Bachelor of Science (Honours) in Architecture

TAYLOR'S UNIVERSITY
Wisdom · Integrity · Excellence

GREEN STRATEGIES FOR BUILDING DESIGN (ARC 61804)
Assignment 1: Passive Design For Green Building

GROUP 20

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TABLE CONTENT

INTRODUCTION

Paramit Factory

Paramit Factory is a state-of-the-art advanced manufacturing facility specializing in high-precision medical and industrial equipment. It is renowned for its sustainable and biophilic design, integrating energy-efficient systems, natural ventilation, green spaces, and solar power to minimize environmental impact.

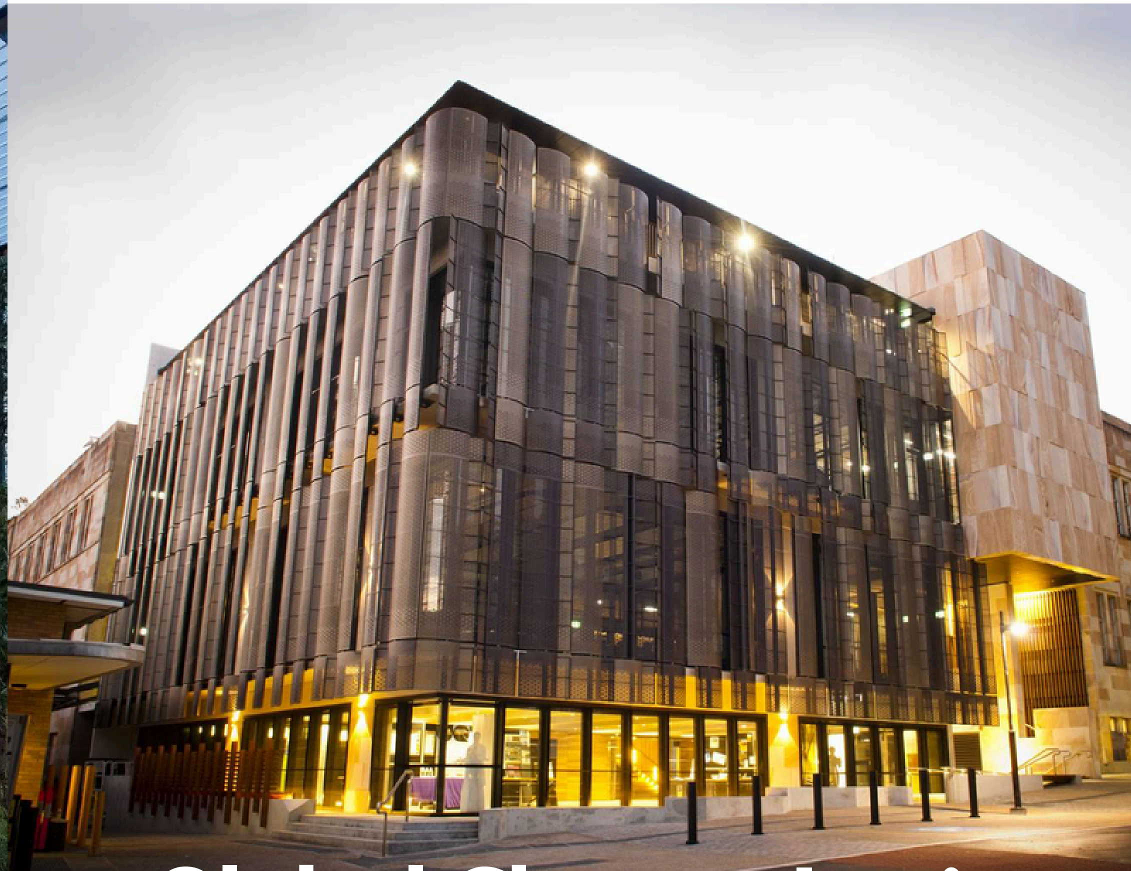
Penang Science Park, Lorong Perind, Bukit Minyak 21 Simpang Ampat, Penang Malaysia.

Factory and warehouse - 11 216.5 m^2
Office block - 1 684.5m^2

Design Unit Architects Sdn Bhd

IEN Consultants Sdn Bhd

“ Factory in the Forest”



Global Change Institute

The Global Change Institute (GCI) is a leading research hub dedicated to addressing critical global challenges. GCI brings together interdisciplinary experts to develop innovative solutions for a sustainable future. A world-class example of sustainable architecture, one of Australia’s greenest and most innovative academic buildings.

The University of Queensland, St Lucia QLD 4067, Australia

3865 m^2

HASSELL (Primary design firm)

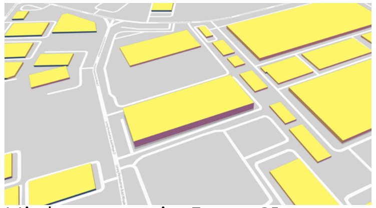
Arup (Climate-responsive systems)

1.0 SITE ANALYSIS

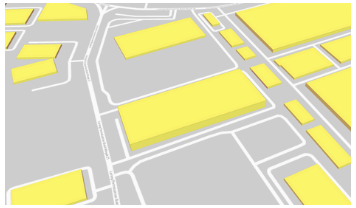
1.1 SITE ANALYSIS

PARAMIT FACTORY
PENANG, MALAYSIA

SUN PATH DIAGRAM

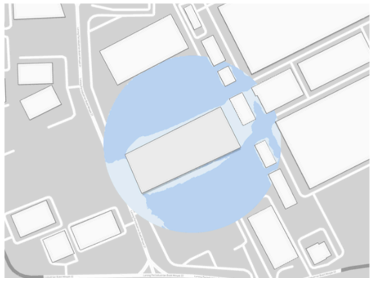


Highest sun in June 21 causes long hours of sun exposure at the southeast side

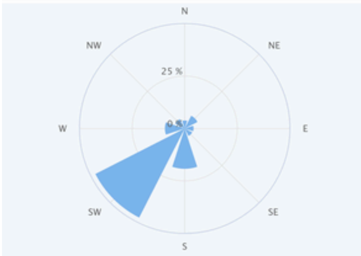


Lowest sun in Dec 21, low exposure of sunlight

WIND ROSE



During SW monsoon season, the wind speed is up to 2 m/s



N Northern	NE Northeastern	E Eeastern	SE Southeastern	S Southern	SW Southwestern	W Western	NW Northwestern
3.8%	6.8%	4.2%	4%	19.2%	47.7%	9.4%	5%

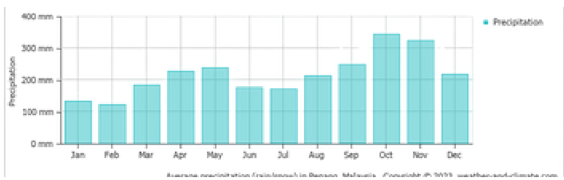
Prevailing Winds:

- NE Monsoon(Nov-Mar)
  - wind speed >2m/s
- SW Monsoon(May-Sept)
  - wind speed <2m/s

Low-Wind Challenges

- April & October: 70% of hours <2 m/s

PRECIPITATION & RAINFALL



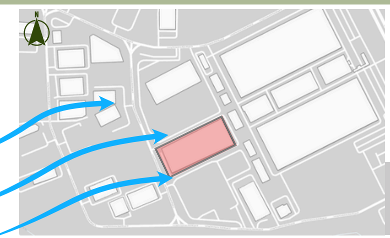
Wettest Months:

- April–May (Inter-Monsoon): 250–300 mm/month
- October–November (NE Monsoon onset): 300–350 mm/month

TOPOGRAPHY

- **Elevated** ~3–5 meters above sea level (low-lying coastal plain)
- Flat to gentle **slope** (0–5% gradient)
- Historically mangrove/swamp as **natural drainage** (now reclaimed land)

SURROUNDING CONTEXT



Costal area (*Gertak Sangguk Fishing VIllage)* at the west direction promotes sea breeze for natural ventilation

Penang airport flight path at the south direction causes noise restrictions and the height limits of the building

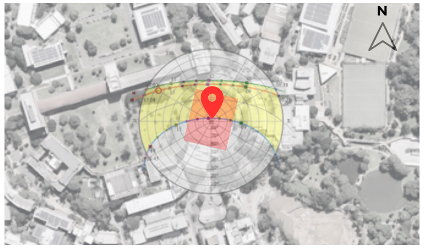
LEGENDS

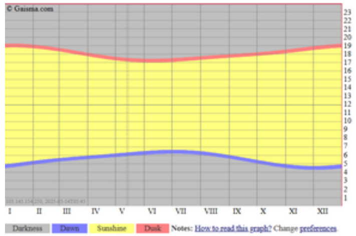
- Paramit Factory
- Industrial Cluster (electronics factories)

1.2 SITE ANALYSIS

GLOBAL CHANGE INSTITUTE
BRISBANE, AUSTRALIA

SUN PATH DIAGRAM





Sunrise, sunset, dawn and dusk times, graph

East-west alignment with a southeast entrance to maximize sunlight.

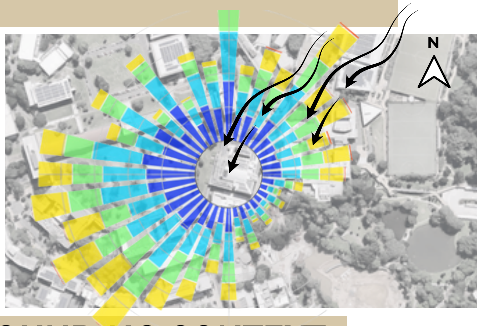
Plenty of sunlight from 5:00AM to 7:00PM

WIND ROSE

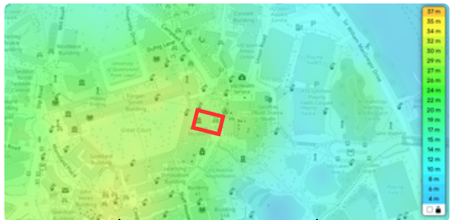
Wind Direction: Northeast winds (prevailing) → Ideal for natural cross-ventilation.

Wind Range: Designed for light to moderate wind variations. Optimizes year-round natural cross-ventilation

- Average wind speed over the year ranges from **2m/s to 4m/s.**
- **Lower** in June and **higher** in February and December



TOPOGRAPHY



- Located on a gentle eastward slope(2-3% grade) descending toward Brisbane River

- No hills or mountains nearby

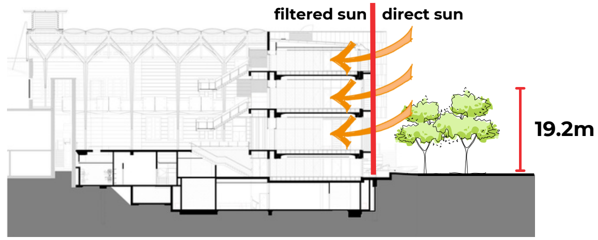
- River proximity (≈520m from site)

SURROUNDING CONTEXT

East-side tree canopy provides filtered shade for the 19.2m building

Filtered **sunlight** balances natural cooling with daylight penetration

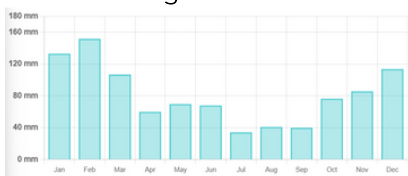
Morning sun mitigation reduces heat gain during peak warming hours.



