Green Strategies for Building Design Reflective Write-Up

ZEB BUILDING, SINGAPORE

GREEN SCHOOL, BALI

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1.0 Introduction

1.1 ZEB Building, Singapore

The Zero Energy Building (ZEB) in Singapore is a sustainable research facility designed to **achieve net-zero energy use**. It combines passive design strategies such as natural ventilation, sun shading, and green landscaping with active systems like solar panels and energy-efficient lighting. ZEB demonstrates how **technology and climate-responsive design** can work together in a **tropical environment,** making it a practical reference for my project.

1.2 Green School, Bali

The Green School in Bali showcases a **low-impact, open-air design** using bamboo and natural materials. Built around the site's landscape, it relies on natural lighting, ventilation, and vegetation instead of mechanical systems. Its architecture **blends with nature** and **offers strong inspiration for passive strategies** in **tropical climates.**

2.0 Site Planning

2.1 ZEB Building, Singapore

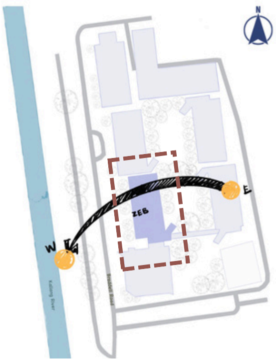

Figure 2.1.1 Building Orientation

The Zero Energy Building (ZEB) demonstrates a highly disciplined approach to site planning, where **climate-responsive orientation** plays a key role in its energy performance. Located in Singapore's hot-humid tropical climate, the building is aligned along the **east-west axis.** This minimizes solar exposure on the longer facades and reduces internal heat gain, since the most intense solar radiation in tropical regions comes from the east in the morning and west in the late afternoon.

Figure 2.1.2 Buffer Zones

Beyond just orientation, the building integrates buffer zones—such as corridors, service areas, and staircases—on the facades most exposed to sun, acting as thermal barriers. These not only reduce direct solar heat entering the internal spaces but also help lower the building's dependence on artificial cooling. The building footprint is compact and efficiently placed on a flat urban plot, but what stands out is the precise planning to optimize solar control and airflow access.

2.0 Site Planning

2.2 Green School, Bali

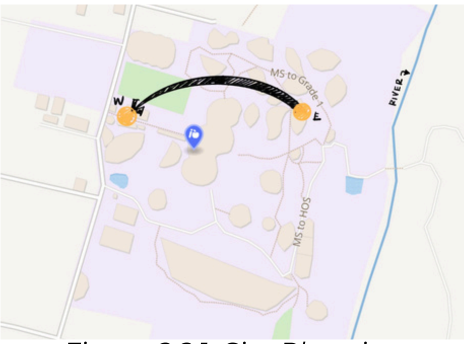

Figure 2.2.1 Site Planning

In contrast, the Green School's site planning is **organic, immersive, and context-sensitive**. Built in a lush jungle setting with uneven terrain and a river running through the site, the school's masterplan is guided by **natural features rather than imposed geometry**. Buildings are designed around **existing trees**, elevated on bamboo stilts to avoid ground flooding, and carefully placed to maintain **natural water flow** and avoid disrupting the ecology.

Figure 2.2.2 Aerial view of Green School, Bali, showing its integration with existing vegetation and natural site contours. The buildings are planned around trees, adapting sensitively to the tropical rainforest context.

Circulation paths in the school meander around trees and slopes, giving a strong sense of **spatial discovery and connection to nature**. Instead of clearing land or reshaping the site, the Green School adapts to it, promoting **ecological sensitivity and landscape preservation**. This approach reflects a deep respect for place and environment, which I find meaningful and inspiring for my own project.

2.3 Application

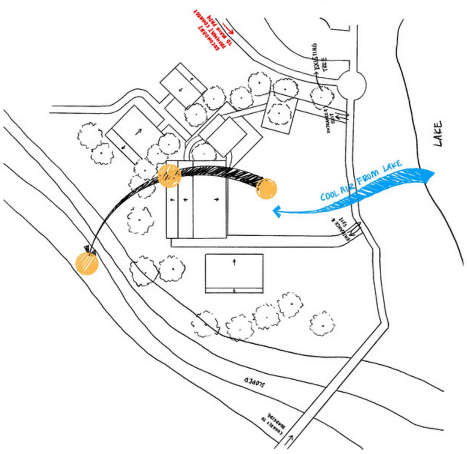

Figure 2.3.1 Building Plan

In my recreational hub design, the orientation of the building follows an **east-west alignment**, mainly to connect directly with the site's existing entrance and circulation path. While this exposes the longer façades to morning and evening sun, I addressed this by incorporating **deep roof overhangs, timber shading screens, and vegetation buffers** to reduce direct solar heat gain.

