



**Energy
Sustainability
Unit**

Progress update on EAEF Project 68-Singapore

**EC-ASEAN Energy Facility (EAEF) Project 64 & 68
3rd Meeting
24 March 2006
Kuala Lumpur, Malaysia**

Sun Hansong

**Energy Sustainability Unit
Department of Building
School of Design and Environment
National University of Singapore**



Outline



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- Review of procedure of benchmark development
- Meeting and Seminar
- Updates on Energy Smart Tool
- Updates on Prof. Santamouris' visit to NUS
- Result of preliminary analysis of Malaysian data
- Proposal of benchmarking-based building energy simulation
- Next phase work plan

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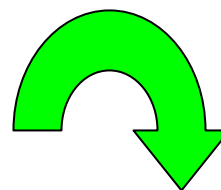


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Procedure of benchmark development

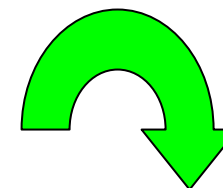
Design sample frame

Ensure the sample is representative of the entire building stock targeted and covers a wide spectrum of each building parameter.



Parameter investigation

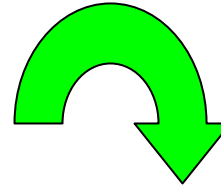
Understand manageable and unmanageable factors



Design data collection form & define terminology

Procedure of benchmark development

Data collection & processing



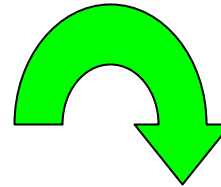
Primary filtering, data normality and validity test

Apply filtering, statistical integrity and normality tests to ensure accuracy and validity of data set to achieve a homogeneous and representative database.

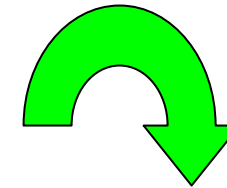
Procedure of benchmark development

Parameter analysis & normalization

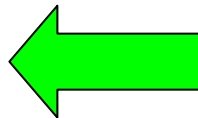
- Weather normalization
- Primary determinant factors
- Correction factors
- Secondary determinant factors



Determination of energy performance indicators



Develop web-based benchmarking and application concepts



Establish benchmark

e.g. Cumulative percentile curve benchmarking look up tale, clustering, classification.



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Meeting and Seminar

- **Seminar on EAEF Project 64 & 68:**
Energy Performance Contracting & Benchmarking
School of Design & Environment, National University of Singapore, 13 January 2006.
- **Launch of Energy Smart Office Environment Building, Singapore, 16 December 2005.**

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The Energy Smart Tool

<http://www.esu.com.sg/smarttool.php>



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The header of the Energy Smart Tool website. It features the 'ES ENERGY SMART' logo on the left. The main title 'ENERGY SMART TOOL' is centered in a blue bar. To the right, there are links for 'ESU Website | FAQ | Contact ESU'. Below the title bar is a navigation menu with links for 'Home', 'About Energy Smart Tool', 'How To Use', 'Registration', and 'Useful Information'.

A login box with the 'SINGAPORE' logo above it. It contains a 'Login Box' title, a 'User ID' input field, a 'User Password' input field, and a 'Go' button. There are also links for 'Forgot password?' and 'Register'.



Energy Smart Tool is an online performance-based building energy benchmarking tool developed by the Energy Sustainability Unit (ESU) of Department of Building, School of Design and Environment, National University of Singapore. The main objective of the Energy Smart Tool is to provide comprehensive, reliable and accurate benchmarks of energy consumption and efficiency in buildings. This tool is intended to be a starting point in assessing building energy use and saving potential. It provides you with a direct comparison of your building energy performance to other similar facilities, which can help to identify the position of your facility, and to set energy use and efficiency targets.



News & Events

- ~ Official Launch of Energy Smart Tool
- ~ Launch of NEA's Energy Smart Office Labelling Programme



Case Studies

- ~ Best Practices of Energy Efficient Building



NEA Energy Smart
Building Labelling Programme



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The Energy Smart Tool- Visitors Report

By 17 March 2006, 2793 visitors from more than 15 countries have browsed the ESU website.

By 8 March 2006, 41 visitors from 28 companies and government agencies have registered for the Energy Smart Tool.

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Prof. Santamouris' visit to NUS

From 5 February to 28 February 2006:

8 meetings with NUS professors, government agencies, research centre and companies.

6 workshops with ESU researchers

1 public talk: 115 participants

1 seminar to Singapore CES members

1 site visit to Singapore HDB public houses.

