PASSIVE GREEN BUILDING CASE STUDIES

HERIOT-WATT UNIVERSITY PUTRAJAYA, MALAYSIA

TRANSOCEÁNICA BUILDING SANTIAGO, CHILE

SITE PLANNING

LOCATION

1, Jalan Venna P5/2, Precinct 5, Putrajaya, Malaysia

CLIMATIC CONDITION

Tropical Rainforest Climate

High humidity, warm temperatures year-round (averaging 25–32°C)

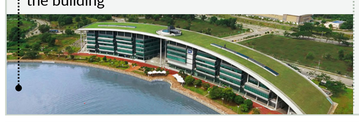
High Precipitation

Abundant rainfall with two distinct monsoon seasons

NATURAL WATER FEATURE

Front Facing Lake

The front facing lake contributes to cooling of the building

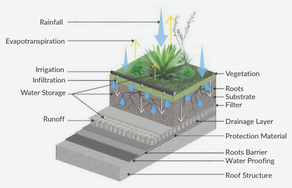


HOT WITH HIGH PRECIPITATION ALL YEAR-ROUND

01 Active Stormwater Management

Green Roof

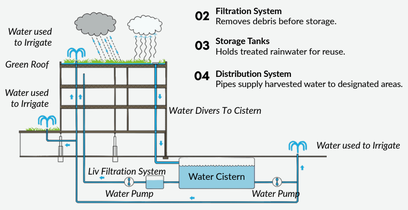
The green roof system effectively **manages rainwater** by absorbing, filtering, and storing it, while also incorporating **drainage** and **root protection layers**.



Waterproofing Layer

Low vapor diffusion releases moisture, blocks roots, and resists fire and radiant heat.

Rainwater Harvesting



01 **Roof Collection Surface**
Large roof area channels rainwater into gutters.

02 **Filtration System**
Removes debris before storage.

03 **Storage Tanks**
Holds treated rainwater for reuse.

04 **Distribution System**
Pipes supply harvested water to designated areas.

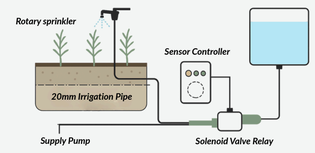
Irrigation System

Controller Signal – The timer/controller sends an electric signal.

Valve Activation – Solenoid opens, allowing water flow.

Valve Shutoff – Signal stops, solenoid closes, cutting water flow

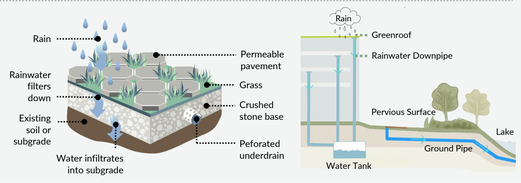
Water Distribution – Pressurized water reaches sprinklers

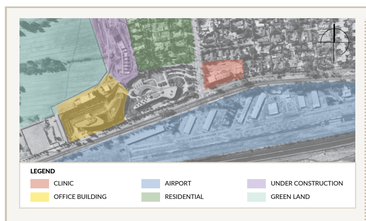


02 Drainage

Pervious Surface

01	Rainwater Falls on the Surface
02	Water Passes Through Surface Layer
03	Water Passes Through Surface Layer
04	Water Infiltrates the Soil
05	Excess Water Drains Off





LOCATION

Sta. María 5888, 7660268 Vitacura, Santiago Metropolitan Region, Chile

CLIMATIC CONDITION

Hot, Dry Summer

Temperatures up to 35°C with minimal precipitation

Cool, Wet Winter

Temperatures can drop to 0°C with high rainfall & precipitation.

TOPOGRAPHY

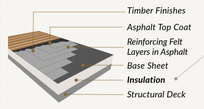
Sloped Terrain

Situated on sloped terrain, which poses a risk of soil erosion.

HOT, DRY SUMMERS

01 Roof System

Roofing with Insulation



Summer
keep the interior cooler by preventing heat from entering the building

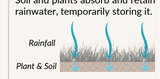
Winter
retain interior warmth by preventing heat from escaping.

Green Roof

The green roof above the underground parking absorbs **rainwater** and **insulates** to boost energy efficiency.

Absorbing Rainwater

Soil and plants absorb and retain rainwater, temporarily storing it.

