KURDISTAN ENGINEERING UNION

SUSTAINABLE ARCHITECTURE

Green Roofs
An urban agricultural opportunity

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Sustainable architecture refers to the practice of designing buildings which create living environments that work to minimize the human use of resources. This is reflected both in a building's construction materials and methods and in its use of resources, such as in heating, cooling, power, water, and wastewater treatment.

The operating concept is that structures so designed "sustain" their users by providing healthy environments, improving the quality of life, and avoiding the production of waste, to preserve the long-term survivability of the human species .

Hunter and Amory Lovins of the Rocky Mountain Institute say the purpose of sustainable architecture is to "meet the needs of the present without compromising the ability of future generations to meet their own needs."

The term, however, is a broad one, and is used to describe a wide variety of aspects of building design and use. For some, it applies to designing buildings that produce as much energy as they consume. Another interpretation calls for a consciousness of the spiritual significance of a building's design, construction, and siting. Also, some maintain that the buildings must foster the spiritual and physical wellbeing of their users.

One school of thought maintains that, in its highest form, sustainable architecture replicates a stable ecosystem . According to noted ecological engineer David Del Porto, a building designed for sustainability is a balanced system where there are no wastes, because the outputs of one process become the inputs of another. Energy, matter, and information are cascaded through connected processes in cyclical pathways, which by virtue of their efficiency and interdependence yield the matrix elements of environmental and economic security, high quality of life, and no waste. The constant input of the sun replenishes any energy lost in the process.

Millennials who live in the cities find it difficult to relate to stories shared by the older gen-eration. As elders of the family walk down the memory lane and get nostalgic, the current generation draws up a blank. Most of these stories relate to the open areas and green spaces that stretch as far as eyes could see. Cities are breeding grounds for opportunities and growth. However, they are also places where one could only see tall buildings and vehicles.

Though people migrate to cities for a better life, it is natural to connect with their roots. One such ingenious idea is the green roof concept. Though this idea has been in use since the Hanging Gardens of Babylon, it has become one of the most sought-after designs in the past two decades.

The extensive green roof system is a layered system in which an owner does mini-mum intervention and lets the vegetation grow like they do in the wilds. The roof space with an extensive green roof system is not for recreational activities. However, they are for non-accessible terrace space.

