MEBS6016 Energy Performance of Buildings

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Assignment 01: Fundamentals of Building Energy Performance

1. (a) Briefly explain the possible benefits of energy efficiency.

(6 marks)

Discuss the key strategies to achieve energy efficiency for new buildings and existing buildings, respectively.

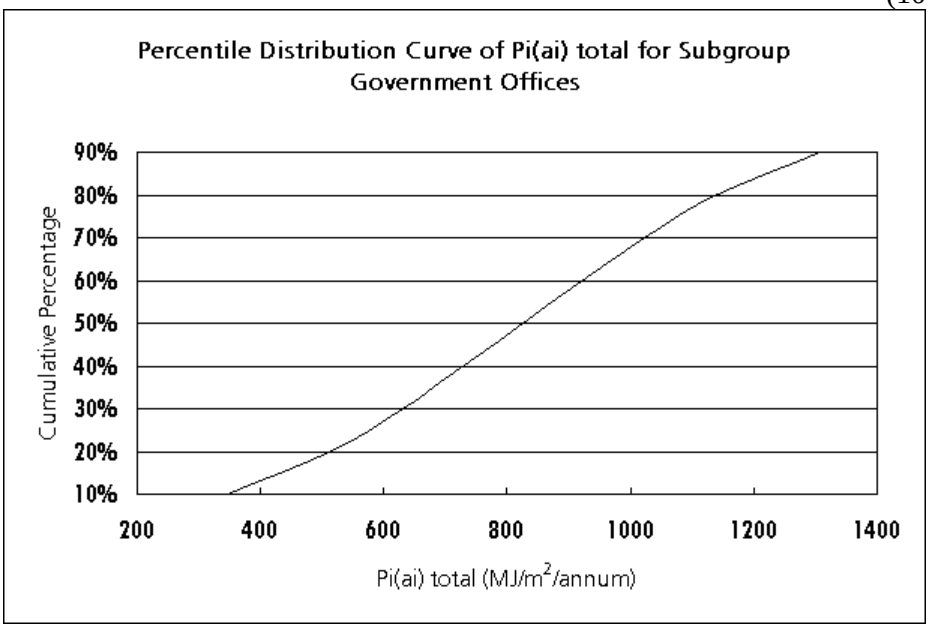
(9 marks)

(b) A government office building has a total gross floor area of 20,000 m^2 and consumed 3.2 x 10^6 kWh of electricity in one year. The annual cost of electricity is $3.5 millions and this includes both energy charge and demand charge. If the demand charge constitutes 15% of the annual electricity cost, determine the following indicators for assessing the energy performance. Assume the ratio of net floor area to gross floor area is 0.7.

i) Average cost of electricity in $ per kWh
ii) Energy utilization index (kWh/m^2/annum), based on net floor area
iii) Energy cost index ($/$m^2$/annum), based on net floor area

If this building is compared with the energy consumption benchmark shown on the following graph, find out the percentile of this building and comment on the performance level.

(10 marks)



(Source: Electrical & Mechanical Services Department, Hong Kong)

[Ans.: i) $1.09 per kWh, ii) 228.6 kWh/m^2/year, iii) $212.5 /$m^2$/year; 54%]

2. (a) The EU Directive on Energy Performance of Buildings is an important energy policy affecting Europe and the world. Briefly describe how the directive works and its possible contribution to help Europe meeting the Kyoto Protocol.

(5 marks)

Explain the four major requirements of the directive and their implications to energy efficiency in buildings.

(10 marks)

(b) An engineer has used a building energy simulation software to investigate two energy-efficient design options and the following results were obtained.

	Base case	Option A	Option B
Annual energy consumption (MJ)	360,000	180,000	252,000
Initial capital cost ($)	0	$200,000	$100,000

Assume energy price is $1 per kWh, the study period is 10 years, the interest rate is 10%, and all other costs are neutral. Calculate the following parameters for each design option and comment on which one is preferred.

i) Annual energy cost savings in dollars
ii) Simple payback (SPB)
iii) Return on investment (ROI)
iv) Net present value (NPV)

(10 marks)

[Ans.: i) A: $50,000, B: $30,000, ii) A: 4 years, B: 3.3 years, iii) A: 25%, B: 30%, iv) A: $107,250, B: $84,350]

3. (a) Building energy codes can be designed with the requirements based on a prescriptive approach or a performance approach. Briefly discuss the advantages and drawbacks of each approach.

(11 marks)

Building energy simulation is a powerful method for studying energy performance, but the user must also understand its limitations. Briefly describe four situations where simulation method is not recommended for the building energy analysis.

(4 marks)

(b) A variable speed drive (VSD) is proposed to be installed on a chilled water pump to save energy. The existing flow rate of the pump is 100 litre/second and the VSD can reduce average flow to 70 litre/second. The pump's energy consumption before installing the VSD is 8,000 kWh per year. The initial cost of the VSD is $20,000 and additional maintenance cost for the VSD is $200 per year. Assume energy price is $1 per kWh and the pump energy is proportional to cubic of the flow rate. Estimate the following parameters:

v) Annual energy savings in kWh
vi) Annual energy cost savings in dollars
vii) Net annual cost savings in dollars
viii) Simple payback (SPB) of the measure

(5 marks)

For a study period of 10 years, construct a table to show the cash flow analysis. Assume the interest rate is 8%, then calculate the discount factor for each year and determine the present value of the net annual cost savings for each year. Show the results on the table and estimate the total life cycle cost.

(5 marks)

[Ans.: i) 5,256 kWh, ii) $5,256, iii) $5,056, iv) 3.96 years; Total LCC: $13,926]