A PROPOSAL FOR A GREEN OFFICE BUILDING : A CASE STUDY IN TIRANA ALBANIA

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IN

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Approval sheet of the Thesis

This is to certify that we have read this thesis entitled **"A Proposal for a Green Office Building: A Case Study in Tirana, Albania"** and that in our opinion it is fully adequate, in scope and quality, as a thesis forthe degree of Master of Science.

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

A PROPOSAL FOR A GREEN OFFICE BUILDING: A CASE STUDY IN TIRANA, ALBANIA

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As the world is facing the challenge of climate change, all industries including Construction industry have evolved and found new resources and implementation methods for a lesser environment impact. Green Office Building is a product of this evolvement of Construction Industry. The methodologies used to substantiate these points are varied. Through wide research on different studies and statistics and through a specific case study this research will discuss the term of Green Office Building, what it represents, how it started, the advantages and disadvantages of implementation in construction projects. The main objective is to evaluate this approach toward green construction methods and implement them in Albania.

Keywords: *Green Office Building, Environment, Sustainable, Life cycle, Renewable Energy, Non-toxic materials*

ABSTRAKT

PROPOZIM PËR GREEN OFFICE BULDING: NJE STUDIM NE TIRANË, SHQIPËRI

Koçi, Elkid

Master Shkencor, Departamenti I Arkitekturës

Udhëheqësi: Dr. Paolo Camilletti

Ndërsa bota po përballet me sfidën e ndryshimeve klimatike, të gjitha industritë, përfshirë industrinë e ndërtimit, kanë evoluar dhe kanë gjetur burime dhe metoda të reja zbatimi për një ndikim më të vogël mjedisor. Green Office Building është produkt i këtij zhvillimi të Industrisë së Ndërtimit. Metodologjitë e përdorura për të vërtetuar këto pika janë të ndryshme. Nëpërmjet një hulumtimi të gjerë mbi studime dhe statistika të ndryshme dhe përmes një rasti specifik, ky hulumtim do të diskutojë termin e Green Office Building, çfarë përfaqëson, si filloi, avantazhet dhe disavantazhet e zbatimit në projektet e ndërtimit. Objektivi kryesor është vlerësimi i kësaj qasjeje ndaj metodave të ndërtimit të gjelbër dhe zbatimi i tyre në Shqipëri.

.

Fjalët kyçe: Ndërtess e gjelbër zyrash, mjedisi, i qëndrueshëm, cikli i jetës, energjia e rinovueshme, materiale jo toksike

Dedicated to my family.

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The realization of this thesis is the fruit of a wide collaboration of people without whom it would not be possible.

I would first like to thank my supervisor, Dr. Paolo Camilletti, whose expertise was invaluable in formulating the research questions and methodology.

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I want to thank my family. You have been and are still the support and motivation to move forward.

Last but not least, I want to thank Aneta Shkalla for supporting and pushing me. Thank you darling.

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INTRODUCTION

1.1 Problem Statement

One of the sectors that uses the most energy and has the most impact on the environment is the construction industry [1]. Buildings utilize a lot of materials and energy, and therefore contribute significantly to carbon emissions. The green building movement started to gain traction as a way to lessen these consequences and enhance the building-construction process.

1.2 Thesis Objective and Scope of Work

The green building idea has gained popularity over the past ten years, and attention has been focused on creating various building grading methods for the green building standards. Building rating tools offer systematic frameworks for evaluating the performance criteria, making it possible to measure and compare structures in order to advance the transition to more sustainable methods of building design, construction, use, and deconstruction.

The major goal of this study is to identify the guidelines, construction standards, and building requirements that must be adhered to for the design of green buildings.

For this investigation, a thorough examination of the literature was conducted. The literature study highlights the gap in the literature and offers a thorough grasp of the associated literature in green building grading systems. Based on this research, it gathered the most relevant articles possible. A screening was conducted to further reduce the selection criteria after collecting the articles using keyword search through several search engines.

Based on the aforementioned perspectives, the research aims to investigate the physical environment simulation of the design of green architecture using three green office buildings in various climates as examples.

1.3 Methodology

With the advancement of technology and the outside factors, these green systems have proved their influence on the building's energy consumption, by reduce it and producing enough to sustain itself and more. there are research papers that are focused on the importance of these systems in the building design and how these systems might be integrated on the building that have shown great results. this can be seen in real life case studies that have these systems as design features, such as the atrium, double skinned facades, solar panel placed on top of the roof, rainwater harvesting etc.

These research paper and case studies and more have proven their importance and are taken into consideration for the design of the green building. through planning and 3d modelling, as well as keeping in mind the specifications of the land, it has been designed a green office building that is a step further towards the better and environmentally friendly building designs.

For this project idea, there are used the programs such as Autocad and Revit for 3d modelling, Lumion for renders and Photoshop.

1.4 Organization of the thesis.

This thesis is divided in 5 chapters. The organization is done as follows:
In Chapter 1, the problem statement, thesis objective and scope of works is presented. Chapter 2, includes the literature review Chapter 3, consist with Site Analysis and Project. In Chapter 4, conclusions and recommendations for further research are stated.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction.

If we try to define the term of Green Building we can define it as a construction technique or as a set of operations used to build a building that regardless of the purpose of its use has a focus on reducing the negative impact on climate and nature (World Green Building Council, 2016). Green Building is the best method of approaching the way of construction while maintaining the natural balance and meeting the needs for living space and services for the population, which is always growing, in a changing environment and with the undeniable need for a high quality of life for people. Green Building relies on the reuse of materials, the use of toxic-free, ethical, and sustainable materials that reduce waste and pollution of materials. (Yudelson, 2010).

Research on this topic is important to know in depth all the benefits that come from this concept although not new but that its application remains at insufficient levels to meet the requirements and challenges we face on the other hand this research also helps to see the difficulties that this construction model brings which then lead us to seek solutions to make it possible to overcome the problems (Ding et al., 2018).

2.2 Green Building.

Green Building or otherwise known Green Architecture is a way of construction which brings as little negative impact on the environment but which is still able to offer and produce buildings which will serve a purpose whatever it is, by following this way of construction which that from conception to construction including all operations required in it will have an approach of reducing carbon footprint, reducing waste pollution and preserving the environment (Planet and Universe, 2014). The need for Green Building is more immediate in developed cities which are also the most populated parts of the planet and the benefits of this way of conceiving and building quickly show their positive effects starting with the reduction of carbon dioxide up to 38 % and in reducing the energy used up to 33% which translates into benefits for the users of these buildings making a healthier life and reduced cost of using energy that in large buildings translates into savings of 1 million $ every year for every building (Balaban and Puppim de Oliveira, 2017). Since this method of building is focused on the best ways to use materials, such as by using demolition debris for other buildings or renewable energy sources like the sun or wind, it ultimately translates into a protection and care for the environment as a whole. In Europe, the construction industry is responsible for 34.7% of all waste, so reducing waste is one of the major advantages of green building. (Koutsogiannis, 2019). Engaging in Green Building and facing problems to give a more positive result have resulted in new practices and techniques in construction example for this is the most efficient thermal insulation which significantly reduces the continuous loss of energy used for heating or creation of rainwater reserves in these ecological buildings to use it for the purpose of reducing waste (India, 2019). The benefit that comes from Green Building is a benefit for all people directly or indirectly but also a benefit for the environment and nature as a positive step which should continue in the future to maintain as much as possible the balance between use and his protector.

2.3 International Certification Systems for Green Building

Building grading systems are among the most difficult since they incorporate several disciplines, including environmental, economic, social, cultural, and value-based components (Sala, Ciuffo, & Nijkamp, 2015). The British Research Establishment (2008) states that more than 600 grading instruments have been recorded globally. For instance, well-known certification standards utilized include:

- **BREEM, UK**
- **LEED, US**
- **CASBEE, Japan**
- **GREEN STAR, Australia**

International System	Country	Introduced Date
BREEAM	UK	1990
LEED	US	1998
CASBEE	Japan	2001
Green Star	Australia	2003

Table 1 : List of Global Certification Programs

2.3.1 BREEAM, UK, 1990

(The Building Research Establishment for Enviromental Assessment Method)

BREEAM is the most well-known and efficient method for assessing a building's environmental impact. This criteria currently serves as a standard for best practices in sustainable design and describes the environmental performance of a building. BREEAM may be used to assess a single building or a collection of developments anywhere in the world, independent of national boundaries.

BREEAM evaluates the following building types:

- Educational
- Office
- Medical
- Court
- Penitentiary
- Industrial.

The areas under which BREEAM awards points are Energy, Management, Health and Well-Being, Transportation, Water, Materials & Waste, Land Use, Pollution, and Ecology.

2.3.2 BREEAM Gulf

(The Building Research Establishment for Enviromental Assessment Method)

Building types that may be evaluated under the BREEAM Gulf Scheme include Entirely new construction, major building renovations, newly added expansions to existing buildings, a combination of new construction and building renovation, new construction or building refurbishments that are a part of a larger mixed-use complex, and existing building fit out

These two certification systems aim to achieve the best results in energy efficiency through the many innovational technologies, implemented in these green buildings. However, there are some differences among them, which depending on certain factors, one is better suited than the other from different typologies of building. This can be seen in the comparison table 2 below:

BREEAM Section	**UK, Weightings %**	**Gulf Weightings %**
Management	12	8
Health & Wellbeing	15	15
Energy	19	14
Transport	8	5
Water	6	30
Materials	12.5	9
Waste	7.5	7
Land Use & Ecology	10	5
Pollution	10	7
Total	100	100

Table 2: Comparison between BREEAM UK and BREEAM Gulf

2.3.3 LEED, US, 1998

(Leadership od Energy and Enviromental Design)

LEED, a US standard, is a green building certification scheme that is recognized globally. Building owners and operators have a clear framework for choosing and implementing practical and verifiable green building design, construction, operations, and maintenance solutions according to the US Green Building Council (USGBC), which created LEED. Some 14,000 projects in 50 US States and 30 other countries have adopted LEED (LEED, 2006).

The areas under which LEED awards points are Energy and atmosphere, materials and resources, indoor environmental quality, sustainable sites, water efficiency, and innovation in operations.

The measuring system is intended for rating and certifying commercial, institutional, and residential structures, both new and old.

2.3.4 CASBEE, Japan, 2001

(The Mechanism for the Complete Evaluation of Environmentally Friendly Structures)

A cooperative industrial, governmental, and academic initiative was introduced in Japan in April 2001 with the help of the Housing Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The Japan Green Building Council (JAGBC)/Japan Sustainable Building Consortium was founded as a consequence of this effort, and it established the (CASBEE, 2010).

JPGBC/JSBC has gathered the following tools since CASBEE development began in 2001:
Heat Island urban development, and urban area & buildings are among the topics that are covered

Energy efficiency, resource efficiency, local environment, and interior environment are the four assessment categories addressed by CASBEE.

As they don't necessarily reflect the same ideas, it might be difficult to approach these four categories using the same criteria as the target fields for the evaluation tools that are now available in Japan and elsewhere as described above. (2010) (CASBEE)

2.3.5 Green Stars, Australia, 2003

In Australia, the National Built Environmental Rating System is used.

In order to rate the environmental performance of various building types, the Green Building Council of Australia (GBCA) is committed to providing top-notch grading tools. Initiated by GBCA, the Green Star Initiated by GBCA, the Green Star

Categories that Green Star focus are Energy, transportation, water, materials, land use & ecology, emissions & innovation, management, indoor environmental quality

Workplace, Workplace Interiors, Workplace Existing Building, Shopping Center Design, Healthcare Education, Multi Unit Residential, and Mixed Use.

2.3.6 Comparison between (BREEAM verses LEED)

The comparison between the two schemes BREEAM and LEED has promoted innovation, both in the schemes and in delivered buildings:

Scheme	**BREEAM, UK**	**LEED, US**
Strength	- allows for the benchmarking and comparison of various constructions Independently	- Effective marketing effectively spreads the word, and there is a wealth of information.

	certified; bespoke version may evaluate any building; quantitative thresholds - Safety for cyclists and pedestrians	- Percentage thresholds do not require training or an assessor. - Online LEED office - Comfort of occupants and internal pollutants - Acoustics and water
Weaknesses	- Exact specifications -Complicated weightings system - market profile - high cost of compliance, and delayed accountability (App. 3 weeks)	Based on US systems; extensive documentation required; no independent audit of the evaluation; challenging to evaluate mixing of building function and form.
Costs	An increase in building expenses of around 2–7%	An increase in building expenses of around 3-8%

Table 3: Comparison between BREEAM and LEED

2.4 System used in Green Buildings

2.4.1 Rainwater Harvesting

This procedure entails collecting run-off from an area or building with an impervious surface and storing it in a number of containers. The water that these devices gather usually finds its way into a storage container.

The terminology used to describe the gathering of rainwater varies greatly. It is also known as rainwater harvesting, groundwater gathering, or roof water collection.
As this technique catches and saves the free water that falls on your roof, it is especially helpful in urban environments. After that, you may use it to provide your house or place of business with water on a consistent basis [2].

