Twin Pine Towers

ID: 185792

1

// Innovation

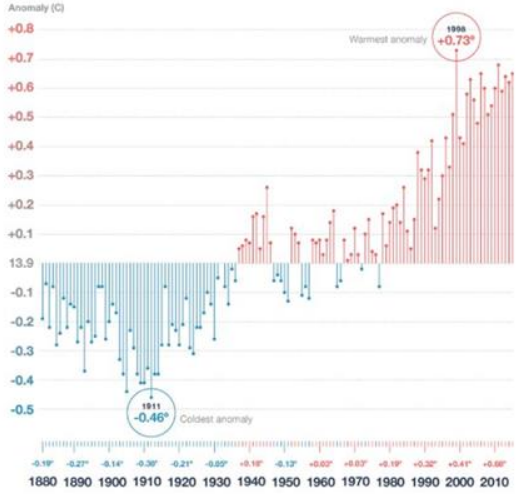
/ Influece of context towards sustainable architecture

/ The effects of future technology on the aesthetics of sustainable buildings

/_

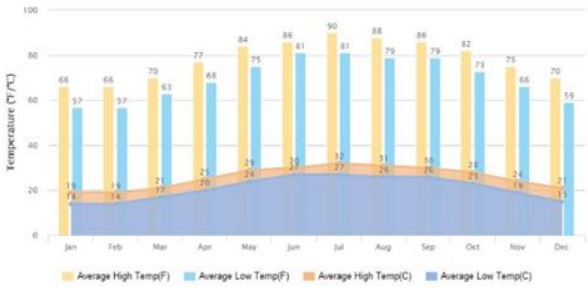
/_ 1.1 We live in a dynamic world...

Climates Changes



Global Climate Change has resulted in a average surface temperature rise of (0.18°C / 0.32°F) yearly according to the NOAA.

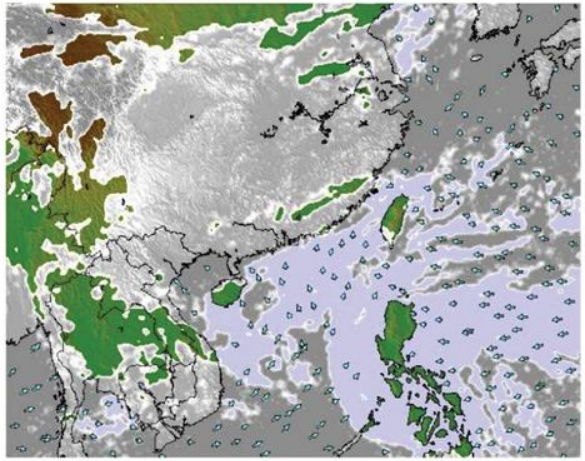
Seasonal Changes



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
°F	66	66	70	77	84	86	90	88	86	82	75	70
°C	19	19	21	25	29	30	32	31	30	28	24	21
°F	57	57	63	68	75	81	81	79	79	73	66	59
°C	14	14	17	20	24	27	27	26	26	23	19	15

Hong Kong's Climate requires shading in the summer and heating in the winter. These opposite conditions make it challenging to create static architecture and building facades.

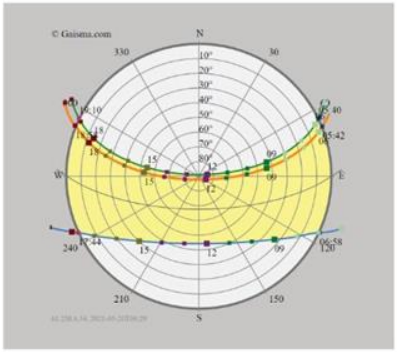
Weather Changes

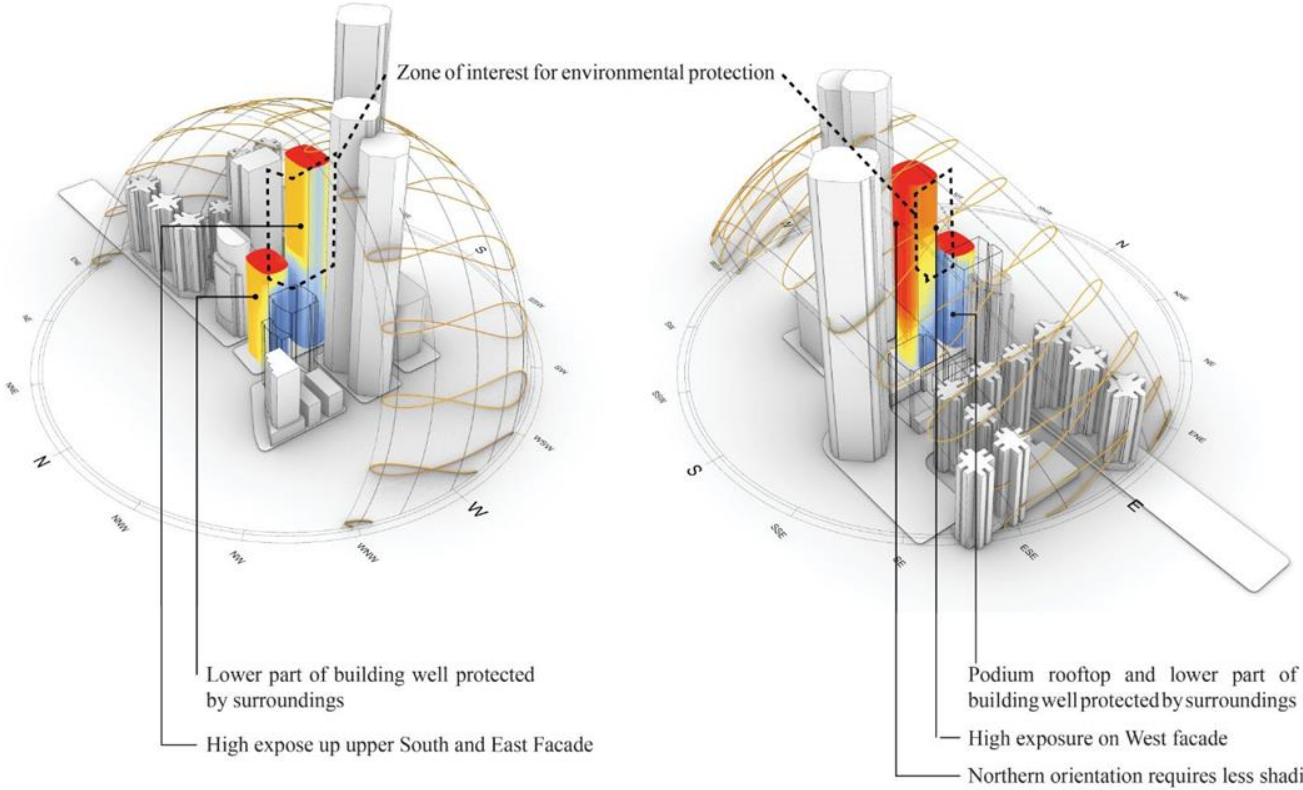


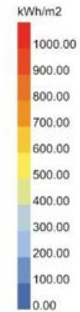
Daily Changes occur between day and night temperatures. Rainy days and Sunny days. Overcast skies and cloud cover changes incident radiation received across different areas of the facade.

