T.C.

ISTANBUL AYDIN UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

"ARCHITECTURE & ENERGY"
STRATEGIES TO ACHIEVE ZERO ENERGY BUILDING

MASTER'S THESIS

Kamar ATTAL

Department of Engineering

Energy Technology Program

May, 2023

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Thesis Advisor: Assist. Prof. Dr. Eylem Gülce Çoker

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APPROVAL PAGE

DECLARATION

I hereby declare with respect that the study “Architecture & Energy” Strategies to Achieve Zero Energy Building, which I submitted as a Master thesis is written without any assistance in violation of scientific ethics and traditions in all the processes from the project phase to the conclusion of the thesis and the works, I have benefited from are those shown in the References. (4/May/2023).

Kamar ATTAL

FOREWORD

This thesis was written for my master's degree in Energy Technology Program with specialization in "Architecture & Energy" Strategies to Achieve Zero Energy Building at the Istanbul Aydin University, Istanbul. The subject of this thesis is related to Architecture & Energy, Naturalistic Behavioral observation of road users. This is a very fascinating research topic as it is a blend of technical and social sciences ranging from pure transportation concepts to human behavioral and habitual characteristics.

After thanking Allah Almighty and my family for their endless support, I would like to thank a few people here. I am grateful to my supervisor (Assist. Prof. Dr. Eylem Gülce Çoker) and Dr. Mhd Wasim Raed for their guidance's, reviews, and recommendations. Especially who has been guiding me every step of the way as we worked together on this review. These people were always present to help me with my research whenever I needed them. Working with these people was a steep learning curve for me as they did not only polish my research skills but also gave me an insight into the dimensions of the real Energy and its impact on architecture.

May, 2023 Kamar ATTAL

“ARCHITECTURE & ENERGY”
STRATEGIES TO ACHIEVE ZERO ENERGY BUILDING

ABSTRACT

Zero energy buildings are about integrating architecture and energy technology into one place. During recent years, climate changes have emerged, with increasing global warming issues. Commercial and residential buildings were considered the largest consumers of energy. More people are becoming environmental activists, including governments, merchants, and commercial property owners. Which helped the architectural designers to work with alternative energy engineers, structural engineers, and others, and to learn about the latest technology. Therefore, architecture tends to design zero-energy buildings. In this paper, Strategies and applications are presented to achieve zero-energy buildings (ZEB).

Keywords: Zero Energy Building, Strategies, ZEB, Digitalization, Case Study.

“MIMARLIK VE ENERJI”
SIFIR ENERJILI BINAYA ULAŞMA STRATEJILERI

ÖZET

Sıfır enerjili binalar, mimariyi ve enerji teknolojisini tek bir yerde birleştirmekle ilgilidir. Son yıllarda artan küresel ısınma sorunlarıyla birlikte iklim değişiklikleri ortaya çıkmıştır. Ticari ve konut binaları en büyük enerji tüketicileri olarak kabul edildi. Hükümetler, tüccarlar ve ticari mülk sahipleri de dahil olmak üzere daha fazla insan çevre aktivisti haline geliyor. Bu, mimari tasarımcıların alternatif enerji mühendisleri, yapı mühendisleri ve diğerleriyle çalışmasına ve en son teknolojiyi bilmesine yardımcı oldu. Bu nedenle mimarlık, sıfır enerjili binalar tasarlama eğilimindedir. Bu yazıda, sıfır enerjili binalara (ZEB) ulaşmak için stratejiler ve uygulamalar sunulmaktadır.

Anahtar Kelimeler: Sıfır Enerji Bina, Stratejiler, ZEB, Dijitalleşme, Vaka Çalışması.

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LIST OF ABBREVIATIONS

HVAC **:** Heating, ventilation, and air condition

NZC **:** Net Zero Carbon

NZEB **:** Net Zero energy building

PV **:** Photo Voltaic

ZEB **:** Zero energy building

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I. CHAPTER A.

A. Introduction

Some people may think that architecture is the design of buildings only, but it is a misconception. Architecture is not only a design, but rather it is full of different aspects, including the aesthetic aspect, integrating the environment into the building, saving energy, integrating the "use" of technology inside the building.

Some may say that technology does not have a factor within architecture, but most of the modern designs depend on different types of technology, the most important of which are fire detection systems and security systems. Heating and cooling systems, movable facade systems, control systems, alternative energy systems and other energy-saving systems. Therefore, the architect should be well acquainted with the latest technologies, and be in contact with the electrical, mechanical, structural, and other engineers during the design of the project.

Architecture tends towards zero-energy buildings, which have different definitions, including green building, zero-energy buildings, ZCB, sustainable building, and other names, but they are also energy-producing. This type of building has grown over time and during the increase in climate change solutions, issues global warming in recent years. Buildings are considered one of the largest consumers of primary energy, as they use 40%.

The demand for energy increases dramatically during the increase in the needs and services of comfort. Here comes the concept of zero-energy buildings.

In order to reach zero-energy buildings, it includes many steps, including site selection, site study, weather study, direction of the building to be designed, design, selection of building materials, natural lighting, landscaping, green roofs, air catcher "natural ventilation", water recycling, heating and cooling systems, carbon-neutral buildings, alternative energy including solar energy, photovoltaic glass, wind energy, linear energy, biomass system, smart building, energy efficiency.

In this paper, we will see these steps in detail, with a case study of office building.

B. The Concept and History of Green Building and "ZEB"

Throughout nature, we find various examples in the shelter of animals and insects combined from nature. Such a way that it is difficult to notice these houses, including spiders and their weaving of threads in different forms integrated with the surrounding nature.

Bee houses in trees or mountains in a polygon shape with no spaces between them, and ant houses in the earth use a special material that is filtered from poor mud to conduct heat, to provide the inside of the building with moisture and heat.

When we return to the history of man with architecture, we will find many civilizations that merged architecture with the surrounding environment and clearly preserved the environment. From these civilizations the Pharaonic civilization, the roofs of the pyramids were directed towards the original directions with high accuracy, and the temples were directed where the rays reach the interior on the day one a year Fig (1, 2).

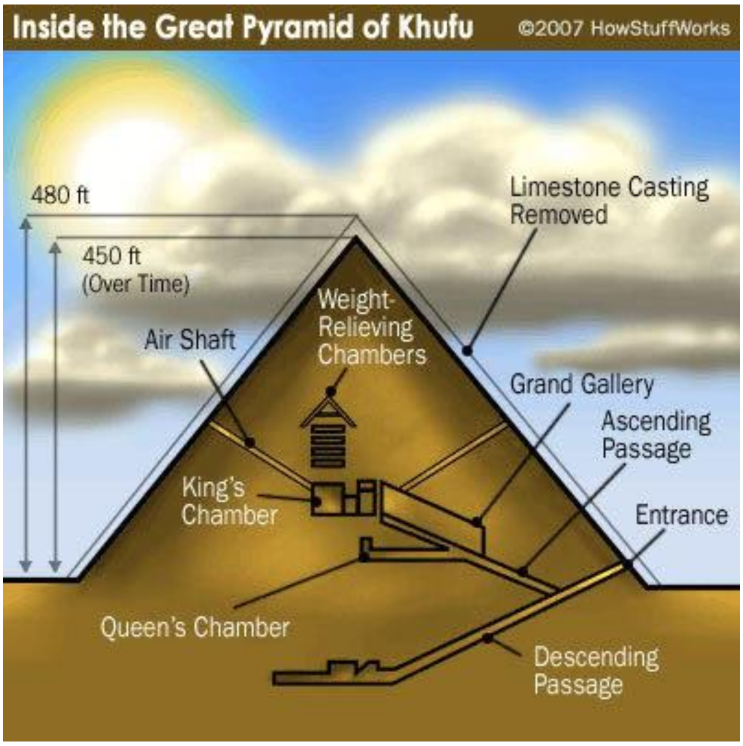


Figure 1 Inside the Great Pyrramid of Khufu [(2021), Information about the pyramids]

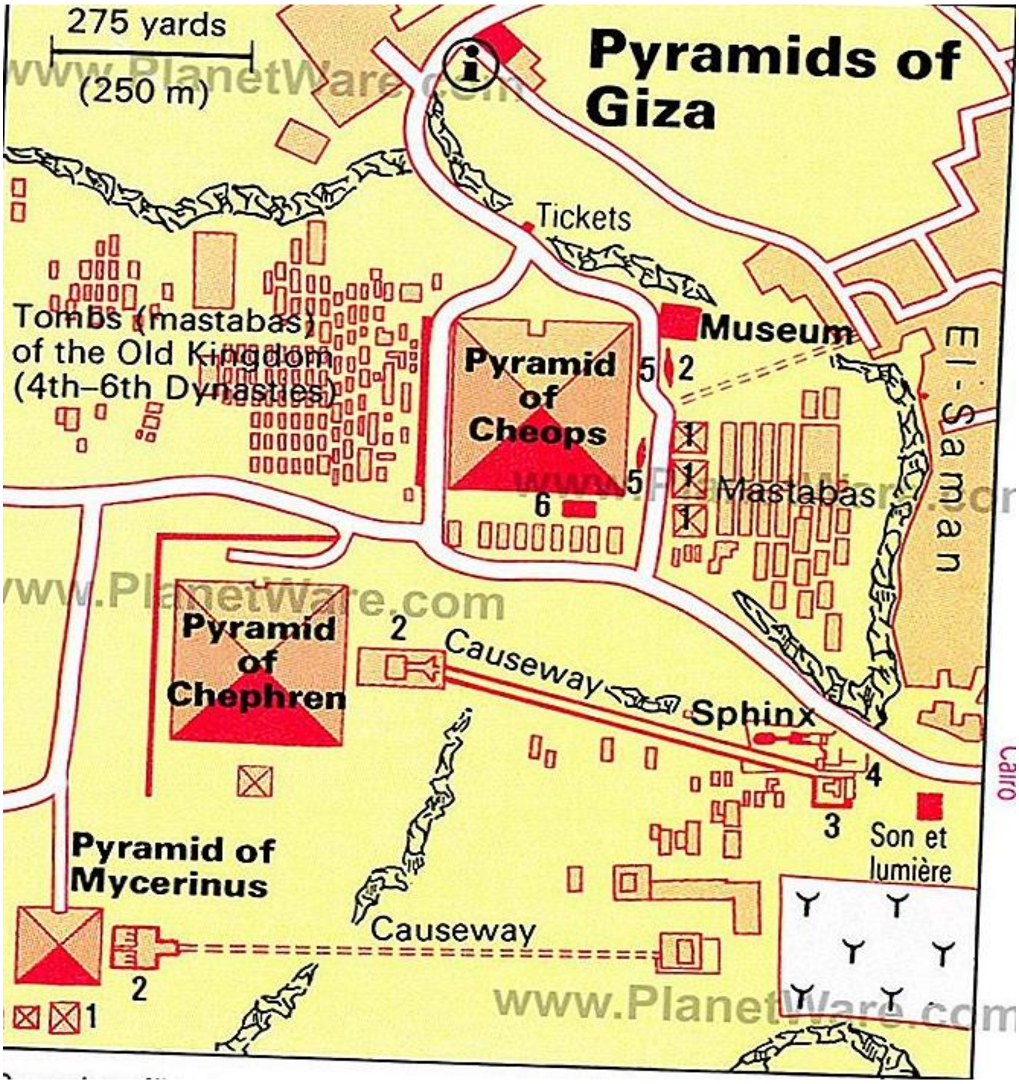


Figure 2 Pyramids of Giza Area [(2022), "The Pyramids of Giza: Attractions, Tips and Tours"]

As for the Greek civilization, they used the sun's rays for heating inside the building. When planning the city of Olinith, the streets were directed at equal angles to receive the sun's rays evenly. The building faces the eastern side, with large openings on its western side.

Pablo Bonito (New Mexico, America, designed in the form of a semi-circle in the form of terraces in a style that considers the angles of the sun in summer and winter, building materials of mud bricks, which absorbs heat during the day and during the night, radiates it in the air at night, thus making it moderate temperature throughout the day, the roof is made of mud and thatch, which insulates heat.[ADEL, Y., (2016), H. AYMAN, (2016), AYMAN EL-HADI**, (**2011), AYMAN EL-HADI, (2016)].

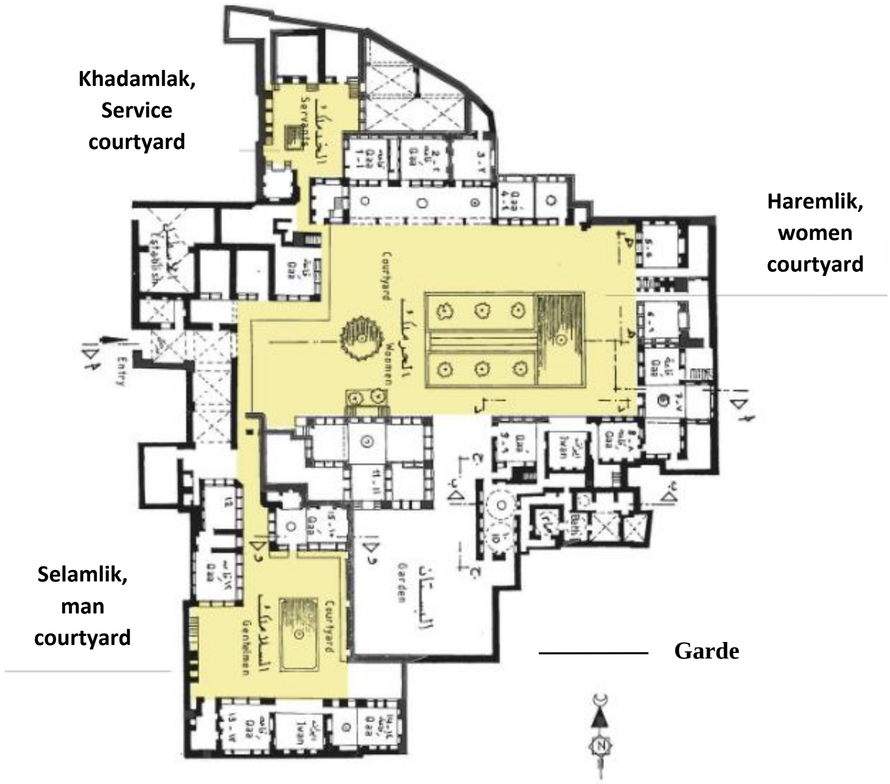


Figure 3 AL- Azm Palace [(20 October 2022) , ‘’Courtyards’’]

Figure 4, 5, 6 The Colors of the Damascene House [(20 October 2022) , ‘’Courtyards’’]

There is Islamic architecture and Araba houses are characterized by natural ventilation and its integration with nature, natural lighting throughout the day, and building materials of stone that acts as a heat insulator, and from it different colors, the inner courtyard, and other features. Like Triple courtyards functional gradation of the courtyards in the Damascene houses, first Haremlik, living area for women and women gest, second Selamlik man, and man gest, third Khadamlak, serves living, cleaning and kitchen. Fig (3, 4, 5, 6)

C. Go Back Green, Zero Building “Environmentally Friendly”

Buildings use nearly 40% of global energy, 20% of energy and 20% of quantitative carbon dioxide emissions. This helps reduce global warming, when green building applications and zero building applications are used, pollution is reduced or not.

The phenomenon of global climate the climate is changing rapidly in some developing countries and does not pay attention to environmental issues, which will be the cause of global pollution problems in the coming years. Environmental trends have emerged aimed at preserving the environment, living in a healthy way, and preserving the future, which is the main goal of “green buildings, zero energy, environmentally friendly.”

Through the design, construction, construction, and operation of the green building system "ZEB" contributes to reducing the negative impacts of construction and human intervention in the environment. Through design and full use of available resources, land, materials, energy, and land. Saving energy during the construction and operation process with modern methods of construction, materials and working smartly to reduce energy consumption. The life cycle of the building is studied during the design and construction process, methods of operation, long-term use, energy needs of users, and the overall reduction of resources and cost. Using locally available materials reduces the total cost, using materials that can be reused or reused.

Zero building provides a better environment for consumers, the consumer enjoys sunlight, natural lighting, and natural ventilation, and reduces exposure to toxic substances that help in activity, vitality and living a better life. When building green or energy-free buildings, the government offers tax incentives, a significant tax cut, and better yields and interest rates. With alternative energy, energy is saved, and bills are reduced [K.UJJVALA, (2022), INES GENDRE, (2022)].

When demolished after the zero-building life cycle ends, it is reused or recycled. Wood, clay, brick, and stone can be recycled or reused on their condition. On the other hand, iron is recycled and used again, and concrete as aggregate for future construction. This has to do with the architect and his choice of materials, according to the terms of no “ZEB” buildings.

II. CHAPTER B

A. Definition of Sustainable Buildings

Sustainability is the achievement of human well-being and development while preserving natural resources. Sustainability is achieved by dealing with the environment in a big way, taking advantage of its multiple resources, researching the development of building methods, designing cities, planning and residential complexes, and so on. Serves people and the environment and preserves human health by using alternative and renewable energy sources. There are five factors considered for a sustainable environment (ecosystem, energy, material type, waste, and mobility) [ROGER MORRISON, (2021), KRISTIN HOHENADEL,(2022), SABA NIRPANI, (2021)]. Design a building that consumes energy, natural materials, and water in the least possible way: alternative energy, such as wind and solar energy, automatically helps conserve and save energy, and uses it for cooling, heating, and lighting, and recycles wastewater for irrigation. Gardens, recycled building materials, and environmentally friendly buildings are designed, implemented, operated, maintained, and Recycled at the end of its life, considering the surrounding environment and energy reduction [BETH YANG, (2018)].