The advantages of rainwater include the following ones:

- It is a relatively clean and cost-free source of water
- It gives you complete control over your water supply (ideal for cities with water restrictions)
- It is socially and environmentally responsible
- It encourages self-sufficiency and helps conserve water
- It is better for landscape plants and gardens because it is not chlorinated
- It lessens stormwater runoff from homes and businesses
- It can solve the drainage problem
- It uses simple technologies that are inexpensive and easy to maintain
- The system is highly adaptable and can be modular in design, enabling extension, reconfiguration, or relocation, as necessary
- It can provide an ideal backup supply of water for emergencies
- The system can be readily retrofitted to an existing structure or installed during new home building

Water can be preserved by using a technique called rainwater Harvestin. It is an good approach to conserve water and benefit the environment.

Rainwater may primarily be utilized in three different contexts:

- Use of irrigation
- Non-potable, indoor usage
- Water utilization for the entire house

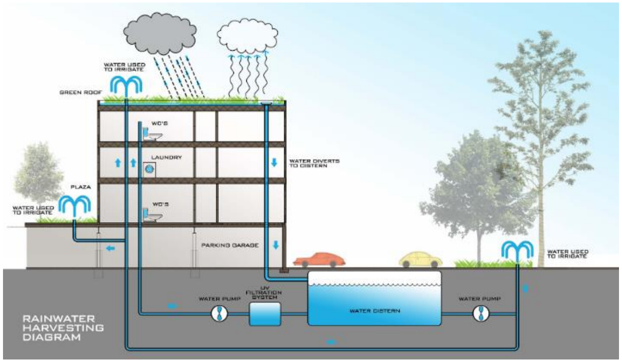


Figure 1: Rain water harvesting system [2]

2.4.2 Grey Water Recycling

The gray water recycling system is a method of gathering and reusing clean water from sinks, dishwashers, showers, and restrooms.

This procedure is made feasible by a number of various systems or procedures that allow gray water to be filtered and then reused in washing machines, toilets, and outside faucets.

By using this technique, it is feasible to utilize 50% less fresh water. [3]

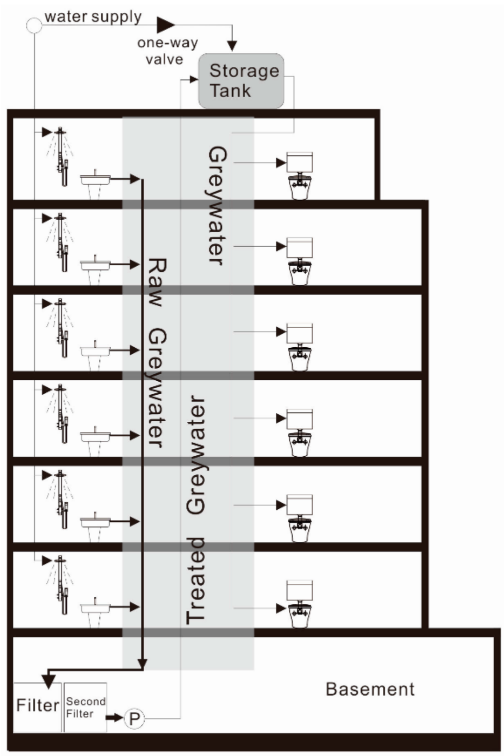


Figure 2: Grey Water Recycling System [3]

2.4.4 Natural Ventilation

Natural ventilation is the act of moving air naturally that is, without the aid of a fan or other mechanical system through an enclosed area. To provide ventilation and space cooling, it makes advantage of external air flow brought on by pressure differences between the building and its surroundings.

In a building, there are primarily two forms of natural ventilation that may be used:

1. Ventilation driven by wind (Uses Natural force of wind)
    a. Ventilation on one side alone.
    b. Ventilation on both sides.
2. Ventilation for stacks.

Both are made by regular pressure changes (the pressure induced by buoyancy). Whereas stack ventilation is fueled by pressures created by buoyancy as a result of variations in temperature and humidity, pressure differences that drive wind-driven ventilation make advantage of the wind's inherent forces. The two forms of natural ventilation can thus be optimized using various methods. [4]

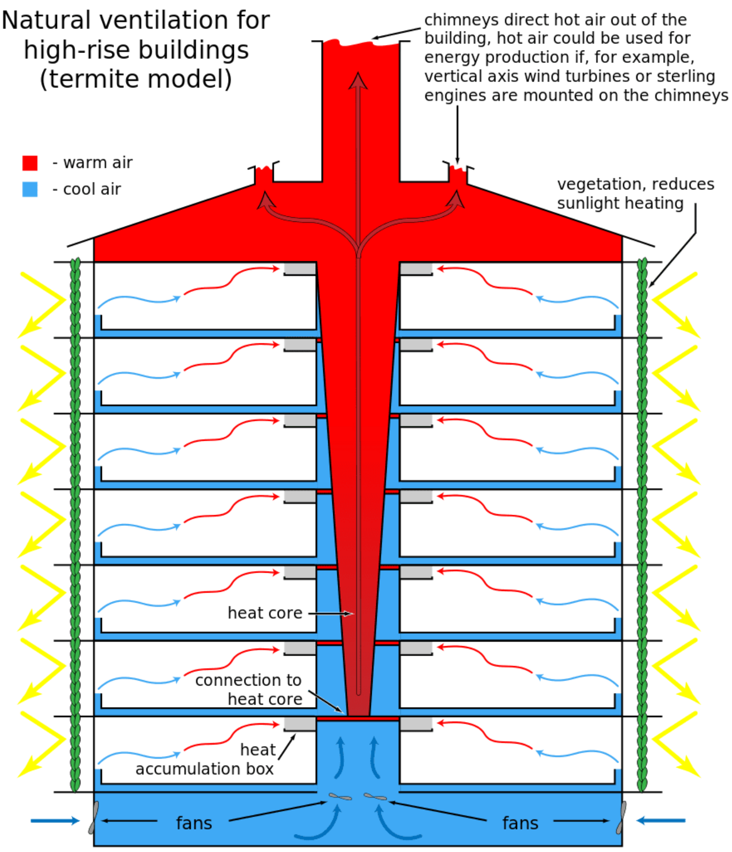


Figure 3: Natural Ventilation System [4]

2.4.5 Radiant Heating

Radiant heating systems send heat via panels in the walls, ceiling, and floor of a house. The systems largely rely on radiant heat transfer, in which heat is transferred from a heated surface to nearby objects and people via infrared radiation.

Many advantages are offered by radiant heating. It is often more efficient than forced-air heating and more efficient than baseboard heating since it eliminates duct losses.

Hydronic (liquid-based) systems are ideal for homes that are off the grid or in locations where power is costly since they utilize relatively little electricity.

The most common and economical radiant heating systems for areas where heating is a major industry are hydronic (liquid) systems. With hydronic radiant floor systems, warm water is piped from a boiler through tubing laid out in a pattern beneath the floor. Zoning valves, pumps, and thermostats that regulate the flow of hot water through each tubing loop are used in certain systems to regulate the temperatures of the rooms. [5]

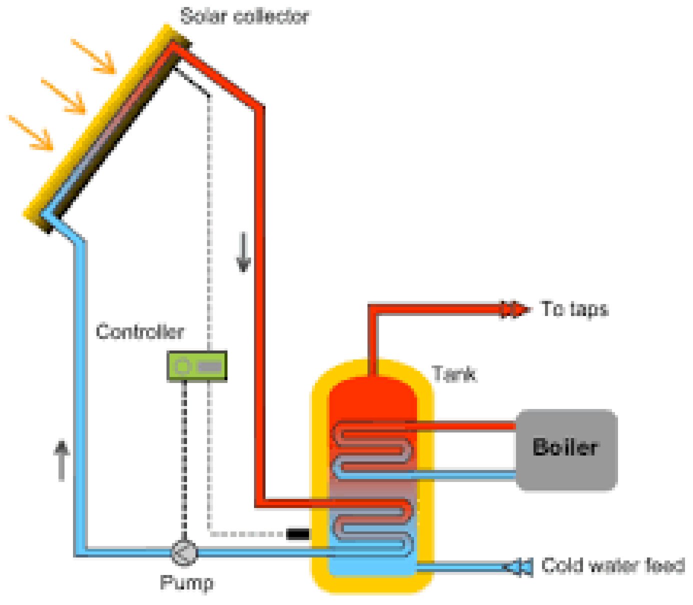


Figure 4: Radiant heating [5]

2.4.6 Geothermal Systems

Technical systems that use geothermal energy are known as geothermal systems. The depth at which the thermal energy present in the subsurface may be exploited is one of the several classifications for geothermal systems.

Depending on whether a depth of less than or more than 400 m is considered, geothermal systems can be classified as shallow geothermal systems or deep geothermal systems (by governmental definition in various countries). Shallow geothermal systems are used to deal with low temperature and enthalpy. Deep geothermal systems can handle temperatures and enthalpies ranging from medium to high [6].

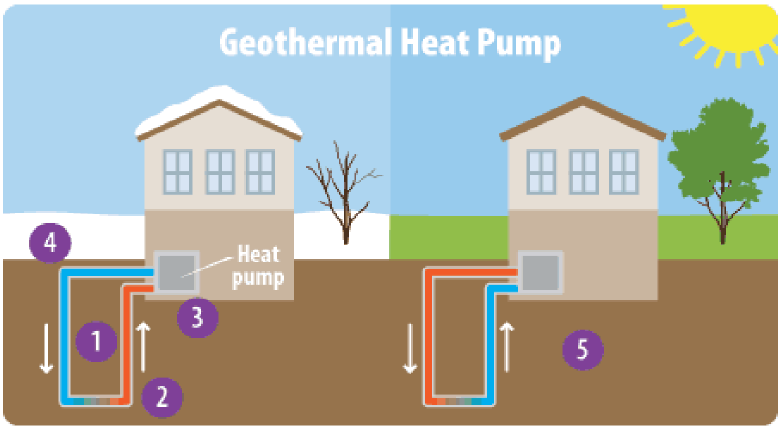


Figure 5: Geothermal System [6]

2.4.7 Solar energy

The most plentiful and pure renewable energy source is solar energy. It can be used for household, industrial, and commercial purposes to produce power, give light, or heat water. Photovoltaics, solar heating, and solar cooling are the three major methods of capturing this energy.

- Photovoltaics

A solar-powered gadget generates energy using a process known as solar induction. This technique works by releasing electrons from a semiconductor-based substance. These electrons may be utilized to create energy via an electrical circuit.

When the semiconductor material on a solar panel is ionized and struck, the outside electrons break loose from their atomic bonds. Solar cells are not 100 percent efficient due to the nature of the semiconductor structure [7].

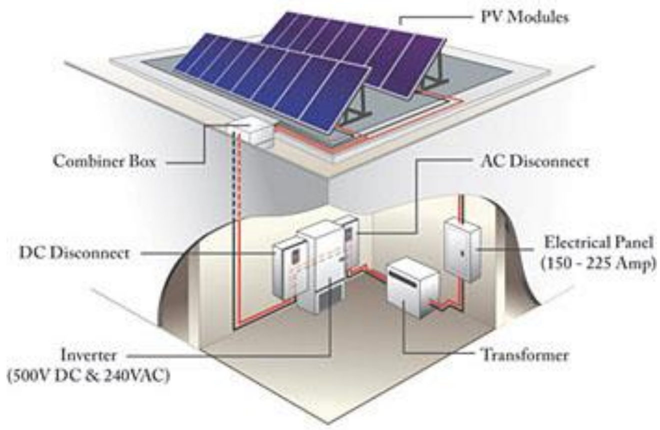


Figure 6: Photovoltaic Panel [7]

- **Solar heating & cooling**

Sun heating and cooling (SHC) systems use solar thermal energy to heat water, chill spaces, and heat swimming pools in residential, commercial, and industrial environments. These technologies have eliminated the need for electricity and natural gas.

2.5 Evaluation of Green Building Features

There are several scientific study articles and studies relating to green building office design, specifically the term green. Several writers have researched various facets of sustainability, from the "Green" idea to the financial effects of green construction technologies.

The green office building, according to the EPA (United States Environmental Protection Agency), is a structure and the use of practices that are resource- and environmentallyconscious throughout a building's life cycle, from planning to design, construction, operation, maintenance, renovation, and demolition.

Green building design refers to the use of energy-saving and environmentally friendly technology in the planning and construction of buildings in order to reduce their energy consumption. Hence, including green building principles into the design of office buildings is crucial for lowering energy usage.

Ones of the key characteristics of a green building are:

- Little alteration of site conditions and landscapes
- Making use of environmentally friendly and repurposed building materials
- The utilization of non-toxic and recyclable/recycled materials
- Recycling and efficient use of water
- Using environmentally friendly and energy-efficient equipment
- Using renewable energy sources
- Interior air quality for comfort and safety of people
- Succinct building management and controls
- Renovation
- Demolition

If we take a broader view, it may be divided into three categories [8]:

1. Building: site choice, design, and construction
2. Lifetime use - upkeep and operation
3. Remodeling and Destruction.

1 – Construction Phase

Sustainable design takes into account not just where but also how structures are built, as well as the surrounding area.

