

25.5 DEG C AND HUMAN COMFORT

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***Abstract:** Since the Hong Kong Government promulgated the initiative of maintaining 25.5 deg C for air-conditioning space in summer months in 2004, there has been different opinions about its applicability, especially on human comfort under in-door environment. This paper will illustrate the Government rationale of kicking off the initiative, the measures taken and the results in energy saving in connection to the initiative.*

INTRODUCTION

In the past decade, the total local energy consumption at end-use level in the territories grew at an average rate of 1.2 % per annum with about 50% accounted by electricity. In year 2004, electricity consumption has recorded 141,202 TJ or 39,200 GWh¹, and out of which about 30% (against 31% in year 2003) was expended in space conditioning. This is equivalent to over HK\$ 10 billion per year in monetary terms. In view of the substantive portion of electricity consumed in space conditioning, the Hong Kong Government, in 2004 October has, apart from her target objective to trim down the annual electricity consumption by 1.5% from 02/03 onwards for a consecutive four years, directed that 25.5 deg C shall be adopted as the standard indoor room temperature during Summer months in Government premises.² Such manoeuvre will give a clear message to the public that the Hong Kong Government would take the lead in minimising energy consumption, and hence the reduction of green house gas from the demand side. The Hong Kong Government had appealed to public in 2005 during the World Environment Day celebration event to adjust their room temperature to 25.5 deg C with slogan "No Freezing Summer".

TEMPERATURE SETTING AND GREEN HOUSE GAS

CO₂ emission is one of the major natural green house gas which result in climate change in form of global warming. Various scientific research and publicity have given us alarm on the environmental impact and the probable consequence that human would face if we do not take immediate actions. The 700-page Stern Review by British economist Sir Nicholas Stern in October 2006 which was widely discussed provides an economical review of global warming. It suggested investing 1% of the global GDP for mitigation of climate change, or otherwise our global GDP might be at risk and drop 20% than it might be. Saving energy in our air-conditioning system would have significant effect which is a major consumption of electricity in our commercial and domestic sectors.

¹ Hong Kong Energy End-Use Data 2006 published by EMSD Sep 2006.

² There are exceptions on venues managed by LCSD.

According to simulation of the energy consumption of a typical office building with central air-conditioning, for every 1 deg C increase in temperature setting, the reduction of electricity consumption in the air-conditioning equipment is about 3%. A preliminary simulation result, run on a desktop computer is shown in Figure 1. The result shows a theoretical saving over 4%, but in practical case due to equipment efficiency, the energy saving will be around 3% as shown in our analysis below.

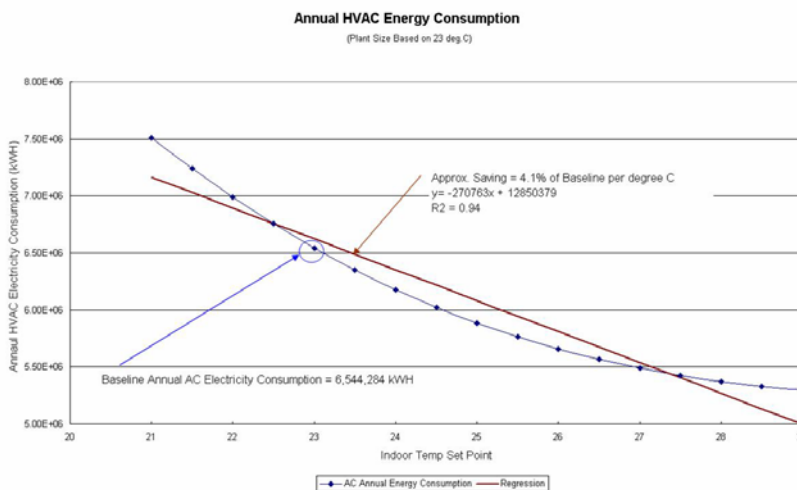


Figure 1 Preliminary Desktop Simulation Result

As the electricity consumption used to represent 50%³ of the overall electricity consumption of a typical office premises, thus by setting the temperature 1 degree higher, the electricity consumption will be reduced by 1.5 %, and is equivalent to elimination of about 246,000 tonnes CO₂⁴ emission. Such CO₂ reduction, if realised, represents about 0.6% total Carbon Dioxide emission⁵ in year 2004.

