Oxford House meets Pines...

ID: 284526

1

// Innovation

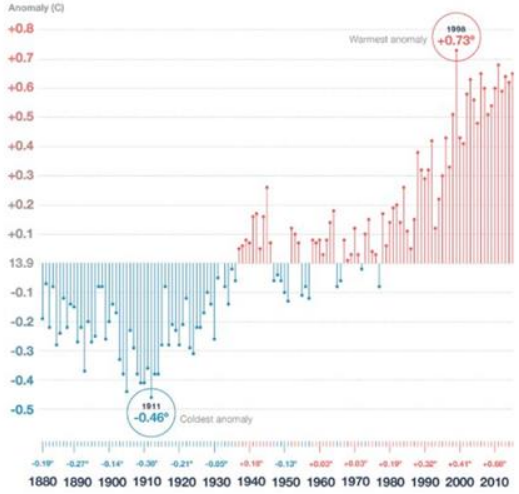
/ Influece of context towards sustainable architecture

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

/_

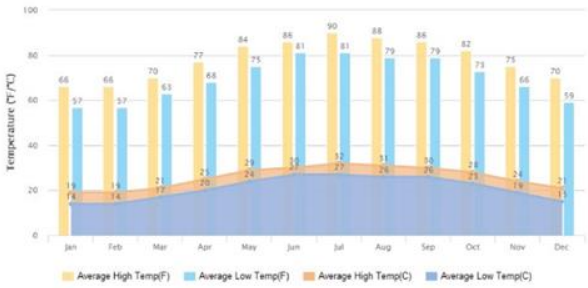
/_ 1.1 We live in a dynamic world...

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.

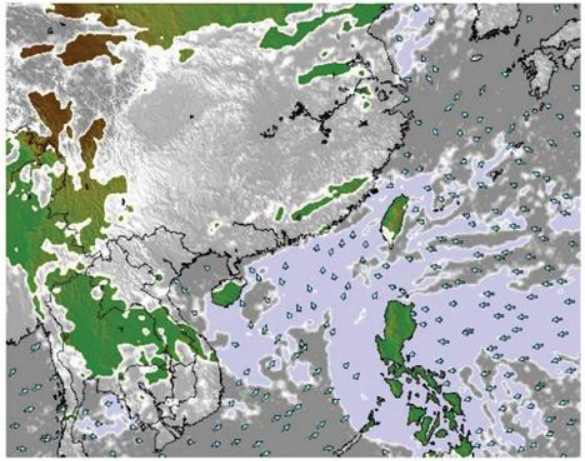
Seasonal Changes



	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.

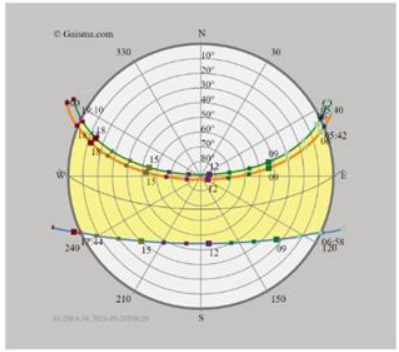
Weather Changes

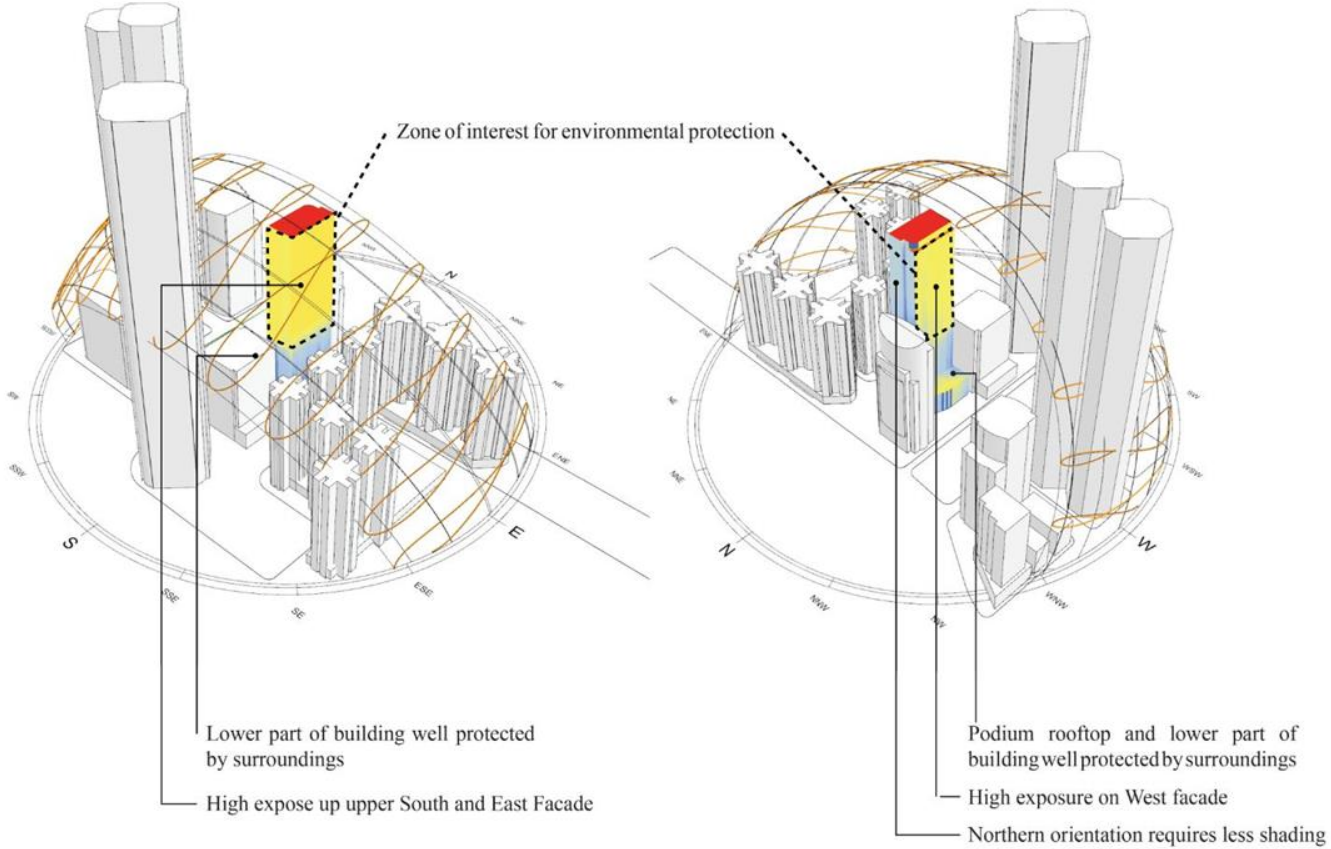


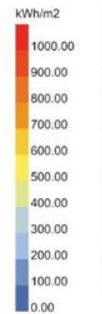
Daily Changes occur between day and night temperatures. Rainy days and Sunny days. Overcast skies and cloud cover changes incident radiation received across different areas of the facade.