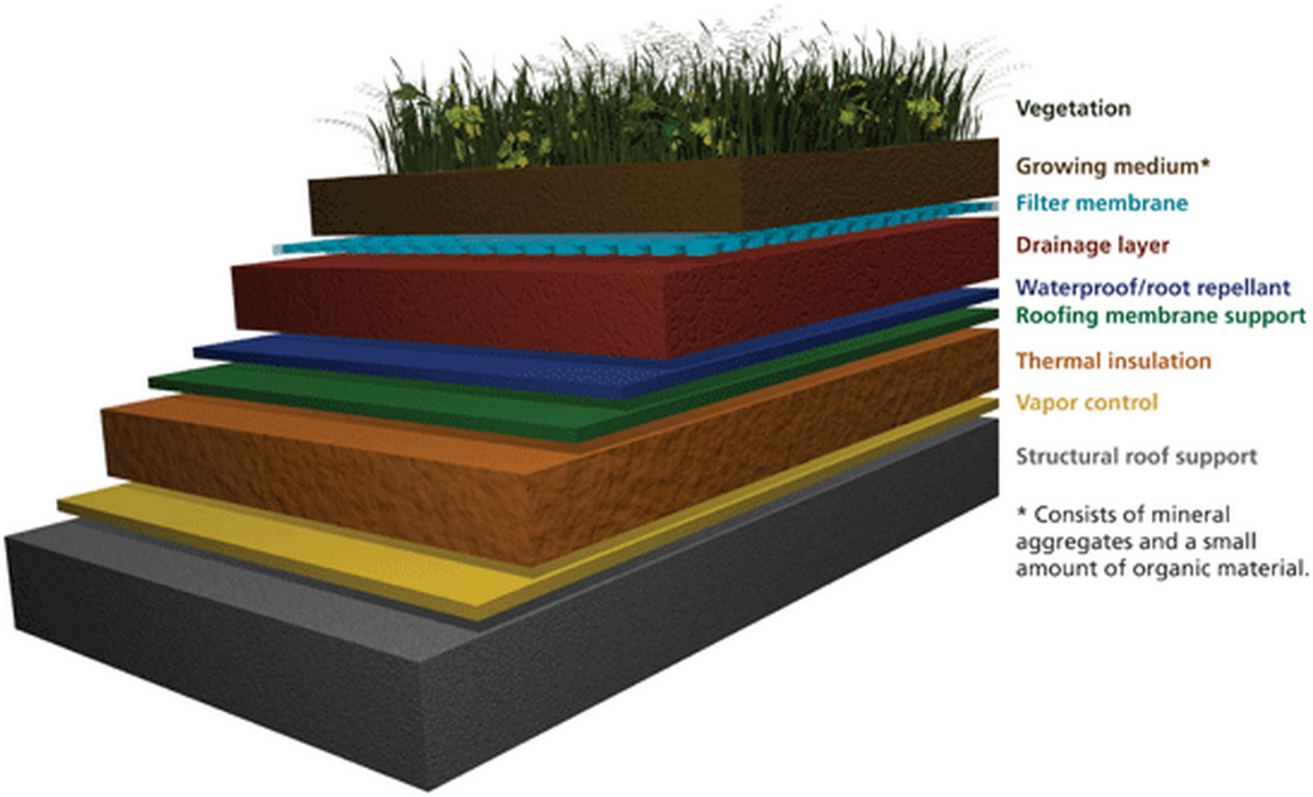


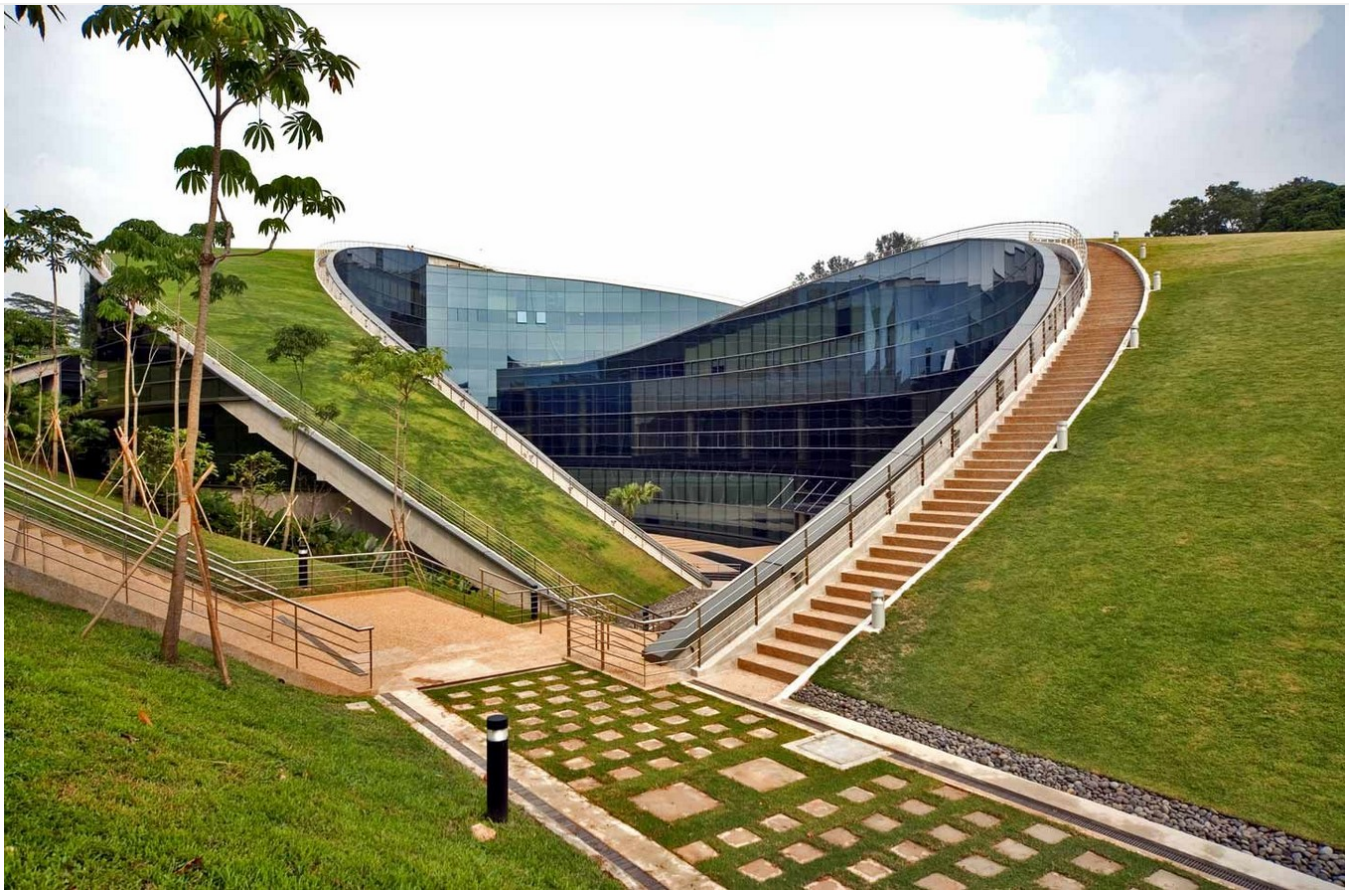
Image showing the various layers in a green roof system.