Principles of Sustainability in Architecture: Formation of the Building Related to the Environment Around it: On the roads Integrate the building, service provision, roads and communicate in the best possible way with the natural environment. Promoting a connection with nature, such as gardens and green roofs, is an important component of green design [ROGER MORRISON, (2021)].

Energy Efficiency: The field of sustainable architecture is moving towards reducing energy consumption as much as possible and making the building produce the largest amount of its energy by using alternative energy, solar energy, wind energy, and others. While designing, the designer should consider at least the procedures involving the use of the building. Possible energy in the process of heating, cooling, and lighting by using products that provide energy conservation and energy saving. The two stages of construction and operation of the building with the least possible negative impact on the environment and the lowest cost [ROGER MORRISON, (2021), BETH YANG, (2018), SALMA MOUNIR, AZZA REDA ABU AL-SAUDSaud, (2021)].

Reduce Energy Consumption: It is a large and complex step that must be carefully thought out. Emphasis is placed on air conditioning systems that consume a large amount of energy and thus reduce the environmental impact of the building. Architects consider when designing the building's orientation, the direction of the sun's path in the sky, the wind circulation pattern and the building's appropriate materials for its surrounding environment. In the event of a high temperature, proper ventilation is essential in the design. Air conditioning is used most of the time, but another method is indoor gardening or patios to allow the air to move smoothly and cool the air naturally and healthily. If the building temperature drops, ventilation is an important component and sufficient layers of insulation to keep the building warm, using large windows for natural lighting and heating the place with sunlight. But glass is not a good heat insulator, so narrow double glazing is used to reduce heat loss [ROGER MORRISON, (2021)].

Intelligent User Design: Design that helps promote interaction between people and sustainable buildings. Achieving continuous efficiency and the relationship between the mass, the movement spaces, the building configuration, the used space, and the technological and mechanical system in the building. Considering the user's daily life and needs, the building design must meet some conditions. The building is designed to enjoy a long and easy life with flexibility in lifestyle [ROGER MORRISON, (2021), SALMA MOUNIR, AZZA REDA ABU AL-SAUDSaud, (2021)]. The design has been adapted to the principles of the surrounding environment.

B. Definition of Environmental Architecture

It is a way of adapting to buildings in the external environment and preserving natural resources and ecosystems for a better future. The environment is things that surround us and affect the existence of living organisms, and architecture considers the environment as one of the main axes of sustainability. It uses specific materials and selected products with distinctive characteristics, and it is one of the most important strategies in integrating the environment and architecture, these materials provide advantages for the environment and the population: maintains the safety of residents and preserve their health, rationalization in energy consumption, flexibility in design, reducing maintenance costs, helps rationalize dwindling natural resources, reduces the environmental impacts associated with the building materials industry [EURONEWS, (2021), ANS GLOBAL, (2021)].

1. The Influencing Relationship with the Common Factors Between Environment and Architecture

a. Climate

It is affected by the temperature above the earth's surface throughout the day, from sunrise to sunset. Heat emissions from the earth that are not affected by the change in the temperature above the earth’s surface, and the effect of night and day, summer, and winter, and when we head inside the earth, we reach what is called thermal stability, where there is no difference between temperatures.

b. Energy

Buildings consume a lot of energy. There are many factors that can gain heat from the sun, the morphology of the earth: the half of the earth facing the sun gains more heat than the half of the earth facing the other side, the mass of the building: if the building is several adjacent blocks or close to each other so that the buildings are shaded with each other , which reduces heat gain, and if the building is a single block, increases heat gain. Building orientation plays a major role in heat gain. Orienting the building towards the original four directions, the north gets the heat of the morning, so it is customary to make the largest facade towards the north so that the sun sets and directs the lightest sunlight to the western facade. Design: In most designs, there is a patio that allows air movement and helps in natural ventilation. During the day, the building absorbs heat from the walls and ceilings, but the courtyard gets cooler at night and the cold seeps into the building during the day and lowers the building's temperature.

c. Building Materials

One of the most important building elements is the selection of environmentally friendly building materials and the ability of buildings to preserve heat or prevent it from being gained from the surrounding environment. Building materials have the characteristics of heat reduction, heat insulation or delaying heat conduction, waterproofing and many other properties, and this depends on their composition, thickness, color, and surface texture [(2021), “The Relationship between Architecture and Environment”].

D. Zero Carbon Building

It is a highly energy efficient building produced on site, using renewable energy that does not produce carbon. To reduce NZC is replacing unsustainable, or low emission building materials, changing practices that increase carbon emissions. Building materials are replaced at a level of less carbon dioxide per kilogram. To achieve ZEB, NZE, zero or zero carbon emission is one of the basics (ZCB).

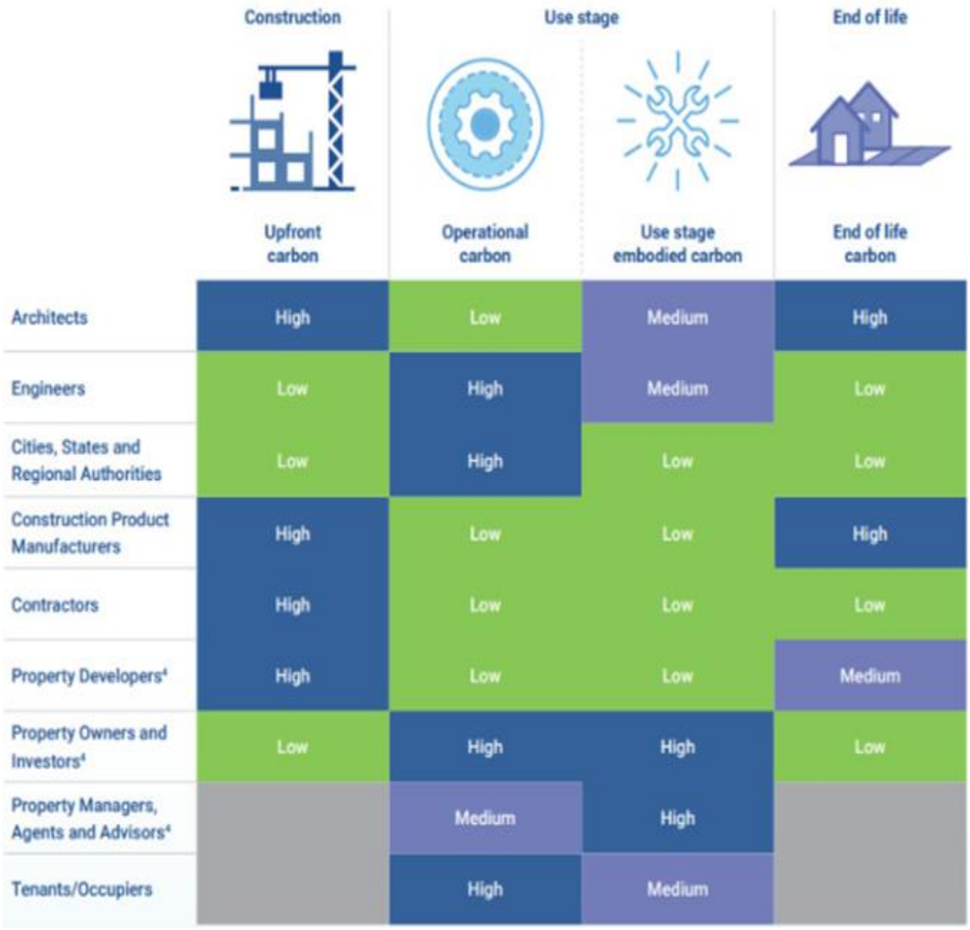


Figure 7 Zero Carbon Building [SPONSORED POST, (16December 2021)]

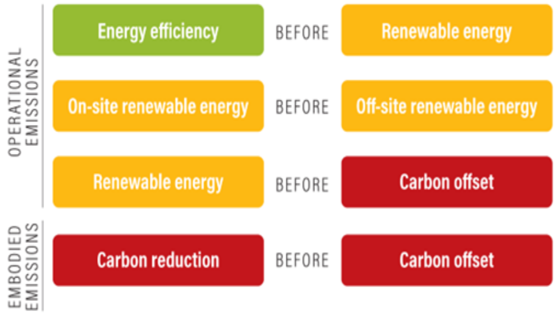


Figure 8 The Order to Achieve ZCB [SPONSORED POST, (16December 2021)]

Net-Zero Carbon = Total Carbon Emitted - Total Carbon Avoided to Achieve ZCB: There are many ways to achieve ZCBs through gathering between energy efficiency, renewable energy, and carbon offsets, in the following order of priority

{KRISTIN HOHENADEL,(09des 2022)}:

During efficient construction, more carbon is avoided. The energy needed can be supported by renewable energy. In addition to the laws of the governments, and the municipality, to achieve different degrees of influence ZCB. These principles are designed to make ZCB easier to reach and turn it into an easy target to reach. [(2020) , “5 Strategies to Consider to Achieving a Net Zero Building (NZB)”]

E. Definition of Green Architecture

It is an architectural design technique that is created in line with the surrounding environment of the building and the greater focus on the effects that will be left behind, as green architecture gives an accurate meaning to the design of buildings or homes that are energy-saving or environmentally friendly. The surrounding environment is an essential component of green architecture. It has a strong influence on the shape of the building, the design, and the way the building works [IBRAHIM JAWAD KAZEM AL-YOUSSEF, SHAHD ABDEL ABBAS HAMOUDI, (2018), MOAMEN BANI MUSTAFA, (202), GREEN BUILDING, (2020)].

The goal is environmental protection. The building is designed to adapt and integrate with the surrounding environment in terms of space and consumption of materials and energy. The site survey must be studied, the climate and the surrounding environment study, and how it will affect the design that will be implemented.

1. The Importance of Green Architecture for the Environment

Currently, the world is directed to the most sustainable and environmentally friendly building, where engineers face the challenge to make the building less harmful to the surrounding environment [MOAMEN BANI MUSTAFA, (2022)].

2. Therefore, Some Principles of Green Architecture Must be Known

1. Energy sufficiency.
2. Efficient use of water.
3. Efficiency of land use.
4. Reducing the environmental impact and preserving the natural environment.
5. Characteristics.
6. Adequacy of the material.
7. Low maintenance costs.
8. Waste Reduction.
9. Use of renewable energy.
10. Indoor environment quality [IBRAHIM JAWAD KAZEM AL-YOUSSEF, SHAHD ABDEL ABBAS HAMOUDI, (2018), MOAMEN BANI MUSTAFA, (2022), GREEN BUILDING, (2020)].

F. Definition of Zero Energy Building

Zero-energy buildings (ZEB) are described by saving a large portion of energy by applying renewable energy sources and technologies. The basic idea of zero buildings is to get the required energy from renewable sources of energy, available locally, low cost, non-polluting.

(ZEB) is defined as high energy performance (URL-2) and exhibits low primary energy consumption (fossil-based energy). Through the integration of renewable energy technologies and modern construction methods, to generate an amount of energy greater than the amount consumed. In this case, we can solve one of the biggest problems, such as eliminating the risk of carbon emissions by reducing dependence on the use of fossil fuel energy.

There are other names such as green architecture, lack of energy, sustainable architecture, environmentally friendly buildings, and others. After studying the area for the land selection, he designs structures that are sensitive to the ecosystem and integrated with nature in terms of design, construction, and life cycle assessment. Considering the social life and environmental standards. These structures are considered suitable for the climatic data and the environment of their site. They are designed in harmony with the use of renewable energy and the use of natural materials so that the production of the amount of waste is reduced (2019, Association Environmentally Friendly Buildings, Eco-Friendly). Zero energy buildings produce what they need from the consumed energy. During the year it can produce enough energy for daily consumption and more in some cases. In some environmentally friendly buildings, when there is a sudden change in weather conditions, the building resorts to using the main electricity grid to compensate for the energy shortage. The building's alternative energy needs are met, and the excess energy is returned to the main network when the weather improves. [BIG RENTZ, (2021), ADMIN, (2022) , THE NATIONAL INSTITUTE OF BUILDING SCIENCES, (2015)] The building gives energy same of the energy consumed, *there are two types of buildings after the study:*

1. A positive energy building is production exceeds consumption.
2. Near-zero energy buildings are production is lower than consumption [ADMIN, (2022)].

G. Difference Between Green Buildings and Zero Energy Buildings

ECO, sustainable, and green buildings often demand the use the most natural resources with less energy consumption to be used in the building. While zero-energy buildings utilize all energy from natural resources and consume zero energy.

The goal of sustainable architecture and green buildings is to benefit from resources while minimizing the negative impact of the building and the surrounding environment. Zero-energy buildings achieve an important goal, which is to produce as much renewable energy as you consume throughout the year. This helps reduce greenhouse gas emissions. ZEB goals for the design process must be defined and set.

The green building differs in a way that it takes into account all the environmental influences, including water pollution and the use of materials, on the other hand ZEB focuses only on the energy consumption used in the building to produce the same amount of energy consumed, and more than the energy needed from the renewable energy source.

Other aspects such as using recycled building materials and minimizing waste, ZEB may or may not be considered "green". Given that other green structures require fossil fuels and "or" imported energy to meet the requirements of the population, they are habitable. In contrast, ZEB has a much lower environmental impact during the life of the building.

Green building technology can be called "green building" in terms of resource efficiency from design, implementation and beyond to the demolition stages [K.MEAGHAN, (2011), K.MEAGHAN, (2016), ADEL, Y., (2016), (2016), ‘’What is Zero Energy Building?Difference between Green Building and Zero Energy Buildings’’].

III. CHAPTER C

A. Strategies to Achieve Zero Energy Buildings

Global warming issues are increasing with the passage of time, the trend towards zero-energy buildings is increasing. In this chapter, we find the sequential steps to clarify the access to zero-energy buildings. [SPONSORED POST, (2021), SIMON WYATT, (2020), "Zero Energy Buildings – Features, Benefits and Materials", "How to Achieve a Net Zero Energy Building", JESUS ARCAS, (2020), JOE EMERSON, OTHERS,(2017), (2020) , "5 Strategies to Consider to Achieving a Net Zero Building (NZB)", BILL GILLIES, NREL, (2015), BIG RENTZ, (2021), ADMIN, (2022), STEVEN ASSOCIATE, (2016)]

1. Site Selection

It is the process of assessing the physical, mental, and social characteristics of specific sites with the ambition of developing an architectural solution that addresses and enhances its internal and external context. The choice of the site varies according to the requirements and circumstances, the budget, and the project, if it is a residential complex, mall, company, and other projects. The owner may have to look for a new site to suit the project and labor requirements. Customers come with a specific land to start the project. During this stage, the earth and its layer are studied. The types of soil on the earth are rocky, sandy, and silty. Conducting an analysis of the surrounding areas of religious centers, residential areas, commercial places, empty lands, and surrounding projects in the land. The impact of the project on the community and the activities surrounding it in a positive way. By integrating, developing, and urging the development of the region, which will benefit the community in a positive way. [ENGMARWA, (2021), KARISSA ROSENFIELD, (2022), ABDUL QADIR AL-AWAJ, (2018)]

2. Site Analysis

After selecting the site for a zero-energy building, the site is studied. This is an important point for identifying the site, which helps in directing the building and choosing the location of the main entrances, the secondary doors of the building, and other important matters. It is considered.

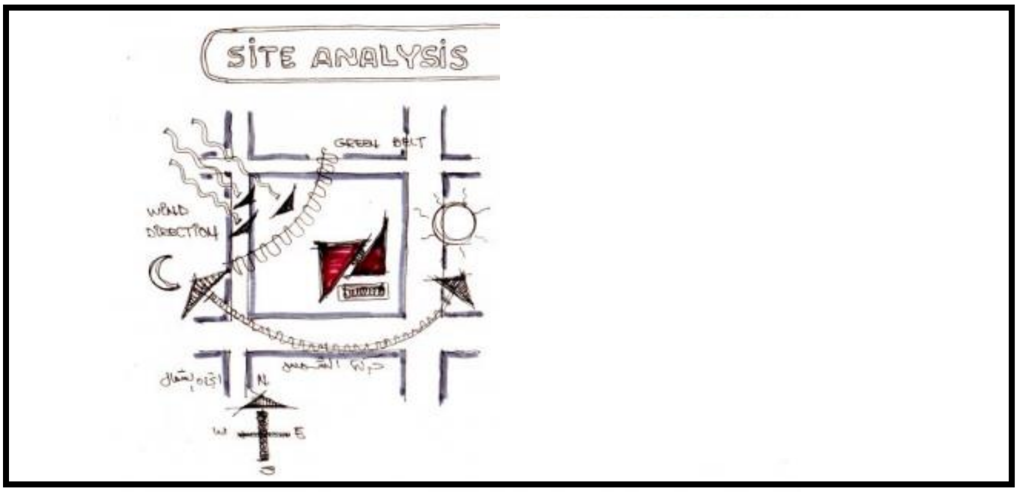


Figure 9 Site Analysis [ENGMARWA, (13 June 2021)]

3. Traffic and Mobility

Find out if the main streets are crowded for sound insulation, or quiet, private means of transportation, the direction of movement of cars, government means of transportation, and areas of stations closest to the project, and these are the strengths of the project [ENGMARWA, (2021), KARISSA ROSENFIELD, (2022), ABDUL QADIR AL-AWAJ, (2018)].

