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Impact of Performance-Based Building Energy Code

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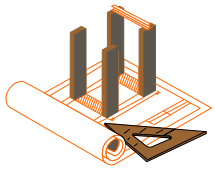


Building Energy Codes

Building Energy Codes

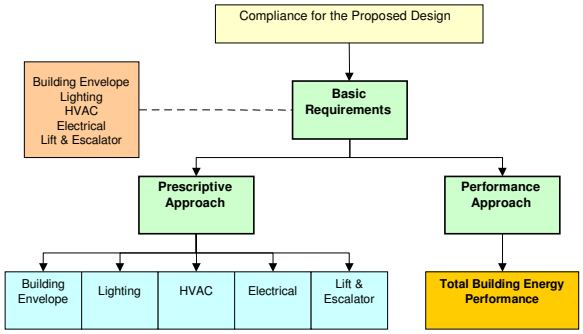
- Why we need building energy codes (BEC)?
  - Energy efficiency is often discounted in a commercial free market
  - Barriers to energy efficiency
    - Separation of interests between developers & tenants
    - Time & capital constraints of designers/consumers
    - Lack of institutional support & coordination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

Building energy codes in Hong Kong

Code	Year implemented	Status	Scope
OTTV (building envelope)	1995	Mandatory	Commercial buildings and hotels
Lighting	1998	Voluntary	All buildings except domestic, industrial and medical ones
Air-conditioning	1998	Voluntary	All buildings except domestic, industrial and medical ones
Electrical services	1999	Voluntary	All buildings except special industrial process
Lifts and escalators	2000	Voluntary	All buildings except special industrial process
Performance-based building energy code	2003	Voluntary	Commercial buildings and hotels

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



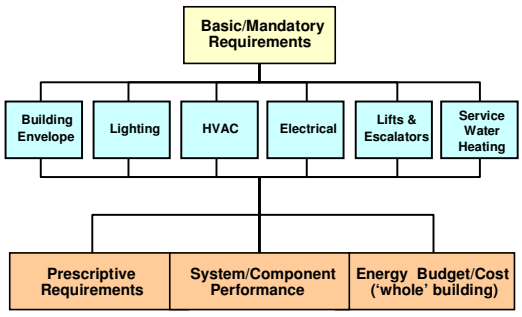
Framework of the comprehensive building energy codes

Building Energy Codes

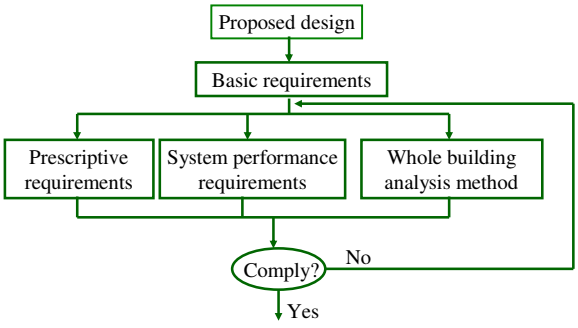
- **Prescriptive** approach
  - Specify minimum requirements for each component e.g. insulation levels & equipment efficiencies
    - For example, maximum U-value for roofs
  - Simple but least flexible
  - Who needs it?
    - People not knowledgeable about energy efficiency
    - People who simply want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



Performance Concept

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

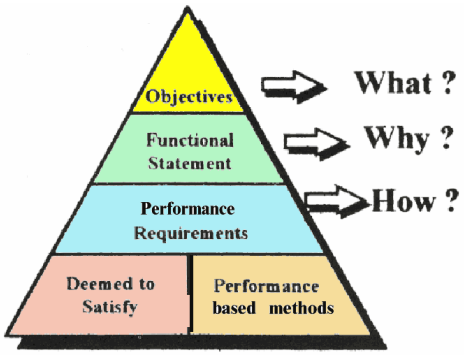
Performance of a building/flat

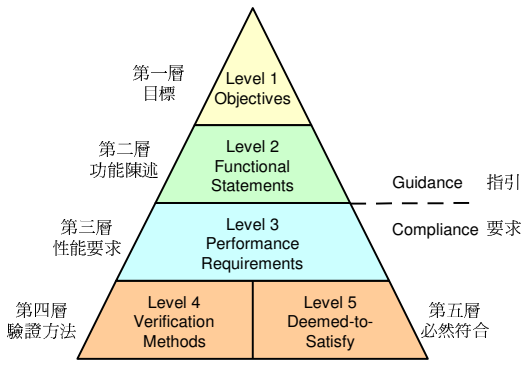
We get info. about performance of a car, what about buildings?