Though there is a broad level design principle to execute the idea, each green roof is a unique scenario and is dealt with individually. All green roofs would have a layered struc-ture with top vegetation accompanied by a growth medium, filter fabric, and a drainage system. Under the drainage layer, coatings of waterproofing, root repellent, and various

sect the third arc, forming a sunken courtyard that acts as the central space of the build-ing. Varying between two-five storeys, the glass building accentuates the thoughtfully de-signed multi-level courtyard and reflects it.

The sweeping curved green roof structure of NTU's school of art,design and media set a high bench-mark for design of green roofs.

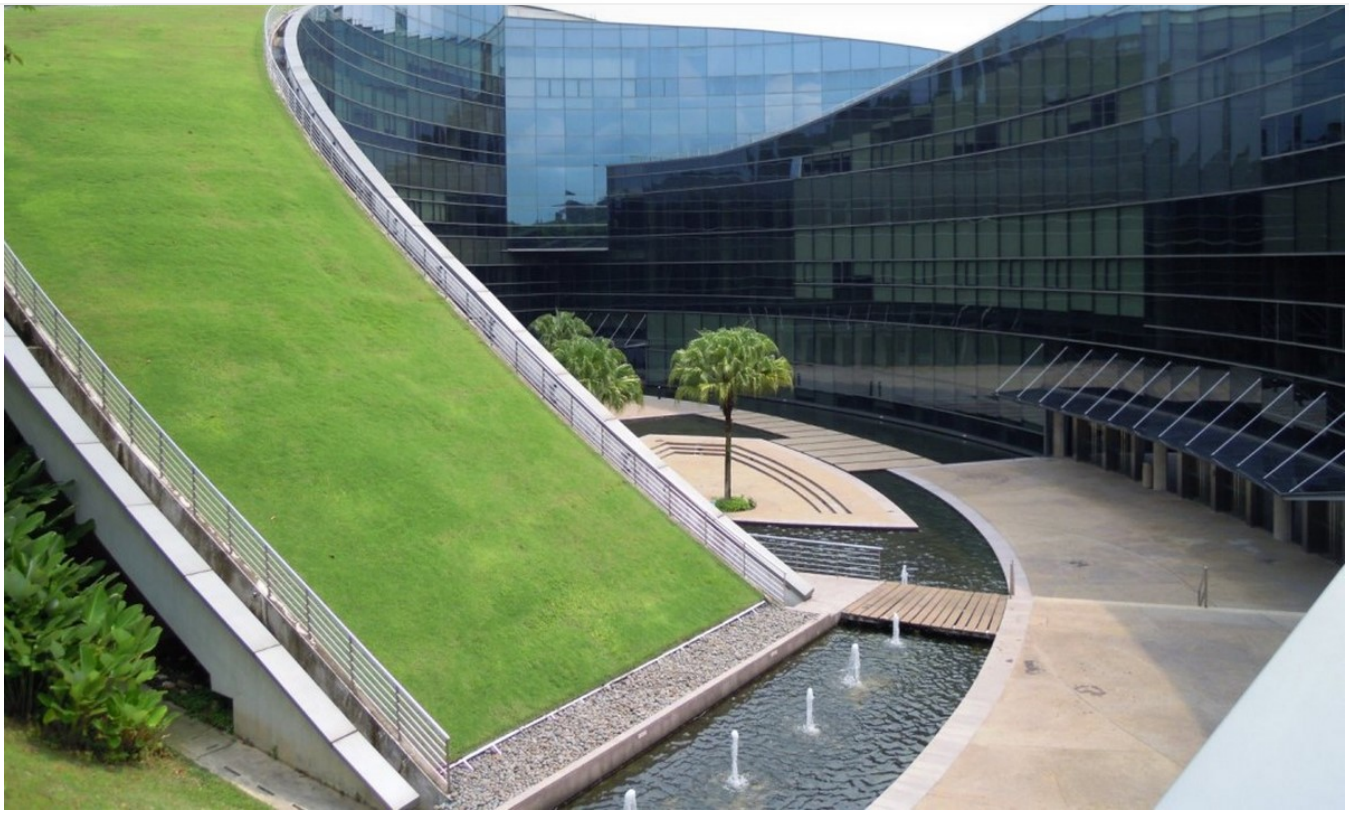
The sloping curved roof of the building is accessed by a series of steps running along the



