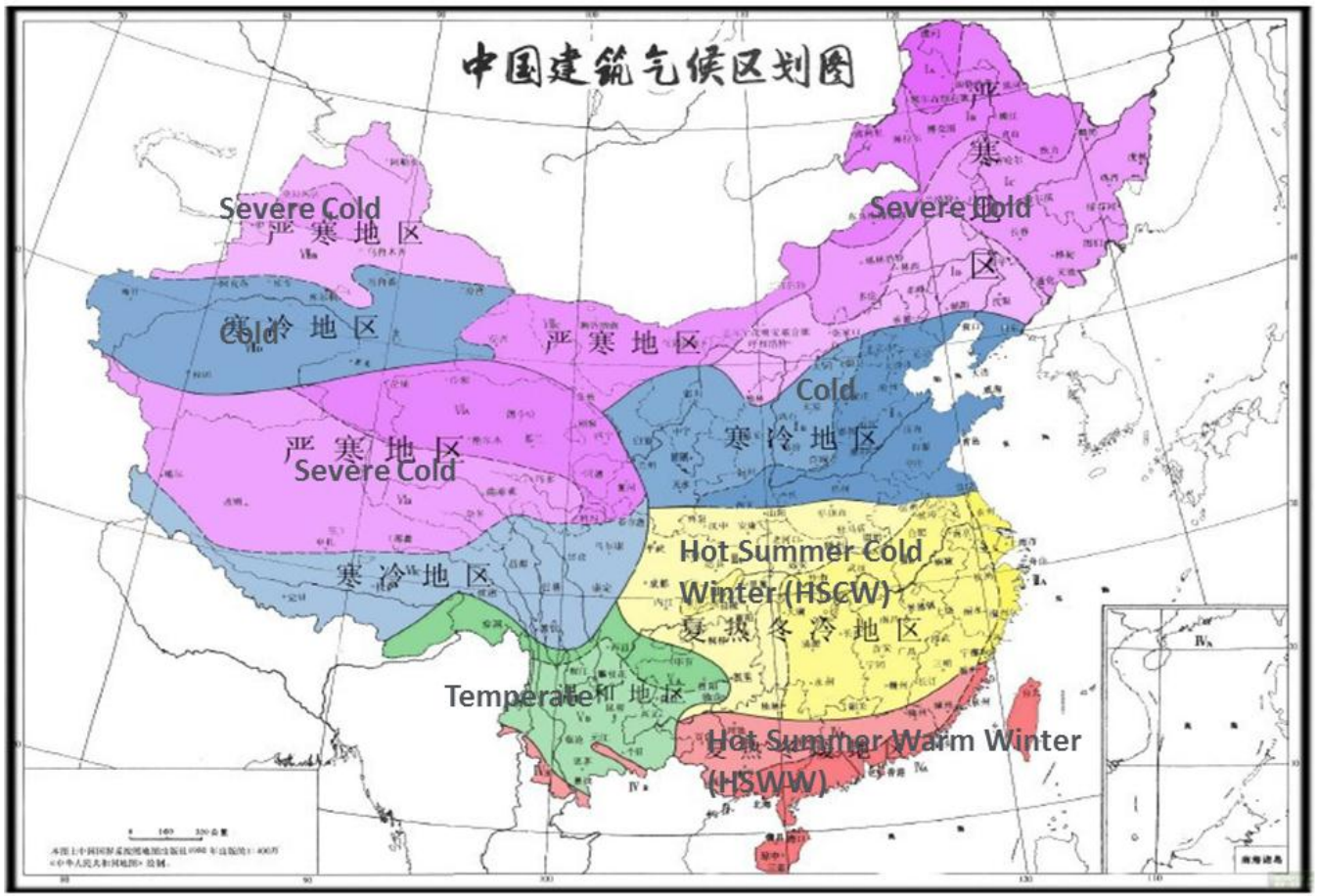
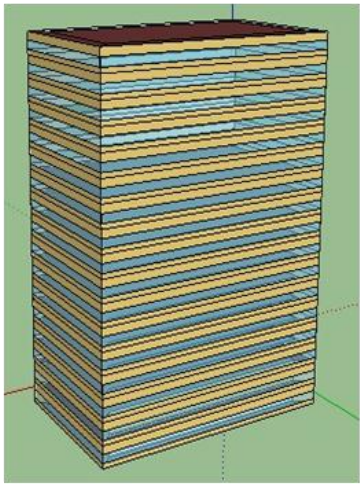
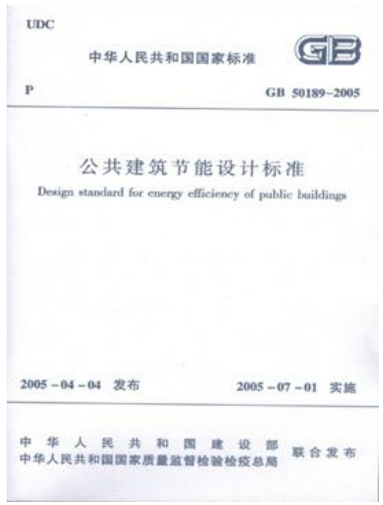
Commercial building energy efficiency standards & performance evaluation

