

# Energy Benchmarking Tool for Low-Carbon Transformation in Hong Kong: A Scientific Approach and Its Practical Applications

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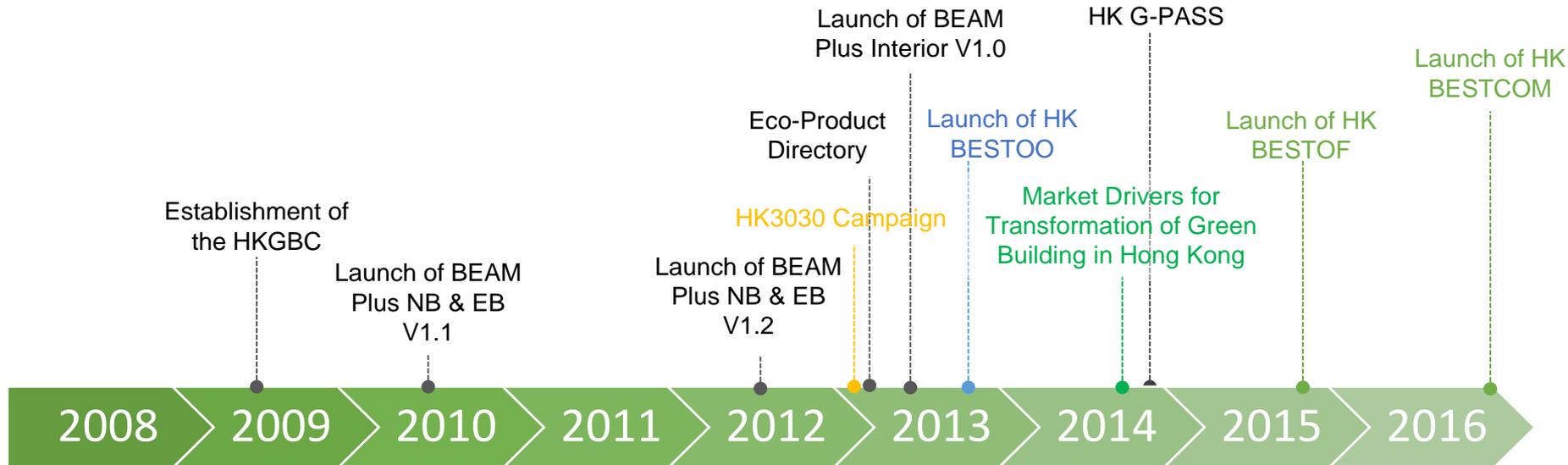
Hong Kong Green Building Council

# Hong Kong's Green and Energy Saving Initiatives

## Environmental drivers



- BEAM Plus assessment systems (NB/EB/Interiors/Neighbourhood)
- HKGBC Benchmarking and Energy Saving Tool – Office Occupants (HK BESTOO)
- HKGBC Benchmarking and Energy Saving Tool – Office Buildings (HK BESTOF)
- HKGBC Benchmarking and Energy Saving Tool – Commercial Buildings (Office/Retail) (HK BESTCOM)
- Eco-Product Directory
- HKGBC Green Product Accreditation and Standards (HK G-PASS)
- HK3030 Campaign
- Market Drivers for Transformation of Green Buildings in Hong Kong



Organisers:

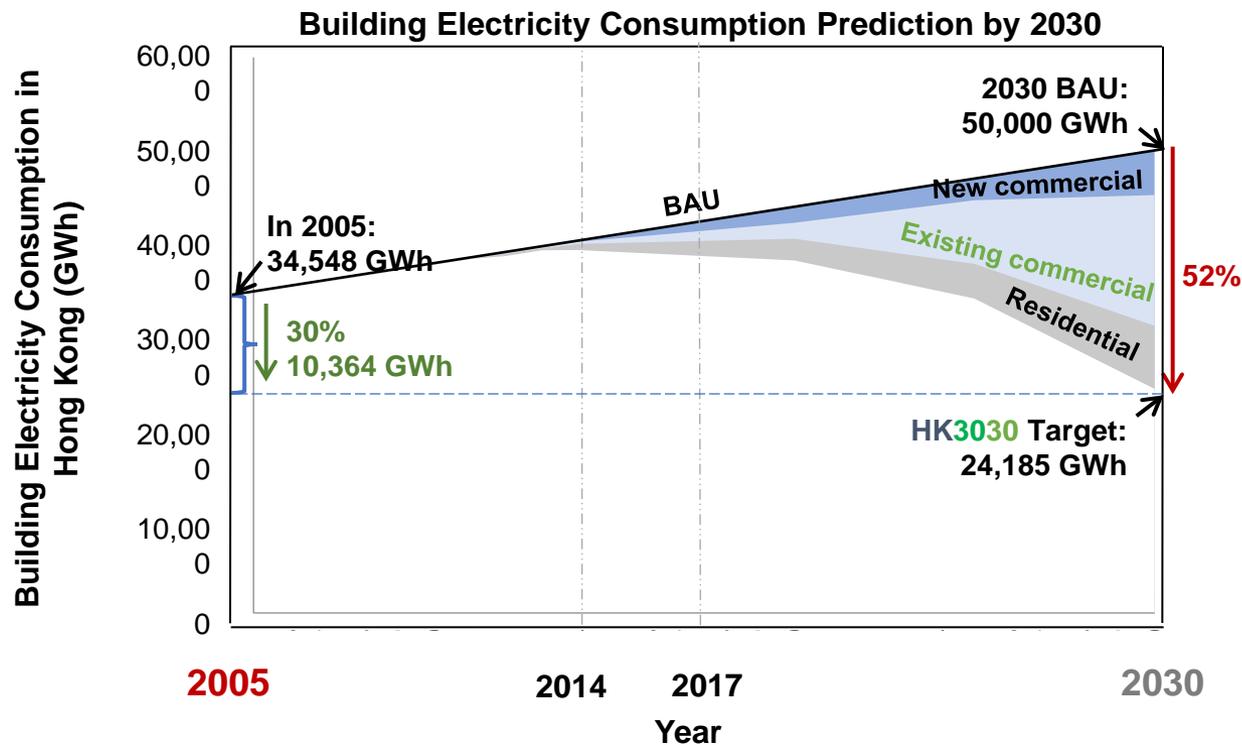


International Co-owners:



# HKGBC HK3030 Campaign

- HK3030 Campaign aims to enable a **reduction of 30%** to the absolute building electricity consumption by 2030, as **compared to the level of 2005**.