/_ 1.2 Identifying issues with current massing orientation

Analysis Period: All Year
Location: Hong Kong, Quarry Bay







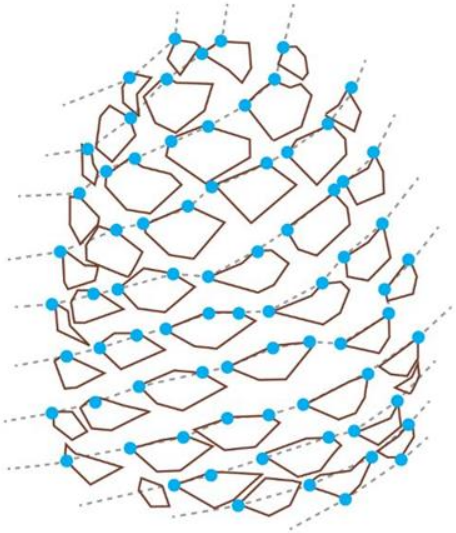
Hong Kong's climate is sub-tropical, tending towards temperate for nearly half the year. During November and December there are pleasant breezes, plenty of sunshine and comfortable temperatures. Many people regard these as the best months of the year. January and February are cloudier, with occasional cold fronts followed by dry northerly winds. It is not uncommon for temperatures to drop below 10 Degree C in urban areas. The lowest temperature recorded at the Observatory is 0 Degree C , although sub-zero temperatures and frost occur at times on high ground and in the New Territories.

/_ 1.3 Solutions from nature and technology

Biomimicry

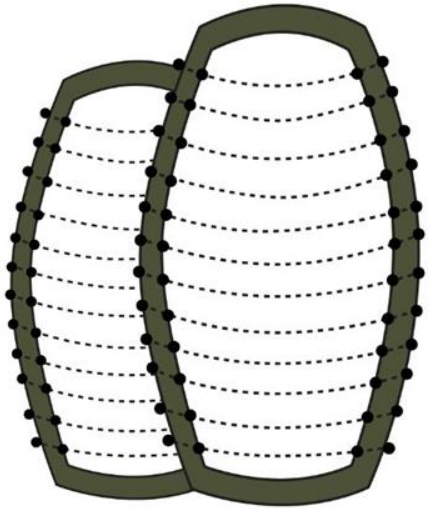
Pine Cones are hypersensitive to the climate. It opens and closes to control temperature and humidity in order to protect its seeds.

AI Optimization



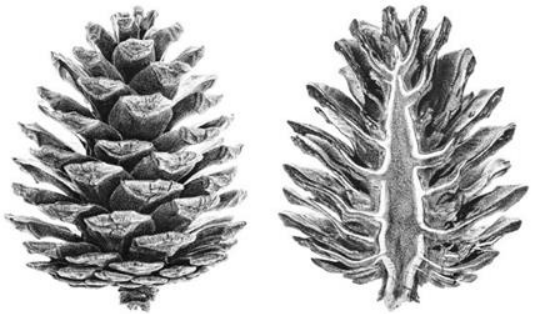
Machine Learning and computation design approach can be used to find the most optimized result for a performance based approach.

Twin Tower Approach



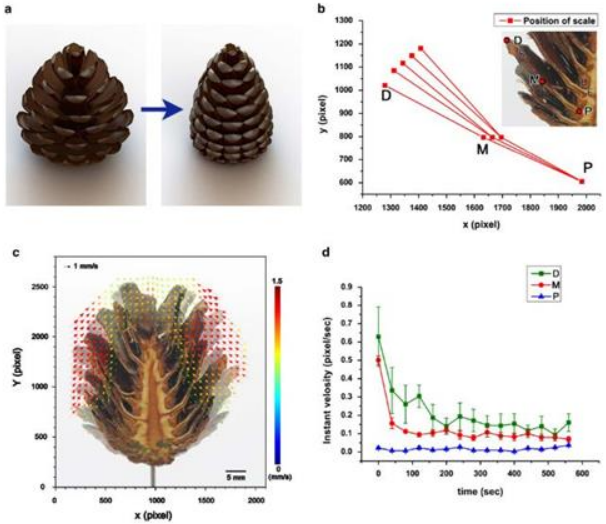
A Twin Tower approach is used to make a co-joining atrium. This functions as a green breakout space and performs as a stack effect for the atrium.

Ability to regulate internal climate



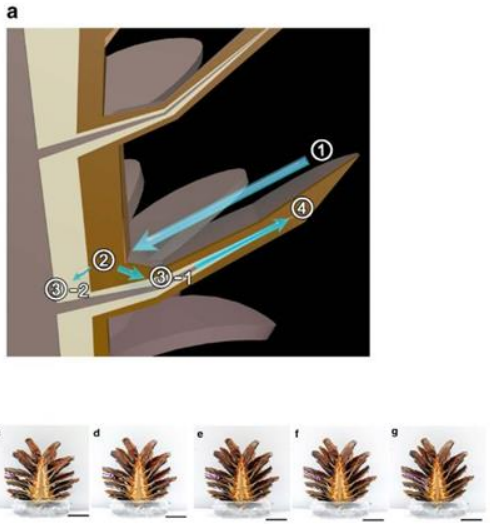
Pine Cones consists of two layers an inner cone layer where the seeds sit and an outer layer to protect its seeds. This is similar to a double skin facade where the function of the outer layer is to proects its inhabitatnts.

Adapt to temperature changes



Changes in profiles have been measured with its realtion to heat and moister. The outer layer bends under a hydroscopic behaviour without requiring any additional energy.

Harvest rain water



Water is delievered through its petals from the top layer to the core and back out into the bottom layer where it deforms under different moisture settings. The petals are arranged in layers and staggers in an 'ABAB' pattern between layers.

2

// Advancing Net Zero

/ The allegory of sustainability

/ Integration between technology and sustainable architecture

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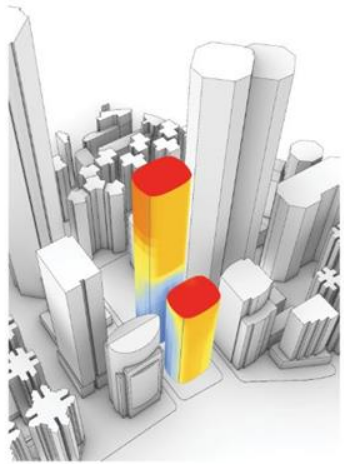
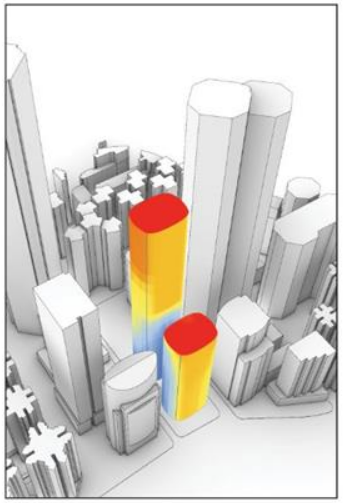
/_ 2.1 Passive strateges: AI Generative Design



Multi-Objective Machine Learning

A machine learning approach is used to refine results over time. For each generation, the computer generates massings randomly and performes an evaluation matrix with nested parameters. The best scoring designs are know as 'Elites', these are carried forward into the next generation. Another 95% is randomized and the process is repeated for eight generations. With more start designs per generation, the data would be more diversed whilst increased number of generations would refine for one optimal solution. The machine learning algorithm is conducted through 'Discover' a grasshopper plugin.