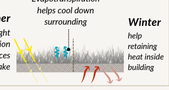


Providing Insulation

Evapotranspiration helps cool down surrounding

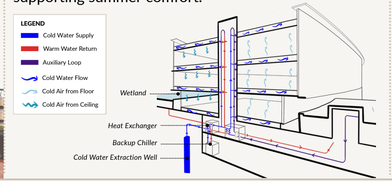
Summer *Sunlight absorption reduces heat intake*

Winter *help retaining heat inside building*



Geothermal Cooling

The building uses **12°C** water from a **75-meter-deep well** to pre-cool fresh air, reducing energy use and supporting summer comfort.

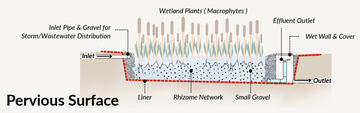


COOL, WET WINTERS

01 Stormwater Management

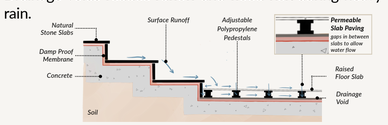
Artificial Wetland Lagoon

Artificial wetland **surrounds** the building, treating stormwater for irrigation and **reducing potable water use**.



Pervious Surface

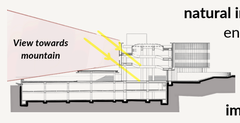
- Permeable paving materials enable **water infiltration**, **reducing** runoff and boosting groundwater recharge.
- Drainage voids **reduce runoff** and **flood risk** during heavy rain.



The building uses raised floor slabs with gaps, creating a permeable surface that allows water to flow through into the drainage void below.

SLOPED SITE ADAPTATION

Split-Level Design



The building adapts to the **natural incline** with offset floors, enhancing views, sunlight, and spatial integration while **reducing shadowing** and **improving** daylight access.

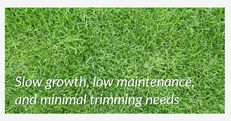
STRATEGIC LANDSCAPING

GREEN ROOF FUNCTION

Heriot-Watt University features a landmark **300m by 30m** green roof, the first of its kind in Malaysia, designed as a key part of its **sustainable strategy** to enhance aesthetics, reduce heat, improve insulation, and support water conservation through **rainwater collection**.

GRASS TYPE

The green roof is planted with Japanese Carpet Grass, a groundcover species selected for its adaptability to Malaysia's **tropical climate** and its functional advantages for rooftop landscaping.



GRASS MAINTENANCE

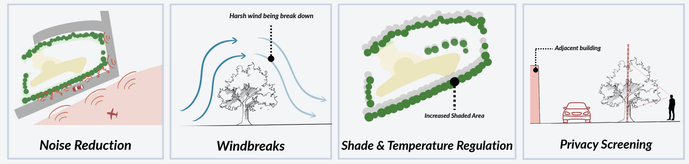
Grass maintenance keeps the green roof **healthy**, **prevents overgrowth**, and ensures **proper drainage** in Malaysia's tropical climate.

SURROUNDING LANSCAPING

Despite different plant palettes, both projects use trees with **large canopies**, dense foliage, and strong root systems to blend with their surroundings and **improve comfort** and **environmental quality**.

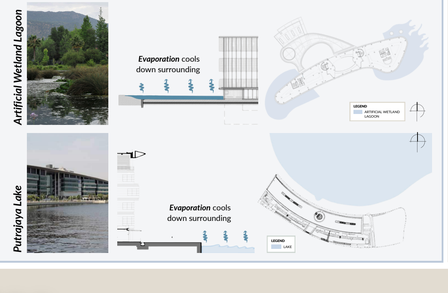
Environmental Buffer

Both projects use native, climate-adapted landscaping to provide key environmental buffer functions.



WATER FEATURES

Both projects use water features - **Putrajaya Lake** and an **artificial wetland lagoon**, not only for **flood control** and **biodiversity**, but also to enhance cooling through natural evaporation.



GREEN ROOF FUNCTION

The green roof is built above an **underground parking area**, cleverly disguising infrastructure and transforming it into a walkable, park-like space.

GRASS TYPE

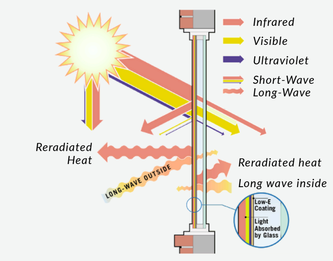
The building uses a **diverse mix** of native and adaptive grasses and groundcovers, carefully selected for their resilience in a **Mediterranean climate** and their functional roles in roof stabilization, temperature regulation, aesthetics, and biodiversity support.