/_ 1.2 Identifying issues with current massing orientation

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







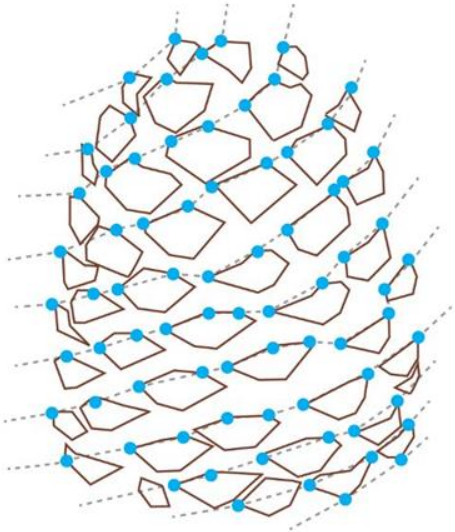
Hong Kong's climate is sub-tropical, tending towards temperate for nearly half the year. During November and December there are pleasant breezes, plenty of sunshine and comfortable temperatures. Many people regard these as the best months of the year. January and February are cloudier, with occasional 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

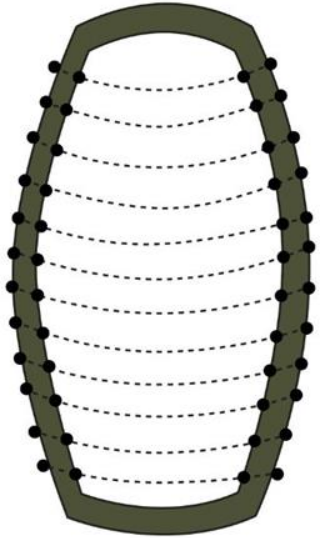
Pine Cones are hypersensitive to the climate. It opens and closes to control temperature and humidity in order to protect its seeds.

AI Optimization



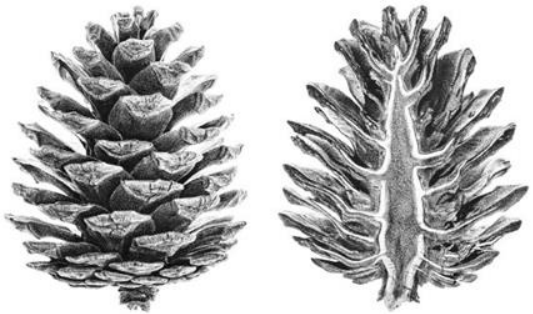
Machine Learning and computation design approach can be used to find the most optimized result for a performance based approach.

Double Skin Architecture



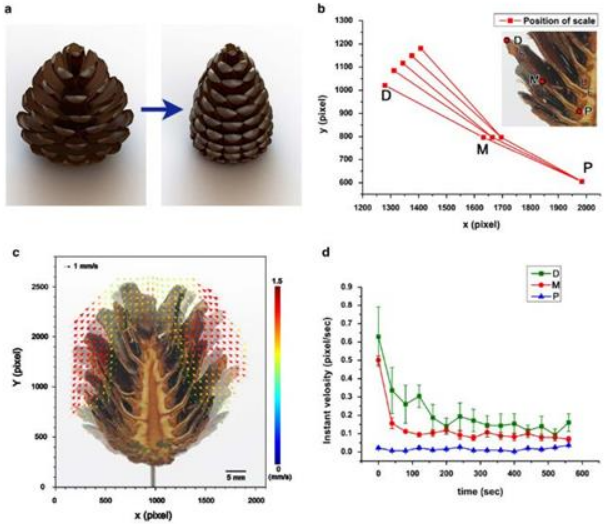
Protective Facade is used on top of the curtain wall approach which makes up majority of Hong Kong's office towers.

Ability to regulate internal climate



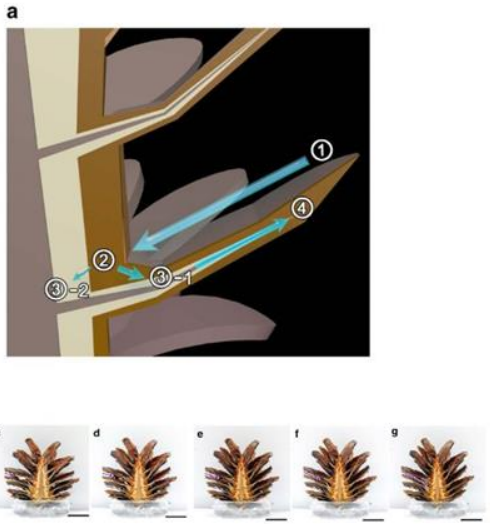
Pine Cones consists of two layers an inner cone layer where the seeds sit and an outer layer to protect its seeds. This is similar to a double skin facade where the function of the outer layer is to proects its inhabitatnts.