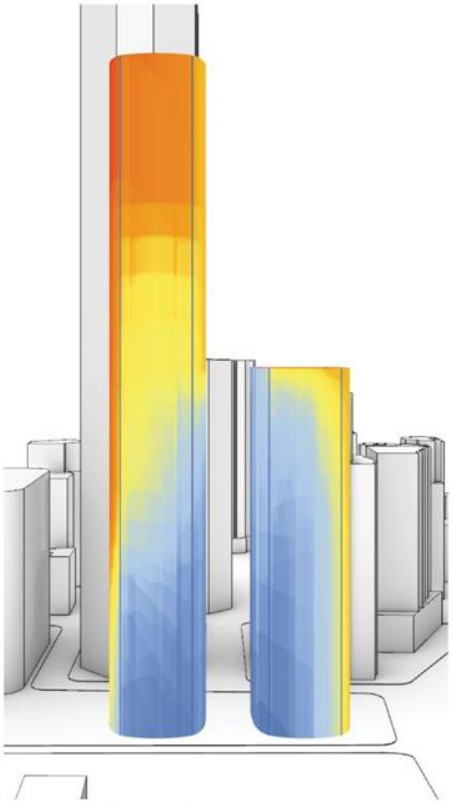
/_ 2.2 Data Driven Design



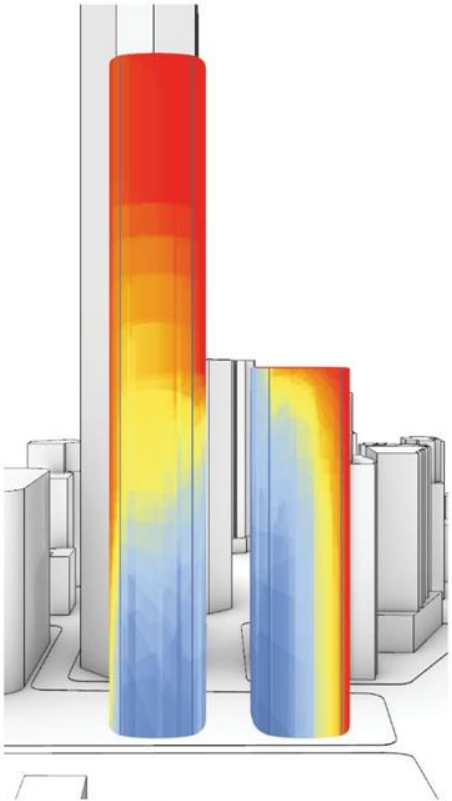
Digital Revolution in Architecture

A generation is evaluated against a multi-objective matrix. This consists of 6 parameters, solar radiation, facade area, embodied carbon, structural efficiency and area accuracy. All of these data are remapped into a domain from 0-1 and plotted onto a hexagonal radar diagram. The larger area hatched in 'blue' would signify better overall results.

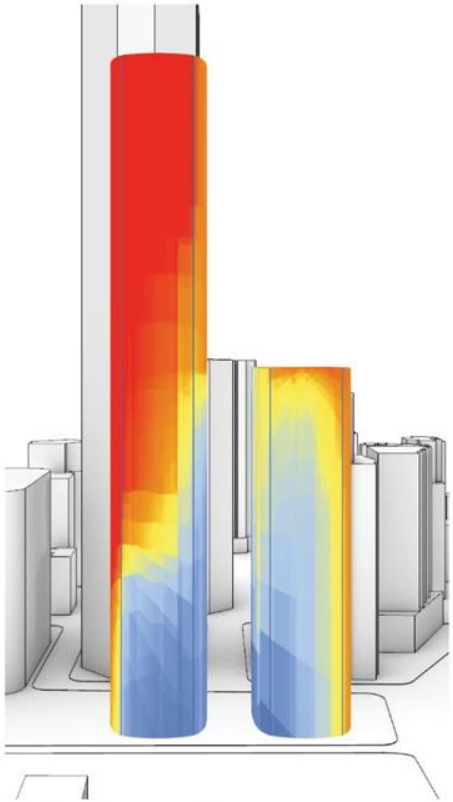
/_ 2.1 Solar Radiation Simulation



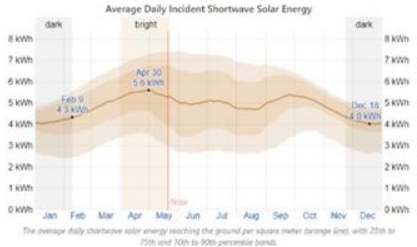
Test Date: Februrary 9th
Average Solar Radiation (kWh/m2): 0.358



Test Date: April 30th
Average Solar Radiation (kWh/m2): 0.607



Test Date: December 18th
Average Solar Radiation (kWh/m2): 0.522



Solar Energy, Hong Kong

*(ref: The Weather Park,2021)**

The average daily incident shortwave solar energy experiences some seasonal variation over the course of the year.

The brighter period of the year lasts for 1.6 months, from April 2 to May 22, with an average daily incident shortwave energy per square meter above 5.3 kWh. The brightest day of the year is April 30, with an average of 5.6 kWh.

The darker period of the year lasts for 2.5 months, from November 23 to February 9, with an average daily incident shortwave energy per square meter below 4.3 kWh. The darkest day of the year is December 18, with an average of 4.0 kWh.

**https://weatherspark.com/y/127942/Average-Weather-in-Hong-Kong-Hong-Kong-SAR-China-Year-Round#:~:text=The%20hottest%20day%20of%20the,high%20of%2066%C2%B0F.*

/_ 2.2 Data Remapping

6.51 30°	6.51 30°	6.51 30°	6.51 30°	6.35 29°	6.35 29°	6.35 29°
6.51 30°	6.51 30°	6.51 30°	6.51 30°	6.35 29°	6.35 29°	6.35 29°
6.51 30°	6.51 30°	6.51 30°	6.51 30°	6.35 29°	6.35 29°	6.35 29°
6.51 30°	6.51 30°	6.51 30°	6.51 30°	6.35 29°	6.35 29°	6.35 29°
6.48 30°	6.51 30°	6.51 30°	6.51 30°	6.35 29°	6.35 29°	6.35 29°
6.48 30°	6.48 30°	6.48 30°	6.48 30°	6.33 29°	6.33 29°	6.33 29°
6.46 30°	6.46 30°	6.48 30°	6.48 30°	6.33 29°	6.33 29°	6.33 29°
6.41 29°	6.46 30°	6.46 30°	6.46 30°	6.3 29°	6.33 29°	6.33 29°
6.33 29°	6.43 30°	6.46 30°	6.46 30°	6.3 29°	6.3 29°	6.3 29°
6.3 29°	6.43 30°	6.43 30°	6.43 30°	6.3 29°	6.3 29°	6.3 29°
6.3 29°	6.4 29°	6.43 30°	6.43 30°	6.3 29°	6.3 29°	6.3 29°
5.63 25°	5.61 25°	5.48 24°	5.52 24°	5.54 24°	5.36 23°	5.31 23°
5.36 23°	5.24 23°	5.35 23°	5.5 24°	5.36 23°	5.25 23°	5.31 23°
5.21 22°	4.96 21°	5.35 23°	5.36 23°	5.36 23°	5.17 22°	4.97 21°