Prof. Santamouris' visit to NUS

Presentation topics:

- Benchmarking Methodology of ESU-EAEF Project 68
- Energy Performance of Hotel Buildings in Singapore
- Introduction of EU Project 64-2003
- Energy Smart Labeling for Office Buildings
- Rating Techniques for Buildings
- Short Description of the New Energy Related Standards of CEN for Buildings
- Cool Paints for Cool Communities
- Passive Cooling- The State of the Art
- Sustainable Housing in Europe
- Latest developments on energy efficient cooling systems and materials

Result of preliminary analysis of Malaysian data



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52 office buildings cross over Malaysia;
20 office buildings in KL and Selangor area;
10 buildings in Malaysia with system level data.

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Result of preliminary analysis of Malaysian data



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Analysis was conducted to determine the primary parameters which impact building energy use. Data normality was also tested.

OCA (occupied area) shows the best significance against GFA (gross floor area) and ACA (air conditioned area) and number of occupants.

$EUI_{oca} = TBEC / OCA$ is the best indicator of building energy performance.

However, the conclusion is constrained by the limited sample size and uncompleted data set.

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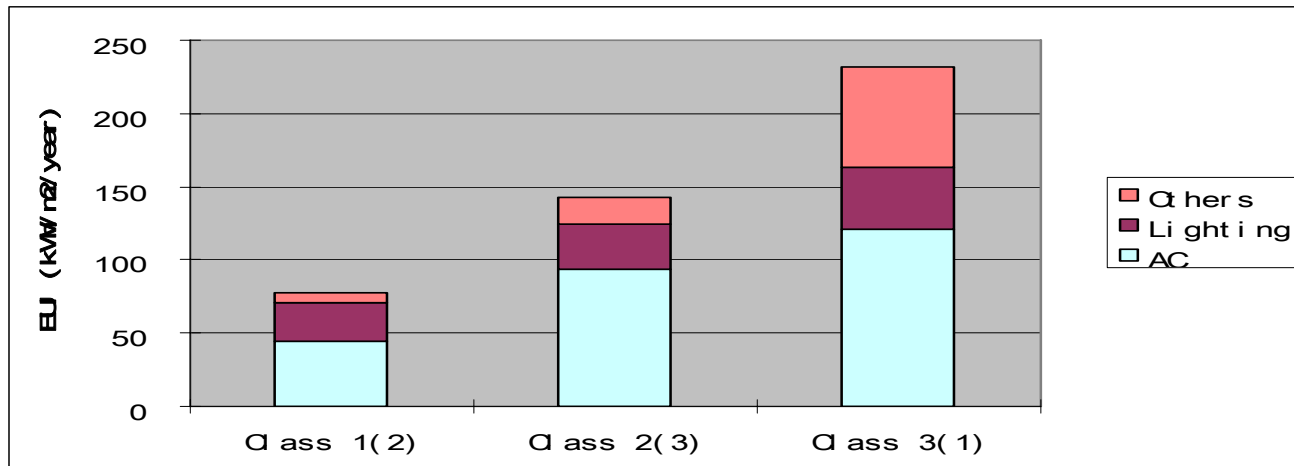


Result of preliminary analysis of Malaysian data

Cluster analysis was conducted to classify buildings with respect to the total building and system energy use.

It shows that buildings can be classified into three classes in Malaysia.