When compared to typical residential structures, office buildings use substantially more water and electricity, which has a bigger negative impact on the environment during construction. Hence, including green building principles into the design of office buildings is crucial for lowering building energy usage [9].

Local politicians, planners, developers, and architects are challenged by sustainable design for the built environment to consider the relationships among their structures, the environment, and their communities. The objective is to incorporate local ecology into design and construction, lessen the impact of natural resources, consume less non-renewable energy, use environmentally friendly products, safeguard and conserve water resources, improve indoor environmental quality, and enhance maintenance and operation procedures [10].

Because sustainable design should fall into the five areas listed below.

1. Sustainable sites and responsible land use development: deals with site planning and reducing the effect of the building on the environment
2. Resource and material conservation: deals with reducing waste generated on the building site and utilizing eco-friendly products
3. Energy conservation and atmospheric quality: this section focuses on energy conservation, encouraging the use of waste and renewable energy, and reducing the building's negative effects on the environment and air quality
4. Water efficiency, conservation, and management: covers how much water is used by the building and how to lessen its negative effects on water quality
5. Interior environmental air quality: discusses tools or methods for enhancing indoor air quality

2- Lifetime use

The management of green buildings is extremely important for reducing gas emissions, utilizing energy more effectively, lowering energy costs, and maintaining the sustainability of the environment. Green building management practices are a thorough collection of strategies used to safeguard the environment and lessen the damaging effects of buildings.

Creating a comfortable and happy living space for owners and tenants is the primary goal of green building management.

World green building standards are examined in research (Management Core Practices for Enhancing Green Building Performance) to examine the green building management criteria and its sub-criteria applied globally. This study identified five key practices for managing green buildings, namely sustainable procurement, sustainable operation, resource management, repair and maintenance management, and environmental health, based on the "management" criteria and sub-criteria addressed in various established green building standards [11].

Public education on green construction is another component of management that is crucial. Humans use buildings throughout their whole lives, and they may play a significant role in bringing about change for resource conservation strategies like energy efficiency and material recycling.

On tenant habits like reducing space heaters beneath the desk, turning off lights, and being aware of when to close or open a window, a building's design and subsequent ecological performance may be reliant [12].

In addition, many individuals will buy, rent, and want to upgrade their own homes at some time in their life for residential structures. People will increasingly need to take advantage of tax benefits for green house features, learn how to renovate their homes themselves, or hire contractors for modifications like solar panel installation, greater insulation, or water-saving fixtures. Learning green construction techniques is therefore analogous to learning other fundamental skills in the home economy like preparing wholesome meals or managing finances.

3- Remodeling and Destruction

Decommissioning a building can refer to both rehabilitation and destruction. Green buildings should be decommissioned in the most efficient manner possible with the least negative environmental impact. The building materials utilized should be reusable or simple to disassemble in order to accomplish this purpose.

This design and construction approach promotes the development of structures that serve as a supply of materials for other structures. Reusing and recycling building materials saves energy and resources.

Minimal levels of contamination in building materials and components make it simpler to reuse them in the future, make it easier to get rid of leftover garbage that can't be used, and preserve the soil. Controlled destruction may be necessary if there are no more viable options for separating constituent parts and maximizing reuse and subsequent use [13].

2.6 Office Building Typology

2.6.1 Low Rise Building

One to three story buildings that are typically found on vast sites in low density suburban developments. Low-rise office buildings are frequently found next to roads, either as individual structures or gathered as office parks or campuses. The three types of offices are low-rise, single-tenant, and multi-tenant. This causes this type to vary more in size and structure. However, as seen in the pictures to the right, a generic floor plan can be derived from these differences. The flexibility required for the building to function as a speculative development is provided by this type, which is easily adaptable to single- or multi-tenant usage as appropriate. The majority of low-rise office buildings have many cores and elevator banks and restrooms that are centralized. For maximal travel requirements, numerous cores and staircases are required because the floorplate is frequently fairly large.

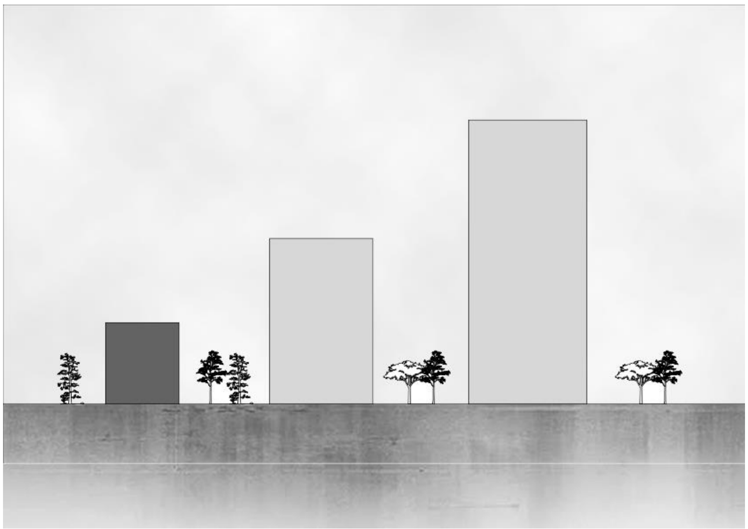


Figure 7: Low Rise Building

2.6.2 Mid Rise Building

The most common kind of office buildings are mid rise structures, which can be found in both suburban and more populated urban regions. Although they are frequently constructed as speculative constructions and have the flexibility to allow a greater range of tenant kinds and numbers of tenants, they are used in build-to-suit development situations. The floorplans presented to the left are typical floorplans because of their effective use of space and flexibility.

A single core houses the mechanical systems, support spaces, restrooms, and vertical circulation.

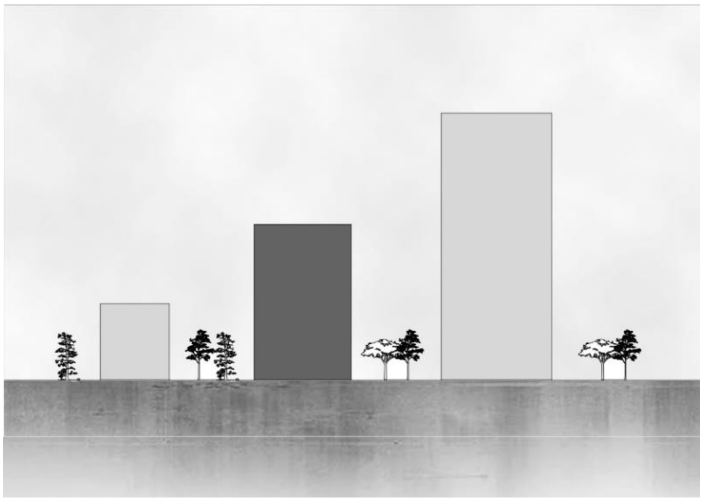


Figure 8: Mid Rise Building

2.6.3 High Rise Building

Buildings with thirteen to fifty stories or more that are situated in highly populated urban areas. The majority of sites have exceptionally high property values and are quite modest. Developers have little choice but to construct vertically because to the tiny location. In order to maximize rentable space, developers aim for the highest possible height in order to generate a profit and offset the cost of the building's materials and construction.

The core size grows as a result of the mechanical systems and vertical circulation being subjected to larger demands as height rises. In addition, the design offers the flexibility needed in what is frequently a speculative building and is quite similar to that of the mid-rise type. High-rise office buildings are frequently mixed-use, including a hotel into the upper floors, for example, or including retail or restaurant amenities in the lower and ground floors, due to financial considerations and site-specific zoning.

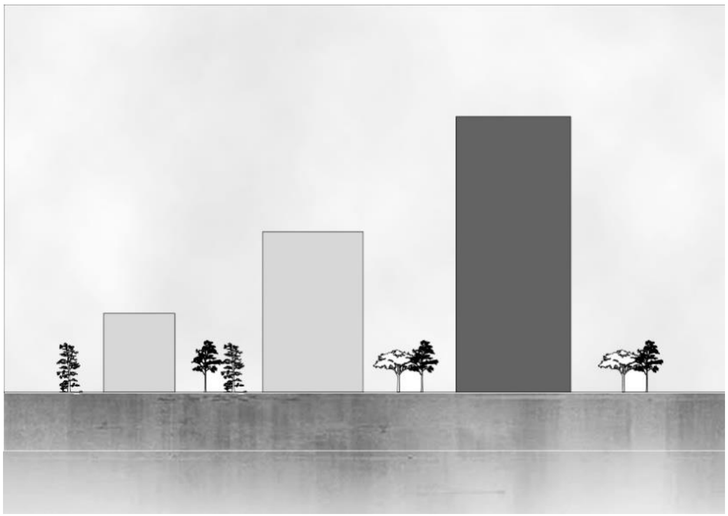


Figure 9: High Rise Building

2.7 Case Study

Nowadays, the matter of energy efficiency has become an important part of the building design. We can see this implemented on different building typologies around the world. However, the method and the implementation differ from building to building.

Some of the systems used, such as water filtration, natural lighting and ventilation etc, are similar in various buildings, depending on the external and internal factors.

2.7.1 The Edge – Amsterdam, Netherlands

This office building is in Zuidas business district, in Amsterdam. The concept behind it was to open a window in connecting the workspace with the outside world. This was achieved through the 15 story atrium.Many features, such as rooftop solar panels, rainwater harvesting system, sensors that measure temperature and carbon dioxide levels etc, have been incorporated in the building design, acting as a means to reduce the energy use by the building. The water for the toilets and the plant watering comes from the reserved water supply from the harvesting system, while the lighting of the building is brought by the atrium, directed towards north, and Ethernet-powered LED-connected lighting.

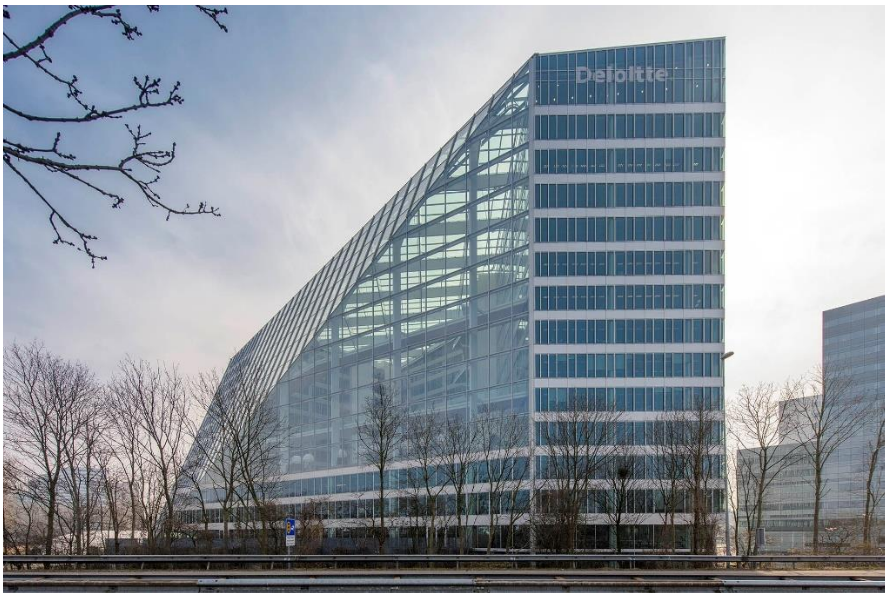


Figure 10: The Edge [14]

2.7.2 Bullitt Center – Seattle, USA

The different green and blue infrastructures are combined in Bullitt Center as a self-sustained building. As a 6-story commercial office building, it would need more energy to use for different aspects of the building. As such, the architects have implemented a rainwater harvesting system to collect and filter the water used in the facilities, as well as a group of aerobic composters for green recycling. On its rooftop are placed photovoltaic cells that operate a certain amount of energy for the building to use. Due to its green and blue systems, the building can produce 30 % more energy than it needs.

Figure 11: Bullitt Center [14]

2.7.3 The Edge – Amsterdam, Netherlands vs Bullitt Center – Seattle, USA

The Edge and Bullitt Center use almost the same systems to reduce energy consumption, even though they are located in different parts of the world. The Edge is a high rise building, its main feature is the 15-story atrium, while Bullitt Center is a 6 floor building that due to its functions focuses on the decrease of the energy consumption.

Both of them use the rainwater harvesting system to filter the water for the buildings to use. However, the Edge uses solar panels for energy, while the Bullitt Center uses photovoltaic cells that produce 30 % more energy than the Bullitt Center needs.

Due to the atrium feature oriented north, Edge has more natural lighting and ventilation than the Bullitt Center.

It is noticed that the Edge has implemented more systems that are focused on the natural lighting, ventilation etc, whereas the Bullittt Center uses fewer systems, focused on producing the amount of energy needed for the building to function and then some.