Test Date: Februrary 9th
Average Solar Radiation (kWh/m2): 0.520

8.2 30°	8.2 30°	8.2 30°	8.2 30°	8.1 30°	8.1 30°	8.1 30°
8.2 30°	8.2 30°	8.2 30°	8.2 30°	8.1 30°	8.1 30°	8.1 30°
8.2 30°	8.2 30°	8.2 30°	8.2 30°	8.1 30°	8.1 30°	8.1 30°
8.2 30°	8.2 30°	8.2 30°	8.2 30°	8.1 30°	8.1 30°	8.1 30°
8.16 30°	8.2 30°	8.2 30°	8.2 30°	8.1 30°	8.1 30°	8.1 30°
8.16 30°	8.16 30°	8.16 30°	8.16 30°	8.05 29°	8.05 29°	8.05 29°
8.12 30°	8.12 30°	8.16 30°	8.16 30°	8.05 29°	8.05 29°	8.05 29°
8.03 29°	8.12 30°	8.12 30°	8.12 30°	8.01 29°	8.05 29°	8.05 29°
7.9 29°	8.06 29°	8.12 30°	8.12 30°	8.01 29°	8.01 29°	8.01 29°
7.86 28°	8.06 29°	8.06 29°	8.06 29°	8.01 29°	8.01 29°	8.01 29°
7.86 28°	8.02 29°	8.06 29°	8.06 29°	8.01 29°	8.01 29°	8.01 29°
6.89 24°	6.91 24°	6.75 23°	6.8 23°	6.93 24°	6.72 23°	6.64 22°
6.57 22°	6.43 21°	6.55 22°	6.76 23°	6.7 23°	6.54 22°	6.64 22°
6.37 21°	6.02 19°	6.55 22°	6.54 22°	6.7 23°	6.46 21°	6.23 20°

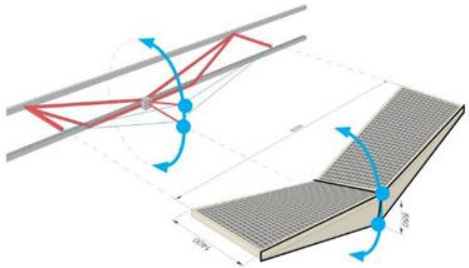
Test Date: April 30th
Average Solar Radiation (kWh/m2): 0.656

11.45 30°	11.45 30°	11.45 30°	11.45 30°	11.05 29°	11.05 29°	11.05 29°
11.45 30°	11.45 30°	11.45 30°	11.45 30°	11.05 29°	11.05 29°	11.05 29°
11.45 30°	11.45 30°	11.45 30°	11.45 30°	11.05 29°	11.05 29°	11.05 29°
11.45 30°	11.45 30°	11.45 30°	11.45 30°	11.05 29°	11.05 29°	11.05 29°
11.41 30°	11.45 30°	11.45 30°	11.45 30°	11.05 29°	11.05 29°	11.05 29°
11.41 30°	11.41 30°	11.41 30°	11.41 30°	11.02 29°	11.02 29°	11.02 29°
11.38 30°	11.38 30°	11.41 30°	11.41 30°	11.02 29°	11.02 29°	11.02 29°
11.3 30°	11.38 30°	11.38 30°	11.38 30°	10.98 29°	11.02 29°	11.02 29°
11.2 29°	11.34 30°	11.38 30°	11.38 30°	10.98 29°	10.98 29°	10.98 29°
11.18 29°	11.34 30°	11.34 30°	11.34 30°	10.98 29°	10.98 29°	10.98 29°
11.18 29°	11.32 30°	11.34 30°	11.34 30°	10.98 29°	10.98 29°	10.98 29°
9.61 24°	9.45 24°	9.13 23°	9.22 23°	9.55 24°	8.76 22°	8.72 22°
9.02 23°	8.69 22°	8.93 22°	9.2 23°	8.83 22°	8.59 21°	8.72 22°
8.78 22°	8.23 20°	8.93 22°	8.99 23°	8.83 22°	8.44 21°	8.08 20°

