Awards programs
  - Japan manufacturers and retailers
  - U.S. : ENERGY STAR manufacturers and retailers
  - China: manufacturers
- International comparison of awards programs
- Recommendations for China retailer awards



**Publication:** International Comparison of Energy Efficiency Awards for Appliance Manufacturers and Retailers

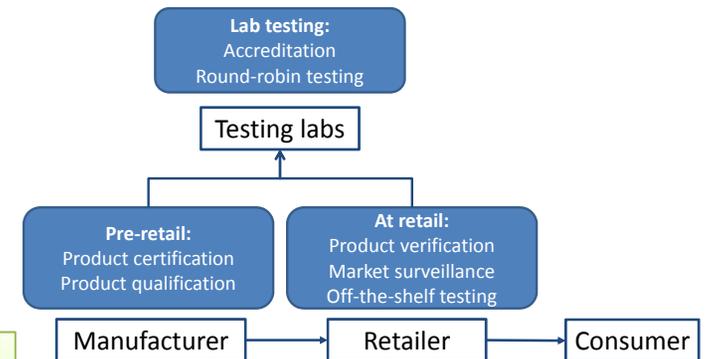
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5833e-appliance-awardsoct-2012.pdf> (English)  
<http://china.lbl.gov/sites/all/files/lbl-5833e-appliance-awardscn-oct-2012.pdf> (Chinese)

# Low Emission & Efficient Buildings and Equipment

## Project: Monitoring and Information Systems for Energy Efficiency Labeling Check-Testing Laboratories

### Collaborator: China National Institute of Standardization

- Motivations for enforcement of appliance S&L programs
- Overview of enforcement methods
- Overview of product certification and verification practices around the globe
  - U.S. ENERGY STAR and federal MEPS
  - U.S. voluntary programs
  - China
- Comparison of international practices
- Recommendations for China in third party product certification and verification



**Publication:** International Comparison of Product Certification and Verification Methods for Appliances  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5629e-appliance-certificationjune-2012.pdf>

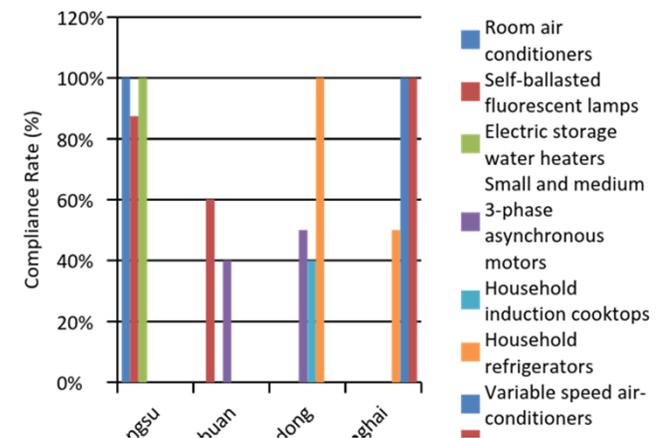
# Low Emission & Efficient Buildings and Equipment



**Project:** Status of Local Enforcement of Energy Efficiency Standards & Labeling Programs in China

**Collaborator:** China National Institute of Standardization

- LBNL assessed the continuation of the CNIS pilot check-testing program for appliance energy efficiency standards and China Energy Label in 2009
- Improvements illustrated in high labeling compliance across regions but low compliance (40-60%) with both labeling and standards compliance in Sichuan
- Wider range in standards compliance rates for same products (50-100% for refrigerators, with lowered average rate of 63% compared to 96% in 2007).
- Areas of necessary improvement identified: greater local awareness (especially manufacturers), product sampling methodologies, greater standardization of testing.
- Paper on study presented for 2012 International Energy Program Evaluation Conference



2009 Energy Efficiency Pilot Testing Compliance by Product and Region

**Publication:** Status of the Local Enforcement of Energy Efficiency Standards and Labeling Program in China  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5289e-local-esl-enforcementnov-2011.pdf>