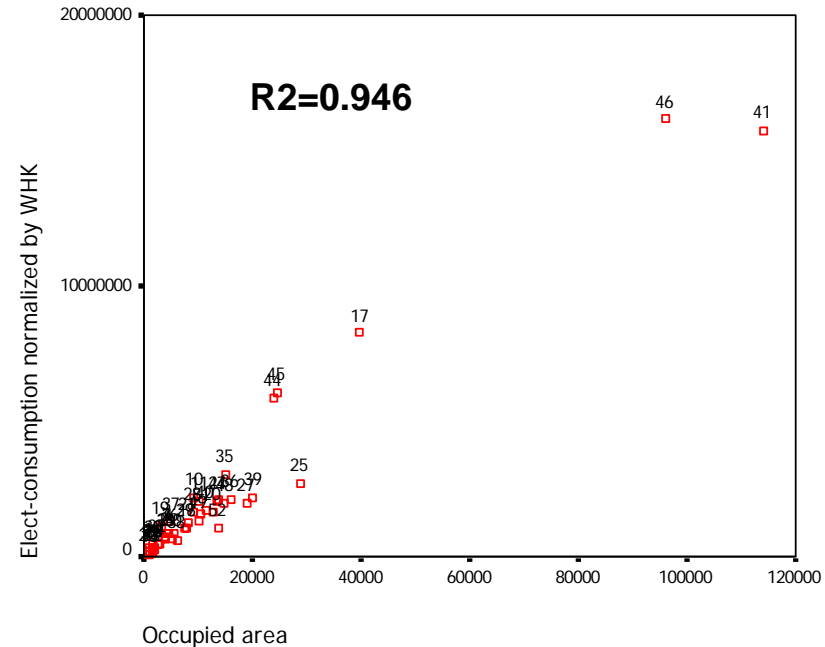
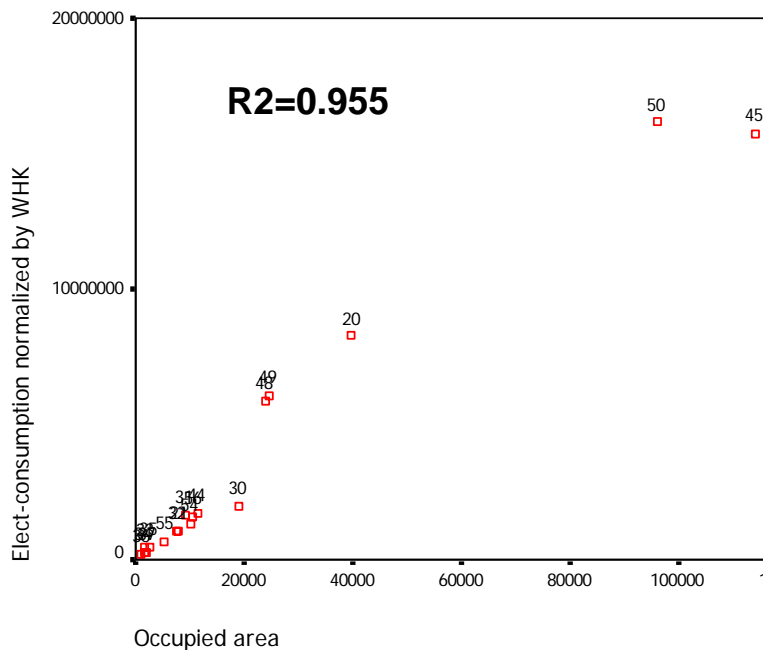
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Result of preliminary analysis of Malaysian data

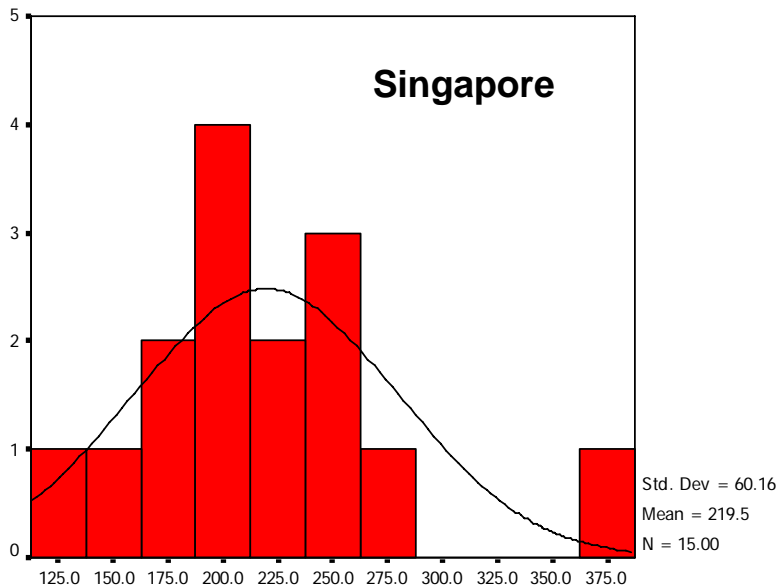
Weather did not show significant impact on EUI.