	The Edge	The Bullitt Center
Location	Amsterdam, Netherlands	Seattle, USA
Typology	High rise (15k)	Middle rise (6k)
Main feature	Atrium 15 floor high, oriented towards north	-
Water systems	rainwater harvesting system	rainwater harvesting system
Lighting	Natural lighting + Ethernet-powered LED-connected lighting	-
Ventilation	Natural, atrium	-
Energy produce	Solar panels	Photovoltaic cells
Rating	-	-

Table 4: The Edge vs The Bullitt Center

2.7.4 Angel Square – Manchester, United Kingdom

The commercial structure 1 Angel Square, designed by 3DReid, has a variety of offices that can be simply rearranged to change the amount of space required for a particular task and to meet building requirements. This is made feasible by the building's mechanical, electrical, and structural design. In order to improve the building's heating and cooling systems, the façade is covered with a double-skinned face and high thermal mass concrete. The building performs its own ventilation through the atrium's natural stack effect with the help of an aerodynamic system that heats the waste air and recycles it for the heating process. The rainwater collection technology is also used to cut down on water usage.

This office building gets the highest BREEAM rating in the UK thanks to its features, which resulted in a 50% decrease in energy use and an 80% reduction in carbon emissions.

Figure 12: Angel Square [14]

2.7.5 Federal Center South Building 1202 – Seattle, USA

Federal Center South Building 1202 is located in Seattle, USA. previously been a warehouse. Now is the headquarters for the U.S. Army Corps of Engineers. Through the interior, timber from the non-historical 1202 warehouse has been reused, mostly in the common areas between divisions. The building is redesigned with active and passive systems to make the building self-sustained. The building is naturally ventilated and the shading devices on the facade optimize the daylight in it. It uses a variety of shading devices such as: horizontal shades, vertical blades, and internal window coverings. Moreover, it also provides rainwater harvesting and natural drainage systems. The building managed to achieve a Gold LEED certificate.

Figure 13: Federal Center South Building 1202 [15]

2.7.6 Angel Square – Manchester, United Kingdom vs Federal Center South Building 1202 – Seattle, USA

These two buildings are very similar and yet different from one another, due to their location (climate) and systems used. Both use active and passive systems focused on the natural lighting and ventilation, as well as achieving the reduction of energy consumption.

On one hand, Angel Square is a high rise building, where the main feature is its double skin facade combined with the high thermal mass concrete to optimize the heating and cooling processes. On the other hand, The Federal Center is a middle rise building composed of passive and active systems combined with shading devices on its facade to optimize natural daylighting.

Angel Square uses more innovative technologies that reuses the water from the rainwater harvesting systems and the waste air for the heating process, while the Federal Center is more oriented towards the passive and active systems (rainwater harvesting system included) that combined with the facade of the building manages to reduce its energy consumption.
Both buildings are awarded for their achievements.

	Angel Square	Federal Center South Building 1202
Location	Manchester, UK	Seattle, USA
Typology	High rise	Middle rise (3-4k)
Main feature	Double skin facade + atrium	Passive and active systems + shading devices
Water systems	rainwater harvesting system	rainwater harvesting system +natural drainage systems
Lighting	Natural lighting, atrium	Natural lighting, Shading devices such as: horizontal shades, vertical blades, and internal window coverings
Ventilation	Natural, atrium	Natural
Energy produce	high thermal mass concrete = 50% reduction in energy consumption	Reduction of energy consumption
Rating	Highest in UK: BREEAM rating	Gold LEED certificate

Table 5: Angel Square vs Federal Center

2.7.7 Genzyme Center – Massachusetts, USA

Genzyme Center is home to a variety of biotech companies. As part of its design, is the 12-story high atrium that supplies the building with 75% natural light and is responsible for the natural ventilation of the building through the stack effect. From the atrium, light gets distributed in the entire building via the many hanging mirror panels that reflect it towards the interior. The structure of the building is made of concrete as a solution in regulating the high thermal mass and different applications. The roof is designed as a green roof, in order to collect the rainwater for the cooling towers.

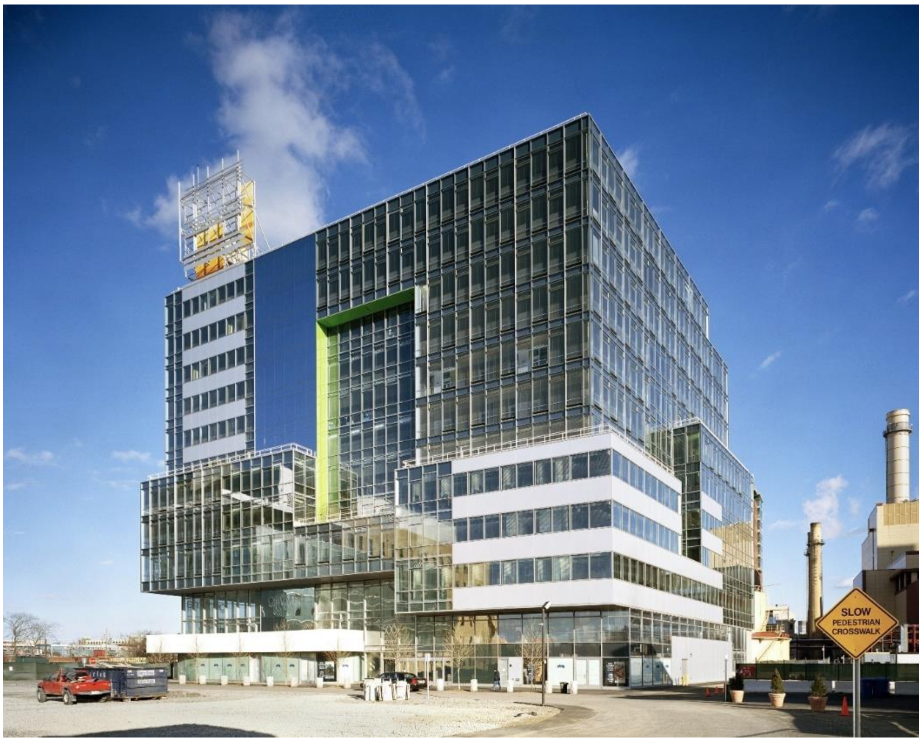


Figure 14: Genzyme Center [16]

2.7.8 Powerhouse Kjørbo – Bærum, Norway

Snøhetta is a Oslo- based study that specializes in designing buildings that produce twice the amount that it needs. This was the chase of two seafront buildings from the 1980's. The two office buildings were renovated in order to produce more energy than it needs. Taking inspiration from 100 project systems used worldwide, they came up with a way to integrate different parameters together. The solar panels cover the exterior of the buildings and aid in generating almost 41kWh/m2 each year, as well as natural ventilation, energy efficient lighting. Part of the facade are the external shading devices used to contribute from the outside in lowering the needs for cooling in summer, while the exposed concrete decks aid in the reduction from the inside. The buildings are well insulated through its elements like walls, ceiling and windows. By taking into consideration renovations made, the energy consumption of the two buildings was reduced by 90%., which BREEAM-NOR rated them as an outstanding project.

Figure 15: Powerhouse Kjørbo [17]

2.7.9 Powerhouse Kjørbo – Bærum, Norway vs Genzyme Center – Massachusetts, USA

These buildings differ from each other by a lot. One of them is a renovation project that was redesigned to produce twice the amount of energy needed from the buildings, while the other one is the home of several biotech companies that make the building designed focused on natural ventilation.

The powerhouse uses shading devices combined with solar panels, implemented on its facade to cool and heat the building from outside, while on the inside the exposed concrete decks and the well-insulated elements of the building impact the heating and cooling processes.

On the other hand, the Genzyme Center uses the 12-story high atrium to optimize the natural daylight and the natural ventilation within the building. The light is distributed through the hanging mirrors installed on the atrium walls. Just like the Powerhouse, The Genzyme Center has a complete concrete structure that solves the regulating of the high thermal mass. A feature that makes the building more unique is its green roof that collects the rainwater for the cooling tower.

Taking all of these facts in consideration, both buildings achieve the right levels of energy usage reduction. However, the Powerhouse was specifically designed to reduce its energy consumption, where it was noted that 90 % of its energy was reduced. This rated them as an outstanding project by the BREEAM-NOR.

	Powerhouse Kjorbo	Genzyme Center
Location	Baerum, Norway	Massachusetts, USA
Typology	Middle rise (3-4k)	High rise
Main feature	external shading devices + exposed concrete decks	12 story high atrium
Water systems		green roof, in order to collect the rainwater
Lighting	energy efficient lighting	75% natural light, atrium+ hanging mirror panels that reflect it towards the interior
Ventilation	Natural ventilation t, atrium	Natural ventilation stack effect, atrium
Energy produce	solar panels	Concrete structure as a solution in regulating the high thermal mass
Rating	BREEAM-NOR rated them as an outstanding project.	-

Table 6: Powerhouse Kjorbo vs Genzyme Center

CHAPTER 3

DESIGN APROACH MODEL

3.1 Site Analysis

3.1.1 Train Station in Tirana, Albania

The Train Station was the railway junction of Tirana, which was connected to other cities in Albania, which was closed in 2013 after the decrease in the number of passengers and nowadays the new Boulevard of Tirana has been built.

Train Station is characterized by a flat terrain with a relatively large amount of greenery, dominated by private residences from 1 to 3 floors, some of which have been adapted as service facilities.

Figure 16: Train Station

3.1.2 Location

The location of the site is between the new Boulevard of Tirana and the Jordan Misja street, which is not very developed where 1 to 3 storey buildings dominate, where most of them are residences and some of them are mix used houses. Several multi-storied buildings, mainly apartments, can also be noticed.

Figure 17: Site Location

3.1.3 Site Photos

Figure 18: Existing Site Photo

3.1.4 Accessing

The site is easily accessible both from the new Boulevard as well as from the Jordan Misja

Street.

Figure 19: Streets

3.1.5 Greenery

An important element in our site is the greenery, which is characterized by fruit and decorative trees that are mainly located in the private courtyards of the houses, it is also noticeable that it is a flat surface with little greenery.

Figure 20: Greenery

3.1.6 Sunpath

One of the advantages of our site is precisely the solarization. the presence of low buildings, mainly 1 to 3 floors, makes a favorable site. Something that facilitates us in the process of design and orientation of the object that will be proposed, since natural light is a main factor in the productivity of the users of this object.

Figure 21: Sun Path

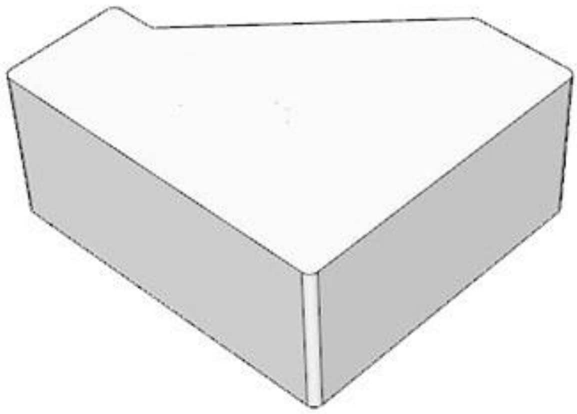
3.2 Project

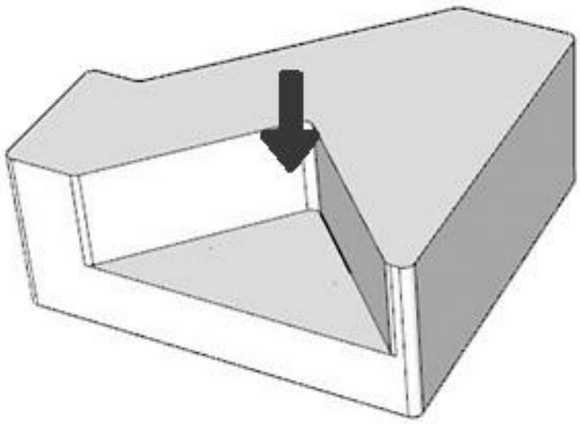
3.2.1 Concept

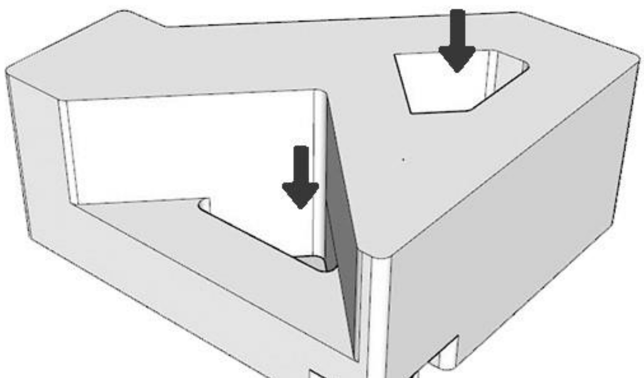
The challenge was the design of a low-rise office building which would adapt to the needs and conditions of the site. The right selection of the right systems and materials in order to achieve green building.

Since the typology of buildings on the site is regular, the proposal is designed to fit the surrounding context by using a composition of regular volumes.

An important element of the volume is the use of the atrium so we had to orientate the building towards the north se we get the cleanest light and the sun does not overheat the building.