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

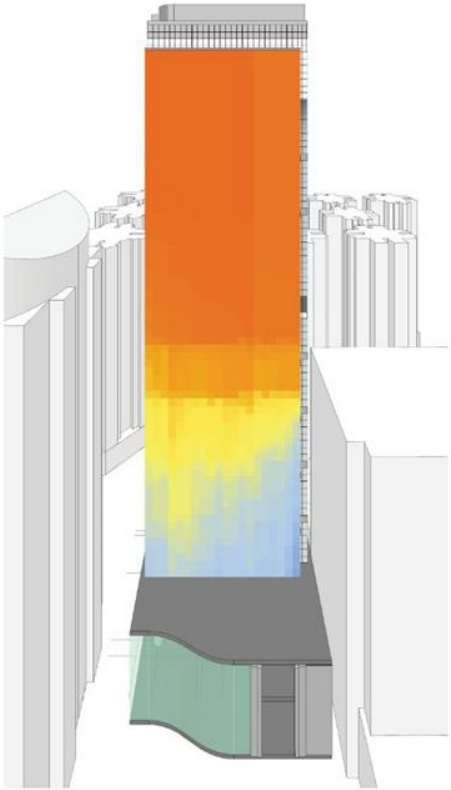
// Advancing Net Zero

/ The allegory of sustainability

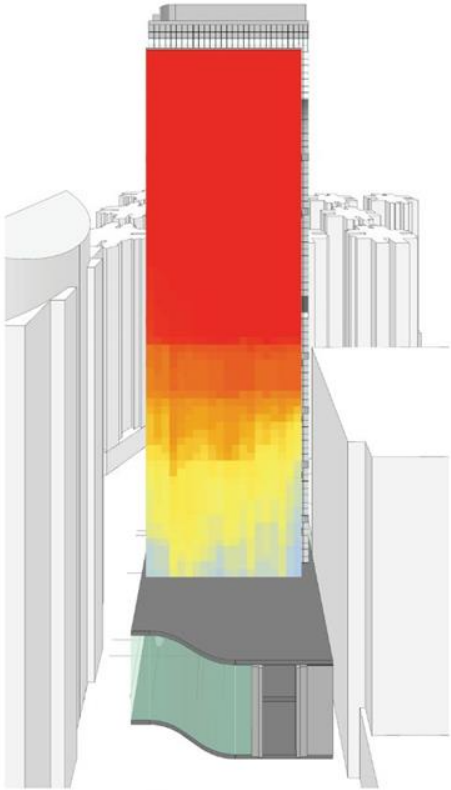
/ Integration between technology and sustainable architecture

/ _

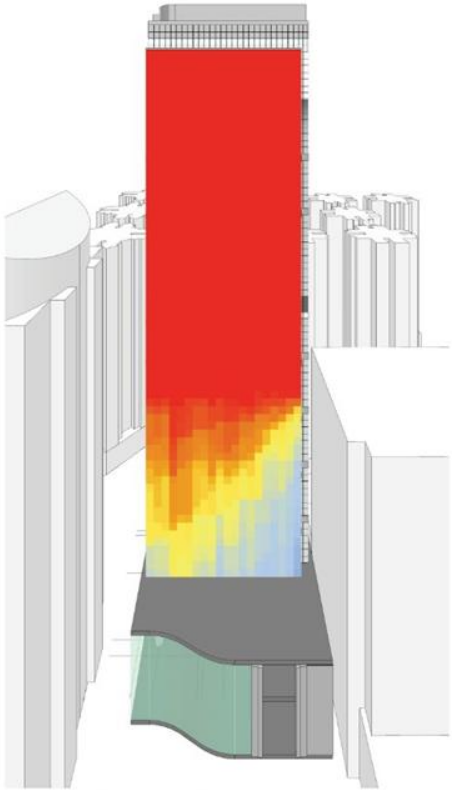
/_ 2.1 Solar Radiation Simulation



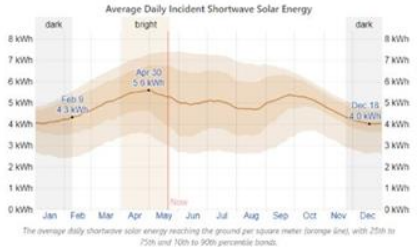
Test Date: Februrary 9th
Average Solar Radiation (kWh/m2): 0.520



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



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



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°

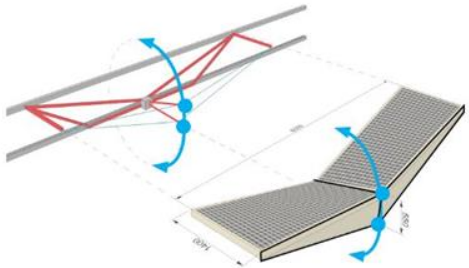
Test Date: April 30th
Average Solar Radiation (kWh/m2): 0.656