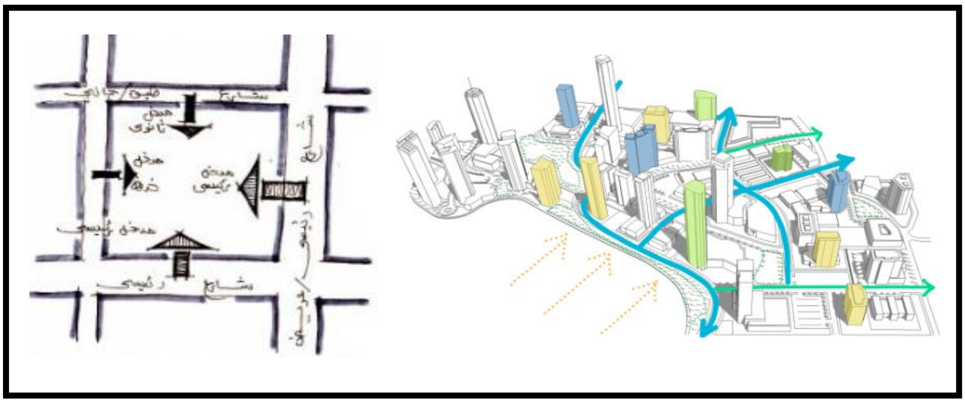


Figure 10 and 11 Streets and roads surrounding the land a detailed study to know the main, wide, secondary, and secondary streets, for the appropriate selection of the project entrance and the selection of the sub-entrances of the project [ENGMARWA, (13 June 2021), ARPIT SHARMA, (2022)].

4. Streets and Roads Surrounding the Land

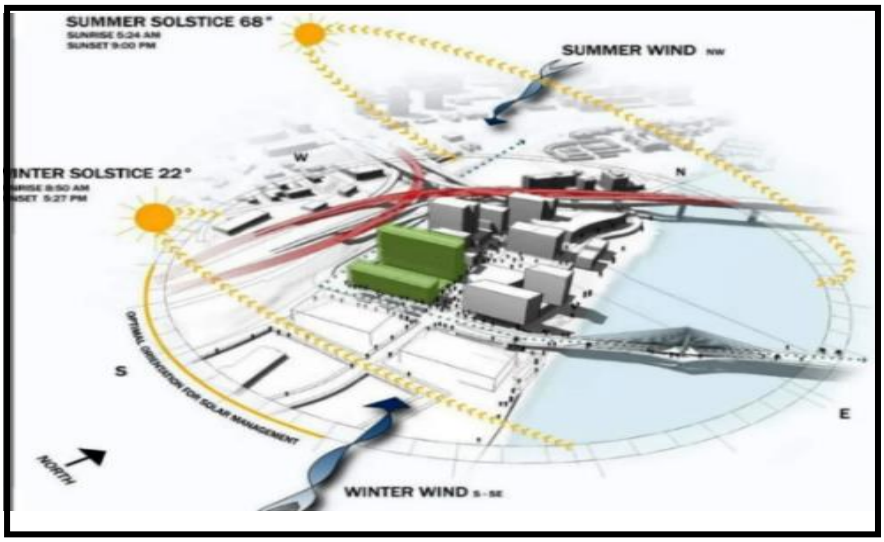


Figure 12 Visual Study, Surrounding Areas [ARPIT SHARMA, (2022)].

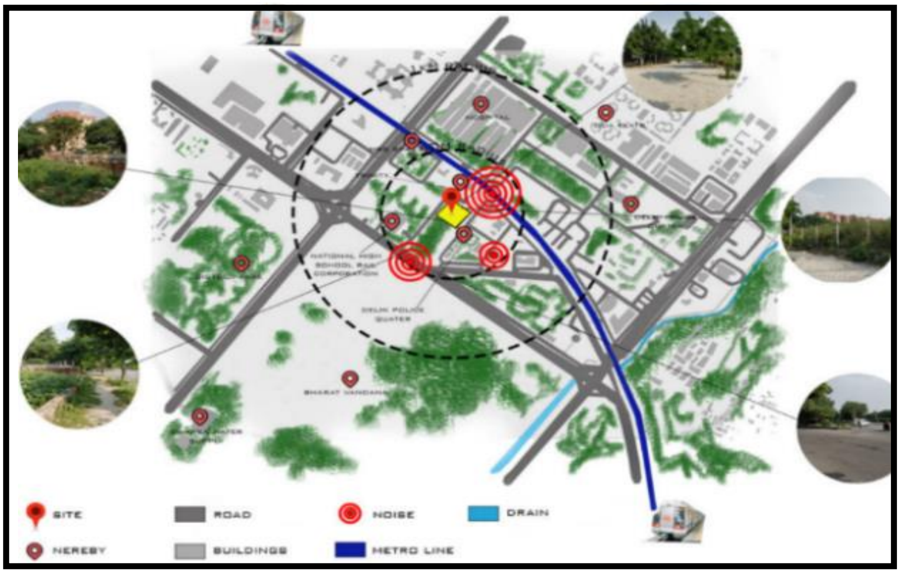


Figure 13 Sun Movement [ARPIT SHARMA, (2022)].

5. Environmental and Climatic Study

Knowledge of the north direction of the site, the place of sunrise and sunset, wind patterns, temperature, rain patterns, soil nature.

6. Visual Study

It is the study of the visual angles of the building itself for the areas surrounding the site in the event that there are gardens, landscapes, and they raised anything they want to reflect through a glass facade, a place of attraction, or a terrace overlooking the area to be shown.

7. Surrounding Areas

It is a detailed study of the area adjacent to the site to show the strong points of the building such as gardens, monuments, religious places, residential and commercial complexes.

8. Choosing the Appropriate Entries for the Project

The building shall have a main entrance, one or two service sub-entrances, the entrance for cars, etc... depending on the type of project. This is due to studying the types of streets, the direction of movement of cars, and how they enter and exit the project land easily and smoothly [ENGMARWA, (2021), KARISSA ROSENFIELD, (2022), ABDUL QADIR AL-AWAJ, (2018)].

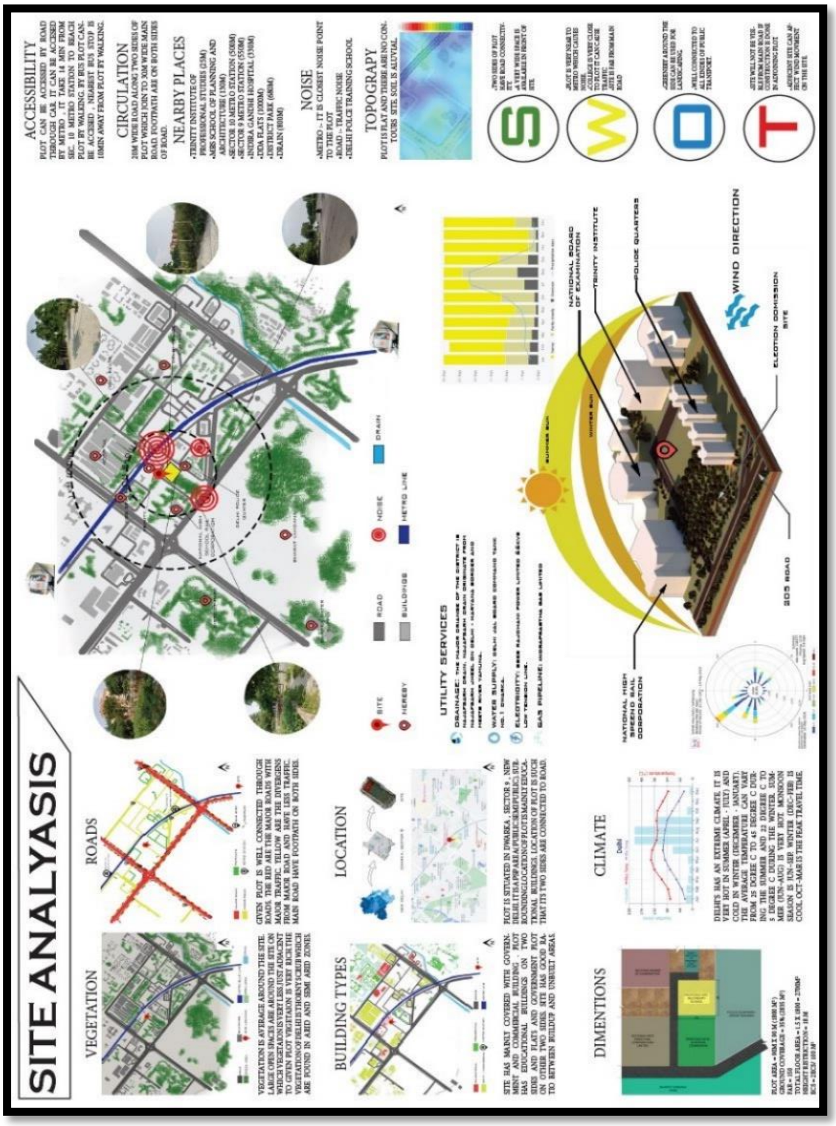


Figure 14 Environmental and Climatic Study and Other Studies [ARPIT SHARMA, (2022)].

9. Orientation

Orientation of the building plays an important role in achieving zero building strategies; When the building is directed to the south, there are some mechanisms that generate renewable energy, such as solar energy. The use of natural lighting to reduce the load of energy systems, which represents 25% of the total energy consumption, through the openings of the building and the arrangement of windows is one of the important strategies when choosing the direction of the building. During the selection of the site, a study is made that shows the direction of the air for the natural flow of air inside the building, reducing the use of air conditioning systems and conserving resources at the same time. One of the energy conservation factors is through the good orientation to benefit from the shade, natural sunlight inside the building for heating, natural lighting, and ventilation, which helps to reduce the use of air conditioning, heating, and lighting systems. During the guidance, methods of protection from the sun are also considered, during the first stage, including reducing direct and reflected rays that hit the building during the day, using trees and shrubs with permanent greenery that reduce the number of rays that reach the building and shading it, planting green spaces around the building. "landscape" helps to prevent the sun's rays from reflecting on the building and reduce the temperature surrounding the building, using fountains, artificial waterfalls, beside or inside the building that help moisturize the air, reduce its heat, and cool the air. Shading walkways with trees and umbrellas. The other stage is to protect the building from the sun's rays, by making the facade of the building the largest on the north side, shaping the building with different sizes and heights to benefit from the building's shade [KARISSA ROSENFIELD, (2022)].

10. Divide the Project into Main Parts

This process helps to know the main and sub-parts in the project. It is used to deal with the building as parts or blocks next to each other or on top of each other or both with hatred. Such as the main element, the theater, the sub-elements, the number of chairs, the bathroom, the cafeteria, and the reception hall. This also explains the closed and open spaces, parking lots, gardens, and outdoor corridors.

11. The Design

The most important elements are how to design, the shape of the building plays an important role in energy conservation. The design begins with a simple square, rectangular, and triangular geometric shape, which is gradually developed (concept). Choosing environmentally friendly building materials, recycled materials, thermal insulation materials, waterproof materials, to conserve the largest amount of energy. Also, regarding windows and doors, it should be tightly closed and be double, or triple parts. These are the basics to conserve energy.

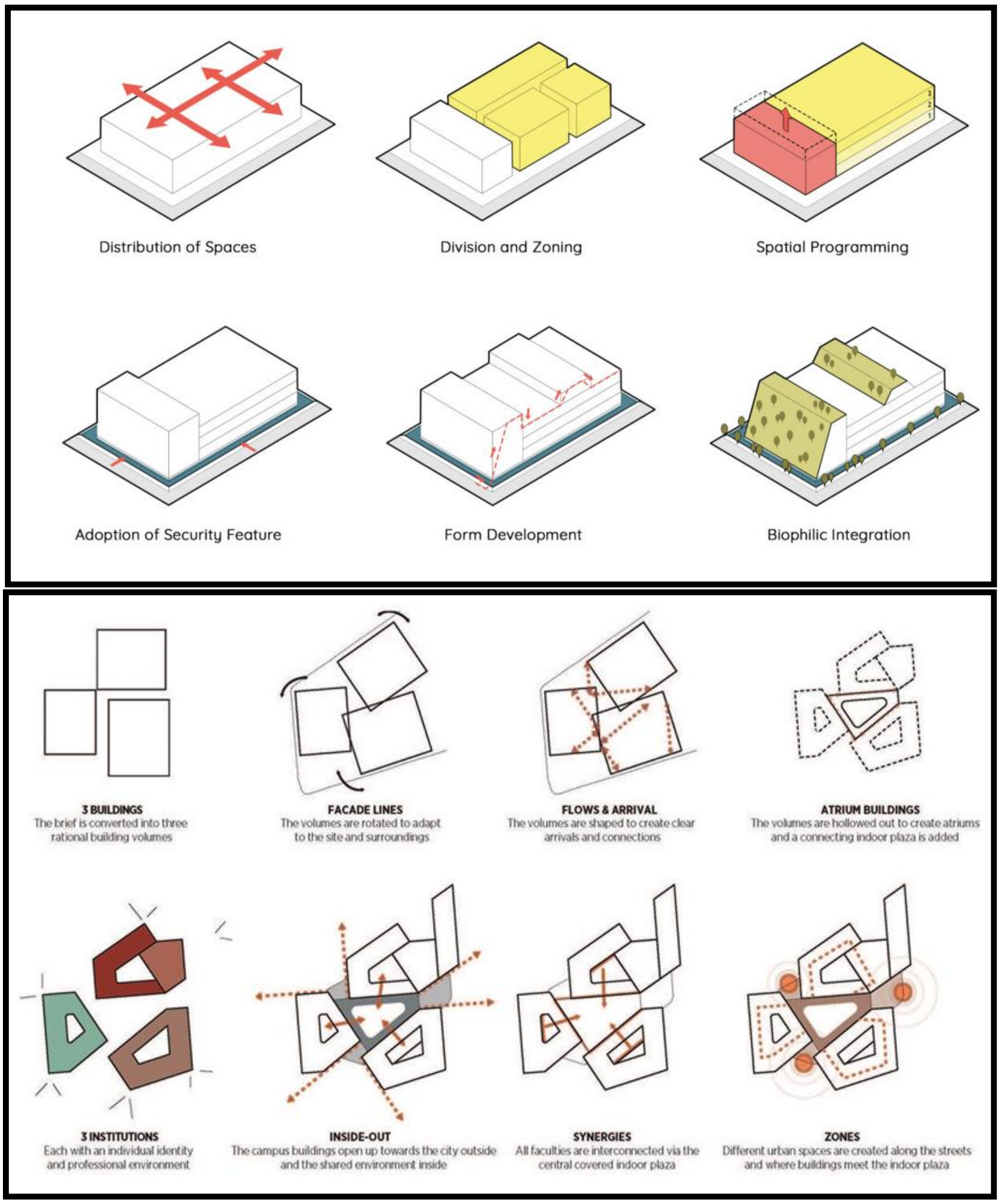


Figure 16 The Design [(2022), ‘’ Architecture Concepts :8 Concepts trending among Architecture Students’’].

12. Environmentally Friendly Building Materials

a. Green Concrete

Figure 17 Fly Ash [NAGHAM HAIDER, (2021)].

Figure 18 Fly Ash Aggregates [NAGHAM HAIDER, (2021)].

Figure 19 Rumum [NAGHAM HAIDER, (2021)]

It is a group of reused materials such as crushed concrete, stone dust, and marble waste as green aggregates in the concrete industry. Among the alternative materials in green concrete is characterized by reducing the dead load of the building, facilitating its transportation, and helping to speed up the work. Soundproof, good heat and fire resistance. Reducing carbon dioxide emissions in the concrete industry by 30%. Increase the manufacture of concrete residues. Increased development and no pollution. [NAGHAM HAIDERN, (2021)].

b. ICF Insulating Concrete Walls

It is a new building system using thermal cell blocks. It is corner blocks and walls that are collected like a logo. It is made of foamed polystyrene and is hollow from the inside. In the inner voids, skewers and concrete are placed to support it. Its most important advantages are the completion of work on time and in a short period, an excellent insulator in thermal and sound insulation. With a thermal mass inside [NAGHAM HAIDERN, (2021)].

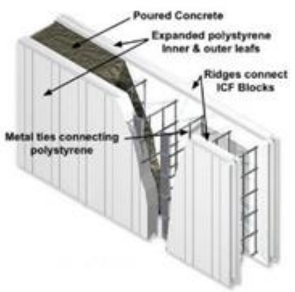


Figure 20 ICF Insulating Concrete Walls [NAGHAM HAIDER, (2021)].

