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Building Energy Codes

• Why we need building energy codes (BEC)?
  • Energy efficiency is often discounted in a commercial free market
  • Barriers to energy efficiency
    • Separation of interests between developers & tenants
    • Time & capital constraints of designers/consumers
    • Lack of institutional support & coordination
  • BEC can promote efficiency and ensure good practice is considered & used

Building energy codes in Hong Kong

<table>
<thead>
<tr>
<th>Code</th>
<th>Year implemented</th>
<th>Status</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTTV (building envelope)</td>
<td>1995</td>
<td>Mandatory</td>
<td>Commercial buildings and hotels</td>
</tr>
<tr>
<td>Lighting</td>
<td>1998</td>
<td>Voluntary</td>
<td>All buildings except domestic, industrial and medical ones</td>
</tr>
<tr>
<td>Air-conditioning</td>
<td>1998</td>
<td>Voluntary</td>
<td>All buildings except domestic, industrial and medical ones</td>
</tr>
<tr>
<td>Electrical services</td>
<td>1999</td>
<td>Voluntary</td>
<td>All buildings except special industrial process</td>
</tr>
<tr>
<td>Lifts and escalators</td>
<td>2000</td>
<td>Voluntary</td>
<td>All buildings except special industrial process</td>
</tr>
<tr>
<td>Performance-based building energy code</td>
<td>2003</td>
<td>Voluntary</td>
<td>Commercial buildings and hotels</td>
</tr>
</tbody>
</table>
Building Energy Codes

• Control framework in HK
  • Building (Energy Efficiency) Regulation [1995]
  • Overall thermal transfer value (OTTV)
  • Energy Efficiency Registration Scheme for Buildings
    • Building services energy codes
    • Lighting [1998]
    • Air-conditioning [1998]
    • Electrical services [1999]
    • Lifts and escalators [2000]
  • Performance-based building energy code [2003]
    • Using total-energy-budget approach

Building Energy Codes

• Prescriptive approach
  • Specify minimum requirements for each component e.g. insulation levels & equipment efficiencies
  • For example, maximum U-value for roofs
  • Simple but least flexible
  • Who needs it?
    • People not knowledgeable about energy efficiency
    • People who simply want an easy way to compliance

Building Energy Codes

• Performance approach
  • Set maximum allowable performance level without specifying the methods, materials and processes to be employed to achieve it
  • For example, custom & fixed energy/cost budgets
  • Flexible but more complex
  • Who need it?
    • People who wants to minimise first cost
    • People who want flexibility

Compliance paths in building energy codes

- Proposed design
- Basic requirements
- Prescriptive requirements
- System performance requirements
- Whole building analysis method

Comply?

Yes

No
**Performance Concept**

- What is “Performance”? 
  - Performance is meeting expectations 
  - How well one does a work or activity 
- CIB definition: 
  - “The objectively identifiable qualitative or quantitative characteristics of the building which help determine its aptitude to fulfill the different functions for which it was designed.”

**Performance Concept**

- Building performance 
  - Functionality 
  - Serviceability 
  - Building-occupant comfort 
- Trends 
  - Use as the major criteria for building design 
  - The need to study, measure, and predict the level of building performance (to quantify)

**Performance of a car**  
**Performance of a building/flat**

We get info. about performance of a car; what about buildings?

**Assessment of Performance**

- Parameters of building performance 
  - Structural 
  - Fire and life safety 
  - Accessibility 
  - Durability 
  - Sound insulation (acoustic) 
  - Environmental 
  - Energy efficiency

**The triangle of performance-based approach**

- Objectives
- Functional Statement
- Performance Requirements
- Deemed to Satisfy
- Performance based methods

**What?**  
**Why?**  
**How?**
Performance Concept

- Performance-based codes
  - Multiple performance options
  - Performance option baseline
    - Important to define building conditions for calculations
    - Need to decide basis for tradeoffs
  - Code compliance & building simulation
    - Use software to calculate the performance
    - Usually comparative, not absolute

Performance Concept

- Examples of performance-based BEC
  - USA & Canada:
    - ASHRAE Standard 90.1
    - Canada’s National Building Energy Code
  - Australia & New Zealand
    - Building Code of Australia
    - New Zealand Building Code Clause H1
  - United Kingdom
    - New Part L of the Building Regulation
      - Elemental method, target U-value method, carbon index method
PB-BEC in Hong Kong

- Main documents (can be downloaded from [http://www.emsd.gov.hk](http://www.emsd.gov.hk))
- Performance-based building energy code (PB-BEC)
- Guidelines on PB-BEC
  - Explain the approach & provide examples
- Making reference to ASHRAE 90.1-2001 & other modern codes

ASHRAE/ESDA Standard 90.1-1999

Energy Standard for Buildings Except Low-Rise Residential Buildings

5th Edition

Approved by the ASHRAE Standards Committee June 10, 1999, and by the ASHRAE Board of Directors June 29, 1999.