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

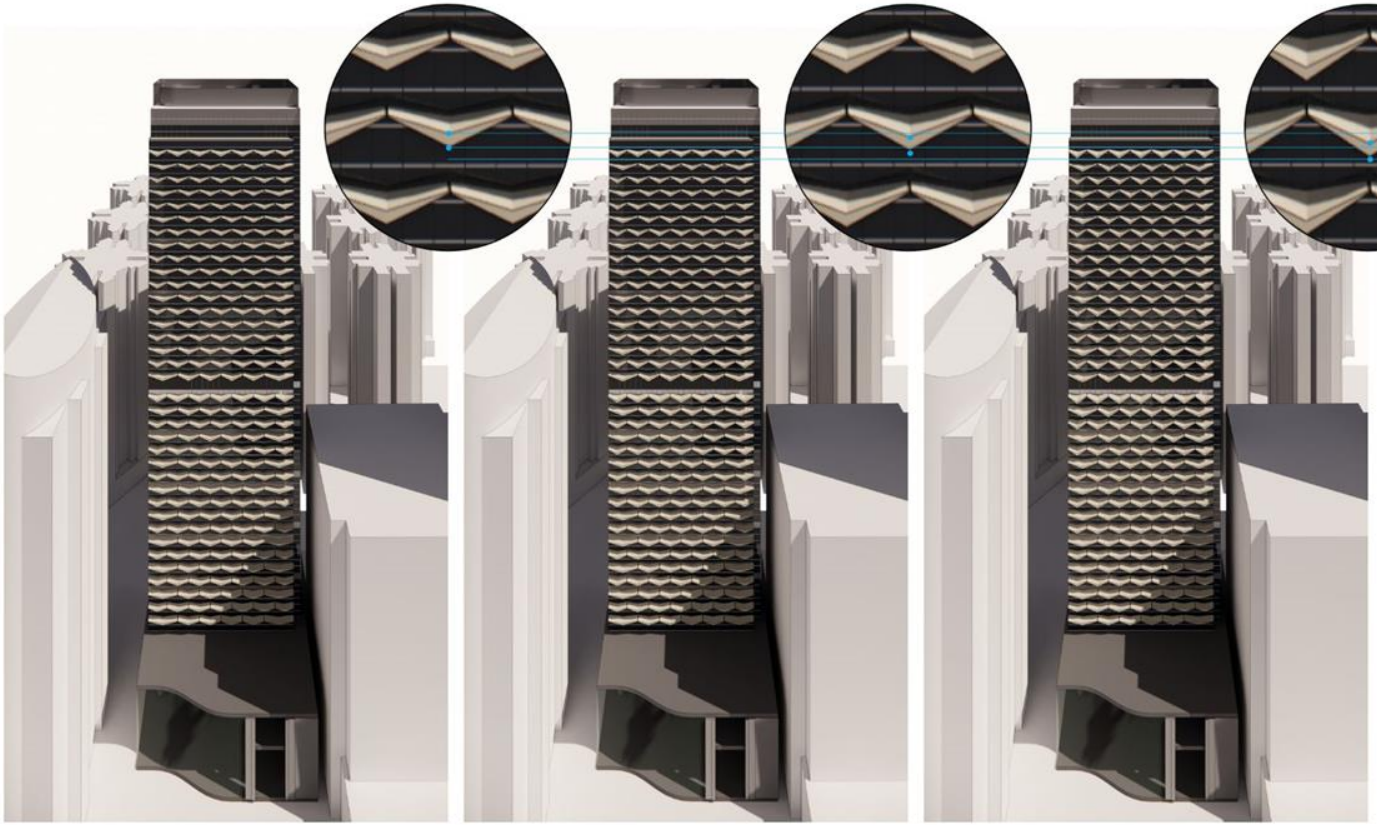
Angle of movement



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

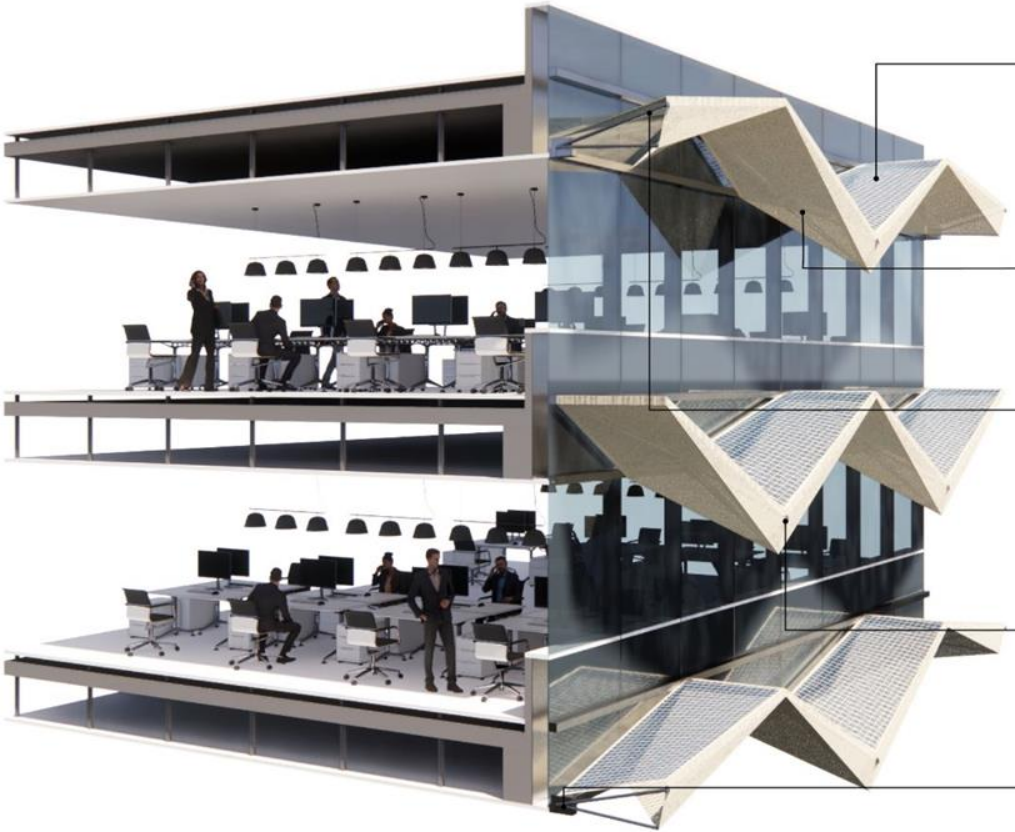
Rainy Day

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)**

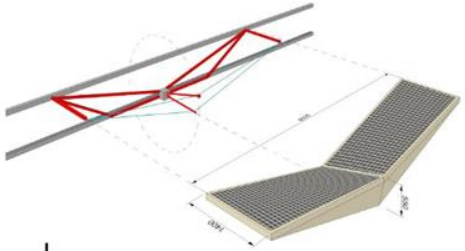
Bottom Layer:
Vinyl Membrane

Structure:
50mm GRFP Square Tube

Fixings:
Stainles steel Memebrane fixing

Movement Control:
Rotary Actuator / Control Box

/_ 2.6 The essence of sustainable materials

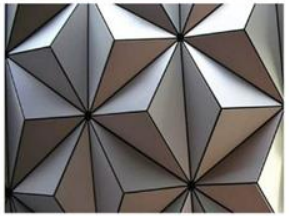


Advancement of Materials and Technology

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)**

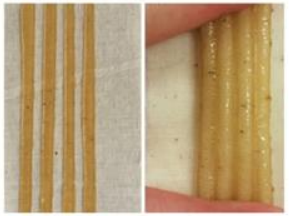
Transparent solar panels

Bio Textiles

