China’s Building Energy Efficiency Policy and Passive Building Development

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China Passive Building Alliance
OUTLINE

1. Building Energy Efficiency in China
2. Guideline of Ultra-low Energy Building
3. Cutting-edge Research
4. Summary
Most People are familiar with Shanghai, the largest city in China. Now, with lots of skyscrapers.

SHANGHAI. CHINA.
This is what SHANGHAI looks like 20 years ago.
Each year there are 1.5 billion m² new construction in China.
During the next two decades, over 80 billion m$^2$ (900 billion ft$^2$) of new and rebuilt buildings will be constructed in urban areas worldwide.
Building Energy Efficiency in China

**LAWs**

Energy Conservation Law of the People's Public of China (2016 Revision)

Renewable Energy Law of the People's Public of China
http://www.gov.cn/fwxx/bw/gjljgyh/content_2263069.htm

**REGULATION**

Regulations on energy conservation for civil buildings
http://www.gov.cn/flfg/2008-08/07/content_1067062.htm

**CODEs and STANDARDS**

Design  Construction  Operation  Test and Evaluation

Mandatory  Voluntary

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Building Energy Efficiency in China

Building Energy Efficiency Standard develop history:

North -> Central -> South, Residential -> Public

- **1995**
  - JGJ 26-86: Design standard for Civil Buildings
  - JGJ 26-2010: Design standard for energy efficiency of residential buildings in severe cold and cold zones

- **2001**
  - JGJ 134-2001: Design standard for energy efficiency of residential buildings in hot summer and cold winter zone
  - JGJ 134-2010 Revision

- **2003**
  - JGJ75-2003: Design standard for energy efficiency of residential buildings in hot summer and warm winter zone
  - JGJ75-2012 Revision

- **2005**
  - GB 50189-2005: Design standard for energy efficiency of public buildings
  - GB 50189-2015 Revision
Building Energy Efficiency in China

Baseline 100

History

Future

30–30–30!

- 30% new buildings achieve nearly zero energy consumption
- Renewable energy meets 30% of energy demand of new buildings
- 30% of renovated buildings achieve nearly zero energy consumption

Cold residential building JGJ26
Public building Code GB50189

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Development of Ultra-low energy building in China
Development of Ultra-low energy building in China

Ultra-low energy / Passive Building / NZEB Pilot Projects

- **Beijing Office**
  - CABR NZEB 4,200 m²

- **Sichuan Office**
  - Huagou Pilot 13,078 m²

- **Hebei Res**
  - Great wall Home 120,000 m²

- **Henan School**
  - Hebi Passive School

- **Shandong Office**
  - Qingdao Ecological Park 10,000 m²

- **Tianjin Res**
  - 10,000 m²

- **Zhuhai office**
  - Gree ZEB center

- **Zhejiang Office**
  - Menred NZEB center

Development of Ultra-low energy building in China
## Central Government - Policy and Standards

### China State Council
- **Opinions on Further Strengthening the Administration of Urban Planning and Construction**
- “develop green, energy-effective buildings, such as passive houses”

### NDRC & MoHURD
- **Action Plan for Urban Adaptation to Climate Change**
- “promote passive ultra-low energy green buildings by using high-performance components of the thermal envelope to improve building tightness and indoor environment”

### MoHURD
- **13th Five-Year Plan of Building Energy and Green Building Development**
- “develop ultra-low energy neighbourhoods; nearly zero-energy building pilot projects; and by 2020, construct ultra-low energy and nearly zero energy buildings totalling more than 10 million square meters.”
- National Guideline for residential buildings - published in 2015
- National Standard – on going, planned to be finished in 2018
## Local Government - Policy and Standards

<table>
<thead>
<tr>
<th>Province/Municipality</th>
<th>Local Technical Standard</th>
<th>City</th>
<th>Local Fiscal Reward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>On-going, ready by the end of 2017</td>
<td>/</td>
<td>2016-2019</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1000/m²</td>
</tr>
<tr>
<td>Hebei</td>
<td>Effective on May 1st, 2015</td>
<td>Shijiazhuang</td>
<td>2017-2020</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>300-100/m²</td>
</tr>
<tr>
<td>Shandong</td>
<td>Effective on December 1st, 2016</td>
<td>Tsingtao</td>
<td>2016-2019</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>200/m² (City Gov) Partial Incremental Cost (Province Gov)</td>
</tr>
</tbody>
</table>
China Passive Building Alliance was established in 2014, Beijing
Led by the China Academy of Building Research
Built by more than 60 enterprises and institutions.