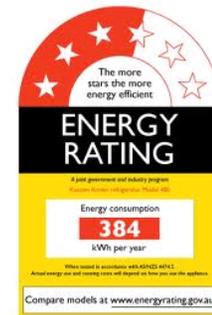
# Low Emission & Efficient Buildings and Equipment



## **Project:** International Review of Standards & Labeling Programs - Implications and Gap Analysis for China S&L in 12<sup>th</sup> FYP Period

### **Collaborator:** China National Institute of Standardization

- LBNL conducted in-depth comparative review and analysis of S&L program development and implementation in the U.S., EU, Australia and Japan to identify lessons learned
- Programmatic elements reviewed include: legal framework, standard-setting and revision technical and regulatory process (tools, data availability), program enforcement, program resources
- No single country has best practices in all elements, but national examples for specific elements exist → can serve as basis for gap analysis with China's programs
- Study unique in focusing on *how* best practices can be achieved, not only what the best practices are
- Identified and illustrated not only drivers of different paths of S&L development but also country-specific context for examples for best practices (e.g., level of decentralization, industry and regulatory structure)
- Presented initial findings at 2nd Annual Asian Energy Efficiency Standards & Labeling Forum hosted by the CNIS



| Energy efficiency standard achievement percentage | Annual Electricity Consumption |
|---|--------------------------------|
| 108%  | 175kW h/年                      |
| 91%   | 206kW h/年                      |

**Publication:** International Comparative Analysis of Appliance Efficiency Standards & Labeling Programs: Implications for China  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-5742e-appliance-standard-comparisonjune-2012.pdf>

# Low Emission & Efficient Buildings and Equipment



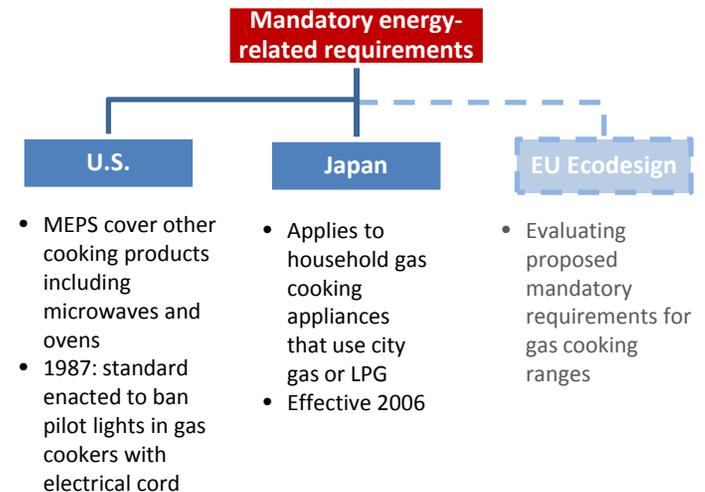
## Project: Technical Assistance on Appliance Efficiency Standards Development

### Collaborator: China National Institute of Standardization

- LBNL provided the CNIS with international review and comparison of S&L programs for products for which the CNIS will be developing new or revised MEPS
- For each product, comprehensive review and analysis of major existing S&L programs by:
  - Product scope and categorization
  - Energy efficiency values and related requirements (e.g., power management)
  - Key details of test procedures and extent of harmonization
- Identified and assessed emerging trends and issues and major barriers in international MEPS development experiences
- Provided estimated energy savings potential for China if international efficiency levels are adopted

- 2011 Products: external power supply, flat-screen TV, residential gas cooktop, copy machines, LED displays
- 2012 Products: computer monitors, commercial gas stove

### Comparison of Energy Requirements for Residential Gas Cooktops



**Publication:** Comparison of Test Procedures and Energy Efficiency Criteria in Selected International Standards & Labeling Programs for Copy Machines, External Power Supplies, LED Displays, Residential Gas Cooktops and Televisions