FACADE DESIGN

GLASS FACADE

01 Low-E Glass

Blocks **60–70%** of heat, **reduces glare** and cooling demand, with curtains added where light needs limiting.



02 Window-to-Wall Ratio

70%

70% window-to-wall ratio maximises natural light with a glass-dominated facade.

SHADING SYSTEMS

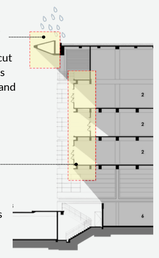
01 Massing & form

Overhang Roof

Shades windows to cut heat and glare, allows airflow even in rain, and shields walls from weather damage.

Offset Floors

Self-shading upper floors reduce heat gain, while floor gaps enhance natural cross-ventilation.



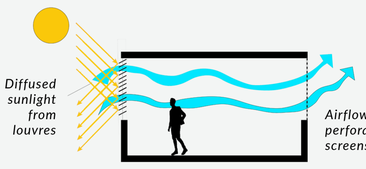
02 Screens & Louvers

Perforated Screens

- Diffuses light, reduces glare.
- Allow **ventilation** for thermal comfort
- Modern, decorative touch to facade

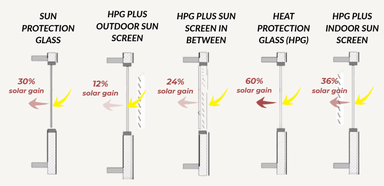
Aluminium Louvers

- Allows **airflow** for HVAC/ducting systems.
- Shields M&E equipment from rain/debris.
- Permits maintenance while maintaining aesthetics.



GLASS FACADE

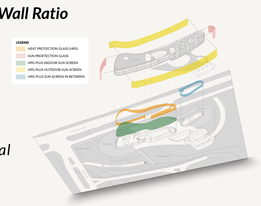
01 High-Performance Glazed Curtain Walls



02 Window-to-Wall Ratio

80%

80% window-to-wall ratio maximizes natural light, offers expansive views.

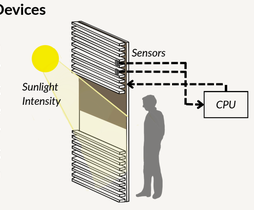


SHADING SYSTEMS

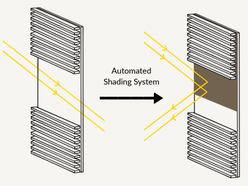
01 Screens & Louvers

Automated Shading Devices

Adjust based on **sunlight intensity** and **angle**, allowing for more **precise control** of light entry and optimizing performance for both **summer** and **winter**.

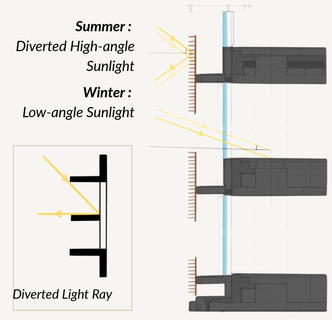


High-performance glazing admits light while **filtering heat** and **UV**, enhancing comfort and reducing cooling load.



Quiebravista Woodscreen 85 by Hunter Douglas

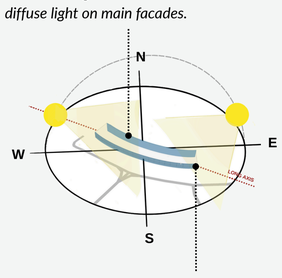
The Quiebravista Woodscreen 85 features horizontal wooden slats on aluminum supports for **sun shading**.



DAYLIGHT

TROPICAL CLIMATE ADAPTATION

*The building's **north-south** axis **maximizes** diffuse light on main facades.*



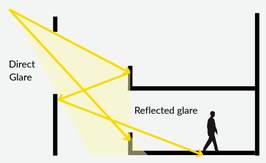
***East** & **west** facades receives **strong** low-angle **sunlight** in the **morning** and **afternoon**.*

Designed to handle the **tropical** climate, it focuses in capturing **diffuse light** on the main **north-south** facade, avoiding **direct sunlight** on the **east-west** facade.