2015 Building Technologies Office Peer Review






UDC
中华人民共和国国家标准
GB
P
GB 50189-2005
公共建筑节能设计标准
Design standard for energy efficiency of public buildings
2005-04-04 发布
2005-07-01 实施
中华人民共和国建设部
中华人民共和国国家质量监督检验检疫总局
联合发布

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Project Summary

Timeline:

Start date: Feb, 2014

Planned end date: Dec, 2015

Key Milestones

1. Chinese reference office building model; 05/31/2014
2. Performance analysis and comparison with ASHRAE 90.1 08/31/2014
3. Cost-benefit analysis 12/31/2014

Budget:

Total DOE $ to date: $130K (2014)

Total future DOE $: $160k (2015)

Target Market/Audience:

Companies/manufactures, building owners, design institutes working on building codes and standards

Key Partners: (list key partners)

China Academy of Building Research (CABR)
CSTC-MOHURD, China
Dow, 3M, Land Lease, SOM

Project Goal:

- Evaluate the energy and cost-benefit performance of the Chinese new commercial building standard.
- Influence future standard development and provide more stringent standard for the future

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Purpose and Objectives

Problem Statement: Compare the gaps and experience between ASHRAE 90.1 and Chinese GB50189, and understand the current performance and future roadmap of the Chinese commercial building standard.

Target Market and Audience:

- Building owners, government agencies, U.S. companies working in both US and Chinese market
- Energy savings of the commercial building standard in China:
  - 249 mtce energy savings from 2010 to 2030 (~12.5 mtce/year)
  - 1.1 billion tons CO2 to from 2010 to 2030 (~55 million tons/year)

Impact of Project:

1. Final deliverables:
- standard performance analysis
- Chinese reference building models

2. Impact analysis:
- Short-term: current standard performance analysis
- Mid-term: establish methodologies for standard performance analysis and necessary models
- Long-term: influence future standard upgrade and pushing more stringent standards

3. Work with industrials:
- Help US industries understand their design/technologies saving potentials in Chinese market
- Promote more efficient technologies in China, bring to scale, and reduce technologies cost in the long run.

Approach

Approach:

- Surveying building characteristics and cost data in China
- A Chinese prototypical office reference buildings based on the surveyed data, model the reference buildings in E+
- Analysis on energy savings of China's office building meeting the proposed new energy standards, compared with the previous 2005 energy standard and ASHRAE 90.1. Conduct the cost effectiveness analysis of the new commercial building energy standards.

Key Issues:

- Lack of data in developing Chinese reference buildings → Chinese partners surveyed design drawings to get building characteristics
- Lack of cost database → work with US and Chinese industrial to collect cost data
- Government targets vs long-term energy targets → develop a quantitative roadmap for the standard future upgrade

Distinctive Characteristics:

- First time to do quantitative analysis for the Chinese standards
- Energy models meet Chinese building characteristics, comfort and operation conditions

Progress and Accomplishments

Lessons Learned: Lack of data on building characteristics and cost; China side has very little funding on standards development

Accomplishments:

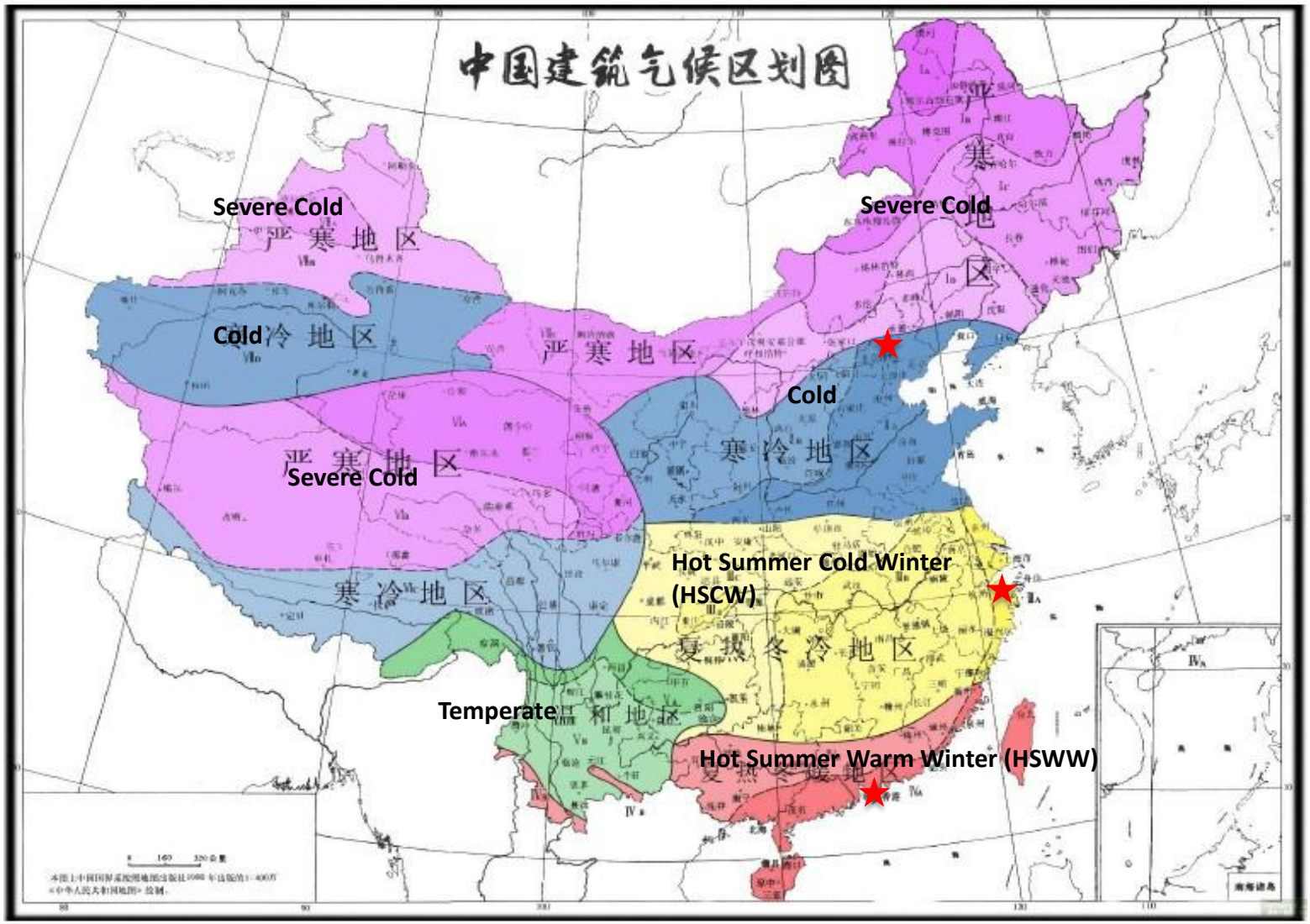
- Chinese office reference building models (06/2014)
- Energy performance analysis in comparison with ASHRAE 90.1 (08/2014)
- Cost-benefit performance of the Chinese standard (12/2014)

Market Impact:

1. New standard is proved to be 26% more efficient than its previous version in 2005 (lower than original 30% target set by MOHURD)
2. Calculated relative shorter payback periods in China
3. Huge impact: ~500M m2 new construction added every year in China
4. Big potentials to push more stringent standards in the future based on the comparison with ASHRAE90.1
5. Accelerate more efficient technologies penetration in China, and bring down technologies cost, and in turn benefit US market

Awards/Recognition: n/a

Chinese Climate Zones



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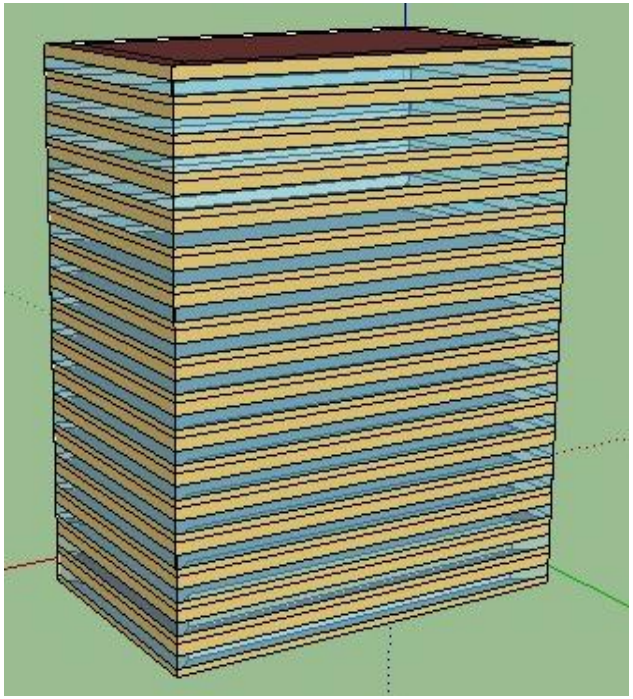
Accomplishment: Chinese reference buildings