Test Date: December 18th
Average Solar Radiation (kWh/m2): 0.873

Incident Solar Radiation

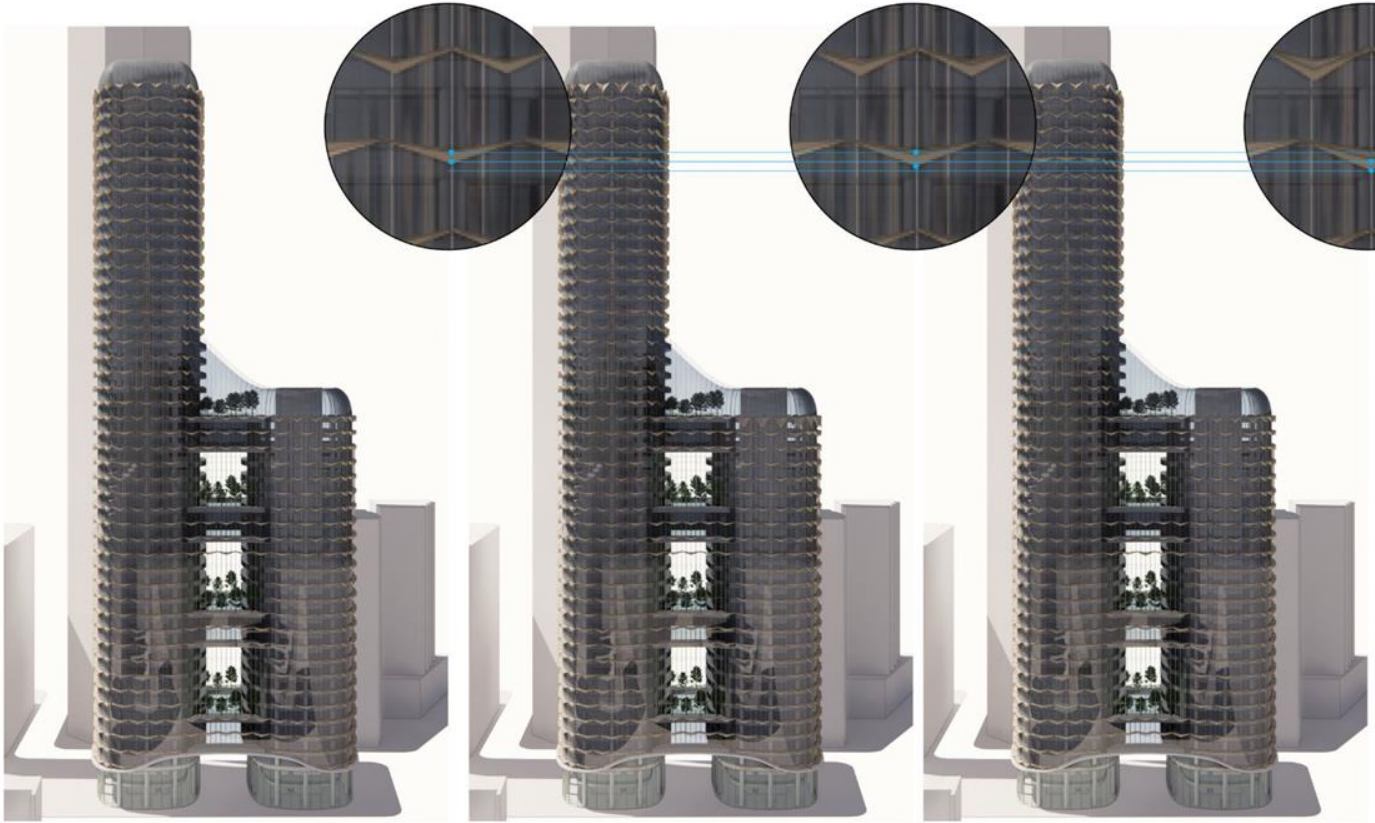
Angle of movement



Translating Big Data

The simulated results in **'Black'** represent live data of incident solar radiation which could be capture on site through simple infared sensors. These datapoints are interpolated to sample each piece of glass independently. The captured data then goes through an algorithm to determine the best angle to be adjusted by the shading module. The angle of movement is denoted in **'Blue'**. The remapping of the data is proccessed through a computer unit inside the building. This data is then relayed to the control box to move the modules accordingly. Creating an optimized shading result which could be resampled hourly.

/_ 2.3 Optimizing for a kinetic shading system



Test Date: Februrary 9th
Average Solar Radiation (kWh/m2): 0.520

Test Date: April 30th
Average Solar Radiation (kWh/m2): 0.656

Test Date: December 18th
Average Solar Radiation (kWh/m2): 0.873

Changes in Solid Glass Ratio

By rotating the angle of the shading module just like how a pine cone would open. The increase in rotation increases the shaded area of glass. Thus increasing the solid glass ratio. Incident solar ration is reflected through the vinyl and the heat gain would not transmit into the building.

/_ 2.4 Active Facade Strategies

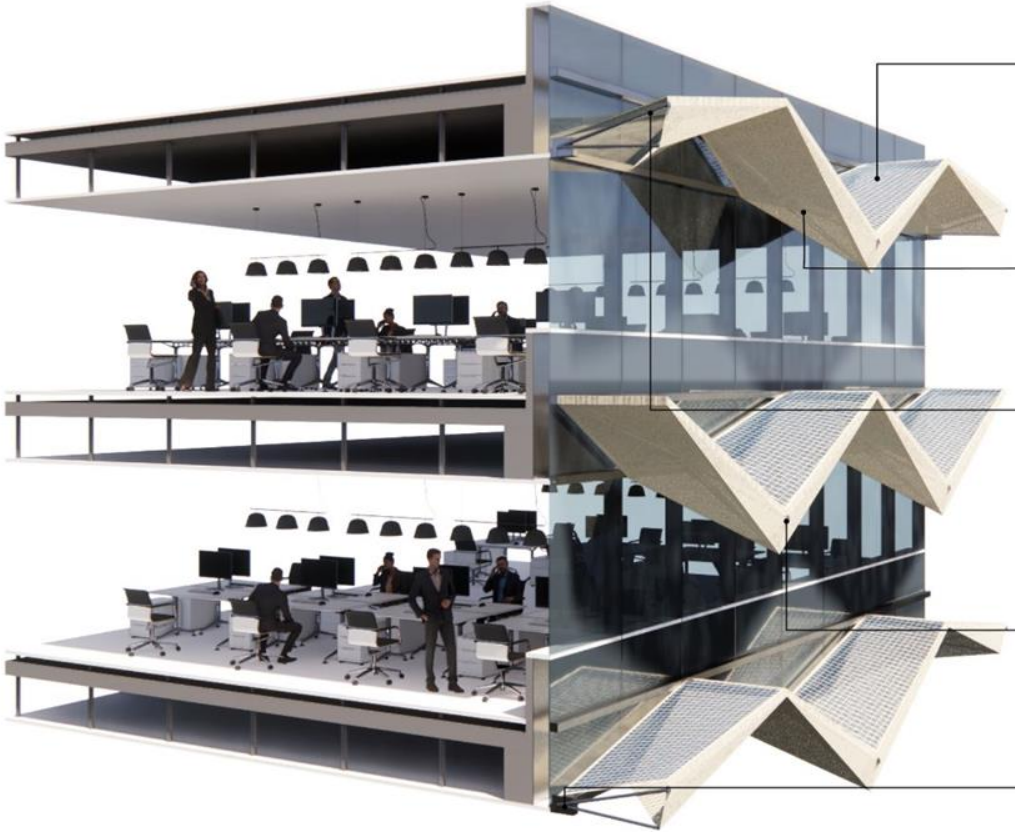
Rainy Day

Upward position for water catchment to be integrated with grey water recycling system and rainwater used for cooling towers.

Sunny Day

Downward position to provide the maximum solar shading towards glazing area without compromising views. At the same time, increase incident solar radiation on solar cell fabric membrane.

/_ 2.5 Additional Materials



Top Layer:
Lightweight Solar Fabric by FTL Solar
*(ref: Inhabitat,2021)**

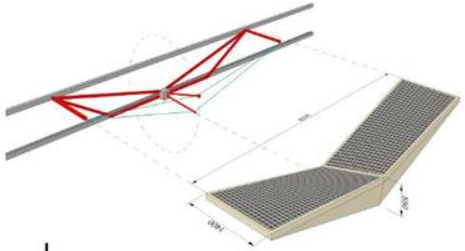
Bottom Layer:
Vinyl Membrane

Structure:
50mm GRFP Square Tube

Fixings:
Stainles steel Memebrane fixing

Movement Control:
Rotary Actuator / Control Box

/_ 2.6 The essence of sustainable materials

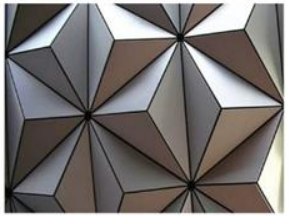


Advancement of Materials and Technology

The underlying pricipal is the the module to have the ability to swap out into new materials as technology progresses. The two major parts include a flexible surface and a driver for kinetic movement.