20 buildings in KL VS. 52 buildings in whole Malaysia

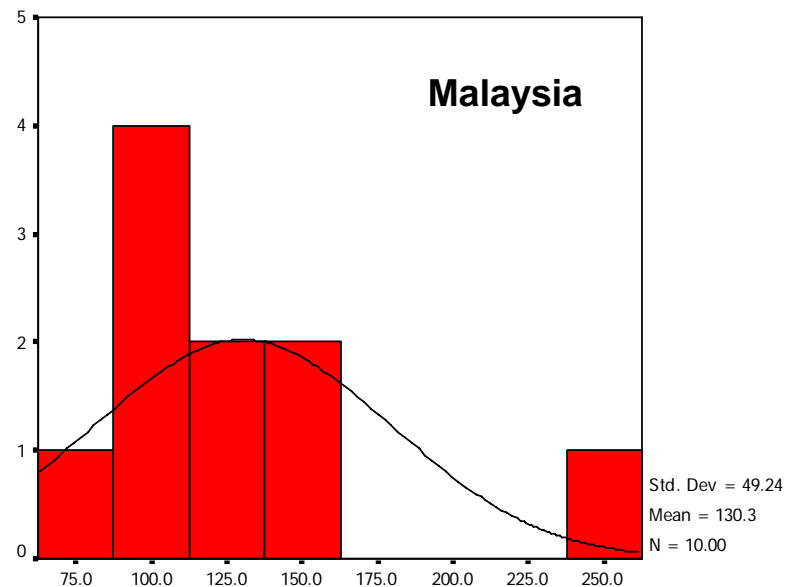


Result of preliminary analysis of Malaysian data

EUI comparison between Singapore and Malaysia: 15 buildings in Singapore VS. 10 buildings in Malaysia



EUI

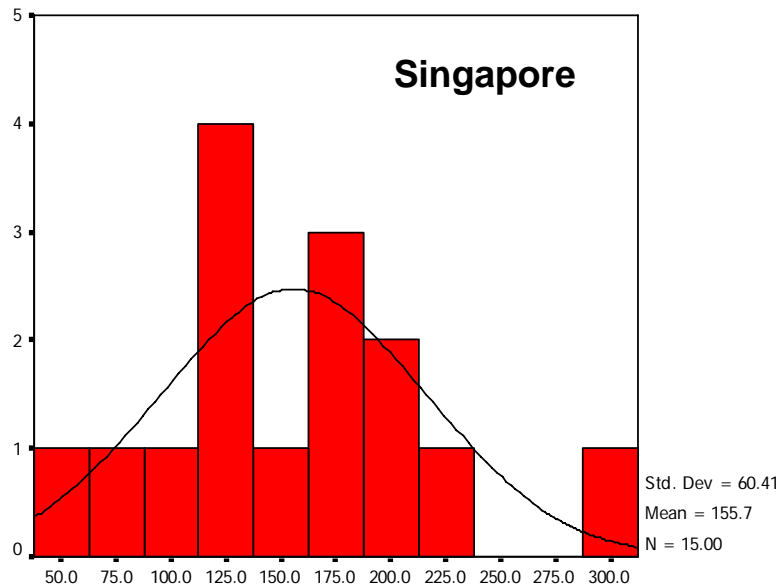


Total EUI based on GFA (gross floor area)