WHY 25.5 DEG C⁶

In recommending the 25.5 deg C initiative, the Hong Kong Government has made reference to other countries, and taken human comfort into consideration. The initiative aims to strike a balance between the energy saving, hence less CO₂ emission, and thermal comfort, despite the fact that 25.5 deg C may not be the most preferred room temperature for every person. The following table shows the general design/designated room temperature in a number of countries :

Table 1 Design/Designed Room Temperature⁷

Country	Australia	China	Singapore	USA
Design/Designated Temperature	23 ~ 26	25 ~ 27	22.5 ~ 25.5	25.5 (78 deg F)

³ From Hong Kong Energy End-use data 2006, the percentage in office is about 48%. (p11)

⁴ Based on 700g CO₂ generation per 1kWh generation, will differ for different fuel mix

⁵ A total of 37,600 thousand tonnes CO₂ emission in year 2004 – EPD Air Quality Reports, 1997 – 2004; EPD Annual Air Quality Statistics 2005.

⁶ It is not necessary the thermostat setting, but the actual temperature maintained indoor.

⁷ Australia OHS 32; China ‘China Energy Label’; Singapore Standard CP13:1999; USA ASHRAE Standard 55

HUMAN THERMAL COMFORT⁸

There are six primary elements which will affect human perception of thermal comfort inside a building. Four are environmental variables, namely, temperature, humidity, heat radiation and air movement while the other two are human related, namely the clothing and the metabolism rate⁹. There is a thermal comfort zone based on self judgement and experienced by most people and is usually measured on 7-point scale (the thermal sensation scale in ASHRAE). Without going deep into the scale and its associated computer model to compute the thermal comfort, it must be pointed out that, under most conditions, the thermal conditions considered acceptable by majority, will still be subjected to disagreement by a certain percentage of occupants. In ASHRAE standard 55-2004, the PMV (predicted mean vote) model is used, and comfort zone is based on a PMV value between -0.5 and +0.5.

There used to be queries to Hong Kong Government whether the temperature setting of 25.5 deg C is applicable as high relative humidity of 90% are not uncommon in Hong Kong, especially in summer rainy season. Coincidentally, the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) had conducted a study in 2005 to investigate the relation of thermal comfort with high humidity and came out with a finding that 'No significant psychological differences in human response to exposures between 60 to 90% RH for the temperature range 20 – 26 deg C ET while sedentary'¹⁰. The crux of the issue remains as how the indoor environment, through the operation of the air-conditioning plant, would satisfy the thermal comfort of the majority of occupants, and such will, in turn, much depend on the activities being carried out in the particular venue .

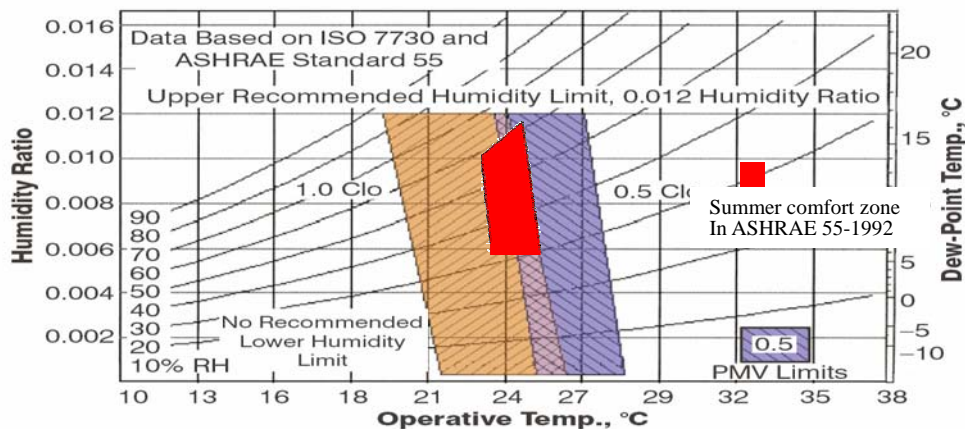


Figure 2 Acceptable Ranges of Indoor Temperature (ASHRAE 55 – 2004)

CURRENT SITUATION IN GOVERNMENT PREMISES

⁸ 'Thermal Comfort' is that condition of mind that expresses satisfaction with the thermal environment.