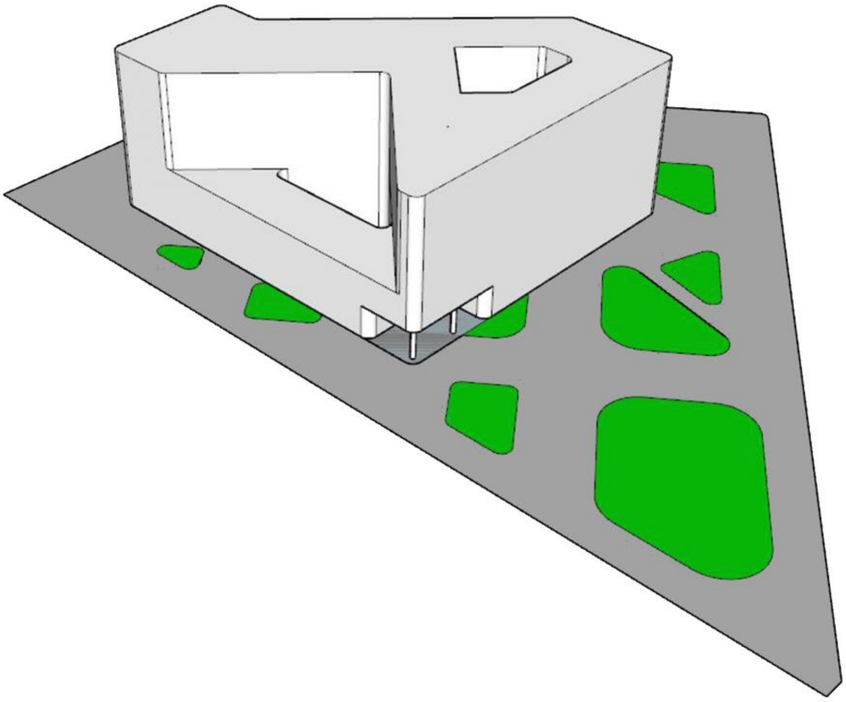


Figure 22: Conceptual Diagram

3.2.3 Site plan

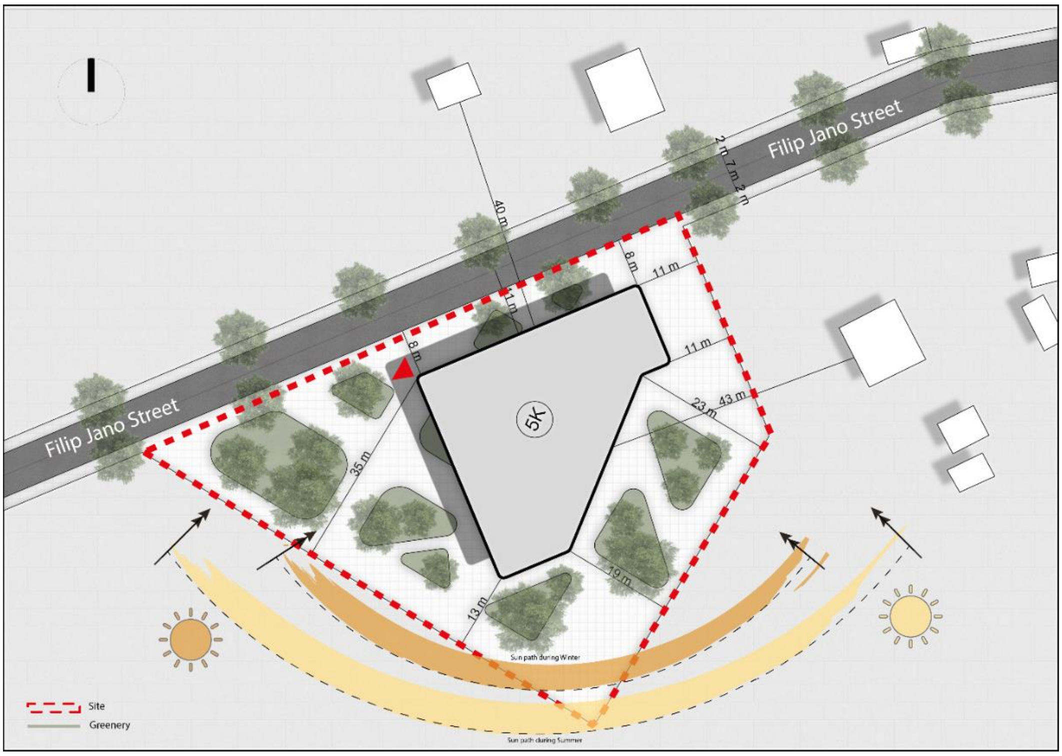


Figure 23: Site Plan

3.2.3 Floor Plan

The underground plan will be used for vehicle parking, among which there are 20 parking spaces for normal cars and 21 more will be for electric cars, and parking spaces for bicycles or electric scooters have been placed. Also, in the parking lot there are 2 cisterns to collect rainwater.

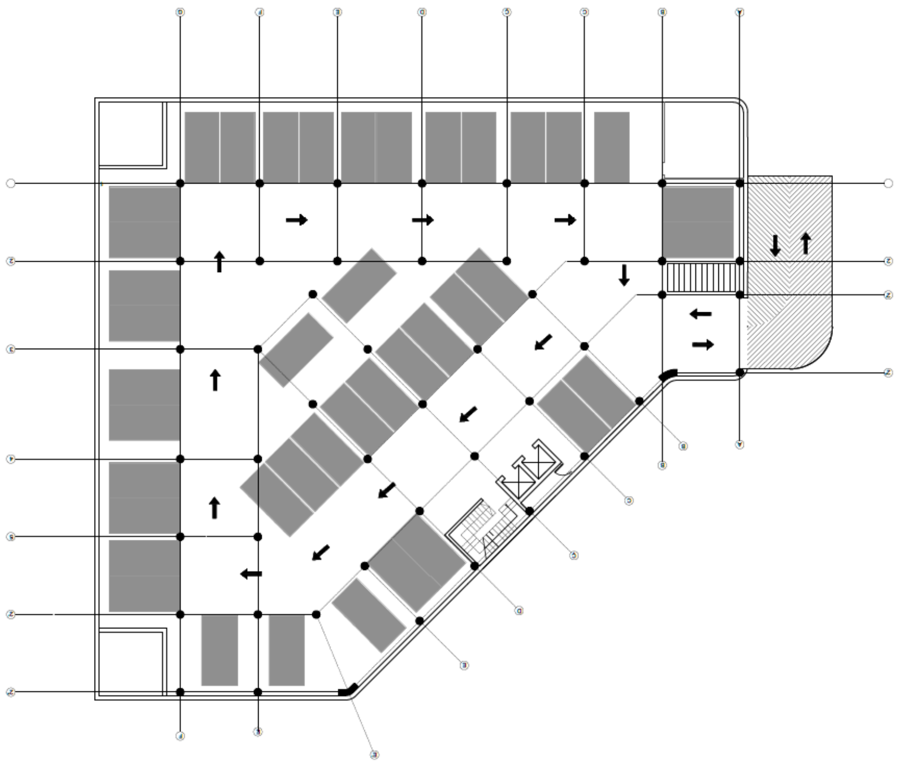


Figure 24: Underground plan

The ground floor, like the other floors, is thought to be spatially divided to enable the creation of common spaces. office spaces. meeting rooms, recreation areas, service facilities, as well as sanitary facilities, without forgetting the emergency stairs and elevators.

Another element are the atriums where 2 such are located. one of them goes up to the 3rd floor, where the building is broken, which leads to the creation of a green terrace.

Another atrium has been placed inside the building to give it natural light, plus a ramp has been placed around it to make it possible for people to move between the different levels.