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





Hierarchy of performance-based approach (Nordic 5 levels)

The Nordic Five Level System

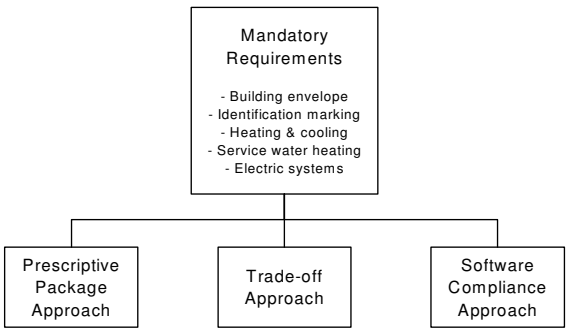
Level	Basic Heading	Description/Comments
1	GOAL	Address the essential interests of the community at large, and/or the needs of the user-consumer.
2	FUNCTIONAL REQUIREMENT	Building or building element specific requirements. A functional requirement addresses one specific aspect or required performance of the building to achieve the stated goal.
3	PERFORMANCE/OPERATIVE REQUIREMENT	Actual requirement, in terms of performance criteria or expanded functional description.
4	VERIFICATION METHODS	Instructions or guidelines for verification of performance.
5	ACCEPTABLE SOLUTIONS	Supplements to the codes with examples of solutions deemed to satisfy the requirements.

Performance Concept

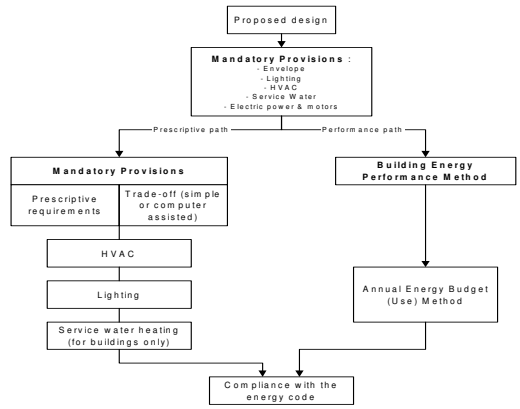
- Performance-based codes
  - Multiple performance options
  - Performance option baseline
    - Important to define building conditions for calculations
  - Need to decide basis for tradeoffs
- Code compliance & building simulation
  - Use software to calculate the performance
  - Usually comparative,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

Performance Concept

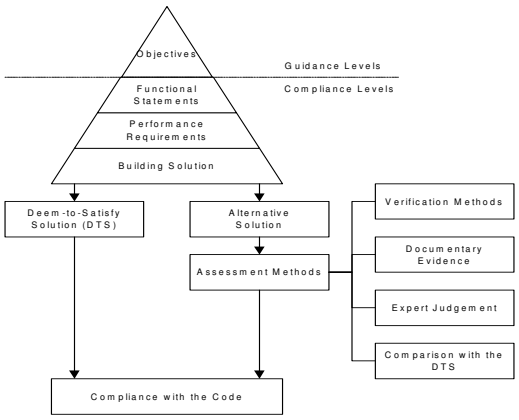
- Examples of performance-based BEC
  - USA & Canada:
    - ASHRAE Standard 90.1
    - Canada's National Building Energy Code
  - Australia & New Zealand
    - Building Code of Australia
    - New Zealand Building Code Clause H1
  - United Kingdom
    - New Part L of the Building Regulation
      - Elemental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



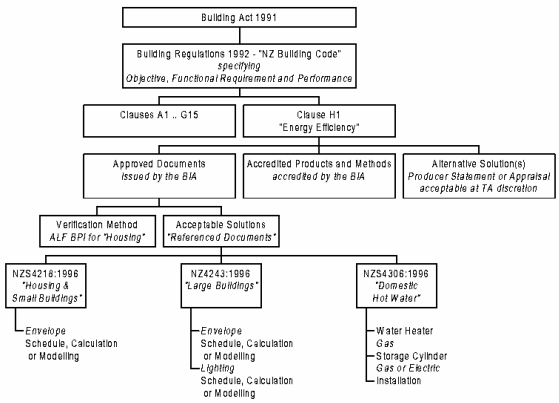
Compliance options of US Model Energy Code