**URL:** <http://china.lbl.gov/sites/all/files/lbl-5574e-appliance-ee-comparisonjune-2012.pdf>

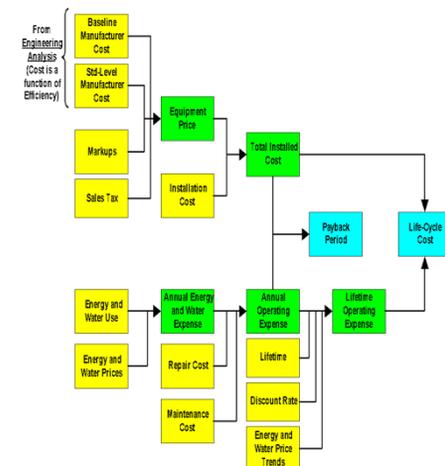
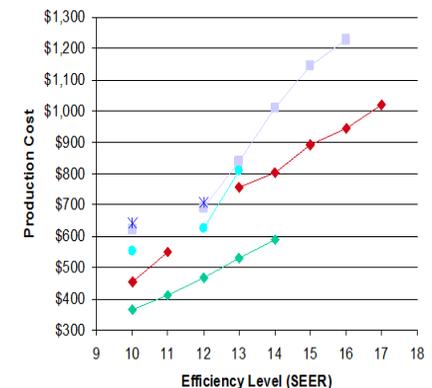
# Low Emission & Efficient Buildings and Equipment



## Project: Frameworks for Standards Setting and Labeling Development

### Collaborator: China National Institute of Standardization

- LBNL conducted an in-depth review of the existing framework for standards and labeling development used in the U.S., Australia and the EU
- Supporting analyses include:
  - Market assessment
  - Technology assessment and screening analysis
  - Engineering analysis
  - Life-cycle cost and payback analysis
  - Shipment analysis
  - National impacts analysis
  - Manufacturer impact analysis
  - Environmental assessment



**Publication:** International Review of Frameworks for Standard Setting & Labeling Development  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-6030e-sl-development-frameworkseptember2012.pdf> (English)  
<http://china.lbl.gov/sites/all/files/sl-development-framework-cn-final.pdf> (Chinese)

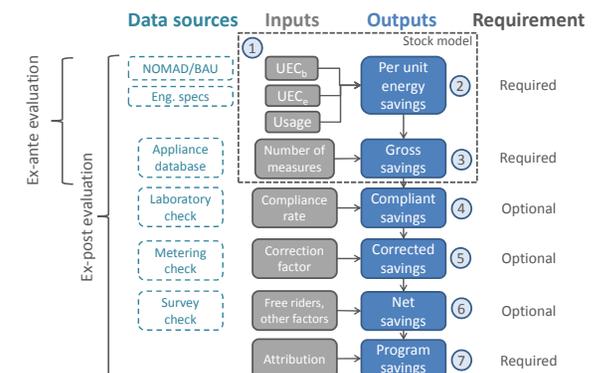
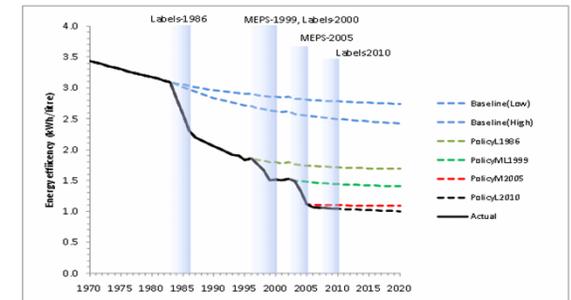
# Low Emission & Efficient Buildings and Equipment



