Performance Synergy from Integrated Design, Construction and Operation. Case Study on a High Performance Grade A Office – Swire One Taikoo Place

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WORLD SBE HONG KONG 2017
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Sustainability Synergy

Sustainability Synergy in Building Design, Construction & Operation

- Energy efficiency
- Material & resources
- Microclimate & comfort
- Sustainable community
- Performance Verification

All-round sustainable and Green design high-rise

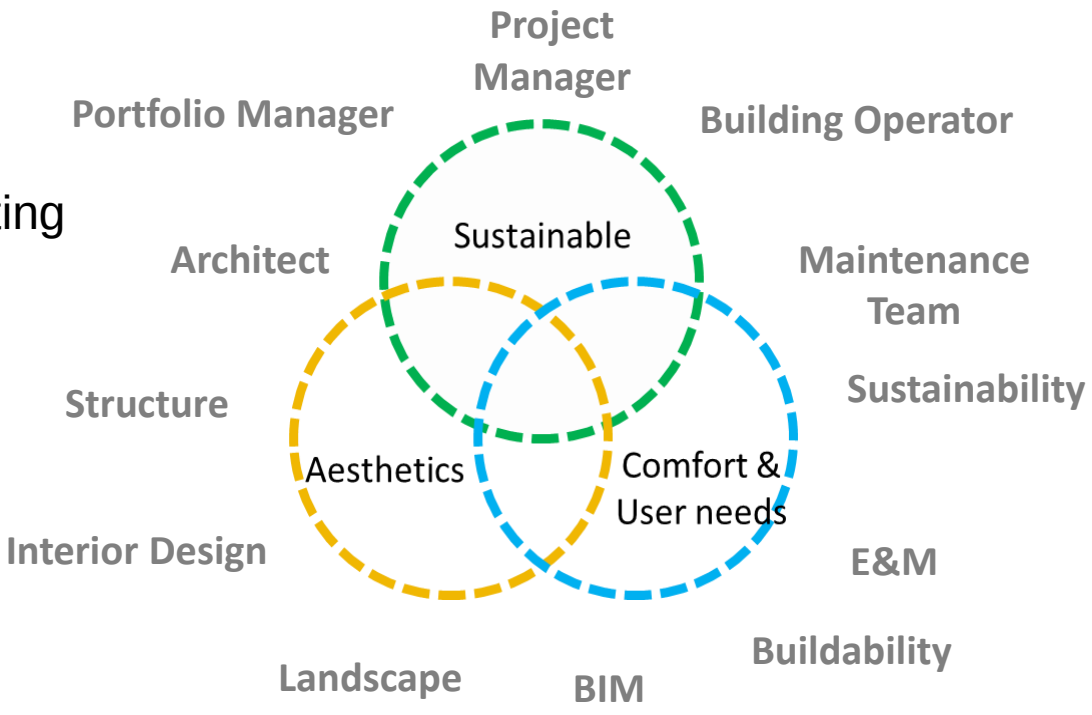
Low carbon emission through whole building life cycle

Exemplar 30% total energy saving against BEC baseline

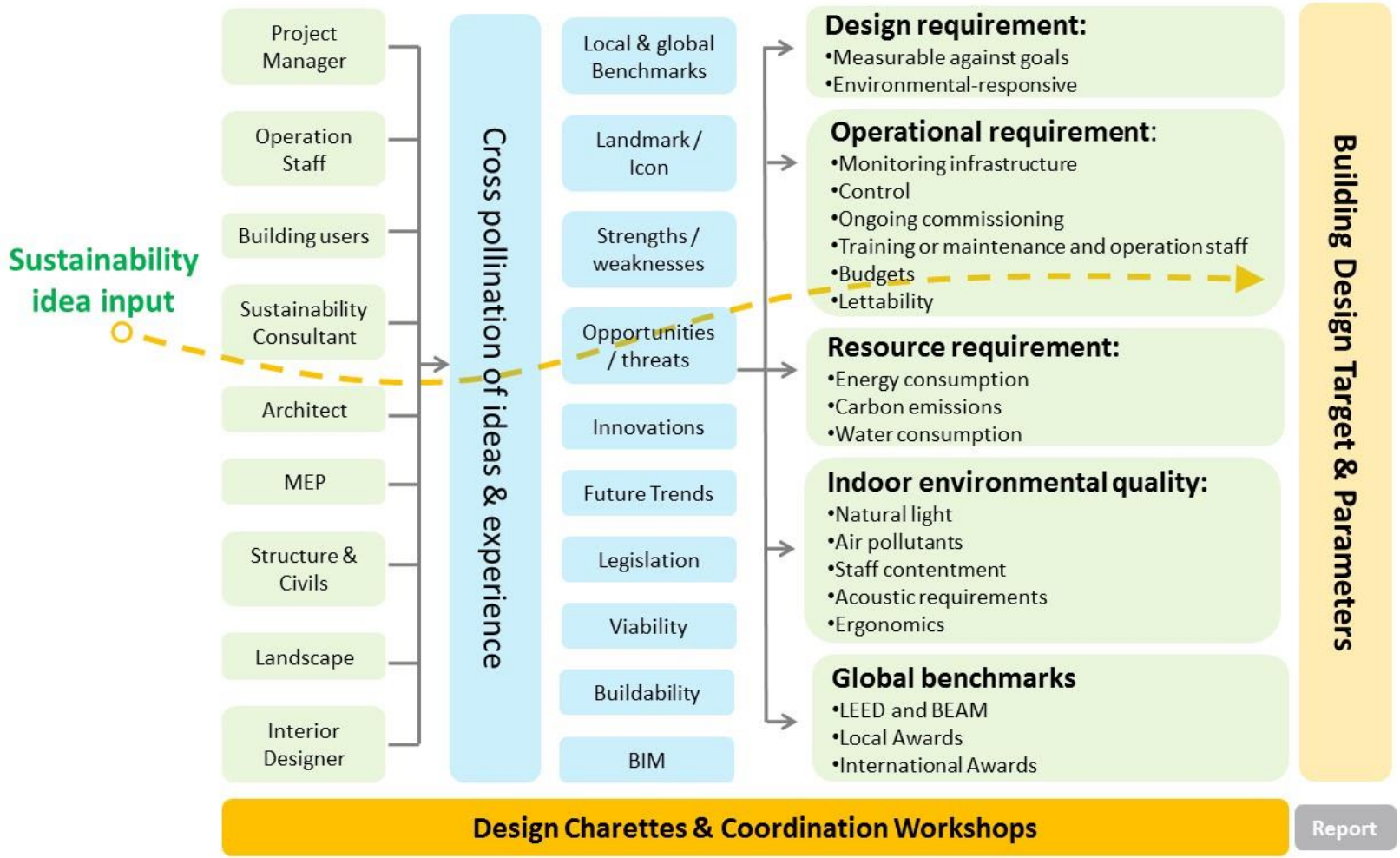
Verified design performance suits for occupants and operational needs

Integrated Design Approach

- Common Goal
- Early Involvement of “Full Team”
- Care of User Needs
- Operational Consideration
- Enhanced Communication Channel
- Benchmarking and Target Setting