PRECIPITATION & RAINFALL

Brisbane Rainfall

Annual average: 979mm



The mean monthly precipitation over the year, including rain, hail and snow

LEGENDS

- GCI
- Trees
- Surrounding Buildings
- Water

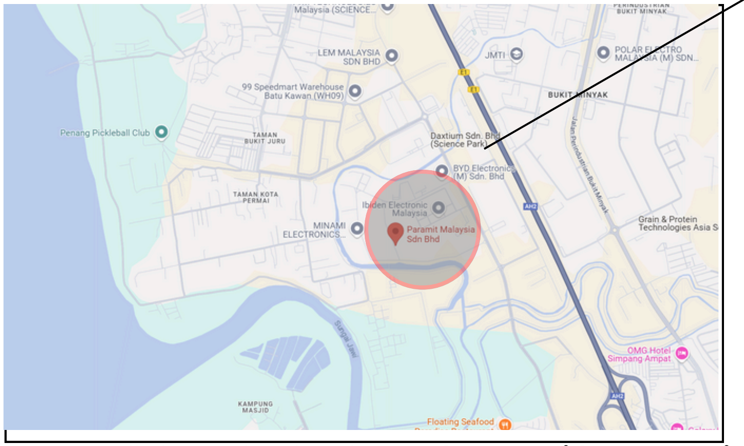
1.3 COMPARATIVE ANALYSIS

PARAMIT FACTORY		GLOBAL CHANGE INSTITUTE
Paramit focuses on managing sun exposure due to its specific highest/lowest sun angles	**SUNLIGHT OPTIMIZATION**	GCI directly aligns to maximize sunlight during specific hour from 5:00 AM to 7:00 PM.
Paramit has distinct prevailing monsoons impacting wind direction and speed.	**WIND PATTERN**	GCI benefits from prevailing northeast winds, ideal for cross-ventilation, with moderate annual wind speeds.
Paramit is a low-lying coastal plain, historically mangrove/swamp.	**TOPOGRAPHY**	GCI sits on a gentle slope near a river, with no surrounding hills or mountains.
Appears to have two distinct wet seasons (April-May and Oct-Nov).	**PRECIPITATION**	Appears to have a more concentrated wet season, likely during summer.
Industrial Cluster (factories) to the east.	**SURROUNDING CONTEXT**	East-side trees filter sunlight, reducing morning heat while balancing cooling and daylight.

2.0 SITE PLANNING

2.1.1 SITE SELECTION

2.1.2 ORIENTATION



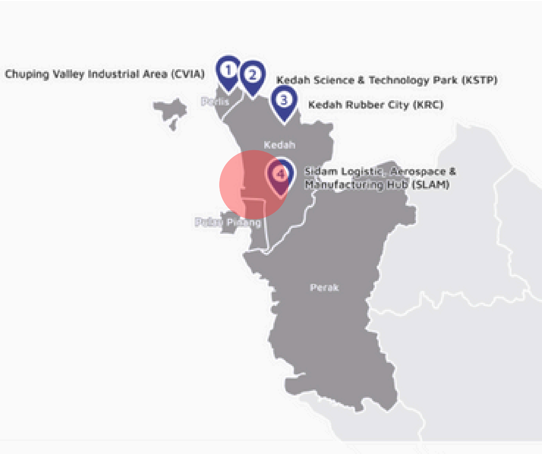
Location Context

Close to major transportation networks (Second Penang Bridge, highways and logistic hubs).

Batu Kawan, on the mainland side of Penang, is part of the South Seberang Perai district in northern Malaysia.
It is envisioned as Penang's first green smart city, emphasizing:

- Sustainable mobility
- Waste management
- Green building initiatives

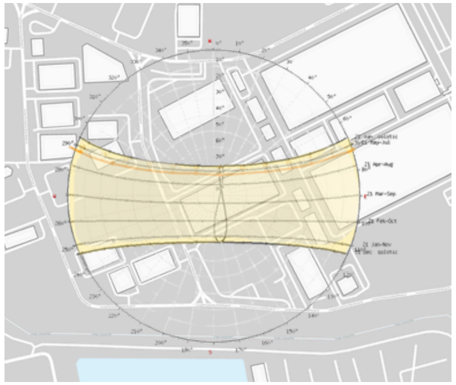
Strategically located within the **Northern Corridor Economic Region (NCER)** — a Malaysian government initiative to boost sustainable economic growth in the north.



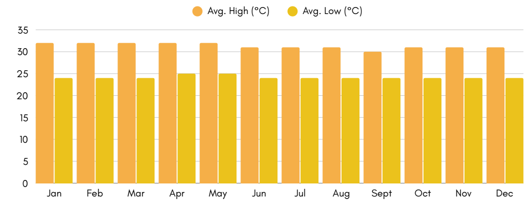
The site was chosen in a relatively undeveloped area, allowing flexibility in master planning for environmental integration.

The site originally contained natural vegetation and rainwater paths. Hence, instead of clearing them, the design preserved much of the existing forest and integrated the building around it

Climatic-responsive orientation



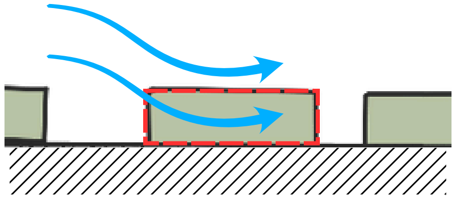
Embedded within a **tropical equatorial** context, characterized by consistently high ambient temperatures ranging from **30°C to 33°C** and intense year-round solar exposure.



Building Elevation

Recognizing the thermal implications of its latitude near the equator, the architectural massing is deliberately oriented along a **north–south axis**, mitigating direct solar gain on its longer façades

Site Section

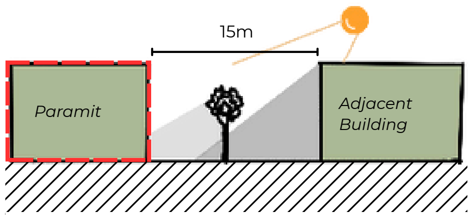


Site is located at low lying area and every building has average height of 2-3 storeys

Wind speed and direction is not obstructed by any high-rise building or tall vegetation. Natural ventilation can be easily designed to maximise the potential, inviting the wind to enter the building

Distance between building

The distance between Paramit and adjacent building do not allow mutual shading to happen. Building envelope has access abundant sunlight and thus high sun radiation amount.



Topography: Flat
Building Height: 3 sotreys

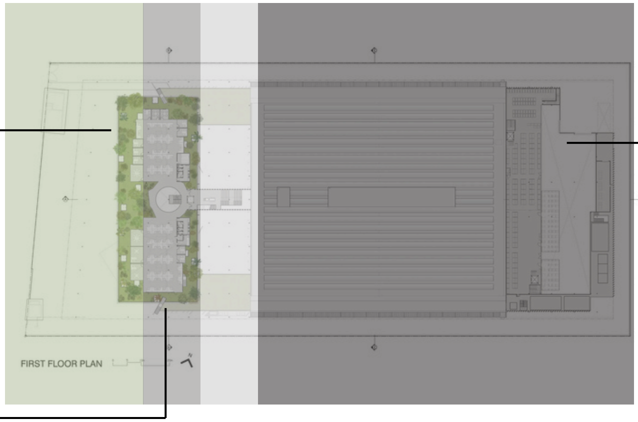
To reduce energy consumption and increase thermal comfort, it is designed to be well shaded with vegetations and shading devices.

2.1.3 BUILDING LAYOUT

Space Planning

Forest located facing west to shade against the hot afternoon sun

Office needs ventilation is situated closer facing the wind direction to capture wind



Manufacturing area where natural ventilation is prohibited, located further away

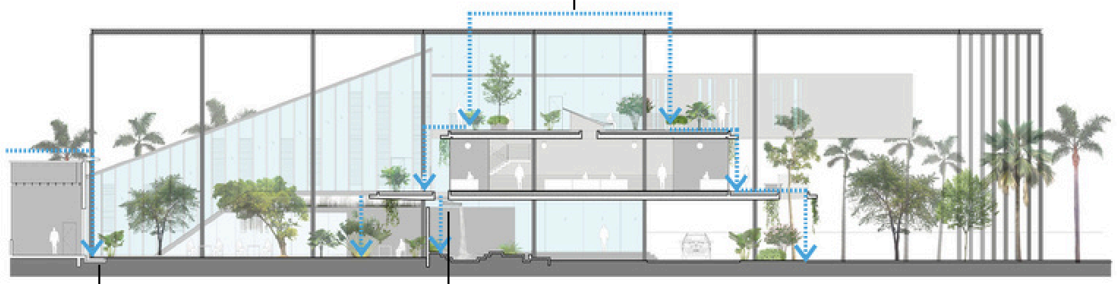
" Forest"
Office
Courtyard
Enclosed Manufacturing Area

The 5-acre rectangular-shaped site was designed to minimize the effect of solar radiation. The site is simply divided into four parallel zones (from west to east): 'forest' car park; office; courtyard; and manufacturing zones.

2.1.4 STORMWATER MANAGEMENT

Apart from greenery and natural light, the factory also celebrates nature by integrating the element of water for environmental and psychological benefits.

Rainwater free-falling from the office green roofs is channelled to water retention ponds that become a landscape feature of the building entrance lobby



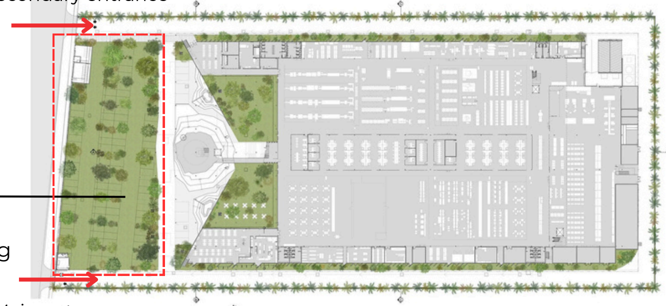
Rainwater from the factory roof is designed to cascade down via a series of spouts to a pebble drain catchment area at the ground level in the courtyard

Dramatic scenery of waterfalls along the glass wall that separates the factory space and the green courtyard

2.1.5 IMPERVIOUS SURFACE

Car park zoning & accessiblity

"Forest" car park zone facing the existing access road



The **main entrance** is where both staff and visitors' cars enter and exit.
The **secondary entrance** is for staff arriving by shuttle bus and motorbikes as well as all stockroom deliveries.
By having two separate entrances, potential congestion of cars, motorbikes, delivery trucks, and pedestrians at the start or end of work is alleviated.