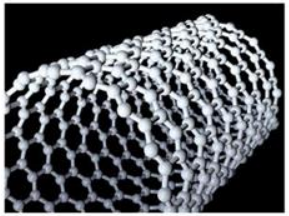
Structures

Mild Steel Structure

GRFP Square Tube



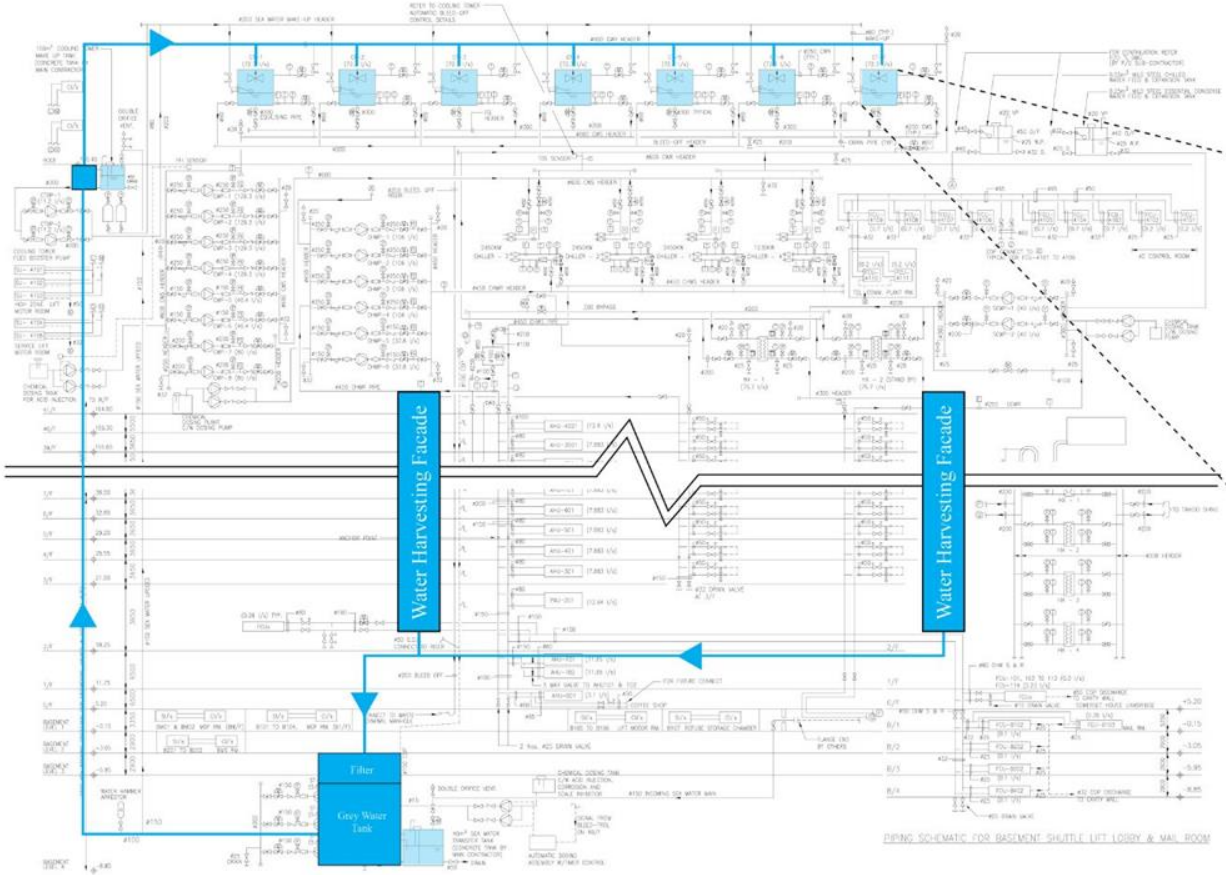
Biomimetic Material
*(ref: Francescaperona,2021)**



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

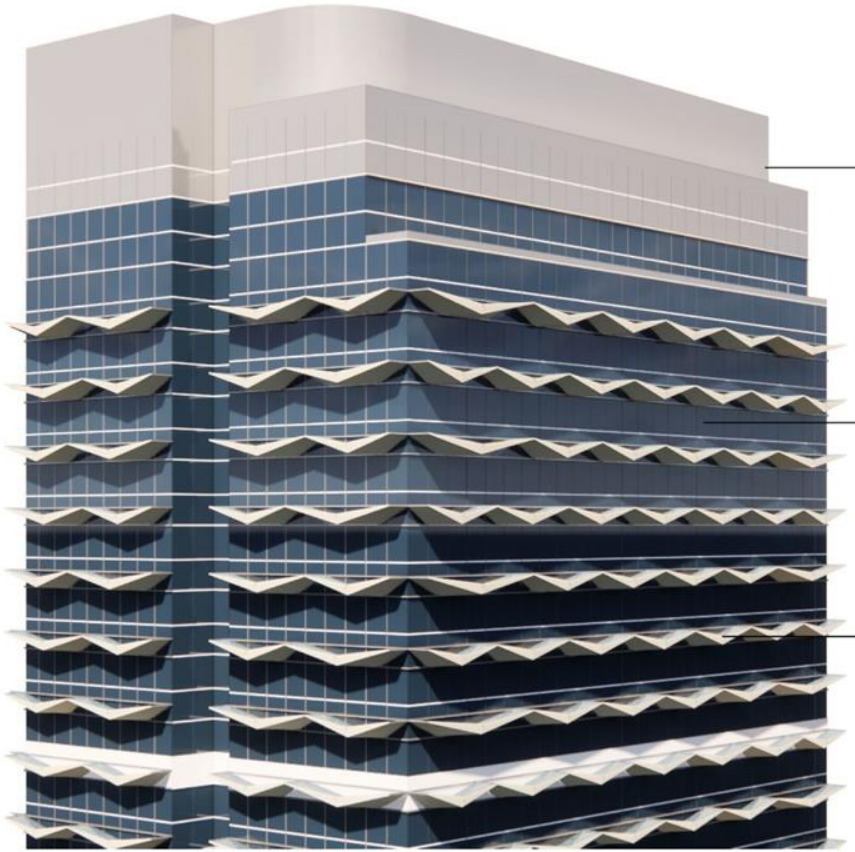
Raw Material Acquisition
- Chloride: Electrolysis to brine
- Ethylene: cracking process of natural gas of petroleum

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



11.5
kg CO_2/kg

Aluminnum Claddding

B1 Use:
No energy use required
B2 Maintenance:
Regular cleaning
B3 Repair:
Replacement of panel systems
B4 Refurbishment:
Aluminum can be dismantled and washed on of off site.
B5 Replacement:
Modular construction for easy replacement