The overall site layout preserves the **natural slope and mature trees**, allowing the building to sit lightly on the land. The **main platform is slightly elevated** to support drainage and improve air movement beneath the structure. A key design gesture is the **roofless deck built around an existing tree,** which becomes a shaded gathering point and a symbolic connection to nature.

Circulation throughout the site is designed to be **organic and gentle**, curving around natural elements instead of cutting through them. Buildings are spaced strategically to promote **cross ventilation and visual openness,** supporting a passive and breathable environment across the site.

3.0 Daylighting

3.1 ZEB Building, Singapore

Figure 3.1.1 Light Shelf

Figure 3.1.2 Light Pipe

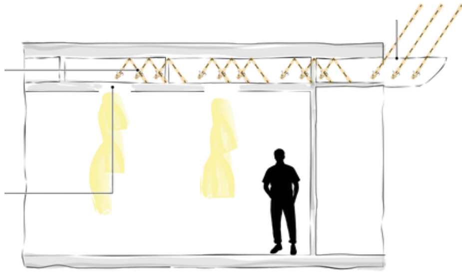

Figure 3.1.3 Light Pipe

The ZEB building in Singapore adopts several passive daylighting strategies to ensure well-lit interiors while minimizing energy use. One key feature is the **light shelf**, a horizontal surface placed above windows to reflect sunlight onto the ceiling. This helps daylight travel deeper into the space while reducing glare and heat.

Another strategy is the use of **light pipes**. These are reflective tubes that collect daylight from the roof and direct it into interior areas without external openings, such as corridors and toilets. A diffuser at the end of the pipe spreads the light evenly across the space.

ZEB also uses **mirror ducts**, which are reflective channels installed along the ceiling to carry daylight horizontally from outer walls into deeper zones. Together, these systems show how daylight can be carefully directed into enclosed areas through simple but effective passive technologies.

3.2 Green School, Bali

Figure 3.1.2 Roof ridge Openings

The Green School in Bali relies on an open and nature-integrated approach. Its **open-sided pavilions** allow daylight to enter freely from multiple directions, removing the need for artificial lighting during the day.

Daylight also enters from above through **roof ridge openings** and **translucent roof panels**, such as polycarbonate strips. These elements brighten central areas, even when surrounded by trees or shaded conditions.

The use of **light-toned natural materials**, like bamboo and thatch, helps reflect daylight softly throughout the interior. This creates a calm, naturally lit environment while strengthening the connection between users and their surroundings.

3.3 Application

My recreational hub is a **semi-open workshop space** designed to activate a quiet area of the park while blending with the natural environment. To support this, the building is **not fully enclosed**, allowing daylight to enter freely and reducing the need for artificial lighting.

The **roof structure is timber**, paired with **metal roofing** for weather durability. To bring in overhead daylight, I inserted **polycarbonate panels** in selected roof sections, especially above shaded or central zones. This creates soft, diffused lighting throughout the day.

Inspired by ZEB, I applied **curtain walls on non-sun-facing façades** to allow natural daylight into more enclosed spaces like the quiet zone, without overheating the interior. Following Green School's open-air concept, the **workshop and seating areas are open-sided,** allowing light to flow in from multiple directions. This enhances visibility and creates a comfortable, naturally lit environment.

Lastly, a **roofless platform around an existing tree** near the entrance provides a well-lit outdoor space that celebrates direct sunlight and natural shade. By combining **transparent roofing, curtain walls, and open-sided spaces**, my design brings in daylight effectively while responding to Malaysia's tropical climate and preserving a strong connection to nature.

4.0 Facade Design

4.1 ZEB Building, Singapore

Figure 4.1.1 Low-e Glass

Figure 4.1.2 Louvers

Figure 4.1.3 Overhang Roof

Figure 4.1.4 Green Wall

The ZEB building employs a well-considered facade system tailored to Singapore's tropical climate. Its **energy-efficient glazing (low-E glass)** reduces solar heat gain while allowing daylight penetration. The facades also integrate **horizontal and vertical louvres** on east and west sides to **block harsh sunlight** while maintaining ventilation.

To complement this, **roof overhangs** provide additional shading for windows and entrances, minimizing solar exposure. Another sustainable feature is the use of a **green wall**, which helps cool the external surface and reduces ambient heat, especially on sun-exposed facades.

4.2 Green School, Bali

Figure 4.2.1 Open-air facade system

Figure 4.2.2 Overhang Roof

Figure 4.2.3 Bamboo Screen

The Green School embraces an **open-air facade system** with minimal enclosure. Most buildings are designed with **no solid walls,** using **bamboo screens, deep roof overhangs,** and **elevated floor levels** to shade and protect users from the tropical climate. The façades are porous, encouraging cross ventilation and constant connection with the outdoor environment.