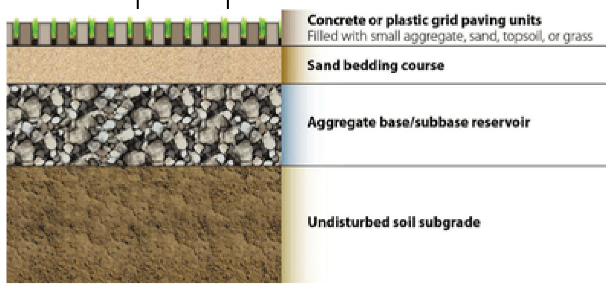
In essence, the car park is conceived as a 'forest' where cars are parked rather than a car park with planted trees.

Pervious Surface

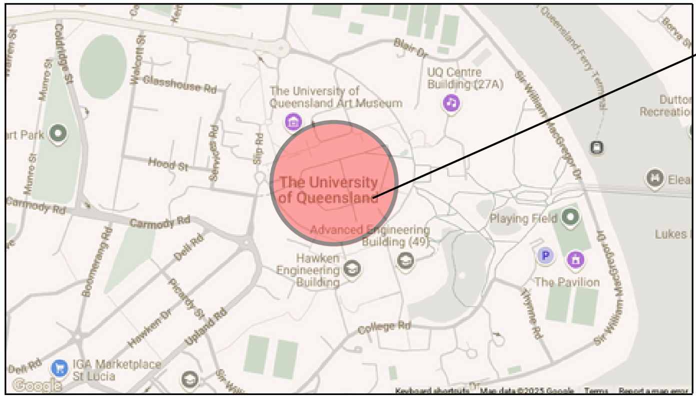
Apart from greenery and natural light, the factory also celebrates nature by integrating the element of water for environmental and psychological benefits.

Almost the entire floor area of the parking zone is covered with pervious surfaces to allow rainwater to percolate through. This strategy reduces the pollution of surface water

Underground pipes then direct the rainwater from the courtyard to the same rainwater harvest tank under the car park area



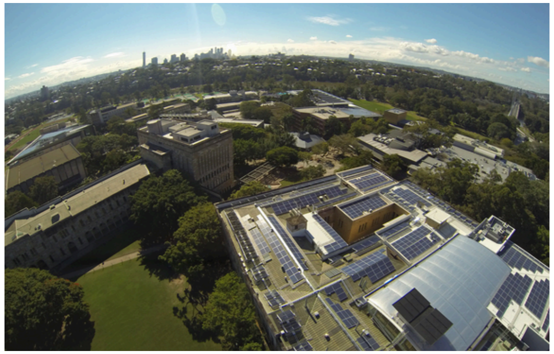
2.2.1 SITE SELECTION



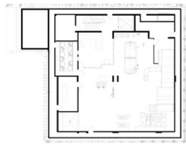
Location Context

Part of a major **educational** and **research precinct** that includes other UQ faculties, research institutes, and student facilities. Surrounding the St Lucia campus is predominantly residential, with nearby suburbs such as Toowong, Indooroopilly, and Dutton Park.

The building showcases sustainable site selection by being built on **high ground** within the existing St Lucia campus, away from floodplains and close to public transport. Set back from the Brisbane River, it maintains natural **buffers** and uses a previously developed site, avoiding greenfield disruption. Its location supports **low-carbon** commuting and efficient land use, reflecting a strong commitment to environmental sustainability.

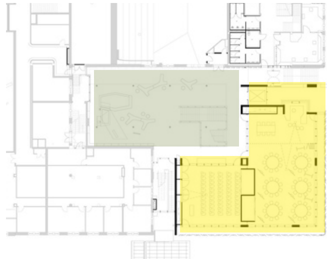


2.2.3 BUILDING LAYOUT



BASEMENT

- Houses the rainwater harvesting tank (60,000L)
- Contains mechanical systems, bicycle storage, and service access



FIRST FLOOR PLAN

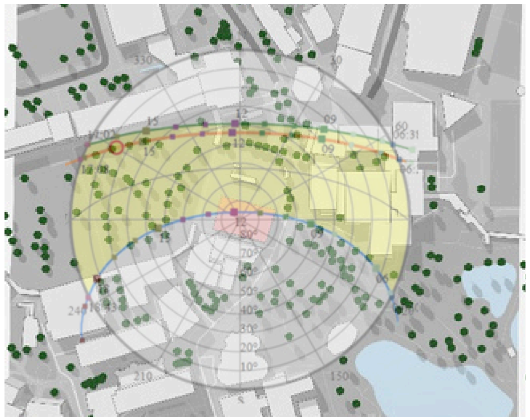
- Open-plan work zones and flexible hot-desking areas
- Designed for activity-based working and collaboration

SECOND FLOOR PLAN

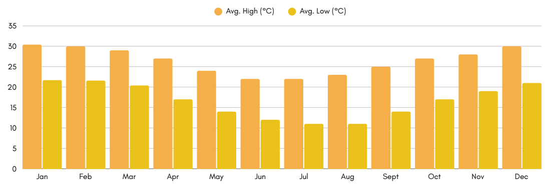
- Acts as a natural ventilation shaft ("lungs of the building")
- Covered by a triple-skin ETFE roof for daylight without heat gain

2.2.2 BUILDING ORIENTATION

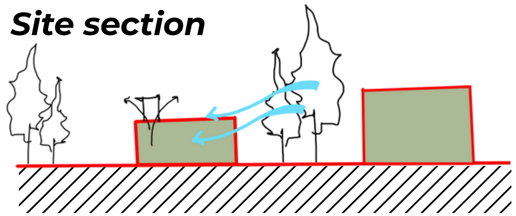
Climatic-responsive orientation



Located in a **subtropical climate** in Brisbane, the GCI building is designed to respond to hot, humid summers and mild winters. With average summer temperatures ranging from 28°C to 33°C and high humidity, passive design strategies were critical.



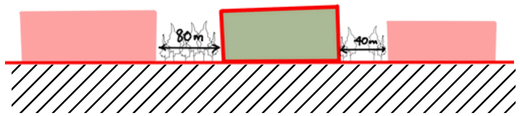
Site section



The building is located on a relatively open, flat terrain with low-rise surroundings.

- No major obstructions block prevailing breezes (especially from the northeast and southeast).
- A thermal chimney helps draw warm air upward and out.
- The building's section is optimized to allow stack ventilation, enhancing passive airflow through naturally ventilated spaces.

Distance between buildings

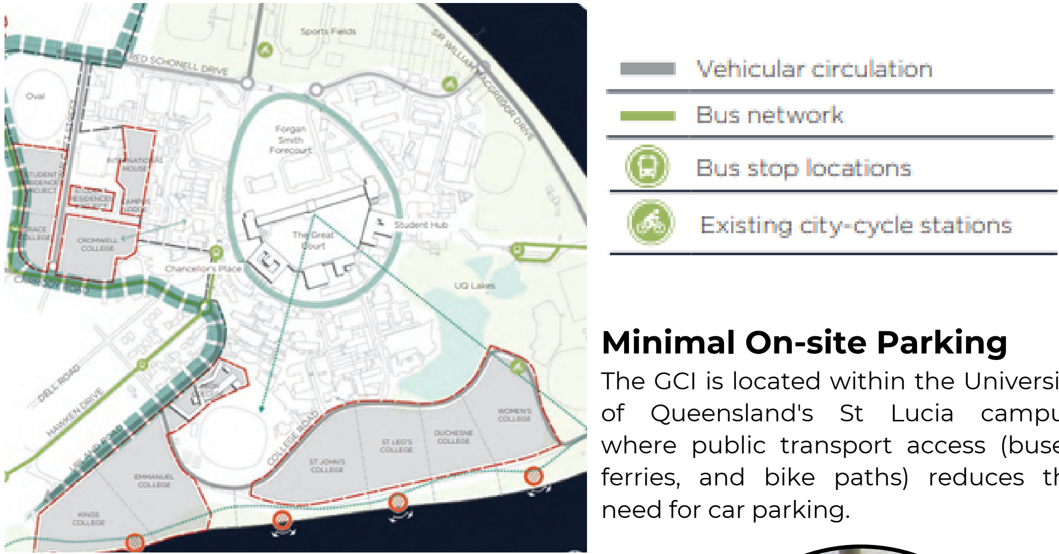


The site planning allows for adequate spacing between adjacent structures, ensuring:

- Unobstructed access to daylight and ventilation.
- Buffer zones planted with vegetation to reduce radiant heat and improve air quality.

Shading elements, vegetation, and distance from nearby buildings all contribute to lower cooling demands and higher occupant comfort.

2.2.4 Impervious Surfaces

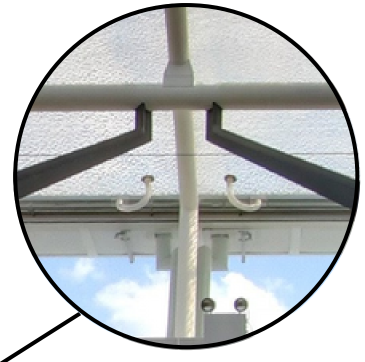


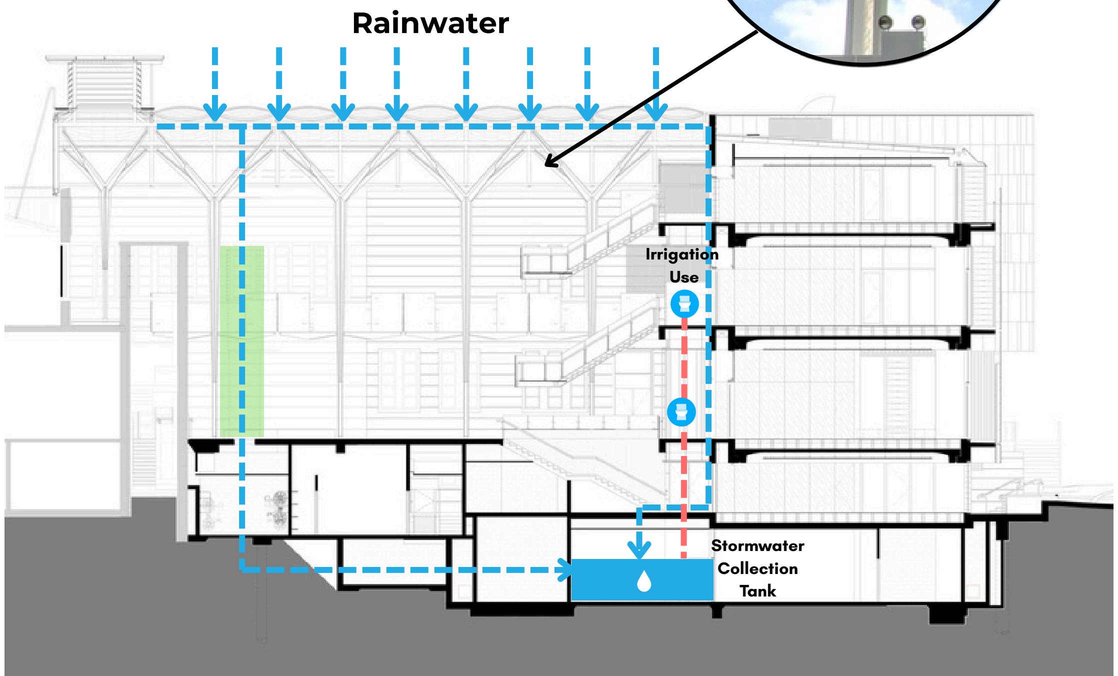
Minimal On-site Parking

The GCI is located within the University of Queensland's St Lucia campus, where public transport access (buses, ferries, and bike paths) reduces the need for car parking.

