Compiled Presentations from Track 1, Breakout Session 2/Afternoon

High Performance Buildings
Collaboration on Building Code and Labeling System

Wei Feng
China Energy Group
Lawrence Berkeley National Laboratory

September 25, 2013
Building Energy Efficiency Code and Labeling System

Concept
• Assist China develop commercial and residential building codes
• Disseminate building simulation tools (e.g. DOE-2) to China for building code development
• Help China to develop a window rating and labeling program

Opportunity
• Evaluate energy savings of China’s new commercial building code (GB50189-2013, 65% savings based on the 1980’s baseline)
• Bring tools developed in the U.S. to China’s building code development

Successes
• Assisted drafting the first national building energy standard (GB50189-2005) development
• Participated in the development of residential energy standards for the Hot Summer Cold Winter region (JGJ134-2001)
• Help China setup a pilot window rating and labeling program, drawn from U.S NFRC. Pilot location was in Guangzhou province.
• Provided training of DOE-2 and other building simulation software

Collaborators:
• China Academy of Building Research (CABR), Guangdong Institute of Building Research
Buildings: Training in Developing New Building Codes

公共建筑节能标准

上海市商业建筑标准

夏热冬暖

新住宅建筑标准

新住宅建筑标准

严寒

夏热冬冷

公共建筑节能标准
Building Energy Efficiency Collaboration with China

• US-China Agenda 21 energy efficient demonstration office building in Beijing; 中美21世纪节能示范办公楼 (美国能源部中国科技部合作项目，1998年始，2003年底完成)

• Establishment of energy efficiency design standard for residential buildings in the HotSummer Cold-Winter Region in Central China (promulgated Oct. 2001); 协助制定夏热冬冷地区住宅节能设计标准 (2001年10月颁布)

• Establishment of energy efficiency design standard for residential buildings in the HotSummer Warm-Winter Region in South China (promulgated Oct. 2003); 协助制定夏热冬暖地区住宅节能设计标准 (2003年10月颁布)

• Development of national energy efficiency design standard for public buildings (expected completion end 2004); 协助制定国家公共建筑节能设计标准 (2004年底完成)


Building codes in China:

- National level: one commercial building code (GB50189), and three residential building code (JGJ 26, 134, 75) – defined on climate zone basis
- Local level: provinces can have their own building code, some provincial level codes are stringent than national level code (e.g. Tianjin, Shanghai, Jiangsu..)

Commercial building code -- GB50189:

- China’s commercial building code
  - equivalent to ASHRAE 90.1
- First released in 1993
  - with initial focus on hotel
- Last update in 2005
- New code will be release at the end of 2013

Source: Wu 2003
Commercial building code -- GB50189:

- Use 1980’s commercial building characteristics as baseline (100%)
- Last update in 2005 achieved 50% energy savings from 1980’s baseline
- New update in 2013 aims to achieve 65% energy savings \(\rightarrow\) To be validated!

Importance of commercial building code

- Commercial building floor space increases from 2.8 billion m\(^2\) (1996) to 7.1 billion m\(^2\) (2008). Approximately, 0.5 billion m\(^2\) new construction was built per year.
- Per capital, increases from 7.4 m\(^2\)/person (1996) to 11.5 m\(^2\)/person (2008)
- Will continue to increase in next 20~30 years because of fast urbanization
Reference Buildings – Models to Support Building Codes

**Office Buildings**

- Small Office
  - 1 floor, 5,500 ft²

- Medium Office
  - 3 floor, 53,630 ft²

- Large Office
  - 12 floors, 498,588 ft²

**Lodging**

- Small hotel
  - 4 floors, 43,200 ft²

- Large hotel
  - 6 floors, 122,120 ft²

**Schools**

- Primary School
  - 1 floor, 73,960 ft²

- Secondary School
  - 2 floors, 210,890 ft²

**Healthcare**

- Outpatient Healthcare
  - 3 floors, 40,946 ft²

- Hospital
  - 5 floors, 241,351 ft²

16 X 16 X 3 = 768 models!
Reference Buildings – Models to Support Building Codes

• A Chinese shopping mall reference prototype developed by LBNL and its Chinese partners

• LBNL is working with CABR to identify key parameters to conduct reference building survey and modeling.
Thank You!