2000 — 2021 — 2031 — 2041

Surfaces



3D Aluminum Panels

Lightweight Solar Fabric by FTL Solar
*(ref: Inhabitat,2021)**

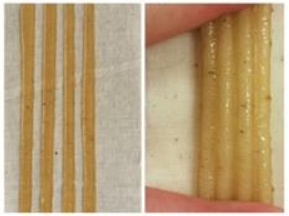
Transparent solar panels

Bio Textiles

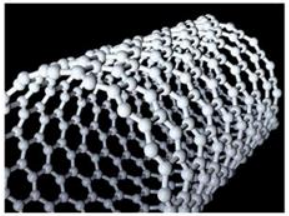
Structures

Mild Steel Structure

GRFP Square Tube



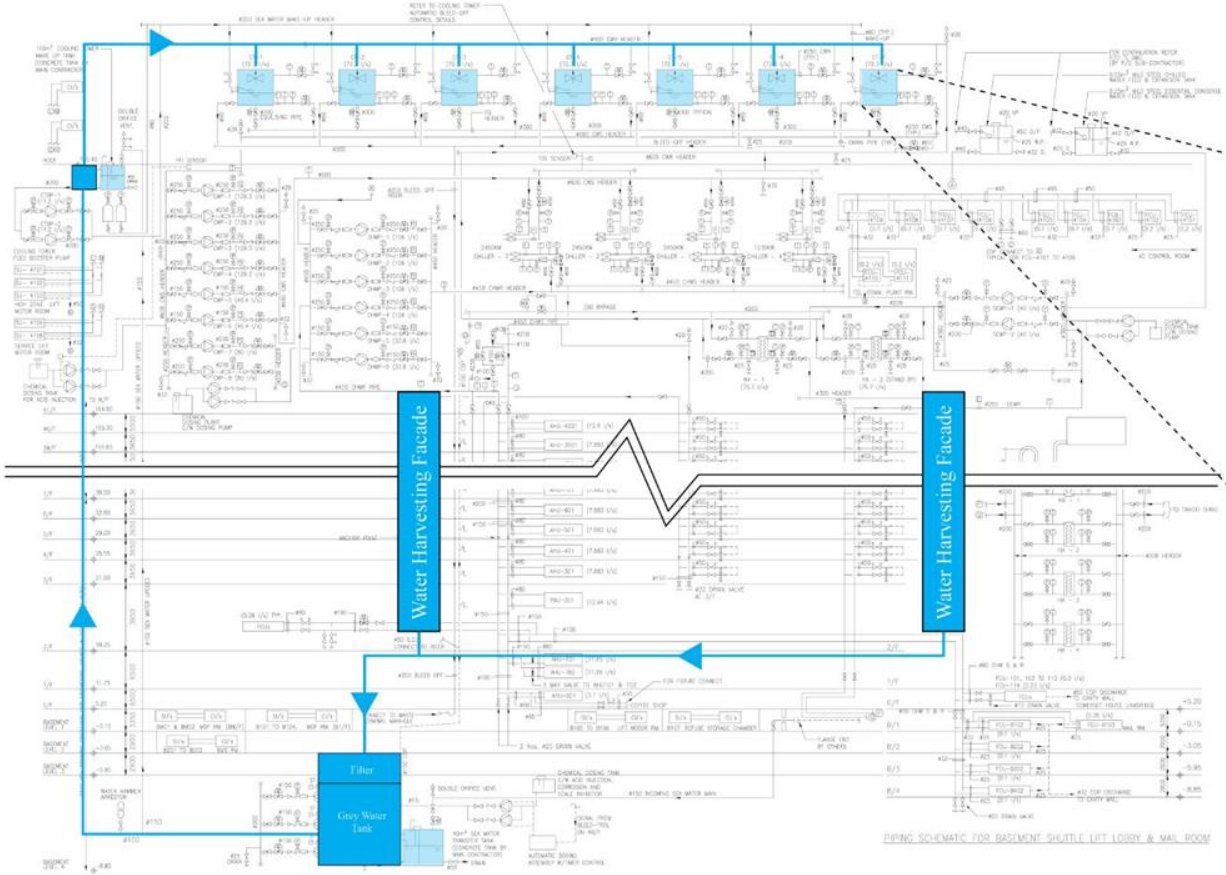
Biomimetic Material
*(ref: Francescaperona,2021)**



Nano carbon tube structure

*https://www.francescaperona.com/portfolio/shape-change-study/

/_ 2.7 Water System Integration



Rain Water Cooling Towers

*(ref: Rain Water Management,2021)**

Another heavy user of water in large commercial buildings are cooling towers. Harvested rainwater can be used as make-up water to replace that which is lost during evaporation and blow down cycle of most cooling systems. Rainwater is also naturally soft water, which means that it is actually more efficient as it can cycle more frequently, can reduce the amount of chemicals needed to treat municipal water for hardness, and can help prolong the life of the cooling system.

**https://rainwatermanagement.com/pages/commercial-rainwater-systems*

/_ 2.8 Life Cycle Analysis

Stages of Life Cycle for PVC Vinyl Based Module

Recycling vinyl
- Water to washa and recycle vinyl
- Electricity power plant for recycling

Waste Manage
- More than 5M tons of phthalates are produced during the process of making vinyl every year.

Repurposed products
- Repurpose into other PVC based products
- ie. Bottles, toys, membranes

Modular replacement and deconstruction
- Easy maintenance for modular structure
- Simple point fixings on curtrain wall mullions

Raw Material Acquisition
- Chloride: Electrolysis to brine
- Ethylene: cracking process of natural gas of petroleum

Polyvinyl Chloride (PVC)
- Materials from chloride and ethylene
- Electricity: for machine working
- PVC requires 20% less energy than other plastics

Land transport from China
- Produced in South Provinces of China and transported via lorries to Hong Kong.
- Lightweight materiafor shipping

Offsite Modular Assembly
- Modules are produced in offsite factories
- Installation of 3m Modules on site

/_ 2.9 Carbon Reduction Strategies

0.9
kg CO_2/kg

Insulated Glass Unit

B1 Use:
No energy use required
B2 Maintenance:
Regular cleaning
B3 Repair:
Replacement of curtain wall systems
B4 Refurbishment:
Polish broken glass
B5 Replacement:
Replace any broken glass

0.9
kg CO_2/kg

Clear Glass with Planar Fixings

B1 Use:
No energy use required
B2 Maintenance:
Regular cleaning
B3 Repair:
Replacement of planar fixing systems
B4 Refurbishment:
Polish broken glass
B5 Replacement:
Replace broken glass

2.6
kg CO_2/kg

Vinyl Membrane

B1 Use:
Kinetic energy is generated from solar powered fabrics.
B2 Maintenance:
Modular construction for ease of replacement
B3 Repair:
Vinyl membrane can be easily replaced if teared.
B4 Refurbishment:
Vinyl can be dismantled and washed in factories or on site.
B5 Replacement:
Modular construction for easy replacement

3

// Practicality

/ Although every part of the building will be covered in photovoltaics, it will be an invisible addition

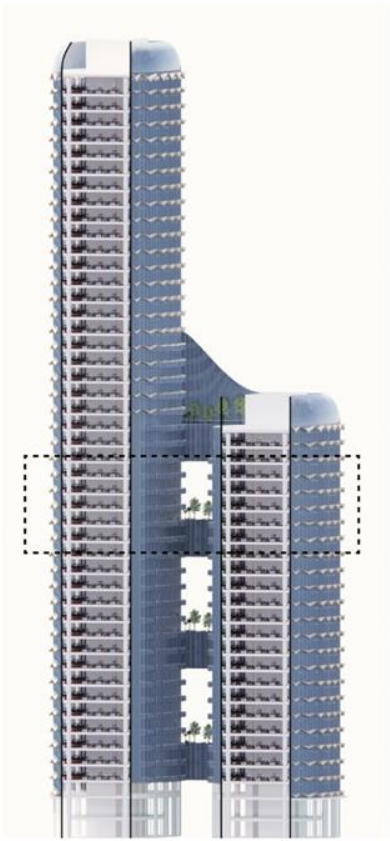
/ A versatile approach to material and form