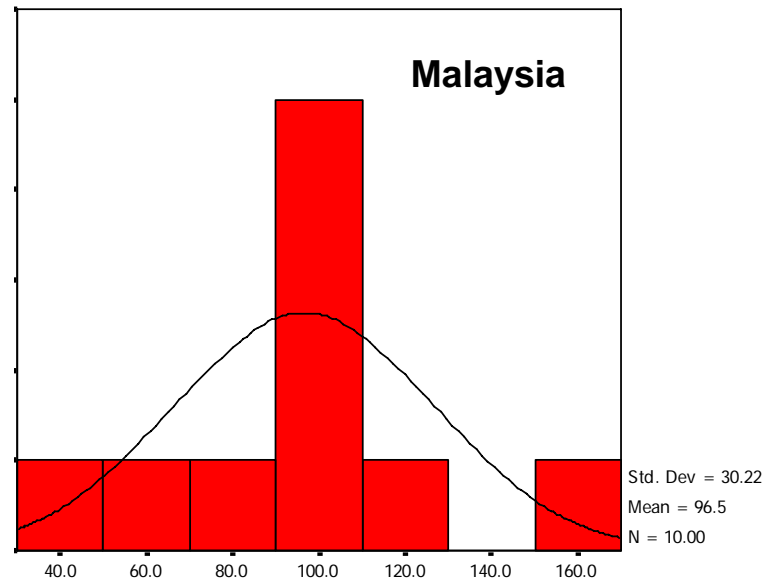


Result of preliminary analysis of Malaysian data

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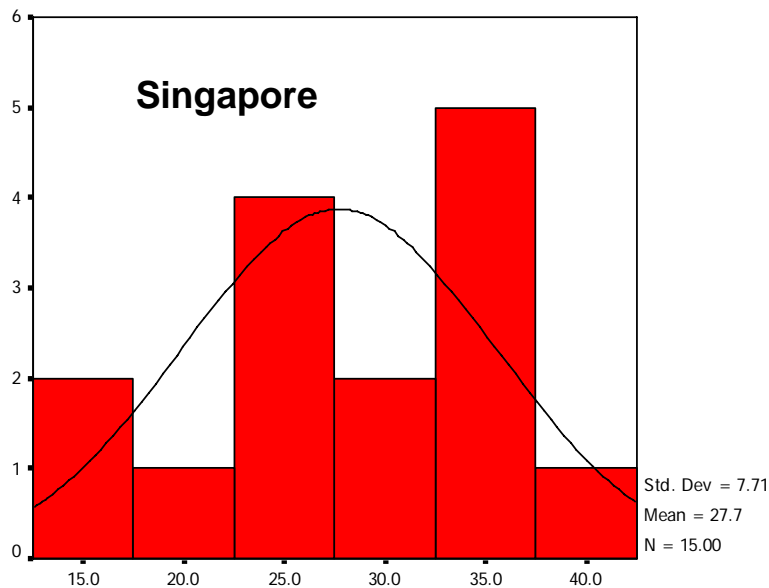
Total air condition EUI based on ACA



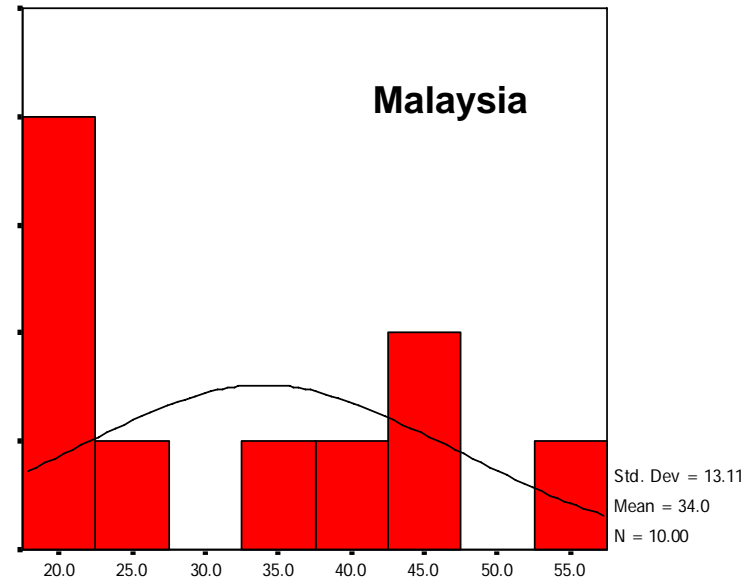
HVAC EUI based on ACA (Air conditioned area)

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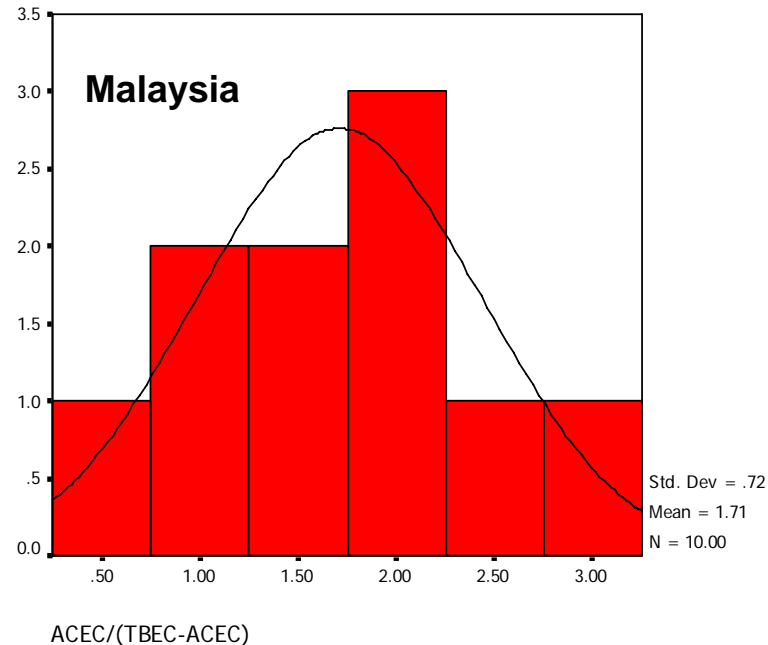
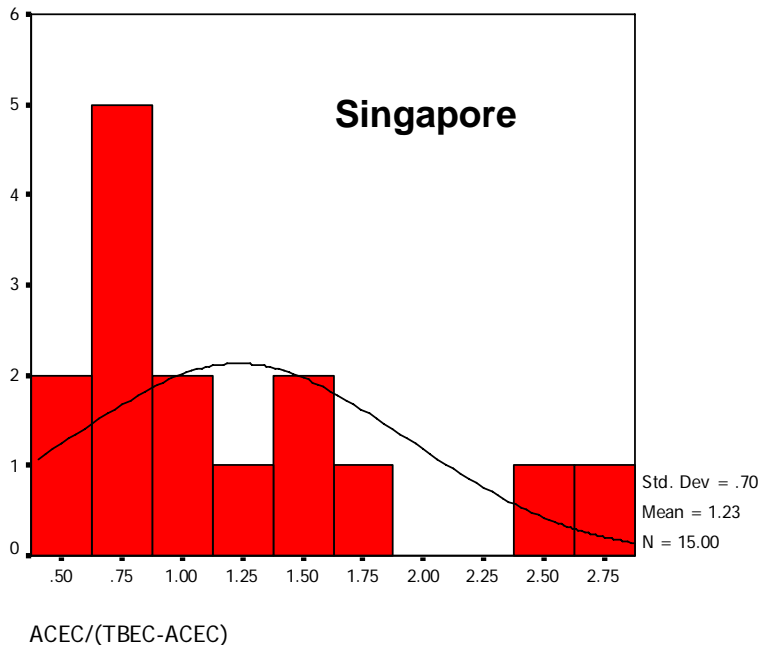
Total lighting EUI based on GFA (excluding car park area and consumption)