Rainwater Harvesting System

A **60,000-litre basement rainwater tank** collects roof runoff for non-potable uses such as cooling, toilet flushing, and irrigation.
This mitigates runoff from impervious roof areas and reduces dependence on mains water.



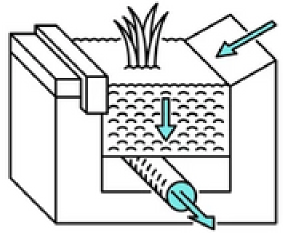


2.2.5 Stormwater Management

The Global Change Institute applies **Low Impact Development (LID)** strategies designed to mimic pre-development hydrology and reduce environmental stress. These include:

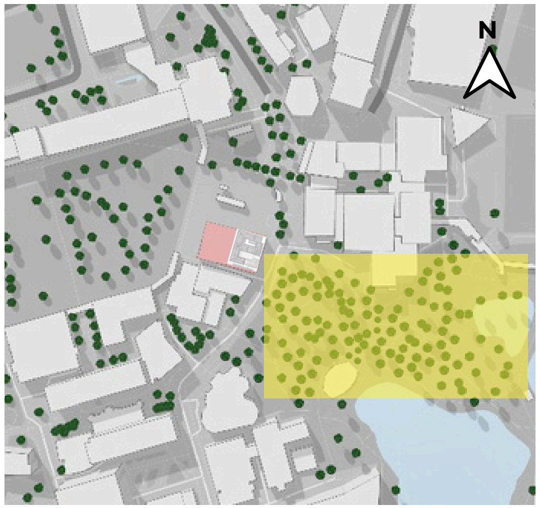
Permeable paving that allows stormwater to infiltrate the ground

Bio-retention swales and rain gardens to filter and slow down water



2.2.6 Landscape Design

Most of the trees are strategically planted on the **eastern side** of the building to offer shade and **minimize heat gain** from the morning sun. A tree positioned on the slope serves as a natural shading element, helping to cool the surrounding area while still allowing dappled sunlight to filter through while maintaining brightness without excessive glare.



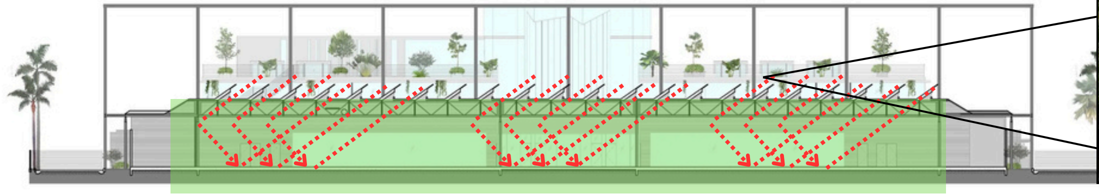
2.3 COMPARATIVE ANALYSIS

PARAMIT FACTORY		GLOBAL CHANGE INSTITUTE
Built on undeveloped land, preserving natural vegetation and rainwater paths.	**Site Selection**	Built on a previously developed site, away from floodplains and near public transport for low-carbon access.
Oriented north–south to minimize solar heat gain in a tropical climate.	**Building Orientation**	Designed for natural ventilation and passive cooling in a subtropical climate.
Zoned into four functional strips (forest, office, courtyard, factory) aligned for climate response.	**Building Layout**	Compact and vertical layout with integrated services and open-plan flexible spaces.
Uses pervious surfaces in the car park to manage runoff.	**Impervious Surfaces**	Features permeable paving to reduce surface water and heat gain.
Rainwater directed to ponds and pebble drains.	**Stormwater Management**	Rainwater harvested in a 60,000L tank and filtered through rain gardens and swales.
Maintains forest buffer and integrates water features for cooling.	**Landscape Design**	Strategically planted trees provide shade and manage glare, enhancing site microclimate.

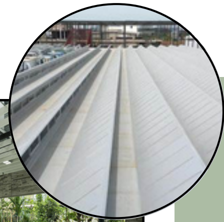
3.0 DAYLIGHTING

3.1.1 DAYLIGHTING ANALYSIS

Daylighting Analysis in Manufacturing Zone



Sunlight rebounds on the white colour surface in deep plan manufacturing area

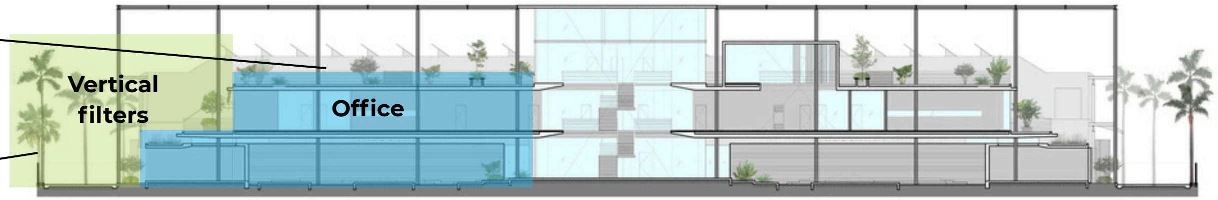


Sawtooth Skylight

Sawtooth roofs with skylights were aligned with the factory and pointed north with a slight **22.5°** angle to receive consistent and even daylight

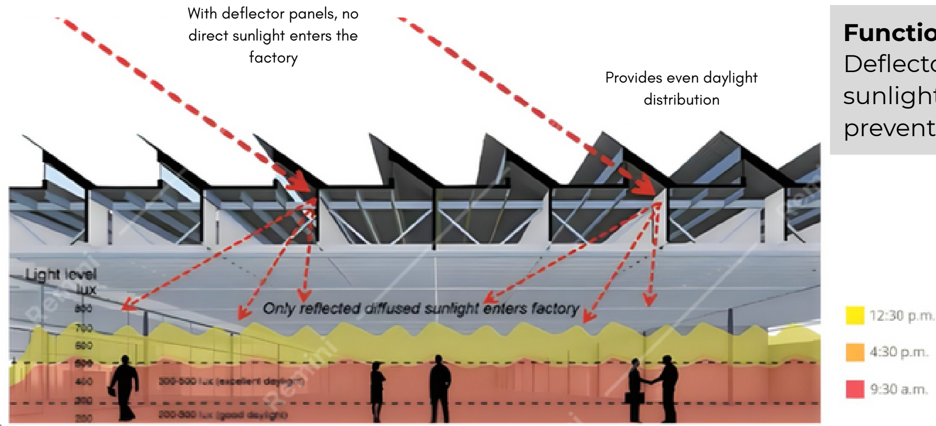
Due to the deep floor plan, the manufacturing zone mainly depends on the skylights above for daylighting. To maximize the potential of the daylight, the ceiling and floor are all white in colour to bounce the maximum amount of light to every corner of the factory.

Daylighting Analysis in Office Zone

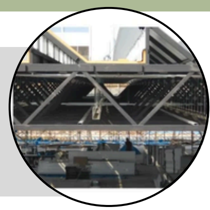


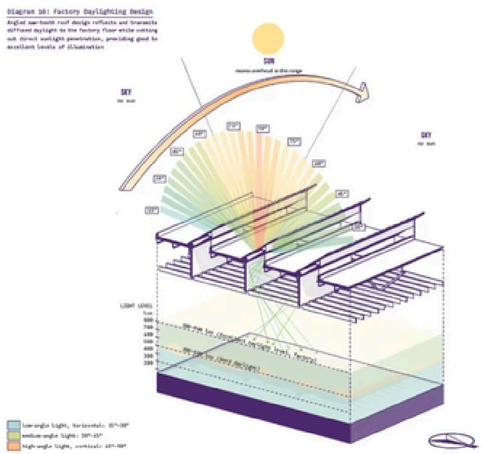
The vegetations along the facade help provides filtered daylight for the edge of the building where there is no skylight and increase view quality from the inside

3.1.2 ROOF DESIGN STRATEGY

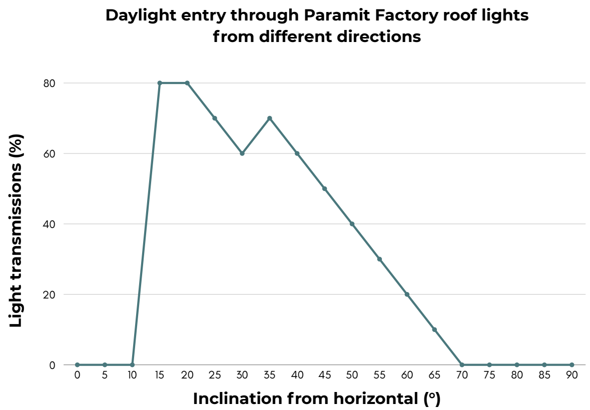


Function of deflector panels:
Deflector panels are used to diffuse the sunlight through of the entire year to prevent direct low angle sun





- The internal white colour deflector panels is a barrier which avoids the low-angle sun to penetrate and instead reflects the sunlight
- Achieving an evenly day-lit work environment without glare throughout the year
- The uniformity of luminance (400-700 LUX) is achieved and plays a huge role on workers' productivity and reduce energy consumption

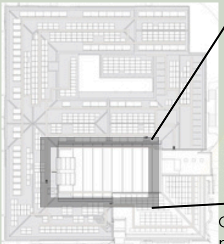


Raytracing simulation was done to analyse sun angle throughout the year to provide to best quality of daylight

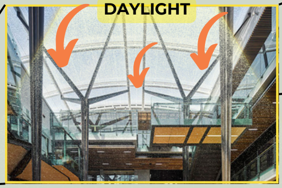
During certain months of the year, the sun angle can get as low as 15°

3.2.1 DAYLIGHTING ANALYSIS (Roofing and Shading Device Strategies)

Daylighting Analysis with ETFE Roof Panel



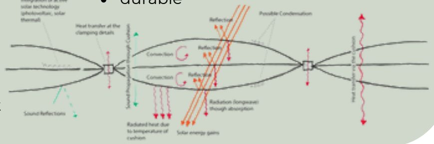
ETFE ROOF PANEL



Chosen for its translucent properties that maximize natural daylight within the space.