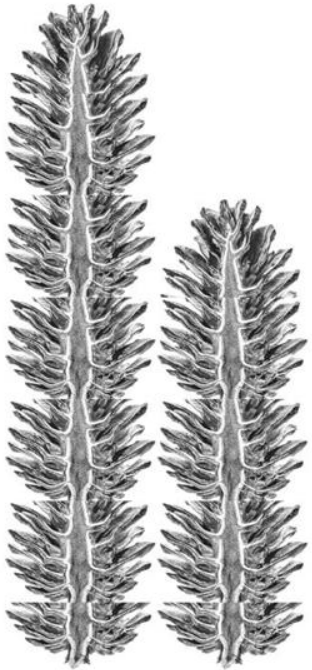
/_

/_ 3.1 Plan and Area Calculation

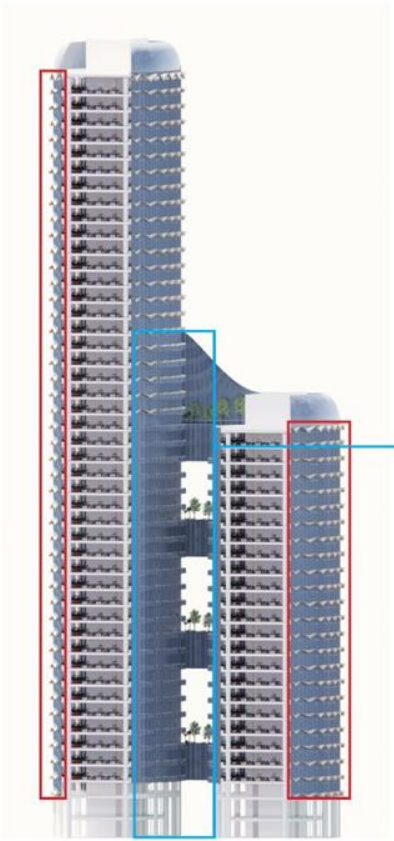
	FTF	MPD	Tower 2		Tower 1
RF		219.9			
L47	5.3	214.6			1200
L46	4.7	209.9			1200
L45	4.7	205.2			1200
L44	4.7	200.5			1200
L43	4.5	196.0			1200
L42	4.5	191.5			1200
L41	4.5	187.0			1200
L40	4.5	182.5			1200
L39	4.5	178.0			1200
L38	4.5	173.5			1200
L37	4.5	169.0			1200
L36	4.5	164.5			1200
L35	4.5	160.0			1200
L34	4.5	155.5			1200
L33	4.5	151.0			1200
L32	4.5	146.5			1200
L31	4.5	142.0			1200
L30	4.5	137.5			1200
L29	4.5	133.0			1200
L28	4	129.0			1200
L27	4.5	124.5			1200
L26	4.5	120.0			1200
L25	4.5	115.5	1200	550	1200
L24	4.5	111.0	1200	1670	1200
L23	4.5	106.5	1200		1200
L22	4.5	102.0	1200		1200
L21	4.5	97.5	1200		1200
L20	4.5	93.0	1200		1200
L19	4.5	88.5	1200	550	1200
L18	4.5	84.0	1200	1670	1200
L17	4.5	79.5	1200		1200
L16	4.5	75.0	1200		1200
L15	4.5	70.5	1200		1200
L14	4.5	66.0	1200		1200
L13	4.5	61.5	1200		1200
L12	4.5	57.0	1200	550	1200
L11	4.5	52.5	1200	1670	1200
L10	4.5	48.0	1200		1200
L9	4.5	43.5	1200		1200
L8	4.5	39.0	1200		1200
L7	4.5	34.5	1200		1200
L6	4.5	30.0	1200		1200
L5	4.5	25.5	1200	550	1200
L4	4.5	21.0	1200	1670	1200
L3	4.5	16.5	1200		1200
L2	6	10.5	1200		1200
L1	6	4.5	1200		1200
		Sub Total	30000	8880	55200
		Total			**94080**

/_ 3.2 Building Section





/_ 3.5 Challenges on Building Code



Kinetic modules considered as eaves?

500mm projection is not significant and would not shade extreme temperatures. Designed modules are 1400mm projectiles.

GFA Concession for green atrium only covered on the sides, external air

Membrane material may be classified as retractable awnings, this gives a larger range up to 2.5m

Part II

Projections

(Format changes—E.R. 5 of 2020)

7. Eaves, cornices, mouldings, etc.

(1) An architectural projection (including eaves, cornice and moulding) that projects over a street—

(a) must not project over the street more than 500 mm; and

(b) must not project at a height of less than 2.5 m above the ground level.

(2) A pipe or gutter (including the appurtenances of the pipe or gutter) that projects over a street—

(a) must not project over the street more than 300 mm; and

(b) must not project at a height of less than 2.5 m above the ground level.

(3) A specified structure that projects over a street—

(a) must not project over the street more than 750 mm; and

(b) must not project at a height of less than 2.5 m above the ground level.

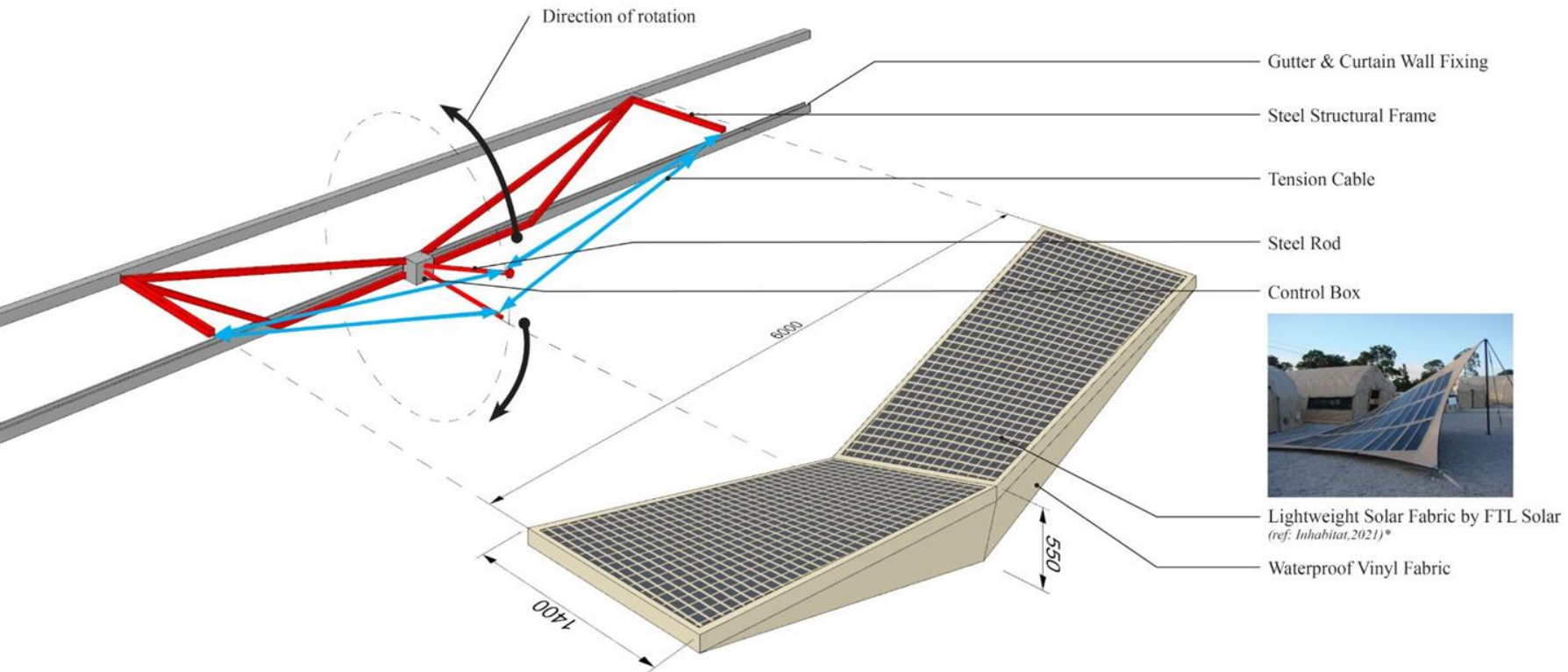
(4) A retractable awning that projects over a street—