## Key Facts:

Buildings take up over **90% of electricity** consumption in Hong Kong

Account for more than **60% of greenhouse gases emission**

The HKGBC was **established in 2009** to lead the market transformation to a sustainable building environment



Organisers:



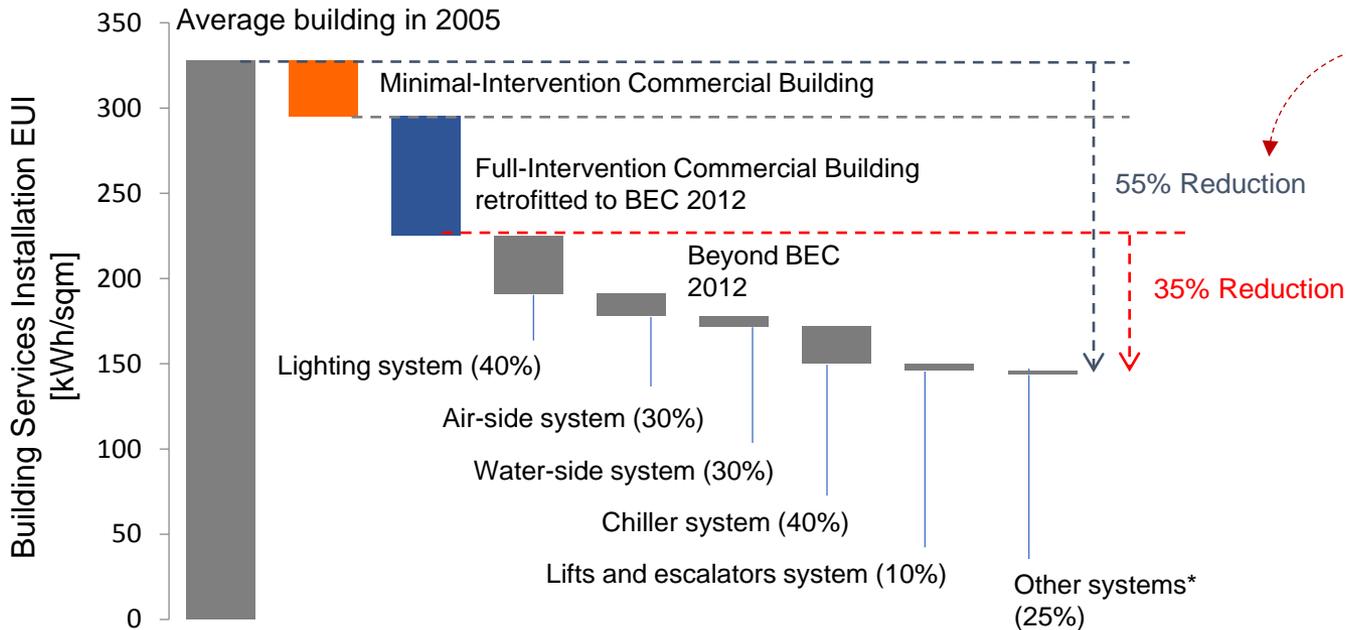
International Co-owners:



# Opportunities for Existing Buildings (EB)

- About **58% of building electricity demand** in the year 2030 will come from existing commercial buildings
- On average, these buildings will need to **reduce energy use intensity by 55%**, as compared to the intensity level of an average commercial building in 2005.

Reporting → **Benchmarking** → Retro-commissioning → Retrofitting



Remark: Bracketed percentage refers to increase in efficiency to that specific system through equipment specifications and enhanced controls/operation

\*Other systems include: Centralised hot water, Pumping, Mechanical ventilation, etc.



Organisers:



International Co-owners:



# Energy Utilisation Index(EUI) doesn't tell the whole story...

A building's energy efficiency can be related to many building characteristics / constraints:

## Service provision

- 24-hour A/C
- F&B
- Convention Centre
- Common Area

**Building A:** EUI: 500 MJ/m<sup>2</sup>/annum

Facilities: Grade A Office, F&B, 24-hour A/C  
Occupancy Rate: 70%

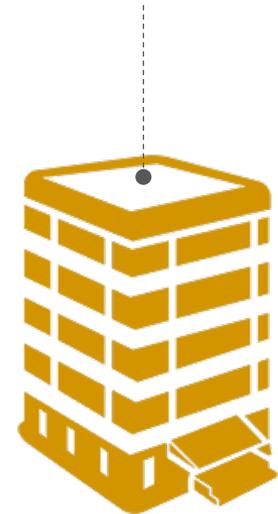
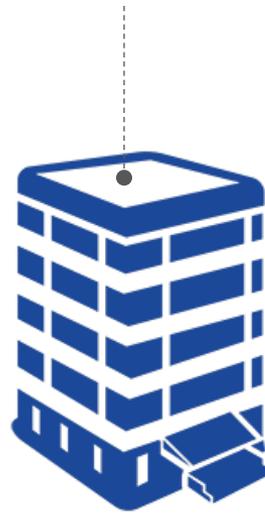
**Building B:** EUI: 400 MJ/m<sup>2</sup>/annum

Facilities: Typical Grade B Office  
Occupancy Rate: 60%

Building Services Installations

Operation Hours

Occupancy Rate



Which building is more energy efficient?

# Benefit of Energy Benchmarking

**Benchmarking brings the answers to following high-level questions:**

- i) Where is each building positioned in the market in terms of its energy use?
- ii) What is the potential of energy saving for the whole building sector of similar buildings?
- iii) How is performance of the local market compared to the rest of the world?