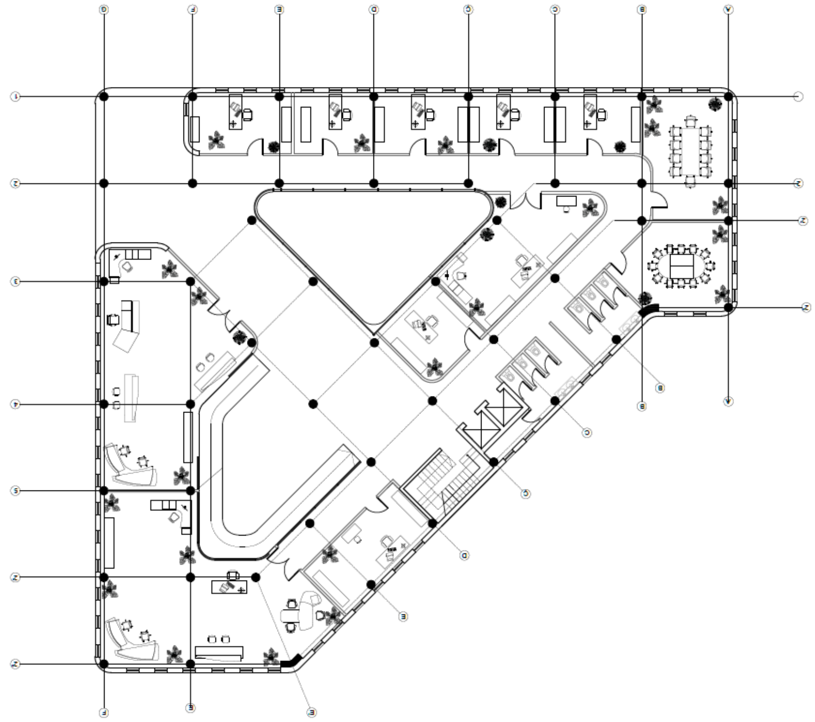


Figure 25: Ground Floor Plan

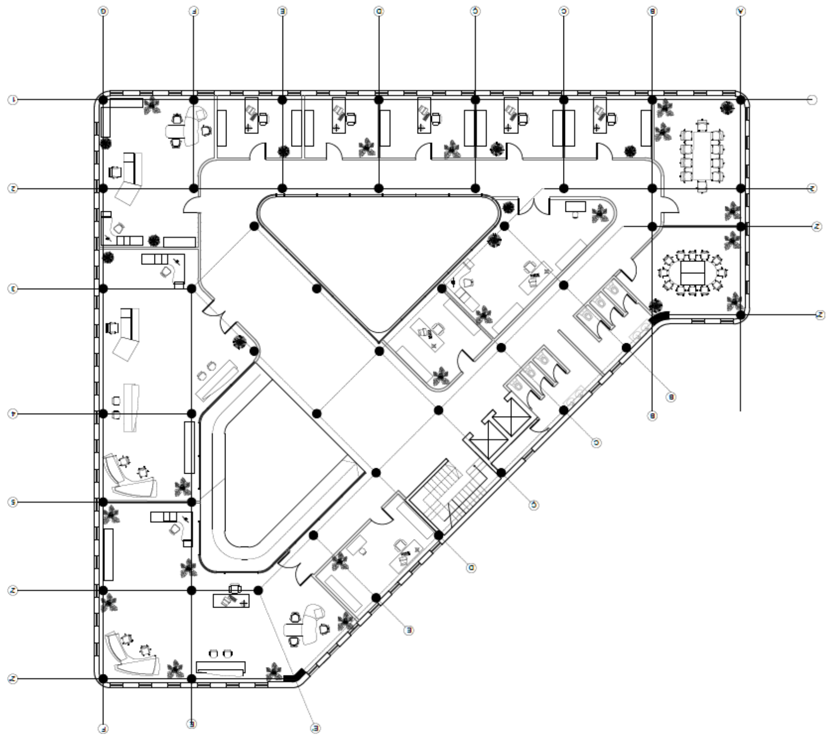


Figure 26: First Floor Plan

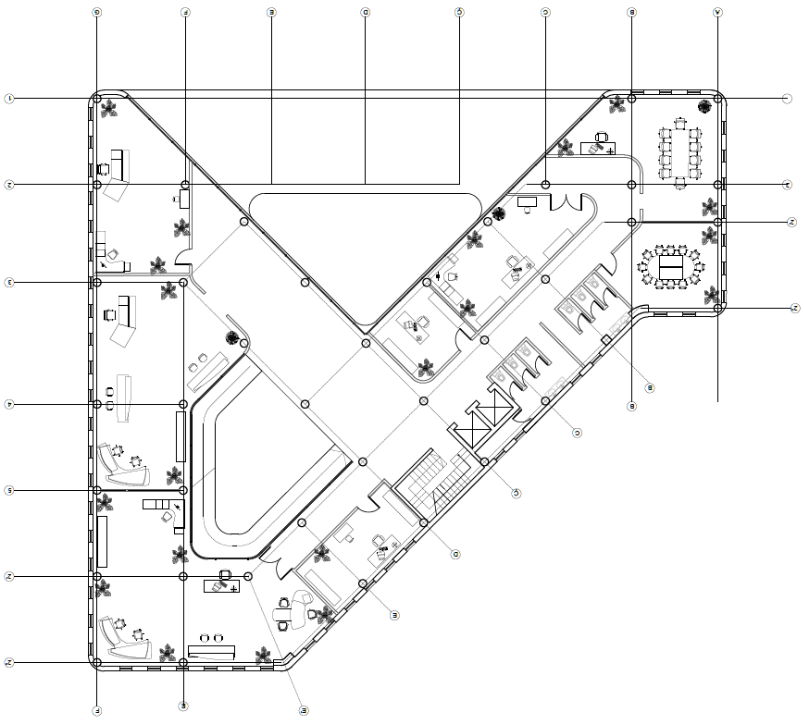


Figure 27: Second Floor Plan

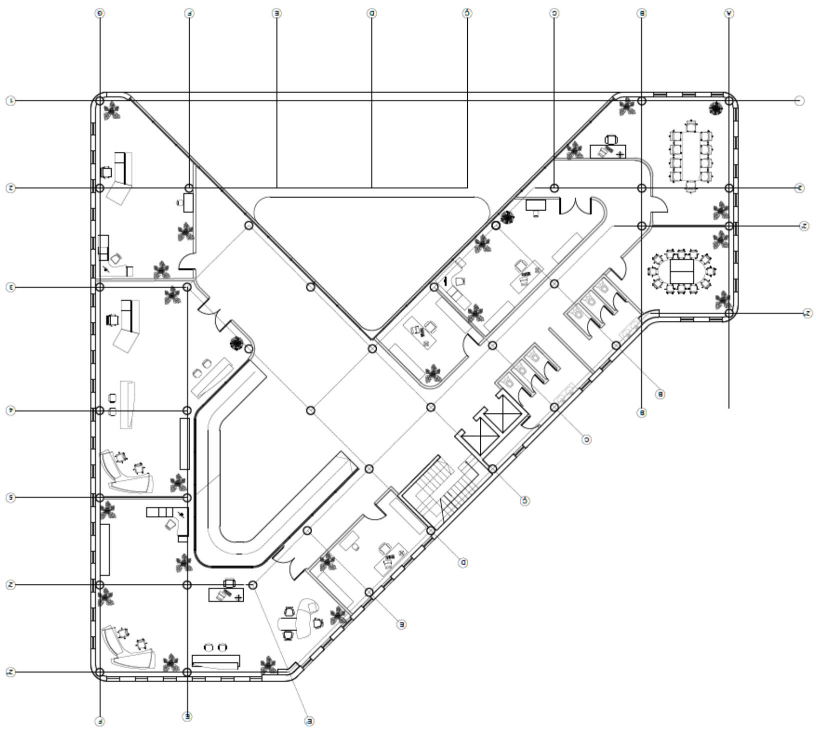


Figure 28: Third Floor Plan

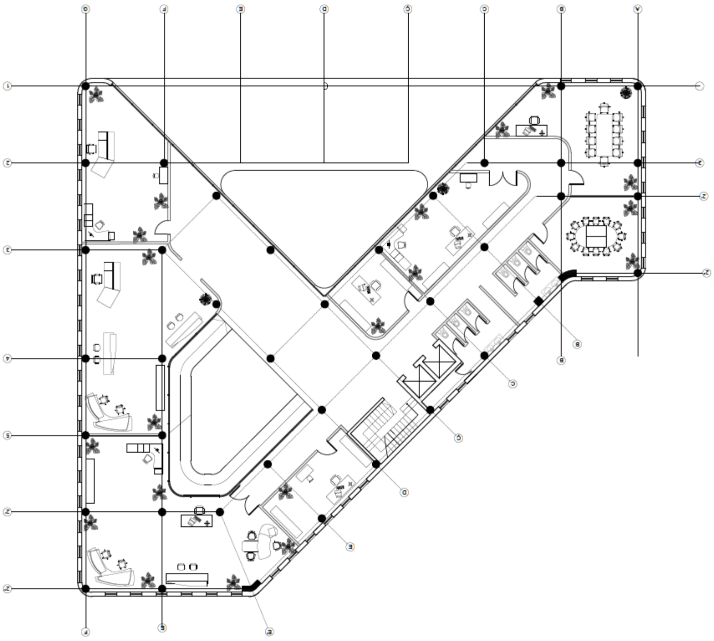


Figure 29: Fourth Floor Plan

3.2.4 Sections

Figure 30: Section A-A

Figure 31: Section B-B

3.2.5 Details

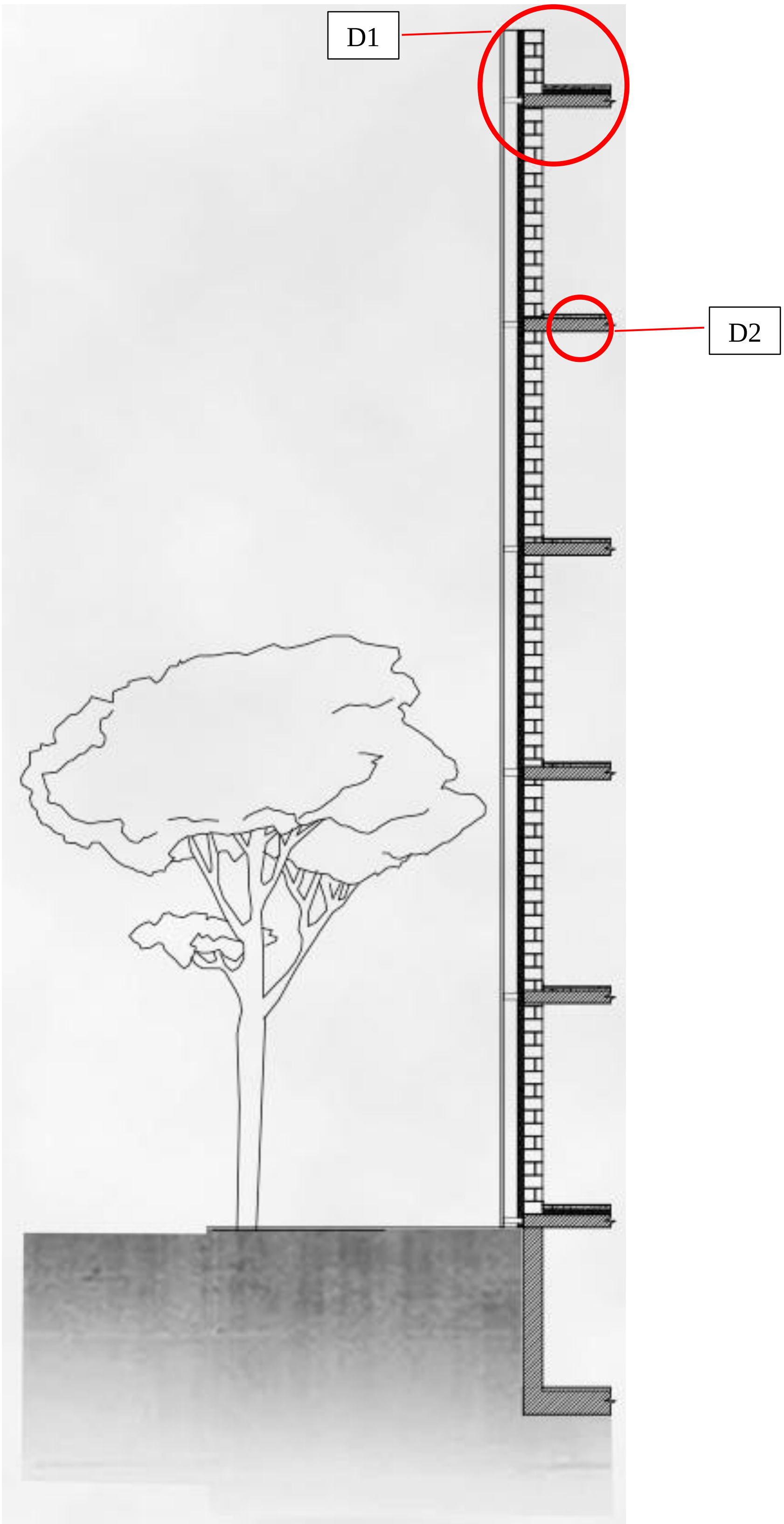


Figure 32: System detail

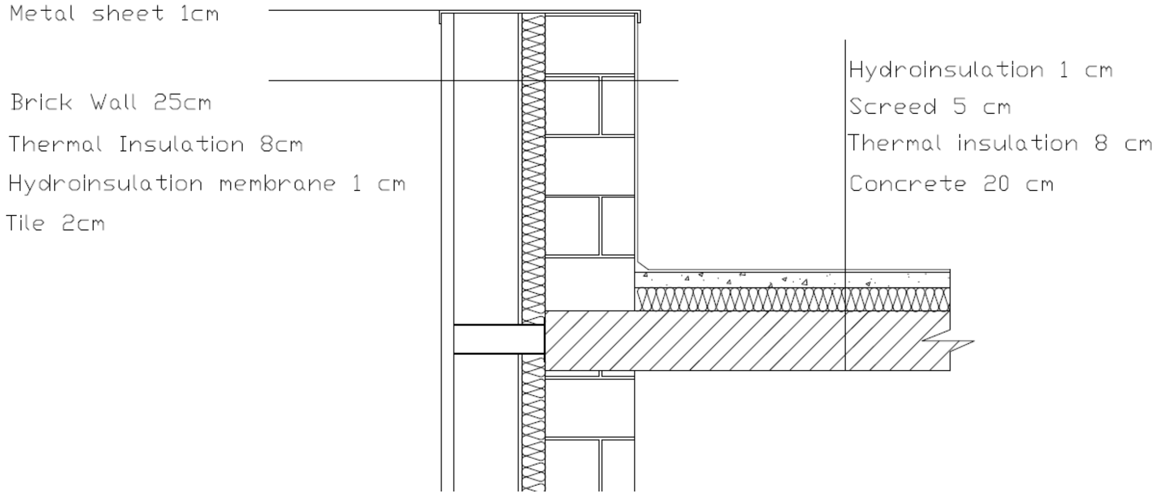


Figure 33:: D1 Roof and Facade detail

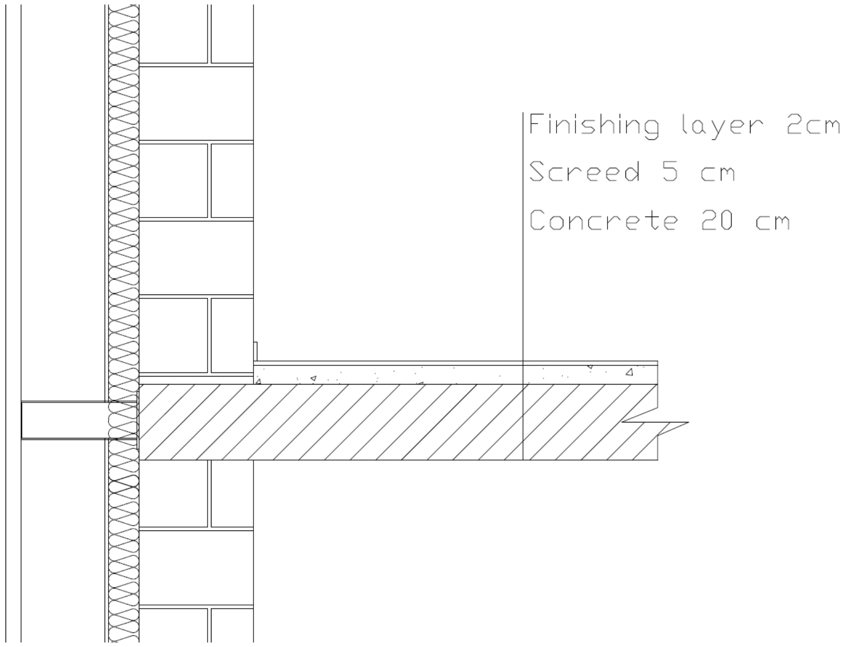


Figure 34:: D2 Floor detail

3.2.5 Elevations

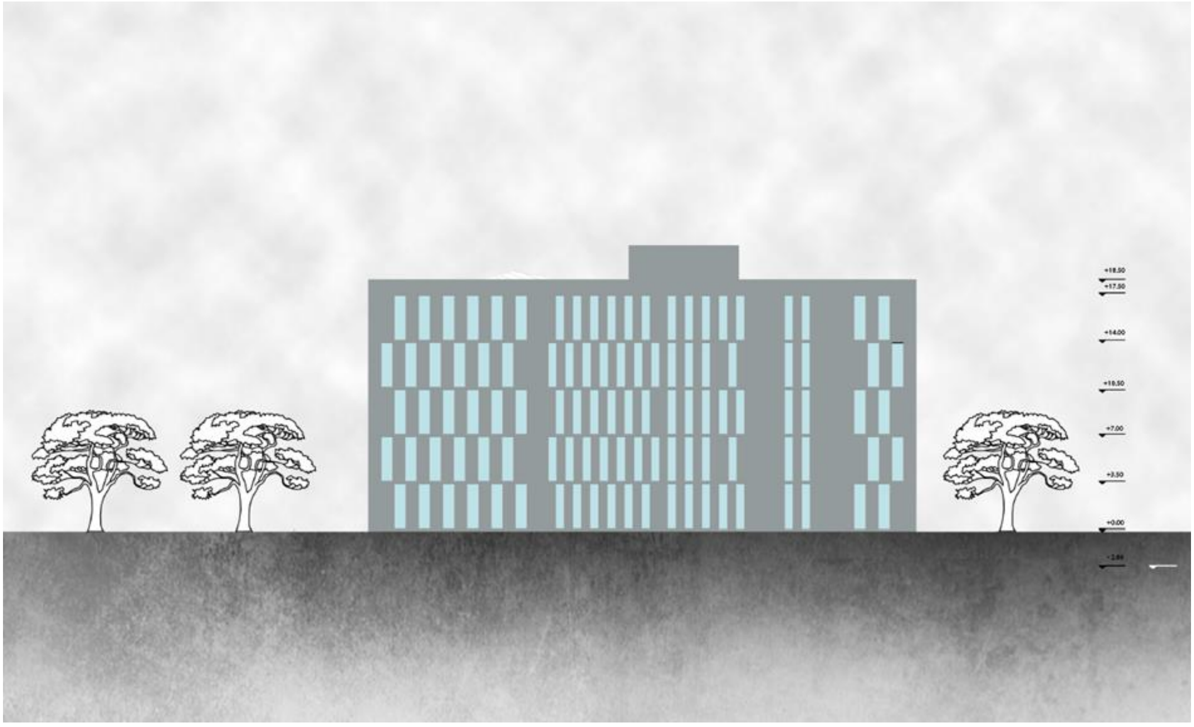