Compliance paths in Canada's model energy codes



Structure of the Building Code of Australia

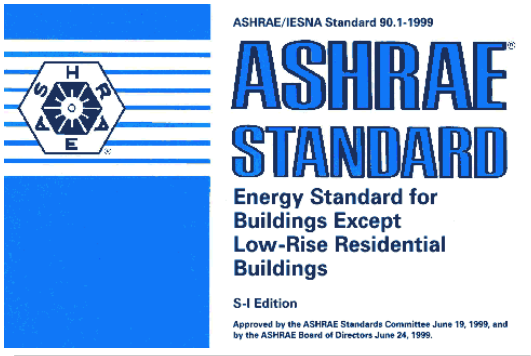


Structure of New Zealand Building Energy Code

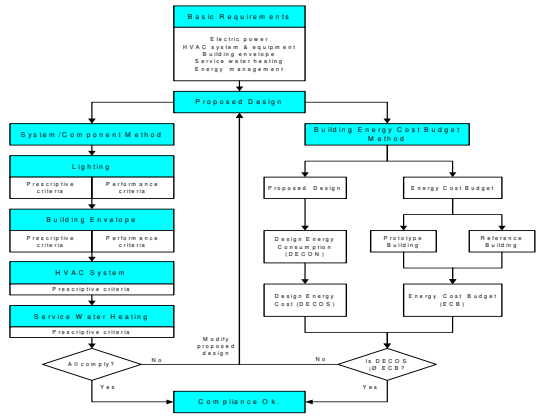
PB-BEC in Hong Kong

PB-BEC in Hong Kong

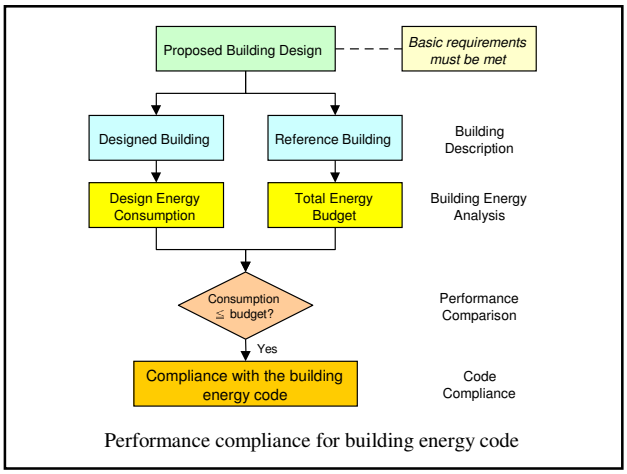
- Main documents (can be downloaded from http://www.emsd.gov.hk)
  - Performance-based building energy code (PB-BEC)
  - Guidelines on PB-BEC
    - Explain the approach & provide examples
- Making reference to ASHRAE 90.1-2001 & other modern codes



ASHRAE 90.1-2001 and earlier versions
- Energy Cost Budget (ECB) section



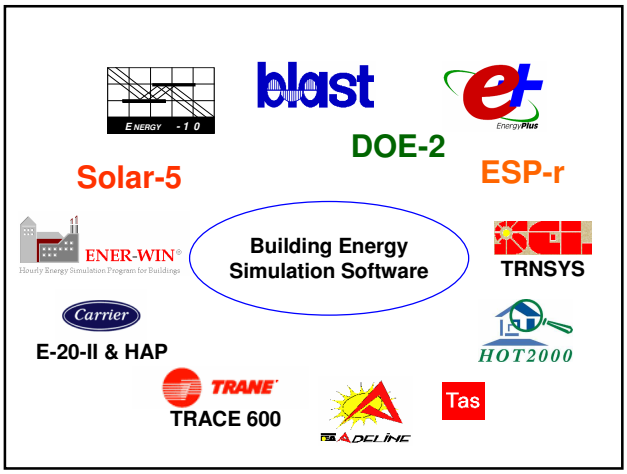
Compliance options in ASHRAE Standard 90.1-1989

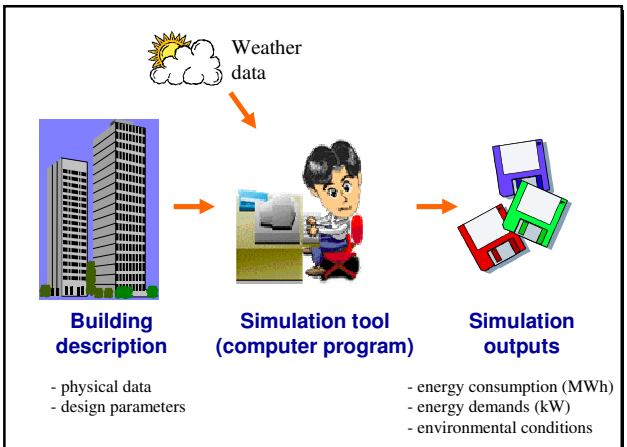


Performance compliance for building energy code

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





Major Implications

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

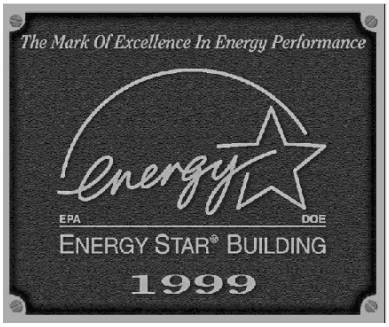
- Combining performance/prescriptive
  - A mix of performance and prescriptive language
    - Level of performance/prescriptive mix
    - How to integrate/interface them?
    - Residential BEC are often more prescriptive; commercial BEC are more to performance
  - Flexibility vs Complexity
  - Current 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

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

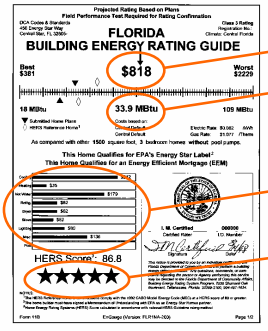
Major Implications

- 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)

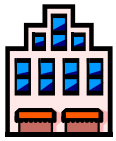


Energy cost
Energy consumption
Breakdown of energy use
Score

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?



Energy label for buildings

Major Implications

- *EU Directive on the Energy Performance of Buildings*, 2002/91/EC, 16 December 2002
  - 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

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