Questions?
Building Energy Codes Development and Enforcement: Progress and Comparative Lessons

Sha Yu and Meredydd Evans

Pacific Northwest National Laboratory

Fourth U.S.-China Energy Efficiency Forum
September 25, 2013
Overview

► Building energy use and codes impacts
► Building codes development and enforcement
  ▼ Rural energy code in China
  ▼ Enforcement system in China and the U.S.
► Lessons learned
► Market opportunities
Buildings in the U.S. and in China will experience increasing share of electricity during the 21st century.

Per capita energy demand continuing to increase in China over the century, while per capita energy demand in the U.S. steadily decreasing.

Overall development of fuel mix in the buildings sectors between the two countries will continue to be very different.

Impacts of building codes and climate policy in China

- Energy codes could significantly reduce building energy use.
- Economy-wide carbon policy has a limited effect on building energy demand and direct CO$_2$ emissions.
- High compliance is essential for any noticeable impact.

China began to adopt building energy codes in the 1980s.
Now there is one code for commercial buildings.
Three other codes cover large residential buildings in different climate zones: severe cold/cold, hot summer-cold winter and hot summer-warm winter.
Energy code for rural buildings went into effective in May 2013.
Energy Code for Rural Buildings

- Despite fast urbanization, rural buildings still account for a big share of total building stock in the near term (40% today and around 25% at 2030).
- Rural buildings demand more energy than urban buildings at least in the near term.
- Designs and energy uses in urban and rural buildings are different.
Contents of the Rural Energy Code

- Architectural layout and energy efficiency design
- Building envelope insulation
- Heating and ventilation system
- Lighting
- Renewable energy use
  - Solar, biomass, geothermal, etc.
Rural Building Energy Codes: Key Considerations

- Understanding building trends, stakeholders
- Making enforceable codes
  - Who will enforce?
  - How will buildings learn of and interpret requirements?
  - How can we build capacity and make this easy?
- Challenges of small buildings
  - Variety of buildings
  - Limited capacity
  - Wide variety of construction materials
Key code enforcement steps in Chinese building construction
Construction site inspection roles

**Construction Company**
- Quality control system

**Construction Supervision Company**
- Checks work onsite; orders tests; prepares documentation on compliance

**Testing Labs**
- Tests components from construction site

**Quality Control and Testing Station**
- Collects and reviews documentation; conducts periodic site inspections; prepares completion report

**Developer**
- Takes completion report to Construction Administration Dept.

**Construction Administration Dept.**
- Accepts and files documents; issues occupancy permit
Lessons Learned

For China

- Enforcement in smaller towns and rural areas.
- Testing and ratings.
- Easier access to training and more user-friendly information.
- Increasingly rigorous codes.

For the U.S.

- The extensive use of third parties in code compliance.
- The “industrialization” of the construction and code compliance processes.
- An example of integrating design and code compliance software.
Market Opportunities

- Codes help build demand for a range of building energy efficiency products like insulation, efficient windows and lighting.
- New post-occupancy and ‘stretch’ code requirements are also building the market for services like building commissioning, energy audits, and performance contracting.
- Because of their large impact on market deployment, codes can also make it easier for companies to obtain value from innovation and R&D.
Advanced Building Decision Tools Collaboration

Wei Feng

劳伦斯伯克利国家实验室

2013年9月
Advanced Building Decision Tools Collaboration

- COMBAT: Commercial Building Analysis Tool for Energy Efficiency Retrofit
- DER-CAM: Distributed Energy Resource Customer Adoption Model
Commercial Building Analysis Tool for Energy-Efficient Retrofits (COMBAT)

**Purpose:** Analyze commercial building retrofit energy savings and investment cost-effectiveness

**Related Tools:** EnergyPlus

**Audience:** Retrofit practitioners, policy makers, facility managers, and engineers (w/o building energy modeling knowledge)

**Developer(s):** China Energy Group at LBNL


**Limitations:** Only applies to China’s hot summer cold winter climate zone with hotel and shopping mall building types

**Impacts summary:** Trained 50+ people in Shanghai in 2012 including key policy makers. Retrofit of shopping mall or hotel can yield 20%~30% energy savings in Shanghai.