Chinese large office reference building

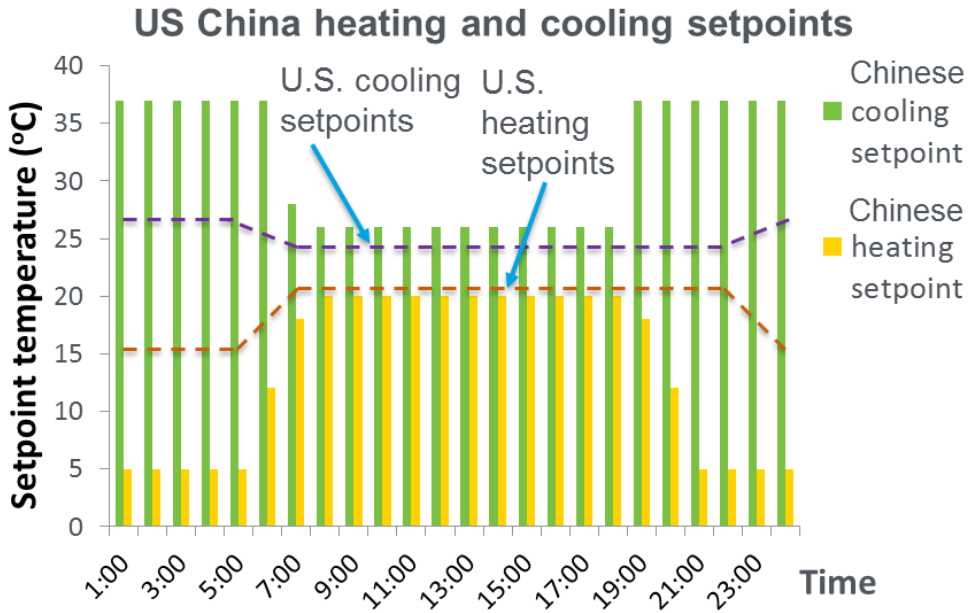
	GB50189-2005	GB50189-2014
Shape	50m * 30m	
Floors	18 floors	
WWR	0.4	
HVAC system	VAV with reheat; terminal hot water radiator (only in cold and severe cold climates)	
Lighting power density	11 W/m^2	9 W/m^2
Plug load power density	20 W/m^2	15 W/m^2
Occupancy density	8 m^3/person	
Chiller COP	4.7	5.2
Boiler efficiency	0.89	0.89
Air tightness	7.5 m^3/(m^2 hr)	3 m^3/(m^2 hr)
OA rate	30 m^3/(hr person)	
Pumps	variable speed	

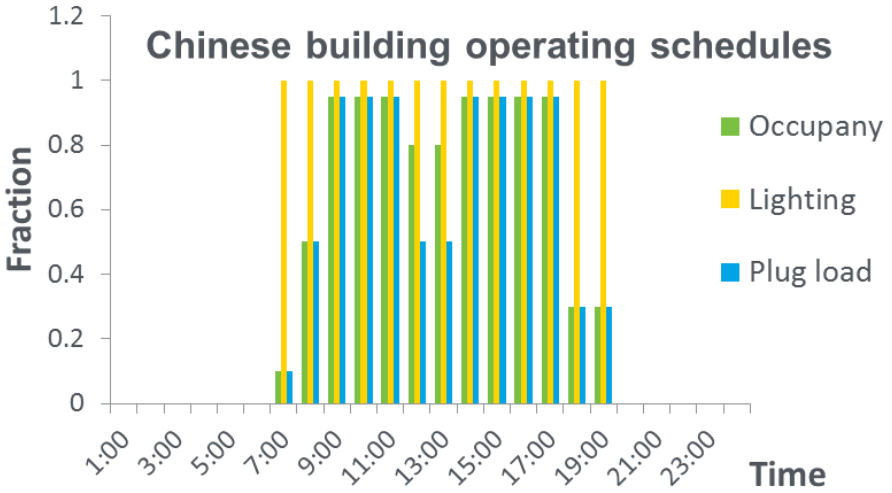
- CABR collect new construction design specs from design institutes
- Reference building parameters determined by the average surveyed data