ETFE Advantages

- lightness
- high heat insulation
- high light transmission
- self-cleaning
- durable

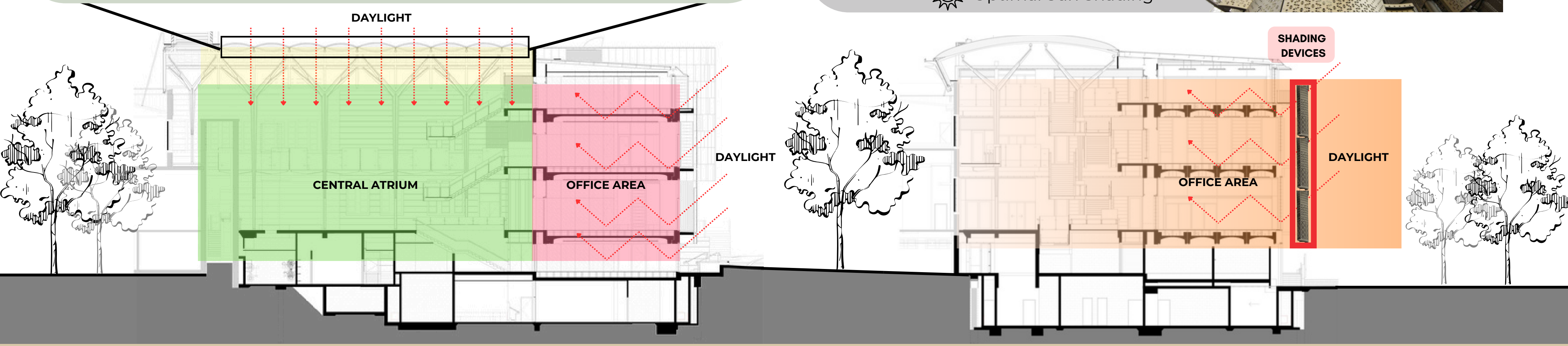


Daylighting Analysis with Shading Device

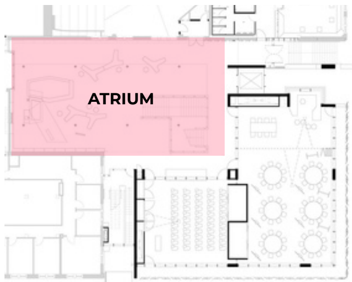
AUTOMATED LOUVRES

The building's operable sun-shading system, made of **custom perforated panels, automatically adjusts** throughout the day via discreet **sensors** and **motors**.

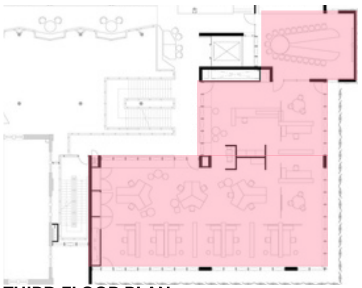
- Rain Protection
- Natural Ventilation
- Optimal Sun Shading



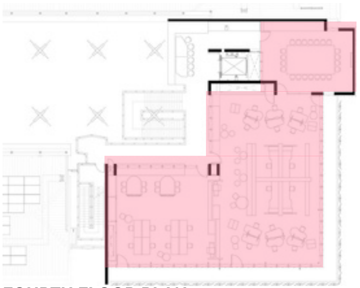
3.2.2 INTERIOR LAYOUT & SPACE PLANNING



SECOND FLOOR PLAN



THIRD FLOOR PLAN



FOURTH FLOOR PLAN

The atrium, serves as a gathering space for students.

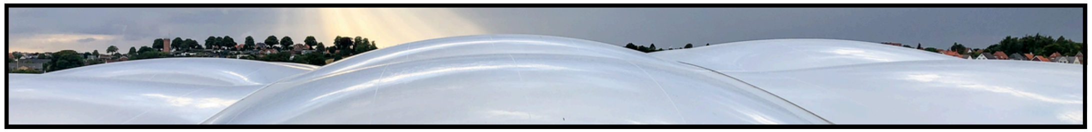
ETFE roof panel covers this area—its translucent properties allow abundant natural light to flood the space.

Classrooms are positioned around the building, around the windows to take full advantage of natural sunlight.

3.2.3 DAYLIGHTING STRATEGIES & MATERIALS

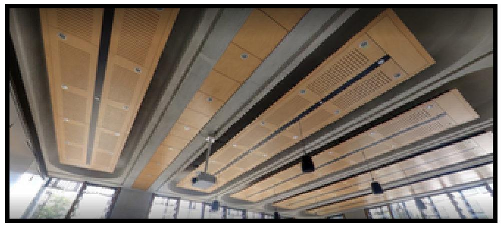
ETFE Atrium Roof

The GCI atrium roof features lightweight **Texlon® ETFE cushions** supported by aluminium frames and a steel substructure. Six triple-layer cushions with a printed dot matrix pattern diffuse daylight and reduce solar heat gain. ETFE offers UV transparency, durability, low maintenance, and a reduced carbon footprint, supporting energy-efficient design.



Smart Lighting Integration

Although not confirmed for GCI, many green buildings integrate daylight sensors and smart lighting systems (e.g., dimmable LEDs) to adjust artificial lighting levels based on the amount of incoming natural light.



3.3 COMPARATIVE ANALYSIS

PARAMIT FACTORY		GLOBAL CHANGE INSTITUTE
Sawtooth skylights with deflector panels to distribute daylight evenly	**ROOFING STRATEGY**	ETFE roof panels & automated louvres adjust sun shading dynamically
White deflector panels avoid glare and reflect diffused light	**LIGHT CONTROL**	Perforated panels and smart louvres for dynamic sun shading
Deep floor plans with skylights in manufacturing areas, vegetated facades for office zones	**INTERIOR LAYOUT**	Central atrium and distributed daylight through ETFE panels
White interior surfaces for light reflection	**DAYLIGHTING STRATEGIES & MATERIALS**	ETFE cushions supported by aluminum frames and smart lighting integration

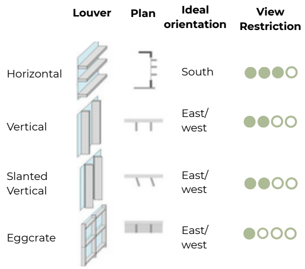
4.0 FACADE DESIGN

4.1.1 DOUBLE SKIN FACADE

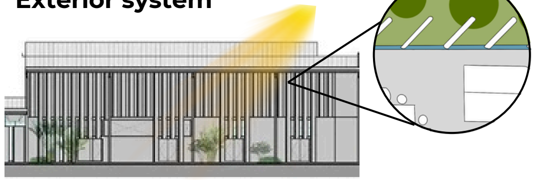
Concrete Fins & Glazed Curtain Wall

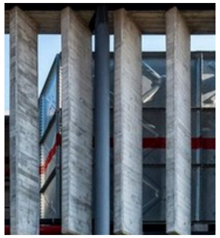
- **Concrete fins** and **full height glazed curtain wall** applied at the **manufacturing area**
- The curtain wall seals and encloses the interior space to create a more suitable environment for manufacturing process
- The louvers allow the workers to view to the green courtyard even in the enclosed manufacturing area

Sun shading- Fins angle

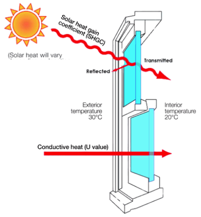


Exterior system

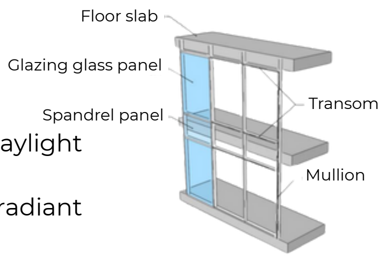




- The energy that absorbed by the fins will be radiation as heat at the exterior
- Solar gain is reduced inside the factory



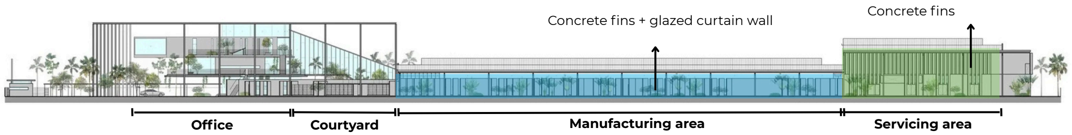
Function of glazed curtain wall: Maximizes natural light while mitigating solar heat gain



Performance:

- **Visible Light Transmittance (VLT):** 40–50% (optimal for daylight without glare).
- **Solar Heat Gain Coefficient (SHGC):** <0.3 (blocks 70%+ of radiant heat).

4.1.2 ORIENTATION

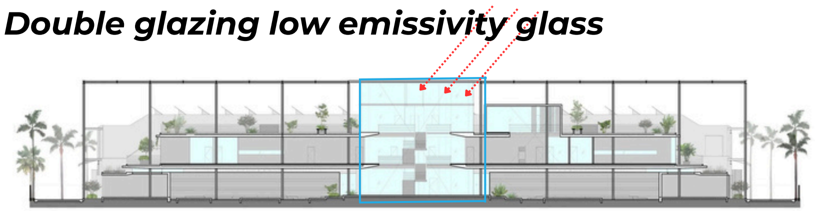


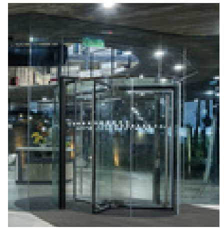
The free standing concrete fins are angled and installed at regular intervals at the north-west and south-east facades to shade the building's interior from low east and west sun

- To create a pleasant environment in the interior with partially captured daylight without glare all year
- At the building service area like water tank area, open facade is applied to allow for natural ventilation while blocking the sunlight

4.1.3 FENESTRATION (WINDOW DESIGN)

Double glazing low emissivity glass

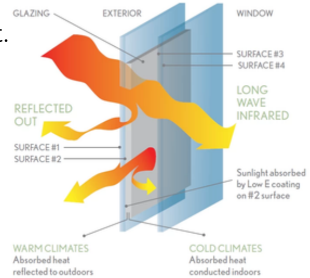




- Installed at all perimeters at the office

Low-E Action:

- Reflects 60–70% of IR heat while allowing 40–50% visible light.
- UV Blockage: 99% of UV rays (protects equipment/workers).



Natural Ventilation

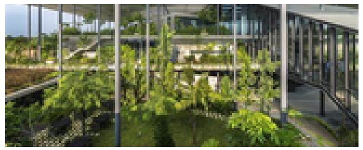
- Operable windows aid in cross-ventilation.
- Louvers in courtyards and public areas allow wind flow while preventing direct rain ingress

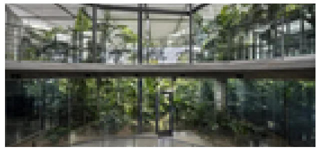
Connection to Nature

- Fenestration is arranged to frame views of vegetation and green roofs, part of the biophilic design.

Natural Lighting

- **North-facing sawtooth skylights** provide diffused, consistent daylight in production area, captures daylight from various angles, distributing it into the interiors.