© Arup

*Note: numbers for illustration purpose, not actual EUI value*



Organisers:



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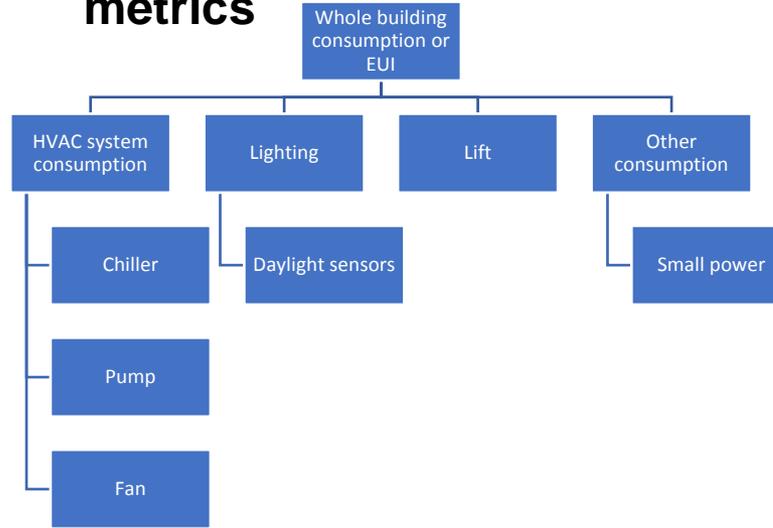
# State-of-the-art Methods and Existing Rating Programs Worldwide

Point-based Rating System (e.g. BEAM Plus, LEED)

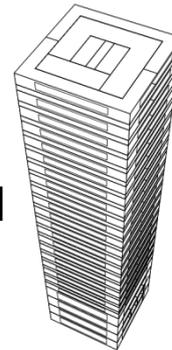


LEED® Facts	
[Your Project Here] [City, State, County]	
LEED for New Construction	
<b>Platinum</b>	<b>110*</b>
Sustainable Sites	26
Water Efficiency	10
Energy & Atmosphere	35
Materials & Resources	14
Indoor Environmental Quality	15
*Out of a possible 100 points + 10 bonus awards	
Innovation & Design	6
Regional Priority	4

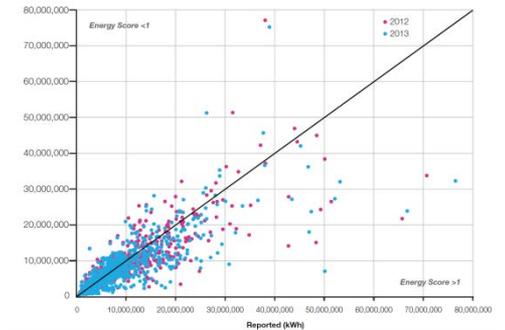
Hierarchical and End-use metrics



Simulation Model-based Approach



Statistical Approach (Regression)



More suitable for Hong Kong's unique building context!



Organisers:



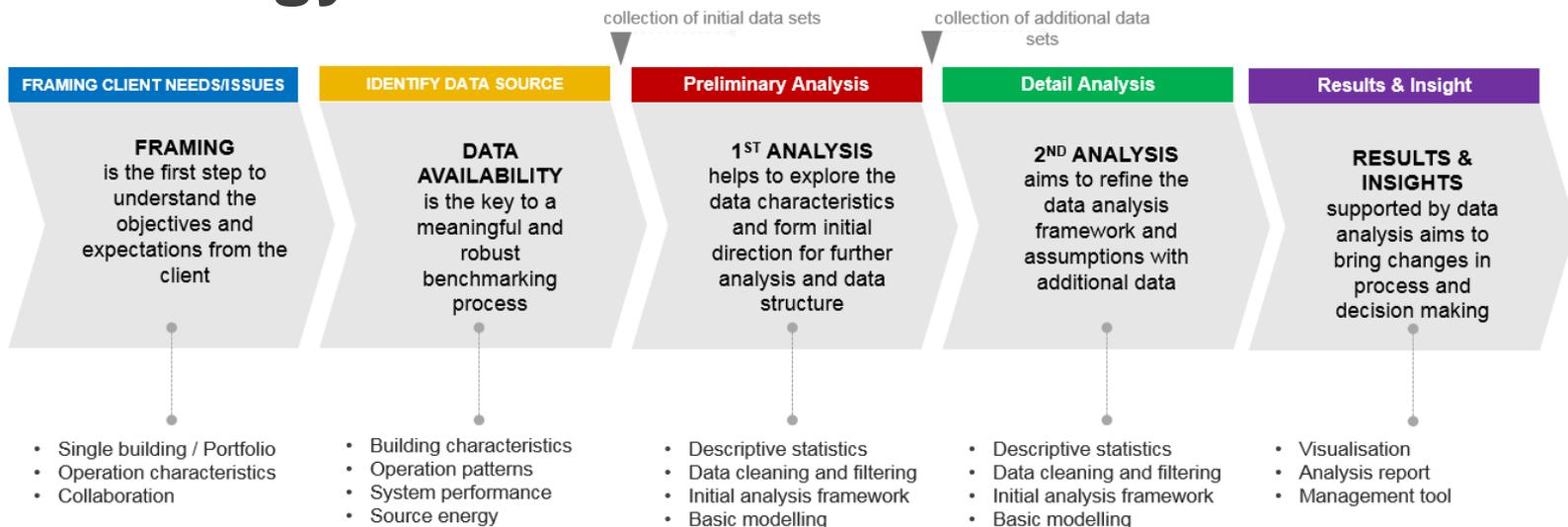
International Co-owners:



# Challenges

- Large no. of mixed-used buildings (e.g. Commercial & Retail, Headquarters)
- Variation in operations patterns (e.g. building w/ 24-hour A/C)
- Data quality (e.g. lack of sub-metering for older buildings)