Figure 21 ICF Insulating Concrete Walls [NAGHAM HAIDER, (2021)].

Figure 22 Perforated Bricks: It Is A Brick With Gaps in It. These Gaps Contain the Type of Insulating Cork [NAGHAM HAIDER, (2021)].

Figure 23 Double Walls: It Consists of Two Layers of Bricks, Between Which There Is A Space for Thermal and Acoustic Insulation [NAGHAM HAIDER, (2021)].

c. Concrete Ceilings

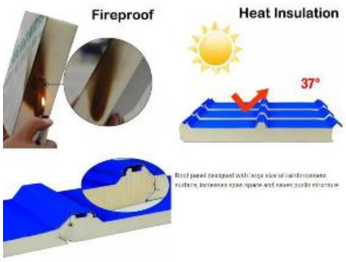


Figure 24 Insulated Metal Ceilings [“Insulated metal ceilings,”].

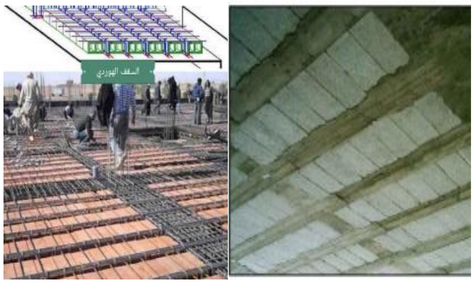


Figure 25 Hollow Block Slab [MUHAMMAD, (2020)].

d. Insulating Materials

Insulation materials are among the most important elements of zero-energy buildings. They are used to protect and isolate the building to reduce the transmission of heat, cold and sound inside the building. They are among the most important factors for energy conservation, in terms of air conditioning, heating and others [MONA EL-ADAWY, (2022)].

e. Waterproofing

This type of insulation is considered one of the most important and dangerous types of insulation in zero-energy buildings in buildings in general. Inside the building. The type of materials used in this membrane varies according to the nature of the building. Among the *places that must be isolated:* bathrooms, toilets, laundry rooms, water tanks, ceilings, open balconies, swimming pools, retaining walls and agricultural basins.

f. Types of Waterproofing Materials

A. Flexible insulating materials: Metal sheets, bitumen, waterproofing fluid, polyethylene linoleum, polyurethane. B. Semi-flexible insulating materials: small asphalt chips, asphalt rolls, asphalt. C. Rigid insulating materials: insulating cement whiteness, waterproofing additives, slate boards, small asbestos boards, small wooden skirting boards, asbestos cement boards, vitrified tiles [MONA EL-ADAWY, (2022), MUHAMMAD KHATTAB, (2022), (2022) **,"Isolation of roofs from rainwater"**].

Thermal Insulation: It is an insulating material that has properties that limit the leakage and transmission of heat from the outside to the inside in the summer, and from the inside to the outside in the winter. To get rid of the temperature difference, insulating materials are used along with the heating and cooling system. The main goal of the zero buildings is to reduce the use of cooling and heating systems [MOHAMED KHATTAB, (2020), (2020), "Top 5 Thermal Insulation Materials,"].

There are 3 Types of Insulators:

1- The heat that penetrates walls, ceilings, and floors.

2- The heat that penetrates windows, doors, and other openings.

3- The heat that is transmitted through the ventilation holes.

g. Heat Insulating Materials

Felt (non-metallic fibers), Light filler granules (natural porous materials), Extruded foamy liquid (organic cellular materials), Solid boards or slats (inorganic foam materials), Stilton [MOHAMED KHATTAB, (2020), (2020), "Top 5 Thermal Insulation Materials,"].

Sound and Noise Insulation:

It is a material that separates the outside perimeter from the inside of the building. The intensity is removed from the sound waves resulting from the noise, and the sound waves are prevented from reverberating inside the place. The process of sound transmission is carried out through the air, by the body of the facility. Acoustic insulation is very important in reducing sound pollution. [MOHAMED KHATTAB, (2020), (2020), "Top 5 Thermal Insulation Materials,"] Sound Insulation Materials: Mineral *wool, Glass fibers (glass wool), Perlite.*

General Properties of Thermal Insulation Materials Used in Buildings [MOHAMED KHATTAB, (2020), (2020), “Top 5 Thermal Insulation Materials,”]:

Table 1 Sound and Noise Insulation

Insulating materials	Density kg/m3	The use	Thermal conductivity coefficient at 24°C W/m. Kelvin	Water absorption percentage by volume of material (ASTM C272)	Water vapor permeability 2 perm/inch (ASTM E96)	Pressure bearing strength kg/m2	firefighting	Thermal qualities change with time
Expanded or molded polystyrene	13-20	Walls	0.0374	2.5	0.6-5	80-528	It burns and smokes	Not affected.
	32-35	roof	0.0331					
Expanded polystyrene	26-28	Walls	0.0288	0.3	0.4-1.4	240 -2000	It burns and smokes	affected a lot Freon gas is not used in its production
	32-35	roof	0.0288					
polyliurethene	26-28	Walls	0.026	2-5	2-4	320-960	It burns and smokes	affected a lot Freon gas is not used in its production
	35-48	roof	0.023					
Light weight concrete	-1040 245	Walls and roofs	0.43-0.065	12.52-49.33 Highly absorbent processable	_	_	It resists heat and melts at 1100C	Not affected.
foam glass	140	Walls and roofs	0.55	0	_	_	It resists heat and melts at 430C	Not affected.
Fiber glass	17-120	Metal roofs and walls	0.051	Too high	Too high	weak	The fibers are fire retardant, and the binders burn	Not affected.
Rock wool	29-120	Metal roofs and walls	0.051	Too high	Too high	weak	The fibers are fire retardant, and the binders burn	Not affected.
perlite	80-240	walls	0.39-0.16	Too high	Too high	Depends on the strength of the cement mix	It resists heat and melts at 1300C	Not affected

h. Glass Windows

It is a closed frame in which there are two or more glasses, fixed to each other by means of aluminum or plastic frames. It consists of two, three or more rooms. The distance between the two chambers is 22 mm. One of its most important features is excellent sound insulation, reduces energy consumption and isolates heat in an excellent way, resists different temperatures, high and low temperatures, and prevents the entry of harmful ultraviolet rays. Keeping the place warm or cool is a major challenge. Was common to use single-layer glass, loses heat completely, is not soundproof. Double glazing has appeared two layers of glass between which is an air insulator, the air insulator reduces the heat transfer coefficient reduced by half. Acceptable sound insulation.

Double glazing has appeared two layers of glass between which is an a very thin metallic heat-reflective coating was used an air insulator chamber was placed on the inside of the "Low-e" paint. Thermal radiation was reduced, but instead of filling the space with air, it was replaced with a gas that is less conductive to electricity, argon and here the heat insulating glass appeared. good sound insulation.

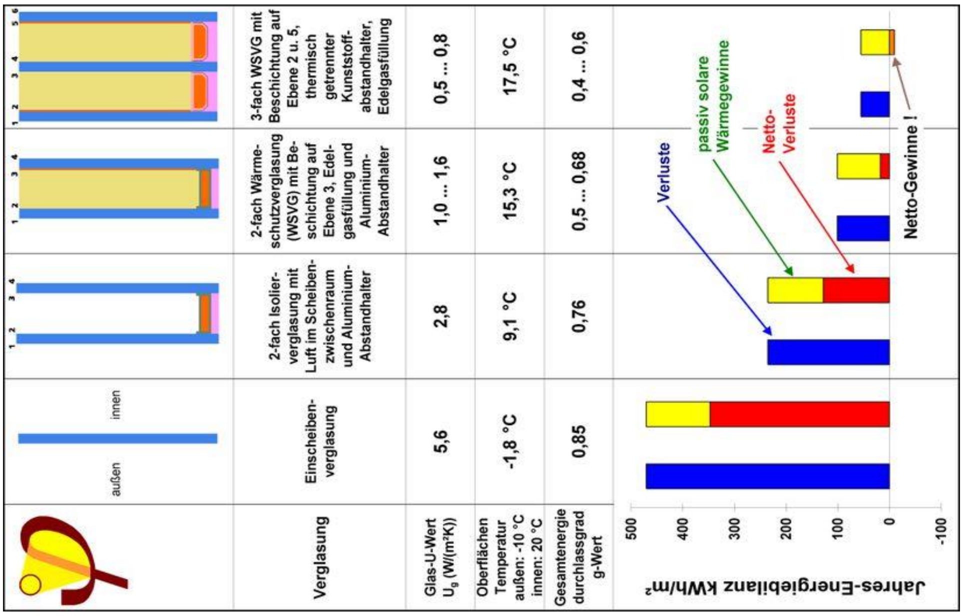


Figure 26 Single-Layer, Double Glazing, Triple Glazing [“Kostengünstige Passivhäuser in Mitteleuropa”].

Triple glazing with two low-e coatings and inert gas filling. Spaces between the glass filled with an inert gas and two low-e coatings. And the window frames are well insulated, which prevents significant heat loss, which gives significant energy savings. Excellent sound insulation, it is not possible to feel the change of climates outside the building, which gave the user comfort [SPONSORED POST, (2021)].

13. Landscape

Zero Energy Building Design a lot of effort, time and money is spent to save electricity, building envelopes, electrical systems and so on. But one of the elements that help make the building zero and more effective is the external landscape, which is the element that may help the building to save energy [PRASHANTI RAO, JANMEJOY GUPTA,(2020)]. Landscapes are outdoor spaces, courtyards, gardens, sidewalks, street furniture, lighting properties, soil systems, water systems, managed bioreserves, golf courses, of course vegetation, trees, water surfaces and streets. The book, "Designing on Earth: The Development of Landscape Architecture," by Norman T. Newton, said of landscape architecture "the art or science if it favors the arrangement of the earth, together with the spaces and objects on it, for safe, efficient, healthy, and enjoyable human use" [PRASHANTI RAO, JANMEJOY GUPTA, (2020)]. Excellent landscape design helps the building to reduce energy consumption, electricity, heating, and cooling. By studying the site and placing trees and shrubs in specific places that help provide natural shading, reduce water use, a quieter place, cleaner air and save energy up to 25% in one place. One of the essential elements in all architecture works is landscaping. One of the functional values of landscaping is to add an aesthetic element to the site, "The building", which has other functions, which some people express as shading devices and evaporative coolers in the summer. Repels strong winds during the winter, filters air and filters light throughout the year. Through the inner courtyard of the building and the use of different plants to make the building environment of better quality. Landscapes affect humans, the environment has physical and physiological influences [PRASHANTI RAO, JANMEJOY GUPTA, (2020)].

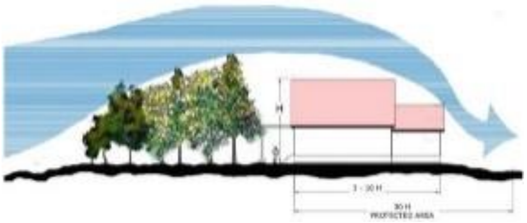
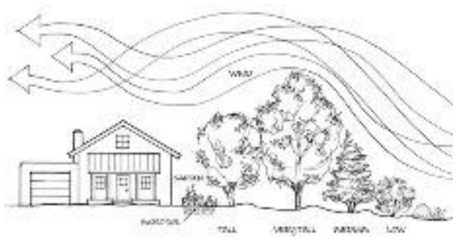



Figure 27 and 28 Wind-Shadows Created by Landscaping [PRASHANTI RAO, JANMEJOY GUPTA, (2020)].

Figure 29 Deciduous Trees Cutting Off Summer Solar Radiation [PRASHANTI RAO, JANMEJOY GUPTA, (2020)].

Energy Efficiency Through Landscaping - Techniques for Different Climate Zones: According to the types of climates solar, thermal and wind can be controlled using landscape strategies an important factor in landscape design is consideration of the mature size of "growth" plant species. With the difference in the weather, the types of plants differ. Usually, local plants are chosen for the speed of adaptation to the environment, soil, and climate [PRASHANTI RAO, JANMEJOY GUPTA, (2020)].

There are five climates' zones:

1. Hot and humid climate strategies.
2. Hot and dry climate strategies.
3. Combined Climate.
4. Temperate climate.
5. Cold weather

[PRASHANTI RAO, JANMEJOY GUPTA, (2020)].

Figure 30 Window Shaded by Trellises with Deciduous Vines [PRASHANTI RAO, JANMEJOY GUPTA, (2020)].

14. Green Roofs

Figure 31 US Coast Guard Headquarters, Washington, D.C. [(2021), "Green Roofs,"]

Green roofs "vegetated roofs" and "living roofs" are about the roofs of the building covered with green plants of medium growth, the roofs represent a quarter of the building area, so green roofs were made in the building that affects the nature of the building environment, green roofs are used in the world as a kind of zero-energy building strategy, "urban planning". Through various studies in terms of climate, geographical location, and use of green roofs, according to [IPCC] the body responsible for climate change, during the last years in the 21st furnace the temperatures have been increased significantly, but with the start of using green roofs the heat waves have been reduced by 2 -3°C [(2021), **"Green Roofs,"**]. A green roof consists of several layers of structural layer, insulation layer, waterproofing membrane, root barrier, drainage material [moisture retention], filter, growing medium (substrate), vegetation [landscape material] (29) [VINAY JAIN(2022), NGUYEN LE TRUNG and OTHERS(2022)].

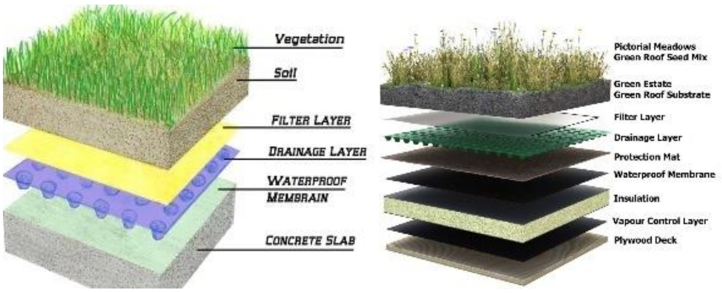


Figure 32 and 33 Components of Green Roof [(2021), “Green Roofs,”, VINAY JAIN, “What is Zero Energy Building?]

a. Benefits of Green Roofs

- Rainwater management.
- Energy.
- Heat islands in urban areas.
- Biodiversity and Habitat.
- Longevity of Roofs.
- Aesthetics [VINAY JAIN(2022), NGUYEN LE-TRUNG and OTHERS(2022)].

15. Wind Catcher and Double Skin Façade

a. Wind Catcher “Malqaf”

During the design of the building from the point of view of the architects, the wind is considered the most important element that is studied, and it received great attention in the design, especially in hot regions. The most important element in the climate is the wind, which provides its users with comfort and cooling in the building at the lowest cost. Wind towers are traditional ventilation tools, which capture air by opening it towards the breeze, in return, by opening it to remove the air. They are used to cool the air inside the building naturally. Windcatcher used these days, with the passage of time, different forms of the air catcher were developed, as they made it a part of the building, by integrating it with the design, or they kept the shape but used different materials in the construction, and windows were designed that perform the same process. In the regions of the Arabian Gulf, a return was made to the traditional architecture, where the air catcher was adopted for the cooling systems. [OMAR ASI, (2019), SEYEDEH ZAEGARI, (2016)]

Figure 34 Qatar University [(2021), “Green Roofs,”].

Figure 35 New Forms of Windcatcher [(2021), “Green Roofs,”].

Figure 36 Office Building [AGI ARCHITECTS, (2023)].

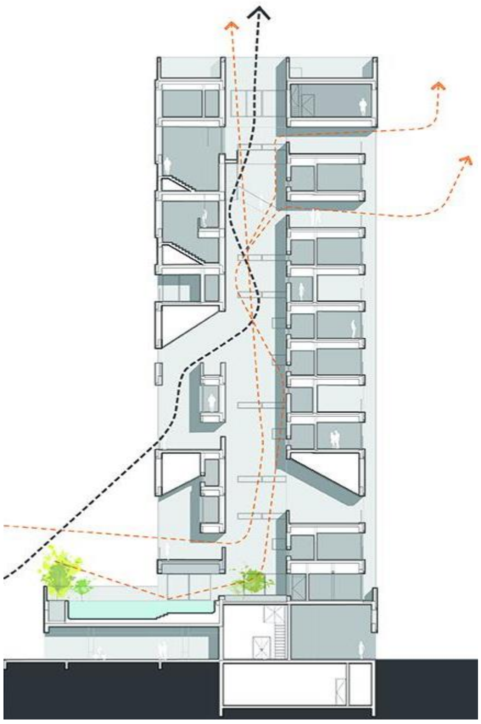


Figure 37 Example showing how a windcatcher is incorporated into the construction Air flow. Kuwait [AGI ARCHITECTS, (2023)].

b. Double Skin Facade (DSF)

It is a smart system between two layers of the building cover, between which there is an air separator with a thickness ranging between (15-200 cm). It consists of one or more sections. Most of the cases, air breakers and other shading devices are used to reduce energy consumption. In the winter period, the double façade acts as a buffer zone between the external environment and the building, reducing heat loss and improving the heat transfer coefficient. Summer the double façade works to reduce heat absorption and reduce its entry, which helps the air space to reduce the heat load against the inner shell. Artificial intelligence has been used to control most buildings through which the movement of ventilation is regulated in the air space, or it is closed to create a heat insulating area [MONA EL-ADAWY, (2022)].