Establish Standards
Organize the compiling of China Passive Ultra-low Energy Building Standard

Technology Promoting
Promote the technology of Passive Ultra-low Energy Building

Platform for Exchanging
Facilitate the communications between research institutions and enterprises of Passive Ultra-low Energy Building industry in China and abroad

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第一批被动式超低能耗评价标识项目

- “华龙城”商业综合楼
- 中国建筑科学研究院近零能耗示范建筑
- 天津芳华嘉园
- 黄石绿地灯塔
- 黑河滨江专家公寓
- 河北省建筑科技研发中心
- 撒玛利亚绿色建筑检测及应用有限公司材料检测
- 华北建筑设计咨询服务中心
- 西藏城建节能环保科技有限公司生产研究中心
- 南京市城市职业学院实验实训中心

• Principles
  • Incremental costs under control
    • Significant for the long-term development of the passive ultra-low energy building
    • Encourages to use local or domestic products so that the incremental costs will be affordable
    • The related building components industry could be promoted at the same time
  • Whole process control of master plan, design, construction, evaluation and operation
  • Link up the current building energy technical code and standard of China
    • Only focus on the special items and technical measures of ultra-low energy buildings

1 General principles

Plan & Design
- Layout & Orientation
- Shape coefficient
- Climate design

Elements
- Thermal Bridge
- Airtightness
- Large drawing

Construction
- High Standard
- Fine
- Quality Control

Operation
- Operation Manual
- User handbook
- Energy saving idea

Performance-based design methods

Passive ultra-low energy green building

Criteria

Fresh Air

Airtightness

Certification

Design Optimization

Energy Simulation

Target Energy

Air distribution

Options

Requirement

Testing

Spot Check

2 Technical Criteria
# Ultra-low energy building in China: National Guideline for Residential Buildings

## 2 Technical Criteria

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Severe Cold</th>
<th>Cold</th>
<th>Hot Summer, Cold Winter</th>
<th>Hot Summer, Warm Winter</th>
<th>Temperate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulative Annual Heating [kWh/(m²a)]</td>
<td>≤18</td>
<td>≤15</td>
<td></td>
<td></td>
<td>≤5</td>
</tr>
<tr>
<td>Accumulative Annual Cooling [kWh/(m²a)]</td>
<td></td>
<td></td>
<td>≤3.5 + 2.0 WDH$<em>{20}$ + 2.2 DDH$</em>{28}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulative Heating, Cooling and Lighting Energy</td>
<td></td>
<td></td>
<td></td>
<td>≤60 kWh/(m²a) (= 7.4 kgce/(m²a))</td>
<td></td>
</tr>
<tr>
<td>Airtightness</td>
<td>n$_{50}$ [h$^{-1}$]</td>
<td></td>
<td></td>
<td></td>
<td>≤0.6</td>
</tr>
</tbody>
</table>

The energy criteria are referenced to the total floor area [m²], which include the floor areas of living room, dining room, kitchen, restroom, hall, hallway, storage room and closet.

WDH$_{20}$:  Wet-bulb degree hours 20 [kKh] – Accumulative value of the difference between the outdoor wet-bulb temperature and 20 °C when the outdoor temperature is higher than 20 °C.

DDH$_{28}$:  Dry-bulb degree hours 28 [kKh] – Accumulative value of the difference between the outdoor dry bulb temperature and 28 °C when the outdoor temperature is higher than 28 °C.

n$_{50}$ is the air changes per hour [h$^{-1}$] at 50 Pa pressure difference.

