Building Energy Standards and Codes

Presented by: Ir K K Lam

Prepared by: Ir K K Lam and Ir Roger S H Lai

Background (1)

International Review:

- BEC widely adopted international
- Mainly on OTTV, Lighting and AC
- Prescriptive BEC
- Performance-based BEC

Background (2)

Hong Kong Situation:

- Energy Efficiency Office set up in1994
- COP for energy efficiency of building services installations in buildings 2010 edition -EMSD
- 4 energy consuming areas:

  -AC (48%), Office equipment (22%),

  -Lighting (19%), Lifts & others (11%)
- Implemented under building energy efficiency ordinance

Prescriptive Energy Codes

- Specifies for each building component the minimum requirements to satisfy the code
- Advantages
  - Simple to use and follow
  - Easy to check and enforce
- Drawbacks
  - Rather restrictive
  - Hindrance to international trading
  - Barrier to innovation and performance optimisation

Performance-based BEC

- Use the total building energy approach
- Provide an alternative channel to the prescriptive BEC
- Advantages
  - More clearly explains what the code intends
  - Permits innovation and alternative solutions
  - More flexible regulatory environment, easily updated and encouraging adoption of new technologies
- Drawbacks
  - Often more efforts are needed for analysis and compliance
  - Can be very complicated, requiring energy experts.

Building Energy Codes in HK

Building Energy Standards & Codes covers:

- OTTV
- Lighting
- Air-conditioning
- Electrical
- Lifts and escalators
- Performance-based BEC

OTTV Code (1)

Mandatory

- Simple to use as there are computer programmes performing the calculations
- Reflective glass or low emissive glass have to be used
- Potential development with other material or facade design

OTTV Code (2)

- Launched 1995 (Buildings Department with support from EMSD)
- Building (Energy Efficiency) Regulation (Cap. 123M)
- Control of building envelope
- Latest review in 2011
  -Tower 24 W/m^2 (previous 30, 35)
  -Podium 56 W/m^2 (previous 70, 80)

Building Energy Efficiency Ordinance

- BEEO (Cap. 610) came into operation on 21 Feb 2011
- Grace period of 18 months, i.e. Ordinance fully implemented in September 2012
- Also include requirement for energy audit for existing buildings
- Registration for Registered Energy Assessor

Energy Efficiency Requirements for Lighting Installations

- Requirements are for the purposes of:
  1. reducing lighting power through imposing maximum lighting power density
  2. reducing energy use through proper lighting control

Lighting Power Density

- Table 5.4 of COP
- Examples of Maximum Allowable Lighting Power Density (LPD)
  -atrium 20 W/m^2
  -office 17 W/m^2 (to be revised to 15 soon)
  - drawing office 20 W/m^2
  -car park 6 W/m^2
  -banquet 23 W/m^2 etc.

Lighting Control Points for Office

- Table 5.5 of COP

Space Area "A"	Min. No. of lighting control pts.
$15x(N-1) \prec A \leq 15xN$	$0 \prec N \leq 10$
$30x(N-6) \prec A \leq 30x(N-5)$	$10 \prec N \leq 20$
$50x(N-12) \prec A \leq 50x(N-11)$	$N > 20$

- Fewer control points can be provided if the actual LPD is lower than the values given in table 5.4

Energy Efficiency Requirements for Air-conditioning installations

1. System Load Calculation:
   -accordance with established international standards
   -Indoor conditions and outdoor conditions specified in Table 6.4
2. Separate air distribution system for process zone
3. Air distribution ductwork Leakage limit
   -see Table 6.6 for pressure above 750 Pa
   -25% of ductwork to be tested in accordance with DW 143

Air-conditioning

4. Air distribution system fan power
   -Encourage the use of variable flow system
   -For CAV system, fan motor power ≤ 1.6 W per L/s
   - For VAV system, fan motor power ≤ 2.1 W per L/s
   -Fan motor power includes both supply & return air fans of the system
5. Pumping system variable flow
   -Variable flow required for system with flow control
   -Capable of reducing flow to ≤ 50% design flow
   -Motor power ≤ 55% at 50% design flow