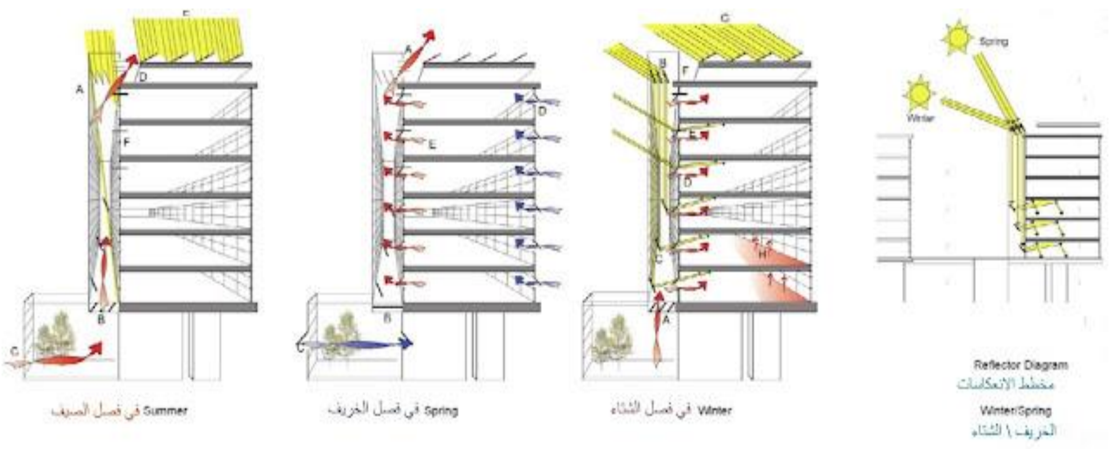


Figure 38 DSF as a smart system with the different seasons of the year [MONA EL-ADAWY, (2022)].

16. Recycling Wastewater

In zero-energy buildings, water is the most important element to feed the building. It must be reduced and preserved. It has a significant impact on the building from an environmental point of view, reducing energy and water consumption. There are simple and easy ways to conserve it, including the use of appliances, taps, water-saving toilets, by water efficiency and water efficiency standards (WELS) label route for water-saving products. There are alternative water sources that can be used to reduce the use of pure water, including rainwater, storms, outdoor water use, wastewater reuse, gray water, blackwater [RACHEL WATSON, (2020)].

a. This Drawing Shows the Incoming and Outgoing Water Flows of the Building

Rainwater is treated on site to provide drinking water, for use inside the building. Gray water is lightly polluted water produced from showers and taps. Non-potable after being treated on site, it can be used in toilets and laundry facilities. The local aquifer is reintroduced after on-site water treatment. Storm water is utilized by green building infrastructure features and landscaping. Excess water is returned to the original water source [“Scenario 1: The Ideal Net Zero Water Building”].

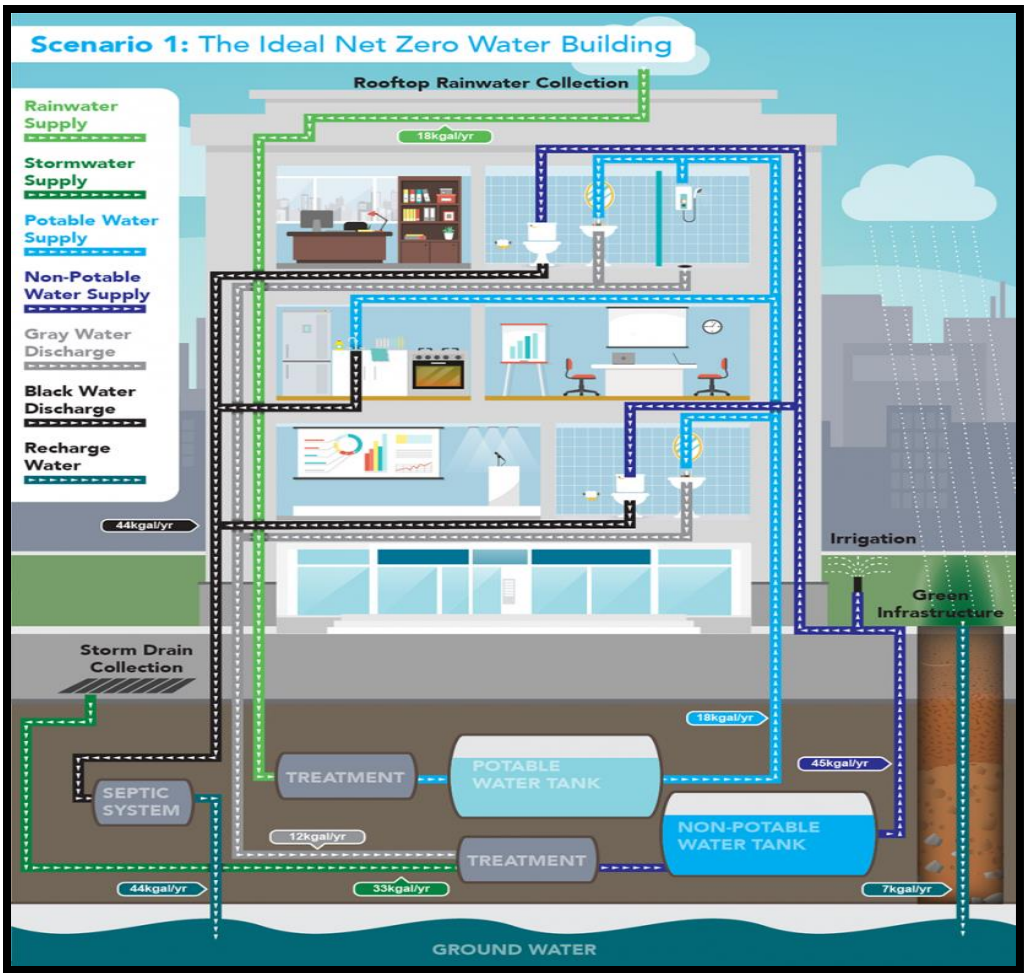


Figure 39 The ideal net zero water building [“Scenario 1: The Ideal Net Zero Water Building”].

17. Heating, Cooling (HVAC) System in Zero Energy Buildings

HVAC stands for heating, ventilation, and air conditioning. HVAC systems, operating systems for supply, play a major role in net energy construction projects. It includes the systems, equipment, and technology used in net energy buildings, to control the movement of hot and cold air, ventilation, heating, and cooling, in residential and commercial buildings. There are various options for choosing HVAC systems, but their working methods are similar, where the outside air is drawn in through mechanical ventilation systems, the air is cooled or heated to the required temperature. (HVAC) also provides a control system for humidity levels, air quality is improved through air cleaners to reduce bacteria, pollutants emitted from cleaning agents, and germs [VINAY JAIN(2022), JEN ANESI, (2016), SHAIMAA SEYAM, (2018)].

a. HVAC Components

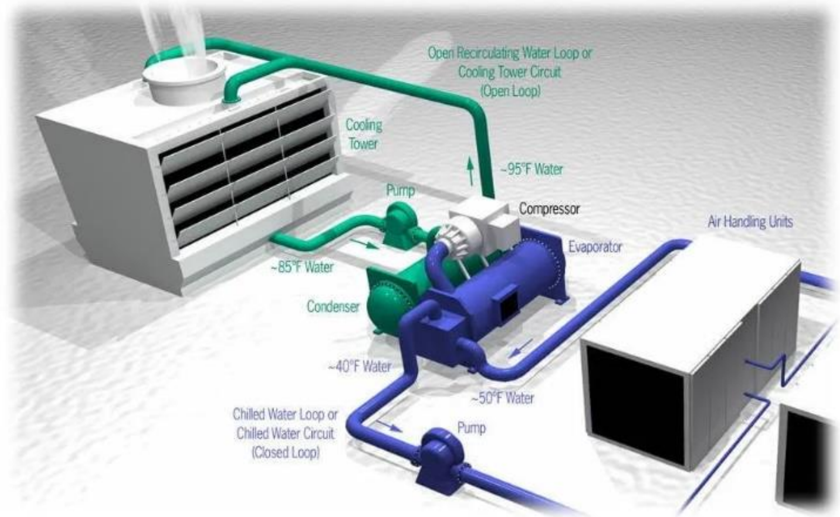


Figure 40 HVAC system [VIRAL NAGDA, “What is HVAC System?”].

b. Types of HVAC Systems

1. Split system.
2. Hybrid heat pump.
3. Ductless mini split.
4. Ducted mini split.
5. Packaged system.

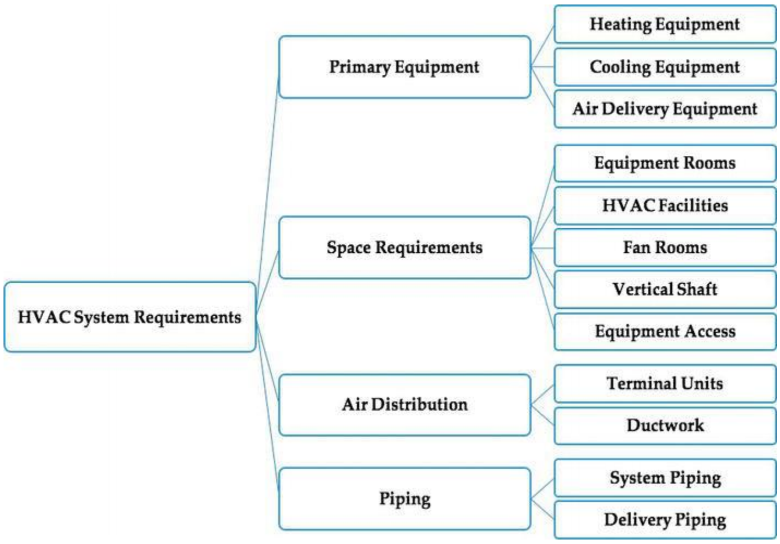


Figure 41 HVAC System Requirements [SHAIMAA SEYAM, (2018)].

c. HVAC Systems Classification

It is the central system, and the local "decentralized". The location of the basic processing equipment varies according to the types of the system, if it is central for the whole building, or local to a specific area for a part of the building. Due to this, the air and water system is distributed based on the classification of the system and the location of the main equipment [INGER ANDRESEN, Anne Grete Hestnes, (2015)].

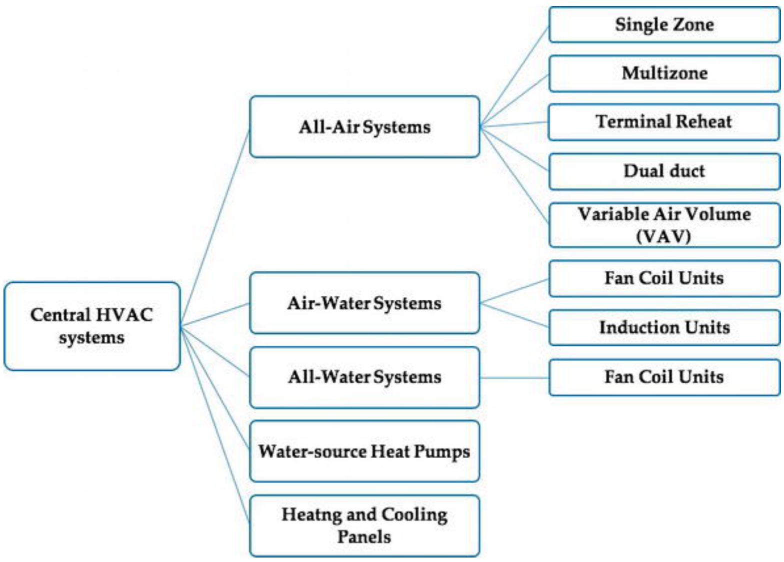


Figure 42 Central HVAC Systems [SHAIMAA SEYAM, (2018)].

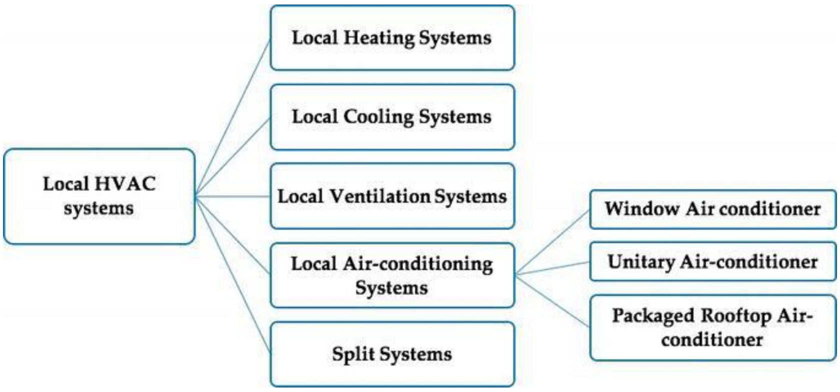


Figure 43 Local HVAC Systems [SHAIMAA SEYAM, (2018)].

d. The Role of HVAC in Zero Energy Buildings

One of the most important parts of ZEB is its highly efficient HVAC system. It would be a ZEB reach without HVAC technology. The heating, cooling, and lighting system is the largest consumer in commercial buildings, hospitals, and other buildings. 40% of the energy is consumed in HVAC, so there is continuous development, through the design of the mechanical system to reduce cooling and heating loads to reduce energy consumption and then use energy sources renewables to achieve a net energy balance [INGER ANDRESEN, Anne Grete Hestnes, (2015)].

B. Renewable Energy Systems

During the architectural design, the architect lays down the method of integrating zero building, alternative energy, and ways of using it, how to store it in batteries or return it to the grid. The goal is to design a building that reduces peak energy use and can use fossil fuels to give the building the energy it needs. Renewable energy reduces carbon emissions in the building over the coming years [(2020) , “5 Strategies to Consider to Achieving a Net Zero Building (NZB)”]. To mix renewable energy into a zero-energy building, there are various methods, PV, solar energy, wind energy, and others. The most important part in zero-entry buildings is the renewable energy to be more relevant to the building. There are different forms of renewable energy. Energy can be obtained from two main sources that provide the building with alternative energy directly, the first being inside the building, and the second indirectly outside the building site. This energy storage method must also be considered if it is inside or outside the building site [BIG RENTZ, (2021)].

1. Renewable Energy on Site

The building and the amount of energy needed inside it are studied using modern technologies. Photovoltaic cells (PV), which are used in facades and roofs, solar energy, and wind energy. Biomass can provide renewable thermal energy on site, through burning agricultural waste, wood, and so on. To warm the place, heat the water, the available renewable energy is chosen and can be obtained, and the system can be maintained periodically and easily. By analyzing the life cycle, the cost, benefits, lifetime use and maintenance cost.

2. Off-Site Renewable Energy

This is due to the size of the building site area, on the NZE scale, and the guidelines used in some buildings allowing the placement of wind turbines and solar collectors in a separate location from the building site [STEVEN ASSOCIATE, (2016)].

a. Solar Energy

To operate and achieve energy self-sufficiency in ZEB through the solar panels used in the building in its various forms, it is 100% clean and renewable energy. The sun emits light known as solar radiation "electromagnetic radiation". The amount of radiation varies according to the season and location [INGER ANDRESEN, Anne Grete Hestnes, (2015), “Fully powered by the sun”]. The various technologies and developments of solar panels absorb the solar radiation and convert it into energy used in ZEB. There are various shapes and technologies for solar panels, including solar There are various shapes and technologies for solar panels, including solar panels on roofs, street lighting poles that contain a solar panel, PV glass. PV glass is one of the most important combinations between building and technology. During the process of searching for a way to integrate solar panels into the building and produce the same amount of energy and take less place and are not visible. Photovoltaic (PV) glass, or solar glass, has been discovered.

It is a new material for generating electricity, characterized by the fact that it absorbs sunlight and converts it into energy. It consists of layers of thermally treated safety glass; the solar cell is invisible. Provides thermal and sound insulation like traditional glass, PV glass allows the passage of sunlight with a small degree of infrared radiation, so it can be used in all types of residential buildings, offices, walls, building facades, umbrellas, and others [INGER ANDRESEN, Anne Grete Hestnes, (2015), “Fully powered by the sun”, LAURA RODRIGUEZ, (2021)].

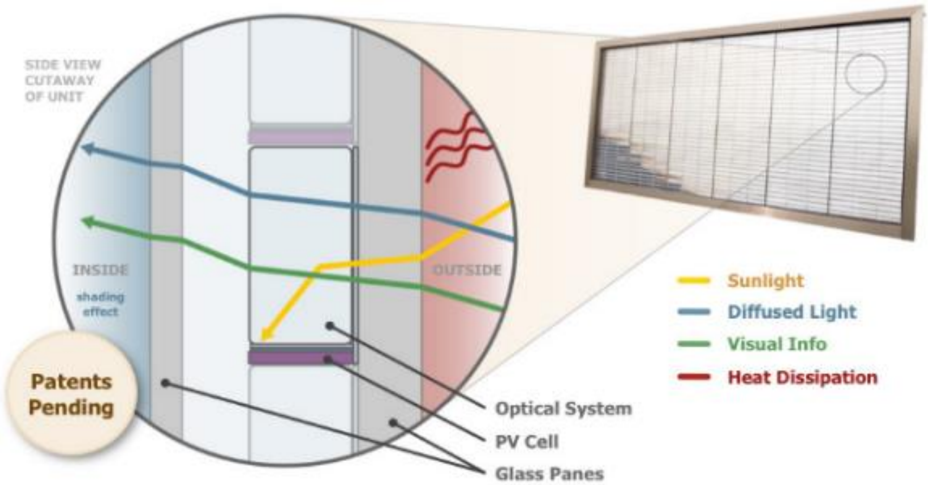


Figure 44 Pv glass window [LISA DAMAST, (2010)].