4.1.4 TYPES AND MATERIALS

Concrete louver
Reinforced precast concrete that Integrated with glass curtain walls

Glass louver
Operable horizontal glass slats + Low-E Coated Glass

Aluminium louver
perforated aluminum panels made up ofAerotec Aluminium Sunshade Louvers

4.2.1 ENERGY EFFICIENCY (strategies)

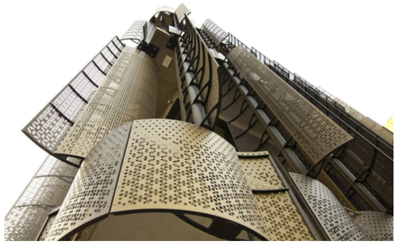
The GCI building's facade is designed to optimize **thermal performance**, **daylighting**, and **natural ventilation** while reducing energy consumption. Key sustainable features include:

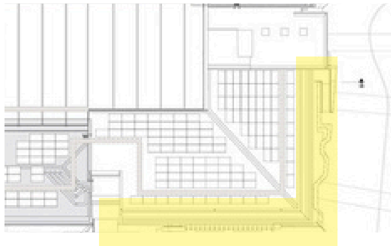
4.1.1.1 Bioclimatic design

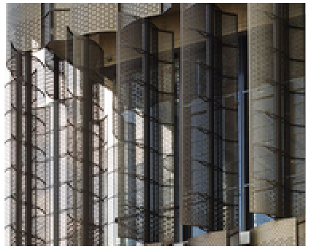
Orientation: North-South Elongation
The building's long axis runs **north-south**, which is optimal for Brisbane's subtropical climate because:

1. **Minimizes East/West Exposure**: Short east and west facades reduce low-angle morning/afternoon sun (harshest for heat gain).
2. **South Facade**: Uses minimal shading (lower sun angles are less intense) but maximizes natural light.

Shading Device







The **facade** plays a crucial role in reducing the building's energy demand:

- **Double-skin facade**: In some sections, this provides a buffer zone for thermal regulation.
- **Insulated panels**: High-performance materials reduce heat transfer.
- **Automated shading**: Adjusts dynamically to sun angles to minimize cooling loads.

Solar System

The facade works synergistically with active systems for net-positive energy performance:

- **138 kWp Photovoltaic System**:
  - **479 solar panels** (240W each) cover 948 m², generating 175,274 kWh/year (FUTURARC, 2014).
  - Excess energy feeds into the national grid.

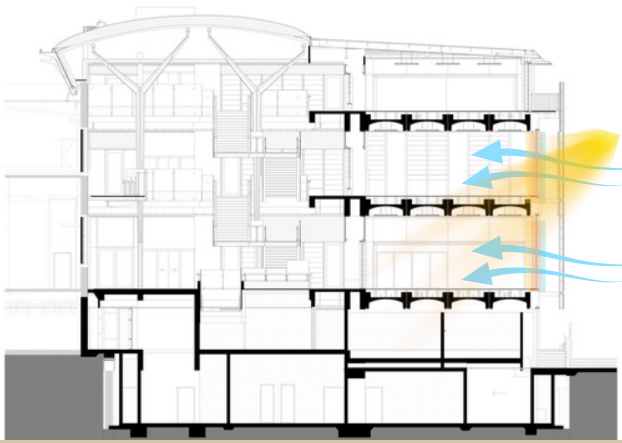
4.2.2 ORIENTATION

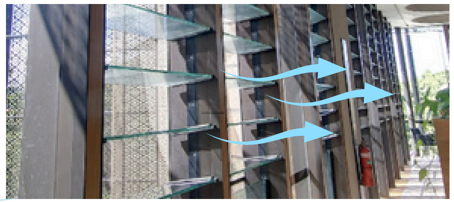
The building's north-south elongation optimizes solar control:

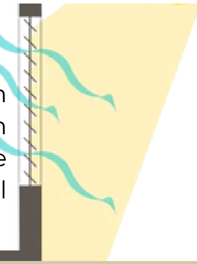
- **North Facade:**
  - Vertical louvers block summer sun but allow winter sun.
  - 40% glazing for balanced daylight.
- **East/West Facades:**
  - Minimal glazing (20%) to reduce low-angle sun penetration.
  - Living walls provide additional shading.
- **South Facade:**
  - Uses diffused glazing for even daylight without overheating.

4.2.3 FENESTRATION (WINDOW DESIGN)

- **High-performance glazing**: Low-e, double-glazed windows with argon gas filling reduce heat transfer.
- **Operable windows**: Allow natural cross-ventilation, reducing reliance on mechanical cooling.
- **Strategic window-to-wall ratio (WWR)**: Balanced to allow daylight without excessive heat gain.



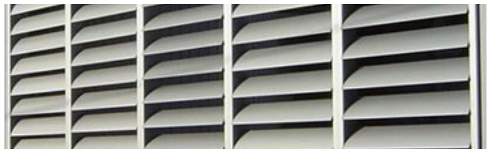




Louver blades can block direct sun from entering while allowing natural ventilation.

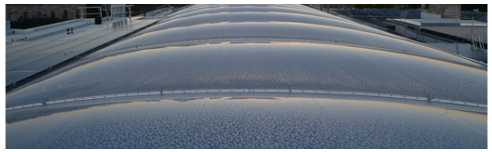
4.2.4 TYPES AND MATERIALS

Sustainable Aluminium Louvres: Perforated, anodised to mimic copper; sun-tracking for passive solar control.



Elliptical Ventilation Louvres: Enable sustainable natural airflow through thermal chimney.

Low-Carbon Geopolymer Concrete: Sustainable precast panels with integrated cooling.



ETFE Canopy: Lightweight, sustainable material allowing daylight and weather protection.

4.3 COMPARATIVE ANALYSIS

PARAMIT FACTORY		GLOBAL CHANGE INSTITUTE
Utilizes on double skin facade with Low-E glass	**ENERGY EFFICIENCY**	Emphasizes bioclimatic design with integration of solar panels and smart shading systems
Oriented to minimize east-west solar exposure, using concrete fins for shading.	**ORIENTATION**	Align north-south to optimize natural light and reduce heat gain with strategic facade treatments.
Low-E double glazing with operable windows and skylights for daylight and ventilation.	**FENESTRATION**	Argon-filled Low-E windows with optimized window-to-wall ratios for better insulation and airflow.
Utilizes concrete, aluminum louvers, and Low-E glass	**TYPES AND MATERIALS**	Utilizes sustainable materials like recycled aluminum, geopolymer concrete, and an ETFE canopy

5.0 NATURAL VENTILATION

5.1.1 BUILDING ORIENTATION

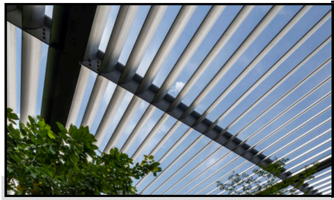
Penang's Climate: Hot, humid with two dominant wind directions:

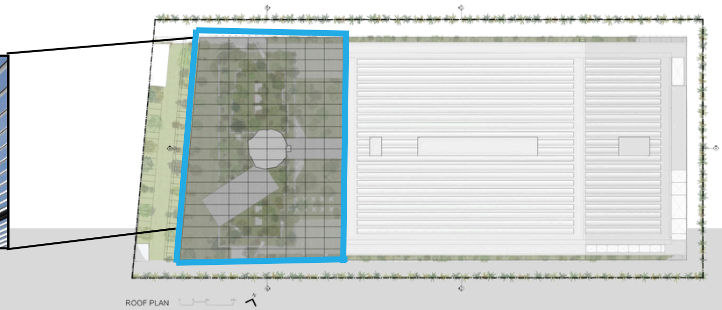
- **NE Monsoon** (Nov–Mar): Strong, cooling breezes from the northeast.
- **SW Monsoon** (May–Sep): Weaker winds from the southwest.

Long façades face NW-SE:

- Catch NE monsoon winds for cross-ventilation.
- Minimize direct sun exposure on east/west walls (reducing heat gain).

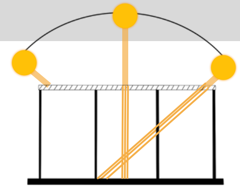
Canopy Roof





Covering one-third of the site at the courtyard and office area and shelters the parking area, roof gardens, and other external spaces below

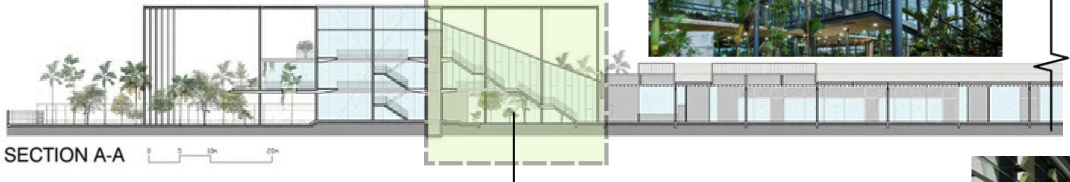
Angled louvers to provides effective solar protection during the hottest part of day allowing penetration of sunlight during morning hour, particularly blocking part of the direct east sun and fully block the direct west sun



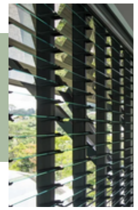
Hot air exits through the canopy roof, creating suction for ground-level airflow, allowing stack ventilation

5.1.2 VENTILATION STRATEGIES

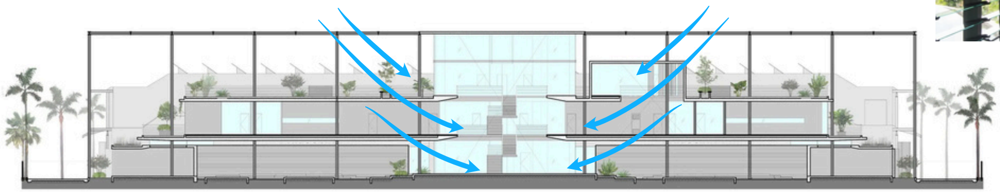
Adjustable glass louver



SECTION A-A



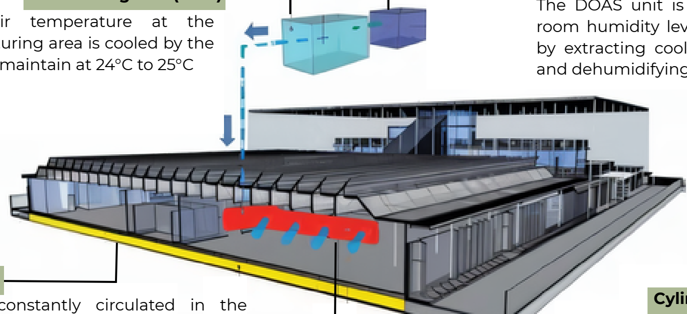
- Internal spaces in the courtyard (**link-bridge, cafeteria, locker room and corridor to manufacturing building**) are installed with adjustable glass louvres facing courtyard to allow for natural ventilation.



SECTION B-B

- Louvres window is more effective in capturing and redirecting the breeze into interior as it has larger opening area, can be **adjusted flexibly into various angles** to improve the indoor air circulation.