**Potential:** More building types and climate zones could be added to the tool. Work with universities (such as Tongji University) to develop and disseminate it.
Commercial Buildings Retrofit and COMBAT

Background:
- Commercial (public) buildings retrofit is targeted to save 14 Mtce in China’s 12th FYP.
- Central and local governments create large incentive programs for commercial building retrofit.
- In Shanghai’s Changning district, over 100 buildings need retrofit in the 12th FYP.
- No tool existed for quick assessment of energy savings and investment cost-effective as the results of retrofit.

Current impacts:
- COMBAT is developed with collaboration from Tongji University and NRDC Beijing office. The tool has been used for analysis in a few retrofit projects in Shanghai. A training workshop was held in Shanghai in 2012 to train Chinese local government officials, U.S. companies, and Chinese ESCOs on the use of the tool for their retrofit analysis.
- Provide training and work with ECP-China, U.S. companies (e.g. Trane, Autodesk, Schneider Electric) and Chinese ESCOs.
- Selected collaborators: Tongji University, NRDC Beijing office, Shanghai Energy Conservation and Supervision Center.
- Selected project using COMBAT: 4 shopping malls and 2 hotels have used COMBAT and compared its calculation results with measured results. More buildings are using the tool in Shanghai’s Changning district.
• 4 shopping malls and 1 hotel
• Calculated savings in line with measured data

<table>
<thead>
<tr>
<th>Building</th>
<th>Energy Consumption Before Retrofit (MegaWatt hours/Year)</th>
<th>Energy Savings (MegaWatt hours/Year)</th>
<th>Energy Saving Rates</th>
<th>Economic Benefits (RMB/Year)</th>
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<thead>
<tr>
<th>Building</th>
<th>Calculated Energy Savings (MegaWatt hours/Year)</th>
<th>Actual Energy Savings (MegaWatt hours/Year)</th>
<th>Relative Error</th>
<th>Absolute Error</th>
<th>Economic Benefits (RMB/Year)</th>
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</table>
COMBAT Demonstration: Inputs

- Building characteristics inputs
- Retrofit measure inputs
- Default cost-effective analysis
COMBAT Demonstration: Outputs

- Energy savings analysis
- Payback analysis
- Individual measure’s cost-effective analysis
Purpose: produces optimal investment decisions and dispatch for technologies as fuel cells, PV, solar thermal, electric / heat storage, heat pumps, EVs, etc.; it minimizes annual energy costs, CO$_2$ emissions, or multiple objectives of providing services to buildings (~100-2000 kW peak)

Related Tools: none

Users: more than 350 DER-CAM web-clients to date for the simple investment version (multiple versions with different copyrights are available at http://der.lbl.gov/der-cam/how-access-der-cam, stochastic versions for EVS and other technologies as PV exist or are currently under design)

Developer(s): developed for 12 years by LBNL, collaboration with China and other countries

Availability: simplified investment web version via https://microgrids2.lbl.gov/ (WebOpt); English and Chinese, SI units. Funded by US DOE, CEC

Limitations: not all features are provided in the simplified web version, in general more work is needed on passive measures

Impacts summary: 40 online accounts from China, 73 online accounts from U.S.; University and teaching, building managers and operators, cost reductions up to 30% and CO$_2$ reductions up to 100% (in ZNEB mode) due to well guided decisions (see next page)

Potential: Expand functionality to be able to develop a district energy system optimization toolkit for China’s low carbon district/city energy system analysis; cheap and simple real time building management service over the web (multiple requests from national and international companies)
Background:

• China’s 12th FYP highlights CHP and other distributed energy as one of its important energy goals
• 1000 distributed natural gas generation in the 12th FYP (each less than 5MW)
• NEA’s 12th FYP states that 30 national-level microgrid demonstration projects will be built by the end of 2015
• China State Grid’s new policy on distributed energy grid connection (less than 6MW)

Current impacts:

• LBNL is working with the Chinese Academy of Science (CAS) – Institute of Electrical Engineering (IEE), and NEA on the development criteria and evaluation methods for 12th FYP’s 30 national-level microgrid demonstration projects by using the DER-CAM tool developed by LBNL.
• Work with ECP-China and U.S. DER companies (e.g. DOW, ICF, Capstone, Honeywell) on China projects.
• Selected collaborators: Tianjin University, Tongji University, Shanghai Energy Conservation and Supervision Center, Shenzhen Microgrid Lab, Shenzhen Institute of Building Research, CAS-IEE, Xiamen University, Hefei University
• Selected DER and microgrid projects LBNL is working on using DER-CAM: Shanghai Changning Central hospital, DongAo Island (Zhuhai, Guangdong), Tianjin University Microgrid Lab (MOST’s 973 project), Shenzhen Microgrid Lab, Shanghai Chongming Island microgrid project
DER-CAM: Active User Accounts Around the World