Lighting EUI based on OCA (Occupied area)

Result of preliminary analysis of Malaysian data

EUI comparison between Singapore and Malaysia: Alternative relative indicator: ACEC/ (TBEC-ACEC)



Result of preliminary analysis of Malaysian data



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EUI comparison between Singapore and Malaysia:

Possible reasons for Singapore's higher EUI:

- Higher internal loads? E.g. data centre, computers.
- Weather condition is tougher?
- Did we compare apples with oranges- building nature is different, e.g. services level, building function?
- Discrepancy of floor area definition. e.g. GFA (car park)?
- Building operation: occupancy density is higher, floor occupancy rate is higher, but more comfortable?
- Data integrity and validity of Singapore and Malaysia data.
- Discrepancy of common design concept, e.g. design efficiency?
- Inefficient building design and/or operation, e.g. curtain wall?

***Further investigation is needed.**



Benchmarking-based building energy simulation



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Objective:

Energy simulation is conducted to evaluate the potential of energy and cost saving in buildings, and give suggestions of economic-effective measures to take.

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Benchmarking-based building energy simulation



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Method:

A series of reference buildings are developed based on the local common designs, standards, literature review of previous studies, and data extracted from benchmarking database of commercial office buildings.

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Benchmarking-based building energy simulation



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Method:

Investigations are conducted with the focus on the application of sun shading device, day lighting, natural and hybrid ventilation, efficient and effective cooling system and technology and cool materials on building design and retrofits processes. The benchmarking and classification system together with the outcome of the simulation can provide the following benefits:

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Benchmarking-based building energy simulation



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Contributions:

Technical potential: an estimation of overall building energy saving potential based on whole building energy performance benchmarking.

Economic potential: a guideline of energy efficient designs and measures in buildings under tropical climatic conditions. The energy and cost saving potential of each individual design and measure and the combined system are provided quantitatively.

