Annex A: Challenge Statements and Building Information Details

Challenge Statement Owner:	**South Beach Consortium Pte Ltd (Developer)** **MCST No. 4622 (Building Owner)**
Building Name:	South Beach Tower
Address:	38 Beach Road, Singapore 189767
Building Typology:	Commercial Office Building
Contact Person	
Name:	Peter Wu
Email:	Peterwu-sbc@cdl.com.sg

Current Situation	South Beach is a mixed-use development comprising of Office, Hotel, Retail and Residential components. The aim of this challenge is to achieve SLE certification for South Beach (Commercial) which includes the Office, Hotel and Retail components only. South Beach Tower obtained TOP in Yr 2015. The current EUI for South Beach (Commercial) is 232 kwh/m2/yr. The current chiller system efficiency is 0.65kw/RT. The chiller system serves the aircon for Office (AHU), Retail (both AHU and FCU) and Hotel (FCU). The current AHU fans are centrifugal belt-driven fans. Based on the current system, South Beach is unable to meet the requirements to achieve SLE certification under BCA GM:2021 In Operation.

Challenge Statement for Demonstration	
Challenge Statement	To achieve BCA GM:2021 In Operation -Super Low Energy certification for South Beach using innovative technologies, smart building systems and optimization strategies. This is to be achieved with the following criteria: 1) no interruptions to business operations; 2) minimal inconvenience to tenants and building occupants; 3) lower cost of maintenance; 4) reduced carbon footprint In addition, to also demonstrate how the proposed immediate solutions can achieve net zero whole life operational carbon by Yr 2030 with a mid-term (3-5years) road map and long-term (5-7 years) road map.
Desired outcomes	Target Energy Utilisation Index (EUI) in kWh/m2/year: 71 Green Mark Certification Target : Super Low Energy Planned date for start of test bedding: Yr 2023 Planned date for completion of test bedding: Yr 2025 Planned date for commencement of operations: Yr 2025

Challenge Statement for R&I	
Challenge Statement	The Authorities issued a guidance note to improve ventilation and IAQ in buildings amidst the Covid-19 situation. The measures include

	• Deactivate the demand control system (e.g. C02 sensors) and fully open the fresh air dampers to maximize outdoor air intake.
	• Daily air purging before each occupancy
	
	Although these measures aim to reduce the C02 concentration, it also increases the relative humidity (RH) and energy consumption of the air conditioning system
	
	This challenge seeks to
	• Achieve significant improvements to the indoor air quality and the system efficiency of the air conditioning system within the office floor.
	• This is to be achieved with the following criteria
	  • no interruptions to business operations
	  • minimal inconvenience to tenants and building occupants
	  • reduced carbon footprint
	  • lower cost of maintenance
	  • payback period to be 3 - 5 years

Desired outcomes	• Airside air conditioning system efficiency to be 25-30% better than Green Mark 2021 Platinum level (0.14-0.15 kW/RT) • Total indoor C02 levels < 800ppm (NEA guidelines in the context of Covid) • Total Relative Humidity to be <65% (SS554 standards) • Respirable suspended particles < 50 µg/m3 (SS554 standards) • PM2.5 particulate <37.5 µg/m3 (SS554 standards) and Planned date for start of test bedding: Yr 2023 Planned date for completion of test bedding: Yr 2025 Planned date for commencement of operations: Yr 2025

Building Information (Office) - South Beach Tower

Building Name	**South Beach Tower**
Building Address	38 Beach Road S(189767)
Building Orientation	☐ North ☐ East ☐ South ☐ West ☑ Others. Please specify: North East
Age of Building	8
Gross Floor Area (total), m^2	59,905.42
Gross Floor Area (less car park and data centre), m^2	59,905.42
Window-Wall Ratio (WWR)	61%
Type of glazing system	☐ Single glazed ☐ Double glazed ☑ Low-e double glazed ☐ Others. Please specify:
Number of Floors	36 (including rooftop)
Average monthly building occupancy rate, %	98%
Current Green Mark Certification/Version	☐ Gold ☐ GoldPlus ☑ Platinum ☐ SLE Version (Please specify): GM NRB Version 3
EUI (kWh/m²/year) for past 3 years	2020: 110 2021: 110 2022: 127
Target EUI (kWh/m²/year)	100
Target Green Mark Certification	☑ SLE ☐ Zero Energy

ACMV

Air-conditioned floor area (%)	90%
Areas air-conditioned (please tick where applicable)	☑ Office ☐ Meeting Rooms ☐ Pantry ☑ Toilets ☐ Function areas ☑ Lift Lobbies ☐ Circulation/Transition spaces ☐ Others, please specify: Lobby
Building Cooling Load (,RT)	Office Hours: Max 1800RT 24 hours: Max 800 RT
Cooling Capacity, W/m^2	144 W/m^2
Air-Conditioning System Type	☑ Water-cooled chilled water system ☐ Air-cooled chilled water system ☐ Unitary Air Conditioning System ☐ Others: _____
For Water-cooled Chilled Water Systems:	
Type of compressor/Number of compressors	Squirel Cage / 1 compressor per chiller
Operational Chilled Water Temp/ΔT, °C	7.6 / ΔT= 5.2 Deg C
Cycle of Concentration,	NA
Condenser Water Treatment System	Impulsive condenser water treatment system

Age of chiller plant, years	8
Type of Refrigerant Used	R123
Number of Chillers and Installed Capacity	1000T – 4nos /500T-2nos
Efficiency of Chiller Plant System (kW/RT)	Chiller Plant: 0.616 Chiller: 0.519 CHW Pump: 0.037 CW Pump: 0.044 Cooling Tower: 0.014
Air Distribution System Type	☑ Air Handling Unit (AHU) ☑ Fan Coil Unit (FCU) ☐ Passive Displacement Cooling (PDC) Others. Please specify:
Number of Air-Handling Units (AHU) and type of fan motor	70 / Blower fan
Number of Fan Coil Units (FCU) and type of fan motor	115
Air distribution system efficiency (kW/Ton)	0.41
Number of Mechanical Fans and type of fan motor	9
Number of Exhaust Fans and type of fan motor	27

Lighting

Area tapping on natural lighting (m²)	
Artificial lighting area (m²)	
Artificial Lighting Type (please tick where applicable)	☑ LED ☑ Compact Fluorescent Lamps ☑ Fluorescent T5 Tube ☐ Fluorescent T8 Tube ☐ Fluorescent T12 Tube
Percentage of LED used (%)	80%
LED Luminaire Type	500
Lighting Power Density (W/m²)	Overall: 15 W/m² Guess Room: NA Office: NA Function Hall: NA Meeting Room: NA
Any occupancy sensors	☑ Yes ☐ No
Any Smart Lighting Management System	☐ Yes ☑ No
Any Daylight Harvesting System	☐ Yes ☑ No

Others:

Vertical Transportation System	☑ Lifts ☐ Escalators ☐ Others. Please specify:
Any energy efficient features	☐ Yes ☑ No. If yes, please specify:
Hot water system	☑ Yes ☐ No. If yes, please specify what type of system:
Purpose (Please specify)	For shower room

Control and Operations:

Does the building have any of the following systems:	
Chiller Plant and air-distribution optimisation/predictive maintenance system	☑ Yes ☐ No
Building energy management system	☐ Yes ☑ No
Smart plug load controls	☐ Yes ☑ No
Demand-controlled ventilation system	☑ Yes ☐ No

Renewable Energy

Does your building have any solar PV installation on the rooftop	☑ Yes ☐ No
If “Yes”, please provide the following information: a. Installed capacity (kWp) b. Panel efficiency, % c. Energy generated (annual), MWh d. Solar leasing model or purchased by owner	a. 79.2 kWp b. 16.8 c. 80,000kWh d. purchase by owner
If “no”, please let us know if you have plans to install or increase the capacity: a. Available roof top area for solar PV system b. Available façade area for BIPV/BAPV system (m^2) and its Orientation	

Challenge Statement Owner:	**CDL Properties Ltd**
Building Name:	Republic Plaza
Address:	9 Raffles Place, Singapore 048619
Building Typology:	Commercial Office Building
Contact Person (Main)	
Name:	George Woon
Email:	george.woon@cdl.com.sg
Contact Person (Second)	
Name:	Lawrence Kwok
Email:	lawrence.kwok@cdl.com.sg

Current Situation	The current building EUI approximately is 190 kWh/m2/yr. To enhance the building's ACMV system and aim for super low energy for upcoming Green Mark renewal.