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

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

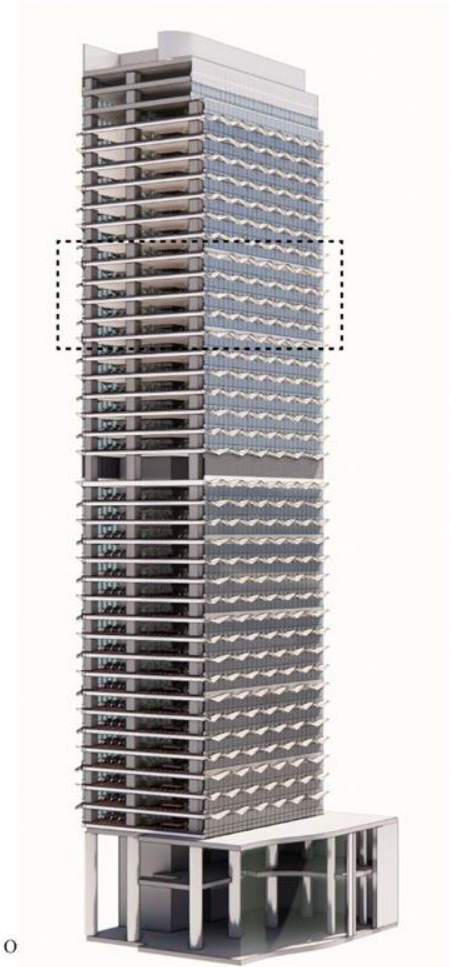
/ A versatile approach to material and form

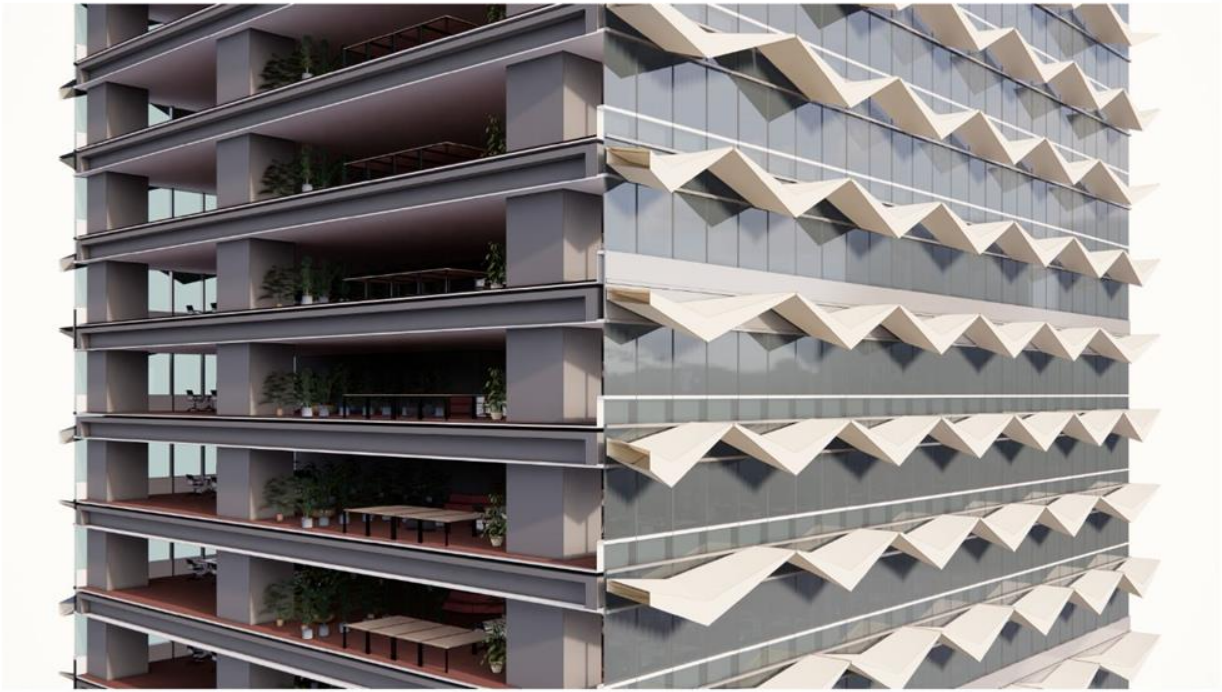
/_

/_ 3.1 Plan

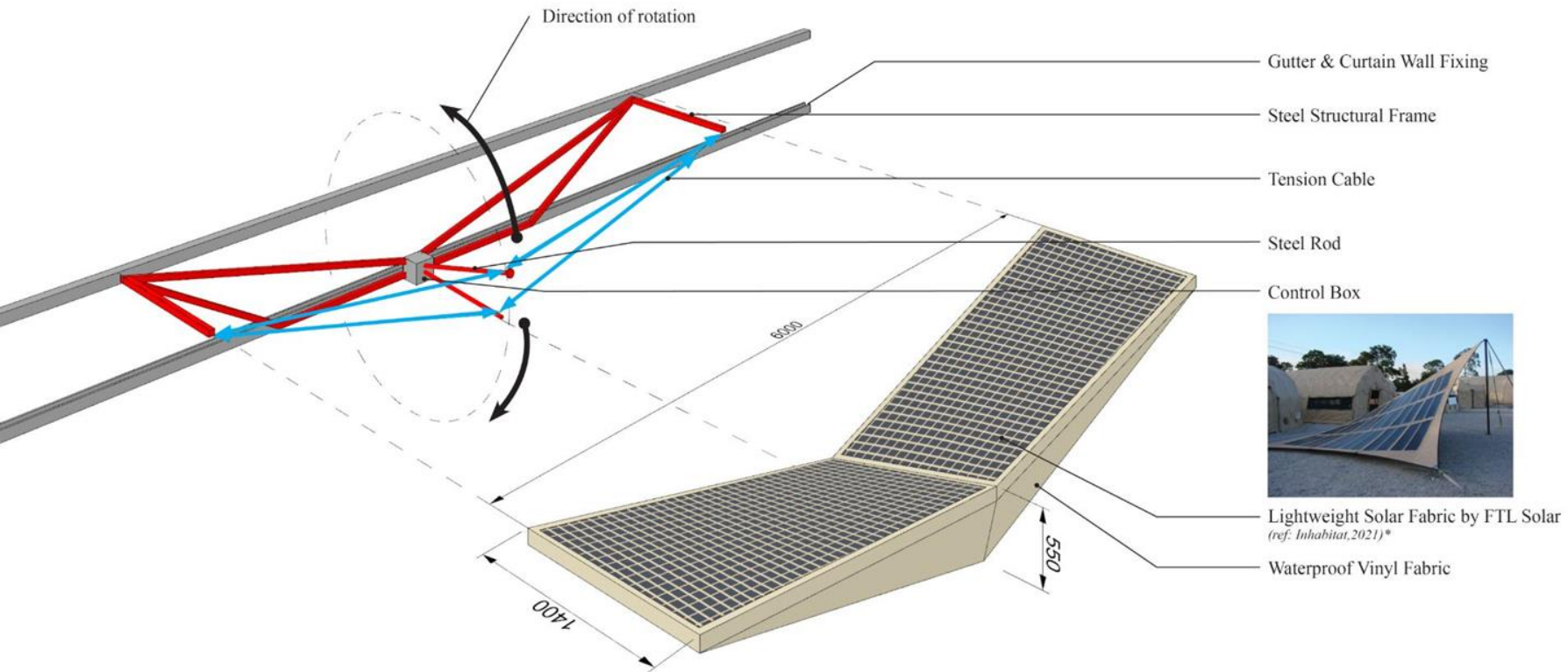
// Sustainable architecture is a revised conceptualization of architecture in response to a myriad of contemporary concerns about the effects of human activity.