Active cooling in manufacturing area



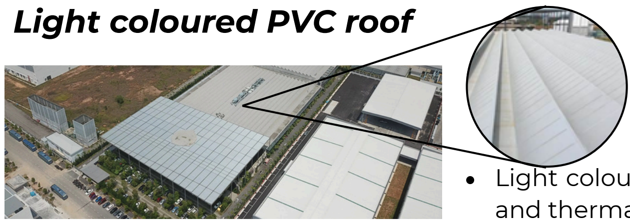
Air handling unit (AHU)
Room air temperature at the manufacturing area is cooled by the AHU and maintain at 24°C to 25°C

Dedicated outdoor air (DOAS)
The DOAS unit is used to maintain the room humidity level throughout the day by extracting coolness from exhaust air and dehumidifying outdoor air

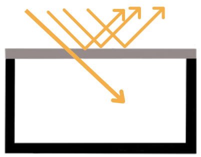
Chilled floor slab
Cool water is constantly circulated in the embedded pipes within the concrete floor slab to cool and maintain the floor at 20°C to 22°C

Cylindrical fabric air supply ducting
It is used to ensure even air distribution by minimizing cool spots, hot spots and draft below air grillers

Light coloured PVC roof



Sika Sarnafil PVC membrane installed on the roof for insulation purpose

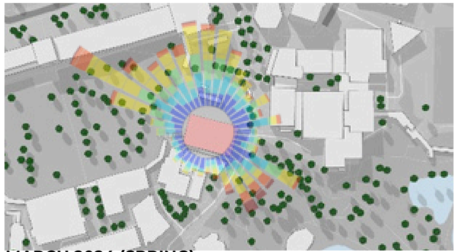


- Light coloured surface help in solar heat rejection and thermal insulation

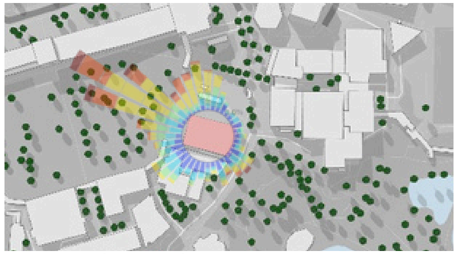
Low emissivity ceiling

- Machines in production space are constantly generating heat so it is cooled actively by chilled floor slab
- It reduces the cooling loss by radiation from the cooled floor to warm non-air conditioned ceiling space

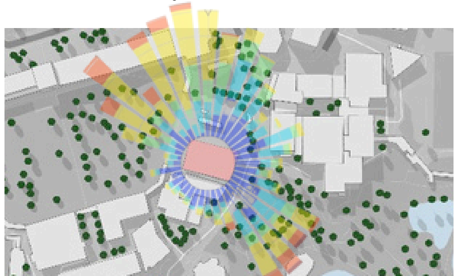
5.2.1 WIND PATH



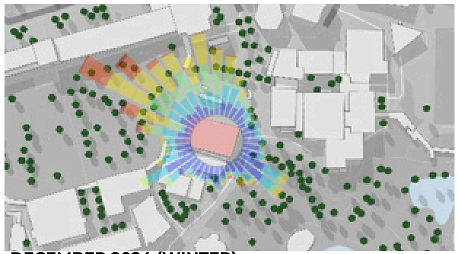
MARCH 2024 (SPRING)
Prevailing Direction
NW → N
Late-summer heat-lows + curved sea-breeze and storm outflows bring brisk NW-N flow.



JUNE 2024 (SUMMER)
Prevailing Direction
NW → N
Winter west winds from inland highs curve coastward as cool, dry NW-W winds.



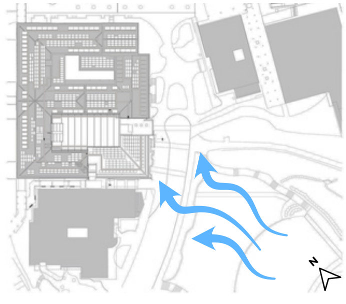
SEPTEMBER 2024 (AUTUMN)
Prevailing Direction
NW → N
"Spring west winds" + peak land-sea pressure gradient give year's punchiest NW-N winds.



DECEMBER 2024 (WINTER)
Prevailing Direction
NW → N
Early-summer sea-breeze veers to NW; storms mix momentum, so not as strong as spring.

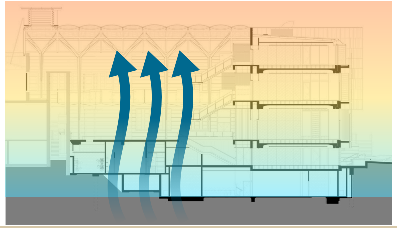
5.2.2 BUILDING ORIENTATION

The structure is generally aligned so that its longer façades face north and south, allowing it to capture prevailing breezes and promote effective cross-ventilation.



Openings on the north and south sides of the buildings allow natural ventilation to occur throughout the interior, as the prevailing winds typically come from the southeast.

- Differences in wind and temperature between the interior and exterior of a building generate pressure variations that promote airflow.



- In stack ventilation, warm air naturally rises, building up positive pressure at the top and drawing in cooler air below due to lower pressure at the bottom.

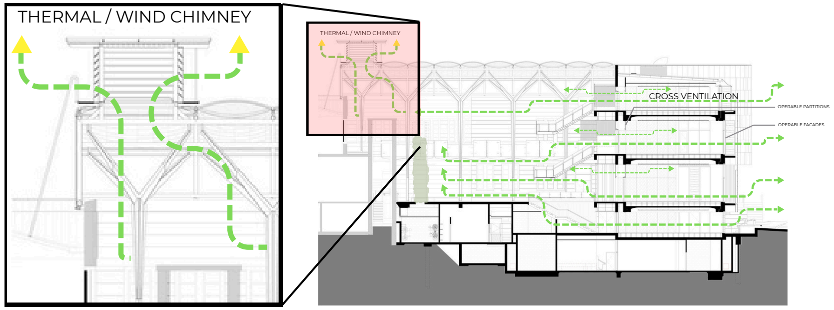
5.2.3 VENTILATION STRATEGIES

5.2.4 PRESSURE DISTRIBUTION

The Global Change Institute (GCI) employs smart ventilation strategies to suit Brisbane's subtropical climate. It combines passive and active systems to maintain indoor air quality and thermal comfort with minimal energy use.

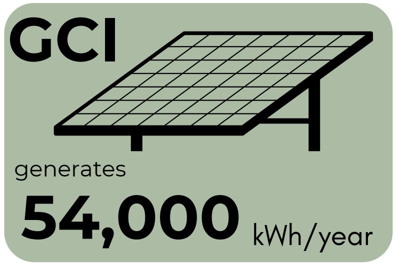
THERMAL CHIMNEY (STACK EFFECT)

- A central thermal chimney facilitates passive stack ventilation, drawing warm air upwards and out of the building while pulling in cooler air from lower levels.



SOLAR-POWERED VENTILATION

- The building's solar panels help power ventilation systems, reducing reliance on grid electricity.



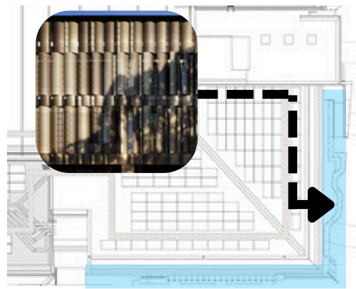
MIXED-MODE VENTILATION (NATURAL + MECHANICAL)

- The building uses a hybrid ventilation system, combining natural ventilation (operable windows, stack ventilation) with mechanical ventilation when needed.
- Automated windows and louvres adjust based on temperature, humidity, and CO_2 levels to maximize airflow.

AUTOMATED GLASS LOUVRES

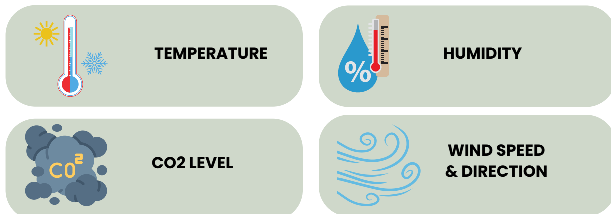
- Glass louvres on the northern façade allow adjustable airflow.

OPERABLE LOUVRES



- Some are user-operated (manual override), while others are fully automated.

Motorized, sensor-controlled glass louvres adjust in real-time based on:



5.3 COMPARATIVE ANALYSIS

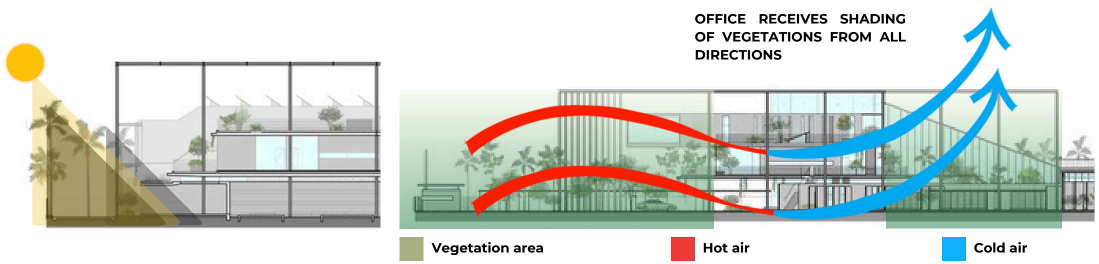
PARAMIT FACTORY		GLOBAL CHANGE INSTITUTE
Long façades face NW-SE to catch NE monsoon winds for cross ventilation	**BUILDING ORIENTATION**	Long façades face North-South to capture southeast breezes effectively
- Adjustable glass louvers facing courtyard - Canopy roof with angled louvers - Chilled floor slab cooling - Low emissivity ceiling	**KEY ELEMENTS**	-Thermal chimney for passive stack effect - Automated louvres - Solar-powered ventilation system
Cross Ventilation: Adjustable louvers direct wind into internal zones (cafeteria, corridors) **Stack Effect:** High canopy roof allows hot air to rise	**VENTILATION STRATEGIES**	**Cross Ventilation:** Automated louvres and windows manage airflow across internal spaces **Stack Effect:** Thermal chimney allows hot air rise and exits via it
Cooler ground air pulled into building via negative pressure	**PASSIVE AIR COOLING**	Passive draw of air via chimney + solar ventilation

6.0 STRATEGIC LANDSCAPING

6.1 STRATEGIC LANDSCAPING

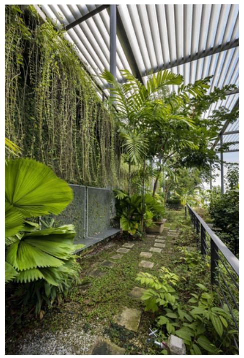
PARAMIT FACTORY
PENANG, MALYSIA

MICRO- CLIMATE

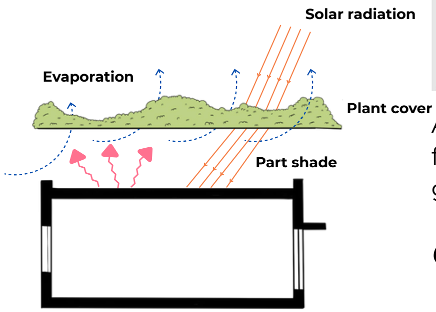


The forest located at the west side uses intense vegetations to shade walls and window against hot afternoon sun. Shading and evapotranspiration from vegetation reduces. Surrounding air temperatures as much as 5°C, creating a cooler environment. Since wind comes mainly from west, the wind brings the cooled air into deeper part of the building by cross ventilation reducing cooling load effectively

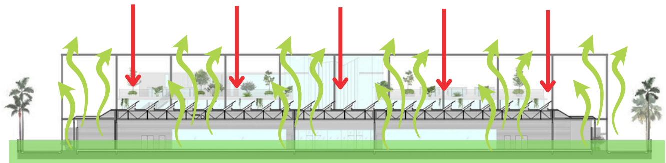
ROOF GARDEN



- The roof garden with evaporate deciduous plants and creeper brings down the temperature of roof and in turn reduce the solar heat gain at the office below
- An immovable air layer is created between foliage and the wall, thus reducing the exterior superficial thermal conductance coefficient.