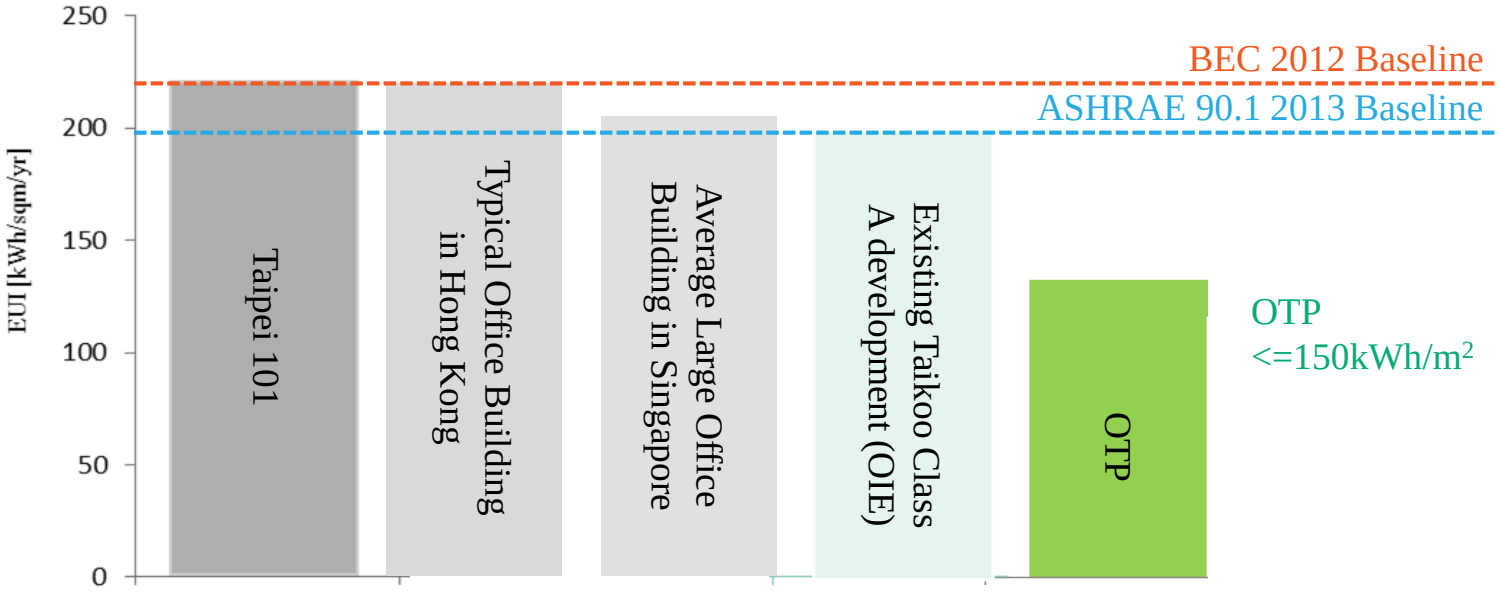


Integrated Design Approach



Passive & Active Design

OTP – Energy Performance

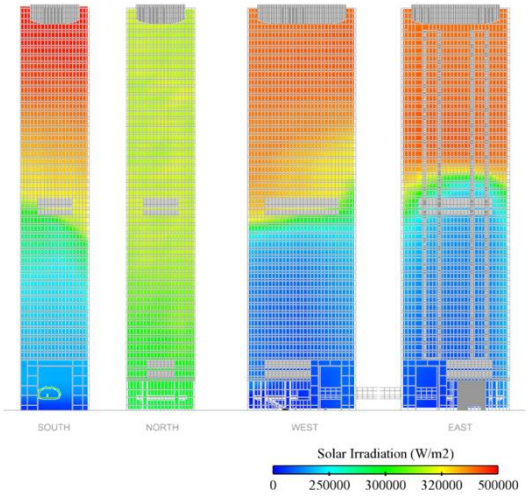


EUI: Total Building Energy Consumption / Building GFA

- Adoption of 12 passive and active sustainable strategies
- 33% Saving Compare to BEAM Plus (Based on BEC Code 2012 as baseline)
- 28% Saving Compare to LEED (based on ASHRAE 90.1 2007)
- Energy use intensity = Lower than 150kWh per m^2 of GFA

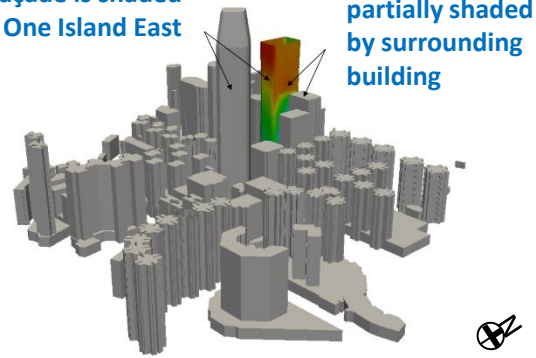
High Performance Envelope (Passive)

Solar on Facade (before optimized)

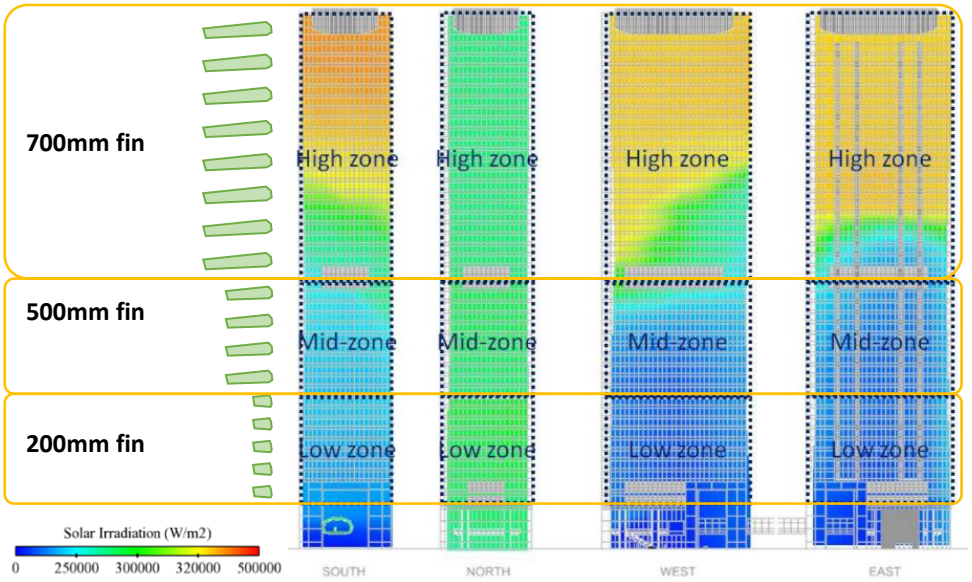


Part of South Façade is shaded by One Island East

The low zone of East Façade is partially shaded by surrounding building

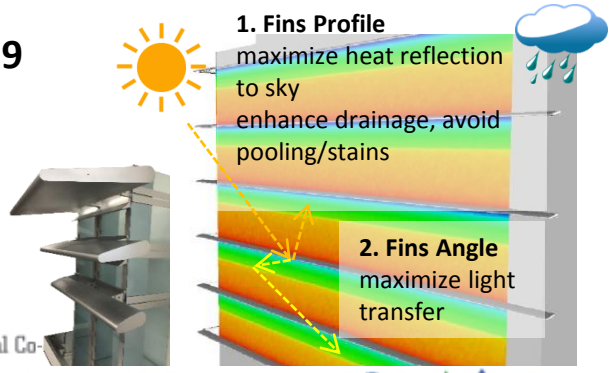


Shading Fin Design and Solar Heat Gain Reduction

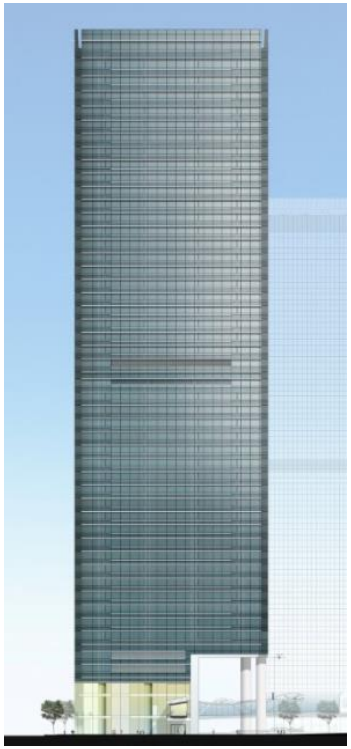


Ultimate OTTV ~15W/m2 (eqv. to 2.6% bldg energy)

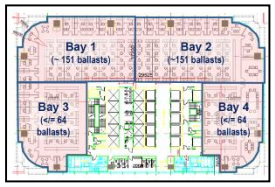
- **External shading fins**
- **Optimized glazing of SC 0.19**



OTP – Active Energy Saving Strategies

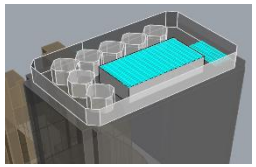


Energy saving % shown is against BEC 2012



(10.8%)

Efficient Office Lighting & Daylight Control
350lx design lux level
66% high LOR reflective fixture,100lm/W efficacy T5
Wide lighting grid & 40% lighting energy saving



(0.3%)

High Performance PV on Roof
PV coverage of 400 m2
Yearly solar radiation analysis with surrounding
Annual energy generation of 43,000kWh

EC Plug Fan in AHU & CO2 DCV
1.7W/L/s fan efficiency
(compared to 2.1W/L/s BEC2012)
Brushless EC motor
Higher efficiency during part-load

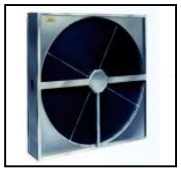
(5.7%)

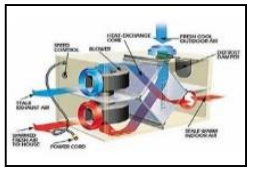
(2.0%)

Trigeneration & Adsorption Chiller
Biofuel combustion for electricity generation
Residual hot water for secondary cooling energy

(9.7%)

Optimized Chiller and Plant Control System





(1.7%)

Free Cooling & Air Economizer / Heat Recovery

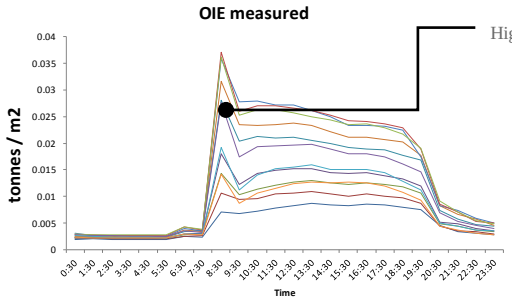
(0.3%)

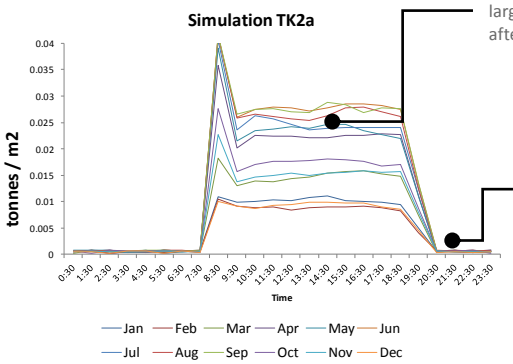
Lift Regeneration & Destination Control

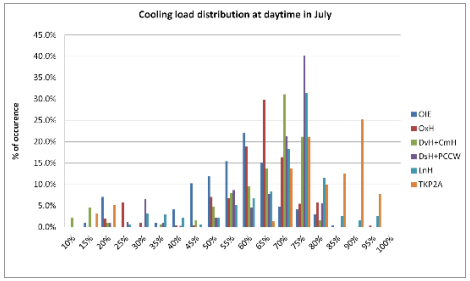
Chiller Optimization – Review on Existing Bldg