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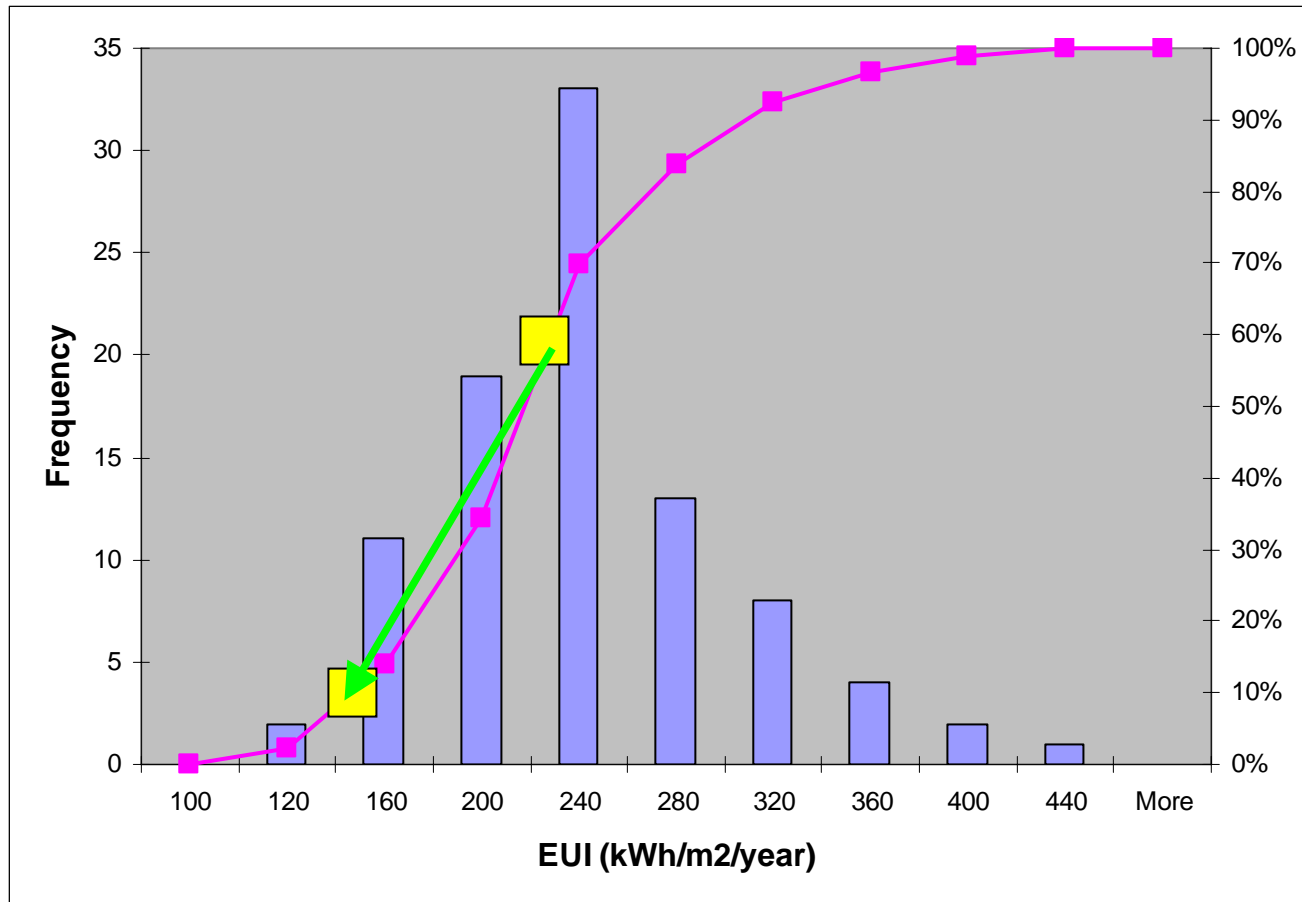


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Benchmarking-based building energy simulation



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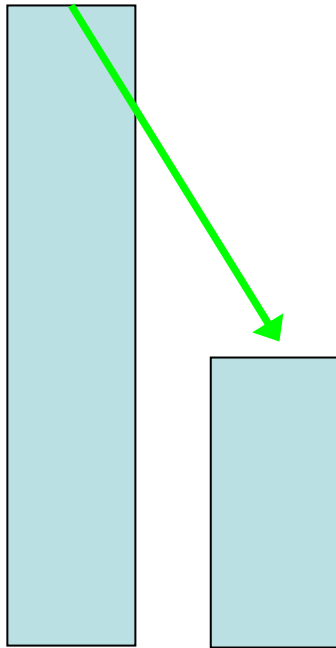
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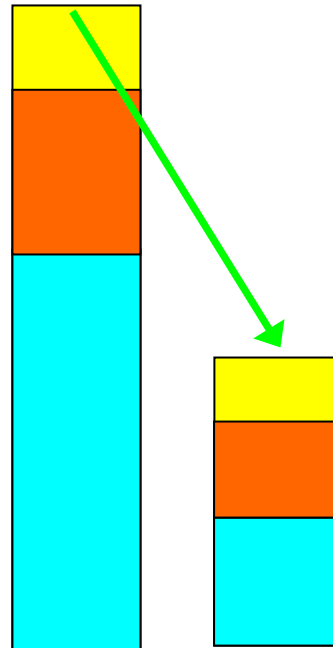
Benchmarking-based building energy simulation