⁹ CAED, Controlling Surface temperature to achieve Thermal Comfort, College of Architecture and Environmental Design, Arizona State University, 2003.

¹⁰ ASHRAE Investigation of Thermal Comfort at High Humidities – Edward Arens et al Building Science at UC Berkeley : Research

The Government has been taking the lead for the implementation of the 25.5 deg C initiative since its launching in 2005. In order to monitor and reinforce the momentum, EMSD has conducted a number of temperature and humidity surveys in October 2006¹¹ at 16 selected venues. The measurements were taken at regular intervals and multiple readings were taken for each location during the day. Large amount of data had been collected and the results indicate that about 90% of the venues have the summer indoor temperature setting close to the 25.5 deg C, while only a small portion of the venues had recorded an average temperature more than 1 degree C lower than the recommended temperature. The operator had been approached to raise the temperature setting. However, for various reasons e.g. complaints from the occupants and the general public, temperature settings of some venues would still need to be closely monitored and adjusted in order to have a better balance on energy savings and the acceptance of the occupants. As a whole, the survey indicated that Government departments have been supporting the initiative and performing towards meeting the target 25.5 deg C within the acceptable ranges for occupants in summer clothing.

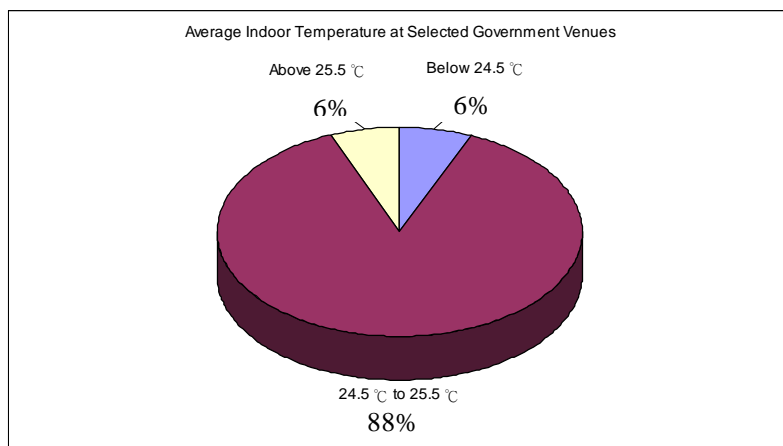
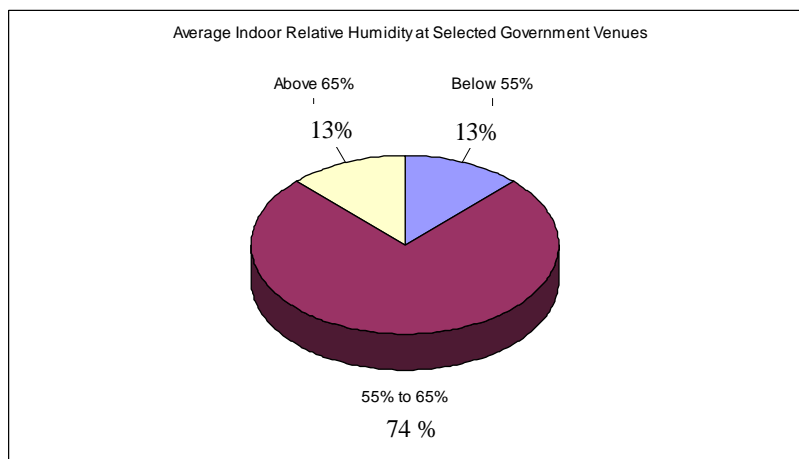