Active user account statistics

Legend:
- SVOW
- WebOpt

Number of user account

US Spain Ireland Germany Switzerland Croatia Bulgaria Chile Poland China India Iran S. Korea Sweden n/a
Sankey diagram shows how distributed energy is transport, converted and balanced.
DER-CAM Demonstration: Inputs

**Inputs:**
- Building end-use load data
- Electricity & gas tariff data
- DER technology data
- Site weather data

**Objectives:**
- Minimize total cost
- Minimize CO\textsubscript{2} emissions

**Outputs:**
- Optimal DER capacities
- Optimal DER operations schedule

- **Investment & Planning:** determines optimal equipment combination and operation based on *historic* load data, weather, and tariffs
- **Operations:** determines optimal week-ahead scheduling for installed equipment and *forecasted* loads, weather and tariffs
## DER-CAM Demonstration: Outputs

### Distributed Energy Resources (DER) Web Optimization Service (WebOpt)

<table>
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<tr>
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<th>建筑物能耗负荷</th>
<th>公共事业耗能费用</th>
<th>能源技术</th>
<th>需求响应</th>
<th>大幅辐射</th>
<th>大电网二氧化碳的边际排放因子</th>
<th>结果</th>
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<td>Electric storage</td>
<td>Demand response</td>
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<td>Heat storage</td>
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<td>Absorption chiller</td>
<td>Ground source HP</td>
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<tr>
<td>Absorption refrigeration</td>
<td>Existing electric chiller</td>
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<tr>
<td>什么都不做（无分布式能源设备）, 建筑耗能不全由公共事业电供应，采用天然气锅炉和电冷热水机</td>
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</table>

- 在初期文件中显示投资回收期
- 显示高成本输入结果

### 注意事项

选择更改：请注意，在加载配置文件时，会加载数据、文件等信息，可能与当前保存的配置文件不同的原始信息。如果该配置文件保存不久，选择更改可能会与当前的WebOpt系统有显著不同。若要更新，需要完成更新步骤，但此步骤的更新不会体现在保存好的配置文件中。

### 七月份工作日

- 初始电消耗总量
- 吸收式制冷
- 电池充电
- 光伏发电
- 电力公司供电
- 电池发电量
- electricity from DG

### 小时

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### U.S. Department of Energy

Berkeley Lab
VisualEPlus 2.0 Introduction

Purpose: a GUI in Chinese and English for the EnergyPlus program, focusing on graphical modeling of HVAC system, and analysis of output results.

Related Tools: no other similar GUI in Chinese; intended to be used in conjunction with Open Studio for building modeling.

Users: building energy practitioners, academia, and students interested in building energy simulation with EnergyPlus, particularly in China.

Developer(s): Tongji University (lead) and Shandong University in collaboration with White Box Technologies, Inc. and ORNL.


Limitations: Simulation GUIs are very complicated software; to limit effort and meet greatest need, VisualEPlus 2.0 concentrates on two areas only – HVAC modeling and report analysis; program is still “buggy” with many areas for improvement.


Potential: VisualEPlus makes EnergyPlus acceptable to the Chinese building energy modeling community, which can then play an important role in building energy efficiency design, standards development, and R&D in China, just as EnergyPlus does in the US.
VisualEPlus2.0 Demonstration: Inputs

Main Interface of English Version

Building model needs to be generated by other programs (i.e., Open Studio) & loaded into VisualEPlus 2.0

Chinese Version

Drop-down Menu for Operation Procedures
**VisualEPlus2.0 Demonstration: HVAC Modeling GUI**

- “Drag-and-drop” style graphical modeling for HVAC systems
- 109 HVAC components in 28 categories
- 11 HVAC templates

**Chinese Interface**

**User Menu**

**English Menu**
VisualEPlus2.0 Demonstration: Output

Visualize simulation result in both standard and customized reports for user selected variables, during user selected time periods, and at various time intervals.
Thank You!
Questions?