The accessible green lawns on the roof acts as a recreational space for the students and helps them to evolve creative ideas.

Irrigated by an automatic sprinkler system that is integrated with a rainwater harvesting system, the green roof of the building is one of the most sustainable features of the build-ing, not only on the water conservation front but the air conditioning loads are also lesser compared to other buildings with a similar footprint.

Due to a thoughtfully designed green roof, the surrounding air is cleaner and cooler and there are no urban heat islands created due to the massive structure. With minimal re-



Due to steep slope of the curve,only the flat portion on the top of the building can be used for any activities.

The multi-layered green roof structure primarily consists of the top vegetation layer, and four interrelated organic matter that includes crushed volcanic rocks, washed sand, pumice, and a moisture retention layer to moderate the soil conditions throughout the year. The turf slows the surface runoff as well as retains the water on its surface, ensuring the drop in air temperature around the building by evaporative cooling.

The green roof that acts as a natural insulator, coupled with the almond-shaped court-yard reflects the heat and brings in natural light ensuring ample daylighting is achieved.

The building blends in with the surroundings seamlessly and yet stands out due to its aesthetic design sensibility.

2. **Brooklyn Botanic Garden Visitor Center, Brooklyn**

Masterfully embedded into the hillside that existed in the Northeastern corner of the Brooklyn botanic garden, the visitor center is an intelligent addition. Designed by Weiss/Manfredi the LEED Gold-certified glass building consists of a semi-intensive green roof spreading over a 10,000 sq. foot of vegetation that includes grasses, spring bulbs, and perennial wildflowers that are mostly native species.

North western view of the building depicting the living roof.

The leaf-shaped green roof is home to around 40,000 plants that helps in regulating the climate as well as create biological diversity as it was designed as an experimental land-scape. To add dynamism to the project, the architects consciously chose non-perennial plants, thus the green roof changes from season to season. In combination with the ex-tensive plantation around the building and the three water gardens, the green roof effort-lessly knits the building into the surrounding lush landscape.

View depicting the lush green living roof.

Envisioned as an urban oasis the architecture and landscape are so perfectly weaved to-gether that the demarcating line is close to diminishing. Also accessed from the top of the berm bisects the Visitor Center, the stepped ramp connects the entryway to the main area. While the fritted glass façade cuts down the thermal heat gain in the southern side, the northern side is artfully built into an existing berm thus creating thermally insulated spaces.

During the fall season the plants on the living roof transform.

The living roof ensures less heat gain thus decreasing the heating and cooling require-ment and the geo-exchange system lends a sustainable solution for heating and cooling of the interior spaces. The urban surface runoff is drastically decreased by the leaf-shaped vegetated roof that collects the water and manages the stormwater harvesting it efficiently. Acting as a transition element between the urban area and the surrounding landscape, the undulating green roof on the western side was designed with woodland bio infiltration basins.

The roof system is described as type three assembly, it consists of a mineral drainage sys-tem under a lightweight growing medium. The root permeable separation fabric ensures that the fine-grained growing layer doesn't blend in with the granular layer that absorbs the moisture to regulate the runoff. An extensive amount of roof stabilization was done to

building the sides of the building have a solid wall construction, while on the front side the plan is stepped back at each level creating terraces on each level. The green roof on each floor creates an overhang that shades the lower floor, minimising the solar heat gain from that large expanse of the façade glazing that brings in ample natural light.

The house has equal amount of built and terrace spaces.