Air-conditioning

6. Frictional loss of water piping system

-For 50 mm dia. or below, flow velocity should be $\prec$ 1.2 m/s

-For dia. larger than50 mm, frictional loss $\prec$ 400 Pa/m & velocity $\prec$ 3 m/s

7. System control

-Min. 1 auto temperature control

-Cooling adjustable to $\geq 29^{o}C$

-Heating adjustable to $\leq 16^{o}C$

-$2^{o}C$ cool/heat dead band

-Control of humidity from 30% to 60%

-Zone control see clause 6.10.3

-For off-hour control see clause 6.10.4

Air-conditioning

8. Thermal Insulation:

   -Calculation of insulation thickness for pipework, ductwork & AHU casing using equation in clause 6.11.1

   -As an alternative, thickness can be obtained from Table 6.11a to 6.11c

9. AC equipment efficiency

   -see Table 6.12a and 6.12b

   -e.g. COP of 2.8 for air cooled centrifugal chiller and 4 to 5.7 for water cooled centrifugal chiller (to be upgraded to ASHRAE 90.1 standard soon)

9. Energy Metering

   -Continuous motoring for equipment above 350 kW

Energy Efficiency Requirements for Electrical Installations

The requirements are for the purpose of:

(a) minimizing losses due to current unbalance and harmonics, and indirect losses due to temperature rise

(b) reducing losses and energy wastage in the utilization of electrical power

(c) monitoring of electrical installation

Electrical

1. Power Distribution loss
   -Transformer efficiency 98% - 99%
   -Main circuit ≤0.5%
   -Feeder circuit ≤2.5%
   -Sub-main ≤ 1.5%
   -Final circuit (>32A) ≤1%

Electrical

2. Motor Installation(motor ≥ 1.1kW)
   -Motor efficiency 76.2% to 93.9% (see Table 7.5.1)
   -Motor sizing ≤125% (to be revised to ISO IE 2 soon)
3. Power Quality
   -Min. power factor of 0.85
   -THD current (see table 7.6.2)
      ≤ 20% (≺40A)
      to 5% (>2000A)
   -Unbalanced load ≤ 10% (I≻400A)

Electrical

4.Metering and Monitoring

-Main circuit, feeder or sub-main ≻ 400A:
Meter or provisions to measure V, A, PF, kWh, kVA & THD

-Sub-main circuit & feeder ≻ 200A & ≺ 400:
Meter or provisions to measure A & kWh

Energy Efficiency Requirements for Lift and Escalator Installations

1. Electrical Power
   - Max. power for traction lift see Table 8.4.1
   - Max. power for hydraulic lift see Table 8.4.2
   - Max. power for escalator see Table 8.4.3
   - Max. power for passenger conveyor see Table 8.4.42
2. Utilization of Power
   - Power factor -0.85
   - Decorative load not more than 50% of rated load with a limitation of 600 kg
   - Lift parking mode requirements
   - Requirements for idling lift

Lifts & Escalators Energy Code

3. THD

   -Lift: 15% (<800A) to 40% (<40A) –see Table 8.6.1

   -Escalator and passenger conveyors: see Table 8.6.2

4. Metering & monitoring

   -Measurement of V, I, total power factor, kWh, kW, & kVA

Performance-based Approach

- Total Energy Budget approach
- Numerical method for building energy analysis using approved programme
- Determination of energy consumption:
  -Building envelope
  -Lighting
  -HVAC
  -Lift & escalator
  -Other systems

Performance-based BEC

- Make reference to ASHRAE 90.1 2001
- Alternative path for compliance with the prescriptive BECs
- Certain basic requirements of the 5 prescriptive BECs must be complied.
- Building energy simulation using approved computer programmes, e.g. DOE2.
- Comparison of the design energy with the energy budget of the reference building.