# Methodology



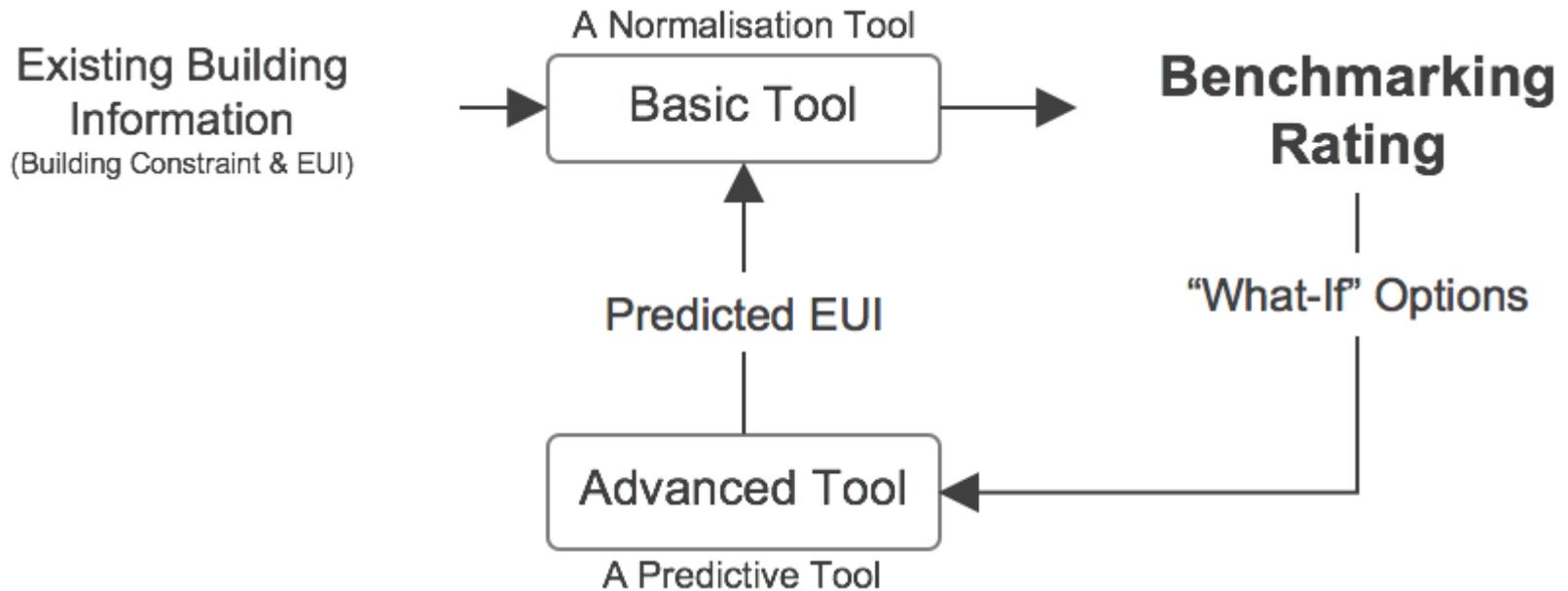
Organisers:



International Co-owners:



# The Benchmarking Tool



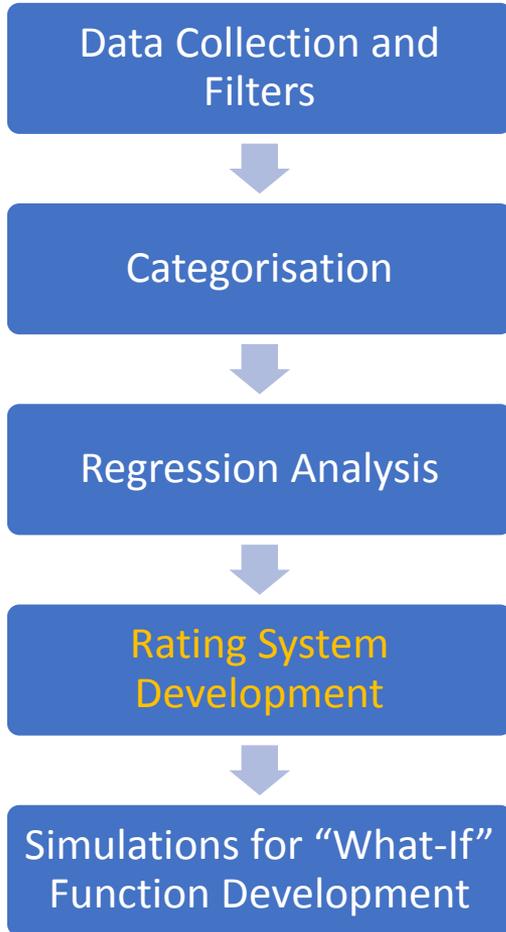
Organisers:



International Co-owners:



# Development Process



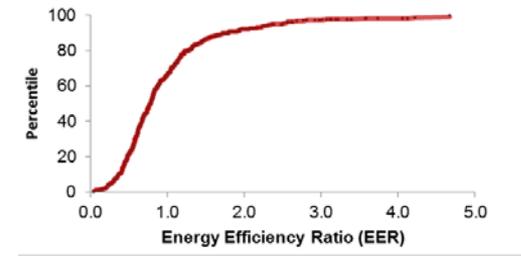
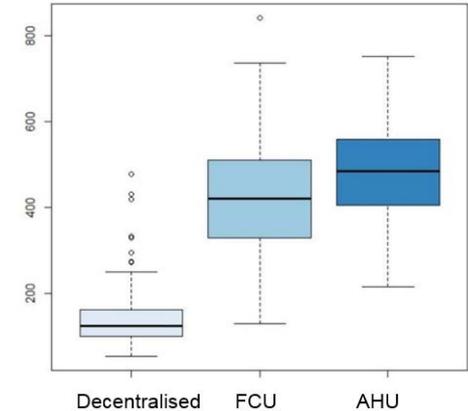
Outliers, wrong inputs, missing data

AHU, FCU and Decentralised

Parameter correlation, transformation (e.g. natural log), sensitivity test

Rating based on normalised EUI  
 $EER = \text{Measured EUI} / \text{normalised EUI}$

Matrix formed by simulations results for key performance parameters (Chiller COP, chilled water loop, LPD etc.)