DAYLIGHTING MECHANISM

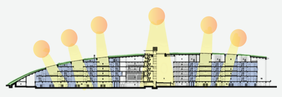
01 High Windows

Captures **low-angle sunlight** near the ceiling to distribute **light deeper** inside while **minimizing glare**.



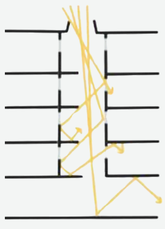
02 Skylight

Brings **natural sunlight** into interiors and the atrium, **reducing** daytime reliance on **artificial lighting**.



03 Lightwells

The **skylight** channels daylight into the **light well**, where reflective surfaces and selective glazing enhance and distribute illumination.

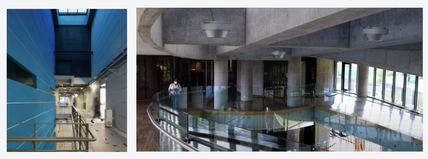


Well geometry (height and reflectance) **controls** light depth, while the combined system **improves daylight delivery** beyond individual components.

MATERIAL REFLECTANCE

01 Light-Colored Materials

Both buildings utilize **light-colored** materials to enhance natural **light distribution** within the interior, minimizing the need for artificial lighting and **reducing** indoor **heat** absorption.



Light Reflectance Value (LRV)

Night Blue — *LRV 12*

Grey — *LRV 21*

Blue and light grey have **high LRV**, so they **reflect** more sunlight and help **reduce** heat absorption indoors.

*Reflects approximately **70-80%** of sunlight*

TEMPERATE CLIMATIC ADAPTATION

*The building's **long axis** runs north-south to maximize solar access*

***North-facing** facades receive **consistent sunlight**, especially in winter when the sun is lower.*

***South-facing** facades support passive heating by admitting solar radiation during colder months.*

Adapts to the temperate climate, it focuses on **capturing direct light** on north-south facade to optimise solar energy.

DAYLIGHTING MECHANISM

01 Extensive Use of Glass Facade

80% of the facade is **glass**, mainly on the north and south sides, to **maximize** winter sunlight and natural lighting.

*Original **full glass** facade designed to maximize natural light.*

***Shading** added to block direct sunlight, reduce heat, and improve comfort while keeping daylight.*

02 Central Atrium

*The building has **two** main wings connected by a **central atrium** that acts as a **light well**, bringing daylight into the core.*

03 Open Plan

Fewer interior walls reduce dark zones, **maximize daylight**, and enhance visual comfort and spatial flow.

VENTILATION

WIND PATTERN

Putrajaya has two monsoon seasons: the Northeast Monsoon (Dec–Mar) with winds from the **NE**, and the Southwest Monsoon (Jun–Sep) with winds from the **SW**. Winds typically range from 5–20 km/h, with occasional gusts up to 30 km/h during seasonal shifts.

CROSS VENTILATION

Building is oriented and gently curved toward prevailing SW winds

STACKED VENTILATION

Vertical voids expel warm air, pulling in cool air from courtyards, while **open staircases** and **perforated landings** improve cross-ventilation, reducing indoor temperatures by 3–5°C with 6–12 air changes per hour.

ACTIVE VENTILATION

01 District Cooling System (dcs)

Supplies **chilled water** efficiently, cutting energy use and environmental impact.

02 Variable refrigerant flow (VRF)

Adjusts **refrigerant flow** for zoned **heating/cooling** and energy efficience

WATER INTEGRATION

Both buildings integrate **water features** as part of their natural cooling strategies, utilizing **surrounding water** sources to enhance cooling and regulate the indoor climate through **evaporative** processes.

WIND PATTERN

The **dominant** winds come from the **west** (W) and **southwest** (SW), with speeds mainly ranging from **5-10 km/h**, and occasional gusts from west-southwest (WSW) reaching **10-20 km/h**.

STACKED VENTILATION

A **full-height atrium** acts as a thermal shaft, drawing **light** and enhancing **ventilation** through natural temperature and pressure differences, reducing mechanical cooling needs.

CROSS VENTILATION

The building's **open-plan layout** and **operable windows** enable **natural cross ventilation**, ensuring steady air circulation and reducing reliance on **mechanical cooling** during moderate weather conditions.

ACTIVE VENTILATION

The geothermal system uses **12°C** well water to pre-cool fresh air, reducing energy use and supporting passive cooling

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