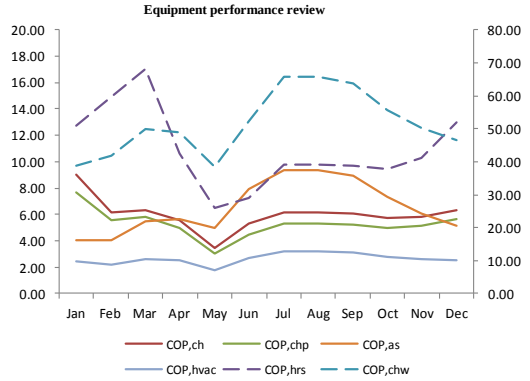
- Annual hourly cooling load analysis exhibits similar trend for OTP and OIE
- Daily cooling load characteristics for designing load-matching strategies and performance-based chiller and plant

Review of existing Swire building operation & cooling load profile and equipment performance to determine TKP2A target









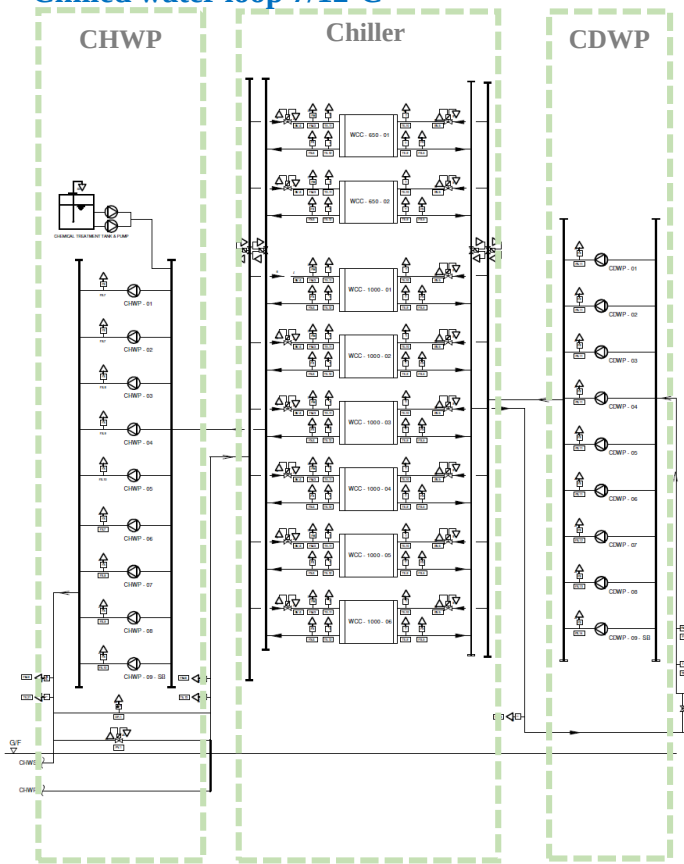
Technical Information	One Island East	Cambridge House	Devon House	Dorset House	PCCW Tower	Lincoln House	Oxford House
Building Height (m)	298.68	159.40	119.93	171.95	176.25	107.15	172.80
Gross floor area (sq.m)	141,500	26,134	76,020	55,886	57,614	30,969	46,734
Average Cooling Capacity of Office Floor (W/sq.m)	185	189	178	148	148	155	185
Chiller	York	York YK	York YK	York YK		Carrier	Carrier
Normal:	1800TR (HV) x 4nos	850TR x 1no 330TR x 1no	850TR x 4nos	1540TR (HV) x 3nos		405TR x 2nos 205TR x 1no	700TR x 3nos
Essential (with gen set)	530TR x 2nos 1030TR x 1no	330TR x 1no	600TR x 1no	500TR x 2nos 250TR x 1no (stand-by)		405TR x 1no	250TR x 1no 103TR x 2nos
Heat reject.	Seawater cooled	Seawater cooled	Seawater cooled	Seawater cooled		Seawater cooled	Seawater cooled
Refrigerant	R134a	R134a	R123	R22	R22	R134a	R134a

Chiller Optimization – Plant Control

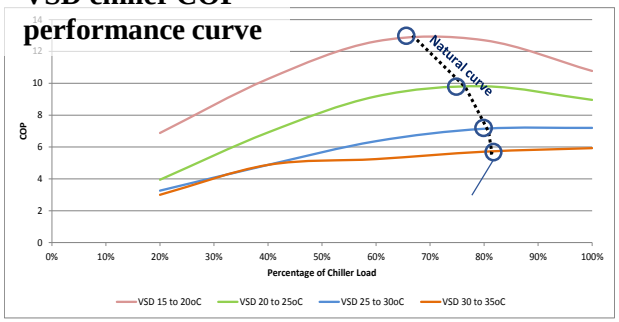
Optimised natural curve chiller sequencing

Building load and CDWT are monitored to compute optimum efficiency operating algorithm - dynamically adjusts chiller combination and load-sharing

Chilled water loop 7/12ºC

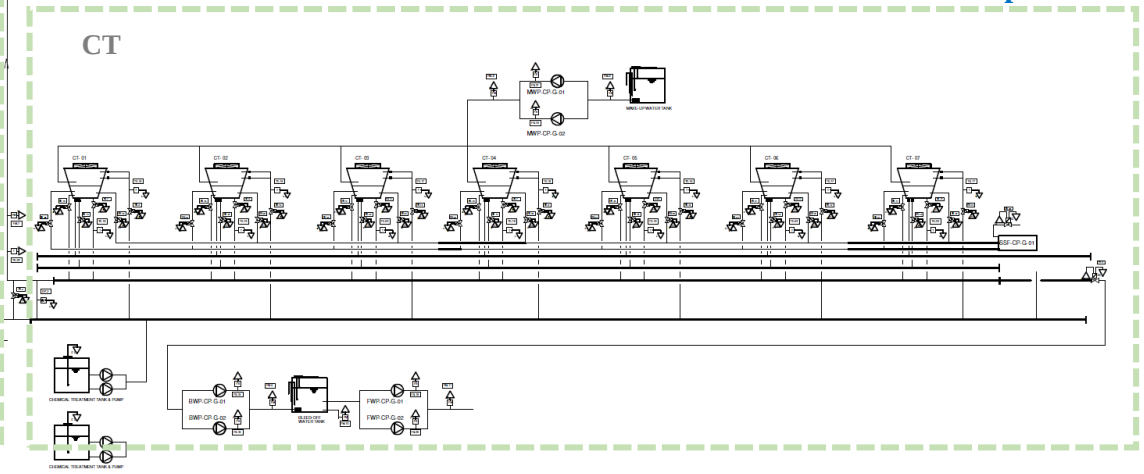


VSD chiller COP performance curve

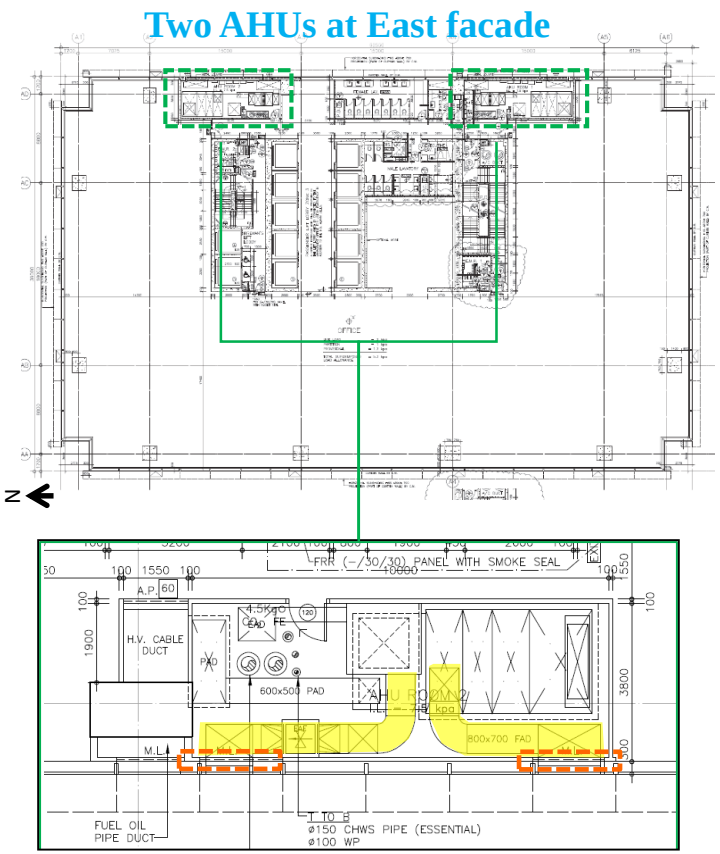


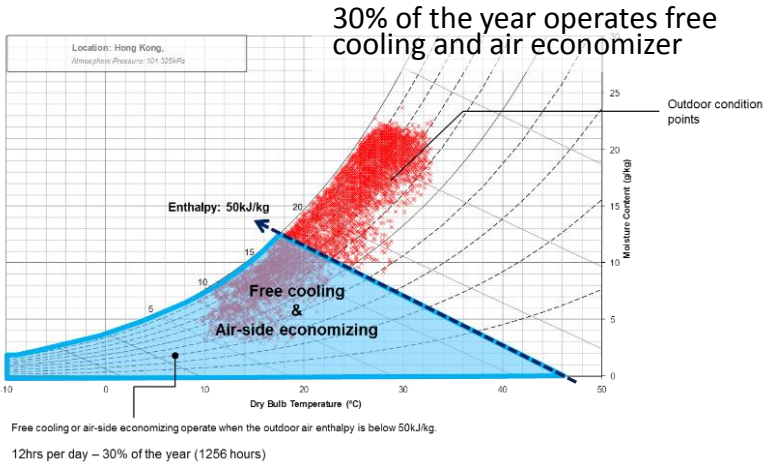
Annual chiller COP 7.79 (simulated achievement verified by supplier chiller offer)