Note: numbers for illustration purpose, not actual EUI value



Organisers:



International Co-owners:



# Online Platform

**HKGBC** 香港綠色建築議會

HKGBC BENCHMARKING AND ENERGY SAVING TOOL - COMMERCIAL BUILDINGS (OFFICE/RETAIL)

Funding Support **CONSTRUCTION INDUSTRY COUNCIL** 建造業議會

Introduction | Free Benchmarking Tool | Recognition Scheme Application | Authorised Assessor List | News | Resources

HKGBC Benchmarking and Energy Saving Tool for Commercial Buildings (HK BESTCOM) is an online benchmarking tool to promote energy efficiency for commercial in Hong Kong

**Key Facts**

Buildings are responsible for over **90% of electricity consumption** in Hong Kong and account for more than **60% of greenhouse gas emissions**

HKGBC Benchmarking and Energy Saving Tool - Commercial Buildings (Office/Retail) is developed by Hong Kong Green Building Council Limited as a part of the HKGBC Benchmarking and Energy Saving Tool (HK BEST) Series.

**Objective**

The objective of the HKGBC Benchmarking and Energy Saving Tool - Commercial Buildings (Office/Retail) is to promote better energy performance for commercial buildings by:

1. Providing an online tool for the building owners to measure and compare their energy consumption to their market peers and to identify potential energy improvement measures to enhance performance;
2. Giving an appropriate class of recognition to which have achieved outstanding energy performance amongst their market peers while accounting for variations in energy consumption across different building types through the issuance of Certificate and Label.

**Useful Links**

- HKGBC
- HK BEST
- Certified Buildings List

**HK BESTCOM offers**

1. **Free Benchmarking Tool**
  - Free for general public
  - Rate the general energy performance of commercial buildings
2. **Recognition Scheme**
  - Provide detailed assessment of building energy performance by Authorised Assessor
  - Obtain specific energy efficiency improvement recommendations via "What-If" assessment
  - "What-If" assessment provides building owners with quantified improvement estimations in different aspects of building operational performance, revealing potential reduction in operation cost
  - Award of certificate based on building energy performance

**Free Benchmarking Tool**

1. What is the **Annual Total Energy Consumption** of the building in the past 12 months?

0 400,000,000 5,000 MJ/annum

Your input is outside the range of common buildings in Hong Kong, please double check your input before proceed.

2. What is the **internal floor area (IFA)** and **gross floor area (GFA)** of the building?

IFA: 0 200,000 10,000 m<sup>2</sup>

GFA: 0 200,000 10,682 m<sup>2</sup>

3. What is the **% area of total building entity** served by CBSE with the following major usage:

- Office: 5.6 %
- Retail (Shopping & Leisure) Area: 10.1 %
- Back of House Area: 7.0 %
- Restaurant: 15.5 %
- Car Park: 23.3 %
- Others: 5.0 %

Total: (The sum of % area of total building entity shall be 100%) 66.5%

4. What is the portion of the building entity being **Common Area**? 5.6 %

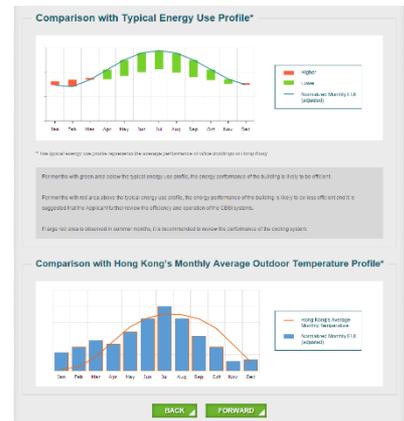
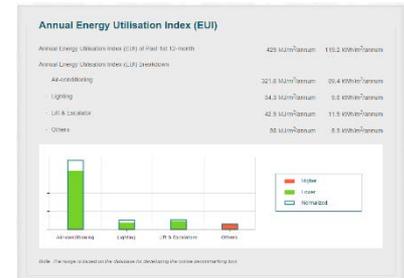
5. What is the **Bimonthly Normal Operating Hours** for office work? 0 336 80 hours

6. What is the **Bimonthly Normal Operating Hours** for retail? 0 336 40 hours

7. What is the **Major Type of Air-side System** serving the AC area of building entity?

FCU  AHU

ENTER



Organisers:



International Co-owners:



# Becoming a HK BEST Authorised Assessor



BEAM Pro + Registered Energy Assessor + Training



Organisers:



International Co-owners:



# Free Benchmarking Tool

**Prepare Basic Information**

- Total Energy Consumption in the past 12 months
- Internal Floor Area (m<sup>2</sup>) / Gross Floor Area (m<sup>2</sup>)
- % Area of Total Building Entity of:
  - Car Park; Retail (Shopping & Leisure); Restaurant; Office; Back of House; Others
- % of Building Entity being Common Area\*\*
- Biweekly Normal Operation Hours for Office Work
- Type of Air-conditioning System
- Major Type of Air-side System

Home > Free Benchmarking Tool > Free Benchmarking Tool

### Free Benchmarking Tool

1. What is the Annual Total Energy Consumption of the building in the past 12 months?

0  MJ/annum  MJ/annum

0  kWh/annum

Note: If input is larger than 60,000,000 MJ/annum, please input manually

2. What is the internal floor area (IFA) and gross floor area (GFA) of the building?

IFA: 0  m<sup>2</sup>  m<sup>2</sup>

GFA: 0  m<sup>2</sup>  m<sup>2</sup>

Note: If input is larger than 200,000m<sup>2</sup>, please input manually

3. What is the % area of total building entity served by CBSI with the following major usage:

- Office:  %
- Retail (Shopping & Leisure) Area:  %
- Back of House Area:  %
- Restaurant:  %
- Car Park:  %
- Others:  %
- Total: 0.00%