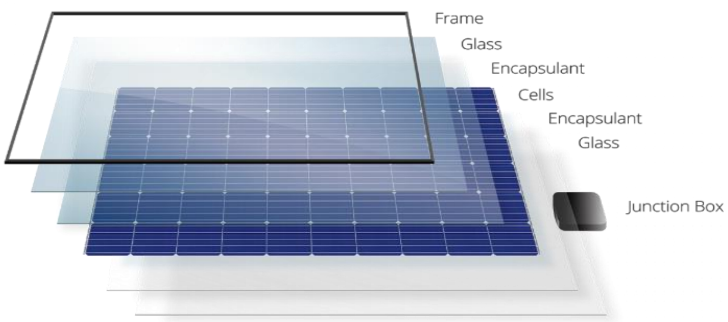


Figure 45 Pv cells [“Photovoltaic glazing & safety glass”].

b. Wind Energy

The idea of wind turbines originated from windmills. A turbine is a large fan driven by wind. The stirring effect results in kinetic energy which is transferred to the generator through a shaft from which electricity is produced. Wind turbines of different sizes are installed in buildings with different uses [ILKER KARADAG AND IZZET YUKSEK, (2020), (2020),“Building-Integrated Wind Turbine Systems"].

Zero energy can be reached by using it as a type of clean energy-producing type free of noise. All systems are delivered with electrical integration of IP rated turbines and network connection cabinets [DEVIN GANNON, (2017)].

Types of turbines:

Turbines are built in high places because the wind speed increases vertically with height.

Turbines are designed in two types:

Vertical Axis, Horizontal axis.

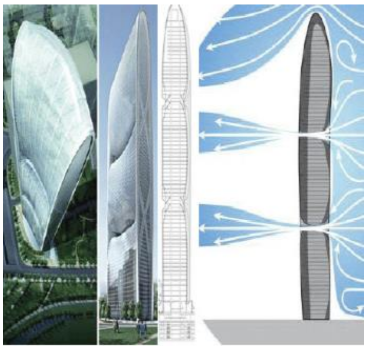


Figure 46 Guangdong Tobacco Tower in China [25,26].

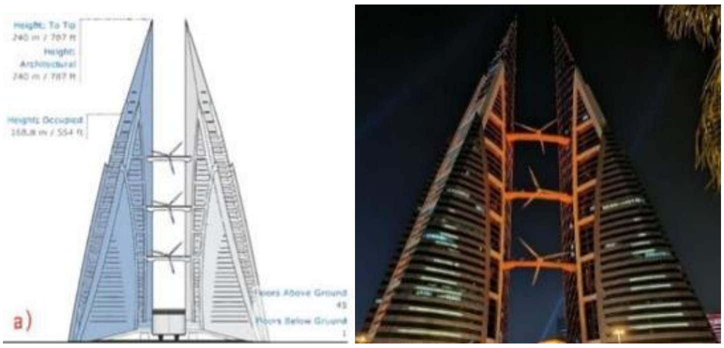


Figure 47 Bahrain World Trade Centre [ILKER KARADAG, IZZET YUKSEK, (2020), MLADEN BOSNJAKOVIC, (2013)].

Figure 48 Commercial wind turbine, Florida [MLADEN BOSNJAKOVIC, (2013)].

Figure 49 Wind turbines integrated into a Chicago parking [MLADEN BOSNJAKOVIC, (2013)]

c. Footsteps Energy

Renewable energy production can be integrated into urban spaces using multi-functional paving. Several industries can benefit from this technology, including sport, hospitality, and attractions. It can be integrated into smart buildings and cities. It gives power to lights inside the buildings, and streetlights in areas with high foot traffic, such as malls and office buildings. It can be used permanently, sometimes paving generates power up to 5 watts, and is connected to an energy storage battery for later use [DEVIN GANNON, (2017)].

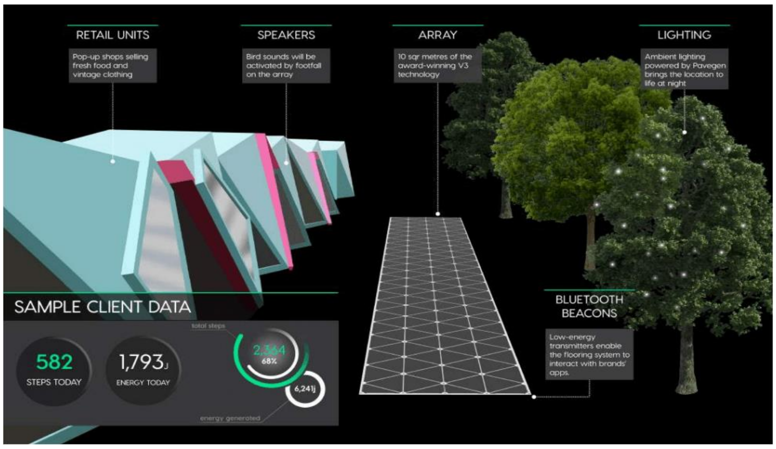


Figure 50 Sample client data for footsteps [DEVIN GANNON, (2017)].

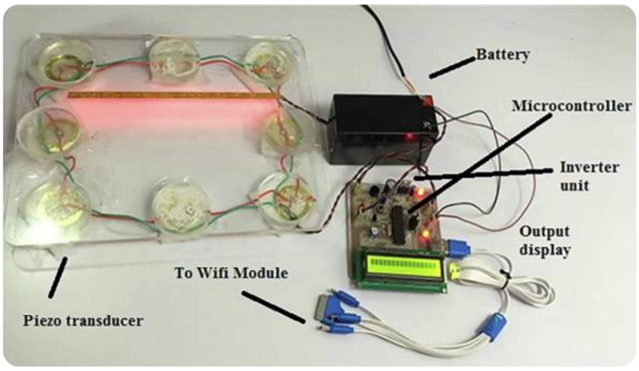


Figure 51 Component [R. JAI GANESH AND OTHERS, (2021)].

Figure 52 and 53 Footsteps [R. JAI GANESH AND OTHERS, (2021)].

How it functions:

When people and vehicles pass, pressure is applied.

The piezoelectric material converts the pressure into unstable electricity, so a bridge circuit is used to convert this variable voltage to linear.

An AC ripple filter is used to filter out any other fluctuations in the output.

The DC output voltage is then stored in a rechargeable battery.

The inverter converts DC current into alternating current [R. JAI GANESH , OTHERS, (2021)].

d. Biomass System

It is the production of energy through wood, agricultural waste, food waste, sewage, and others. Biomass is known as the future of energy, but it is one of the oldest ways to produce energy. In the past, wood was burned for cooking and heating. Thermal conversion when the wooden elements are burned, carbon dioxide is released, and the smoke moves turbines that produce electrical and thermal energy. Pyrolysis, when biomass is heated to 390-570 F (200-300 C) to biomass gasification: It is a thermochemical process in which biomass is burned fusion yields a black liquid known as pyrolysis oil, which may one day be replaced by petroleum.

Converting biomass into energy through the following techniques:

Biomass Gasification: into carbon monoxide (CO), hydrogen (H_2), carbon dioxide (CO_2), methane (CH_4), and nitrogen (N_2). It comes from agricultural waste, wood, and its products. When it becomes a gas, it can generate electric power between 10 kilowatts - 1000 kilowatts.

Biogas: It is a process in which biomass is converted into biogas through the biomethane process. Where animal manure is used in the production of biogas, it is used in special gas for cooking, and in the production of electricity.

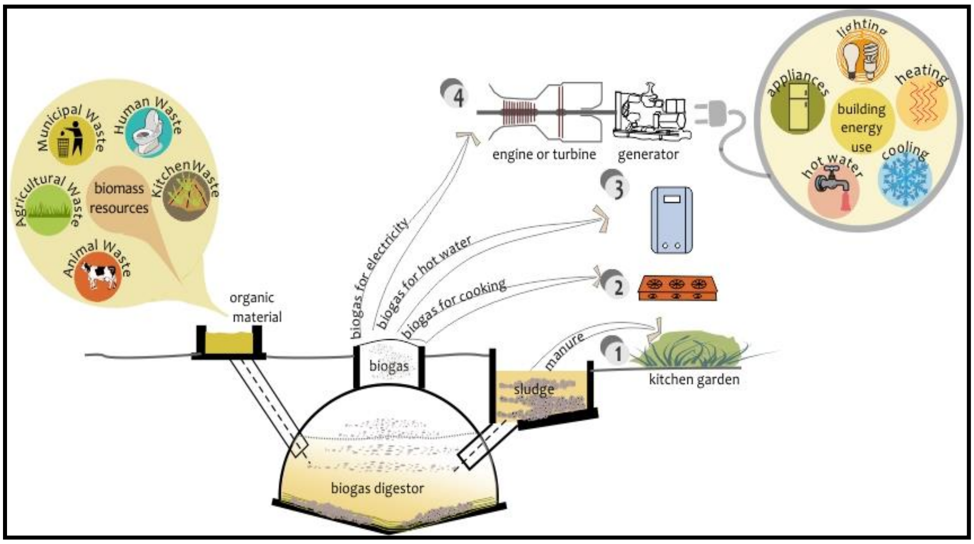


Figure 54 Biomass energy generation system [“Biomass’’].

Biofuels: It is the extraction of oil from the seeds of inedible vegetable oils, using the trans-esterification process to produce biodiesel. It generates electrical energy [NIALL PATRICK WALSH, (2020), “Biomass’’, **Reviewed by pivotal design**].

C. Smart Building

It is a smart building infrastructure (automated building) that uses technology to combine different systems and collect information throughout the year and use this information as references for various operations, including the security system, fire, heating, ventilation, lighting, water, and other systems. Smart building use AI and other technology in the process of operating the building and monitoring other systems through sensors spread throughout the building and through monitoring screens and telephone devices [MONA AL-ADAWY, (2022), ABALKHAIL, (2019)].

Zero energy buildings "green architecture" and smart buildings:

During the past years, green buildings have been integrated with smart buildings to produce an integrated building that is environmentally friendly, and with contemporary developments, this type of building has been developed to become zero energy. The goal of smart building is to provide security, service and user comfort in all aspects that preserve the building environment.

Productivity and well-being for the user are achieved through smart building, and in addition to that, the achievement of resource production, cost, flexibility, and adaptability. The smart building also includes control systems for renewable energy and storage and control technologies to reduce the cost of energy and being the best of the developments of the age [MONA AL-ADAWY, (2022)].

These are divided into: Passive Systems, Active Systems, Smart Materials.

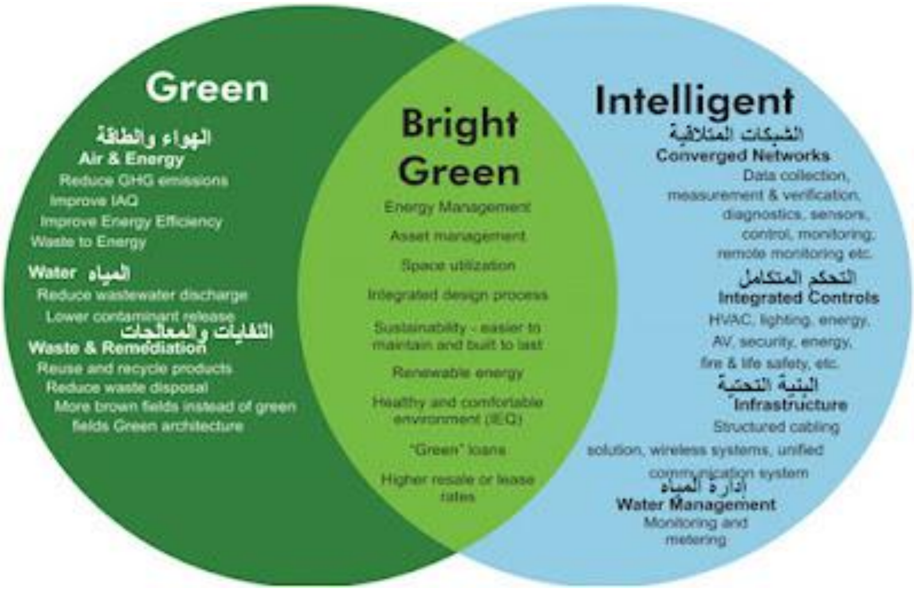


Figure 55 Combine smart buildings and green buildings to achieve a smart green building [MONA AL-ADAWY, (2022)].

Recently, there has been a significant increase in the number of internet-enabled devices and mobile devices, including smartphones, wireless PDAs, and various multimedia devices that support different networks, due to the tremendous improvement in performance and cost reduction in embedded systems. A related technology, called ubiquitous or pervasive computing, is exploring ways to make computers disappear or install smart devices that function without the intervention of the user. Examples include smart offices, smart homes, and others. These ubiquitous systems may not necessarily be mobile; they may be fixed in a house or office and are designed to be "everywhere." A user may not be aware of the existence of a hundred sensors inside the wall or under the floor that adjust the light level and room temperature and monitor home safety. Intelligent appliances in a networked home allow access to a variety of controls from a remote internet browser. The advent of sensor & embedded technology in Office buildings has led to a cost-effective and energy efficient that has a return on investment of 2 years. fig 1. [ÖMER KAYNAKLI, (2012)]

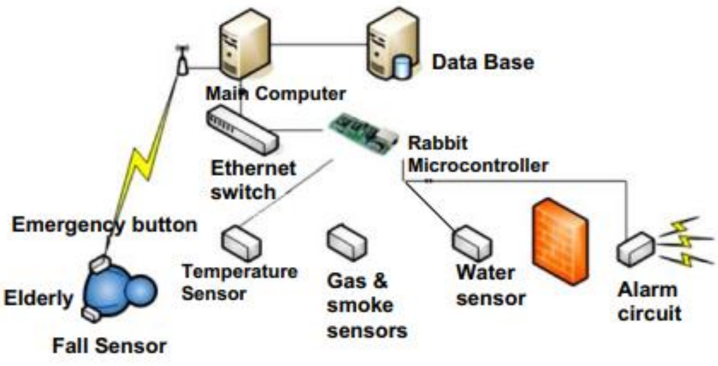


Figure 56 System of the controller [Energy efficiency of smart buildings, Finlan].

D. Energy Efficiency

During the basic design of the ZEB, the reduction of energy use must be considered during the design in its early stages, which is one of the most effective strategies in terms of return on investment and cost. This step increases the efficiency of the building before using renewable energy, designs and techniques can be improved, using energy analysis tools [STEVEN ASSOCIATES, (2016), (2020) ,“NET-ZERO ENERGY BUILDINGS"].

1. Energy Efficiency Measures

1. Choosing the appropriately sized building systems, through the application of ASHRAE 90.1 Safety factors in design standard, can be achieved. 3 dimensional models are designed to simulate and predict the changes that need to be made. Partial load performance should be considered when using variable volume systems. During the design, the designer should think about natural lighting, and use highly efficient lighting and control systems.

2. The designer finds solutions for shifting electrical loads during peak time, which optimizes energy consumption. Some tips for optimizing HVAC loads are: (A) Natural ventilation.

(B) Under floor air distribution systems.

(C) Passive cooling.

(D) High efficiency coolers.

(E) Thermal storage application using phase-change materials (PCMs).

(F) Combined heating and power (CHP).

(G) Heat recovery chillers.

3. The construction and operation phase are an essential step to ensure the quality of the building's performance as designed and intended. The operation phase starts from making energy-related systems, calibrating, and implementing them inside the building according to the design and requests of the project owner [STEVEN ASSOCIATES, (2016), (2020) ,"NET-ZERO ENERGY BUILDINGS"].

2. Operation Phase

- HVAC systems and controls.
- To control the lighting and light.
- Water system.
- Renewable energy systems such as wind and solar energy.

Transmission of Heat Through Buildings:

Heat transfer is the expression of energy or the tendency of heat to move from a warm place to a cold place until the temperature becomes moderate in the two spaces. Heat flux increases as the temperature difference increases [A. BHATIA(2021)].

Types of heat transfer:

1. Via Conduction
2. Via Convection
3. Via Radiation

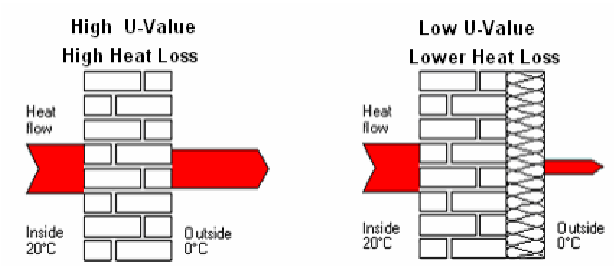


Figure 56 Overall Coefficient of Heat Transfer (U) [A. BHATIA, "Heat Loss Calculations and Principles"].