Challenge Statement for Demonstration	
Challenge Statement	To achieve SLEB certification for Republic Plaza and aim for the building to be the first brown field SLEB for high-rise office buildings in Singapore. To convert a 24-year-old building into the most energy efficient and technologically advanced building through the use of innovative and smart building systems to meet the requirement certification for low energy consumption. The aim will be to lower maintenance cost, deploy lesser manpower, and lower OPEX repair cost.
Desired outcomes	Target Energy Utilisation Index (EUI) in kWh/m2/year: 71 Green Mark Certification Target : Super Low Energy Planned date for start of test bedding: Yr Q1 2023 Planned date for completion of test bedding: Yr Q2 2023 Planned date for commencement of operations: Yr 2H 2023

Challenge Statement for R&I	
Challenge Statement	To improve on the existing air filter system, MERV 14 filer, which has a significant pressure drop that resulted in energy wastage especially by the end of the filer life. Proposed solutions for filtration system should have the following outcomes: • At least 50% air filtration energy use reduction or 25-30% better than Green Mark 2021 Platinum level, whichever is higher. • Healthier IAQ for better tenants and visitors' experience • Deactivation of micro-organisms • Prevention of microbial growth in the filter • Filtration efficiency of 98% • Less frequent service

	If the test-bedding for the technology is successful, CDL will target to implement it in two towers at Republic Plaza progressively.
Desired outcomes	Energy savings of 25-30% better than Green Mark 2021 Platinum levels or better. Planned date for start of test bedding: Yr Q1 2023 Planned date for completion of test bedding: Yr Q2 2023 Planned date for commencement of operations: Yr 2H 2023

Building Information (Office) - Republic Plaza

Building Name	**Republic Plaza**
Building Address	9 Raffles Place, Singapore (048619)
Building Orientation	☐ North ☑ East ☐ South ☐ West ☑ Others. Please specify: Main entrance facing East.
Age of Building	25
Gross Floor Area (total), m^2	102,897.79
Gross Floor Area (less car park and data centre), m^2	84,268.79
Window-Wall Ratio (WWR)	TBA
Type of glazing system	☐ Single glazed ☑ Double glazed ☐ Low-e double glazed ☐ Others. Please specify:
Number of Floors	Tower 1 - 66 and Tower 2 – 23 (including rooftop)
Average monthly building occupancy rate, %	93%
Current Green Mark Certification/Version	☐ Gold ☐ GoldPlus ☑ Platinum ☐ SLE Version (Please specify): GM NRB Version 3
EUI (kWh/m²/year) for past 3 years	2020: 185 2021: 183 2022: 190
Target EUI (kWh/m²/year)	75
Target Green Mark Certification	☑ SLE ☐ Zero Energy

ACMV

Air-conditioned floor area (%)	92%
Areas air-conditioned (please tick where applicable)	☑ Office ☑ Meeting Rooms ☑ Pantry ☑ Toilets ☑ Function areas ☑ Lift Lobbies ☑ Circulation/Transition spaces ☑ Others, please specify: Main Lobby
Building Cooling Load (RT)	Office Hours: Max 2400RT 24 hours: Max 945 RT
Cooling Capacity, W/m^2	67.4 W/m^2
Air-Conditioning System Type	☑ Water-cooled chilled water system ☐ Air-cooled chilled water system ☐ Unitary Air Conditioning System ☐ Others: _____
For Water-cooled Chilled Water Systems:	
Type of compressor/Number of compressors	Chiller 1 to chiller 4 and chiller 6 – Centrifugal Chiller Chiller 5 – Screw Chiller
Operational Chilled Water Temp/ΔT, °C	Design 6.7 / ΔT= 5.5 Deg C
Cycle of Concentration,	11

Condenser Water Treatment System	3D Trasar water treatment system
Age of chiller plant, years	26 years
Type of Refrigerant Used	Refer to below
Number of Chillers and Installed Capacity	900RT – 1 no. (Faulty) HCFC 123 760RT – 4 nos. HCFC 123 350RT – 1 no. R134A
Efficiency of Chiller Plant System (kW/RT)	Chiller Plant: 0.61 Chiller: 0.515 CHW Pump: 0.035 CW Pump: 0.04 Cooling Tower: 0.02
Air Distribution System Type	☑ Air Handling Unit (AHU) ☑ Fan Coil Unit (FCU) ☐ Passive Displacement Cooling (PDC) Others. Please specify:
Number of Air-Handling Units (AHU) and type of fan motor	148. In progress replacing to Axial Fan
Number of Fan Coil Units (FCU) and type of fan motor	202
Air distribution system efficiency (kW/Ton)	0.15
Number of Mechanical Fans and type of fan motor	357
Number of Exhaust Fans and type of fan motor	

Lighting

Area tapping on natural lighting (m²)	Nil
Artificial lighting area (m²)	42,000m2. mainly at lift lobbies, main lobby, offices, carparks, staircase and common areas.
Artificial Lighting Type (please tick where applicable)	☑ LED ☑ Compact Fluorescent Lamps ☑ Fluorescent T5 Tube ☑ Fluorescent T8 Tube ☐ Fluorescent T12 Tube
Percentage of LED used (%)	Est 60%. In progress to replace toilet and M&E to LED
LED Luminaire Type	LED Downlight, LED Strip light, LED Fluorescent tube
Lighting Power Density (W/m²)	Overall: est. 7.42W/m2 Guess Room: NA Office: NA Function Hall: NA Meeting Room: NA
Any occupancy sensors	☑ Yes ☐ No In toilet and staircase
Any Smart Lighting Management System	☐ Yes ☑ No
Any Daylight Harvesting System	☐ Yes ☑ No

Others:

Vertical Transportation System	☑ Lifts ☑ Escalators ☐ Others. Please specify:
Any energy efficient features	☐ Yes ☑ No. If yes, please specify:
Hot water system	☑ Yes ☐ No. If yes, please specify what type of system:
Purpose (Please specify)	Water heater – for selected toilet with shower room facilities

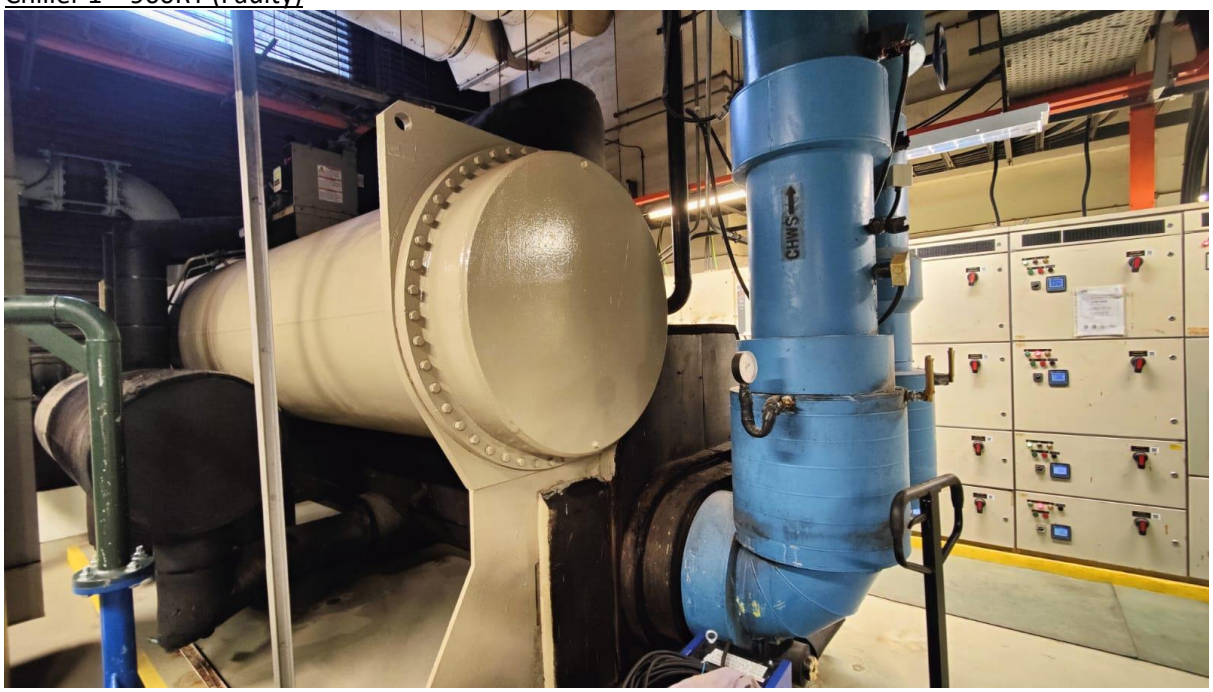
Control and Operations:

Does the building have any of the following systems:	
Chiller Plant and air-distribution optimisation/predictive maintenance system	☑ Yes ☐ No
Building energy management system	☑ Yes ☐ No
Smart plug load controls	☐ Yes ☑ No
Demand-controlled ventilation system	☑ Yes ☐ No Variable Air Volume Control. There is no CO2 sensor controlling the FA intake for AHU.