7

Accomplishment: Chinese reference buildings

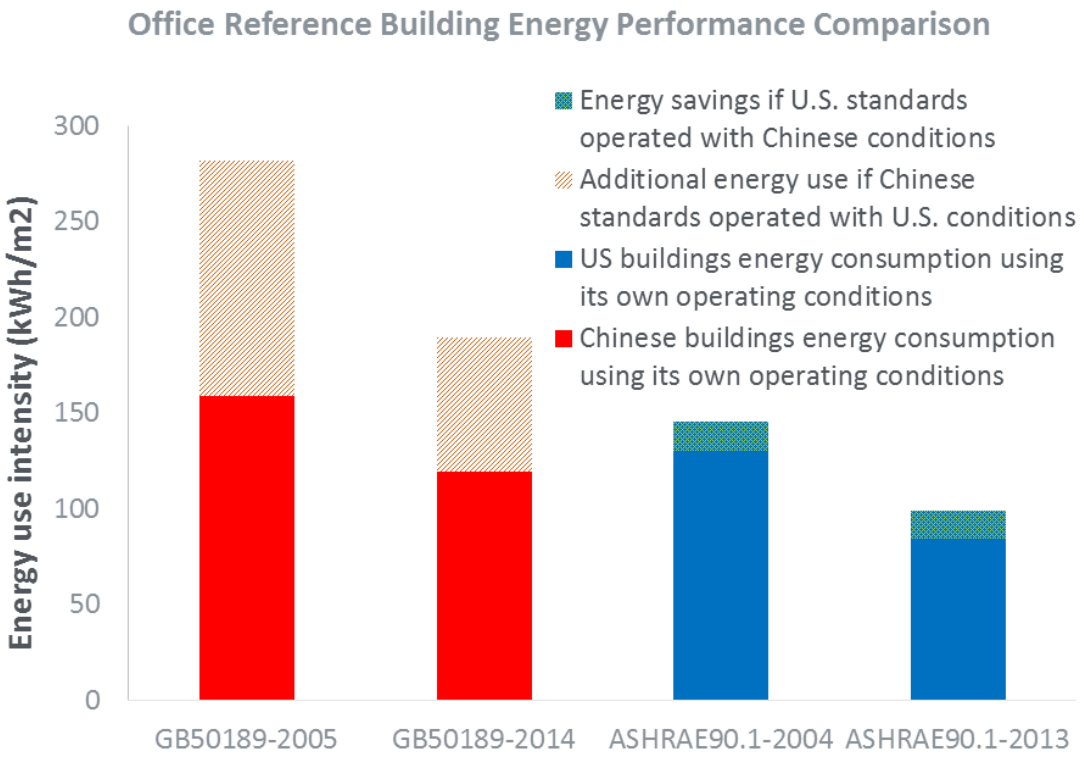
- HVAC systems are different across different climate zones
- Different thermal comfort criteria compared to ASHRAE 90.1
- Discontinuous heating and cooling operation period (e.g. district heating, in Beijing 4 months heating period)





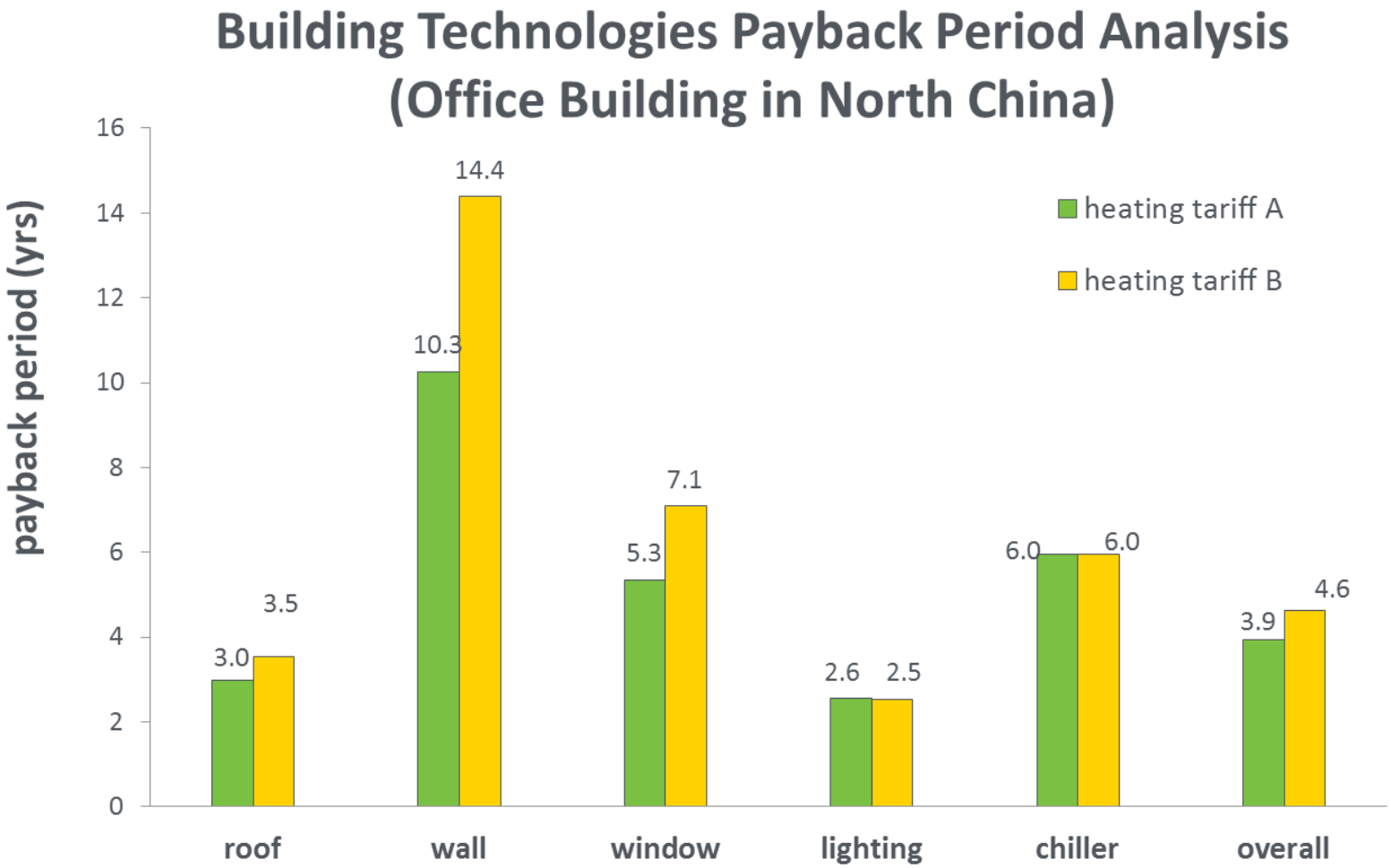
Accomplishment:
compare the standards performance between China and the U.S.