Conduction heat loss:

For buildings, the heat flux is indicated by several symbols: “k”, “C”, “R”, and "U" values. These symbols refer to the same phenomenon as the heat transfer factors, but some of them are determined by the dimensions and limits of the materials. (U = 1/R Total) [A. BHATIA(2021)].

1. k = Thermal Conductivity
2. C = Thermal Conductance
3. h = Film or Surface Conductance
4. R = Thermal Resistance
5. U = Overall Coefficient of Heat Transmission

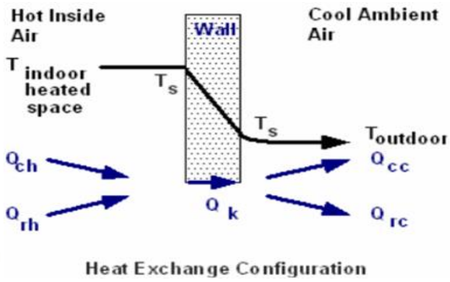


Figure 57 and 58 Heat Exchange Configuration [A. BHATIA, "Heat Loss Calculations and Principles"].

The effects of combining heat transfer modes:

1. Plug through the wall Qk

2. Convection Qcc and radiation Qrc from the wall surface to the cold air and surrounding surfaces.

3. Radiation, Qrh, and convection, Qch, facilitate the transfer of heat from the surrounding surfaces and air to the surface of the wall.

Thermal gradient:

The linearity between the interconnected inner and outer wall surface and the slope of the thermal gradient is proportional to the resistances of the individual layers of the composite structure. The wall is cold on one side and cold on the other. Heat will transfer between the two sides from the hotter side to the colder side.

Under steady state conditions, the total rate of heat transfer (Q) between the two fluids is:

$$Q = Q_{ch} + Q_{rh} = Q_k = Q_{cc} + Q_{rc}$$

Figure 59 Under steady state conditions [A. BHATIA, "Heat Loss Calculations and Principles"].

Assuming that the two sides are at constant temperatures, the hot inner surface is 25°C (77°F), the outer surface is 4.4°C (40°F), the rate of heat conductivity load inside the building can be easily predicted.

Calculation methods:

Formula can obtain the resistance and conductivity of homogeneous materials of different thicknesses. Q = Material thickness in inches, ok = Thermal conductivity Materials are thermally homogeneous when the heat flow in all directions is identical. During the calculation it takes the brick component of the wall assembly [A. BHATIA(2021)].

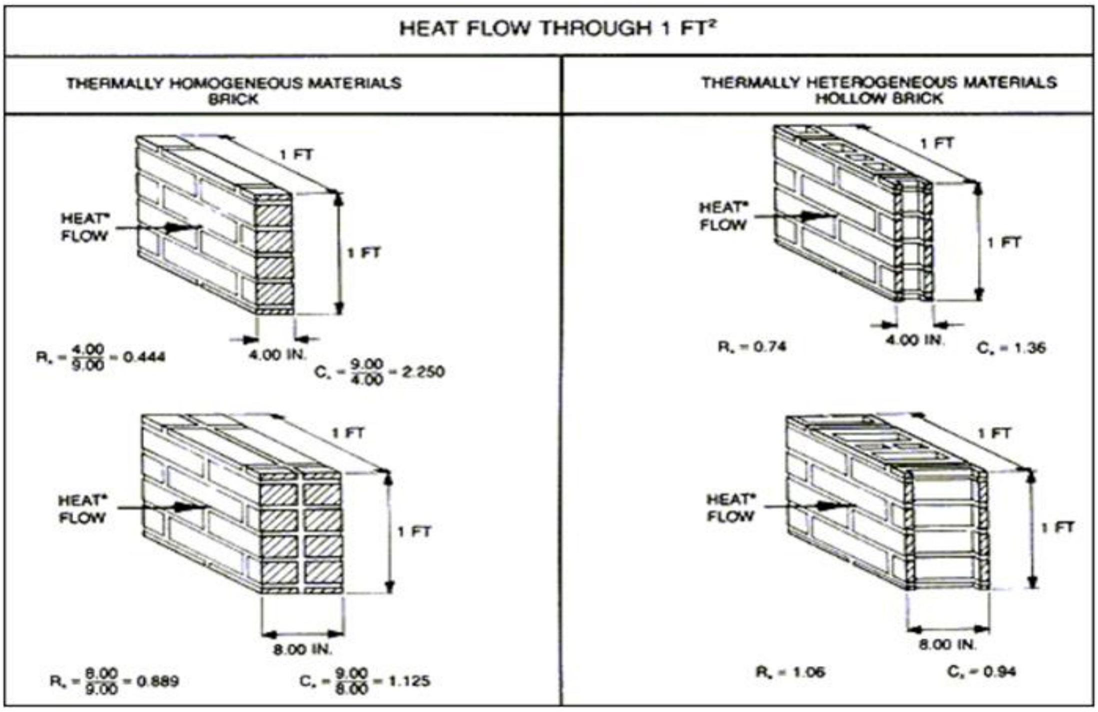


Figure 60 Thermal Transmittance through Materials [A. BHATIA, "Heat Loss Calculations and Principles"].

E. "Zero Code" Methodology

With the "Zero Code" methodology for green building [LEED rating system | U.S. Green Building Council (usgbc.org).], which aims to design and build buildings in an environmentally friendly manner that relies on renewable energy sources such as solar energy, wind energy, and others. The "Code Zero" standards for green building include the use of sustainable building materials and the design of the building in a way that allows saving energy and reducing waste and harmful emissions. These standards encourage the use of natural lighting, adequate ventilation, and intelligent control of temperature and humidity. Buildings that follow these standards can become zero energy, which is buildings that consume a very small amount of energy supplied from non-renewable sources, which reduces dependence on fossil fuels and improves air quality. More information about the "zero code" for green building can be found on the official website of the USGBC (U.S. Green Building Council) [https://zero-code.org/zero-code/., bioshieldpaint.com].

IV. CHAPTER D

A. Digitalization

Buildings and the construction sector are responsible climate change so we had to focus on this problem it would probably be the fight against climate but as an architect we have the opportunity and the skill sets to make a significant impact so, we can make a change by architecture and design and also some tools and strategies that can help us have more meaningful and fulfilling careers in our picture in reality designing. A truly ZERO ENRGY building is hard it's hard to track, it's hard to implement, and it's hard to coordinate because the energy modeling is typically done by another consultant there's a lot of back and forth and it's rarely a part of the early design. Process and it really requires that everyone on the team including the client, the contractor the consultants that everyone is perfectly aligned today. We have tools that tries to make the process a little bit easier as we don't have a lot of energy modeling experience so a lot of us is a real beginner at this and the idea of energy modeling actually sounds really scary to us, but after fiddling around with this tool includes elements of ready-to-use technologies, the first impression that it's really easy to use and it's really accessible to everyone's energy modeling it should be a part of every architects, engineer, general contractor, building energy consultant, HVAC specialist toolbox in fact now adays a lot of developers try to create different option from programs and tools supporting the process ever for example since. Ter-Mus plus, Energy Plus tools and other software launched buildings designed with this tool has helped during the design stages to get to zero energy, and potential impact of each technology and its costs, to ensure the most efficient and cost-effective solution [HASAN AL-PAY HEPERKAN , OTHERS(2022)].

B. Energy Modeling Means

An energy model is a series of calculations generated by your computer that provide you with information on the anticipated energy consumption of your building. It simulates how much energy the building is estimated to consume. It is also used to help designers make smarter decisions. In this way, owners can obtain a better understanding of the estimated cost of their energy bill. It additionally offers you a glimpse into the future of your building so that you can make informed decisions during the design process. However, a lot of the times that's not how energy models are actually used most owners and designers rely on it kind of as a verification document to meet energy performance requirements from the city or certification programs like LEED cause a lot of the times consultants are kind of involved too late or someone else is doing the modeling so there's a lot of back and forth modeling also takes a long time and it's very complicated so the longer your consultant takes to give you feedback the more complicated it is to implement on your project just overall there's a lot of friction in the process. So, digitalization has become one of the biggest game changers of energy modeling. For example, using software to automate energy modeling can reduce the time taken to produce an energy model from days to hours and the results are more accurate the times consultants are kind of involved too late or someone else is doing the modeling so there's a lot of back and forth modeling also takes a long time and it's very complicated so the longer your consultant takes to give you feedback the more complicated it is to implement on your project just overall there's a lot of friction in the process. So, digitalization has become one of the biggest game changers of energy modeling. For example, using software to automate energy modeling can reduce the time taken to produce an energy model from days to hours and the results are more accurate.

C. Ter-Mus PLUS

It is a program affiliated with building information modeling (BIM)/3d and analyzes and simulates dynamic energy using Energy Plus™. The program is designed to digitally represent a building's characteristics, environmental conditions, and energy systems to accurately simulate how it will use energy over time. It can identify areas of energy inefficiency, as well as quantify the potential savings of implementing energy-saving measures [“accasoftware.com”, TerMus PLUS].

Outcome of Ter-Mus PLUS:

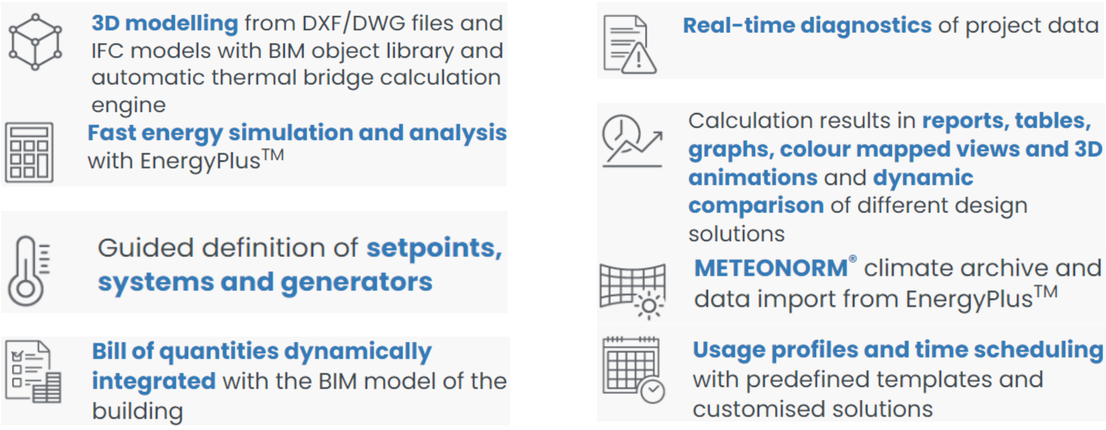


Figure 61 Outcome of TerMus PLUS [“accasoftware.com”, TerMus PLUS].

V. CHAPTER E

A. Example: Odysseus Offices

Figure 62 Odysseus Offices [PIERRE LARUAZ, (2021)].

Building Type: Office building < 28m

Construction Year: 2017

Delivery Year: 2018

Address: ECOUFLANT, France

Climate Zone: [Cbc] Mild, dry winter, warm and wet summer.

Net Floor Area: 478 m^2

Description:

The company ISORE OUEST ATLANTIQUE The project consists of the construction of the head office for it. The architect: Jean Pierre CRESPY. Visualize the consistency architectural between the offices and the storage area. Smart buildings allow the organizing of the lighting and the temperature of the offices according to the natural light and the occupation of the rooms.

Material:

Reinforced concrete walls + 200 mm ITE mineral wool R = 5.7 Aluminum exterior joinery, low-emissive double glazing Uw = 1.6 Polyurethane foam under paving R = 3.7 Rock wool on steel pan R = 5 [PIERRE LARUAZ, (2021)].

Final Energy: 35,00 kWhef/m2.an

Real final energy consumption/m2: 49,00 kWhef/m2.an

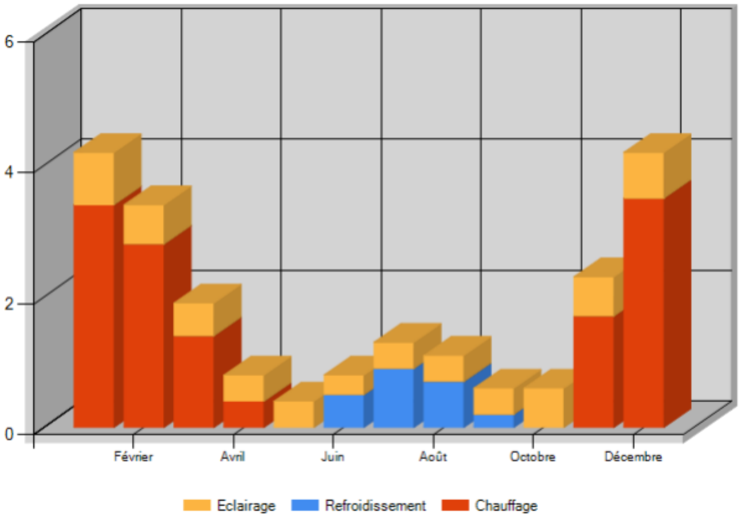


Figure 63 Details of Needs Per Month [PIERRE LARUAZ, (2021)].

The actual consumption for the year 2020: 23,560 kWh EF, according to the statement of invoices from the energy supplier (for 478 m2 S RT of offices, and 464 m2 of workshop).

Renewable systems:

Solar photovoltaic, heat Pump on geothermal probes.

Renewable energy production: 156,00 % only the meeting room is air conditioned 70 photovoltaic panels of 260 Wp for an annual production of 19,000 kwh / year Geothermal energy, 9.5 kwh EP / m2. year. [PIERRE LARUAZ, (2021)]

Smart Building:

BMS:

Centralized Technical Management on cloud, which allows the regulation of lighting and temperature in offices according to natural light and room occupancy.

Systems:

Heating system: Geothermal heat pump, water radiator, radiant ceiling.

Hot water system: Individual electric boiler.

Cooling system: Geothermal heat pump.

Ventilation system: Nocturnal over ventilation, double flow heat. Exchanger [PIERRE LARUAZ, (2021)].

Temperature right:

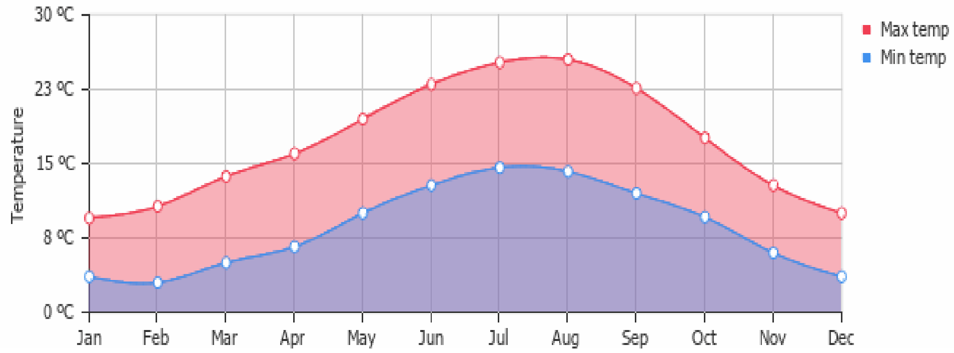


Figure 64 Average day and night temperature in Angers ECOUFLANT, France [35].

$$\text{Temperature right} = \frac{\text{jan +feb +mar +apr +may +jun +jul + aug +sep +oct +mov + dec}}{12} = \frac{9+10+14+15.5+20+23+24+24+23+16+13.3+10}{12}$$

$$\text{max} = \frac{202}{12} = 16.8$$

$$= \frac{5.5+5+6+7.8+9.4+14+15+14.8+13+9.2+7.7+5}{12} \quad \text{min} = \frac{112.4}{12} = 9.4$$

B. Case Study of Office Building to Atchieve Zeb by The Strategies of Zeb and Ter-Mus PLUS

Figure 65 3D.

Description:

Based on the zero-energy consumption design, we designed a two-stories building, considering the building materials, insulation materials, and building orientation using the term us + program. The building materials and insulation materials used in the construction of the building were chosen to reduce heat loss and increase energy efficiency. The orientation of the building was also considered to ensure that the building receives maximum solar energy during the day. This will reduce the need for additional heating. With Ter-Mus PLUS we will get the energy simulation calculation report (for building).

The building is a two-stories office:

First floor: office area, dining area and bathroom.

Second floor: office - meeting room - manager's room - bathroom.

By entering all the information in the program, including the design we made, the location of the land, the climate, the direction of the sun, the building materials, the insulation materials that were chosen, their use, and some other details about the building. The software calculates the amount of heat transfer through the building, and the amount of cooling and heating required during the year. Choosing any of the alternative energy systems most appropriate for the site in terms of weather, wind, sun, lighting, heating, cooling and other systems, and the amount of energy required from users. Systems most likely to use solar energy, footsteps energy, biomass, and wind energy.

General Information:

Located in: Küçükçekmece, Istanbul, Türkiye.