SOFT SURFACE

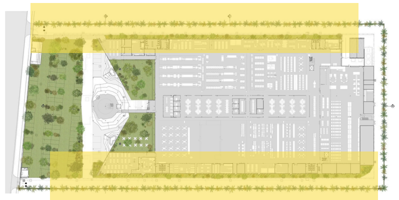


- The use or grasscrete to replace asphalt road is heat island effect
- Minimizing hard surfaces as they heat up during the day and the heat radiates back to the building at night
- Thus, sacrificing thermal comfort
- The office block is also covered by green roof to reduce heat transfer by conduction through the building envelope

TREES WITH HEAVY FOLIAGE

- Trees with heavy foliage planted along west facade are very effective in obstructing the sun's rays and casting a dense shadow.
- Dense shade is cooler than filtered sunlight. These vegetation's filter out the heat and glare from afternoon sun, providing thermal comfort.

SHRUBS



At north and south, shrubs are planted along the facade. These vegetations has smaller foliage in order to allow daylight to penetrate and provide views from inside to the lush greeneries outside, creating a biophilic working environment, which is rare in a factory.

COURTYARD

- Evaporation from the leaf surfaces brings down the temperature of the courtyard to a level than that of the daytime air temperature.
- Thus, around the courtyard, indoor-outdoor activities can be done under a comfortable environment with fresh air, environment with fresh air, which is rare in an industrial park.

The manufacturing zone has a direct view to the courtyard, creating a healthy working environment that seeks connectedness and reciprocity

6.2 LANDSCAPE STRATEGIC

SOFTSCAPE

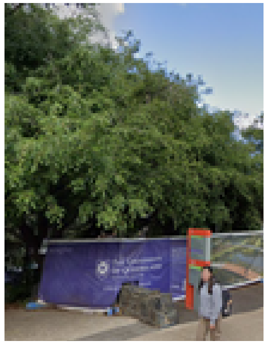
Trees location · Open grass area

Water

Ecological Sensitivity: A strong emphasis on using native Australian plants, particularly those indigenous to the Brisbane region (Yuggera and Turrbal Country). This supports local biodiversity, provides habitat and food sources for native wildlife (birds, insects, butterflies), and connects the building to its specific ecosystem.

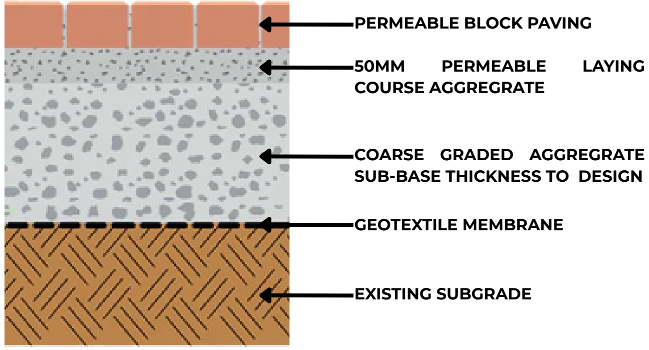
Low Water Use/Drought Tolerance: Native plants are naturally adapted to the local climate, meaning they require significantly less irrigation once established, conserving precious water resources in a region prone to droughts.

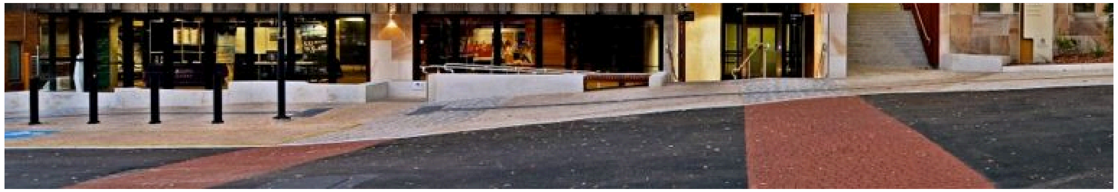
Low Maintenance: Being well-suited to the local conditions, native softscapes typically require less ongoing maintenance (e.g., less pruning, fewer pesticides), reducing resource consumption and chemical use.



PERMEABLE SURFACES

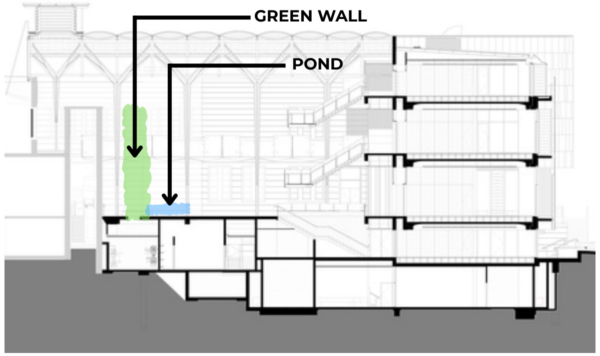
The use of permeable paving helps in stormwater management, allowing water to seep into the ground and reducing runoff.

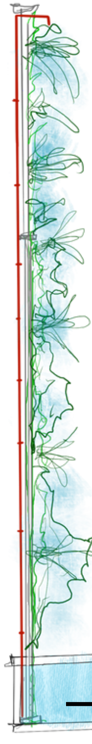




GREEN WALL & FISH POND

Vertical gardens on high solar exposure areas cool the building through evapotranspiration and shade, boosting energy efficiency by cutting mechanical cooling needs and aligning with GCI's carbon reduction goals.





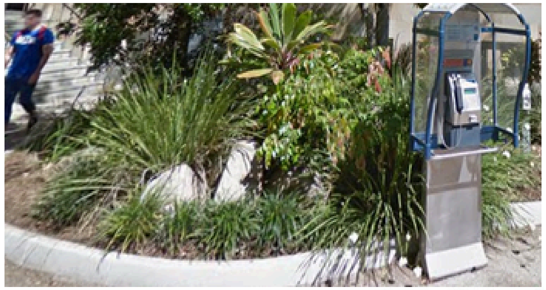
Air Filtration: Plants help to filter pollutants and volatile organic compounds (VOCs) from the air, improving indoor air quality.

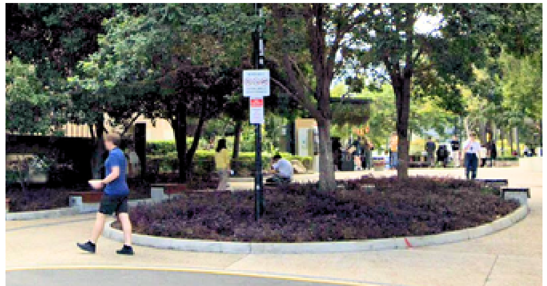
Thermal Regulation: Provides a cooling effect through evapotranspiration.

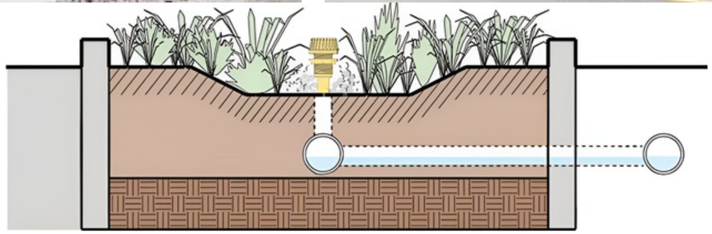
Biophilic Design: Enhances occupant well-being and connection to nature.

The pond acts as a retention basin, capturing and storing rainwater to manage stormwater runoff and enable water reuse within the building.

BIOSWALE SYSTEM







The Global Change Institute (GCI) at the University of Queensland integrates a bioswale system with native and drought-tolerant plant species as part of its sustainable landscape strategy. The bioswale captures and filters stormwater runoff, allowing it to be absorbed into the ground or reused within the building. Native and drought-tolerant plants surrounding the bioswale help reduce water usage and maintenance while enhancing biodiversity. Together, these elements support GCI's goal of creating a resilient, environmentally friendly campus that works in harmony with natural systems.

6.3 COMPARATIVE ANALYSIS

PARAMIT FACTORY		GLOBAL CHANGE INSTITUTE
Microclimate cooling via dense vegetation and shaded courtyards	**Primary Climate Strategy**	Integration with natural systems for thermal comfort and sustainability
Cross ventilation carries cooled air from vegetated zones into interior	**Thermal Comfort Features**	Evapotranspiration from green walls and landscaping reduces cooling load
Roof garden with deciduous plants and green roofs to reduce solar heat gain	**Roof Treatment**	Not specified
Central courtyard with trees cools space and supports indoor-outdoor activities	**Courtyard**	Pond and green wall for passive cooling and stormwater management
Native, low-maintenance softscapes adapted to local conditions	**Plant Selection**	Native Australian plants; drought-tolerant, low-irrigation needs
Vegetation supports biophilic design and reduces heat island effects	**Ecological Function**	Enhances biodiversity, air quality, and provides habitat for native fauna

7.0 CONCLUSION

The Global Change Institute (GCI) in Brisbane, Australia, and the Paramit Factory in Penang, Malaysia, both provide compelling but different blueprints for sustainable development.

The GCI, a "living building," is a prime example of innovative, ultra-low energy design in an institutional setting; its creative use of geopolymer concrete, natural ventilation, and smart systems demonstrates how state-of-the-art research can be translated into a carbon-neutral physical footprint, acting as an important "living laboratory" for sustainable construction.

On the other hand, the Paramit Factory, also known as "Factory in the Forest," demonstrates the power of biophilic design and smart architecture in an industrial setting. By seamlessly integrating extensive greenery, green roofs, and optimized daylighting, it dramatically lowers energy and water consumption while improving employee well-being and demonstrates how industrial spaces can coexist peacefully with nature.

In conclusion, the GCI and Paramit both show that green methods are not only achievable but also necessary. While Paramit demonstrates the innovative effects of incorporating nature and passive design into industry, the GCI promotes research-driven innovation and excellent institutional design. When taken as a whole, they demonstrate that a strong commitment to sustainability has a positive impact on the environment, enhances well-being, and establishes new standards for responsible development around the world.

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