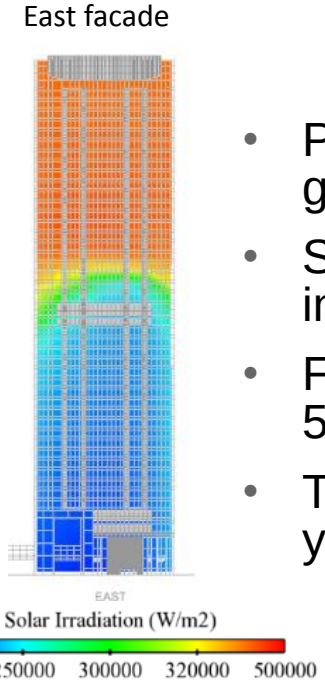
Condenser water loop 32/37oC



Free Cooling & Air Economizer







- Plants at side core reduce solar heat gain at east facade
- Side core design with individual air intake and exhaust
- Free cooling capable of delivering 50% AHU design flow
- Total operation approx. 1256 hrs in a year under part-load condition

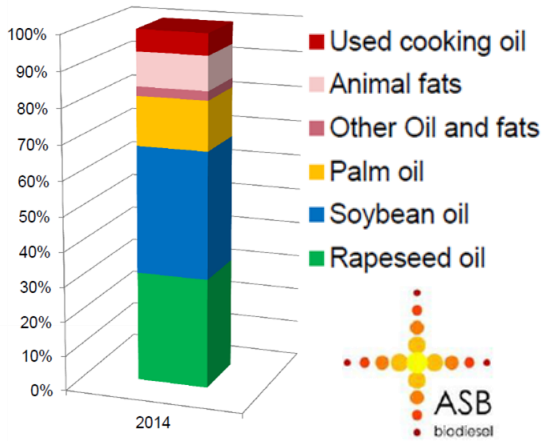
Renewable – Waste to Energy

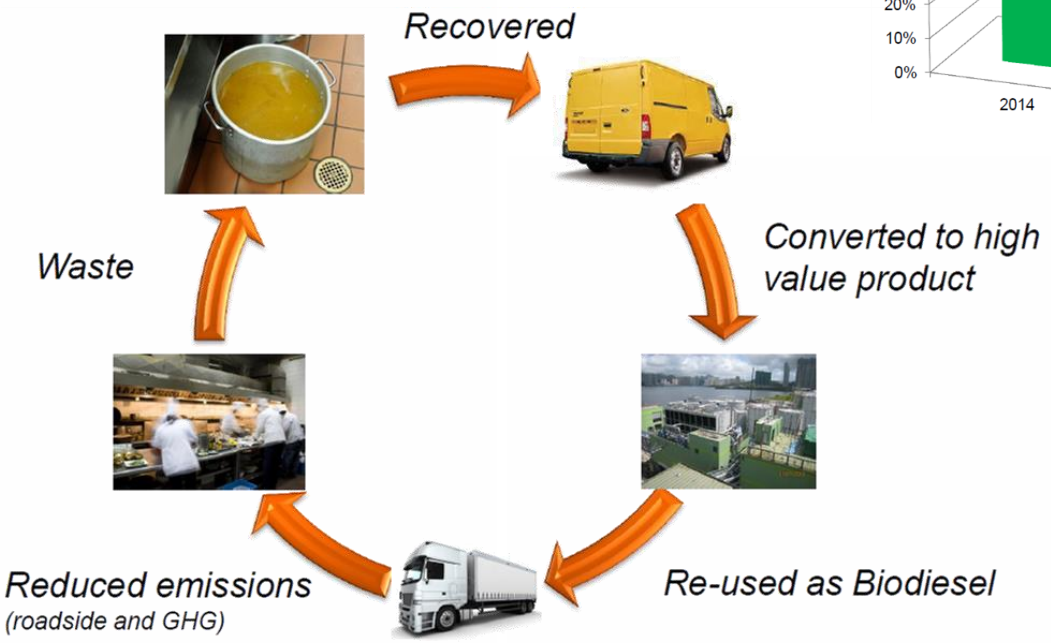
OTP - Bio-diesel Tri-generation System

De-carbonising the city

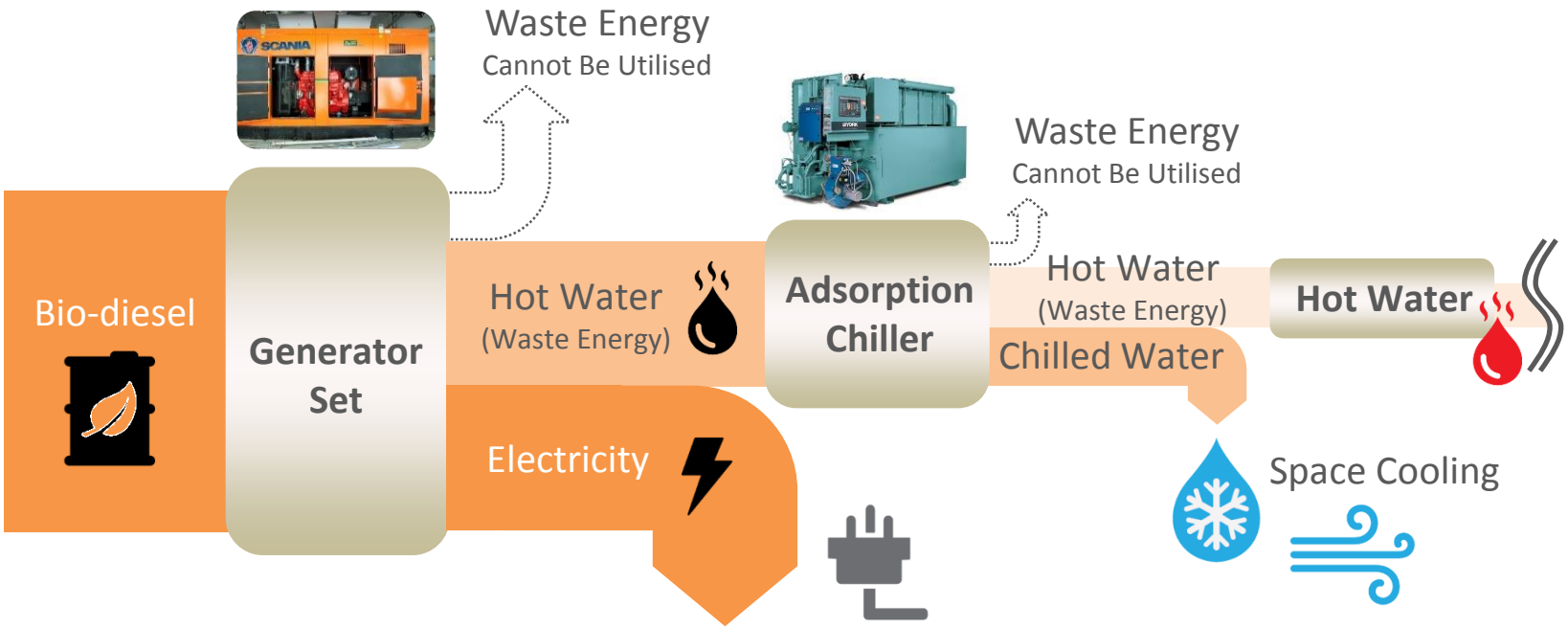
- Utilise waste oil as feedstock
- Transform 135,000L/yr waste oil to biofuel
  Sustainable cycle of low emission impact

Source of Bio-diesel





OTP - Bio-diesel Tri-generation System

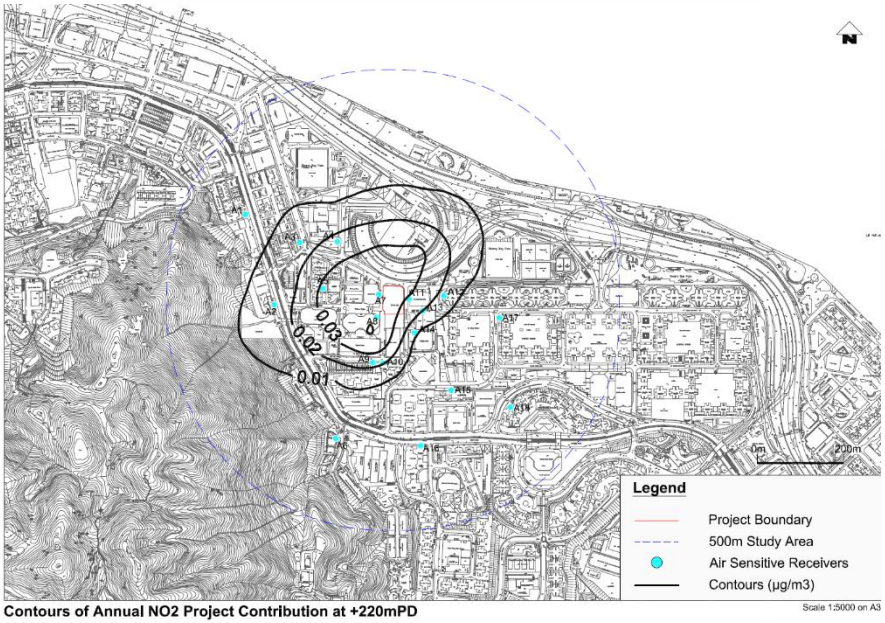


- **Higher Effective Electric Efficiency** than local power utility (ref: USEPA)
- Energy Cascade : outputs 200kW power from B100 bio-diesel burning with simultaneous heat supplied to 140kW cooling adsorption chiller for chilled water generation and domestic hot water use
- Clean electricity – 2% annual building energy use (Offset 278 tons CO2 = 1400 trees)