4. What is the portion of the building entity being Common Area?  %

Fill in details for analysis

Home > Free Benchmarking Tool > Free Benchmarking Result

### Free Benchmarking Result

HKGBC Benchmarking and Energy Saving Tool - Commercial Buildings (Office/Retail) (HK BESTCOM) Assessment Result

**GOOD TOP 25%**

Obtain general result

Average - The energy performance of the building is between the bottom 50<sup>th</sup> percentile and top 25<sup>th</sup> percentile of other similar commercial buildings

Below Average - The energy performance of the building is among the bottom 50<sup>th</sup> percentile of other similar commercial buildings

[BACK](#)



Organisers:



International Co-owners:



# Recognition Scheme

Select the Building Type



## Benchmarking & Energy Saving Tool

Please choose your building type from the following two options:

**1. Commercial Building (office/retail) Served by Centralised Air-conditioning System**

This option covers pure office building, pure retail building, composite building with both office and retail portions. No limit on area percentage is set for office and retail portion as long as the majority of the building is served by a centralised air-conditioning system. The eligible major type of air-side system should be one of the following:

- AHU (CAV/VAV)
- FCU

**2. Office Building Served by Decentralised\* Air-conditioning System**

Your building is eligible for this option only if the office area >40% of the building's internal floor area (IFA) and larger than areas specific for other major uses based on IFA.

\* Decentralised air-conditioning system refers to unitary or split type systems

NEXT



Organisers:



International Co-owners:



# Recognition Scheme

Fill in the details

**Benchmarking & Energy Saving Tool**

1. What is the **Annual Total Energy Consumption** of the building in the past 12 months?

0 60,000,000 MJ/annum

11,289,135 MJ/annum

3,135,871 kWh/annum

2. What is the **Internal floor area (IFA)** and **gross floor area (GFA)** of the building?

IFA

0 200,000

26,315 m<sup>2</sup>

GFA

0 200,000

25,000 m<sup>2</sup>

3. What is the % **area of total building entity** served by the following major usage:

- Office: 68 %
- Retail (Shopping & Leisure) Area: 10 %
- Back of House Area: 7 %
- Restaurant: 3 %
- Car Park: 5 %
- Others: 7 %

Total: 100.00%

4. What is the portion of the building entity being **Common Area** ?

36 %

5. What is the **Biweekly Normal Operating Hours** for office work?

0 336

192 hours

6. What is the **Biweekly Normal Operating Hours** for retail?

0 336

75 hours

7. What is the **Major Type of Air-side System** serving the AC area of building entity:

FCU  AHU (CAV/IVAV)

8. Does the building provide 24-hour air-conditioning for the building?

Yes  No

9. Is the major type of building facade curtain wall?

Yes  No

10. Date of issue of occupation approval (dd/mm/yyyy)?

30/03/2005

11. Does the HVAC system use air-side heat recovery technology for the building?

Yes  No

12. Does the building adopt free cooling strategy for the building?

Yes  No

13. Does the building adopt natural ventilation for the building?

Yes  No

14. Annual Energy Consumption Breakdown

- % of Air-conditioning energy in annual total energy consumption: 60 %
- % of lighting energy in annual total energy consumption: 20 %
- % of Lift & Escalator energy in annual total energy consumption: 12 %
- % of Others energy in annual total energy consumption: 8 %

Total: 100.00%

16. Lighting Installation Breakdown

Office Floors	Area	Biweekly Operation Hours	Is Occupancy Sensor Adopted?	Lighting Power
Corridor	1000 m <sup>2</sup>	123 hours	<input type="radio"/> Yes <input checked="" type="radio"/> No	12.0 kW 43.2 MJ/h
Lift Lobby	1000 m <sup>2</sup>	123 hours	<input checked="" type="radio"/> Yes <input type="radio"/> No	12.0 kW 43.2 MJ/h
Toilet (Office)	1 m <sup>2</sup>	123 hours	<input type="radio"/> Yes <input checked="" type="radio"/> No	12.0 kW 43.2 MJ/h
<b>Shopping, Leisure &amp; Restaurant Floors</b>				
Corridor	123 m <sup>2</sup>	123 hours	<input checked="" type="radio"/> Yes <input type="radio"/> No	12.0 kW 43.2 MJ/h
Lift Lobby	123 m <sup>2</sup>	123 hours	<input type="radio"/> Yes <input checked="" type="radio"/> No	12.0 kW 43.2 MJ/h
<b>Other Areas</b>				
Car Park	123 m <sup>2</sup>	123 hours	<input checked="" type="radio"/> Yes <input type="radio"/> No	12.0 kW 43.2 MJ/h
Plant Room	123 m <sup>2</sup>	123 hours	<input type="radio"/> Yes <input checked="" type="radio"/> No	12.0 kW 43.2 MJ/h
Staircase	12 m <sup>2</sup>	123 hours	<input checked="" type="radio"/> Yes <input type="radio"/> No	12.0 kW 43.2 MJ/h
Toilet (Non-office)	123 m <sup>2</sup>	123 hours	<input type="radio"/> Yes <input checked="" type="radio"/> No	2.0 kW 7.2 MJ/h
Misc.	1123 m <sup>2</sup>	123 hours	<input checked="" type="radio"/> Yes <input type="radio"/> No	1.0 kW 3.6 MJ/h
<b>Total</b>	<b>3751 m<sup>2</sup></b>			<b>99.0 kW 356.4 MJ/h</b>

16. Lift

Does building provide any lifts/escalators?