Renewable Energy

Does your building have any solar PV installation on the rooftop	☐ Yes ☑ No
If "Yes", please provide the following information: e. Installed capacity (kWp) f. Panel efficiency, % g. Energy generated (annual), MWh h. Solar leasing model or purchased by owner	
If "no", please let us know if you have plans to install or increase the capacity: c. Available roof top area for solar PV system d. Available façade area for BIPV/BAPV system (m^2) and its Orientation	No Available/Suitable place for PV.

Chiller 1 – 900RT (Faulty)



Chiller 2, 3 and 4 – 750RT

Chiller 5 - 350RT

Chiller 6 – 750RT

Piping Configuration

AHU

Challenge Statement Owner:	**OCBC Property Services Pte Ltd**
Building Name:	Bank of Singapore Centre (BOSC)
Address:	63 Market St, Singapore 048942
Building Typology:	Commercial Office Building
Contact Person	
Name:	Heng Wee Loon / Lester Chan
Email:	weeloonheng@ocbcproperty.com.sg / lesterchan@ocbcproperty.com.sg

Current Situation	There are many mid-sized commercial buildings that are running on VRF system. Under the portfolio of OCBC, half of its buildings are running on VRF system, and while OCBC has the aspiration to push its buildings towards SLE, there is a challenge to further optimise the energy performance of the VRV buildings. For example, OCBC faces challenges in pushing the Bank of Singapore Centre towards SLE despite conducting a comprehensive Energy audit to identify energy improvement opportunities.

Challenge Statement for R&I	
Challenge Statement	To explore emerging intelligent systems such as industrial metaverse coupled with innovative energy reduction solutions to push towards SLE for buildings cooled by VRV system. Solution should also respond to occupant's thermal comfort in real-time while not cooling unnecessary spaces. The proposed solution proposed should be scalable across similar office type, implementable with minimal disruption/downtime to existing operations within office space. 1. There should not be major overhaul of the current infrastructure such as ducting, wiring etc. 2. Installation can be completed after office offices and/or over the weekend. 3. Measurement and verification period of solution should not affect business as usual usage of space. Maintenance cost and effort of system/solution should also be comparable or less than the current system (eg. VRF system) being replaced; or minimum incremental maintenance effort if the solution is in addition to current setup. The space that will be provided for testbedding will comprise of a 'live' office space and an employee rest and dine area cooled by existing VRF system (estimate about 100 to 900 sqm). As this space will be a 'live' working environment, aesthetics of the pilot setup needs to be duly considered and provided.

Desired outcomes	The solution/system proposed should achieve 25-30% more energy savings than current Green Mark 2021 Platinum levels. Planned date for start of test bedding: Apr/May 2023 Planned date for completion of test bedding: Dec 2023 Planned date for commencement of operations: Dec 2023

Challenge Statement Owner:	**M&C REIT Management Limited**
Building Name:	M Hotel Singapore
Address:	81 Anson Road, M Hotel, Singapore 079908
Building Typology:	Hotel
Contact Person	
Name:	Edeline Tiong
Email:	edeline.tiong@millenniumhotels.com

Current Situation	M Hotel Singapore is strategically located in the heart of the financial district and is managed by Millennium & Copthorne International Limited. The hotel's current EUI is approximately 230 kWh/m2/yr. The hotel's cooling system and other assets are due for upgrading in the next few years. This presents a chance to review existing technologies and to implement new energy efficient building solutions.

Challenge Statement for Demonstration	
Challenge Statement	To achieve SLEB certification for M Hotel Singapore and aim for the building to be the first brown field SLEB hotel in Singapore. This will be achieved through using various innovative and smart building systems to meet the requirement of the certification. The expected results will be lower cost of maintenance and operation, reduction of building carbon footprint and ease of maintenance for the hotel staff.
Desired outcomes	Target Energy Utilisation Index (EUI) in kWh/m2/year: 118 Green Mark Certification Target : Super Low Energy Planned date for start of test bedding: Yr 2023 Planned date for completion of test bedding: Yr 2025 Planned date for commencement of operations: Yr 2025

Challenge Statement for R&I	
Challenge Statement	To develop energy efficient technologies and solutions to push boundaries of energy performance. M Hotel is open to solutions that consider the use of district cooling system (DCS) or In house chiller plant. In addition, energy efficient air side solutions will help to improve the total system efficiency of its ACMV installation and Indoor Air Quality (IAQ). All proposed solutions shall minimally have a simple payback of 5 years or below. Longer payback period can be considered on a case-by-case basis, provided the non-financial benefits are attractive. The complete suite of solutions shall be aligned with M Hotel's aspiration to achieve SLEB status. For ACMV , solutions should meet the following requirements:

	• AHU / FCU solutions – shall achieve 25-30% better than GM 2021 Platinum standard or demonstrate a reduction of energy consumption by 50% or more from existing system. • AC Total System efficiency – shall achieve 25-30% better than GM 2021 Platinum standard • IAQ solutions – Optimisation of Hotel's outdoor air supply while ensuring IAQ compliance • Mechanical ventilation – Optimisation of Hotel's exhaust fan system while ensuring compliance to IAQ and Code of practice For solutions to reduce solar heat gain, the below parameters should achieve 25-30% better than GM 2021 Platinum standard (or current best in class solutions): • Visible Light Transmittance (VLT) • Solar Heat Gain Coefficient (SHGC) • Total Solar Energy Rejected (TSER) • UV Rejection (UVR) • Infrared Rejection (IRR) • Glare Reduction
Desired outcomes	To improve the energy efficiency of building systems to meet the requirement for SLEB certification. For R&I technologies, the energy savings target is set at 25-30% better than Green Mark 2021 Platinum levels. Planned date for start of test bedding: Yr 2024/25 Planned date for completion of test bedding: Yr 2026 Planned date for commencement of operations: Yr 2026

Building Information (Hotel) - M Hotel Singapore

Building Name	**M Hotel Singapore**
Building Address	81 Anson Road, Singapore 079908
Building Orientation	☐ North ☐ East ☐ South ☐ West ☐ Others. Please specify:
Age of Building	38
Gross Floor Area (total), m^2	32,379.32
Gross Floor Area (less car park and data centre),m^2	31,033.00
Window-Wall Ratio (WWR)	29.71%
Type of glazing system	☐ Single glazed ☐ Double glazed ☐ Low-e double glazed ☐ Others. Please specify:
Number of Floors	29 + 2 Basement
Average monthly building occupancy rate, %	90%
Current Green Mark Certification/Version	☐ Gold ☑ GoldPlus ☐ Platinum ☐ SLE Version (Please specific):
EUI (kWh/m²/year) for past 3 years	2020: 181.72 2021: 152.64 2022: 170.75
Target EUI (kWh/m²/year)	168
Target Green Mark Certification	☑ SLE ☐ Zero Energy