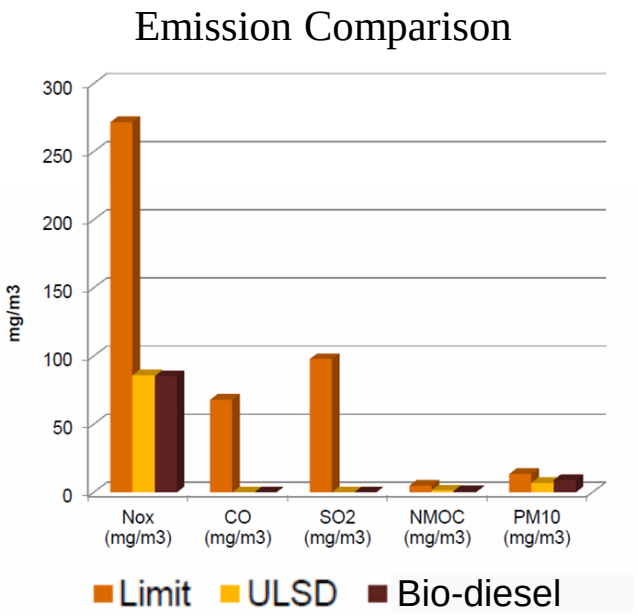
OTP - Bio-diesel Tri-generation System (CCHP)

Negligible Air Pollution Impact

- Comply to EU Stage IV non-road engine emission standard
- Implement emission controls such as SCR, NOx filter
- Bio-diesel is sulphur-free



Contours of Annual NO2 Project Contribution at +220mPD

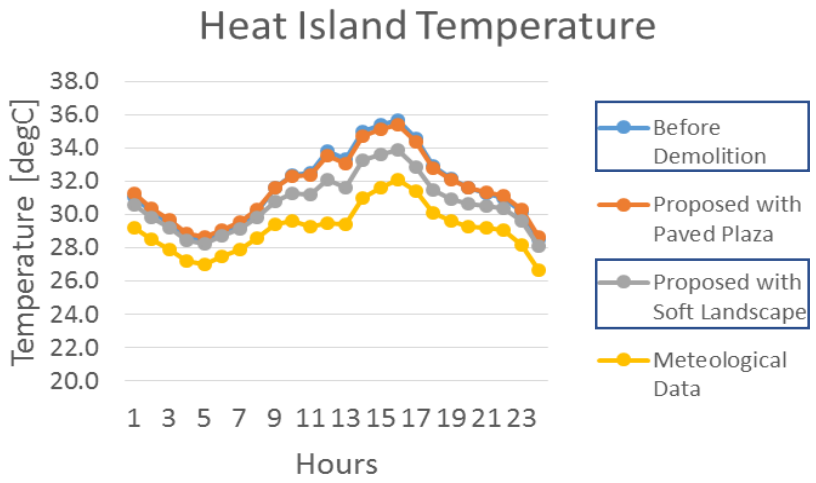


Microclimate & Outdoor Comfort

Taikoo Open Space

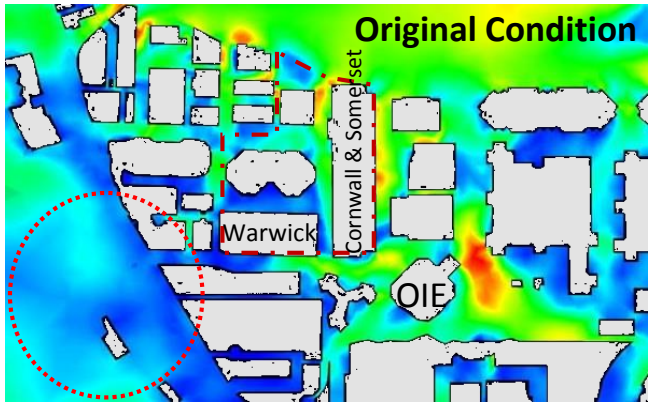
Enhance microclimate :

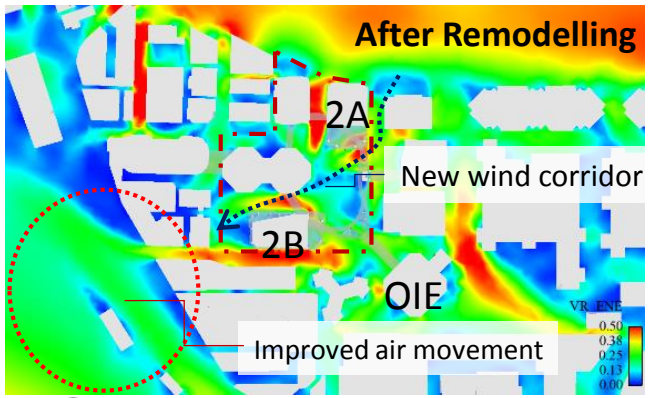
- Sufficient wind corridor
- Rich landscape & water feature

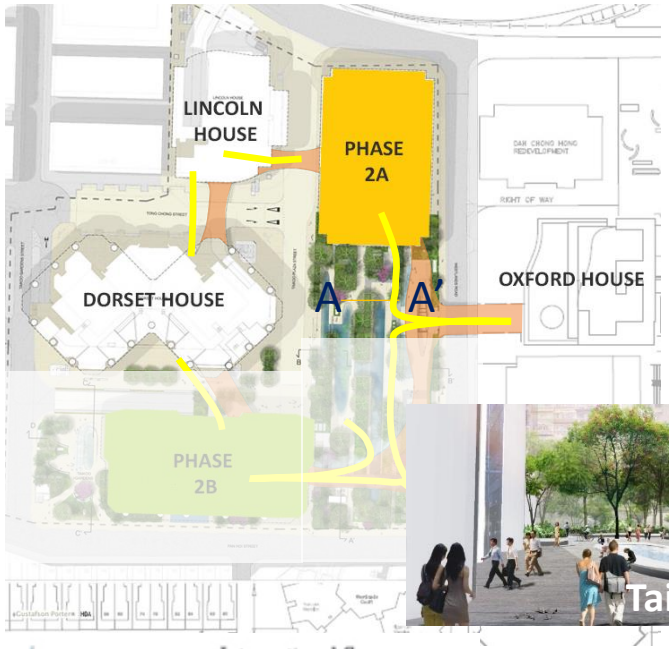


Urban Heat Island Index reduced by max 1.8oC compared to before Somerset's demolition

Air Ventilation Pattern under Annual Prevailing Wind







Green Construction

Low Carbon Construction

Waste Avoidance

Office furniture donation to NGOs

Charity, Crossroads

勞資關係協進會
INDUSTRIAL RELATIONS INSTITUTE

Waste Recovery

Metal Recycling
Concrete Recycling

CONSTRUCTION & DEMOLITION RECYCLING 75%

20% RECYCLED MATERIALS

20% REGIONAL MATERIALS

Beyond Design – Performance Verification

Performance Verification

Design & Construction Stages

- Sharing of whole building cooling load profile to Chiller Manufacturers
- The best and highest technology chiller offer
- Chiller COP Performance verified with manufacturer

Pre-installation Stage

- Extensive FAT ensures quality and performance of final products installed

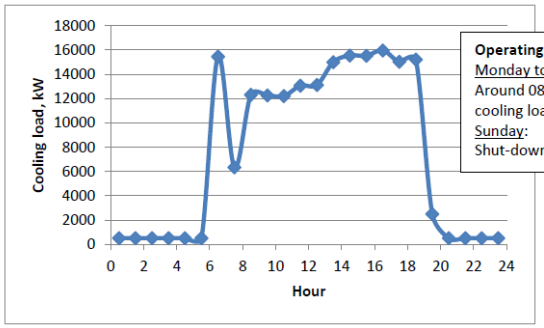
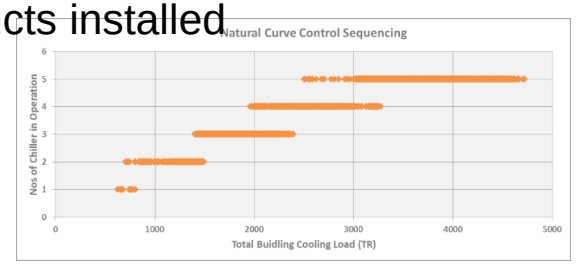
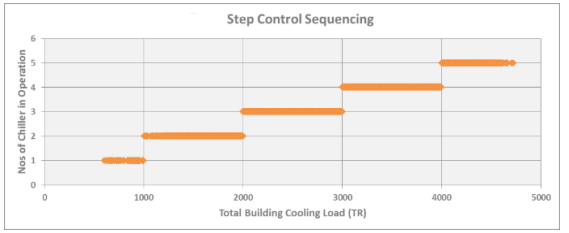
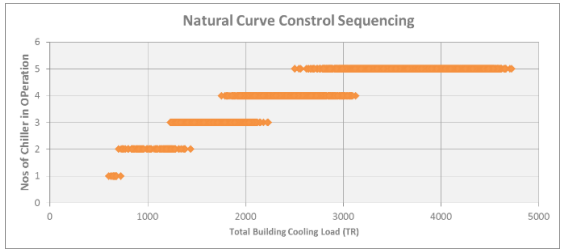