- The performance of the Chinese commercial building standard improves 25% from 2005 to 2014
- The updated Chinese standard is about 20% less efficient than ASHRAE 90.1-2013.
- Due to thermal comfort and operating condition difference, if the Chinese reference building is operated with ASHRAE conditions, its energy consumption will be higher. If ASHRAE adopted Chinese operating conditions, more savings will be observed.
- Building operation can be a big driver for energy savings → learned from the Chinese standard



-- No data center

Accomplishment: Cost-benefit analysis of the standard



- performance relative to 2005 standard baseline
- Relative short payback period, good cost-benefit potential to have more stringent standard

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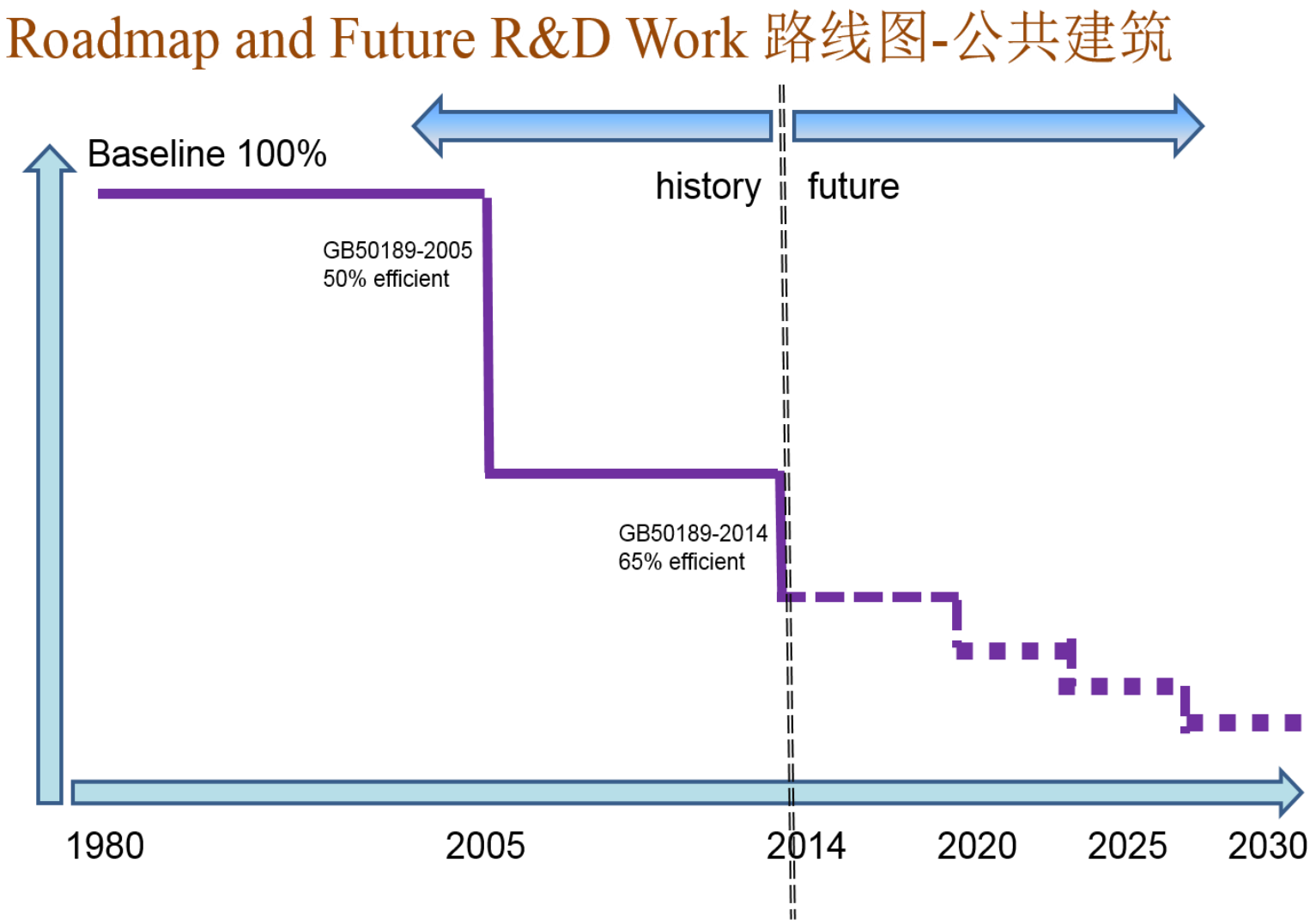
Achievement: A Qualitative Commercial Code Roadmap