ACMV

Air-conditioned floor area (%)	95%
Areas air-conditioned (please tick where applicable)	☑ Guest Rooms ☑ Office ☐ Pantry ☑ Meeting Rooms ☑ Function Halls ☐ Toilets ☑ Lift Lobbies ☐ Circulation/Transition spaces ☐ Others. Please specify:
Building Cooling load (RT)	Office Hours: 397.92 24 hours: 351.13
Cooling Capacity (W/m^2)	43.44 W/m2
Air-Conditioning System Type	☐ Water-cooled chilled water system ☐ Air-cooled chilled water system ☐ Unitary Air Conditioning System ☐ Others: _____
For water-cooled chilled water systems:	
Type of compressor/Number of compressors	Centrifugal chiller / 3 numbers
Operational Chilled Water Temp/ΔT, °C	4.8
Cycle of Concentration	9.56
Condenser Water Treatment System	Automatic water treatment system
Age of chiller plant, Years	19
Type of Refrigerant Used	R11
Number of Chillers and Installed Capacity	3 chillers (400 RT)

Efficiency of Chiller Plant System (kW/RT)	Chiller Plant: 0.657 Chiller: 0.522 CHW Pump: 0.033 CW Pump: 0.058 Cooling Tower: 0.044
Air Distribution System Type	☑ Air Handling Unit (AHU) ☑ Fan Coil Unit (FCU) ☐ Passive Displacement Cooling (PDC) Others. Please specify:
Number of Air-Handling Units (AHU) and type of fan motor	20 AHU / Belt driven Fan motor
Number of Fan Coil Units (FCU) and type of fan motor	104 FCU / single phase motor
Air distribution system efficiency (kW/Ton)	No available data
Number of Mechanical Fans and type of fan motor	10 Supply Air Fan
Number of Exhaust Fans and type of fan motor	7 Kitchen exhaust fans and 10 Toilet exhaust fans

Lighting

Area tapping on natural lighting (m²)	1,346
Artificial lighting area (m²)	31,033.00
Artificial Lighting Type (please tick where applicable)	☑ LED ☐ Compact Fluorescent Lamps ☐ Fluorescent T5 Tube ☐ Fluorescent T8 Tube ☐ Fluorescent T12 Tube
Percentage of LED used (%)	99%
LED Luminaire Type	LED indoor Luminaire Type
Lighting Power Density (W/m²)	Overall: 12 Guess Room: 15 Office: 8 Function Hall: 12 Meeting Room: 13
Any occupancy sensors	☐ Yes ☑ No
Any Smart Lighting Management System	☐ Yes ☑ No
Any Daylight Harvesting System	☐ Yes ☑ No

Others:

Vertical Transportation System	☑ Lifts ☑ Escalators ☐ Others. Please specify:
Any energy efficient features?	☑ Yes ☐ No If yes, please specify energy efficient motor and sleep mode on no usage
Hot water system	☑ Yes ☐ No. If "yes", please specify the purpose and amount used heat pump system

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Control and Operations:

Does the building have any of the following systems:	
Chiller Plant and air-distribution optimisation/predictive maintenance system	☐ Yes☑ No
Building energy management system	☑ Yes ☐ No
Smart plug load controls	☐ Yes☑ No
Demand-controlled ventilation system	☐ Yes☑ No

Renewable Energy

Does your building have any solar PV installation on the rooftop	☐ Yes☑ No
If "Yes", please provide the following information: a. Installed Capacity (kWp) b. Panel Efficiency, % c. Energy Generated (annual), MWh d. Solar leasing model or purchased by owner	
If "no", please let us know if you have plans to install or increase the capacity: a. Available roof top area for solar PV system b. Available façade area for BIPV/BAPV system (m^2) and its Orientation	Plan to have solar PV system in rooftop area

Challenge Statement Owner:	**Parkroyal Kitchener Hotel Pte Ltd**
Building Name:	Parkroyal Kitchener Hotel
Address:	181, Kitchener Road, Singapore 208533
Building Typology:	Hotel
Contact Person	
Name:	Abdul Aziz Selamat
Email:	aziz.selamat@parkroyalhotels.com

Current Situation	PARKROYAL on Kitchener Road is a four-star hotel located in Singapore's ethnic district, Little India. With a gross floor area of 37,721 square metres and a site area of 7,780 square metres, it resides at 181 Kitchener Road, next to Farrer Park MRT station. This hotel is a 21-storey high building and has over 500 guest rooms. With the increase in electricity cost, the group faces challenges in finding avenues to decrease energy consumption while still maintaining thermal comfort and occupants' satisfaction.

Challenge Statement for Demonstration	
Challenge Statement	To convert a 39-yr old building into the most energy efficient hotel through the use of innovative and smart building to achieve 75% energy efficiency. This will include the best-in-class cooling and lighting system and renewable energy to offset energy consumption. This would result in lowering monthly OPEX and easier maintenance.
Desired outcomes	Target Energy Utilisation Index (EUI) in kWh/m2/year: <119 Green Mark Certification Target : Super Low Energy Planned date for start of test bedding: Apr 2023 Planned date for completion of test bedding: Dec 2024 Planned date for commencement of operations: Dec 2024

Challenge Statement for R&I	
Challenge Statement	<u>Challenge Statement 1:</u> Due to restaurant kitchen exhaust, the aircon from the lobby and restaurant is unable to work as efficiently. That results in infiltration of untreated fresh air through the auto glass door entrance and cold air being blown out of the building. This creates a warm lobby and a waste of energy. Condensation and mouldiness were also created due to entering of untreated warm air. The challenge is to develop solutions to the problem through better air circulation design to counter the negative pressure into the lobby and to be more energy-efficient and adapt energy saving technologies to push boundaries of energy performance.

	<u>Challenge Statement 2:</u> The present heat pump system for hot water production releases the evaporator air on the roof. This energy can be recovered and be pumped back to the chiller as part of heat recovery. The challenge is to develop solutions to recover heat for useful areas using environmental friendly refrigerants, in accordance with Hotel's ISO 14001 policy, to achieve the best heating and cooling COP using the most efficient equipment to date.
Desired outcomes	Significantly improve the energy efficiency of ventilation technologies (i.e. 25-30% better than Green Mark 2021 Platinum levels) without compromising thermal comfort, IEQ requirements and occupant satisfaction and comfort. Planned date for start of test bedding: Jun 2023 Planned date for completion of test bedding: Jun 2025 Planned date for commencement of operations: Feb 2026

Building Information (Hotel) - Parkroyal on Kitchener Rd

Building Name	**Parkroyal on Kitchener Rd**
Building Address	181 Kitchener Rd
Building Orientation	☐ North ☐ East ☐ South ☐ West ☐ Others. Please specify: NW, E & SW
Age of Building	42
Gross Floor Area (total), m^2	37,721
Gross Floor Area (less car park and data centre),m^2	28,809
Window-Wall Ratio (WWR)	
Type of glazing system	X Single glazed ☐ Double glazed ☐ Low-e double glazed ☐ Others. Please specify:
Number of Floors	21 + Basement
Average monthly building occupancy rate, %	75%
Current Green Mark Certification/Version	☐ Gold ☐ GoldPlus X Platinum ☐ SLE Version (Please specific):
EUI (kWh/m^2/year) for past 3 years	2020: 159.73 2018: 180 2021: 2019: 173 2022:
Target EUI (kWh/m^2/year)	< 115
Target Green Mark Certification	X SLE ☐ Zero Energy

ACMV

Air-conditioned floor area (%)	
Areas air-conditioned (please tick where applicable)	X Guest Rooms X Office X Pantry X Meeting Rooms X Function Halls ☐ Toilets X Lift Lobbies ☐ Circulation/Transition spaces ☐ Others. Please specify:
Building Cooling load (RT)	Office Hours: 24 hours:
Cooling Capacity (W/m^2)	
Air-Conditioning System Type	X Water-cooled chilled water system ☐ Air-cooled chilled water system ☐ Unitary Air Conditioning System ☐ Others: _____
For water-cooled chilled water systems:	
Type of compressor/Number of compressors	Screw – 2, Centrifugal - 1
Operational Chilled Water Temp/ΔT, °C	9degC
Cycle of Concentration	9
Condenser Water Treatment System	Chemical
Age of chiller plant, Years	10
Type of Refrigerant Used	R134A
Number of Chillers and Installed Capacity	2 x 400RT, 1 x 500T

