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
- BEC - one of the first initiatives
- 4 energy consuming areas:

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

  -Lighting (19%), Lifts & others (11%)
- Compliance on voluntary basis.

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

- 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
- Review in 6/2000
  -Tower 30 W/m^2 (previous 35)
  -Podium 70 W/m^2 (previous 80)

Lighting Energy Code

Published in 1998, latest revision 2007

- Requirements:

1. Minimum Lamp Luminous Efficacy
   -6~14 lm/W for Tungsten
   -130~160 lm/W for SOX (Low pressure Na lamp)
   -65~97W for Fluorescent tubes
   -CFL to comply with EELS (energy efficiency label)
2. Maximum Lamp Control Gear Loss (ballasts)
   -Fluorescent – 7 to 18 W
   -CFL – 7 to 10 W
   - All electronics ballasts to comply with EELS

Min. Allowable Luminous Efficacy for other lamp types

Lamp type		lm/W
GLS	Tungsten filament lamp	6-14
TH	Tungsten halogen lamp	11-22
MBI	Metal halide lamp	65-80
MBF	Mercury vapor lamp	35-50
SON	High pressure sodium lamp	130-160
SOX	Low pressure sodium lamp	30-120

Other factors to be considered

- Colour Temperature

2000K to 6500K

- Colour Rendering

Class 1A	excellent colour quality
Class 1B	very good colour quality
Class 2	good colour quality
Class 3	poor colour quality
Class 4	very poor colour quality

Lighting Energy Code

3. Maximum Allowable Lighting Power Density (LPD) (some examples)
   -office 25 W/m^2
   -car park 8 W/m^2
   -banquet 40 W/m^2 etc.
4. Lighting Control Points in Office
   -1 control point per $10m^2$ up to $200m^2$
   -1 control point for every $50m^2$ above $200m^2$ (see formula in the code)

Lighting Energy Code

Summary

- Efficacy & control gear loss stipulated
- Max. LPD for different areas stipulated.
- Maximum area served by a switch stipulated.
- Control parameters are more stringent in the 2007 edition.
- CFL and electronics ballasts to meet the EELS requirement.

Air-conditioning Energy Code

Published in 1998, latest revision 2007

1. Load design: (adopts other international standards)
   -Indoor conditions
   -Outdoor conditions
   -Load calculation
2. Air side power (fan > 5kW)
   -CAV ≤ 1.6 W / l/s
   -VAV ≤ 2.1 W / l/s ;
   -fan power consumption < 55% full load power at 50% flow (basically calls for VSD for fan control)
   -Duct leakage test
   -Zone control, min. one zone for one floor.

Air-conditioning Energy Code

3. Water side power (pump)
   -Variable flow to 50%
   -Friction loss ≤ 400 Pa/m
4. Minimum COP (for >10 kW)
   -2.2 for (air-cool unitary plant)
   -to 5.2 (water cool centrifugal)
5. Insulation: (thick enough to prevent condensation)
   -Depending on diameter of the chill water or refrigerant pipes
   -Ductwork, AHU

Air-conditioning Energy Code

6. Office control points -System min. 1 auto control

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

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

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

-Control of Humidity, Zone, & Off-hour

Air-conditioning Energy Code

Summary

- The code sets out the min requirements for achieving energy efficient a/c design
- System load design stipulated
- Air & Water side system design stipulated
- Control requirement stipulated
- Insulation requirement stipulated
- AC equipment efficiency stipulated
- Variable speed drives to be used to control air flow and water flow

Electrical Energy Code

Published in 1999 latest revision 2007

General approach: minimize losses in the distribution system, reducing losses and wastage in utilization, reducing losses due to power quality problems, appropriate metering for monitoring purposes.

Electrical Energy Code

1. Power Distribution loss
   -HV to be used for buildings> 50-storey/175m
   -Transformer efficiency 98% - 99%
   -Main circuit ≤0.5%
   -Feeder circuit ≤2.5%
   -Sub-main ≤ 1.5%
   -Final circuit (>32A) ≤1%

Electrical Energy Code

2. Power Utilisation (motor $\geqslant$ 5kW)

-Motor efficiency 84% to 92%

-Motor sizing $\leq$125%

-Direct drive whenever possible. Synchronous belt drive if need to be used

-Total Power factor $\geqslant$ 0.85 *(including effects of harmonics)*

3. Power Quality

-THD current

$\leq$ 20% (<40A)

to 5% (>2000A)

-Unbalanced load $\leq$ 10% (I>>100A)

Electrical Energy Code

4.Metering and Monitoring

-Main circuit > 400A:

Meter or provisions to measure V, A, PF, kWh & kVA

-Sub-main circuit & feeder > 200A:

Meter or provisions to measure A & kWh

Electrical Energy Code

- Summary
- One of the first of its kind.
- The IEEE had obtained permission from HK Government to include this code into their new revision of Standard 241 “Recommended Practice for Electrical Systems in Commercial Buildings”
- Standard forms available for submission
- Requirements of power distribution, utilization & power quality stipulated.
- Requirements of metering & monitoring stipulated.

Lifts & Escalators Energy Code

Published in 2000, latest revision 2007

For lifts

1. Max. Power

   -max power allowable depends on speed and load

   i.e. not to exceed kW limit according to load and speed

   (e.g. 750kg 1m/s not to exceed 6.7kW, 5000kg at 9 m/s not to exceed 275.5kW)

2. Energy Management

   -at least 1 lift in a lift bank can be put to standby

   -standby lift should not respond to call

   -Meters or metering provisions for V, A, PF, kWh & kVA

   -2 minute idling shut off fan

Lifts and escalators

3. For escalators
   - Max allowable no load power depends on step width, rise of escalator, and speed.
   - Max allowable no load power also depends on whether the escalator is for public service or non-public service. The public service escalators have higher limits.
   - Public service escalators are those with 140hr/wk operating hour and at least 0.5hr reaching 100% brake load during any 3-hour intervals.

Lifts and escalators

4. The code for escalators is also applicable to passenger conveyors. Max allowable no load power depends on step width, length of conveyor, speed, and whether it is for public service
5. THD

   -Lift: 15% (<800A) to 35% (<80A)

   -Escalator and passenger conveyors: 22.5% (<400A) to 35% (<80A)
6. Total power factor > 0.85

Lifts & Escalators Energy Code

- Standard forms available for submission
- For lifts, the code does not have requirements on traffic analysis. This however should be taken into account in a prudent design.
- Maximum power demand of motor drive stipulated for various combination of loading and speed.
- Requirement of THD stipulated.
- Energy management requirements

Performance-based BEC

Published in 2003, latest revision in 2007

- 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 of around 800MJ/yr/m^2 (~222 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 (HK building environment assessment method) sponsored by Business Environment Council
  - The IBI (Intelligent Building Index) sponsored by the Asian Institute of Intelligent Buildings (AIIB)

Building Assessment Schemes (3)

- Government has been proposing a third scheme called CEPAS (Comprehensive Environment performance Assessment Scheme).

- The Professional Green Building Council (PGBC) is also considering some initiatives in building assessment.l

HK-BEAM

- 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 about 95 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 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 around 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 BEC and EERSB scheme has laid down a firm base in this aspect

Thank You