Technical Potential



**Level 1:
Building Bmark**

Economic Potential



**Level 2:
Systems Bmark**

**General Potential
ECMeasures:**

Measure 1: 30% saving

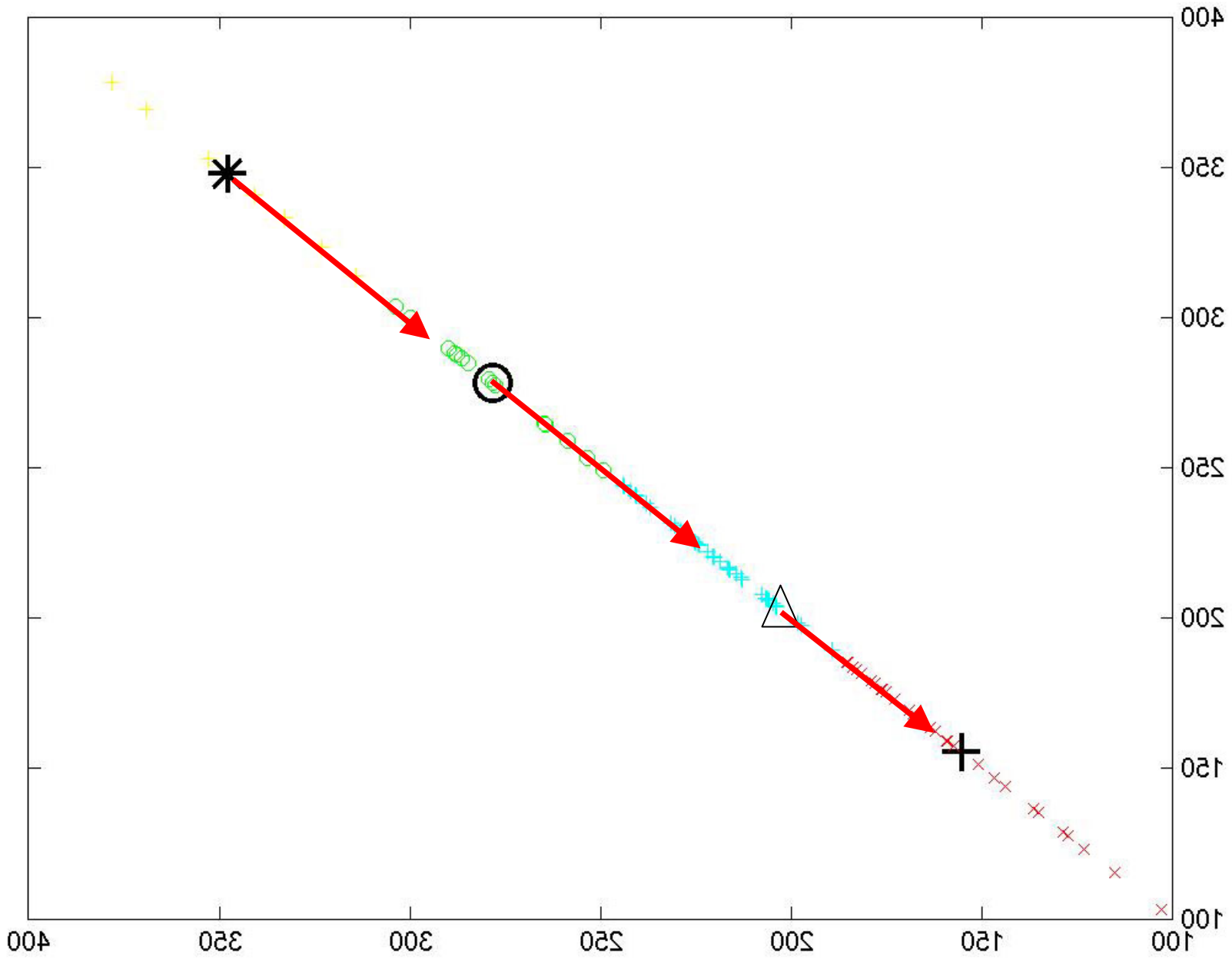
Measure 2: 15% saving

Measure 3: 10% saving

Measure 4: 10% saving

Measure 5: 5% saving

**Level 3: Reference
Building Simulation-
Guideline**



Next phase work plan

- Data collection in Singapore and Malaysia
- Web-based building energy benchmarking system in Malaysia
- Benchmarking of systems' energy performance
- Advanced benchmarking and classification methods
- Building energy simulation
- Other building types: hotel
- Publications: journal, final report and guideline

Thank you

Sun Hansong (Project Leader of EAEF Project 68)

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Statement



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