/_ 3.2 Building Section



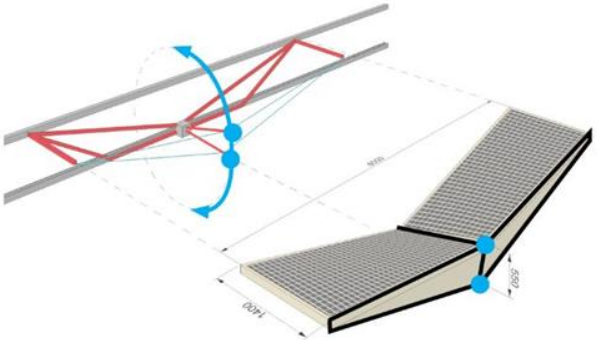


/_ 3.3 Modular system to achieve optimization and automation



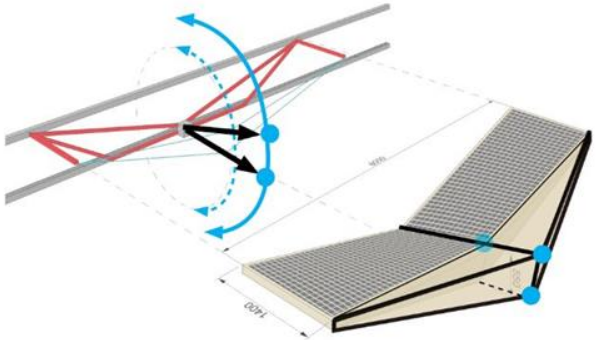
/_ 3.4 Cost Quality Optimization

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



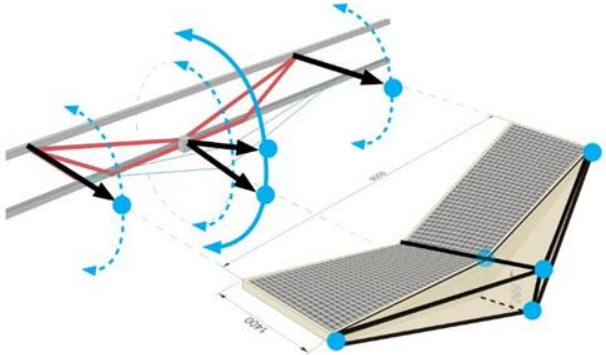
2 variable points of control with 1 rotary motion. Only can control the angle of module through rotation.

2 Direction Movement
(For high exposure office towers)



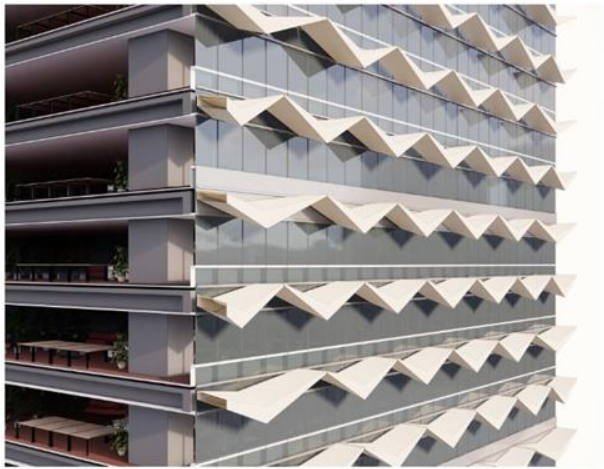
2 variable points of control with 1 rotary motion and 2 linear motion to control depth of module. Can control both the angle of module and size of the module.

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.

/_ 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.