Rather than filtering sunlight through glass or shading devices, the Green School relies on **spatial openness** and **material porosity** to **manage light, airflow, and thermal comfort naturally.**

4.3 Application

For my recreational hub, I applied a hybrid facade strategy. On facades **facing direct sunlight** (east and west), I installed **timber louvre screening** to **filter intense sunlight, prevent rainwater from entering, and maintain ventilation**. These screens serve both environmental and protective functions.

In more enclosed areas like the quiet zone, I used **curtain walls** on the north and south sides to bring in natural daylight without excessive heat gain. I also added **adjustable louvre windows** to allow airflow while offering shading control.

To enhance weather protection, I designed **roof overhangs** over transparent and open zones. Meanwhile, the **workshop and seating areas** maintain **open facades**, reflecting Green School's natural, breathable interface between indoors and outdoors.

Lastly, I also introduced green wall to soften the hard surface, reduce heat absorption, and visually connect the building with the park's greenery.

This combination creates a facade that filters sunlight, protects from rain, and strengthens the connection to nature.

5.0 Natural Ventilation

5.1 ZEB Building, Singapore

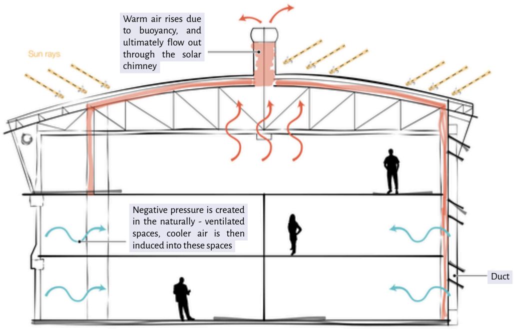

Figure 5.1.1 Stack Ventilation

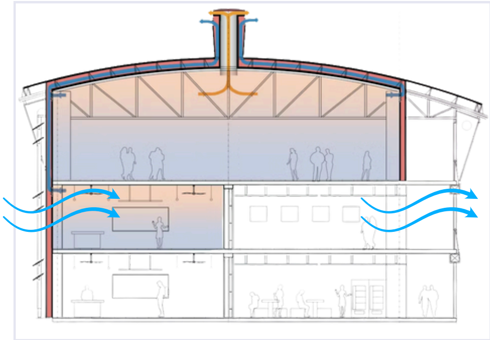

Figure 5.1.2 Cross Ventilation

ZEB uses a **combination of cross-ventilation and stack ventilation** to reduce reliance on mechanical cooling. One of its key passive strategies is the **solar chimney,** a vertical shaft designed to enhance airflow by creating a pressure difference. As warm air rises within the chimney, it pulls cooler outdoor air into the building, promoting continuous air circulation, even in enclosed spaces.

In addition, ZEB features **automated windows and ventilated corridors,** which allow natural breezes to flow through the building. These systems are integrated into the façade and roof design, enabling indoor spaces to remain thermally comfortable while minimizing energy consumption.

5.2 Green School, Bali

Green School achieves full natural ventilation through its **open-air layout** and **minimal enclosure.** The use of **open-sided structures, high-pitched roofs, and raised floors** allows wind to move freely throughout the spaces. Wide eaves and overhangs protect users from rain while allowing uninterrupted airflow.

The building orientation and openness work with the site's natural wind direction, maintaining air circulation and comfort throughout the day without mechanical systems.