Efficiency of Chiller Plant System (kW/RT)	Chiller Plant: 0.647 Chiller: 0.468 CHW Pump: 0.092 CW Pump: 0.063 Cooling Tower: 0.022
Air Distribution System Type	X Air Handling Unit (AHU) X Fan Coil Unit (FCU) ☐ Passive Displacement Cooling (PDC) Others. Please specify:
Number of Air-Handling Units (AHU) and type of fan motor	30 / TEFC Motor
Number of Fan Coil Units (FCU) and type of fan motor	Rooms - 543
Air distribution system efficiency (kW/Ton)	
Number of Mechanical Fans and type of fan motor	5
Number of Exhaust Fans and type of fan motor	4

Lighting

Area tapping on natural lighting (m^2)	
Artificial lighting area (m^2)	
Artificial Lighting Type (please tick where applicable)	X LED ☐ Compact Fluorescent Lamps ☐ Fluorescent T5 Tube X Fluorescent T8 Tube ☐ Fluorescent T12 Tube
Percentage of LED used (%)	85%
LED Luminaire Type	
Lighting Power Density (W/m^2)	Overall: Guess Room: Office: Function Hall: Meeting Room:
Any occupancy sensors	X Yes ☐ No
Any Smart Lighting Management System	X Yes ☐ No
Any Daylight Harvesting System	☐ Yes X No

Others:

Vertical Transportation System	X Lifts ☐ Escalators ☐ Others. Please specify:
Any energy efficient features?	X Yes ☐ No If yes, please specify:
Hot water system	X Yes ☐ No. If “yes”, please specify the purpose and amount used – Guestrooms & Kitchen

Control and Operations:

Does the building have any of the following systems:	
Chiller Plant and air-distribution optimisation/predictive maintenance system	X Yes ☐ No
Building energy management system	☐ Yes X No
Smart plug load controls	☐ Yes X No
Demand-controlled ventilation system	☐ Yes X No

Renewable Energy

Does your building have any solar PV installation on the rooftop	☐ Yes X No
If “Yes”, please provide the following information: i. Installed Capacity (kWp) j. Panel Efficiency, % k. Energy Generated (annual), MWh l. Solar leasing model or purchased by owner	
If “no”, please let us know if you have plans to install or increase the capacity: e. Available roof top area for solar PV system f. Available façade area for BIPV/BAPV system (m²) and its Orientation	On Roof top and carpark roof

Challenge Statement Owner:	**Resorts World at Sentosa Pte Ltd**
Building Name:	Hotel Michael
Address:	8 Sentosa Gateway, Resorts World Sentosa S098269
Building Typology:	Hotel
Contact Person	
Name:	Davis Seow
Email:	davis.seow@rwsentosa.com

Challenge Statement for Demonstration	
Challenge Statement	To convert the hotel into the most efficient and technological advanced building using innovative and smart building systems to achieve 75% energy savings (from 2005 levels). This could include smart innovative and comprehensive hotel room management, hybrid cooling system, smart hot water management, outdoor cooling solutions for natural ventilation and novel renewable energy solutions.
Desired outcomes	Target Energy Utilisation Index (EUI) in kWh/m2/year: <119 Green Mark Certification Target : Super Low Energy Planned date for start of test bedding: Planned date for completion of test bedding: Planned date for commencement of operations:

Building Information (Hotel) - Hotel Michael, Resorts World Sentosa

Building Name	**Hotel Michael**
Building Address	8 Sentosa gateway, Resorts World Sentosa S098269
Building Orientation	☐ North ☐ East ☒ South ☐ West ☐ Others. Please specify:
Age of Building	12 years
Gross Floor Area (total), m^2	29,382
Gross Floor Area (less car park and data centre),m^2	27487.9 (rooms), 2475.21 (F&B outlets), 1415.09 (Pool/Gym/other facilities)
Window-Wall Ratio (WWR)	
Type of glazing system	☐ Single glazed ☒ Double glazed ☐ Low-e double glazed ☐ Others. Please specify:
Number of Floors	11 (L2 to L12)
Average monthly building occupancy rate,%	86.57%
Current Green Mark Certification/Version	☐ Gold ☒ GoldPlus ☐ Platinum ☐ SLE Version (Please specific):
EUI (kWh/m^2/year) for past 3 years	2020:126 (188 with DCP consumption) 2021:138 (218 with DCP consumption) 2022:127 (167 with DCP consumption)
Target EUI (kWh/m^2/year)	
Target Green Mark Certification	☒ SLE ☐ Zero Energy

ACMV

Air-conditioned floor area (%)	90%
Areas air-conditioned (please tick where applicable)	☒ Guest Rooms ☒ Office ☒ Pantry ☒ Meeting Rooms ☐ Function Halls ☒ Toilets ☒ Lift Lobbies ☒ Circulation/Transition spaces ☒ Others. Please specify: F&B Outlets
Building Cooling load (RT)	Office Hours: 24 hours:
Cooling Capacity (W/m^2)	31
Air-Conditioning System Type	☐ Water-cooled chilled water system ☐ Air-cooled chilled water system ☐ Unitary Air Conditioning System ☒ Others: DCP CHW
For water-cooled chilled water systems:	
Type of compressor/Number of compressors	Centrifugal compressor. Dual compressors type.
Operational Chilled Water Temp/ΔT, °C	5.
Cycle of Concentration	10.
Condenser Water Treatment System	Auto chemical dosing.
Age of chiller plant, Years	13
Type of Refrigerant Used	R134A
Number of Chillers and Installed Capacity	6. 3000RT.

Efficiency of Chiller Plant System (kW/RT)	Chiller Plant: 0.7109 Chiller: 0.5977 CHW Pump: 0.0133 CW Pump: 0.0428 Cooling Tower: 0.0377
Air Distribution System Type	☒ Air Handling Unit (AHU) ☒ Fan Coil Unit (FCU) ☐ Passive Displacement Cooling (PDC) Others. Please specify:
Number of Air-Handling Units (AHU) and type of fan motor	6 AHU & 7 PAU / Induction motor
Number of Fan Coil Units (FCU) and type of fan motor	582 Permanent split capacitor motor
Air distribution system efficiency (kW/Ton)	
Number of Mechanical Fans and type of fan motor	20/ Induction motor
Number of Exhaust Fans and type of fan motor	16/ Induction motor

Lighting

Area tapping on natural lighting (m^2)	NA
Artificial lighting area (m^2)	29,328
Artificial Lighting Type (please tick where applicable)	☒ LED ☐ Compact Fluorescent Lamps ☐ Fluorescent T5 Tube ☐ Fluorescent T8 Tube ☐ Fluorescent T12 Tube
Percentage of LED used (%)	100
LED Luminaire Type	
Lighting Power Density (W/m^2)	Overall: Guess Room: Office: Function Hall: Meeting Room:
Any occupancy sensors	☐ Yes ☒ No
Any Smart Lighting Management System	☐ Yes ☒ No
Any Daylight Harvesting System	☐ Yes ☒ No

Others:

Vertical Transportation System	☒ Lifts ☐ Escalators ☐ Others. Please specify:
Any energy efficient features?	☐ Yes ☒ No If yes, please specify:
Hot water system	☒ Yes ☐ No. If “yes”, please specify the purpose and amount used (for guest room/NA)

Control and Operations:

Does the building have any of the following systems:	
Chiller Plant and air-distribution optimisation/predictive maintenance system	☐ Yes ☒ No
Building energy management system	☐ Yes ☒ No
Smart plug load controls	☐ Yes ☒ No
Demand-controlled ventilation system	☐ Yes ☒ No

Renewable Energy

Does your building have any solar PV installation on the rooftop	☐ Yes ☒ No
If “Yes”, please provide the following information: m. Installed Capacity (kWp) n. Panel Efficiency, % o. Energy Generated (annual), MWh p. Solar leasing model or purchased by owner	
If “no”, please let us know if you have plans to install or increase the capacity: g. Available roof top area for solar PV system h. Available façade area for BIPV/BAPV system (m²) and its Orientation	Roof is covered roof and no space for solar panels

Challenge Statement Owner:	**South Beach Consortium Pte Ltd**
Building Name:	JW Marriott Hotel Singapore South Beach
Address:	30 Beach Road Singapore 189763
Building Typology:	Hotel
Contact Person	
Name:	Edward Teh
Email:	Edward.teh@marriotthotels.com

Current Situation	JW Marriott Hotel Singapore South Beach is a 634-room luxury property located on Beach Road. The majority of the hotel's guestrooms and other facilities are located in the 45-storey tower of the South Beach integrated development, while the space within the low-rise, converted historical buildings house the hotel's additional restaurant and bar concepts. The aim of this challenge is to achieve SLE certification under BCA GM:2021 In Operation for JW Marriot Hotel. Current systems that could be improved are: • Hotel pumping system running on non-renewable energy. • Current AHU is centrifugal AC belt-driven fans. • Current Hotel guestroom room control unit uses Key cards to activate electricity in the room, key cards left in slots when no occupants in the room. • There are no Water Monitoring & Leak Detection Portal or System in the Hotel (Alert features for leak detections etc.)