Figure 1 Cooling load pattern on a summer day (2 July)

	Chiller 1	Chiller 2	Chiller 3
Chiller model	19XRV7777E53MCA52	VSD WCC-1000RT CVHF1070	YKKCKRH95CVGS
CSD/VSD	VSD	VSD	VSD
Chiller capacity	1000 Ton	1000 Ton	1000 Ton
Chiller input	591 kW	549.5kW	610kW
Rated COP	5.95	6.4	5.77
Refrigerant	R-134a	R-123	R-134a
NPLV	0.098 ikW/kW	0.0904 ikW/kW	0.09957ikW/kW
Weight	23424 kg	24169 kg	20139 kg
Evaporator			
CHWET	12.5 °C	12.5 °C	12.5 °C
CHWLT	7.0 °C	7.0 °C	7.0 °C
Flow rate	152.8 L/s	152.2 L/s	152 L/s
Pressure drop	73.6 kPa	72.6 kPa	72.6 kPa
Fouling factor	0.01761	0.01761	0.0176
Condenser			
CWET	37 °C	37 °C	37 °C
CWLT	32 °C	32 °C	32 °C
Flow rate	196.8 L/s	196.8 L/s	196 L/s
Pressure drop	68.6 kPa	84.3 kPa	93.5 kPa
Fouling factor	0.04403	0.044026	0.044
Compressor			
Rated load amps	1033	1115	1025







Design Performance Verification

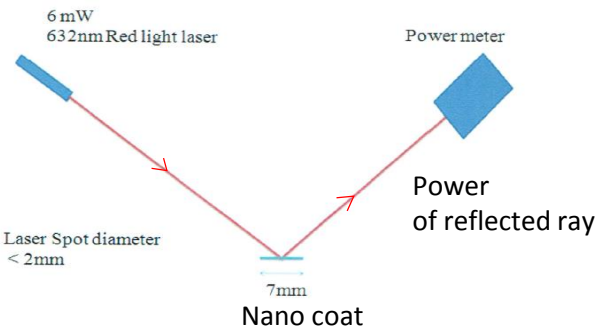
Design & Construction Stage

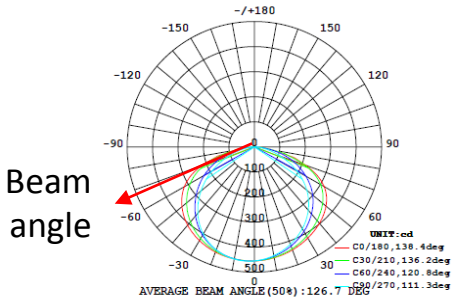
- Third-party Laboratory Test for lighting performance between different brands of luminaire
- Blind test for candidate screening

Pre-installation Stage

- Advanced Quality Assurance Plan with self testing during production
- Sampling for laboratory test on batches of delivery

Testing parameters
Luminaire 1.LOR (>66%) 2.beam angle 3.Efficacy 4.Lumen output
Nano coating 5.Reflectance 6.Diffuse reflectance 7.Anti-UV aging period (10yrs)





UV aging test

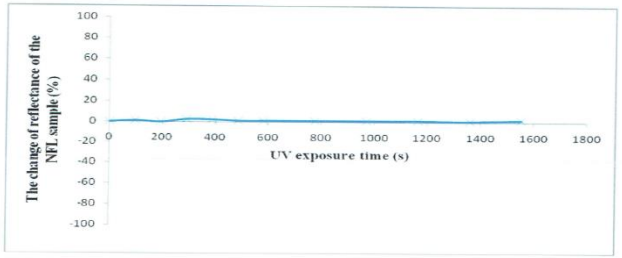
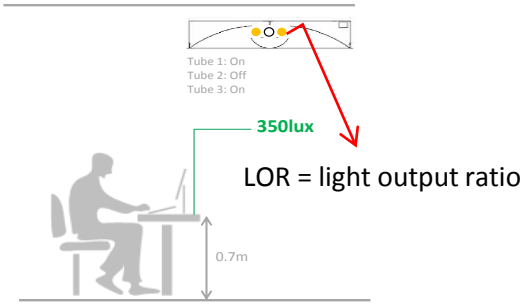


Fig. 5: The change of reflectance of the NFL sample verse UV exposure time without outweighed the error ±2.5% obtained from the power meter.

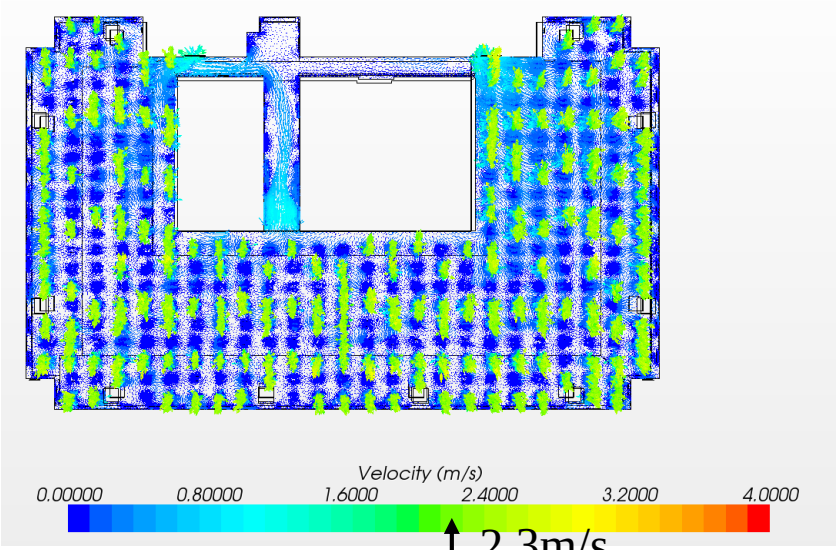


Design Performance Verification

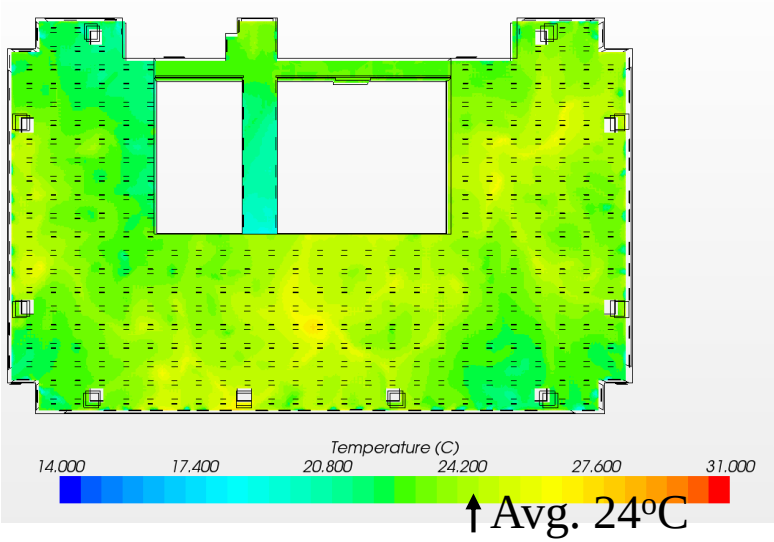
Indoor CFD to verify MVAC design on air flow supply and diffuser location

- Thermal Comfort – achieve design temperature 24°C on 1m occupant level
- Distribution effectiveness for human comfort – no stagnant zone
- Acoustic comfort – minimized noise from system by controlling air velocity < 2.5m/s at RA diffuser

Air Flow Pattern for Office Floor

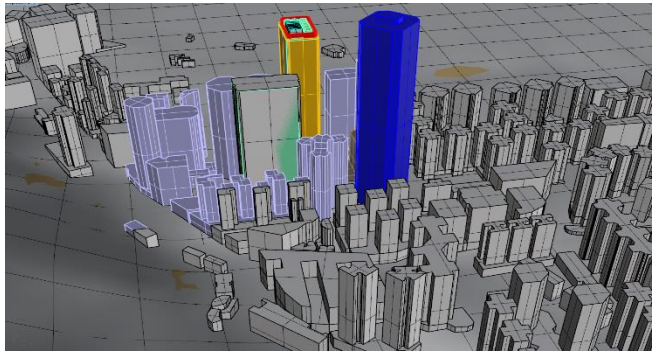


Temperature Profile for Office Floor

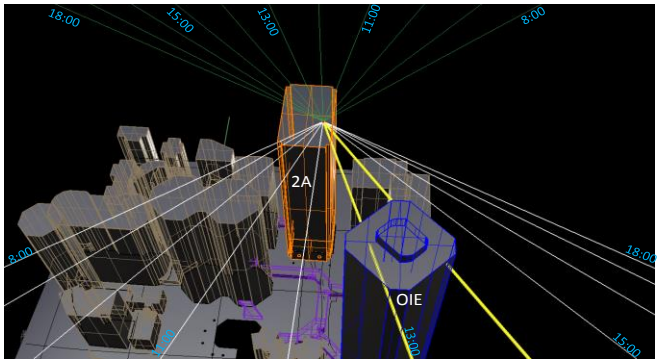


Design Performance Verification

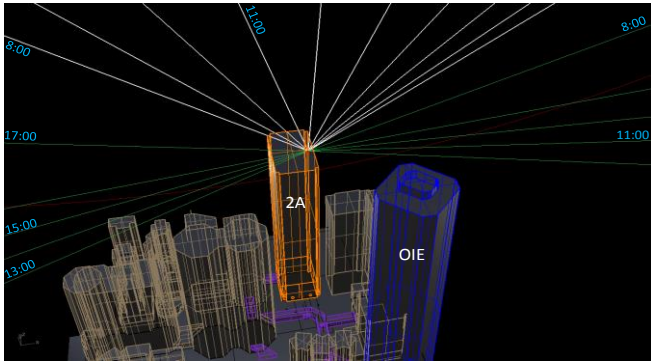
Solar Geometry Analysis for PV Panel for TKP2A