2 Technical Criteria

<table>
<thead>
<tr>
<th>Indoor Environmental Parameter</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature [° C]</td>
<td>≥ 20</td>
<td>≤ 26</td>
</tr>
<tr>
<td>Relative Humidity [%]</td>
<td>≥ 30 a)</td>
<td>≤ 60</td>
</tr>
<tr>
<td>Fresh Air [m³/h·per person]</td>
<td></td>
<td>≥ 30 b)</td>
</tr>
<tr>
<td>Noise [dB(A)]</td>
<td></td>
<td>Day ≤ 40; night ≤ 30</td>
</tr>
<tr>
<td>Unguaranteed temperature rate [%]</td>
<td>≤ 10 c)</td>
<td>≤ 10 d)</td>
</tr>
</tbody>
</table>

a) The energy consumption calculation does not consider the relative humidity in winter.

b) Per capita floor space taken as 32 m² per person.

c) When there are no heating facilities, the percentage of hours with indoor temperature below 20 °C per year.

d) When there is no air conditioning, the percentage of hours with indoor temperature higher than 28 °C per year.

3 Design

Collaborative design:

- Climate Oriented
- High performance building envelop
- No Thermal Bridge
- Building air tightness
- Shading
- Heating Recovery
- Heating and cooling system
- Ventilation of Toilet and kitchen
- Lighting and measurement

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Objectives

Quantitative definition of NZEB of China | Provide technical path of all climate zones
Require not measurement but energy result | Promote the performance of building products

**Fundamental Research**
1. Dynamic heat and moisture transfer
2. Theory and modeling of fresh air demand and coupling with air quality
3. Definition of China NZEB
4. Multi-objective and multi-parameter optimization
5. Climatic adapted technical criteria for multi climate zones China

**Key Technologies and Product**
1. High performance integrated heat insulation wall
2. Multifunction door and window
3. User demand oriented accuracy control
4. R&D integrated high performance heat recovery and dehumidification devices
5. Combined system of renewable energy and energy storage

**Evaluation of Design and Construction**
1. Design methodology and tool of energy oriented multi parameter optimization
2. Construction technology and standardization of thermal bridge-free, high air tightness and fabricated construction
3. NZEB building overall performance test and evaluation method

**Integration and Demonstration**
1. Incremental cost analysis
2. Implementation effect evaluation
3. Research on international NZEB technical criteria and key technology.
13th Five-Year the National Research Project

Nearly Zero Energy Building Technical System Investigation

**Fundamental Research**

- **Topic 1** Basic theoretical research

**Criteria System**

- **Topic 2** Definition and Technical Criteria

**Technical research and product R&D**

- **Topic 3** Passive technical research and product R&D
- **Topic 4** Active technical research and product R&D
- **Topic 5** Coupling study of renewable energy and energy storage

**Design, construction and evaluation methods**

- **Topic 6** Design methodology research and tool development
- **Topic 7** Construction standardization process and quality control
- **Topic 8** Performance testing and Evaluation Technology

**Integration and Demonstration**

- **Topic 9** Technology integration and demonstration project of residential buildings
- **Topic 10** Technology integration and demonstration project of public buildings
Comparison of Wall U-value between standards and best practices

- Limited Wall U-Value in China: 0.8~1.5
- Average Wall U-Value in Pilots: 0.35~0.5

- Heating & Cooling Dominate Public: 63%
- Heating & Cooling Dominate Residential: 81%
- Heating Dominate Public: 54%
- Heating Dominate Residential: 70%

NZEB Pilot projects study
NZEB Pilot projects study

Comparison of Window U-value between standards and best practices

The gap between the best practices and the building codes now is the future revision trend of China building codes.
Summary

- Move forward…
  - Researchers, central and local governments, property developers, manufactures…
  - Beijing certified the first batch of ultra-low pilot buildings last week, with ¥1000/m² subsidy.
  - The 13th Five-Year the National Research Project “NZEB Technical System Investigation” started up last Tuesday, with 5.2 million USD national funding, led by China Academy of Building Research, 2017-2020
  - The National Technical Standards for Nearly Zero-Energy Buildings were launched in 2016, will be published in 2018.
Thank You for listening!
China National Nearly Zero Energy Building Conference

3rd national NZEB conference
637 participants
2017年第四届
全国被动式超低能耗建筑大会

The 2017 China Nearly Zero Energy Building Conference

See you in November!

2017年11月22日-23日
November 22ND -23RD 2017

河北·高碑店
Hebei · Gaobeidian