Compliance options in ASHRAE Standard 90.1-1999
Proposed Building Design

Designed Building

Reference Building

Basic requirements must be met

Building Description

Building Energy Analysis

Performance

Compliance

Code Compliance

Yes

Total Energy Budget

Design Energy Consumption

Compliance with the building energy code

Performance compliance for building energy code

PB-BEC in Hong Kong

• Actual compliance procedure
  • Study the design building
    • Collect info from drawings, specification, survey
  • Develop simulation model for the building
    • Run simulation & fine tune if necessary
  • Establish reference building
    • By modifying the model of design building to meet the prescriptive codes
  • Apply data suggested from Guidelines if needed
  • Calculate & compare energy consumptions

• Establish reference building

Building description

Simulation tool (computer program)

Simulation outputs

- physical data
- design parameters
- energy consumption (MWh)
- energy demands (kW)
- environmental conditions

Major Implications

• Performance approach
  • Advantages:
    • More clearly explains what the code intends
    • Permits innovation & alternative solutions
    • More flexible regulatory environment, easily updated
    • Encourage building/technology research
  • Drawbacks:
    • Often more efforts are needed for analysis/compliance
    • Can be very complex & require energy expertise
Major Implications

- Combining performance/prescriptive
  - A mix of performance and prescriptive language
  - Level of performance/prescriptive mix
  - How to integrate/interface them?
  - Residential BEC are often more prescriptive; commercial BEC are more to performance
- Flexibility vs Complexity
- Current knowledge may not be adequate for some aspects of performance (e.g. environmental)
  - Need to develop verification methods

Different levels of performance and prescriptive mix

<table>
<thead>
<tr>
<th>Level</th>
<th>Performance-Prescriptive Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fully prescriptive</td>
</tr>
<tr>
<td>2</td>
<td>Prescriptive with some performance criteria</td>
</tr>
<tr>
<td>3</td>
<td>As a sub-system with performance and interface requirements</td>
</tr>
<tr>
<td>4</td>
<td>As a sub-system with performance only</td>
</tr>
<tr>
<td>5</td>
<td>As part of a total system in risk (mostly performance)</td>
</tr>
</tbody>
</table>

Major Implications

- Benchmarking energy performance
  - Determine how efficient the building is
    - e.g. “Statement of Energy Performance”
  - Set targets for increased efficiency
  - Also important for energy performance contracting to quantify savings
- Examples:
  - Energy Star Label for buildings
  - Building Energy Rating

Energy Star Label for Building
http://www.energystar.gov/

Building Energy Rating System (Florida)

<table>
<thead>
<tr>
<th>Energy cost</th>
<th>Energy consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakdown of energy use</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td></td>
</tr>
</tbody>
</table>

http://www.fsec.ucf.edu/ratings/

Major Implications

- In Hong Kong, consumers pay a lot of money for housing and workplace, BUT
  - Do we request “energy performance” data?
**Major Implications**

  - Setting of energy performance requirements
  - On building design
    - Target for energy consumption (kWh/sq.m/annum)
  - On building operation & upgrade
    - Energy efficient operation
    - Energy saving technologies
  - Energy performance certificates
  - Boilers and air conditioning systems

**Major Implications**

- Energy benchmark
  - Energy performance contracting (EPC)
    - Contract with an energy service company (ESCO)
    - ESCO will evaluate energy-saving opportunities and guarantee that savings to cover project costs
  - BEC are often used as a benchmark level
  - Building environmental performance assessment
    - Energy is often the key component
    - Use BEC since they are commonly known/agreed

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This presentation can be downloaded at: [http://web.hku.hk/~cmhui/present.htm](http://web.hku.hk/~cmhui/present.htm)