(a) must not project over the street more than 500 mm (when retracted) or more than 2.5 m (when fully extended);

(b) must not project at a height of less than 2.5 m above the ground level;

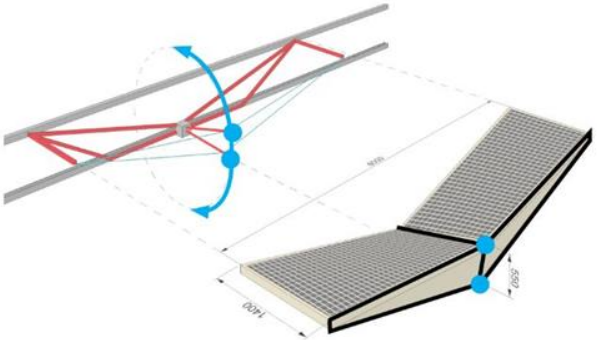
(c) if it projects over a street that has a carriage-way—must have a horizontal clearance of not less than 600 mm from the pavement kerb line; and

/_ 3.3 Modular system to achieve optimization and automation



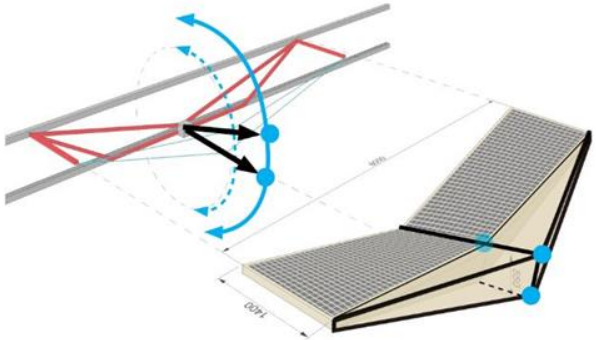
/_ 3.4 Cost Quality Optimization

1 Direction Movement
(For most office towers in Hong Kong)



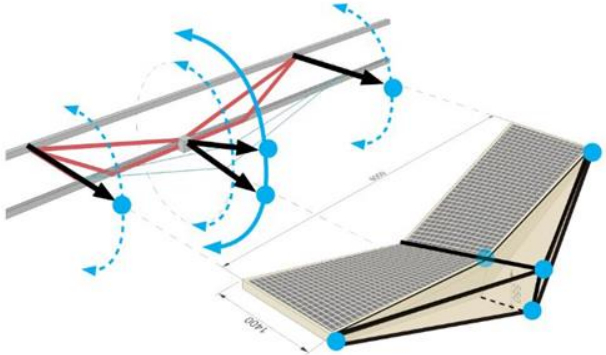
2 variable points of control with 1 rotary motion. Only can control the angle of module through rotation.

2 Direction Movement
(For high exposure office towers)



2 variable points of control with 1 rotary motion and 2 linear motion to control depth of module. Can control both the angle of module and size of the module.

3 Direction Movement
(For extreme environments requiring insulation)



4 variable points of control with 3 rotary motion and 4 linear motion to maxiise the control depth and angle of the module.

4

// Design for People

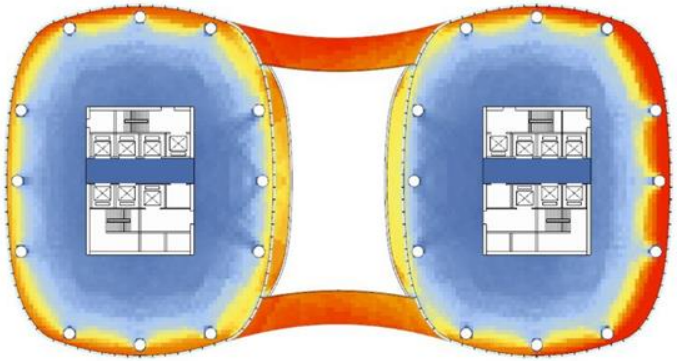
/ Why we need eco-expressionism

/ Visible technologies remind us that we can change the way we generate power

/ _

/_ 4.1 Indoor Thermal Comfort

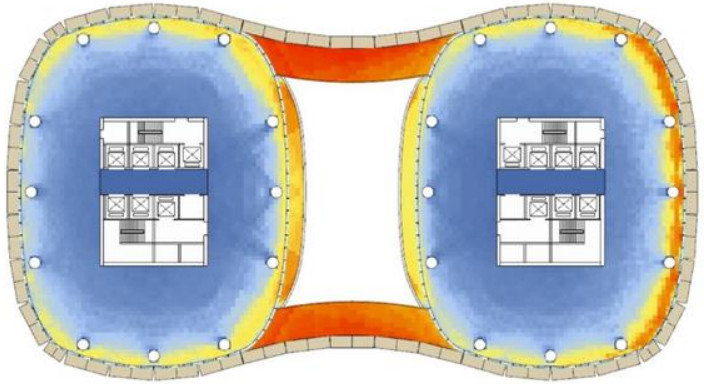
Existing Heatmap



High thermal exposure around the first 5m perimeter of the building. With exceptionally high southern exposure extending 10m deep into the building. Atrium bridge rooftop receive high exposure, making it good for planting trees. Balcony areas are passively shaded.

Reprovisioned Heatmap

28% reduction



The plan is overall much more protect from solar radiation and optimized for human comfort with reduced Southern and East West exposure. Atrium bridge rooftop receive high exposure, making it good for planting trees. Balcony areas are passively shaded.

/_ 4.2 For those moments where the sun hits the table...


4.3 Atrium Connection with Pedestrian Street


4.3 Balconies Towards Green Atrium