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Project Integration and Collaboration

Project Integration:

Partners:

- CABR (China) – collect building design characteristics and cost info
- CSTC-MOHURD (China) – Inform standard roadmap and future upgrade potentials
- SOM – work together on Chinese reference buildings and their design performance compared with reference baseline

Partners, Subcontractors, and Collaborators:

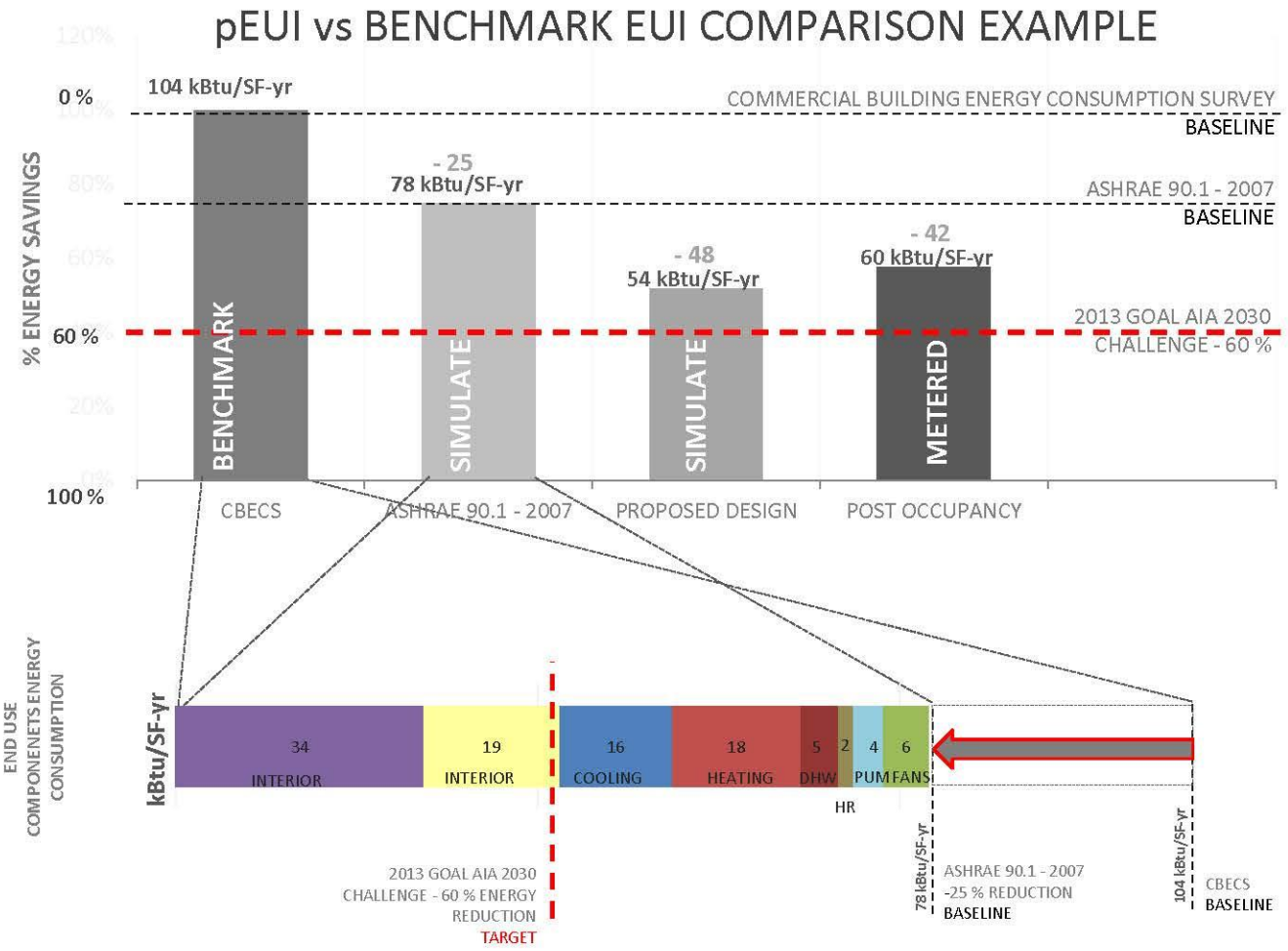
- Other partners: Chinese commercial building revision committee. Feed the performance information back to the committee and advise future upgrade potentials