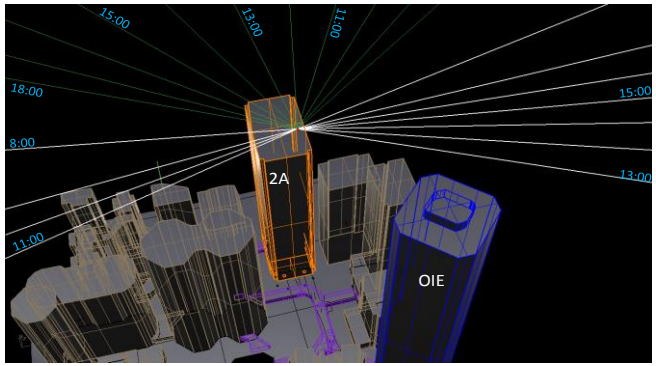
TKP2A and the Surrounding Building at Taikoo Place



When PV panel tilts at >30°(Not Preferred),
GLARE APPEARED at top floor of OIE in summer afternoon



When PV panel tilts at >20° (current design),
NO GLARE resulted in Winter



When PV panel tilts at >20°(current design),
NO GLARE resulted in summer

Thank you

Organisers:

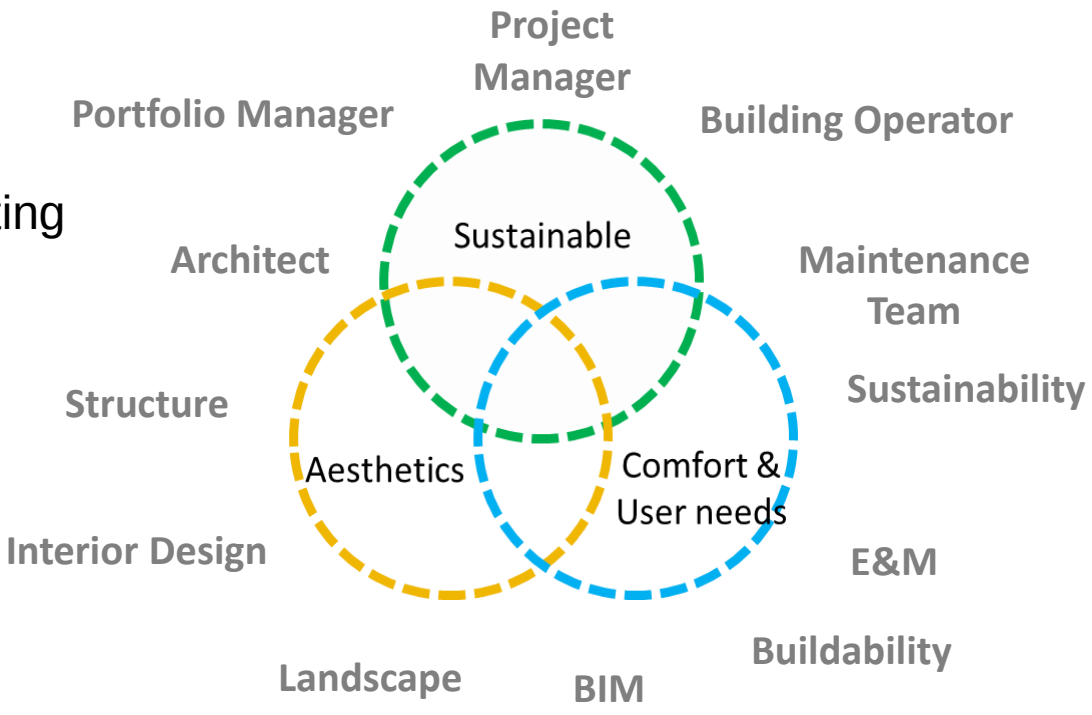
International Co-owners:

Organisers:

International Co-owners:

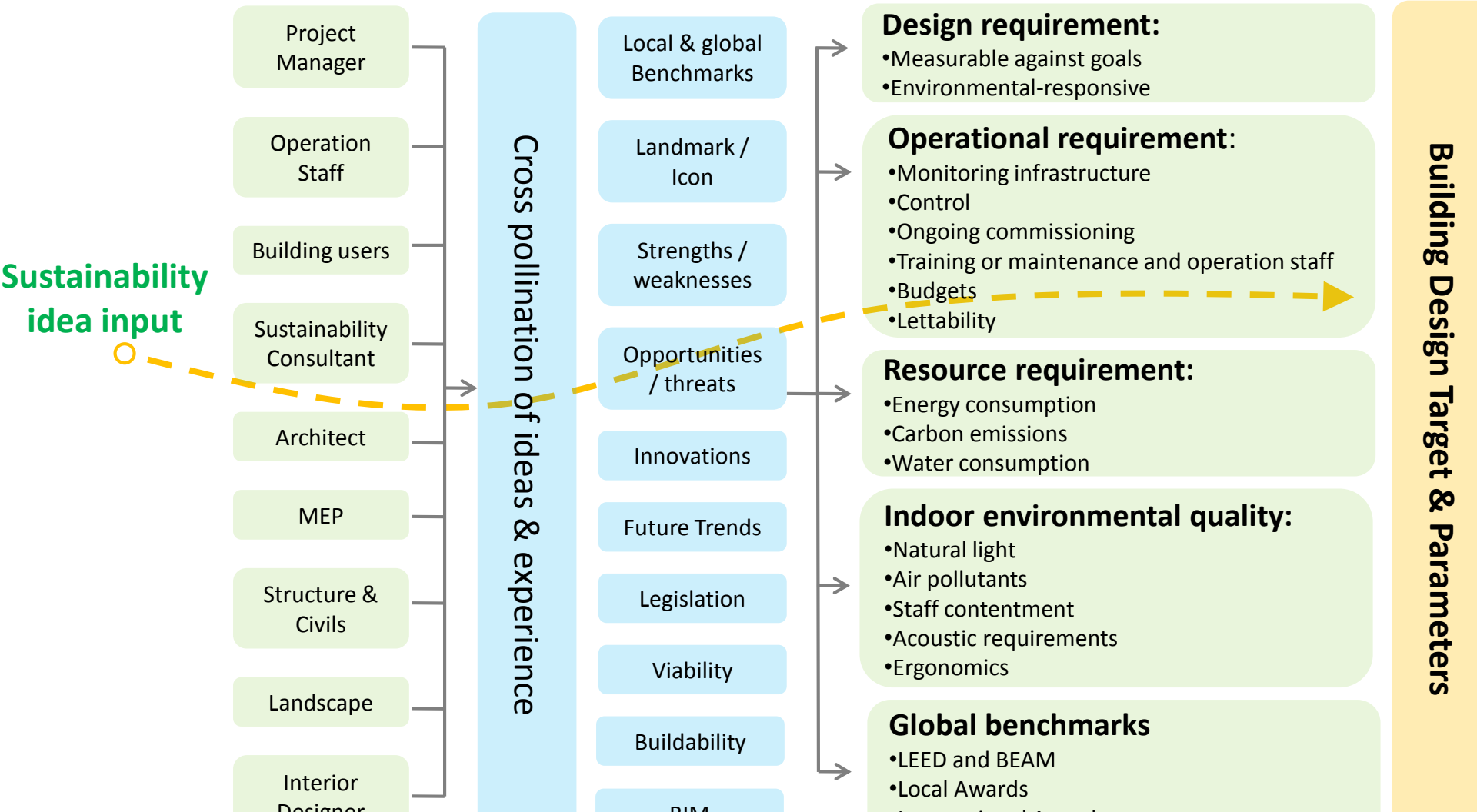
Integrated Design Approach

- Common Goal
- Early Involvement of “Full Team”
- Care of User Needs
- Operational Consideration
- Enhanced Communication Channel
- Benchmarking and Target Setting



3. Multi-parties Coordination

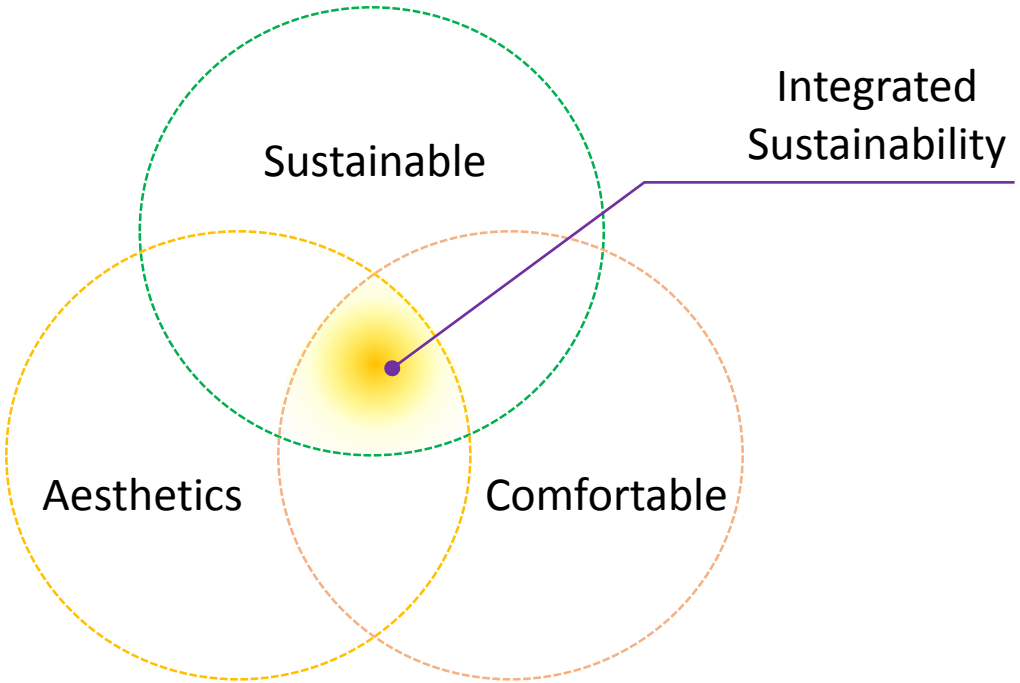
- Pollinate sustainability concepts and gather multi-parties to evaluate, consolidate and refine design
- Apart from client, building users and operators are invited to commit with their concerns addressed to manifest TKP2A design throughout design charette, coordination workshops



1. Outcome-oriented

- To become the high performance sustainable building frontier to satisfy building occupants, the surrounding and the environment in rounded aspects
- TKP2A designs for Integrated Sustainability, leading to sustained and measurable increases in operating efficiency, occupant contentment and marketability

- Building occupants
- The surrounding
- The environment



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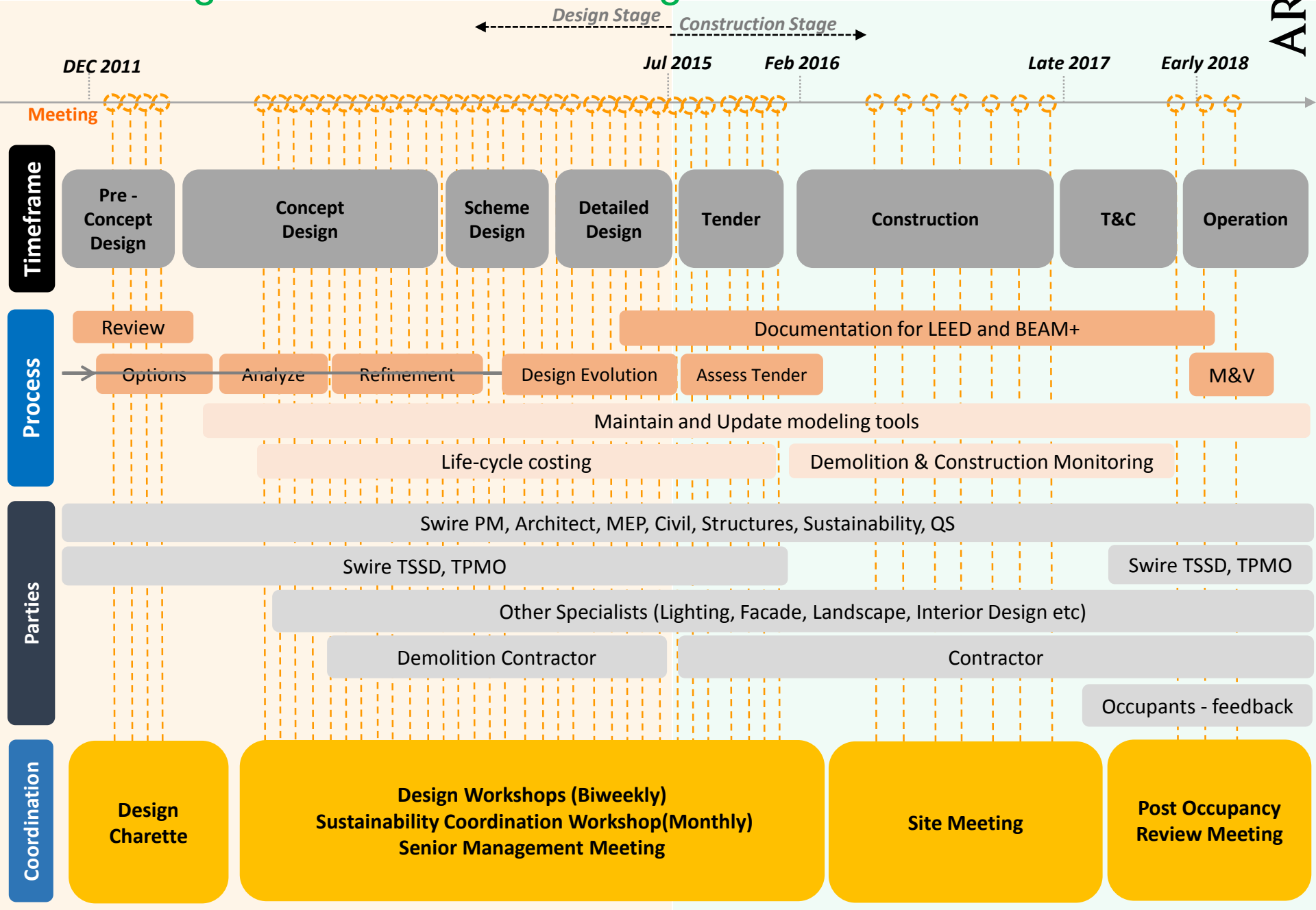
2. Integrated Sustainable Design Process

ARUP



4. Coordination Meeting Intent & Outcome

Design Charette

- **Vision statement** – high performance sustainable building
- **Set target** – OTTV 15W/m^2 (impact from surrounding buildings included), 30% total building energy saving, 40% potable water reduction, 75% C&D waste recycling
- **Outline strategies** – high efficient HVAC equipment, improved operation control, lighting optimization, renewable energy, radiant cooling
- **Design options / schemes**

Sustainability Workshops (Monthly)

- **Comprehensive analysis –** radiance simulation, energy modeling, facade parametric study
- **Evaluate option study and selection –** R&D research
- **LEED & BEAM Plus assessment –** credit evaluation

Design Workshops (Bi-weekly)
- **Project team**
- **Facade team, other design parties**

- **Design requirements –** SC 0.19, VLT 0.22, outdoor air condition for free cooling
- **Design coordination and implementation into detailed design**

Sustainability Designs Coordinated in Meetings

Passive Design
Facade (glazing properties, fins, OTTV, building orientation)

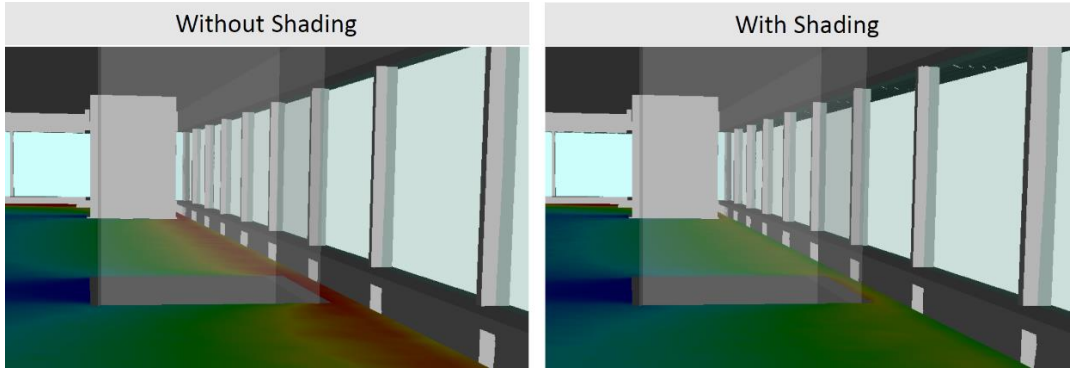
Active Design
Energy (system, innovations, renewable)

Rating Tool
-LEED & BEAM+

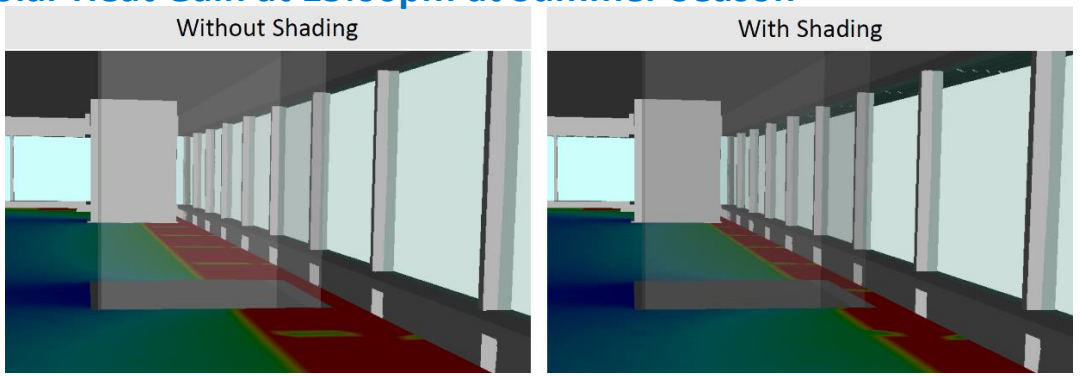
ARUP

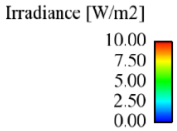
Design Performance Verification

Solar Heat Gain at 11:00am at Summer Season



Solar Heat Gain at 15:00pm at Summer Season





Annual Solar Heat Gain Reduction about 27%
Compare to Baseline OTTV 24W/m2

- Combined effect of solar insulating glazing and shading effect of horizontal fins.
- Solar radiation map onto office space during summer