Figure 35: North Elevation

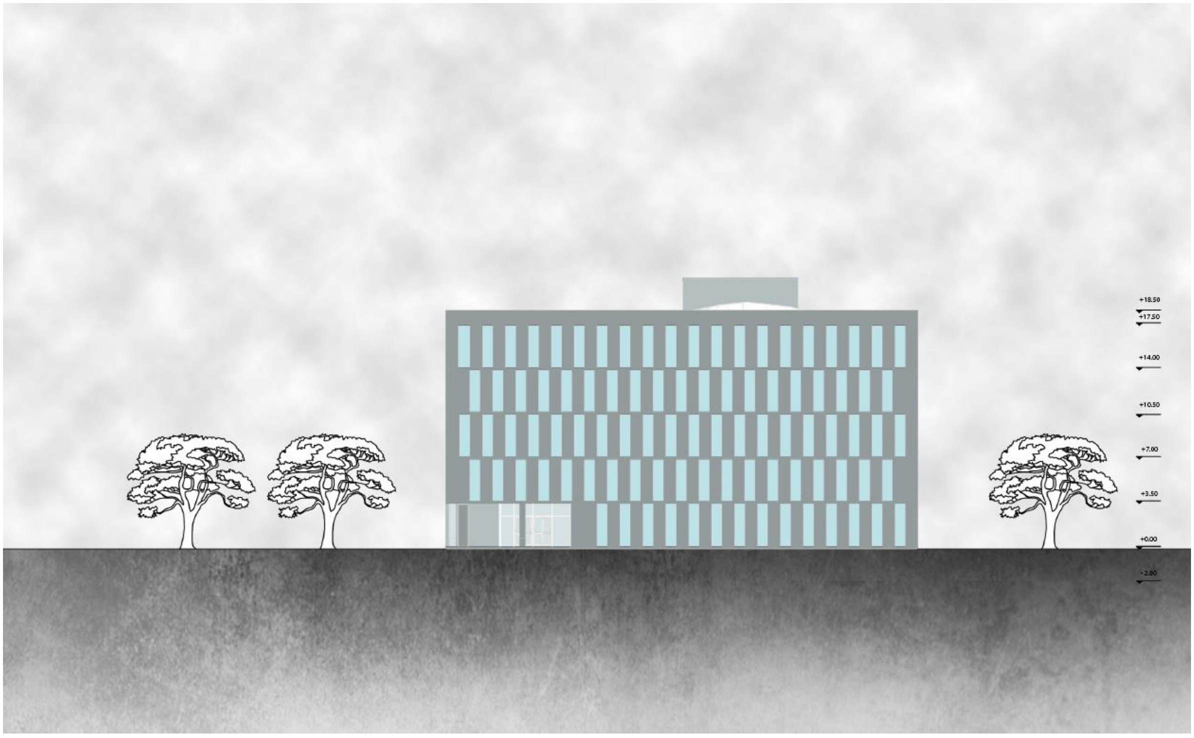


Figure 36: East Elevation

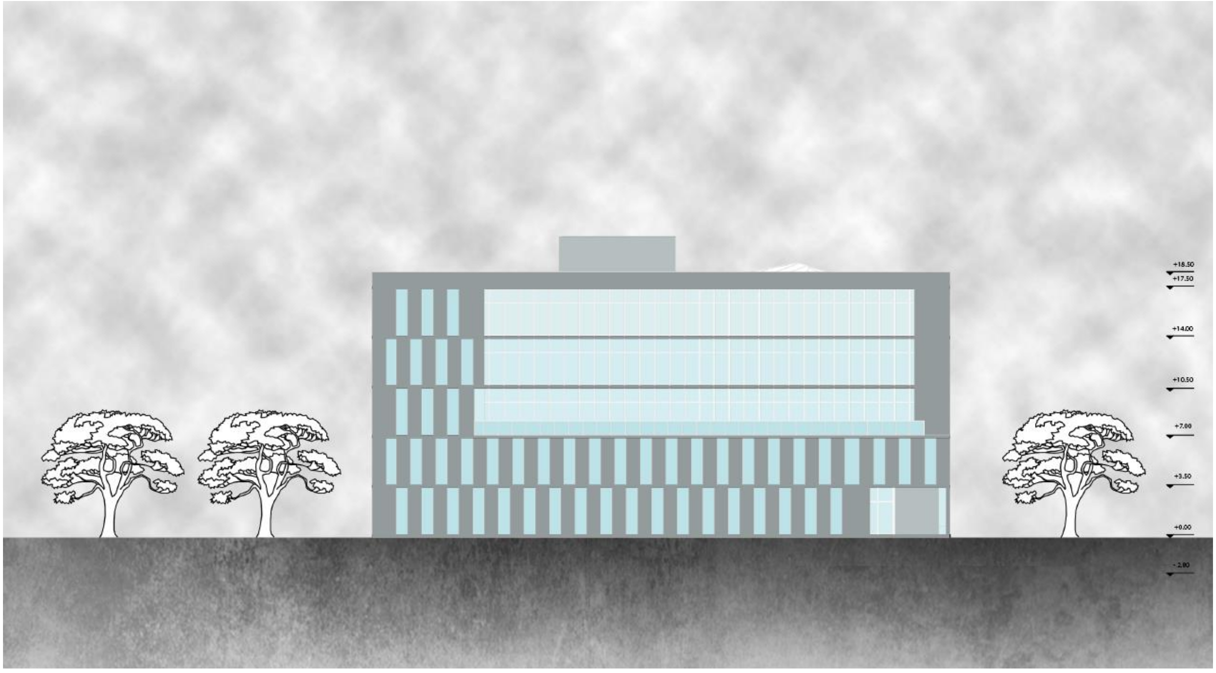


Figure 37: South Elevation

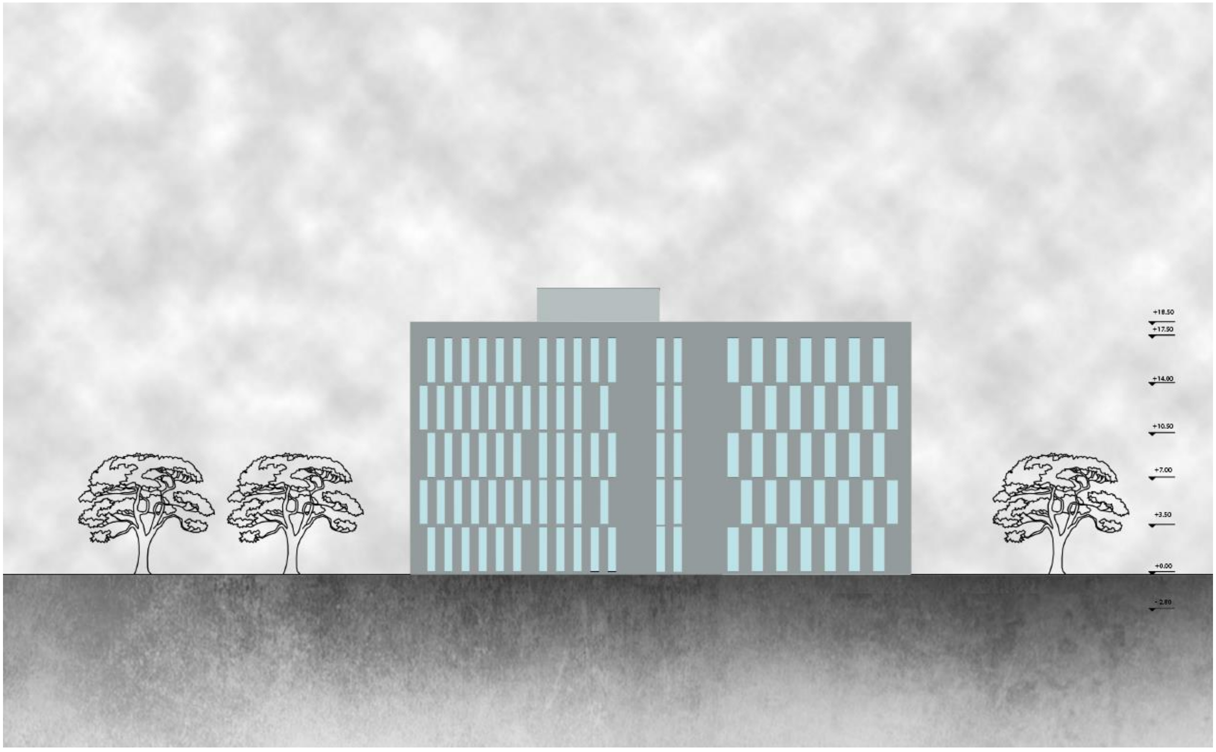


Figure 38: West Elevation

3.2.6 3D Visualization

Figure 39: Render 1

Figure 40: Render 2

Figure 41: Render 3

Figure 42: Render 4

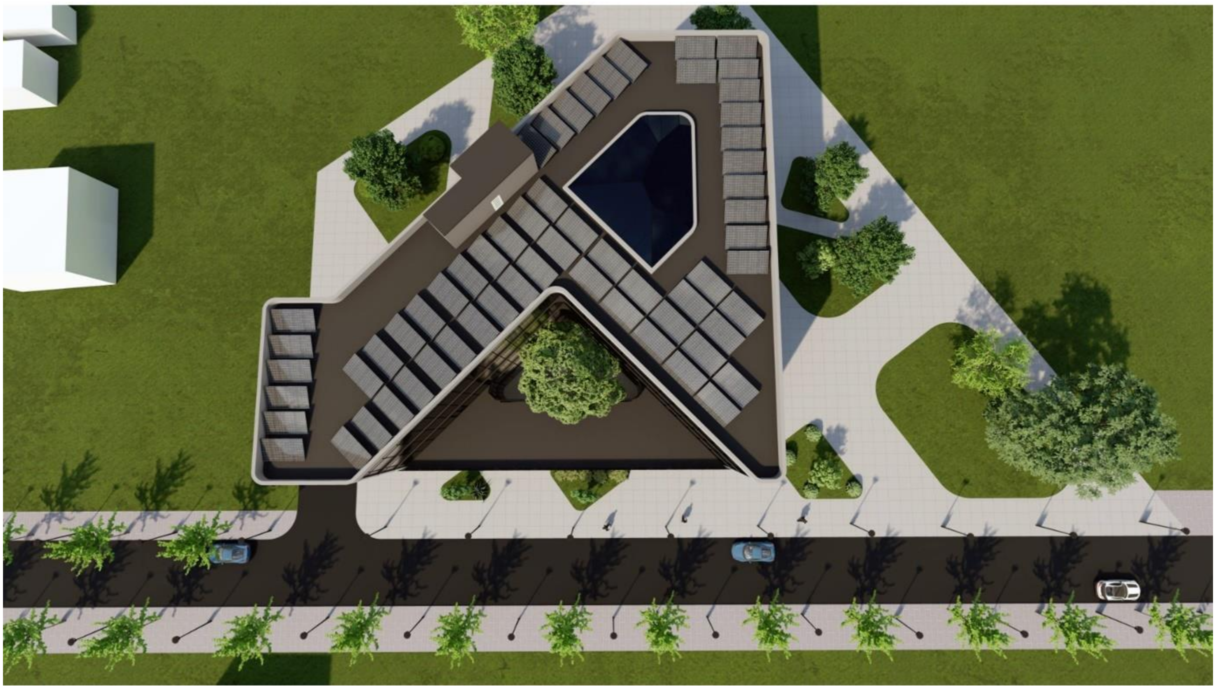


Figure 43: Render 5

3.3 Implementation of Green Systems

- **Solar Energy**

Solar Energy is the most plentiful and pure energy source, which can be used for different purposes ,but here in out Case Study in Tirana Albania, we will use photovoltaic panel to be able to produce electricity as well as to use solar energy for heating and cooling purposes.