Yes  No

- Sub-total rated motor power, of all traction lifts: 200.0 kW 720.0 MJ/h
- Biweekly normal operating hours of all traction lifts: 200 hours
- Sub-total rated motor power, of all escalators and passenger conveyors: 50.0 kW 180.0 MJ/h
- Biweekly normal operating hours of all escalators and passenger conveyors: 200 hours
- What type of motor drive system is the building using for traction lifts?
  - DC motor drive with generator set (DC M-G)
  - AC motor drive with variable voltage controller (ACVV)
  - AC motor drive with variable and variable frequency controller (ACVVVF)
- Are the traction lifts using regenerative drive?
  - Yes  No
- Does the escalators adopt any service-on-demand control?
  - Yes  No
- What type of service-on-demand control does the escalators use?
  - Automatic start/stop  Two-speed escalator

17. Monthly EUI of past 12 month period (kWh/m<sup>2</sup>/month)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
30	30	30	30	30	30	30	30	30	30	30	30

18. Air-Conditioning

- Of Free Chiller?
  - Yes  No
- Chiller heat rejection:
  - Air-cooled Chiller  Water-cooled Chiller
- Chiller Characteristics:
  - Constant Speed Drive  Variable Speed Drive
- Chilled Water Supply:
  - Constant Primary Flow / Variable Secondary Flow  Variable Primary Flow
- Average Chiller Rated COP:
 

4.0 6.5 4.1 COP

RESET SUBMIT BACK



# Recognition Scheme

Result page based on the current condition of the building

**HKGBC Benchmarking and Energy Saving Tool - Commercial Buildings (Office/Retail) (HK BESTCOM)**

**Assessment Result**

**Silver** **TOP 30%**



**Platinum** - Reach Top 10<sup>th</sup> Percentile of range of data  
**Gold** - Reach Top 20<sup>th</sup> Percentile of range of data  
**Silver** - Reach Top 30<sup>th</sup> Percentile of range of data  
**Bronze** - Reach Top 40<sup>th</sup> Percentile of range of data  
**Green** - Reach Top 50<sup>th</sup> Percentile of range of data  
**No Rating** - Below 50<sup>th</sup> Percentile of range of data

## Annual Energy Utilisation Index (EUI)

Annual Energy Utilisation Index (EUI) of Past 1st 12-month: 429 MJ/m<sup>2</sup>/annum 119.2 kWh/m<sup>2</sup>/annum

### Annual Energy Utilisation Index (EUI) Breakdown

Air-conditioning	321.8 MJ/m <sup>2</sup> /annum	89.4 kWh/m <sup>2</sup> /annum
Lighting	34.3 MJ/m <sup>2</sup> /annum	9.5 kWh/m <sup>2</sup> /annum
Lift & Escalator	42.9 MJ/m <sup>2</sup> /annum	11.9 kWh/m <sup>2</sup> /annum
Others	30 MJ/m <sup>2</sup> /annum	8.3 kWh/m <sup>2</sup> /annum



Note: The range is based on the database for developing the online benchmarking tool.

## Comparison with Typical Energy Use Profile\*



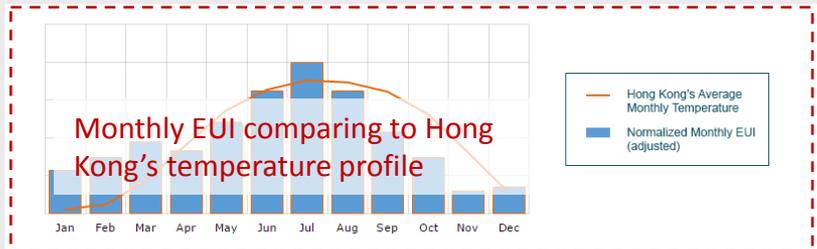
\* The typical energy use profile represents the average performance of office buildings in Hong Kong

For months with green area below the typical energy use profile, the energy performance of the building is likely to be efficient.

For months with red area above the typical energy use profile, the energy performance of the building is likely to be less efficient and it is suggested that the Applicant further review the efficiency and operation of the CBSI systems.

If large red area is observed in summer months, it is recommended to review the performance of the cooling system.

## Comparison with Hong Kong's Monthly Average Outdoor Temperature Profile\*



BACK

FORWARD



Organisers:



International Co-owners:



# Recognition Scheme

## Input for the “What-If” Function

Detail Result		What-if Function			
<b>Improvement Measures</b>					
1. Air-conditioning					
System Configuration					
Case	Oil Free Chiller	Heat Rejection	Chiller	Chilled Water Supply	
Your Current System	No	Air Cooled Chiller	Constant Speed	Constant Primary Flow	
<input type="radio"/> Improvement Option	No	Air Cooled Chiller	Constant Speed	Constant Primary Flow / Variable Secondary Flow	
<input type="radio"/> Improvement Option	No	Air Cooled Chiller	Variable Speed	Constant Primary Flow / Variable Secondary Flow	
<input type="radio"/> Improvement Option	No	Air Cooled Chiller	Variable Speed	Variable Primary Flow	
<input type="radio"/> Improvement Option	No	Water Cooled Chiller	Constant Speed	Constant Primary Flow	
<input type="radio"/> Improvement Option	No	Water Cooled Chiller	Constant Speed	Constant Primary Flow / Variable Secondary Flow	
<input type="radio"/> Improvement Option	No	Water Cooled Chiller	Variable Speed	Constant Primary Flow / Variable Secondary Flow	
<input type="radio"/> Improvement Option	No	Water Cooled Chiller	Variable Speed	Variable Primary Flow	
<input type="radio"/> Improvement Option	Yes	Air Cooled Chiller	Variable Speed	Constant Primary Flow / Variable Secondary Flow	
<input type="radio"/> Improvement Option	Yes	Air Cooled Chiller	Variable Speed	Variable Primary Flow	
<input checked="" type="radio"/> Improvement Option	Yes	Water Cooled Chiller	Variable Speed	Constant Primary Flow / Variable Secondary Flow	
<input type="radio"/> Improvement Option	Yes	Water Cooled Chiller	Variable Speed	Variable Primary Flow	
Average Chiller Rated COP:					
<input type="range" value="5.6"/>				5.6	COP

More efficient system configuration



Based on the current system configuration, more efficient system configurations will be given for users to choose from.

The target operating hours, lighting power density (LPD) and adjustment factor for daylight sensor of a specific area.