Conceptualised as a structure that enhances the quality of life and brings one closer to

The curved roof rises from the ground creating an unique

The curved roof of the top floor accentuated the building making it stand out amongst the other buildings of the neighborhood. The main ideology behind the terraces of each level was to visually as well as functionally induce a feeling of living in a countryside house with surrounding sprawling lawn areas on each level that connected with the landscape and sea at each level.

The three-storied structure has garden space on first- and second-floor levels as well as the curved roof that acts as a crown of the project. These gardens are home to a variety of

The lush foliage gives a feeling of a house located in a groove.

A lush grass lawn creates a blanket over the entire area of the terraces, making them ac-

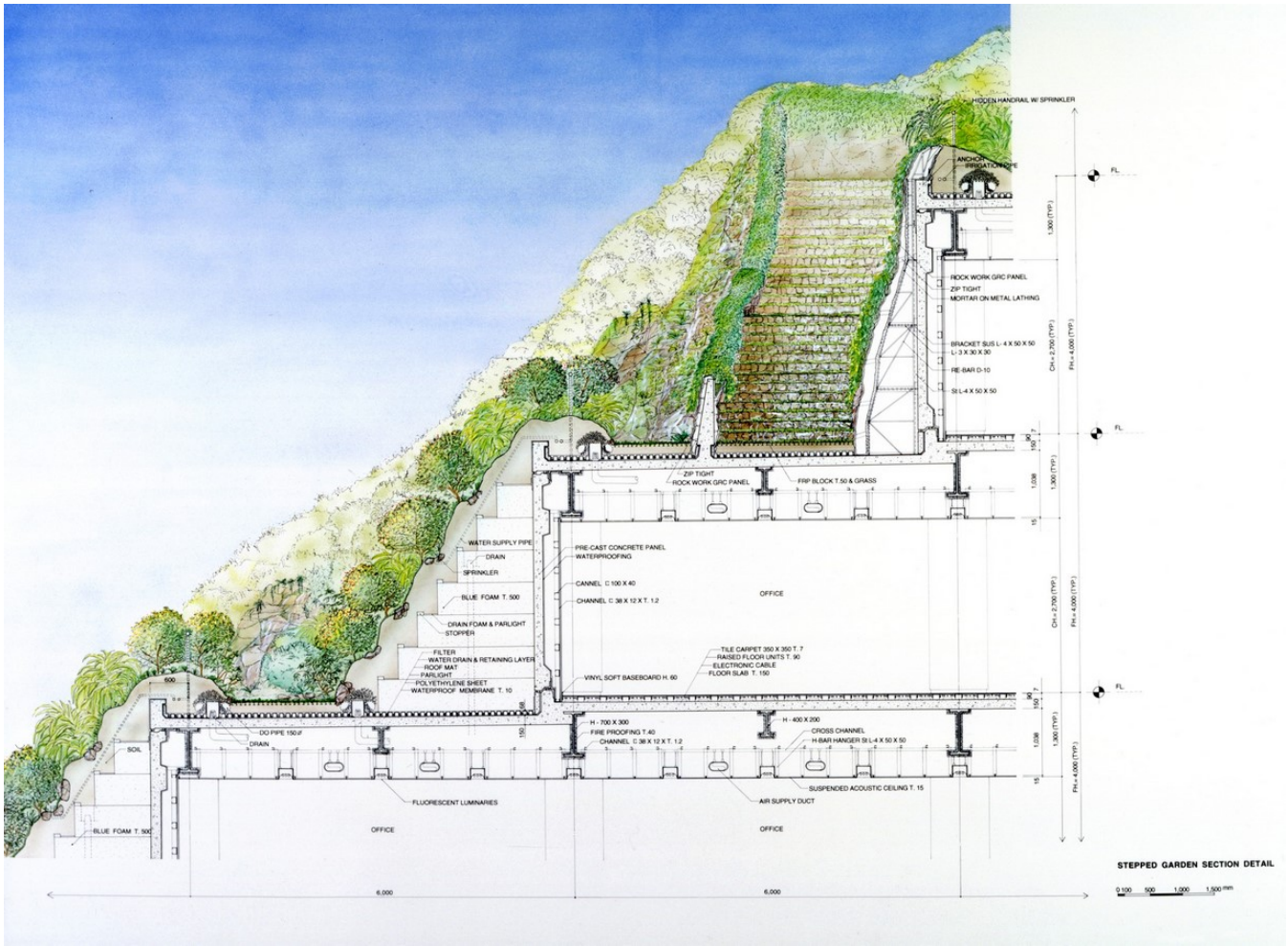
As the water retention capacity of the roof is high, the terrace helps in cooling the air by evaporative cooling, and the cool air is circulated through cross ventilation in the smartly planned spaces. The trees purify the air and cut down the noise disturbance of the touristy island, creating serene living spaces.

Built in the center of the Fukuoka city's park, the building artfully balanced the demand of a developer for maximum utilisation of FSI and the environment and social need for open green spaces that encourage interaction and growth of the culture. Due to limited space availability in the urban area, the new government building had to be located in a park.

The imposing multi-storied building's design inspired by the hanging gardens of Babylon was designed to step back the layout at each level creating terraces on the front portion of the building. The 15 levels of terraces house around 1,00,000 Sq. feet of landscape area, home to a multitude of native species.

The living roofs brimming with flowering and non-flowering plants, herbs, trees, and shrubs create a canopy visually transforming the glass building into a giant stepped gar-den from a utopian region. Architect Emilio Ambasz proved that *'where there is will, there is a way'* and executed every person's fantasy to construct a building without disrupting nature.

The iconic building's landscape was envisaged as a mountain of nature and the vegetation changed with the passing of each season. The accessible terraces on fourteen floors house community spaces for meditation and congregation while the terrace on the 15th floor was designed as a glorious belvedere that bestowed a panoramic view of the bay area and mountains. The intensive green roof system adopted for the terraces was sepa-rately designed for each floor based on the type of vegetation the terrace housed.



Section of the building detailing the living roof system

The growing media had various combinations and the depth of it ranged from 1¦ to 2¦. The building that was planned as a home for 37,000 plants from around 76 native species has now developed into 50,000 plants from a colossal number of 120 species, proving that na-ure has taken over the building. A study conducted in 2001 proved that the microclimate inside and around the building had a huge temperature difference of 15 degrees.

Due to the thick foliage on the building, the surrounding air is purified and the ambient noises are filtered, creating a peaceful reprieve amid the hustle and bustle of the city. The rainwater harvested from the building ensures it has been recharging the groundwater thus saving the city from water shortage issues.

Located on the waterfront of Canada's most culturally vibrant city Vancouver, the conven-tion center was envisaged as a building that harmoniously amalgamates built and open spaces, creating an ecologically responsible architecture. The LEED Canada-certified build-ing was envisaged as a celebration of people and place and aimed at setting a benchmark for sustainable buildings. One of the most iconic concepts that were incorporated in the building is the six acres green roof that is touted as the largest living roof in Canada.

View of the roofline of the convention centre.

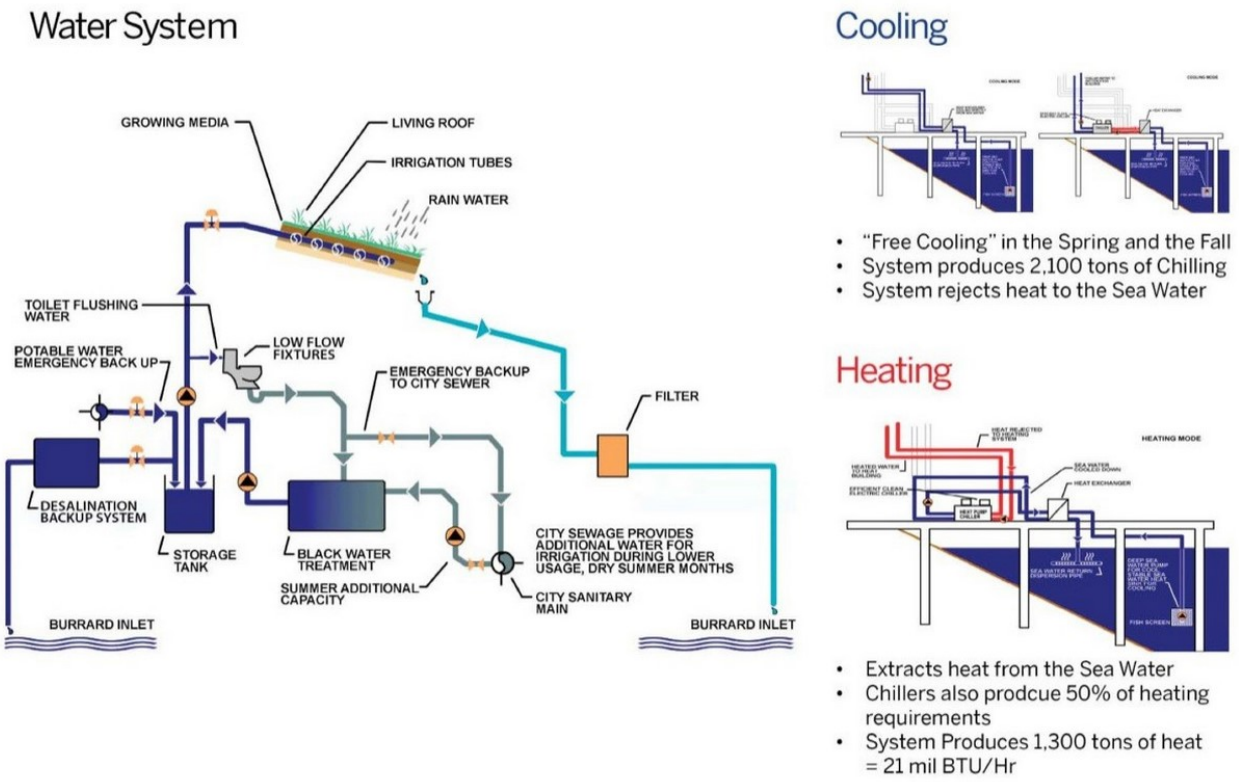
Abode to 40,000 native plant species and grasses, the intensive green roof system has about 1¦ deep growing media that has a sustainable irrigated system integrated with wa-terproofing and root repellent media layer. The system was designed with a metal deck, Densdeck, 4§ insulation media, and a filter cloth. The non-accessible green roof is also home to 240,000 bees in four colonies, whose honey is harvested for the restaurant.

The slope ranging from 3% to 56% has ILD'S patented EFVM (Electric Field Vector Map-ping) system. The slope of the roof built on natural topography creates an ecological and visual connection between Stanley Park and the North Shore Mountains.

Bird's eye view of the building._©httpswww.greenroofs.comprojectsvancouver-convention-centre-ex-pansion-project

Due to the sloping profile of the roof, a natural drainage system is ensured, additionally, it also ensures an innate seed migration pattern. The building has an integrated stormwater drainage system that harvests the surface runoff that is slowed down and retained by the green roof and integrates it with the waterfront. The wastewater produced by the build-ing is treated and reused for the landscape, conserving potable water.

The glass skin brings in diffused daylight while diminishing the demarcation between the indoor and outdoor spaces. Since the roof is non-accessible to the public it has developed into a natural habitat for various migrating and native species alike. Though it is inaccessi-ble for people, viewpoints from various locations are designed to enjoy the beauty of the natural habitat in the centre of a busy city.



The stromwater management system of the roof.mcm

Urban areas are perceived as the place for buildings while green areas are taken as spa-ces that belong in country/rural sides. While the world is rushing towards growth in light-ing speed architects hold the responsibility of balancing development and environment. Sustainability in buildings is a concept that has been getting the attention of designers in the past two decades but sustainable development is a concept that has to be well

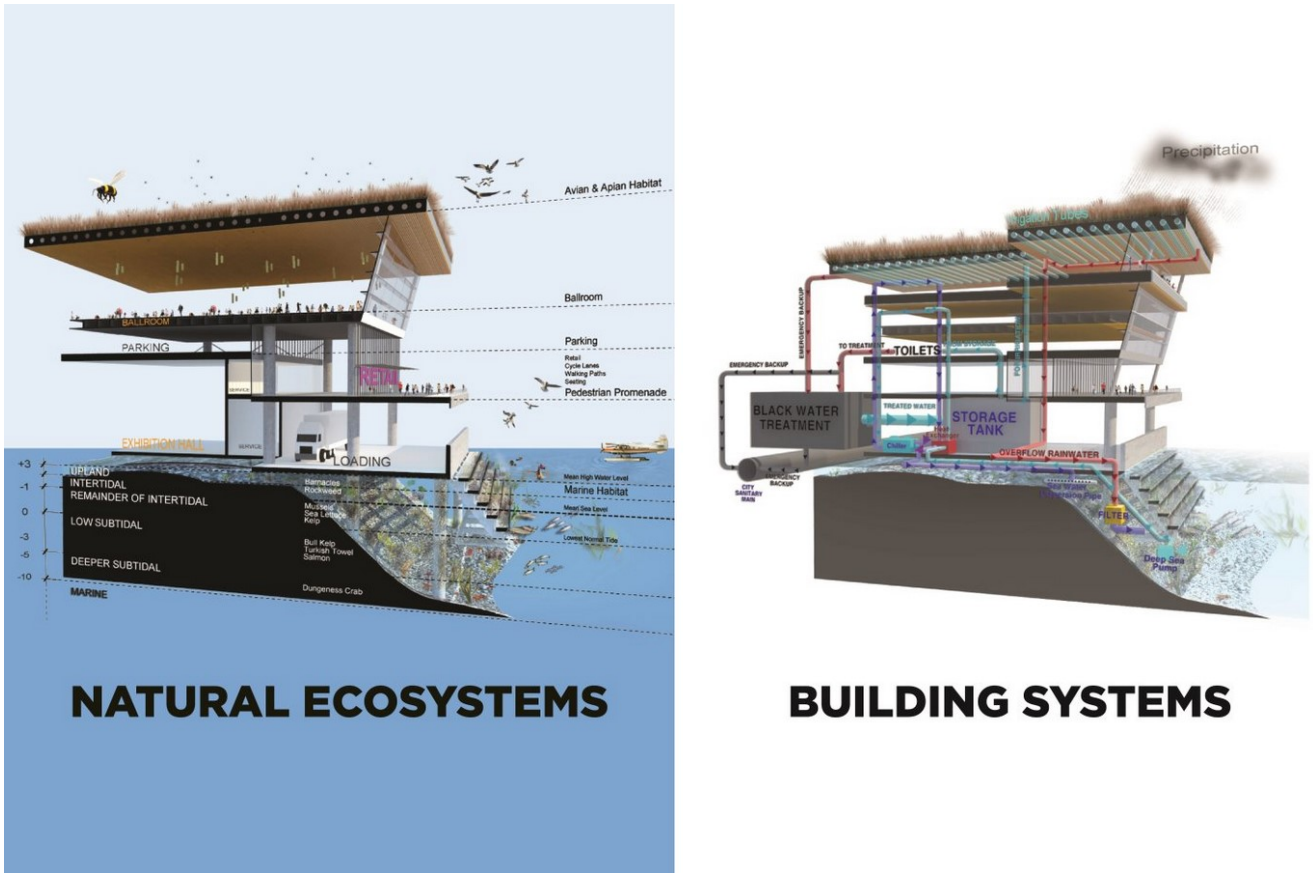


Image showing the ecological impact of the project.west

The green roof is a very perceptive idea that ensures one could give the space utilized for building a structure back to the environment. Though it has its own set of challenges and additional costs for designing and integration, it helps in the reduction of operational costs of building, adds aesthetic value to it, and also creates a space for repose. It helps a person in establishing a connection with nature and would help in the global warming crisis.

The United Nations lists the following five principles of sustainable architecture:

Healthful interior environment. All possible measures are to be taken to ensure that materials and building systems do not emit toxic substances and gasses into the interior atmosphere . Additional measures are to be taken to clean and revitalize interior air with filtration and plantings.
Resource efficiency. All possible measures are to be taken to ensure that the building's use of energy and other resources is minimal. Cooling, heating, and lighting systems are to use methods and products that conserve or eliminate energy use. Water use and the production of wastewater are minimized.
Ecologically benign materials. All possible measures are to be taken to use building materials and products that minimize destruction of the global environment . Wood is to be selected based on non-destructive forestry practices. Other materials and products are to be considered based on the toxic waste output of production. Many practitioners cite an additional criterion: that the long-term environmental and societal costs to produce the building's materials must be considered and prove in keeping with sustainability goals.
Environmental form. All possible measures are to be taken to relate the form and plan of the design to the site, the region, and the climate. Measures are to be taken to "heal" and augment the ecology of the site. Accommodations are to be made for recycling and energy efficiency. Measures are to be taken to relate the form of building to a harmonious relationship between the inhabitants and nature .
Good design. All possible measures are to be taken to achieve an efficient, long-lasting, and elegant relationship of area use, circulation, building form, mechanical systems, and construction technology. Symbolic relationships with appropriate history, the Earth, and spiritual principles are to be searched for and expressed. Finished buildings shall be well built, easy to use, and beautiful.

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