With this system we are able to lower the energy cost bill from the grid and get the heating and cooling from Solar Energy. The photo below will show the detail of how this system works and where it is applied.

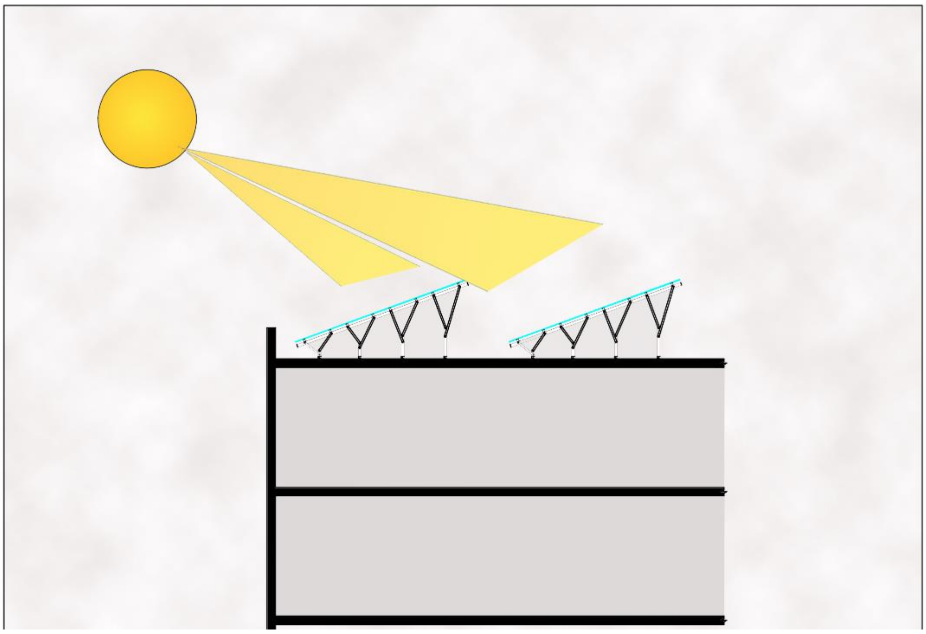


Figure 44: Photovoltaic Panels Detail

- **Rain Water Harvesting**

The terminology used to describe the gathering of rainwater varies greatly. It is also known as rainwater harvesting, groundwater gathering, or roof water collection.
This system catches the water that falls in the roof of the building and saves the water that falls on your roof in containers, it is especially helpful in urban environments. After that, we may use it to provide our building with water on a consistent basis.

Applying this system on our Case Study here in Tirana, Albania gives us free water to use in daily basis.

This system is located in the roof of our building which catches the rain water and after saving it in 2 containers located in the underground parking area.

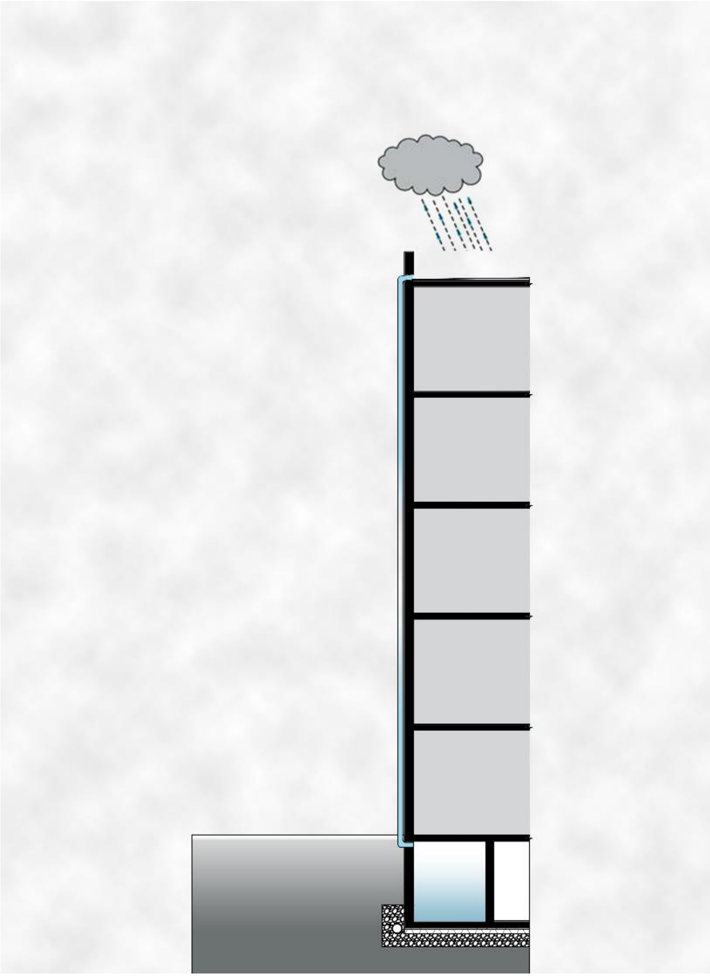


Figure 45: Rain Water Harvesting System

- **Natural Ventilation**

Natural ventilation is the act of moving air naturally that is, without the aid of a fan or other mechanical system through an enclosed area. To provide ventilation and space cooling, it makes advantage of external air flow brought on by pressure differences between the building and its surroundings.

This system is applied in our Case Study in Tirana, Albania by using it mainly in the façade as well as in the atrium as shown in the figure below

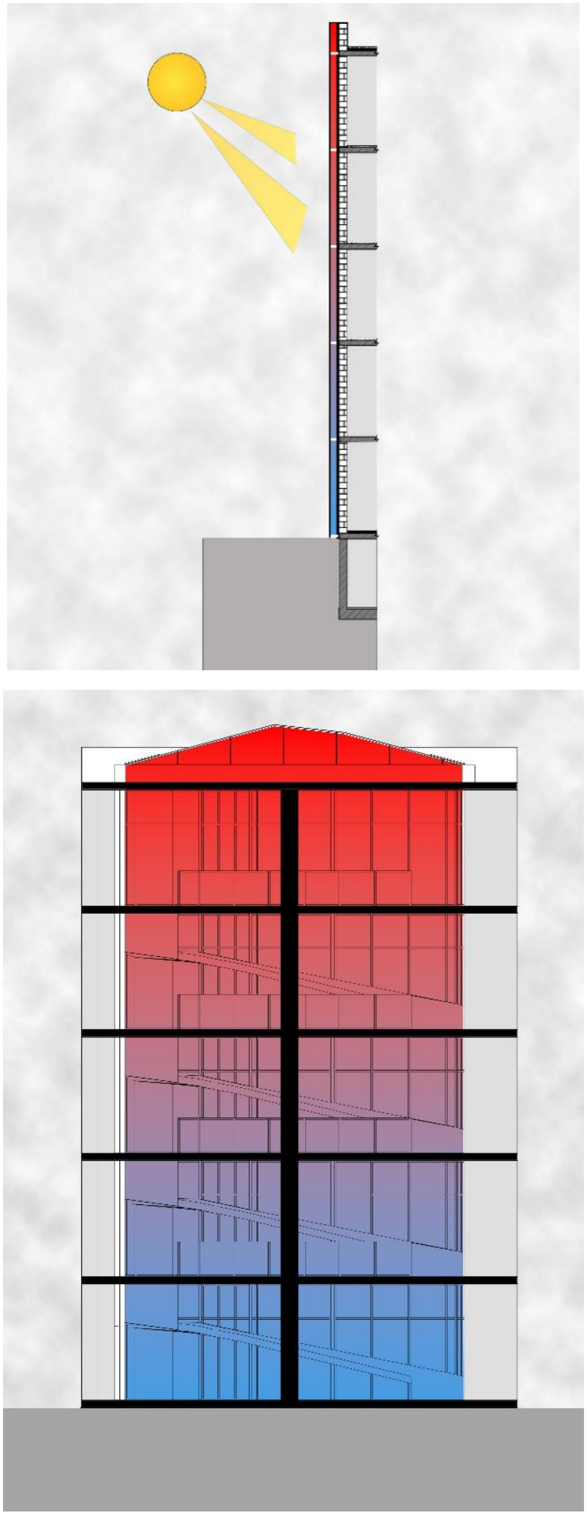


Figure 46: Natyral Ventilation Detail

CHAPTER 4

CONCLUSION

4.1 Conclusions

In conclusion, a green office building is a kind of structure created with the environment and energy efficiency in mind. Green office buildings employ a range of environmentally friendly design strategies and innovations to lessen their environmental effect and raise the standard of comfort, energy efficiency, and indoor air quality.

4.2 Recommendations for future research

There is always room for further research and improvement in the field of green office buildings. Some potential areas for future research include:

1. Optimizing building energy systems: Researchers can continue to develop and improve energy-efficient building systems, such as HVAC systems, lighting systems, and renewable energy systems, to make green office buildings even more energy efficient.
2. Enhancing indoor air quality: More study can be done to determine how indoor air quality affects human health and to provide more practical strategies for doing so in environmentally friendly workplace buildings.
3. Assessing the financial and economic advantages of green office buildings, such as their return on investment, energy savings, and enhanced worker productivity and health.
4. Assessing the environmental effects of green office buildings: Researchers can look at how green office buildings affect local air and water quality, biodiversity, and the usage of natural resources.
5. Examining the part played by green office buildings in fostering sustainable urban development: Academics might look at the contribution made by green office buildings to fostering sustainable urban development and minimizing cities' environmental effect.

6. Creating new materials and technologies for green office buildings: Researchers may concentrate on creating new materials and technologies that will help these buildings be more energy efficient, sustainable, and have better indoor environments.

These are just a few of the many potential areas for future research in green office buildings. By continuing to improve our understanding of green office buildings, we can help to create healthier, more efficient, and more environmentally responsible work environments for the future.

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APPENDIX

Definition of Green Office Building A green office building is a type of building that is designed and built with sustainability in mind. Green office buildings use various sustainable design techniques and technologies to reduce their impact on the environment and improve indoor air quality, comfort, and energy efficiency.

1. **Key Features of Green Office Buildings Green office buildings typically have the following key features:**

- Efficient use of natural light: Large windows and skylights are used to provide natural light and reduce the need for artificial lighting.

- High-efficiency heating and cooling systems: Green office buildings use high-efficiency heating and cooling systems to reduce energy consumption and improve indoor air quality.

- Energy-efficient lighting: Energy-efficient lighting is used throughout the building to reduce energy consumption and improve indoor air quality.

- Water-saving fixtures: Low-flow toilets, showerheads, and faucets are used to conserve water and reduce waste.

- Renewable energy sources: Green office buildings may use renewable energy sources, such as solar panels or wind turbines, to generate electricity.

2. **Benefits of Green Office Buildings The following are some of the benefits of building and operating green office buildings:**

- Reduced energy costs: Green office buildings are designed to be more energy efficient, which can result in lower energy bills.
- Improved indoor air quality: Green office buildings use materials and technologies that improve indoor air quality, reducing the risk of indoor air pollution and improving overall health and comfort.
- Enhanced employee health and productivity: Green office buildings provide a healthier work environment, which can result in increased employee health and productivity.
- Reduced environmental impact: Green office buildings use sustainable design techniques and technologies to reduce their impact on the environment and conserve natural resources.
- Improved sustainability: Green office buildings promote sustainability by reducing waste, conserving resources, and promoting the use of renewable energy sources.

3. **Case Studies of Green Office Buildings There are many successful examples of green office buildings around the world. Some notable examples include:**

- Empire State Building (New York City, USA): This iconic building underwent a major retrofit to improve its energy efficiency and indoor environmental quality. The retrofit included the installation of energy-efficient lighting, HVAC systems, and water-saving fixtures, among other upgrades.
- The Edge (Amsterdam, Netherlands): This office building is one of the most sustainable in the world, with features such as a green roof, energy-efficient lighting,

and a rainwater harvesting system.

- The Crystal (London, UK): This green office building is designed to be highly energy efficient and environmentally friendly, with features such as a green roof, solar panels, and a rainwater harvesting system.

These case studies demonstrate the potential of green office buildings to reduce energy consumption, improve indoor air quality, and enhance sustainability.

4. **Challenges and Limitations of Green Office Buildings While green office buildings offer many benefits, there are also some challenges and limitations that must be considered. Some of these include:**

- Higher upfront costs: Green building materials and technologies can be more expensive than conventional building materials, leading to higher upfront costs for green building projects.
- Lack of standardization: There is currently no single standard or definition for what constitutes a green office building, leading to a lack of consistency and standardization in the industry.
- Limited availability of green building materials: In some regions, green building materials and technologies may be limited or not readily available, making it difficult to construct green buildings.
- Maintenance and operation costs: Green building systems and technologies may require more maintenance and operation costs than conventional building systems, which must be factored into the overall cost of the building.

Despite these challenges, the trend towards green office buildings is continuing to grow as the benefits of sustainable building practices become more widely recognized. With the right approach and planning, green office buildings can provide a healthier and more sustainable work environment for occupants while also reducing environmental impact and saving on energy costs.