Communications:

- ACEEE 2014 summer study (08/2014),
- 2014 Chinese NZEB alliance (10/2014),
- Paulson Institute Conference on building codes (11/2014)

Collaboration with US Industries Partners

- Low energy building design in Chinese market



Source: SOM

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Next Steps and Future Plans

Next Steps and Future Plans:

- Prototypes for other commercial buildings: government office building, shopping center in collaboration with CABR
- Analysis of advanced office building energy standards – cost, benefit, energy savings impact – for the next set of standards to be promulgated after 2015
- Analysis of advanced building energy standards/design guides for new prototypes (government building, shopping mall) – cost, benefit, energy savings impact – for the next set of standards to be promulgated after 2015
- Code compliance and enforcement study in China

REFERENCE SLIDES

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Project Budget

Project Budget: 130k (2014), 160k (2015)
Variances: n/a
Cost to Date: 130k
Additional Funding: industrial in-kind contribution ~200k

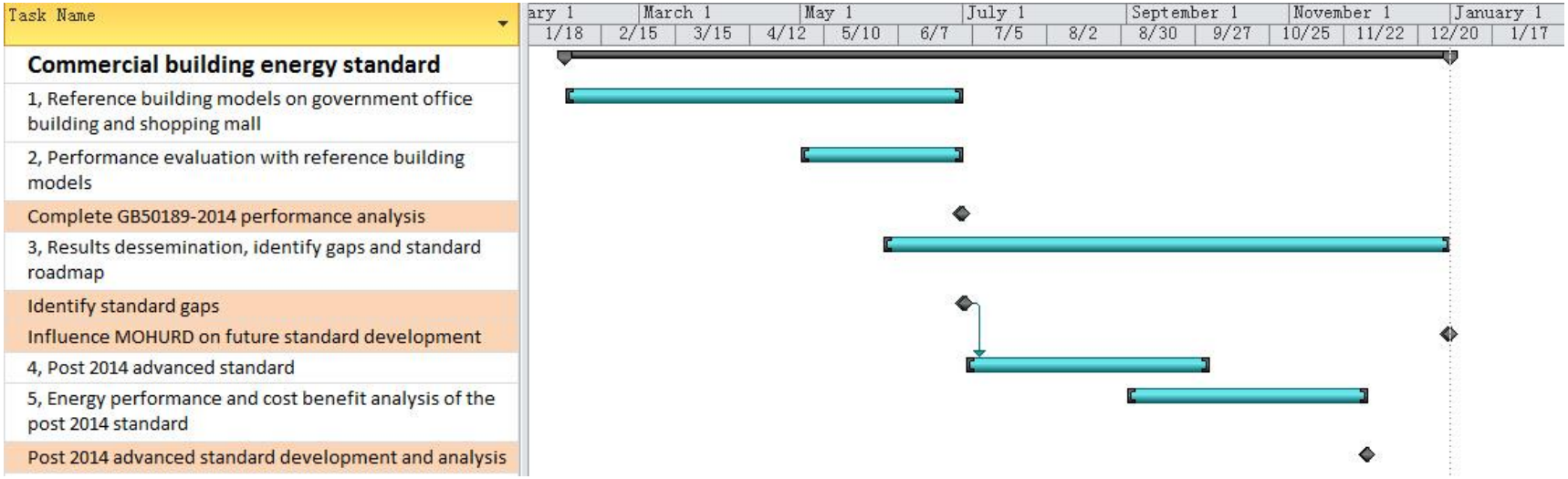
Budget History			
FY2014 (past)		FY2015 (current)	
DOE	Cost-share	DOE	Cost-share
130K	200k in-kind from industries	160K	200k in-kind from industries

Project Plan and Schedule

2014 schedule:

Time	Deliverables
08/2014	Reference office building for China completed
10/2014	Estimated performance of typical compliant office building
01/2015	Costs, benefits, and net energy savings of 2014 commercial building energy standards

2015 schedule:



Time	Deliverables
07/2015	Proposed advanced standard for office buildings, and its performance analysis in comparison with GB50189-2014, 2005 and ASHRAE 90.1
07/2015	Gaps between ASHRAE 90.1 and GB 50189
11/2015	Costs, benefits, and net energy savings of advanced office building energy standards
12/2015	A quantitative roadmap for future energy standard upgrade submitted to MOHURD

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