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

4

// Design for People

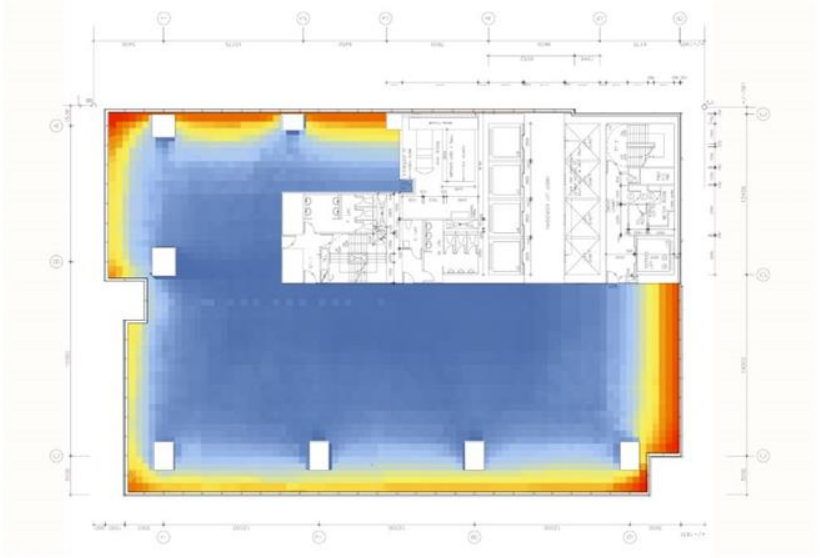
/ Why we need eco-expressionism

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

/ _

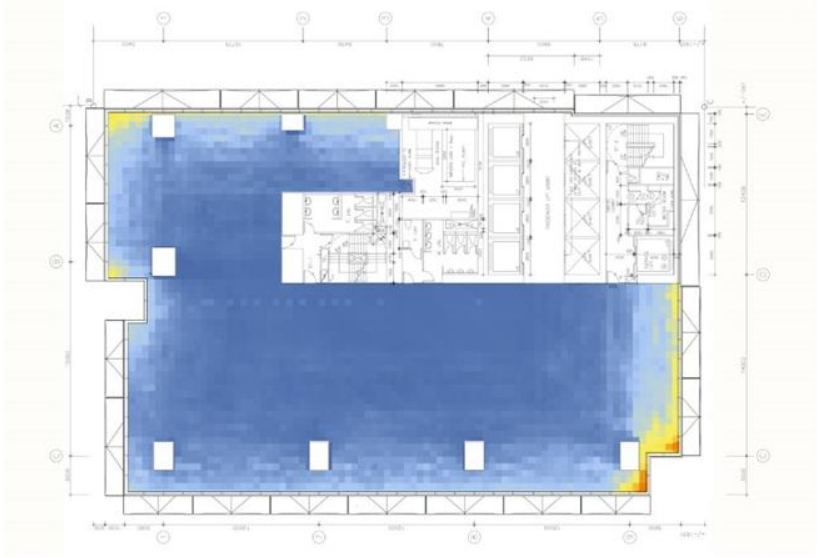
/_ 4.1 Indoor Thermal Comfort

Existing Heatmap



High thermal exposure around the first 5m perimeter of the building. With exceptionally high southern exposure extending 10m deep into the building. Corner of building also receive significantly more solar heat gain.

Reprovisioned Heatmap

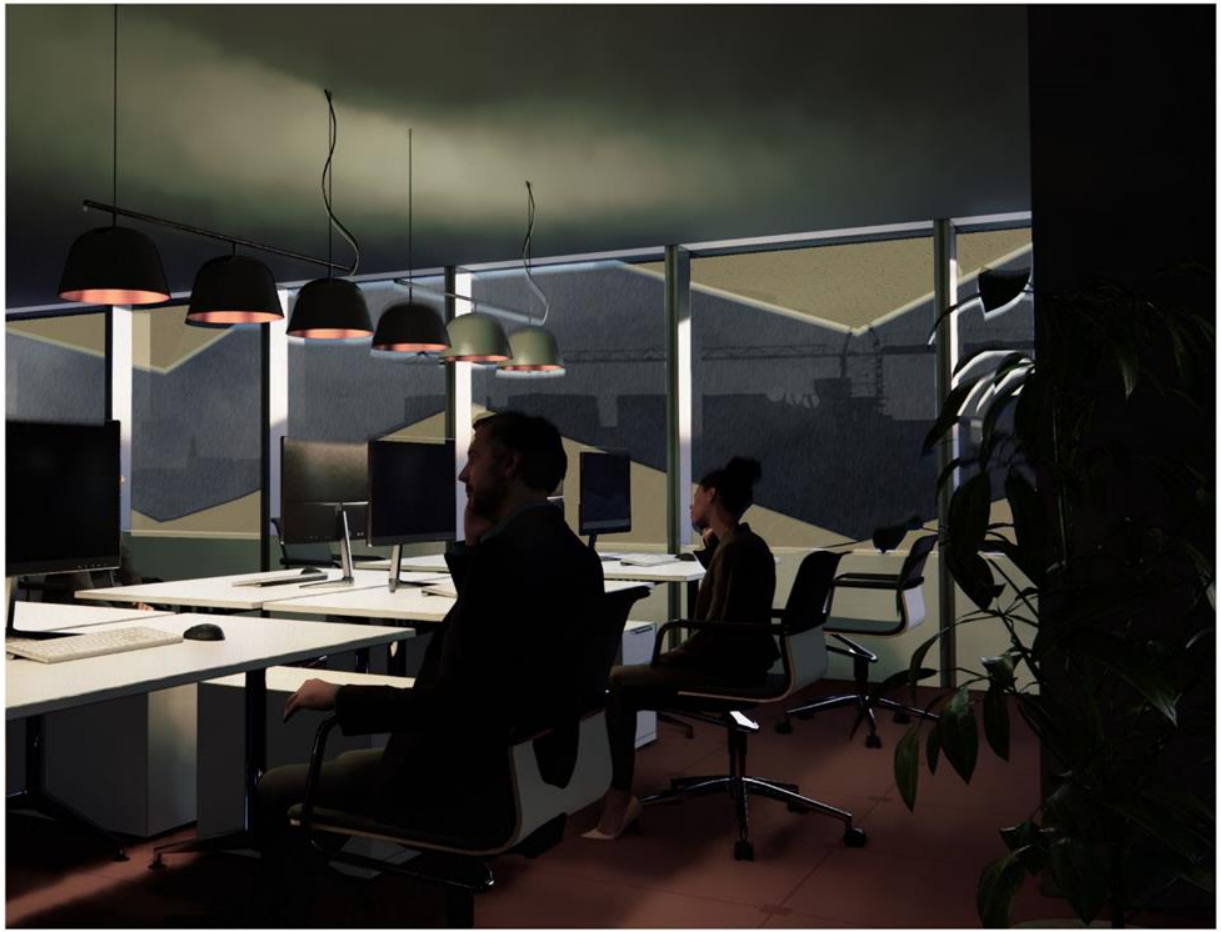


The plan is overall much more protect from solar radiation and optimized for human comfort.

/_ 4.2 The whole building will be covered in photovoltaics but invisible to inhabitants

/_ 4.3 For those moments where the sun hits the table...

/_ 4.4 Protection against typhoons



4.5 An Icon for change

**“Look after the land and the land will look after you,
Destroy the land and it will destroy you.”**

-Aboriginal Proverb-

// Objective:
/Increasing awareness of the environmental benefits of double skin facades and to disseminate such knowledge.