### 2. Lighting

Set target lighting power density (LPD) of the following areas:

Office Floors	Target Biweekly Operation Hours	Target Lighting Power Density	Adjustment Factor for Occupancy Sensors	Total Energy Reduced (weekly)	
Reduce the LPD in corridor to	180.0 hours	12.0 W/m <sup>2</sup>	1.0	456.0 kWh	1641.6 MJ
Reduce the LPD in Lift Lobby to	180.0 hours	10.0 W/m <sup>2</sup>	1.0	540.0 kWh	1944.0 MJ
Reduce the LPD in Toilet (Office) to	180.0 hours	10.0 W/m <sup>2</sup>	1.0	348.0 kWh	1252.8 MJ
<b>Shopping, Leisure &amp; Restaurant Floors</b>					
Reduce the LPD in corridor to	180.0 hours	10.0 W/m <sup>2</sup>	1.0	894.0 kWh	3218.4 MJ
Reduce the LPD in Lift Lobby to	180.0 hours	11.0 W/m <sup>2</sup>	1.0	753.0 kWh	2710.8 MJ
<b>Other Areas</b>					
Reduce the LPD in Car Park to	180.0 hours	3.0 W/m <sup>2</sup>	0.8	636.0 kWh	2289.6 MJ
Reduce the LPD in Plant Room to	180.0 hours	3.0 W/m <sup>2</sup>	1.0	690.0 kWh	2484.0 MJ
Reduce the LPD in Staircase to	180.0 hours	2.0 W/m <sup>2</sup>	0.8	648.0 kWh	2332.8 MJ
Reduce the LPD in Toilet (Non-office) to	180.0 hours	4.0 W/m <sup>2</sup>	0.8	480.0 kWh	1728.0 MJ
Misc.	180.0 hours	5.0 W/m <sup>2</sup>	1.0	93.0 kWh	334.8 MJ
<b>Total</b>				5538.0 kWh	19936.8 MJ

### 3. Lift

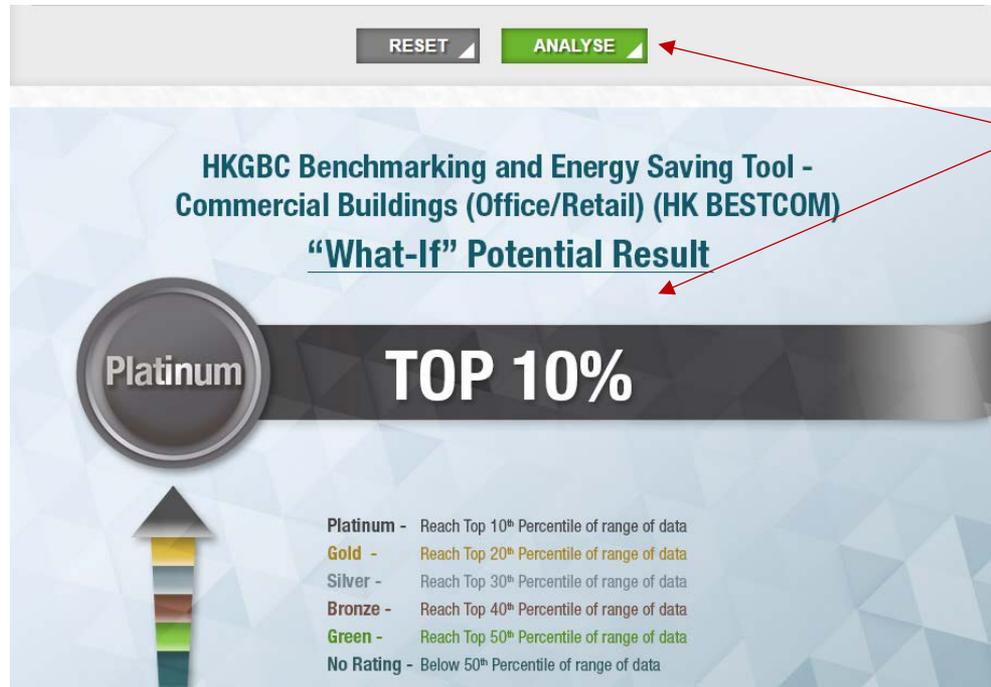
- Change all the traction lift to ACVVVF
- Use regenerative drive for the traction lift

User can choose more efficient systems for traction lifts



# Recognition Scheme

## “What-If” Function Result



After clicking the “Analyse” button, a potential rating will be given based on the selected improvement measures.

# Certification



Calculated Percentile of Operational Energy Performance	Free Benchmarking Tool Rating	Certificate & Label Rating to be Obtained after the Verified Assessment
Reach Top 10 <sup>th</sup> Percentile of range of data	Good	Platinum
Reach Top 20 <sup>th</sup> Percentile of range of data		Gold
Reach Top 30 <sup>th</sup> Percentile of range of data	Average	Silver
Reach Top 40 <sup>th</sup> Percentile of range of data		Bronze
Reach Top 50 <sup>th</sup> Percentile of range of data		Green
Below 50 <sup>th</sup> Percentile of range of data	Below Average	No Rating



Organisers:



International Co-owners:



# For more information...

- HKGBC Benchmarking and Energy Saving Tool – Commercial Buildings (Office/Retail) (HK BESTCOM)

<http://hkbest.hkgbc.org.hk/com/index.html>



- HKGBC Official Website

<https://www.hkgbc.org.hk/eng/index.aspx>



Organisers:



International Co-owners:



# Acknowledgement



## • Steering Committee Members

- Dr Benny CHOW - AEDAS
- Ms Terry CHOW – Hongkong Electric
- Mr Calvin KWAN – The Link Management Ltd.
- Mr Samuel KWONG – John Swire & Sons (HK) Ltd.
- Ir Simon LAM - CLP
- Sr Kenneth POON – LESK Solutions Co. Ltd.

## • Funding Support



## • Consultant Team

# ARUP



Organisers:



International Co-owners:



# Thank you



Organisers:



International Co-owners:

