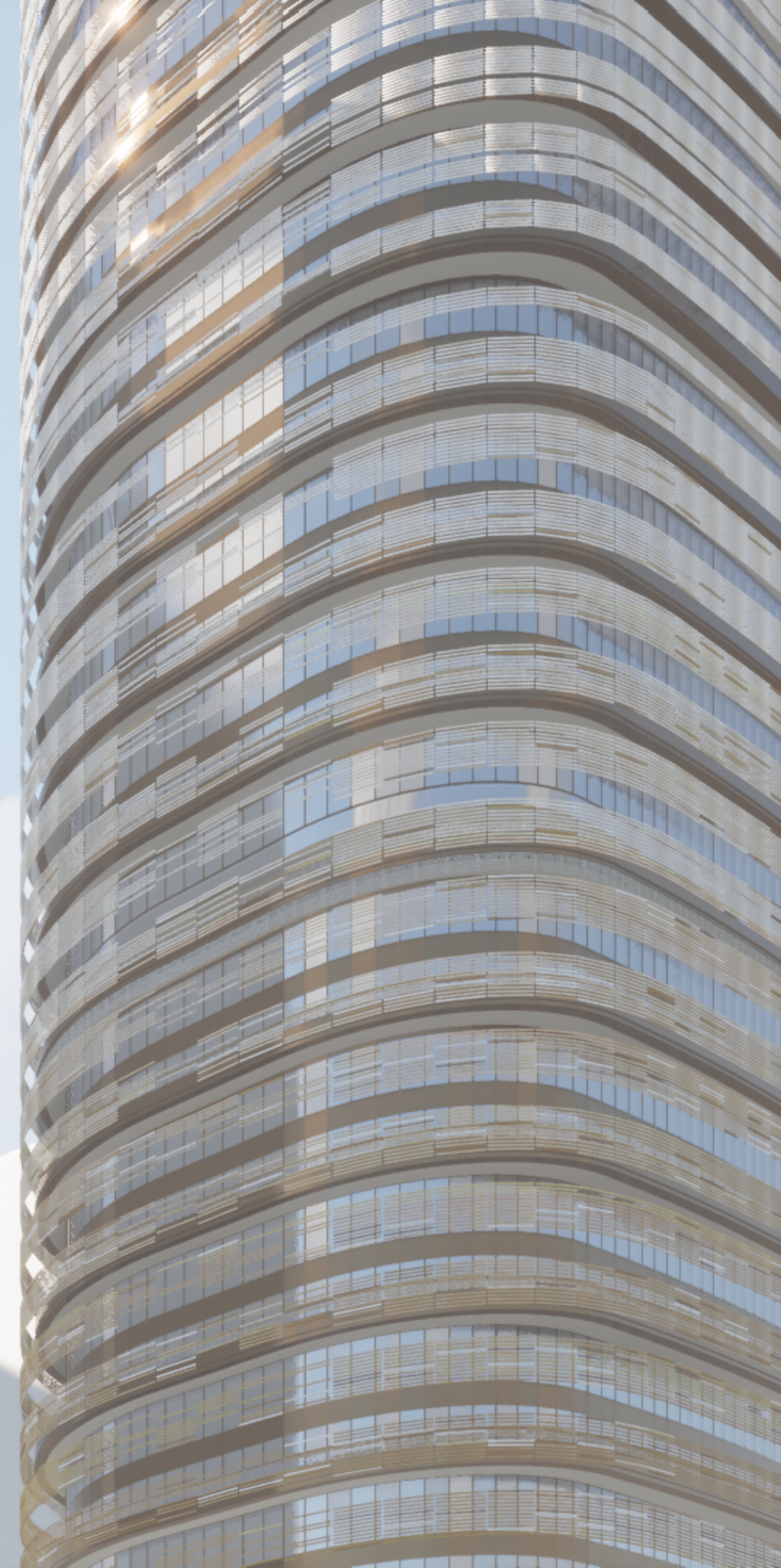


28.05.2021

NET ZERO TOWER

Swire Properties & HKGBC



Executive Summary

Future Building Brief Parameters

Grade-A Office tower

Site:
Taikoo Place, 979 Kings Rd, Quarry Bay, Hong Kong

Site Area:
Notional Site Area: 6,276sqm,
Buildable site area: 4,238sqm

Site Level
4.5mPD

Class of site:
Class C

Permitted Non-Domestic Site Coverage (above 15m) according to buildable site area:
65%

Permitted Non-Domestic Site Coverage (below 15m) according to buildable site area:
100%

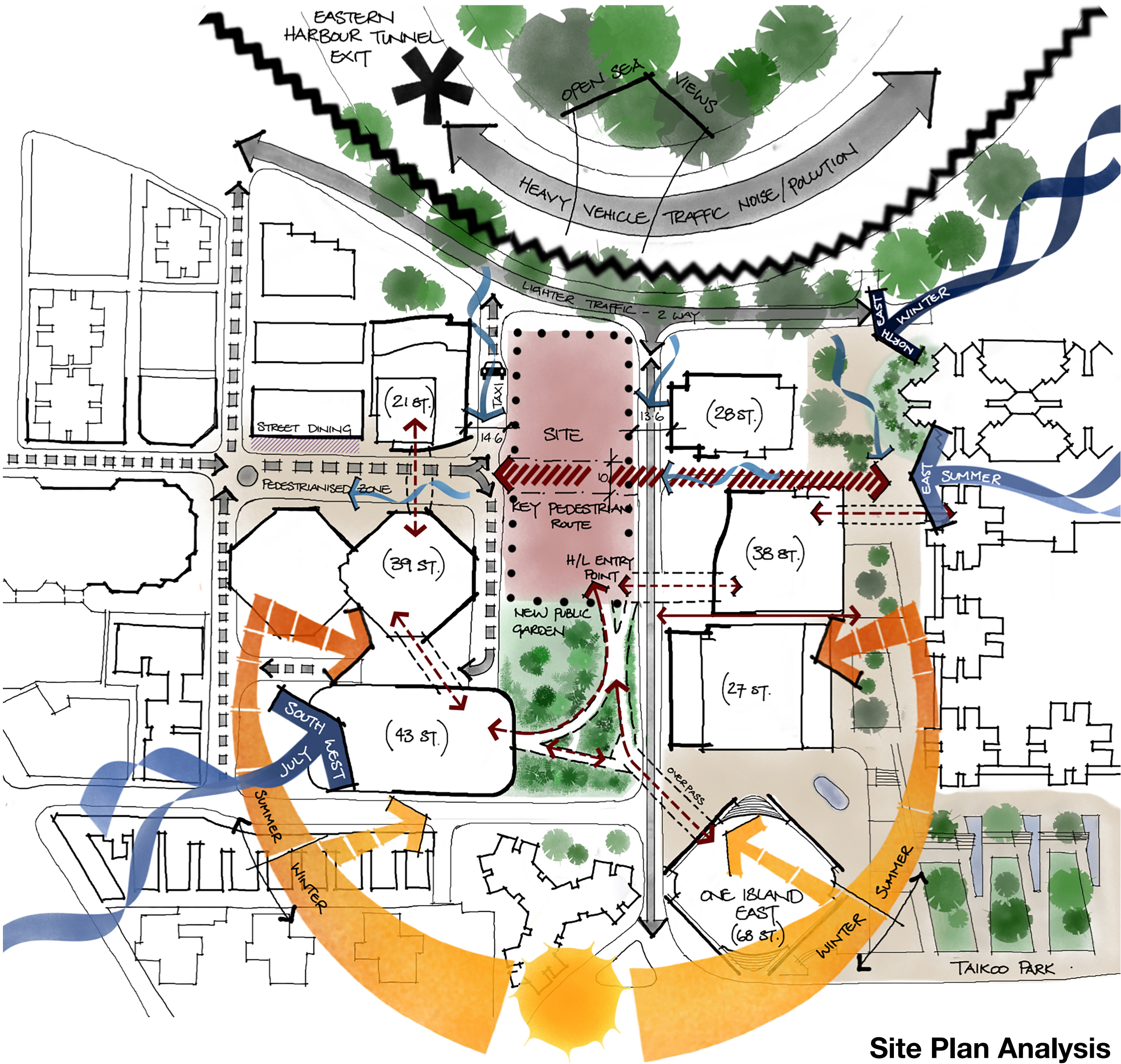
Permitted Gross Floor Area:
94,144sqm

Green area:
1882sqm (total green area for the whole site)
941sqm (minimum green area at primary zone/street level)

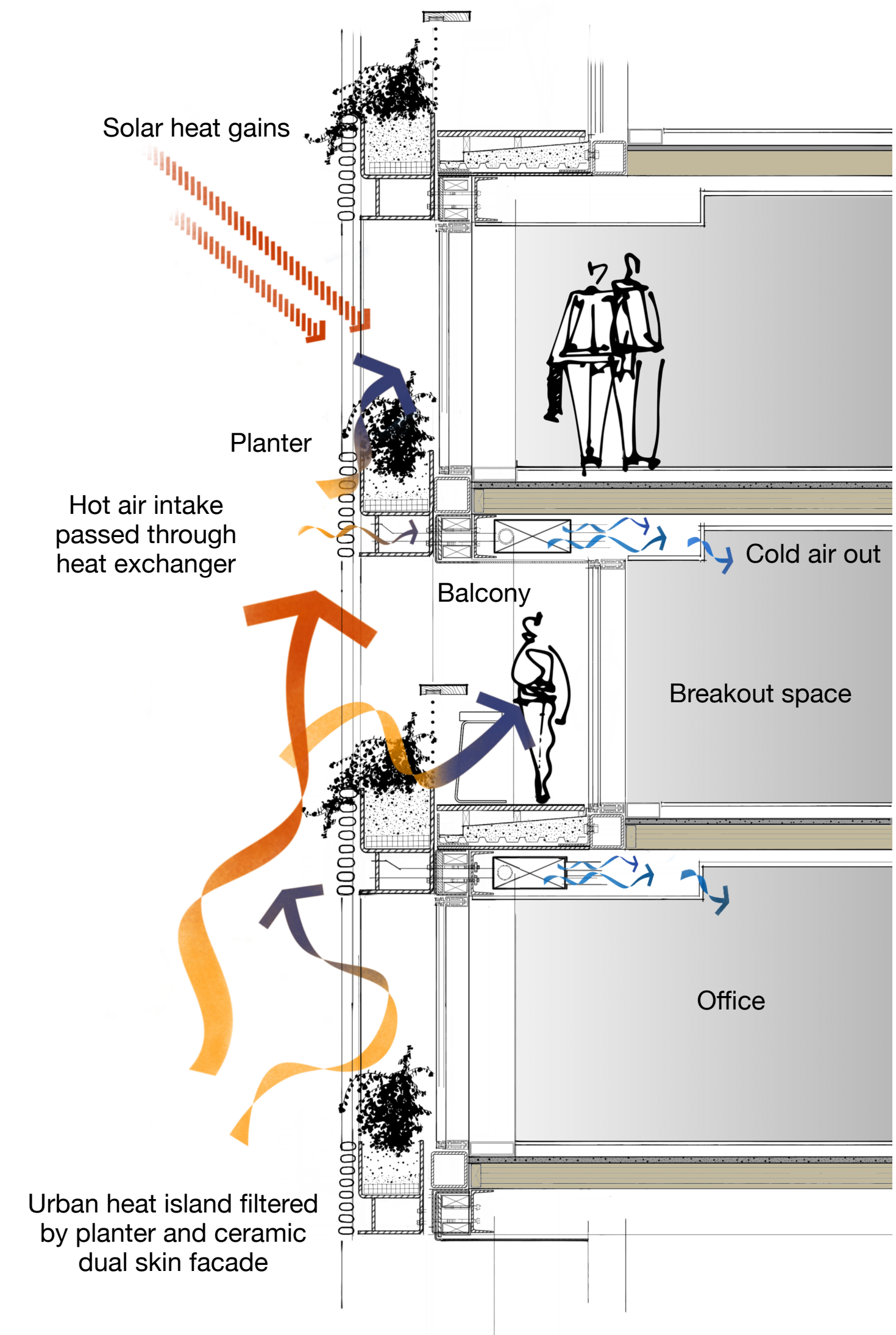
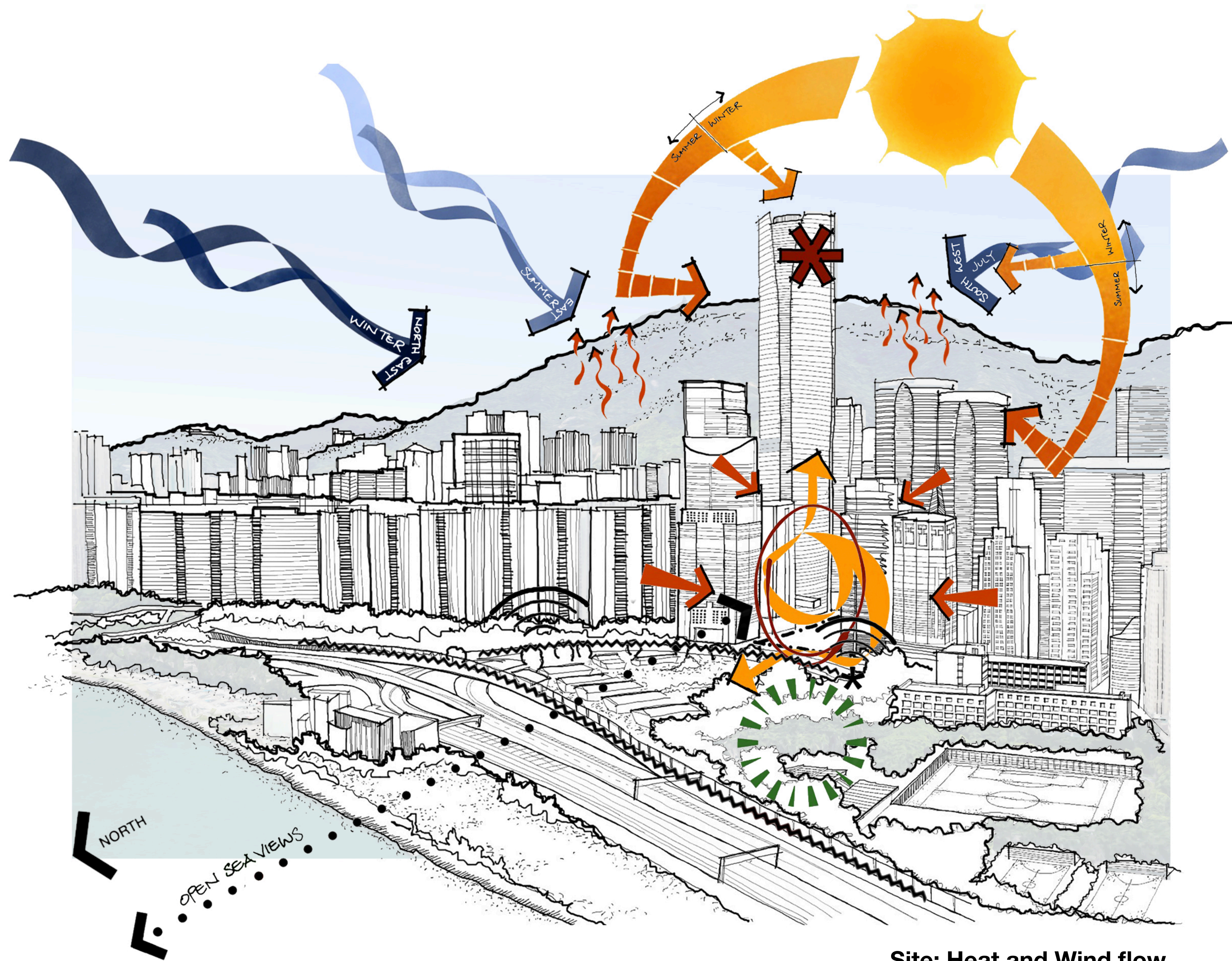
Permitted Building Height:
+225mPD

Non-building Area:
10m wide & 20m tall (along Tong Chong Street direction)

Facilities:
Carpark - 82 car parking spaces
10 motorcycle spaces
26 nos of loading/unloading spaces
Vehicle tunnel at B1 connecting to adjacent building for vehicle in /out
Min. 2no services lifts in addition to passenger lifts system
Main building entrance at ground floor.
Air-conditioned footbridge at 1/F linking up existing buildings.
EVA: Westlands Road and Hoi Tai Street



Site Plan Analysis



1. Construction Systems for low embodied carbon

• **Lighter superstructure** • **Less embodied carbon + energy** • **Sequestered biogenic carbon** • **Increase use of recycled material** • **Intelligent minimization of load-bearing systems** • **Functional durability and Reduced Maintenance** • **Adding years to service life**

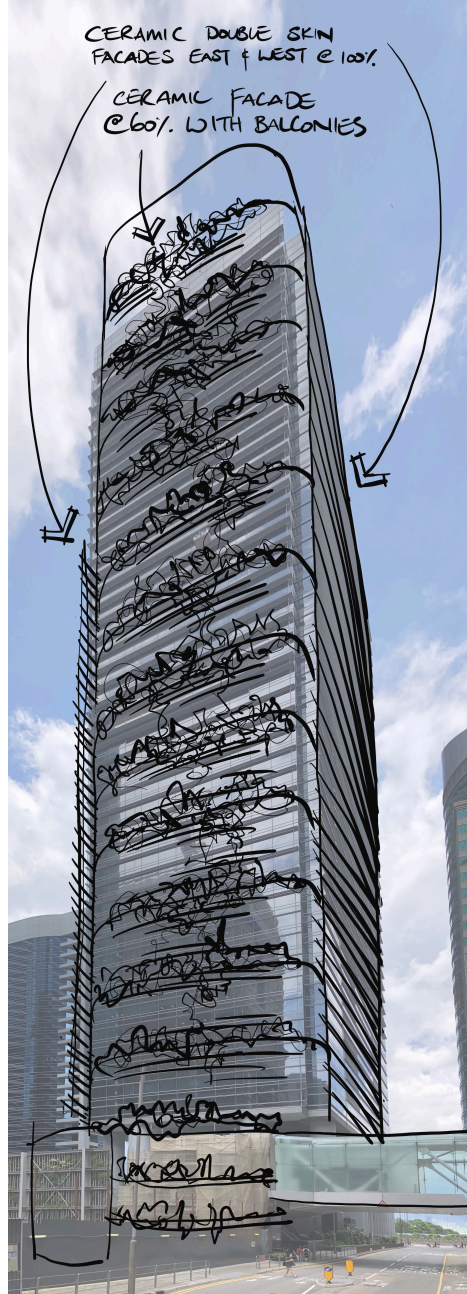
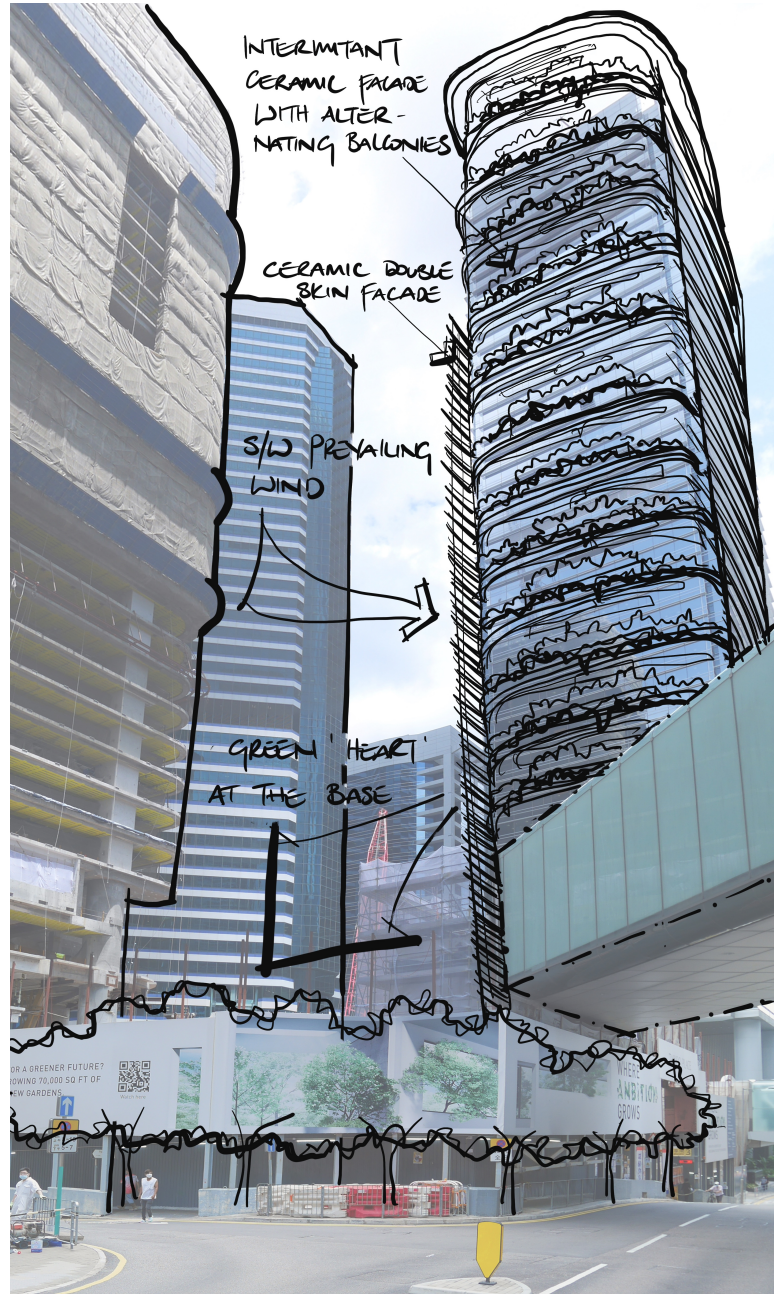
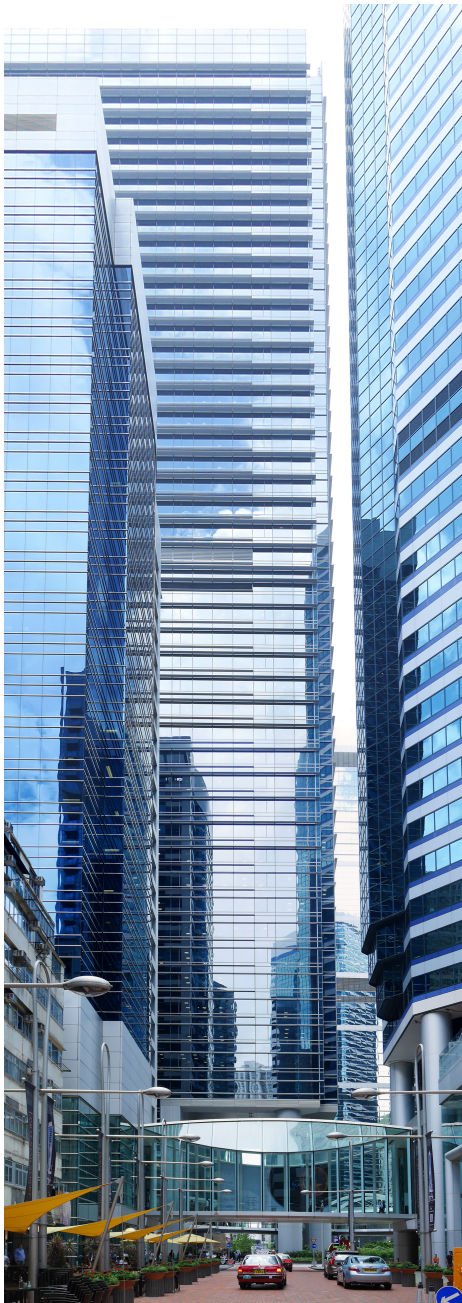
- 1. Concept: The Right Materials in the Right Places:** Concrete for Core & Shear resistance, Mass Timber Primary Interior Structure, Lightweight Lamboo/Steel/Aluminum/Glass at Perimeters
2. Core: Minimized Shear and Core elements to use low-carbon and carbon sequestering concrete (ie. CarbonCure), reducing overall concrete-related embodied carbon
3. Conditioned Areas: Interior Primary Structural System to be comprised of fire-resistant mass-timber components (CLT Slabs & Glulam Post+Beam) where temperature & humidity are controlled
4. Unconditioned Areas Perimeter: To be comprised of steel, glass, aluminum and materials impervious to sub-tropical humidity, minimizing maintenance and maximizing durability
5. Unconditioned Areas: Sub-grade parking & structure to be minimized, parking bays to be harmonized with structural grid of upper levels, limiting transfer structures: minimize transfer structures, aim to align all vertical load-bearing elements, reducing any unnecessary cantilevers, optimizing gross cost by reduction of bulk concrete and steel
6. Passively Tempered Areas: Atria, Exterior Skins comprised of lightweight secondary structures that produce a cooling microclimate using materials indigenous to the region and/or impervious to climatic impacts (ie mould/rot/decay)
7. Envelope Airtightness levels constantly monitored (airtight.ai - to be less than 0.09l/m2): for optimal control of balanced humidity, reduced particulates (TVOC & PM2.5), optimal CO2 (<600ppm) and maximized HVAC efficiency through pressure-balanced ventilation
8. Optimized and flexible hybrid structures providing faster construction times with excellent seismic characteristics and fire resistance, bolstering overall structural resilience
9. Maximized NOI over life of the building due to reduced replacement costs, capital reserve funds, and extended durability with longer service life
10. Pod construction to the WC's
11. Naturally seeded green roof systems

THE SITE

South / Western aspect of the site

Passive Building Form & Envelope Strategies for this aspect:

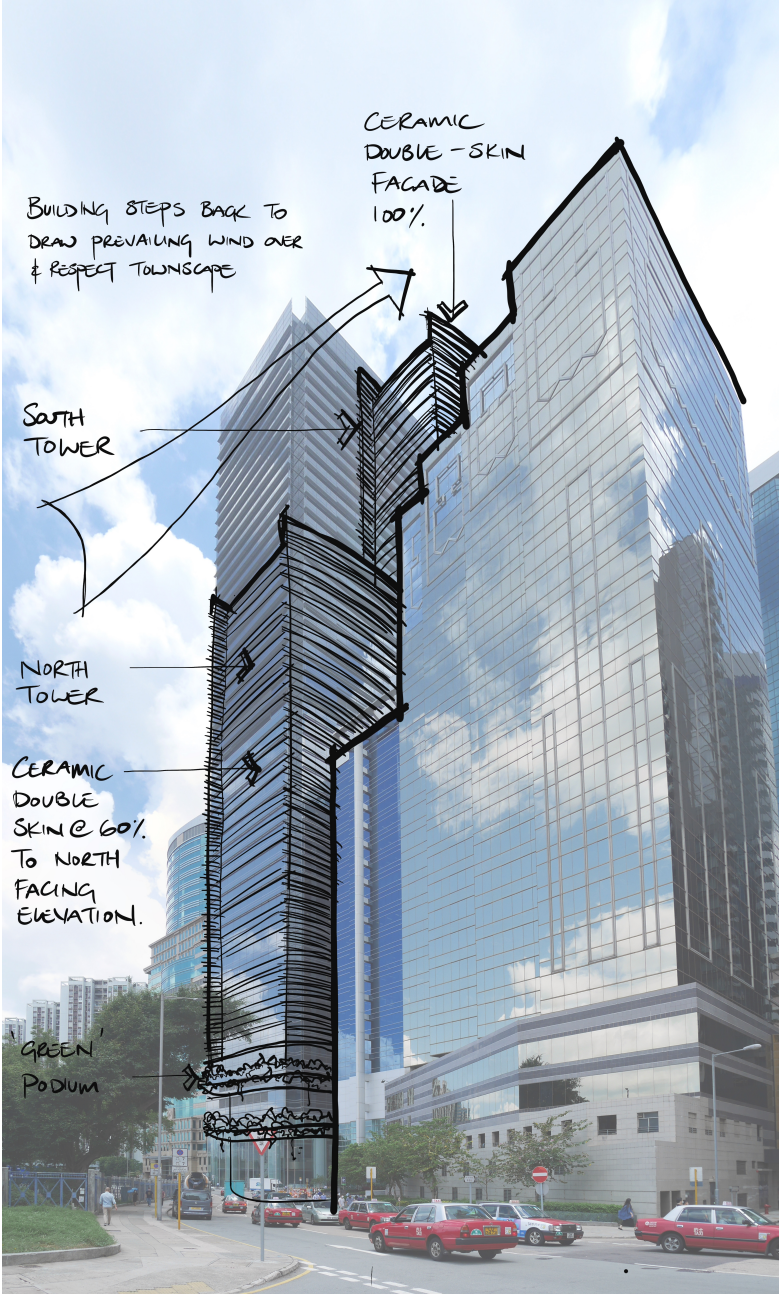
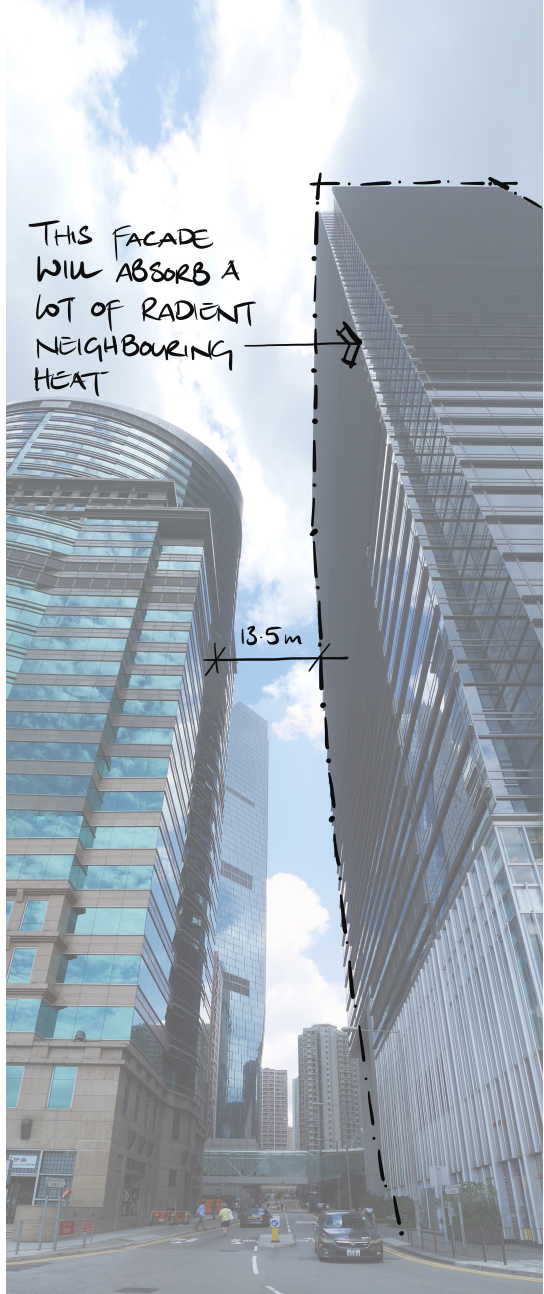
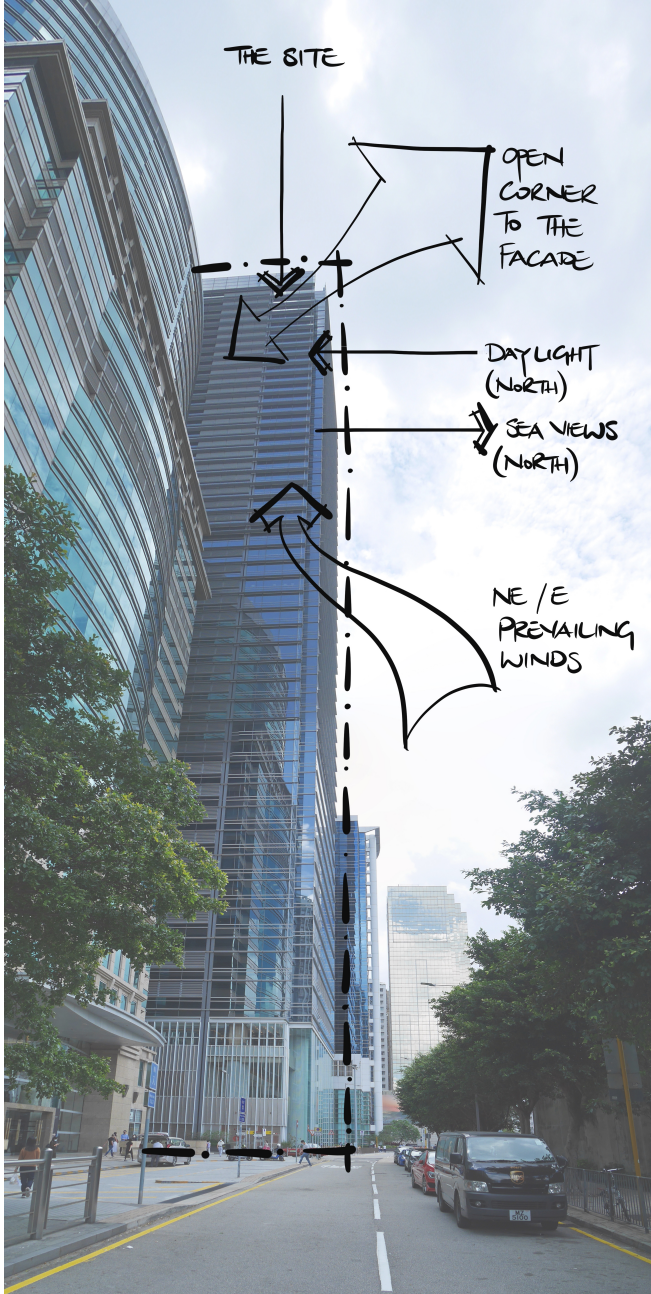
- Double skin facade; maximise shading and use of photovoltaics to these facades to reduce the solar heats gains and maximise the potential for solar energy - maximum solar heat gains from this aspect, low sun heat gains in the winter
- Tall buildings radiating significant heat within 15m of the site south-western boundary - maximise ceramic facade dual skin system to reduce the ambient temperature of the surroundings using the heat of vaporization phenomenon. The heat of vaporization refers to the heat absorbed by the surroundings when water evaporates - utilise filtered grey waste water.



North / Eastern aspect of the site

Passive Building Form & Envelope Strategies for this aspect:

- Double skin facade; maximise the ventilated facades to keep building cool with breathable air flow over the building - prevailing wind from this aspect
- Tall buildings radiating significant heat within 15m of the site Eastern boundary - maximise ceramic facade bioskin system to reduce the ambient temperature of the surroundings using the heat of vaporization phenomenon. The heat of vaporization refers to the heat absorbed by the surroundings when water evaporates - utilise filtered grey waste water.



2. Massing for optimising site conditions

• **Passive cooling** • **Lower solar gain** • **Reduction of heat island effect**

Prevailing wind - East and South-West (summer)

Shading from neighbouring towers

Two-tower massing allows for self-shading,

Towers are elevated from ground plane to enhance prevailing wind ventilation across the public realm throughout the year

Tong Chong Street is the public heart of the development and extends to open spaces and gardens located under and around the elevated towers

1. New urban park

2. Level 0 Podium- hydroponic 'tower', extension of urban park & public plaza

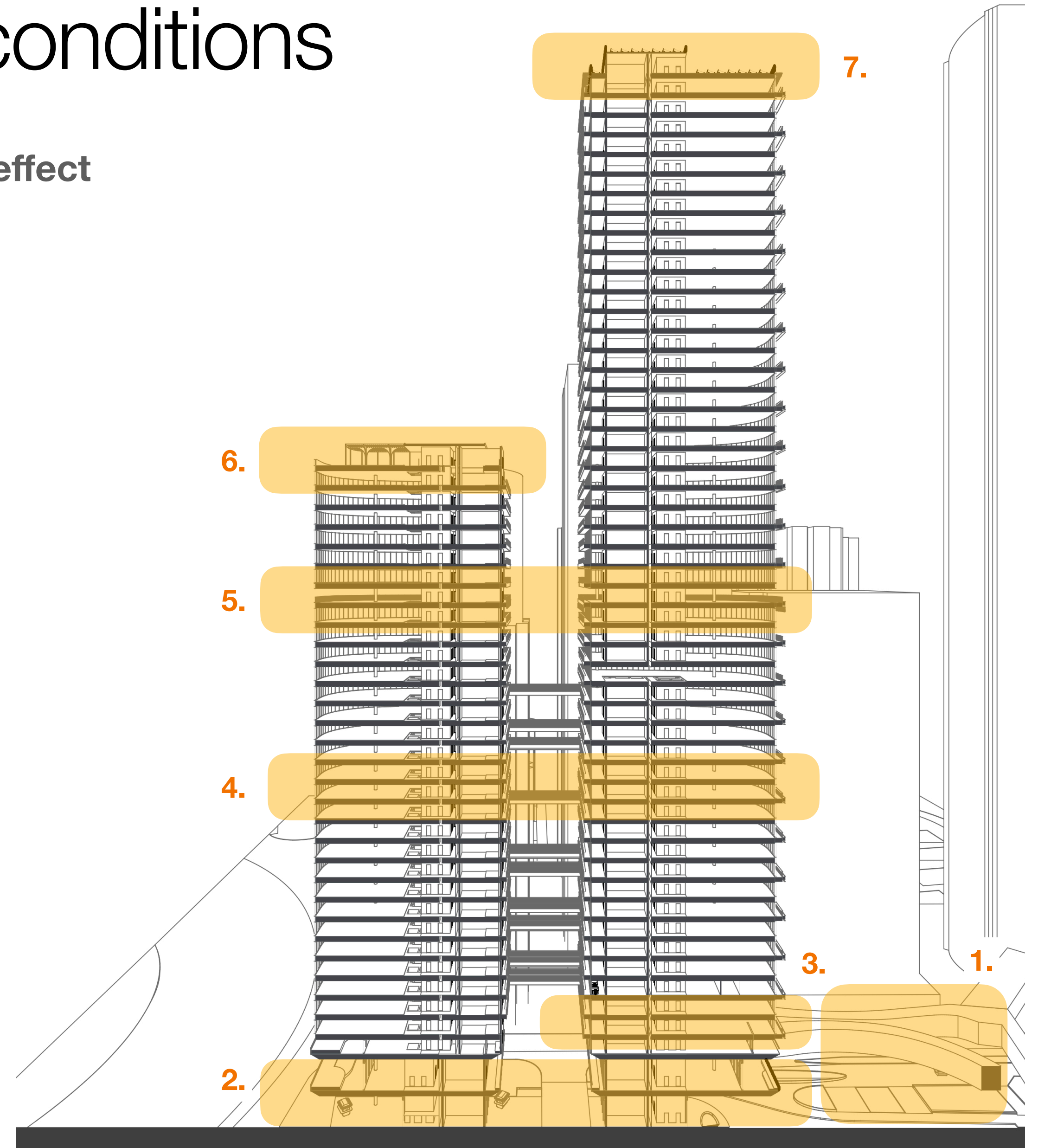
3. Level 2 Podium - hydroponic / urban farm restaurant & bar

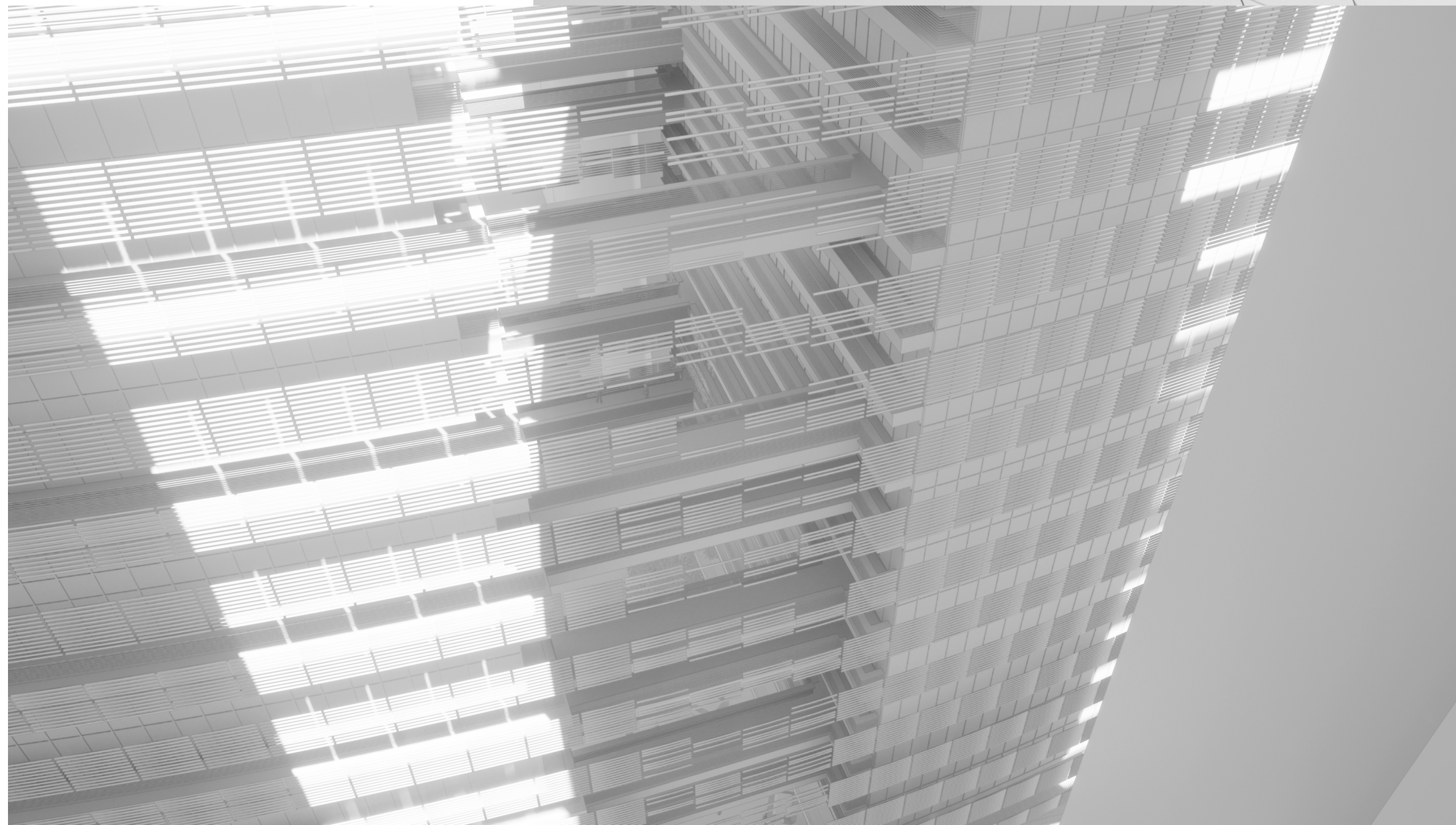
4. Refuge floor

5. Typical floor plate

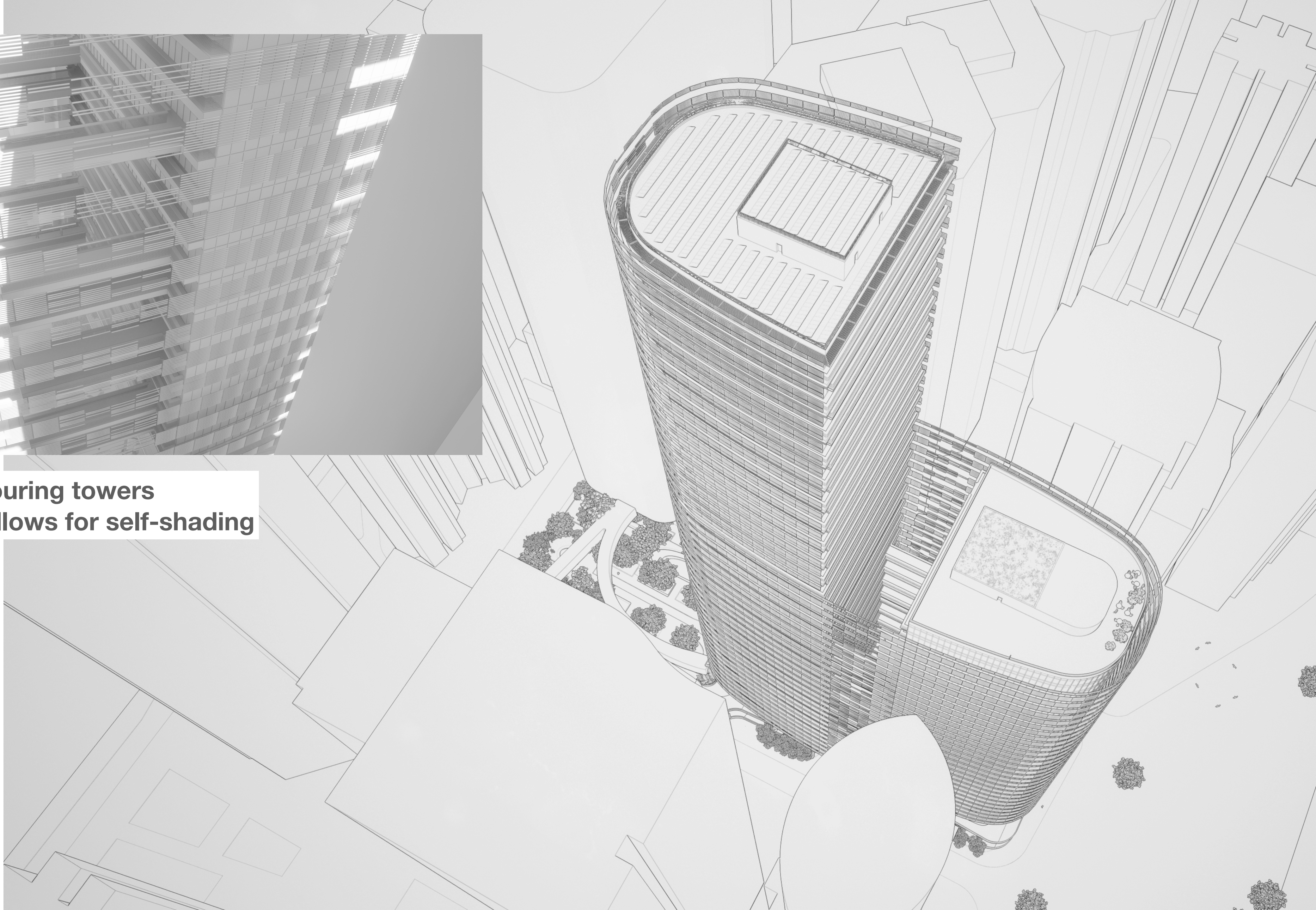
6. Gym / spa zone

7. PV cell and rainwater harvesting





Shading from neighbouring towers
Two-tower massing allows for self-shading



3. Facade Design for optimising solar, cooling and air quality

• Optimised shading • Optimised cooling • Optimised air purifier

low carbon embodied microclimatic outer skin
ceramic pipes holds harvested rainwater for purpose of cooling the facades through evaporative cooling (up to 12°C reduction from conventional building)

ceramic water pipes coated with titanium dioxide TiO_2 which under direct sunlight decomposes organic pollutants and with moisture is able to the air around it

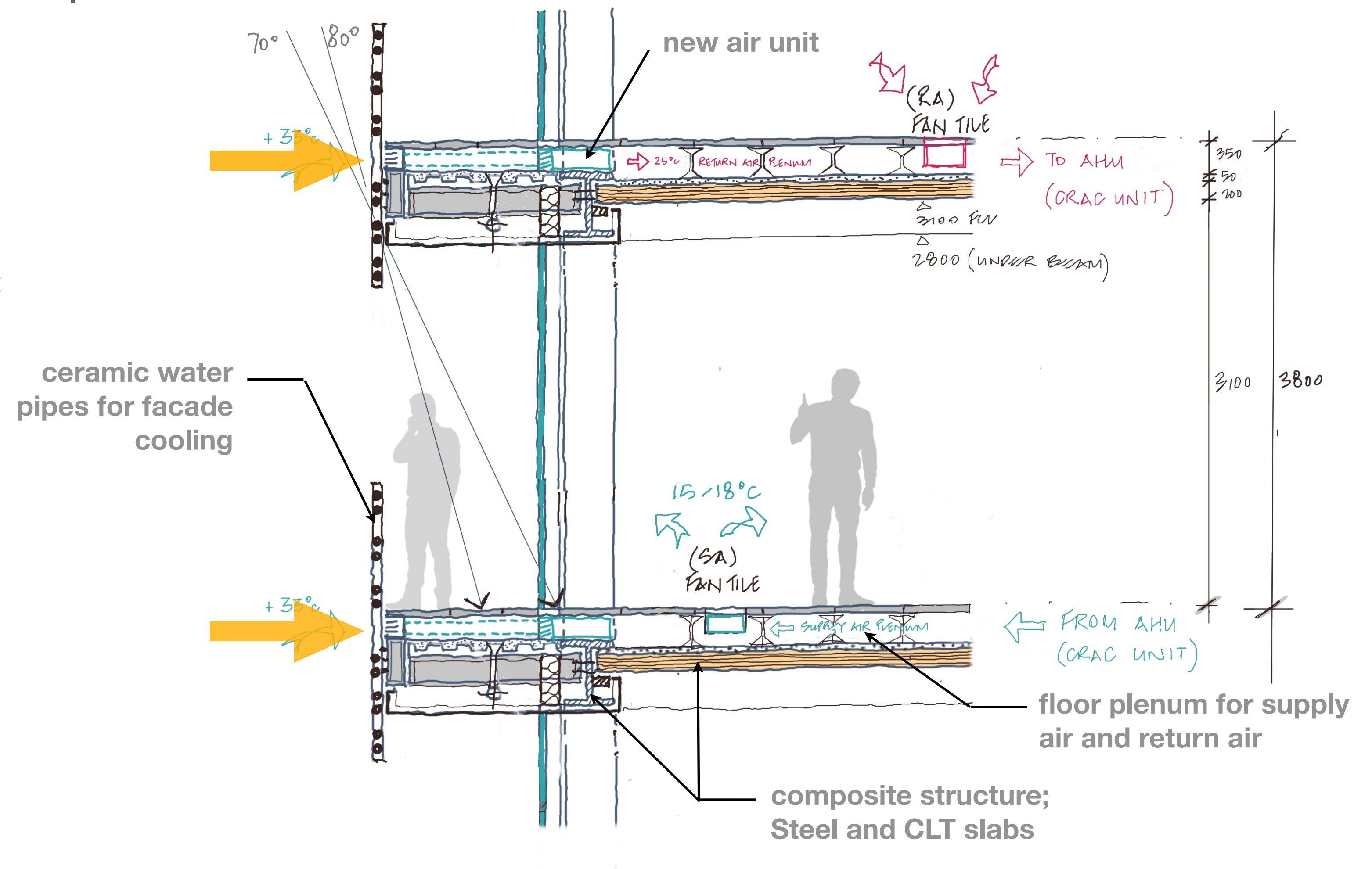
cooling effect of facade reduces the heat island effect to the surroundings

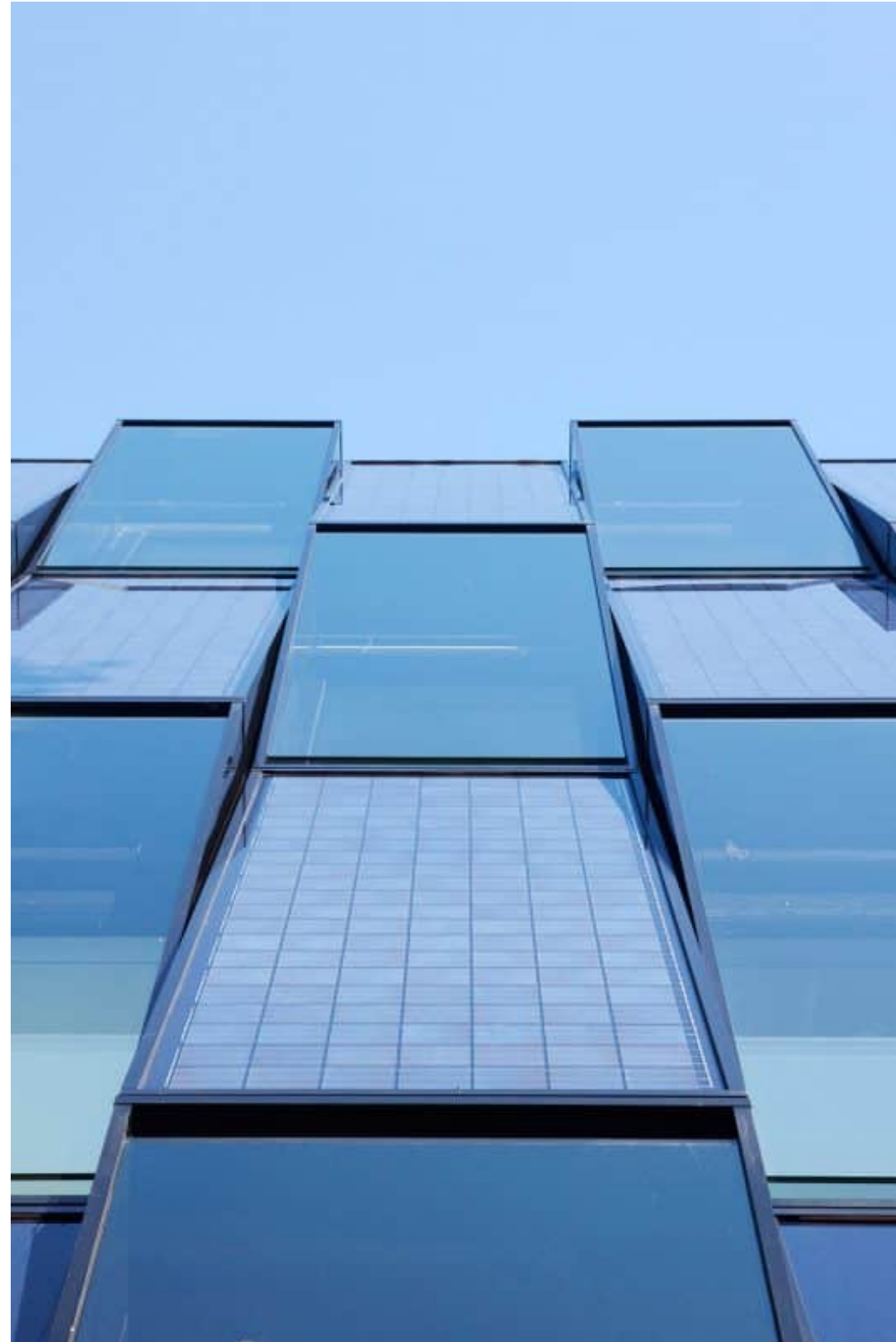
shading control of south and west facades with deep facade set-backs open up outdoor spaces to each floor

daylighting is optimised whilst minimising direct sunlight through the facades

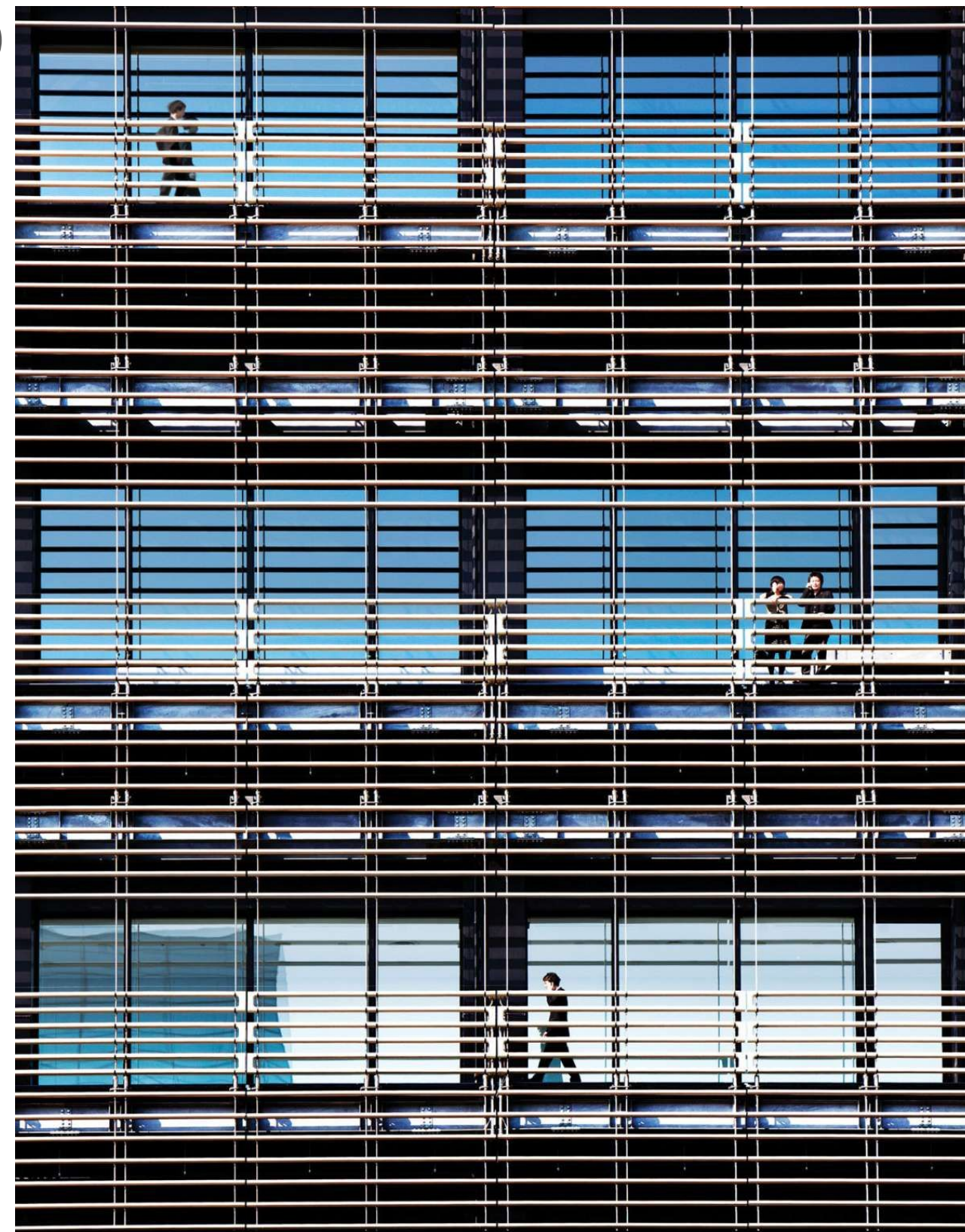
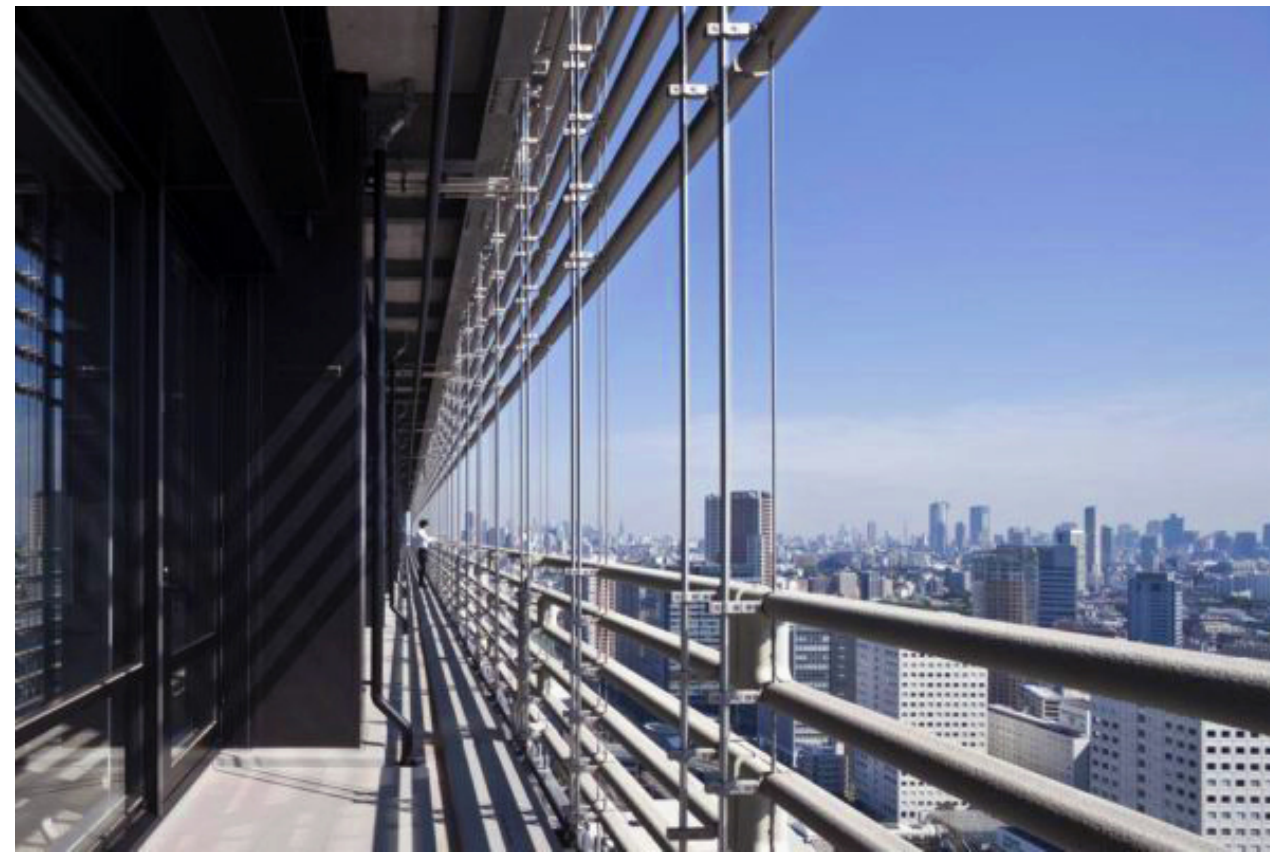
multi-level microclimatic outdoor spaces created as communal gardens for the office floors

outdoor spaces can be non-accountable GFA driven by strong sustainable design



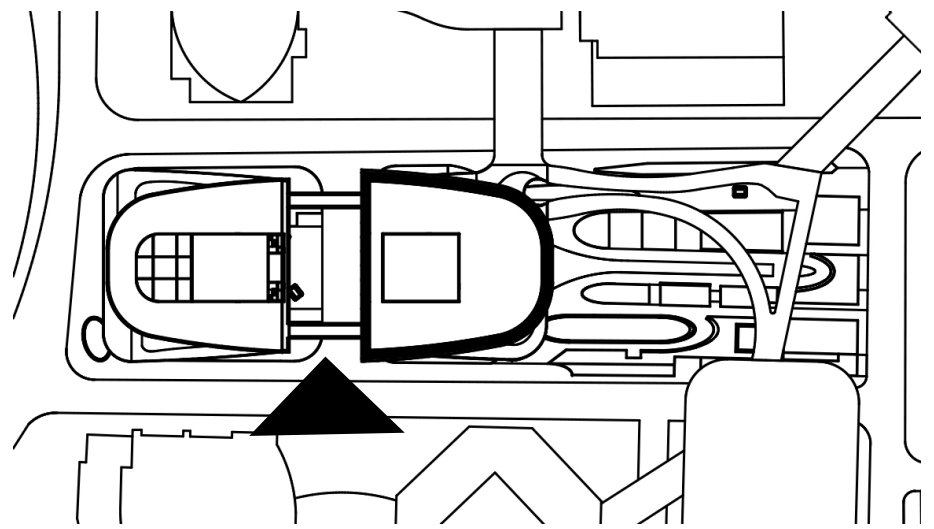
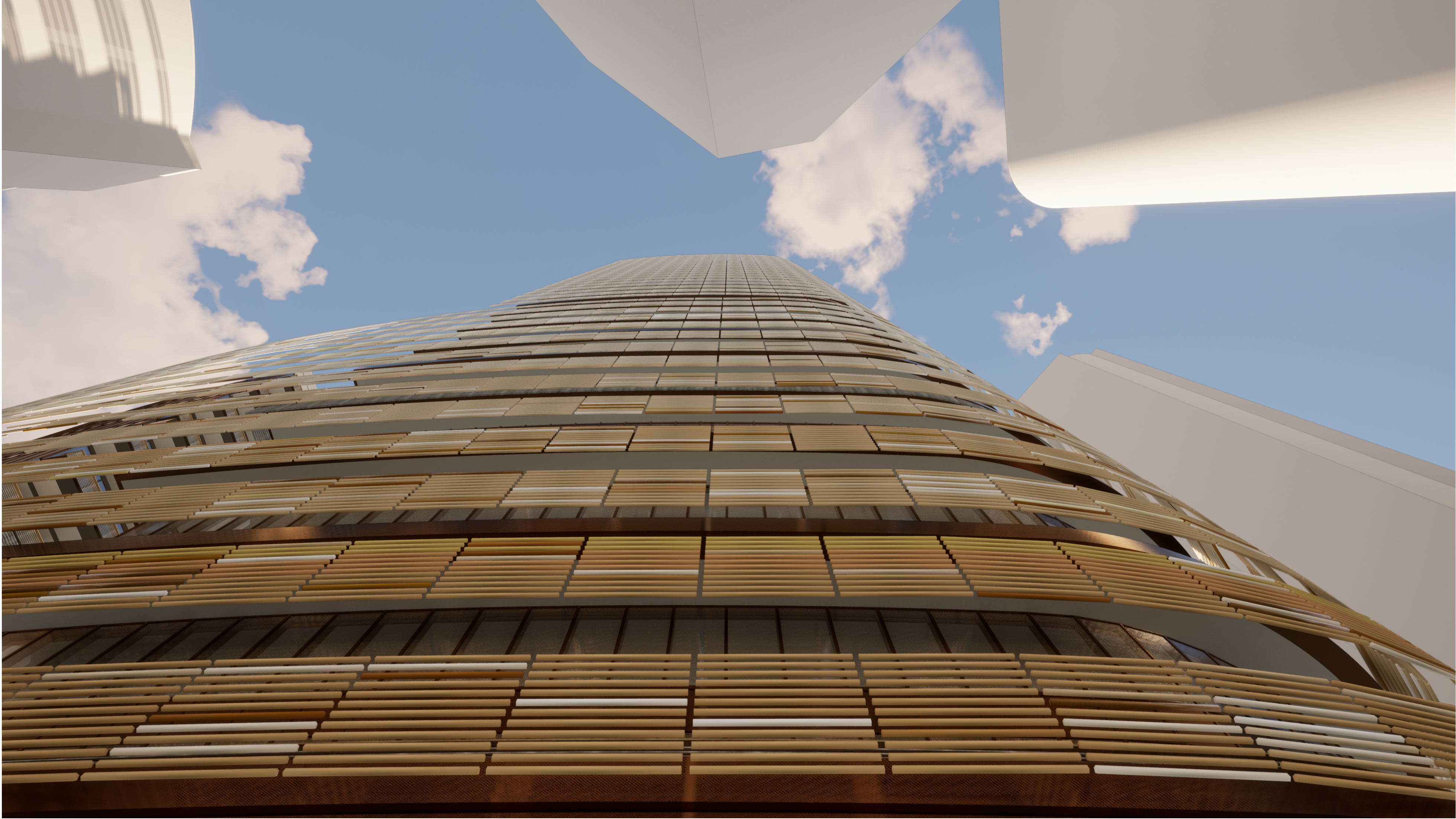


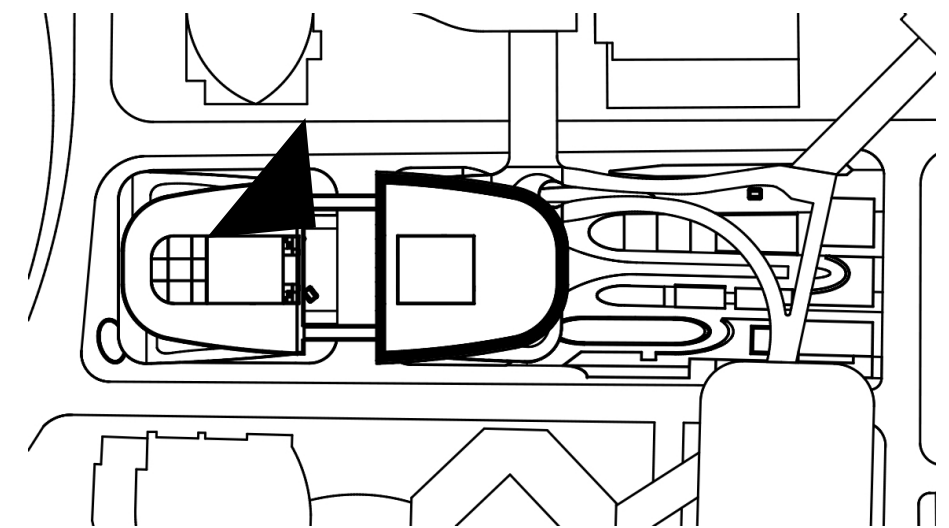
- Ceramic double skin facade (heat absorption)



- PV cells integrated with building facade

- Laminated timber curtain wall system





4. **Passive Energy** to reduce overall energy demand

• **Seawater Geothermal** • **Solar** • **Rainwater** • **Wind** • **Evaporative cooling**

seawater geothermal cooling system by retrieving sea water to cool down buildings' chillers.

A wider consideration for district cooling program for Swire commercial buildings in Tai Koo

utilise PVT panels on roof and facade that harnesses solar energy to drive hot water demand for office toilets, F&B facilities and showers for gyms

rainwater is harvested to support closed loop HVAC system

solar and rainwater are both harvested to support facade evaporative cooling system

prevailing wind flow across the strategic placement of a micro-climate zone creates further cooling through the public and communal spaces in the tower

wind turbine on roof of taller tower to generate energy for lighting and hot water demands

5. HVAC system for energy conservation

- Decentralised underfloor air system

decentralised underfloor air system
minimum 20% energy reduction to overhead
AC system

high personal control of cooling comfort with
air quality monitors located within office space
Excellent IAQ

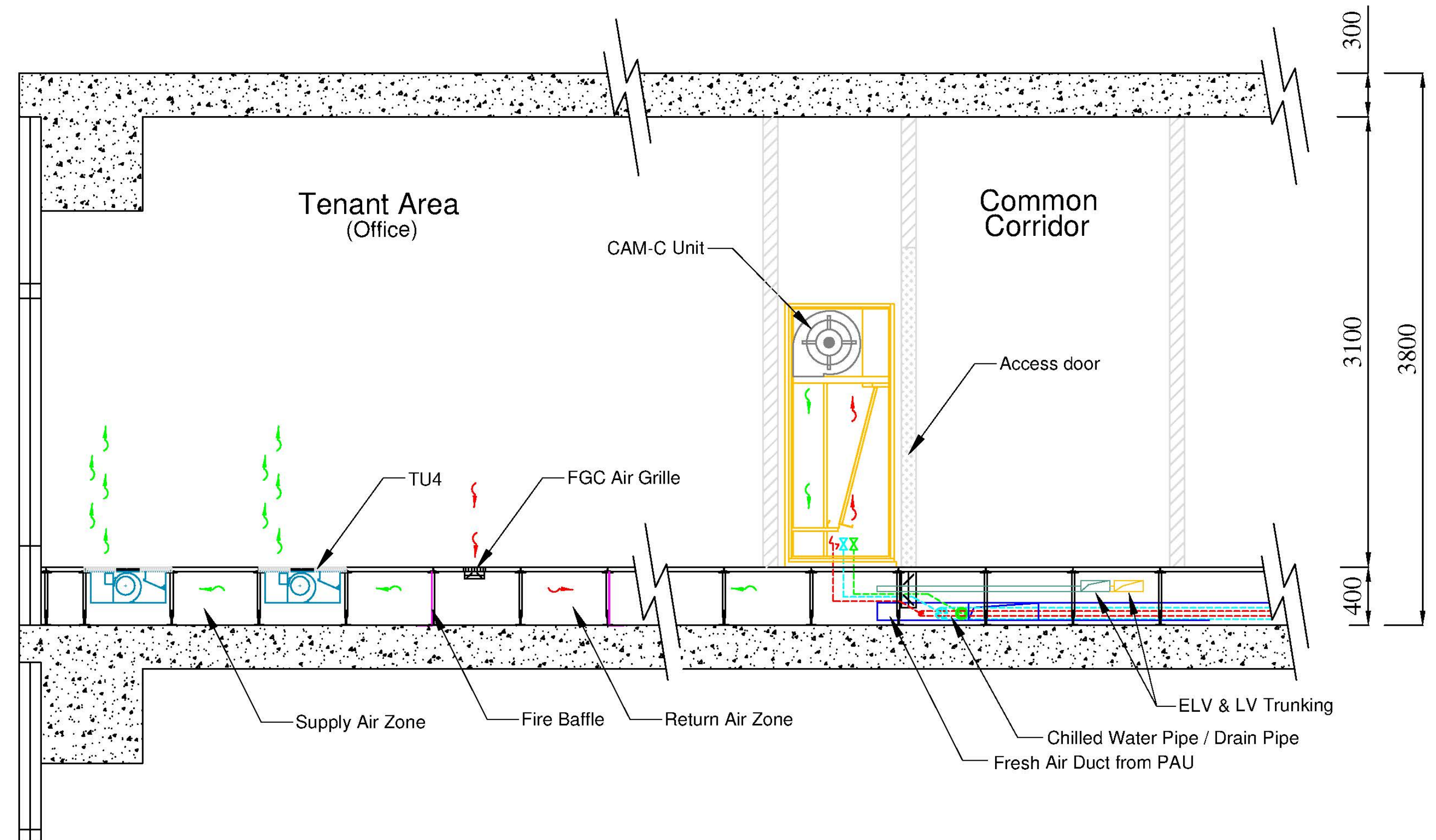
underfloor system relies on plenum space
integrated to raised floor and with no ducting

supply air and return air are served by
individually controlled fan tiles units integrated
to raised floor system

fan tiles are fast to install, relocatable and reusable

TIO₂ filter utilised in CRAC unit and fan
tiles for removing RSP (respiratory small
particles) and VOC's

ceiling zone is free of AC equipment and
ductwork, which can optimise on floor to
floor heights



Generic section showing underfloor AC system

6. Energy Conservation

- Reduction in energy and resource consumption

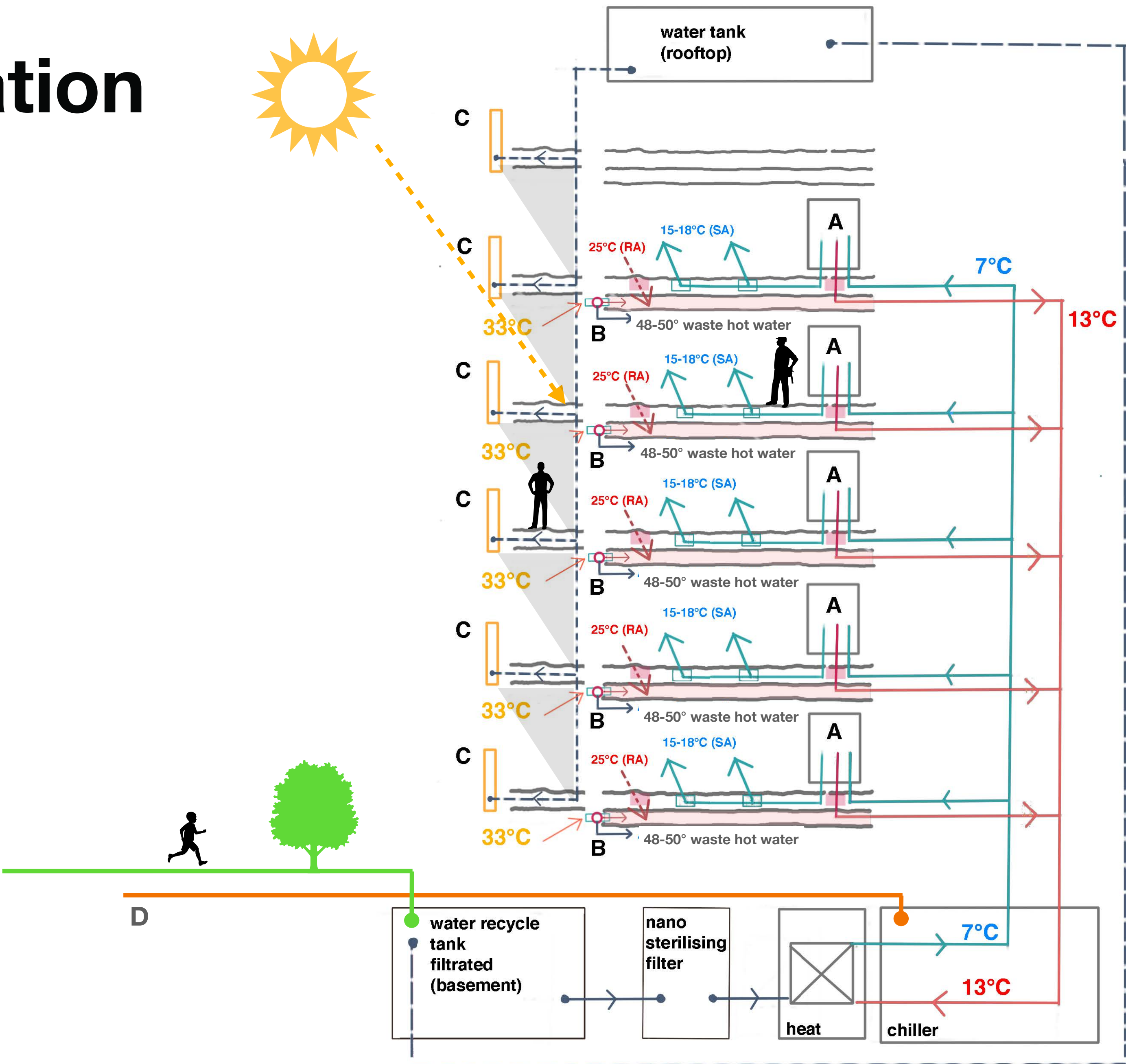
A CAM 2 (CRAC unit) with heat exchanger located in AHU plant room on every floor or as cabinet units in tenant space. Generally, 5 numbers of CRAC units per 13,000sqft of space

B New Air unit - High performance pretreat air unit with heat pump for cooling down and dehumidify incoming fresh air to reduce the duties of chiller plant

48-50° celsius water as wastage for reuse supply to facilities such as F&B, office bathrooms, and gyms showers

C low carbon embodied microclimatic outer skin ceramic pipes holds harvested rainwater for purpose of cooling the facades and outdoor space through evaporative cooling

D seawater geothermal cooling supplying chillers with cold water from Victoria Harbour via a seawater plant with potential of creating a district cooling network for Swire buildings in Tai Koo



7. Electrical system for energy conservation

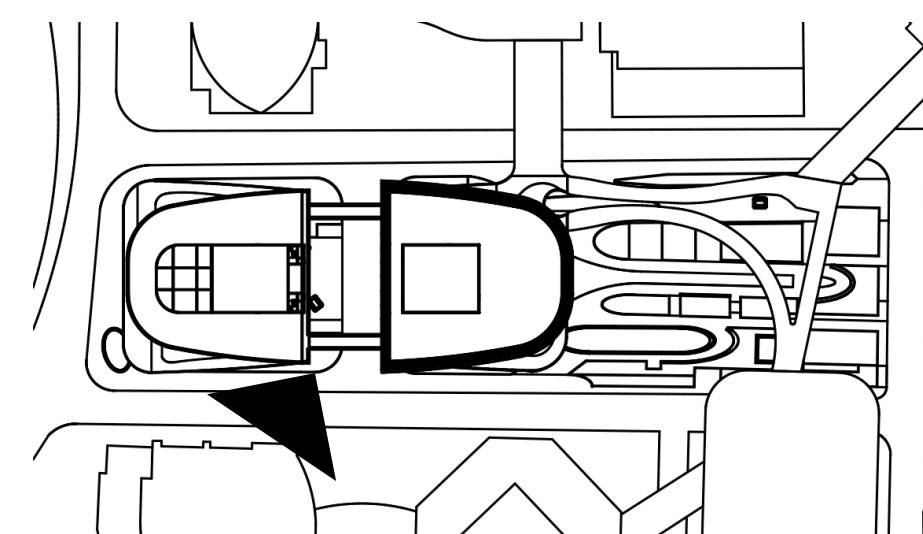
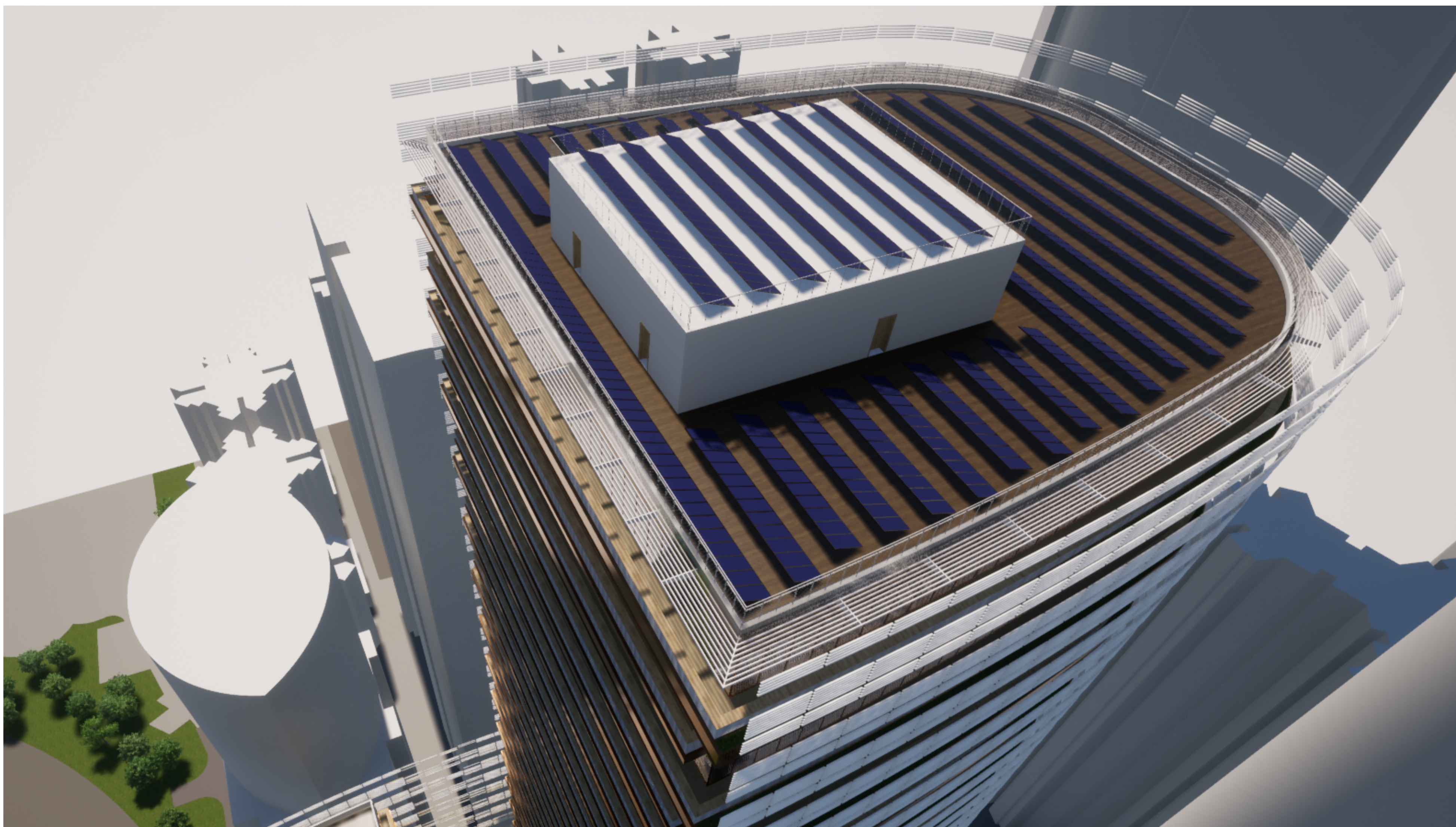
Electrical & Lighting

- A** Shutting down stand-by mode xx% reduction
LED lighting PIR

Diverse measures for reducing standby-losses such
as putting hard switches on the LED light fitting

- B** drivers thereby turning them all the way off and
eliminating standby loss when they are not in use.

A 26kWp photovoltaic system was installed on the
roof providing a small portion of the buildings
electrical energy demand. The whole system is
controlled through an integrated automation
system, which enables the building to be operated
in the most energy efficient mode.



8. Community focused

Hydroponic farm - urban farming that is net zero

showcase of vertical hydroponic / aquaponic farm that utilises energy and resources produced from the net zero building development to drive high yield production on limited land

utilise building's chillers to regulate temperatures in clean room environment

facade PVT supplies power to LED growth lights

closed loop irrigation system - water re-cycled

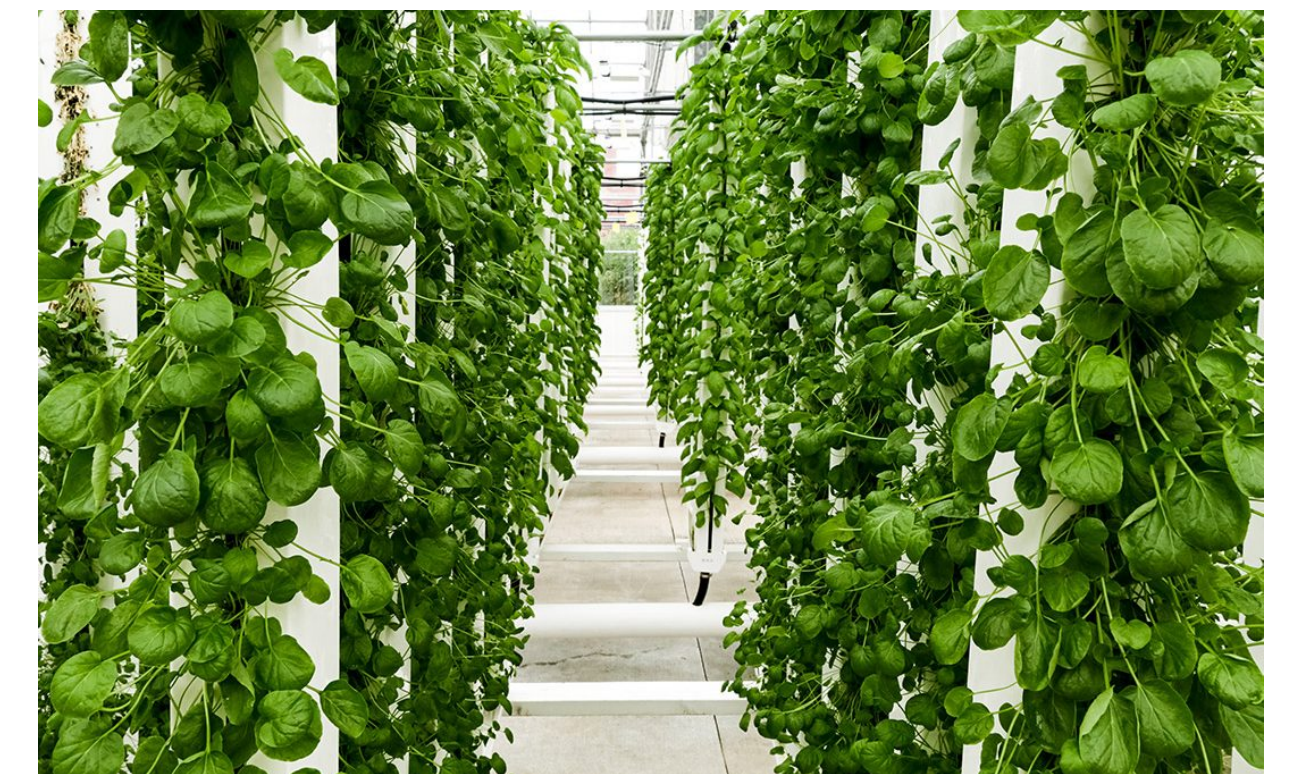
office's New Air Units to supply hot water supply for cleaning

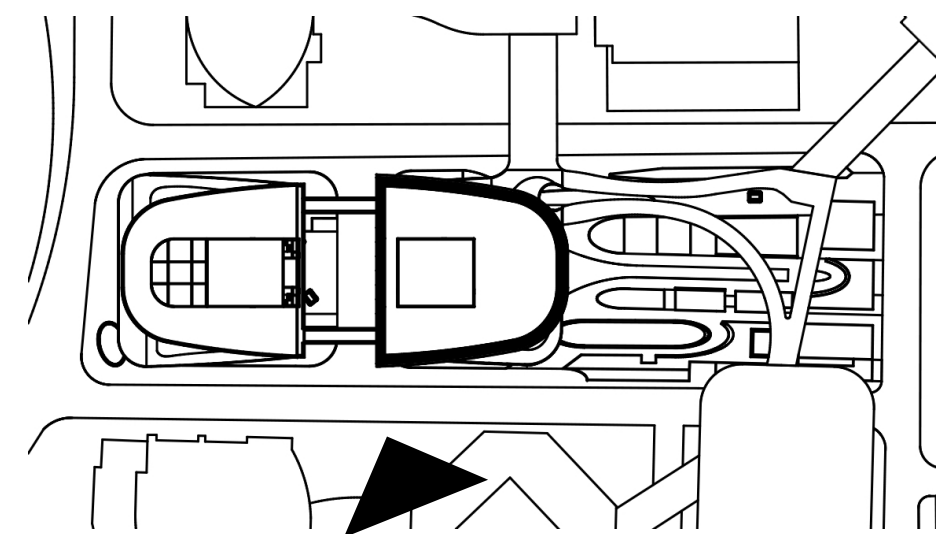
vegetable produce is low carbon, and has little wastage, compared to conventionally farmed vegetables

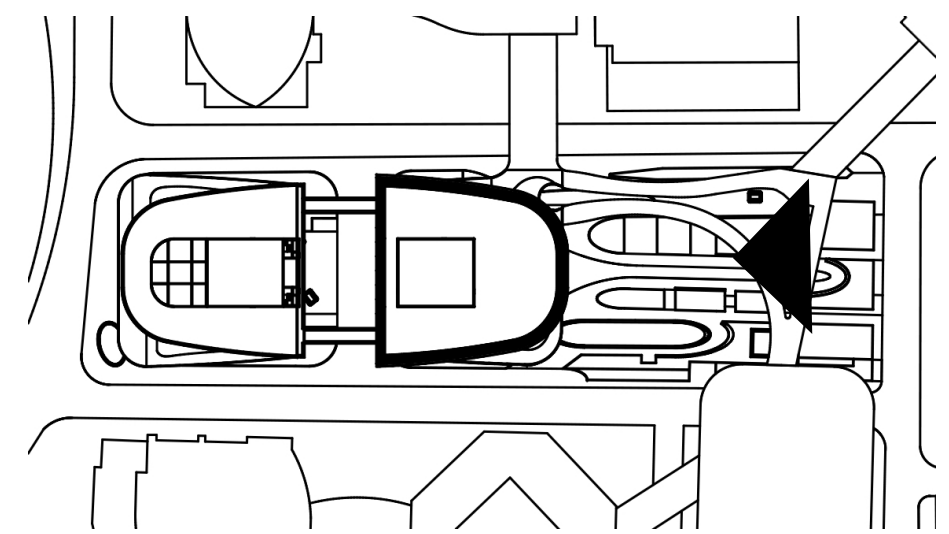
vegetable produce is uses no pesticides and no fertilisers, making then 'clean' and pollutants free.

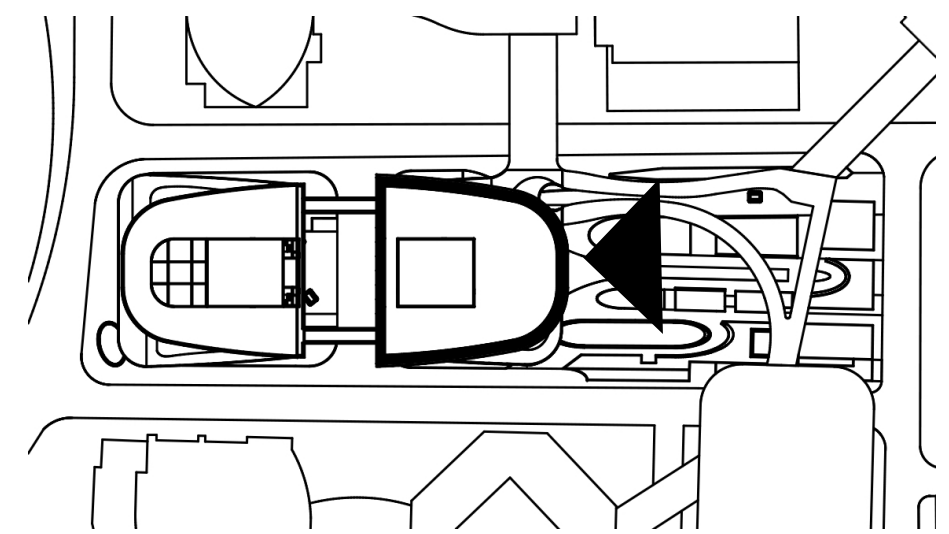
vegetable produce is sold to restaurants and supermarkets within Taikoo Place and beyond

local community can enjoy locally produced clean vegetables without relying on imported produce with high carbon footprint

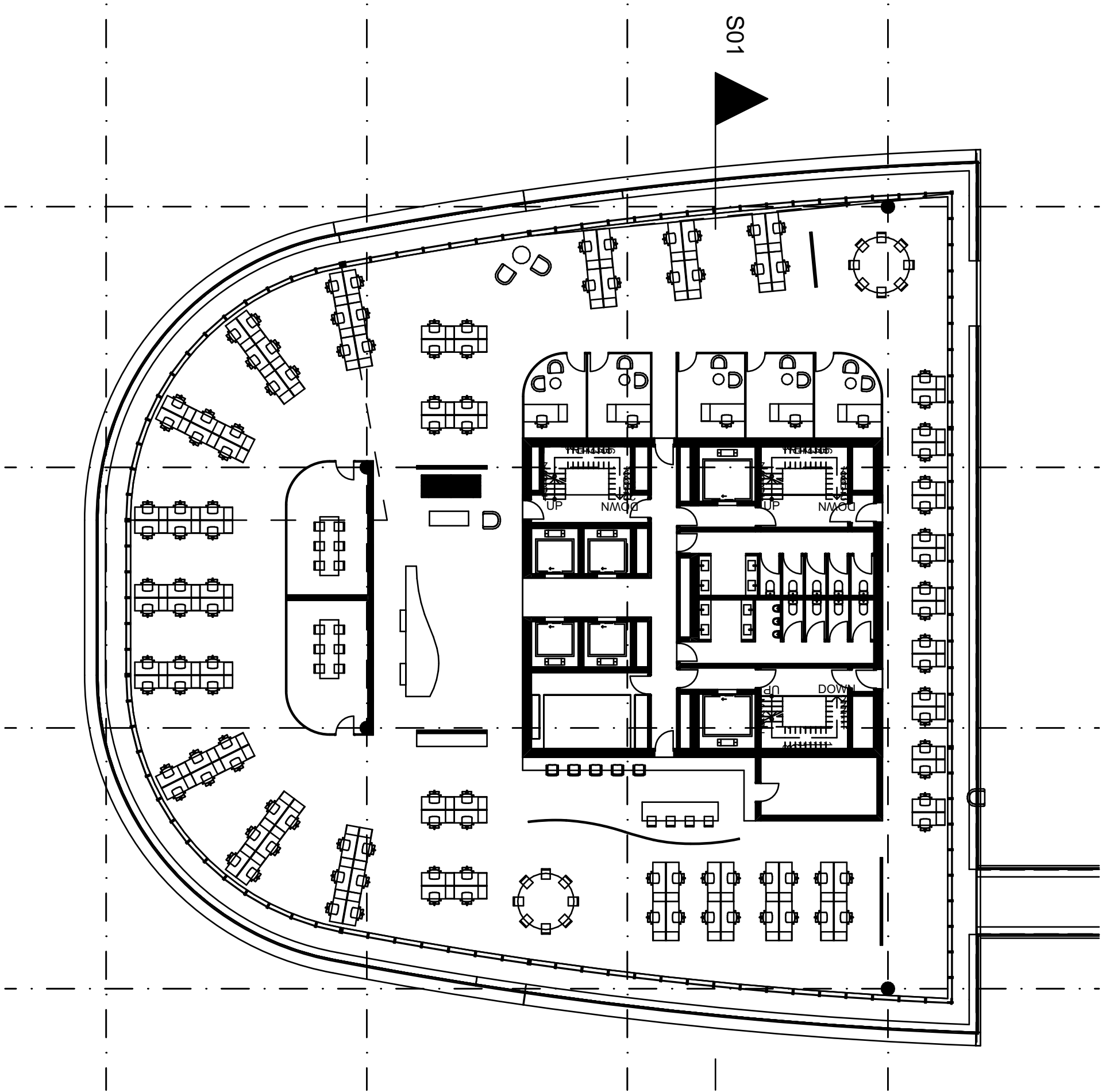








9. Typical Floor plate



9. Typical Floor plate

• occupancy • GFA • building scale

Summary

Podium Site Coverage

Tower Site Coverage

South Tower Total GFA

North Tower Total GFA

Building Total GFA: 94.000 sqm

Total Building Height: 193mPD

Refuge Floor @ level (discounted from GFA)

Ground Level Green area

Total Site Green area

Floor plate approximate occupancy based on 1P/
9sqm: 128 people

Brief target - **Our Project**

100% (below 15m) - 3,014.4 SQM

65% (above 15m) - 2,746.4 SQM

94,144sqm GFA (max)

193mPD

Refuge Floor @ level 25 (discounted from GFA)

2,624 sqm (min. Required at street level)

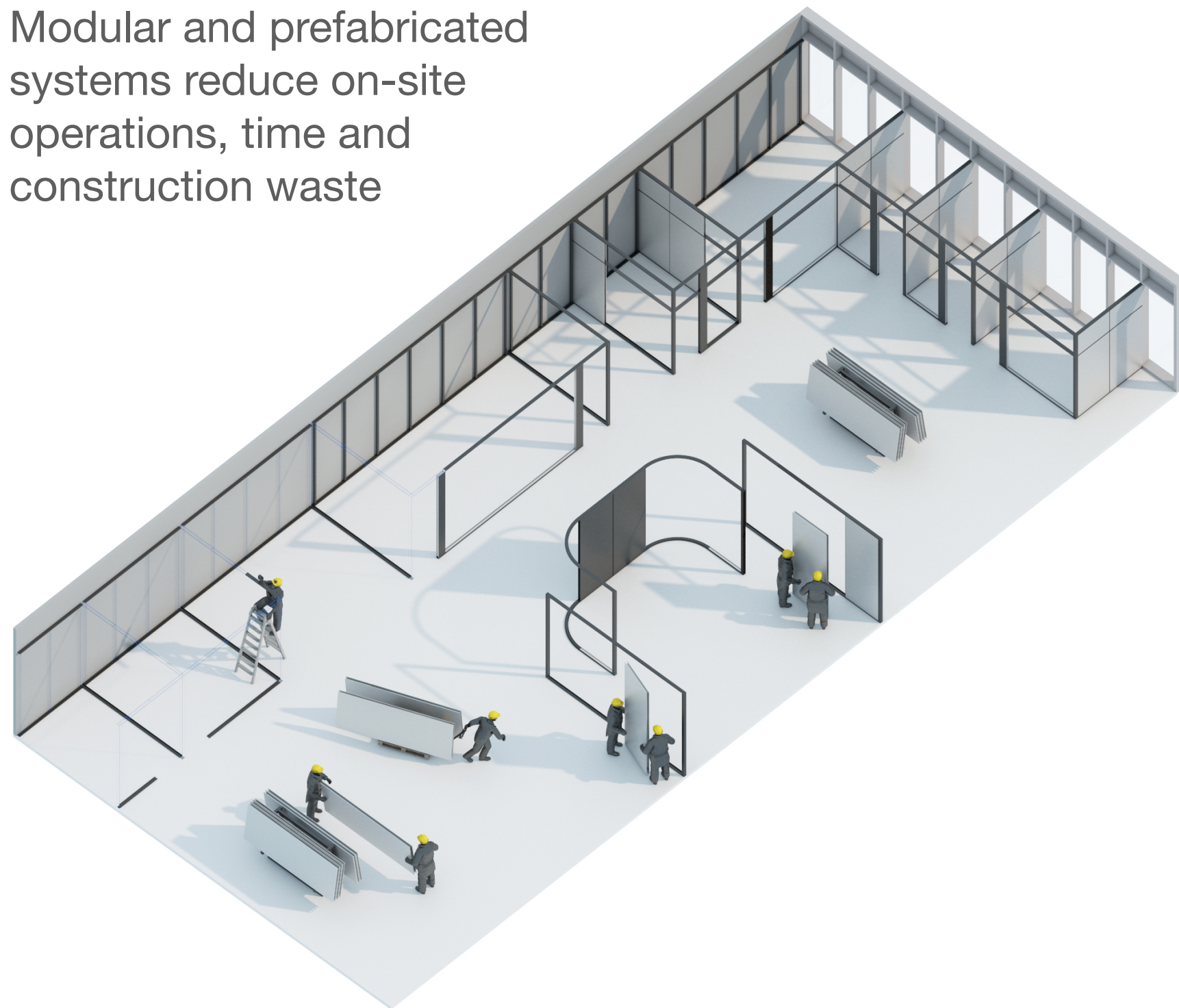
4,272.5 sqm (total site & building target)

9. Circular economy by designing flexible systems

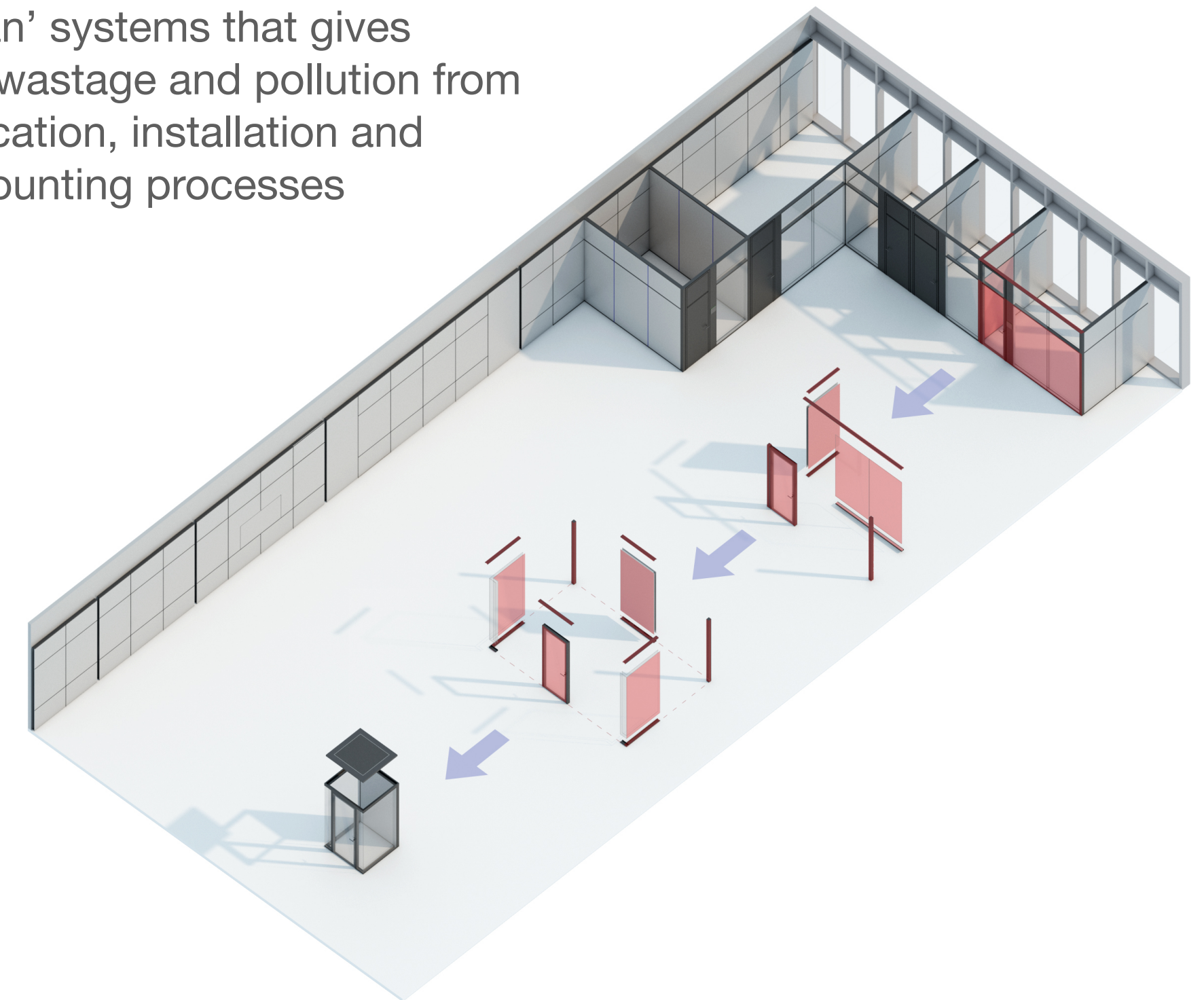
- increase life-cycle • reduce wastage • reduce pollutants

Low embodied carbon interior fit-out systems such as demountable Partition Walls, Flooring and Furniture (fixed and loose) can be championed by Swire Properties as own inventory that is leased to tenants to offset net zero

Modular and prefabricated systems reduce on-site operations, time and construction waste



‘Clean’ systems that gives little wastage and pollution from fabrication, installation and demounting processes



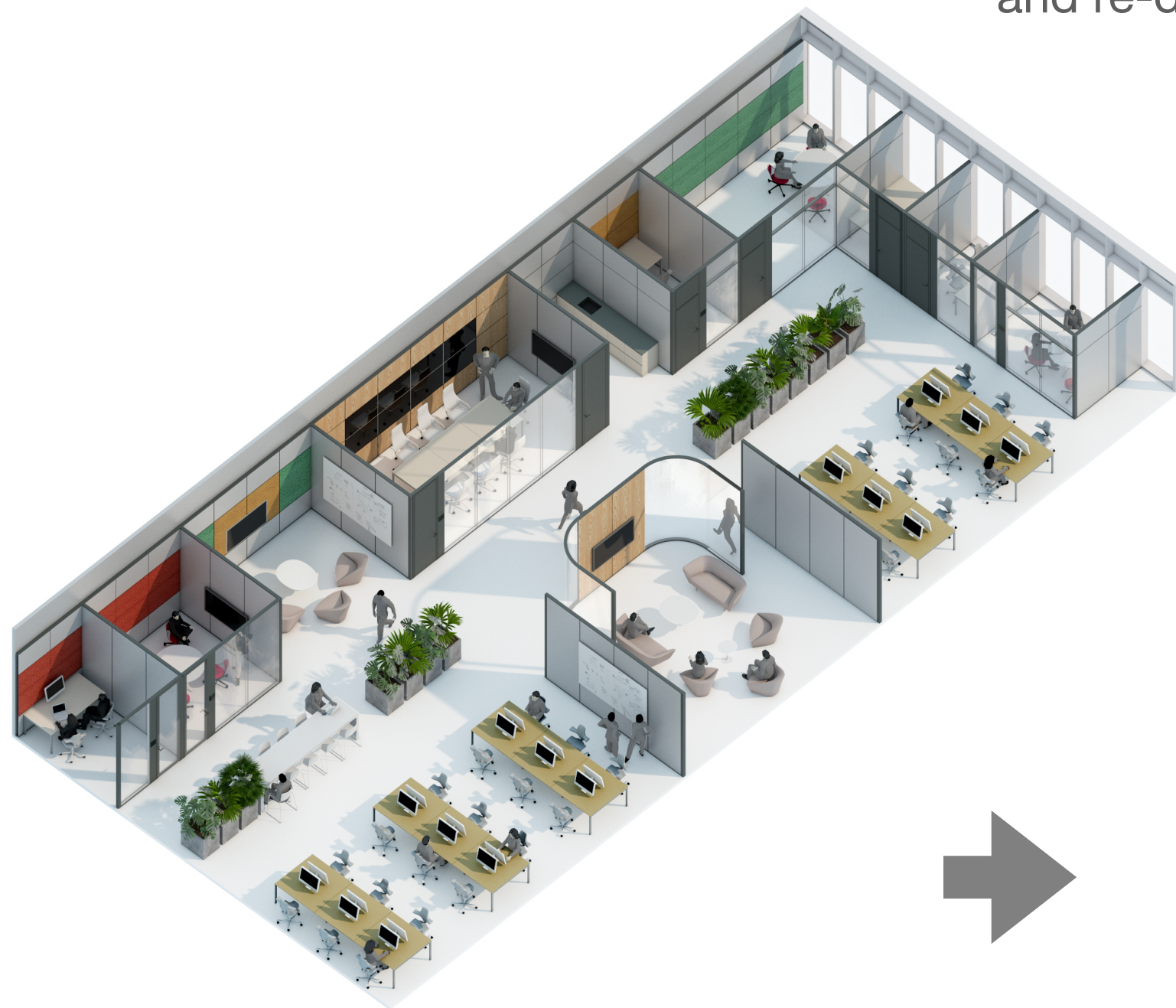
10. Circular economy by designing flexible systems

- increase life-cycle • reduce wastage • reduce pollutants

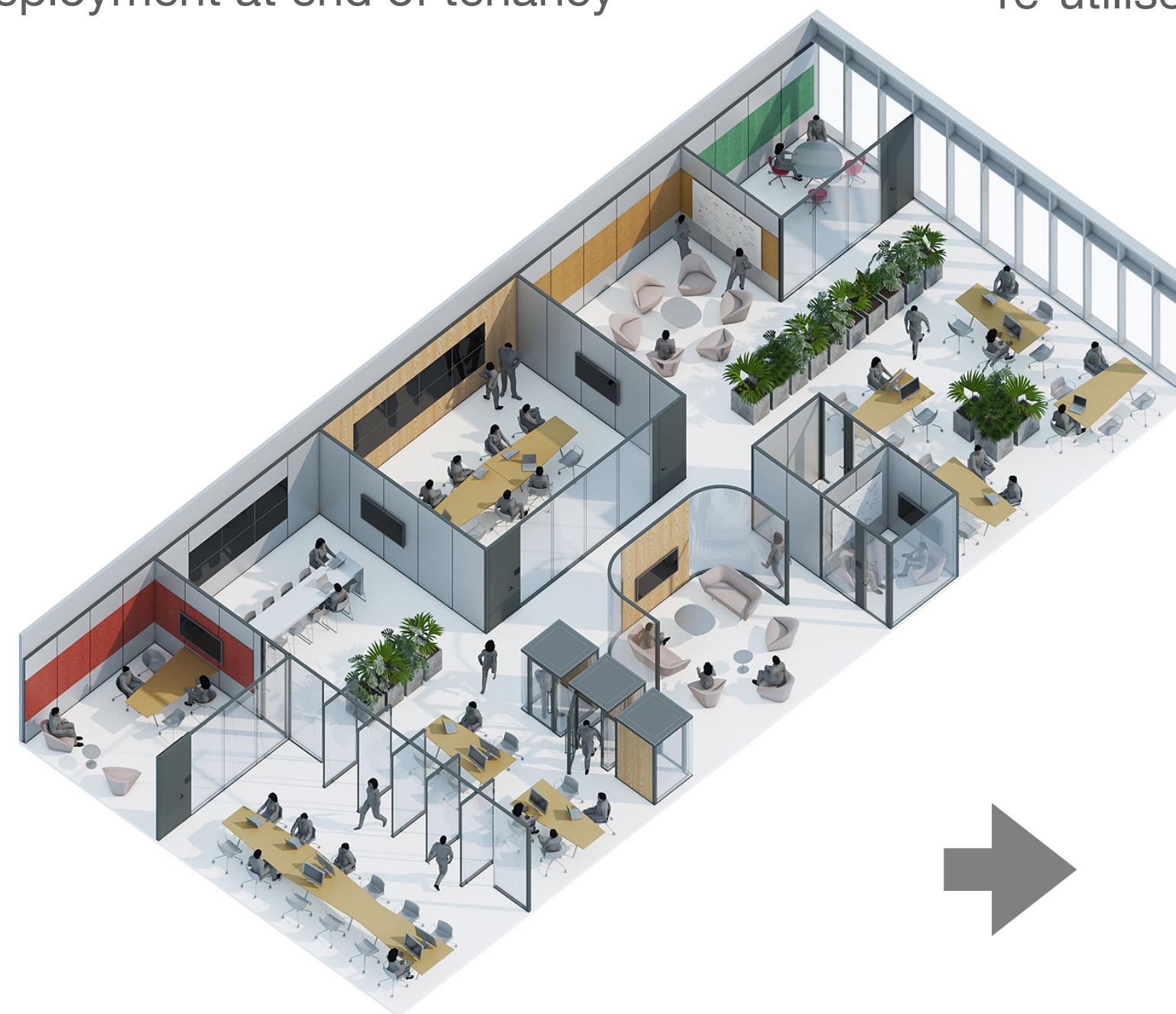
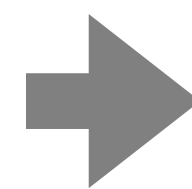
The life-cycle of these systems are managed by Swire Properties, and which can be re-deployed into new tenant leases across Swire's properties

Agile systems with maximum re-use and re-deployment at end of tenancy

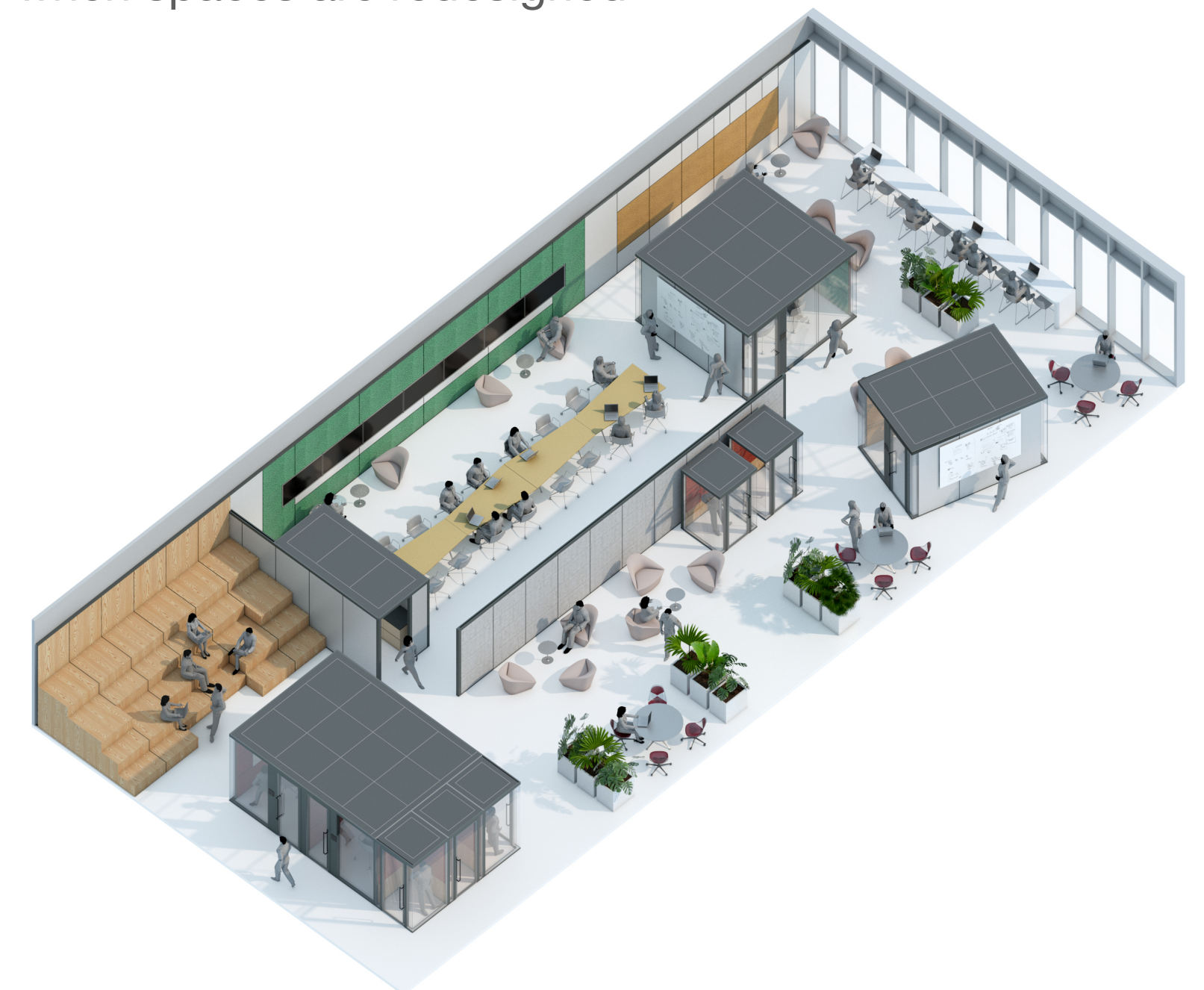
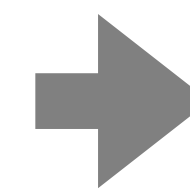
Flexible and adaptable systems that can be re-utilised when spaces are redesigned



Traditional office



Hybrid office



Lab office

DATA AND CALCULATIONS

Approach

- 1. Benchmark performance of the 2-tower, Podium & Sub-grade scheme with BIM to BEM analysis (Building Energy Modelling) with objective performance metrics (EUI in kWh/m2/yr)
- 2. Establish Energy Balance Diagram for conventional systems, with heat-pump based heating and cooling running from HK grid electricity to determine estimated annual operating costs
- 3. Propose Optimized Envelope and Systems to reduce EUI to as close to Net Zero as possible

Preliminary Results

- 1. Benchmark performance of this proposal gives an EUI of ~180 kWh/m2/yr, where a best in class Passive House Level Office Tower must be less than 65kWh/m2/yr (non-primary) or 15W/m2/yr (per PHI: Specific useful cooling demand)
- 2. Characteristics of conventional systems as per the Energy Balance Diagram below, Dominant Cooling load due to IHG
- 3. Targeting EUI better than 200kWh/m2/yr, GHGI better than 50kg/m2/yr

Performance Targets

- 1. EUI under 200 or Specific Useful Cooling Demand<15W/m2 (Treated Area) (only N&S towers modelled to date)
- 2. Optimize Energy Balance to Reduce Ventilation Fan Power, Heat Pump Electrical Draw (Cooling), Reduce Plug Loads and LPD below 3.9W/m2,
- 3. Even the Best Envelope will not reduce loads below 180kWh/m2/yr - a radical approach is needed due to the carbon-intensity of the HK Energy Grid (50% NG / 50% Coal)

Benchmarked BIM to BEM Model Data

Net Zero Tower Swire

Benchmark Analysis 2.1 Baseline (Seawater HP, Conventional Electricity)

Key Values				
General Project Data			Heat Transfer Coefficients	
Project Name:	Swire Net Zero Tower		Building Shell Average:	U value [W/m²K]
City Location:	Hong Kong		Floors:	--
Latitude:	22° 15' 0" N		External:	1.61 - 4.58
Longitude:	114° 10' 0" E		Underground:	--
Altitude:	0.00	m	Openings:	0.61 - 0.61
Climate Data Source:	CHN_Hong.Ko..._CityUHK.epw		Specific Annual Values	
Evaluation Date:	2021-05-27, 8:04 PM		Net Heating Energy:	11.95 kWh/m²a
Building Geometry Data			Net Cooling Energy:	44.58 kWh/m²a
Gross Floor Area:	91338.55	m²	Total Net Energy:	56.53 kWh/m²a
Treated Floor Area:	91326.62	m²	Energy Consumption:	180.26 kWh/m²a
External Envelope Area:	156670.71	m²	Fuel Consumption:	80.86 kWh/m²a
Ventilated Volume:	3675093.20	m³	Primary Energy:	371.53 kWh/m²a
Glazing Ratio:	90	%	Fuel Cost:	13.10 HKD/m²a
Building Shell Performance Data			CO₂ Emission:	23.73 kg/m²a
Infiltration at 50Pa:	0.46	ACH		

EUI of starting/benchmark design

Operational Carbon Intensity is a function of the HK Energy Mix
Targeted ACH @ 50PA

DATA AND CALCULATIONS

Benchmarked Targets to Optimized

Energy Consumption by Targets

Target Name	Energy			CO ₂ Emission kg/a
	Quantity MWh/a	Primary MWh/a	Cost HKD/a	
Heating	1091	1412	25997	47083
Cooling	4071	9466	218531	395784
Service Hot-Water	6607	8972	191566	346948
Ventilation Fans	1821	5464	295109	534476
Lighting & Appliances	2871	8614	465165	842466
Total:	16462	33930	1196370	2166760

Performance optimization is an iterative process, but we see from initial BIM to BEM analysis the specific strategies that must be undertaken to get loads to Net Zero.

Cooling loads are due primarily to occupant (internal) heat gain during a period from 7am to 6pm Mon-Fri is the single largest heat-load the cooling system must eliminate. (120W/pp)

- 1.The most costly load is from equipment (plug loads) and lighting at \$465k HKD/yr
- 2.Followed closely by electricity use from Ventilation Fans and Pumps from Air and Cooling Systems at \$295k HKD/yr and \$218k HKD/yr respectively
- 3.With Service Hot Water and Heating loads representing \$192k HKD/yr and \$26k HKD/yr respectively (20l/pp/day assumed)

Strategies to educate and train workers to be more energy-efficient can have significant impacts on total building loads. Shifting start and finish times of workdays, flex weeks and flex-times can help flatten overall loads and reduce total impacts during the 9-5 at times of peak cooling. Optimized FFE specification (ie. super-low-energy chips in PCs) can add up to significant annual savings. Aiming for a Lighting Power Density with Smart Controls can reduce LPD to less than 4W/m2. Reducing total fan power through CFD analysis and optimized low-velocity high volume airflow (LVHV) and plenum design, together with optimal source cooling (Seawater), powered by renewable electricity supply (Building Integrated and/or Off-site Renewable Energy Credits) are the measures that can get the Swire Net Zero Tower to 0 kWh/m2/yr and Operational Carbon Intensity under 5kg/m2/yr.

Project Energy Balance