Challenge Statement for Demonstration	
Challenge Statement	To achieve BCA GM 2021 in Operation - Super Low Energy certification using innovative technologies, smart building systems and optimisation strategies. This is to be achieved with the following criteria: • No interruptions to business operations • Minimal inconvenience to guests and building occupants • Lower maintenance cost • Reduce carbon footprint In addition, also to demonstrate how the proposed immediate solutions can achieve net zero whole life operational carbon by Yr 2020 with a mid-term (3-5 yrs) roadmap and long term (5-7 yrs) roadmap.
Desired outcomes	Target Energy Utilisation Index (EUI) in kWh/m2/year: <119 Green Mark Certification Target : Super Low Energy Planned date for start of test bedding: 2023 Planned date for completion of test bedding: 2025 Planned date for commencement of operations: 2025

Challenge Statement for R&I	
Challenge Statement	The hotel is looking at new technologies, solutions or system optimisation strategies to improve power consumption efficiency to meet GM SLE requirements. 1) ACMV Challenge Hotel is looking at differing ways that can be applied to reduce the intake air humidity to <60% and re-use the condensate water into the hotel's grey water system. 2) Lighting Challenge Apart from reducing the wastage and buying higher LEDs, the hotel is looking at any other systems that can be used to reduce the power consumption further with the same lumens and with lower effects to harmonics.
Desired outcomes	The energy savings target is set at 25-30% better than Green Mark 2021 Platinum levels. Planned date for start of test bedding: Feb 2023 Planned date for completion of test bedding: 2025 Planned date for commencement of operations: 2025

Building Information (Hotel) - JW Marriott Hotel Singapore South Beach

Building Name	**JW Marriott Hotel Singapore South Beach**
Building Address	30 Beach Road
Building Orientation	☐ North ☐ East ☐ South ☐ West ☑ ☐ Others. Please specify: North East
Age of Building	8 years
Gross Floor Area (total), m^2	47,935
Gross Floor Area (less car park and data centre),m^2	47,935
Window-Wall Ratio (WWR)	61%
Type of glazing system	☐ Single glazed ☐ Double glazed ☑ Low-e double glazed ☐ Others. Please specify:
Number of Floors	South Tower Block – 21 Floors East Tower Block – 6 Floors Podium 3 – 2 Floors Ballroom – 2 Floors + 1 Mezzanine Assembly (Meeting Rooms) – 2 Floors NCO Club – 3 Floors
Average monthly building occupancy rate, %	80%
Current Green Mark Certification/Version	☐ Gold ☐ GoldPlus ☑ Platinum ☐ SLE Version (Please specific):
EUI (kWh/m^2/year) for past 3 years	2020: 151.7 2021: 168.9 2022: 187.9
Target EUI (kWh/m^2/year)	118
Target Green Mark Certification	☑ SLE ☐ Zero Energy

ACMV

Air-conditioned floor area (%)	90%
Areas air-conditioned (please tick where applicable)	☑Guest Rooms ☑Office ☑Pantry ☑Meeting Rooms ☑Function Halls ☑Toilets ☑Lift Lobbies ☑Circulation/Transition spaces ☐ Others. Please specify:
Building Cooling load (RT)	Office Hours: 24 hours:
Cooling Capacity (W/m^2)	
Air-Conditioning System Type (*Managed by MCST – Hotel no control on Chiller Operations*)	☑Water-cooled chilled water system ☐ Air-cooled chilled water system ☐ Unitary Air Conditioning System ☐ Others: _____
For water-cooled chilled water systems:	
Type of compressor/Number of compressors	<Provided by MCST>

Operational Chilled Water Temp/ΔT, °C	<Provided by MCST>
Cycle of Concentration	<Provided by MCST>
Condenser Water Treatment System	<Provided by MCST>
Age of chiller plant, Years	9
Type of Refrigerant Used	R123
Number of Chillers and Installed Capacity	1000T – 4 nos / 500T -2 nos
Efficiency of Chiller Plant System (kW/RT)	Chiller Plant: 0.616KW/RT Chiller: 0.519 CHW Pump: 0.037 CW Pump: 0.044 Cooling Tower: 0.014
Air Distribution System Type	☑Air Handling Unit (AHU) ☑Fan Coil Unit (FCU) ☐ Passive Displacement Cooling (PDC) Others. Please specify:
Number of Air-Handling Units (AHU) and type of fan motor	15 AHU AC belt-driven centrifugal motor 11 PAU AC belt-driven centrifugal motor
Number of Fan Coil Units (FCU) and type of fan motor	1186 Single Phase AC Motor
Air distribution system efficiency (kW/Ton)	*No data available*
Number of Mechanical Fans and type of fan motor	74/ Direct Driven Axial Flow fan
Number of Exhaust Fans and type of fan motor	33 / Direct Driven Axial Flow fan

Lighting

Area tapping on natural lighting (m²)	Sky Gardens- 875 L18 Pool – 962 L6 Pool – 115 **Total Area – 1,952**
Artificial lighting area (m²)	LED
Artificial Lighting Type (please tick where applicable)	☑LED ☐ Compact Fluorescent Lamps ☐ Fluorescent T5 Tube ☑Fluorescent T8 Tube ☐ Fluorescent T12 Tube
Percentage of LED used (%)	90%
LED Luminaire Type	
Lighting Power Density (W/m²)	Overall:10 Guest Room: Office: Function Hall: Meeting Room:
Any occupancy sensors	☐ Yes ☑No
Any Smart Lighting Management System	☐ Yes ☑No
Any Daylight Harvesting System	☐ Yes ☑No

Others:

Vertical Transportation System	☑Lifts ☐ Escalators ☐ Others. Please specify:
Any energy efficient features?	☑Yes ☐ No If yes, please specify:VVF
Hot water system	☑Yes ☐ No. If "yes", please specify the purpose and amount used: 40% Hot water for every hotel guest and for Culinary.

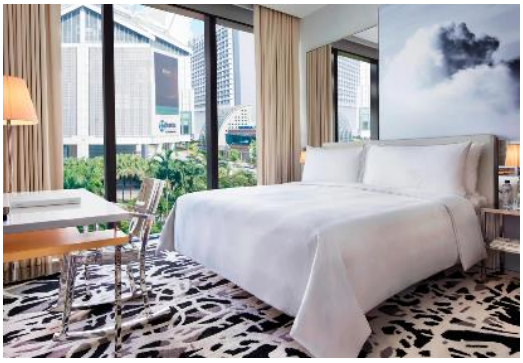
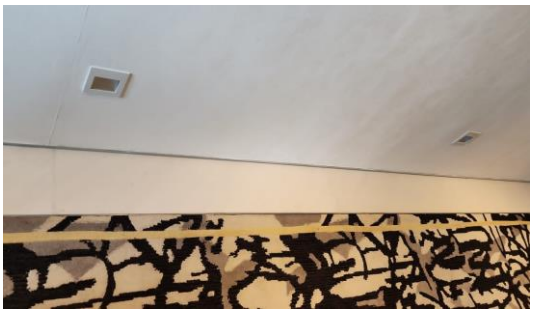
Control and Operations:

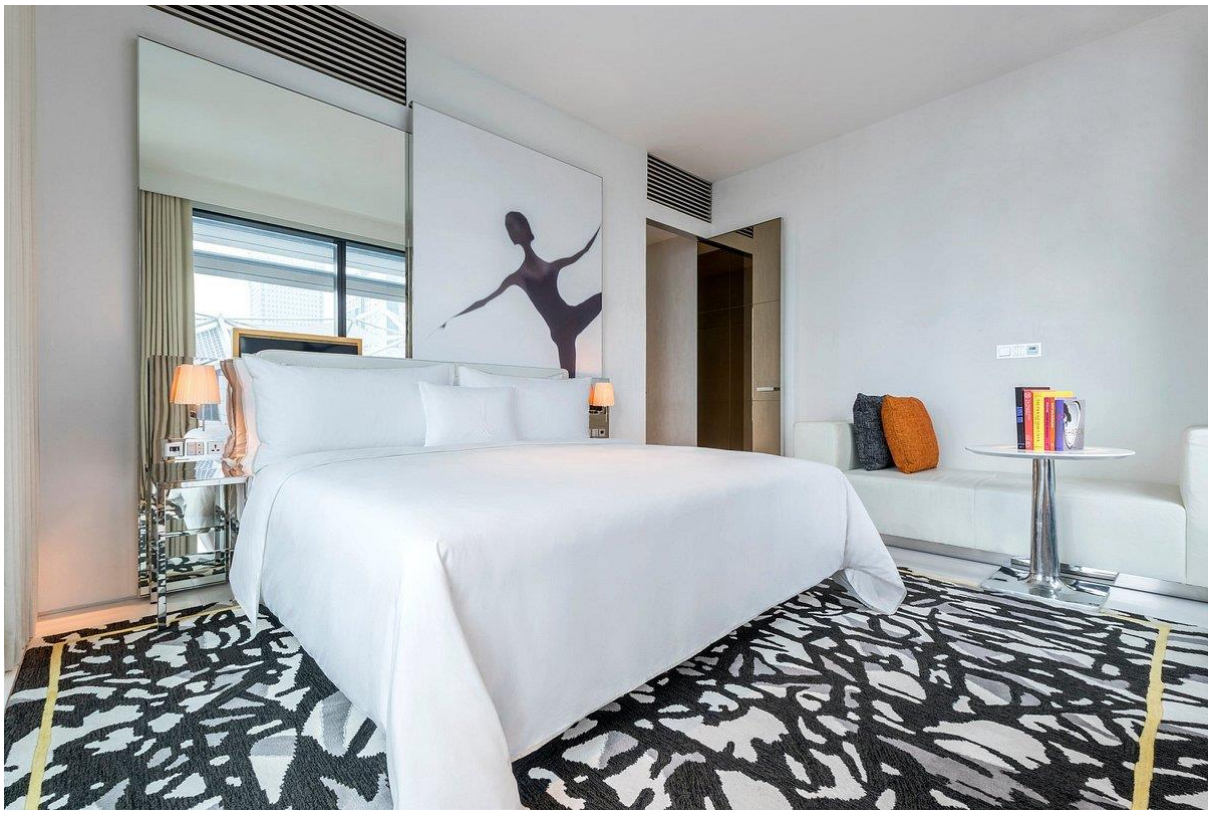
Does the building have any of the following systems:	
Chiller Plant and air-distribution optimisation/predictive maintenance system	☑Yes ☐ No
Building energy management system	☐ Yes ☑No
Smart plug load controls	☐ Yes ☑No
Demand-controlled ventilation system	☑Yes ☐ No

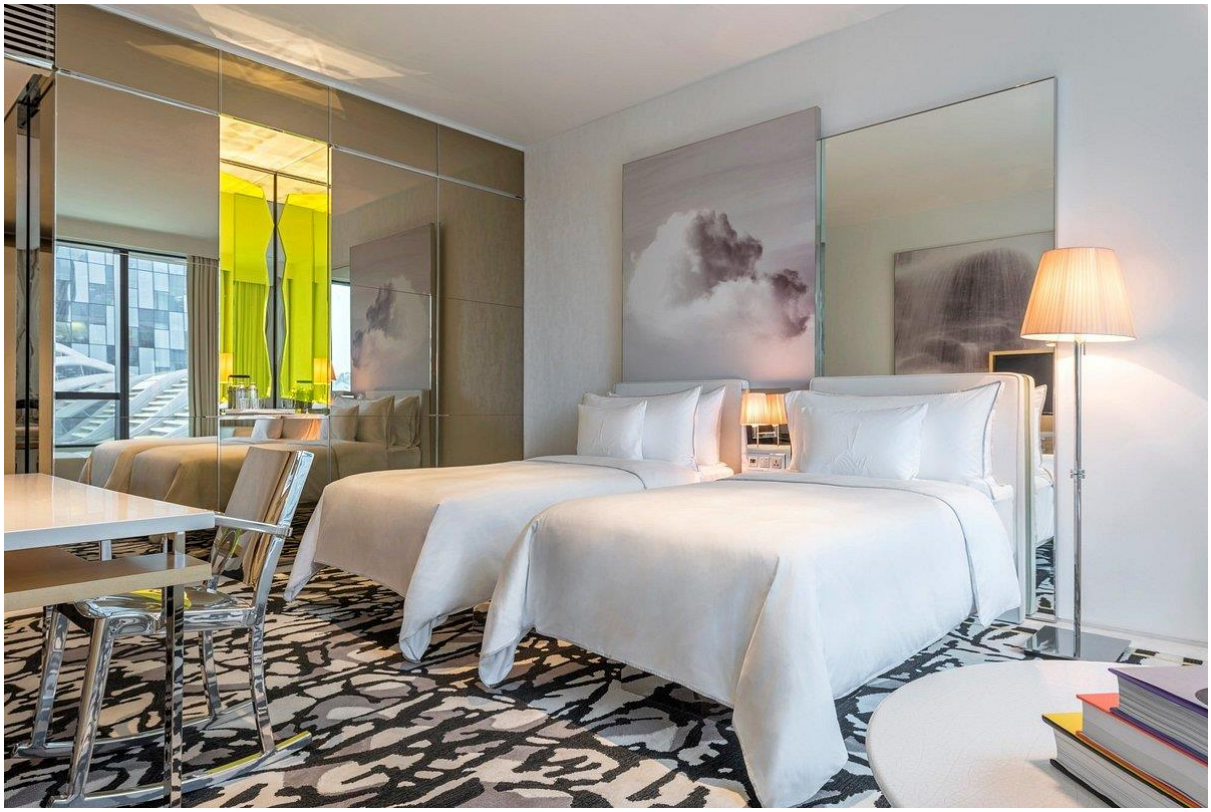
Renewable Energy

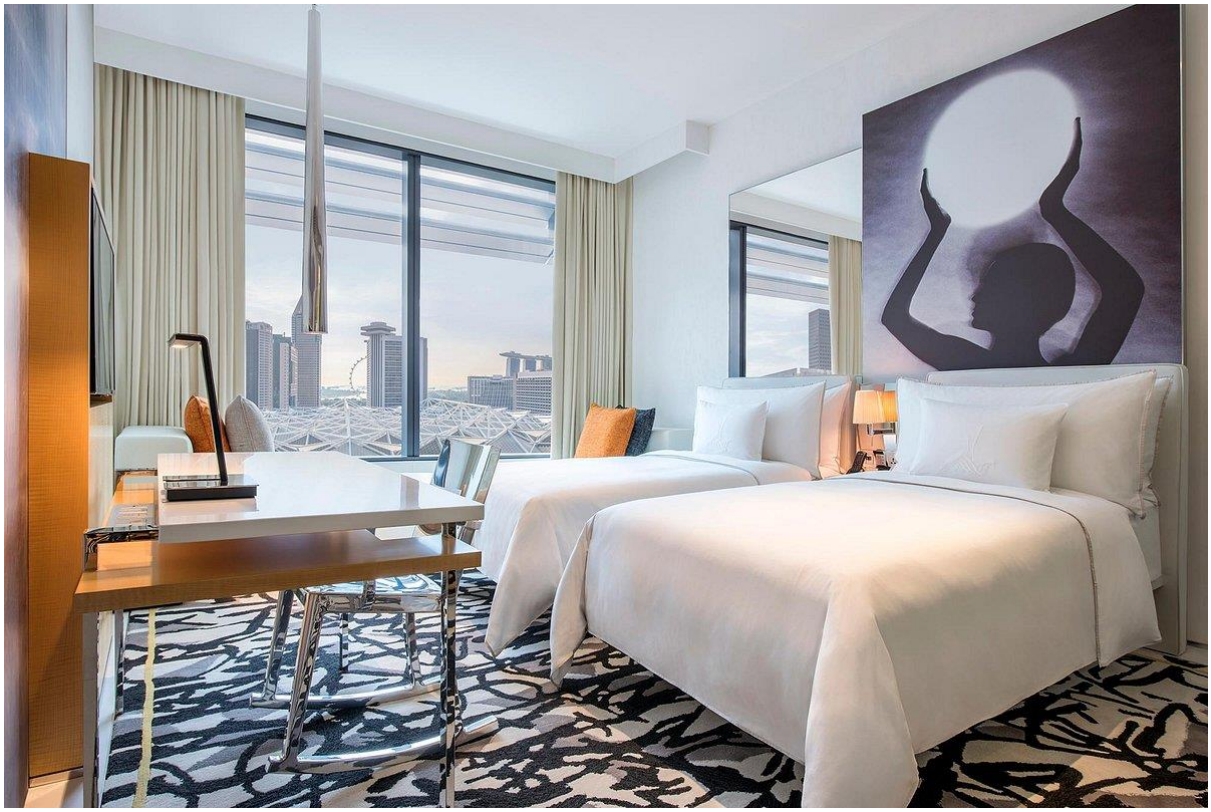
Does your building have any solar PV installation on the rooftop	☐Yes ☑ No
If "Yes", please provide the following information: q. Installed Capacity (kWp) r. Panel Efficiency, % s. Energy Generated (annual), MWh t. Solar leasing model or purchased by owner	
If "no", please let us know if you have plans to install or increase the capacity: i. Available roof top area for solar PV system j. Available façade area for BIPV/BAPV system (m^2) and its Orientation	-To Be Advised-

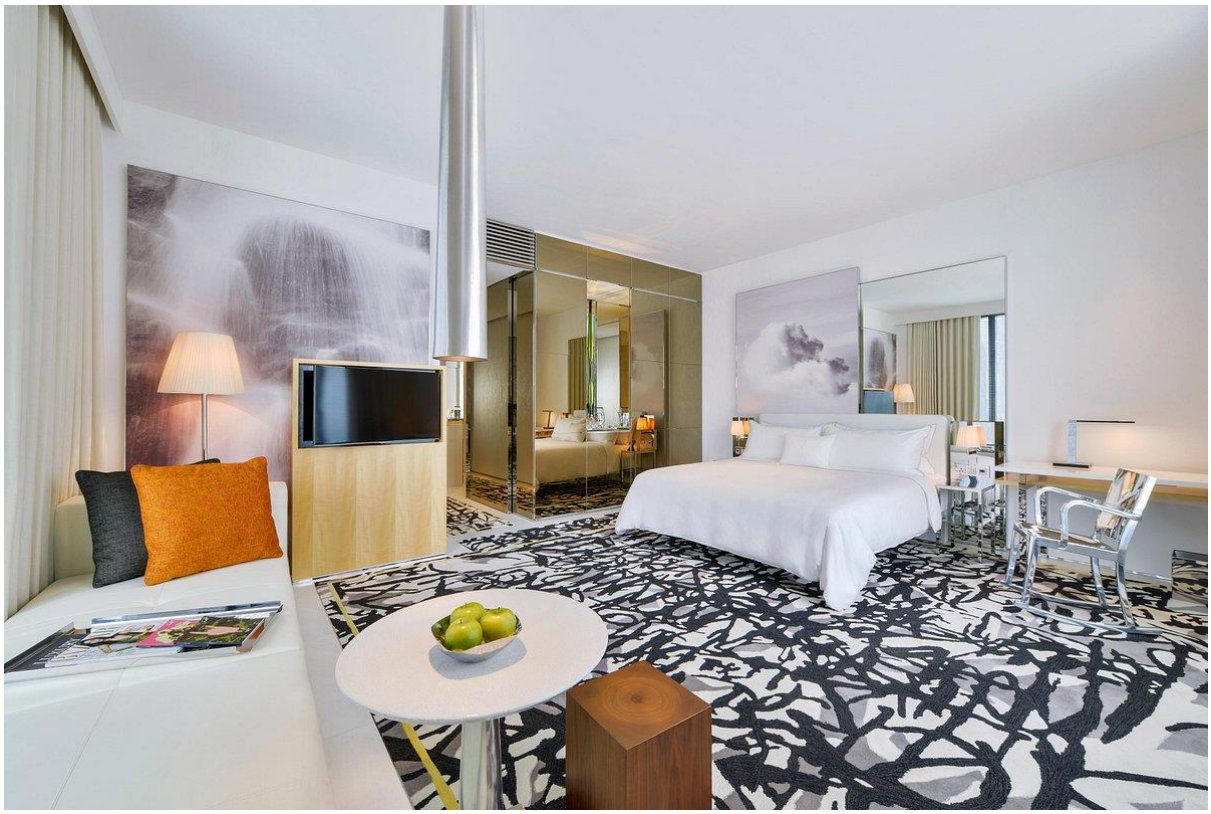
*Site Photos

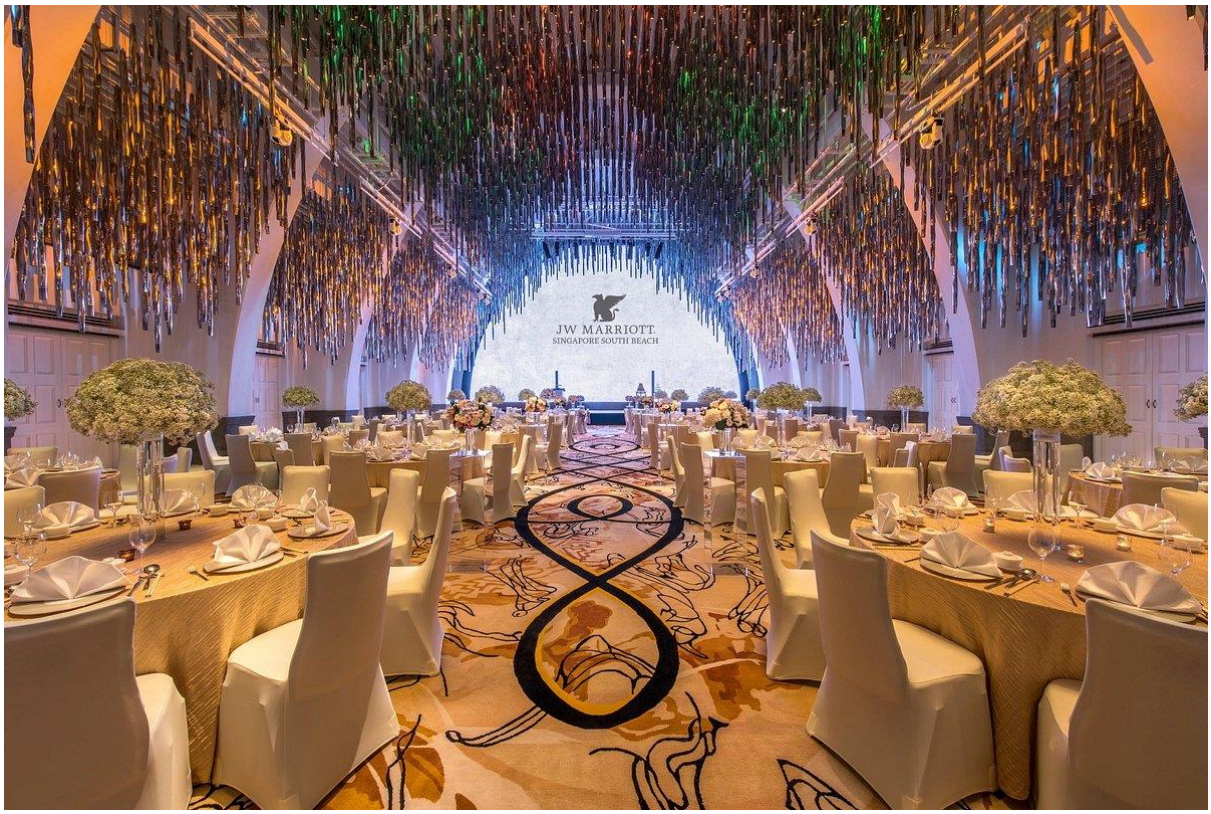
GUESTROOM	LED LAMPS
	
	










JW MARRIOTT
SINGAPORE SOUTH BEACH