Energy Efficiency Building Registration Scheme

Nature of Scheme

The scheme is voluntary self certifying in nature. RPE is required to certify that installations of the building comply with the requirements in the BEC

A Registration Certificate will be issued to successful applicant

Participant is allowed to include the Information of the registration in public signs, display, advertisement, etc. as a commercial sales point

Energy Efficiency Registration Scheme for Buildings

- Latest statistics (up to March 2007)
  - Number of buildings involved 734
  - Cert for lightings 768
  - Cert for a/c systems 434
  - Cert for electrical systems 445
  - Cert for lifts and escalators 392
  - Cert for performance based buildings 5

Energy Efficiency Building Registration Scheme

A list of registered building and latest information on HKEERSB can be found in the Internet :

www:emsd.gov.hk/emsd/english/energy/codes/buildenergy/data.html

Some Examples:

The Center	HK International Airport
Nanyang Plaza	EMSD HQ
Prosperity Centre	North Point Govt Offices
Lippo Sun Plaza	Knowles Bldg, HKU
Laguna City	Fanling Health Centre

Energy Benchmark

- EMSD has commissioned a consultant to help with establishing some energy benchmarks for different facilities and utilization of space. The benchmark is available in the EMSD website.
- Members of the public can check against the energy usage of their facilities with the benchmark, and if they find their venues not very energy efficient compared to the benchmark, they should seek improvements.

Energy benchmarks

- For office buildings, the benchmark is around 1100 MJ/yr/m^2 (~305kWh/yr/m^2), HK has similar figures to some parts of US with similar climate

- ArchSD in recent years has been aiming to design buildings with a consumption benchmark below 200 kWh/yr/m^2

- RMI suggests that this could be improved to 450-650MJ/yr/m^2. Best practice ones can be down to 100-230MJ/yr/m^2. A lot of improvement potentials

Building Assessment Schemes (1)

- Theoretically, buildings may be assessed for a number of objectives.

- Current assessment schemes tend to assess the buildings in their environmental or sustainability aspects. There is also one assessing their intelligence aspects.

Building Assessment Schemes (2)

- In Hong Kong, there are currently two schemes in operation
  - The HK-BEAM Plus (HK building environment assessment method) under BEAM Society sponsored by Business Environment Council
  - The IBI (Intelligent Building Index) sponsored by the Asian Institute of Intelligent Buildings (AIIB)
  - Leadership in Energy & Environmental Design LEED (from USA) is also being used
  - Professional Green Building Council also conducts annual green building award

HK-BEAM PLUS

- Scheme objective: to promote environmentally sustainable building.
- Mainly for commercial buildings
- Assessment is performance based:
  - Site aspects, material aspects, energy use, water use, IAQ, innovation and performance enhancement etc., adopts BEC baseline for energy efficiency assessment
  - Recognizes EERSB
  - In operation since 1996, has assessed more than 100 buildings

CEPAS (1)

- Announced by Building Department for public consultation, being discussed in the CIB (Construction Industry Board)
- Scheme objective: to promote environmentally sustainable building
- Mainly for commercial buildings
- Scope of assessment: IAQ, building amenities, resource use, loading, site amenities, neighborhood amenities, site impacts, neighborhood impacts etc.

CEPAS (2)

- Will adopt BEC for energy efficiency assessment, including the PB-BEC
- Will also recognize PB-BEC
- Will recognize EERSB

- Note: CEPAS and HK-BEAM Plus has a lot of similarities, CEPAS more comprehensive and more open

Intelligent Building Index-AIIB (1)

- Scheme objective: promotes intelligent buildings, not restricted to commercial buildings
- Scope of assessment:
  - Green index, space index, comfort index, working efficiency index, culture index, high-tech image index, safety and security index, management practice and security index, cost effectiveness index, health and sanitation index

Intelligent Building Index –AIIB (2)

- Adopts BEC for energy efficiency assessment, not the PB-BEC
- Recognizes the EERSB
- In operation since 2000, has assessed more than 15 buildings

Summary of Building Assessment Schemes

- Promotes building environmentally sustainable buildings and intelligent buildings
- Energy utilization and energy efficiency aspect is an important part in building assessment
- The BEEO and EERSB scheme has laid down a firm base in this aspect

Thank You