**Project:** Frameworks for Standards, Labeling and Incentive Program Evaluation

**Collaborator:** China National Institute of Standardization

- In-depth review (over 60 studies cited) of the existing framework for standards, labeling, and incentive program evaluation used in the U.S., California, Australia, and EU
- General methodology:
  - Setting the baseline
  - Calculating per unit energy savings
  - Calculating gross savings
  - Correcting for non-compliant products
  - Correcting for performance variance
  - Additional baseline adjustments to arrive at net savings
  - Attributing savings to various programs
- Specific evaluation methodologies (ex-ante, ex-post) and examples are offered for standards, labeling, and incentives



**Publication:** International Review of Frameworks for Impact Evaluation of Appliance Standards, Labeling, and Incentives  
**URL:** <http://china.lbl.gov/sites/all/files/lbl-6003e-sli-evaluation-dec-2012.pdf>

# Low Emission & Efficient Buildings and Equipment



**Project:** Continued Framework Development for S&L Program Development and Evaluation with Data Availability Assessment (2012-2013)

**Collaborator:** China National Institute of Standardization

- Based on review of international methods in program evaluation and standards development, LBNL is developing (in conjunction with CLASP and CNIS )appropriate options for China to undertake:
  - Techno-economic analysis
  - Ex-post and ex-ante evaluation of standards
  - Ex post evaluation of labeling
  - Ex-post evaluation of incentives
- Key data requirements and data gathering methodology (survey, deemed savings values, metered test data, laboratory test data, etc.) need to be identified
- Paper presented at 7<sup>th</sup> International Conference on Energy Efficiency in Domestic Appliances and Lighting conference

**Publication:** Data Availability in Appliance Standards and Labeling Program Development and Evaluation

**URL:** [http://china.lbl.gov/sites/all/files/6282e\\_sl\\_data\\_needs.2013.pdf](http://china.lbl.gov/sites/all/files/6282e_sl_data_needs.2013.pdf)

|   | Primary data sources                        |                      |                      |                             |                  | Secondary data sources       |  |                          |    |
|---|---|----------------------|----------------------|-----------------------------|------------------|------------------------------|--|--------------------------|----|
|   | Direct measurement (metering)               | Laboratory test data | Manufacturer surveys | Program participant surveys | Retailer surveys | Energy/evaluation literature | Deemed values (technical resource manuals) | Simulations and modeling | .. |
| <b>Standards development only</b>                   | Electricity prices                          |                      |                      |                             |                  | X                            |  |                          |    |
|   | Product/component prices                    |                      |                      | X                           |                  |                              |  | X                        |    |
|   | Retail prices & mark-up                     |                      |                      |                             | X                | X                            |  |                          |    |
|   | Discount rates                              |                      |                      |                             |                  | X                            |  |                          |    |
| <b>Standards development and program evaluation</b> | Technology options, product classes         |                      | X                    |                             |                  |                              |  |                          |    |
|   | Usage                                       | X                    |                      |                             |                  | X                            |  |                          |    |
|   | UEC   | X                    | X                    | X                           |                  | X                            | X  |                          |    |
|   | Existing stock, saturation                  |                      |                      |                             |                  | X                            |  | X                        |    |
|   | Lifetime                                    | X                    |                      | X                           | X                | X                            |  |                          |    |
|   | Sales/shipments (real or forecasts)         |                      |                      | X                           |                  |                              |  |                          |    |
| <b>Program evaluation only</b>                      | Site-to-source energy conversion factors    |                      |                      |                             |                  | X                            |  |                          |    |
|   | Emission factors                            |                      |                      |                             |                  | X                            |  |                          |    |
|   | Free ridership                              |                      |                      |                             | X                | X                            | X  |                          |    |
|   | Compliance rate                             |                      | X                    |                             |                  |                              |  |                          |    |
|   | Number of participants and non-participants |                      |                      |                             | X                | X                            |  |                          |    |
|   | Participant spillover                       |                      |                      |                             | X                | X                            |  |                          |    |
|   | Market effects                              |                      |                      |                             | X                | X                            |  |                          |    |
| Heating and cooling degree days                     |   |                      |                      |                             |                  | X                            |  |                          |    |