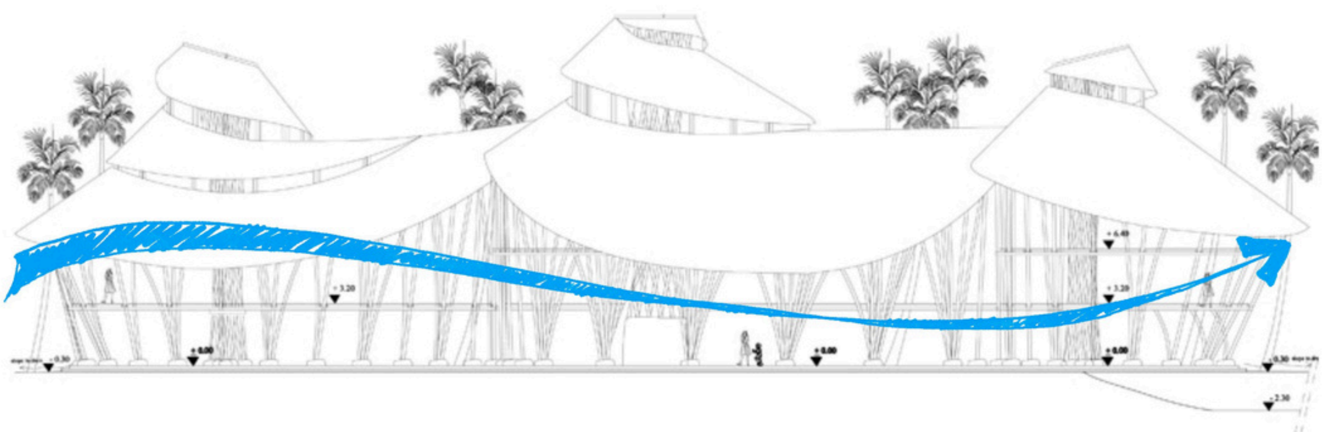

Figure 5.2.1 Cross Ventilation

5.3 Application

In my recreational hub, I applied similar principles to support **natural airflow** in Malaysia's tropical climate. The **workshop and seating areas** are designed with **open facades**, but even when closed, they remain ventilated thanks to **large pivot doors.** These can fully open to transform enclosed zones into **semi-open spaces,** supporting flexible use and cross-ventilation.

For enclosed zones like the **quiet area,** I used **adjustable louvre windows** and **operable curtain walls.** These openings are placed in line with the natural wind path to promote passive cooling.

Inspired by the **solar chimney**, I designed a **clerestory roof with ventilated gaps,** allowing **hot air to escape** from above while drawing in cooler air below. This stack effect improves indoor comfort and maintains airflow throughout the hub naturally.

6.0 Strategic Landscaping

6.1 ZEB Building, Singapore

Figure 6.1.1 Green Roof

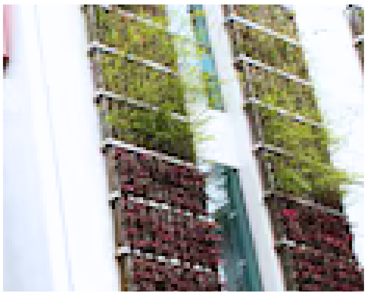

Figure 6.1.2 Green Wall

Figure 6.1.3 Existing Tree

ZEB integrates **landscaping as part of its green building system**, not just as aesthetic enhancement. It features a green roof that reduces solar heat gain, supports stormwater management, and provides thermal insulation for the spaces below.

The building also includes a **vertical green wall,** which shades the façade and cools the surrounding air through evapotranspiration. Additionally, **existing mature trees** are preserved and integrated into the site layout to provide natural shading, reduce ambient temperatures, and soften the building's edges.

These landscape elements work together to support cooling, reduce energy use, and improve the microclimate around the building.

6.2 Green School, Bali

At the Green School, landscaping is fully intertwined with the architecture. The campus is built around **existing vegetation**, using **trees and natural landforms** to define space. Buildings are nestled among trees, and the use of natural materials strengthens this integration.

Shading is provided not just by roof structures but by the **tree canopy itself**, reducing heat while maintaining a strong indoor-outdoor experience.

6.3 Application

My recreational hub sits within a park, so I **prioritized preserving existing trees** and shaping the building around them. These trees provide **natural shading** to the open seating zones, pathway, and especially the **roofless timber platform,** enhancing comfort while reducing solar heat gain.

Inspired by ZEB's green wall, I introduced a **vertical planting system** on a sun-exposed façade near the entrance. It cools the surface, adds visual softness, and improves air quality near the entry point.

Additionally, I incorporated **planter boxes as railings** along the circulation deck and balcony edges. These not only act as **safety barriers,** but also bring **greenery closer to users,** improving the microclimate and enhancing the spatial experience. The greenery reduces reflected heat and blends the architecture with its natural setting.

Altogether, by combining **tree preservation, vertical planting, rooftop greenery, and planter-integrated railings,** my landscaping strategy supports passive cooling, environmental comfort, and biophilic design for a tropical climate.

7.0 Conclusion

This reflective process has strengthened my understanding of how green strategies can shape meaningful, climate-responsive architecture in tropical environments. Studying ZEB in Singapore and the Green School in Bali offered two different yet inspiring perspectives. ZEB with its advanced systems like solar chimneys and green façades, and Green School with its open-air, nature-integrated design.

Applying these ideas in my own recreational hub helped me make more thoughtful design decisions from louvred façades and adjustable openings to green walls and rooftop planting. These strategies not only enhance user comfort but also reduce environmental impact.

Personally, this process has made me more aware of how architecture can coexist with nature while still meeting human needs. It has inspired me to continue exploring sustainable design in future projects. Hopefully, I will have the chance to visit these case study buildings in person one day—to experience the spaces firsthand and deepen my connection to the ideas behind them.

8.0 References

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