Fig 3 Chart showing distribution of Temperature measured



Fir 4 Chart showing Relative Humidity distribution among the venues

On a case by case basis, some Government Departments have asked for exemption to set the

¹¹ The last October was unseasonably warm and recorded a mean maximum daily temperature of 26.4 degC and minimum temperature of 24.7 degC which equaled the records set in 1983. The month was also rather dry with only 31.2 millimetres of rainfall, about 78 percent below normal. ‘The weather of October 2006’ – Hong Kong Observatory.

temperature at lower than 25.5 deg C for venues such as museum, municipal services due to their special operational needs. In these cases, the temperature is still set within the range 22.5 deg C to 25.5 deg C.

Generally, settings of the indoor temperature to 25.5 deg C for Government premises do not require major modification on the central chiller plant and the air distribution system. The air-conditioning system, including central air-conditioning system and split type direct expansion systems are designed with Summer Design Condition of 25.5 deg C and therefore, little or no system constraints was encountered.

ANALYSIS ON THE IMPLEMENTATION

A study was conducted in 2005 to better understand the status of implementation in Government of the 25.5 deg C initiative and to obtain an appraisal of its effectiveness towards energy saving in the summer period. A total of five Government office buildings were selected for the study and a number of data had been collected in order to identify the energy saving due to setting of a higher temperature to 25.5 deg C. The data collected includes the followings :

- monthly electricity consumption (kWh) (April to September 2004, 2005)
- gross floor area
- staff counts
- working hours of staff
- number of office equipment
- weather data in Cooling Degree Days
- other factors which might affect the activity change that would result in significant change in energy consumption (say renovation work within the period, office vacation etc)

Upon detailed analysis, the results show that after adjustment for changes in working hours, weather and activity, an average energy saving of 4.2 % was achieved in the five venues. The reduction in kWh for each degree C rise in room temperature ranges from 0.25% to 3.88% or an average of 1.85%. This is higher than the predicted value of 1.5% (i.e half of 3 %) possibly due to the strengthening of housekeeping measures and other energy saving initiatives being implemented.

PUBLIC INVOLVEMENT

The 25.5 deg C initiative had also been extended to the private sectors and general public. Different form of promotional activities including briefing sessions, workshops, distribution of pamphlets, labels and stickers, energy saving tips, TV API as well as inviting private companies, groups and schools to join the “Energy Conservation Charter 2006 – Suitable Room Temperature” in the Action Blue Sky Campaign. More than 350 companies, groups and schools had joined the Charter to maintain the momentum. It is anticipated that not everyone within these companies, groups and schools would be totally satisfied with the indoor environment, but the steps taken by these groups would certainly have a positive impact on our environment and reduce the risk on our global economy as stipulated in the Stern Review.

CONCLUSION

The 25.5 deg C initiative is one of the measures promulgated by the Hong Kong Government to reduce electricity consumption in summer months, while its effect may not be significant¹², it does bring a clear message to the public that the Government, will and continue to take the lead to conserve energy for the betterment of the next generation. With concerted and distributed effort from the public, down to each household, the energy consumption can be reduced from the demand side, resulting in less emission of green house gas which contributes significantly to global warming. Please join hand-in-hand to put back the minute hand of the 'Doomsday Clock' back by two minutes or more.

REFERENCES

- 1 *Hong Kong Energy End-Use Data 2006* Sep 2006, EMSD, HKSAR
- 2 *Air Quality Report 1997-2004* EPD, HKSAR
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- 6 *Stern Review Report on the economics of climate change* HM Treasury available from http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm

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Ir M S Kam received his first degree from the University of Hong Kong in 1976 and has over 20 years service with the Electrical and mechanical Services Department. He is currently a Senior Engineer in Energy Efficiency Office and is responsible for planning and coordinating the implementation of government energy saving programmes, and promotion of energy efficiency and conservation programmes in the public and private sector.

¹² The annual energy consumption of HKSAG in year 2005/06 is about 2,280 GWh and represents about 5.5% of the overall electricity consumption in the territory.