Küçükçekmece Weather & Climate Data & Graphics: Küçükçekmece climate is warm and temperate. Winter in Küçükçekmece, there is more rainfall than in summer. The summer season starts in the End of June, ends of September. climate is classified as Csa, 'According to Köppen and Geiger' ["KÜÇÜKÇEKMECE CLIMATE (TURKEY) DATA AND GRAPHS FOR WEATHER & CLIMATE IN KÜÇÜKÇEKMECE"]. Climate data source: "Calculated. (Source: Meteonormv.7.3.1)" available by the program. *Climate zone:* [Csa] Mild, cold, and rainy winter, warm and rainy summer.

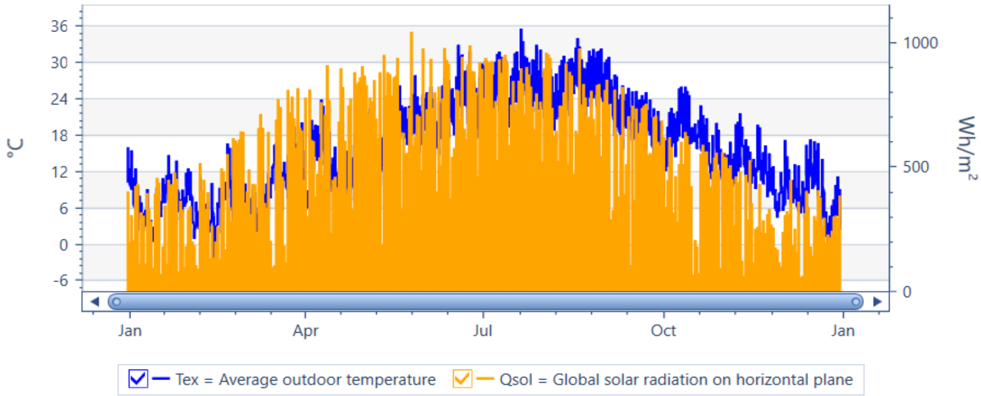


Figure 66 Climate data source: "Calculated. (Source: Meteonormv.7.3.1)".

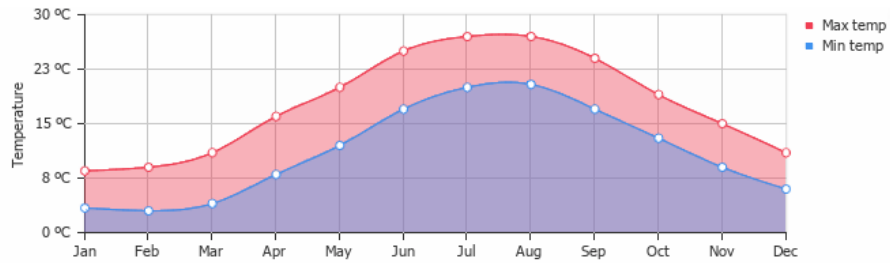


Figure 67 Average day and night temperature in Küçükçekmece Istanbul Türkiye ["Rigid solar model"].

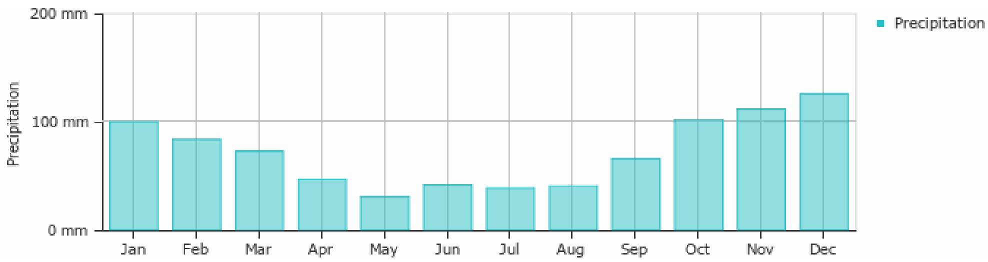


Figure 68 Daily percent of sunshine during the day over the year in Küçükçekmece Istanbul Türkiye ["Rigid solar model"].

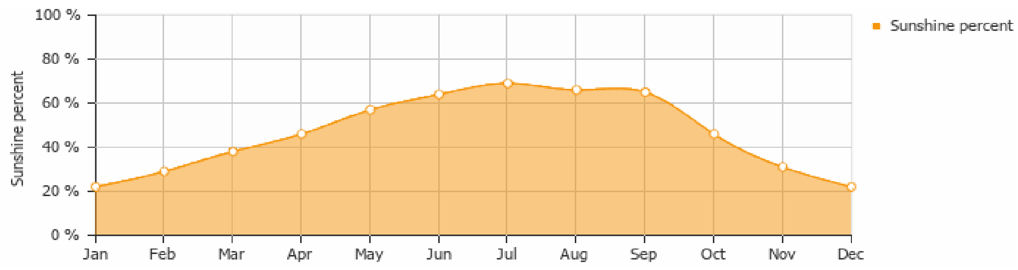


Figure 69 Monthly precipitation over the year, including rain, snow, hail etc. in Küçükçekmece Istanbul Türkiye ["Rigid solar model"].

Site description:

Sunshine at The Site: From Sunrise to Sunset. The building is open on 4 sides. The building is surrounded by a school, residential buildings and Küçükçekmece lake. The building is an office, two floors: first floor: office area, the dining area, and the bathroom. Second floor: office area, meeting room, manager's room, bathroom.

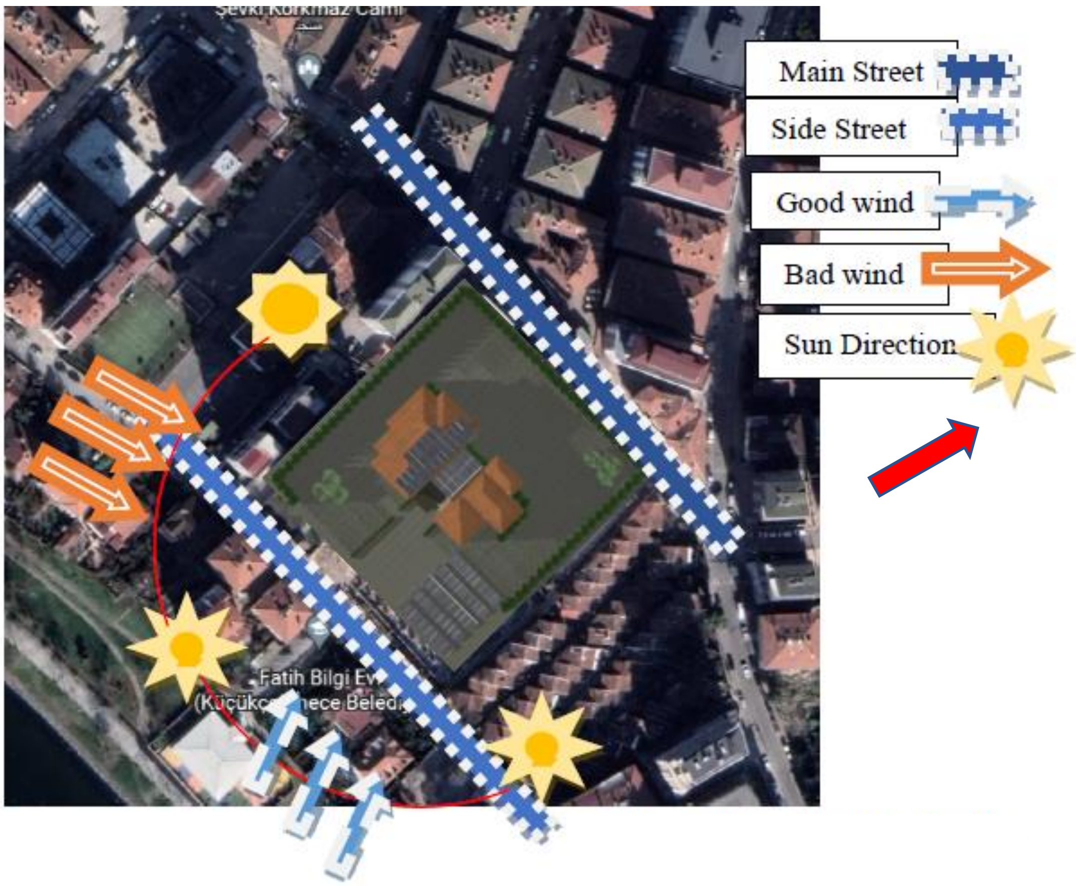


Figure 70 Simple study for the site.

Building data for Ground Floor:

Net Volume: 412.40 m^3

Net walkable surface: 139.80 m^2

Net vertical opaque surface confining with the outside: 159.34 m^2

Transparent surfaces confining with the outside: 32.85 $m^{2.}$

Sub-Unit results:

The results of the sub-unit are representative of the entire building.

Sub-unit data:

Net volume: 412.40 m^3, Net walkable surface: 139.80 m^2

Results for Building: Ground Floor Plan.

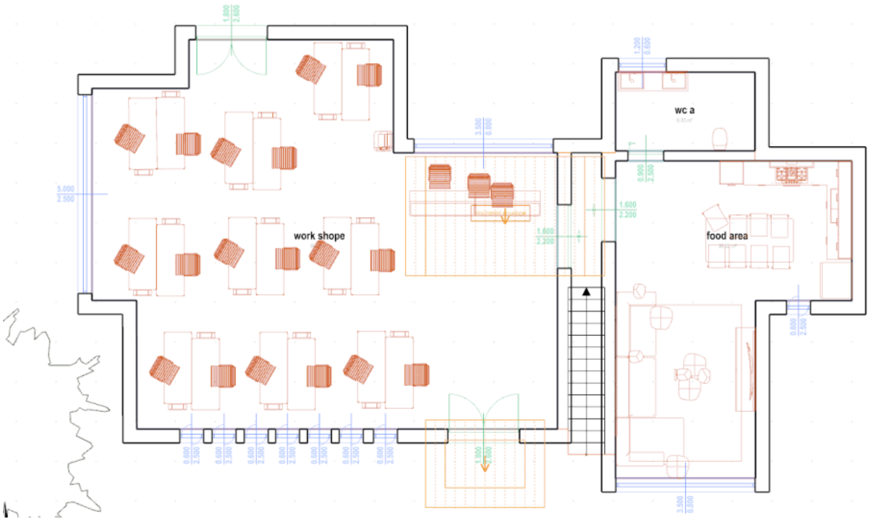


Figure 71 Ground Floor Plan.

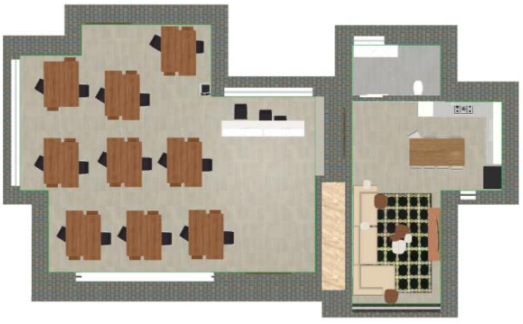


Figure 72 and 73 3D, Ground Floor Plan.

Building Data for First Floor:

Net Volume: 429.48 m3

Net walkable surface: 119.96 m2

Net vertical opaque surface confining with the outside: 153.03 m2

Transparent surfaces confining with the outside: 35.47 m2.

Sub-Unit results:

The results of the sub-unit are representative of the entire building.

Sub-unit data:

Net Volume: 412.40 m^3, Net walkable surface: 139.80m^2

Results for Building: First Floor.

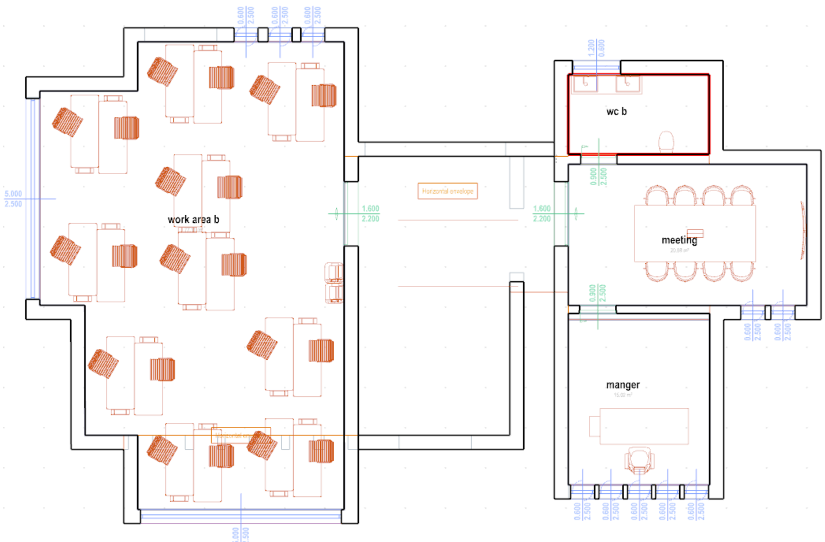


Figure 74 First Floor Plan.

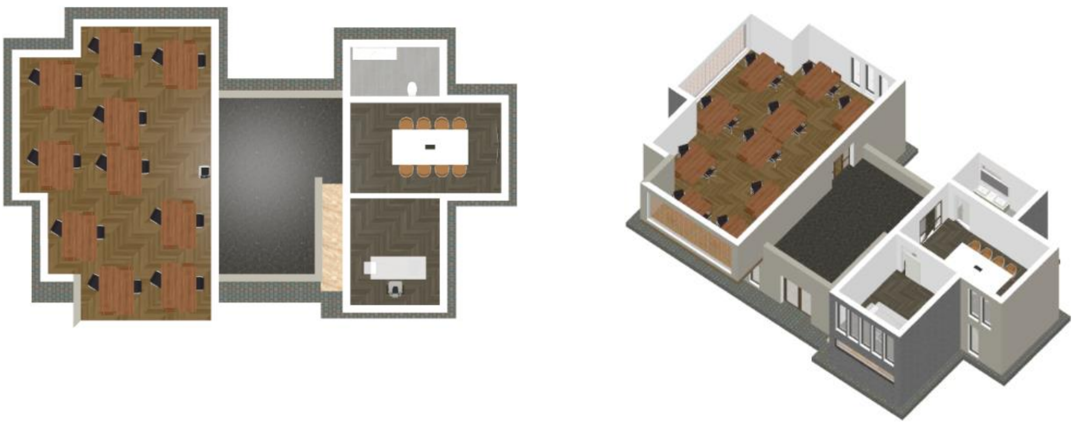


Figure 75 and 76 3D, First Floor Plan.

Roof, 3D Model:

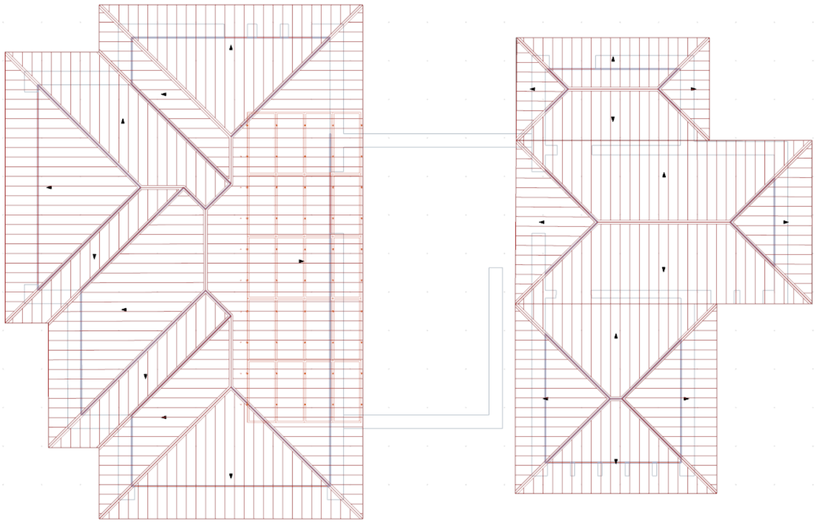


Figure 77 Roof Plan.

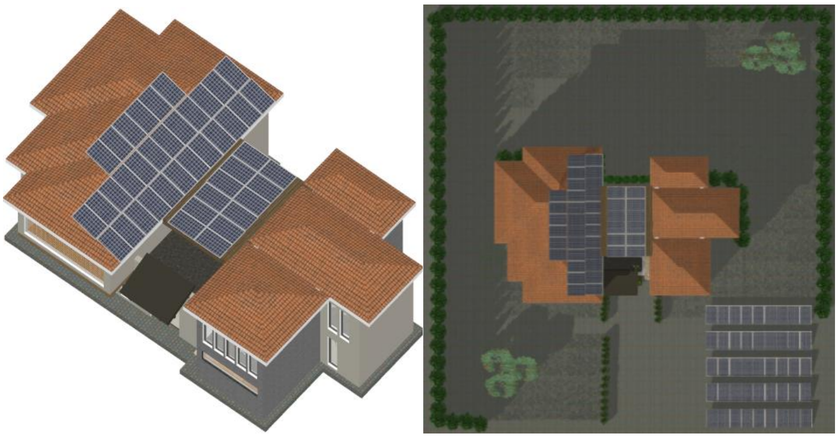


Figure 78 Layout.

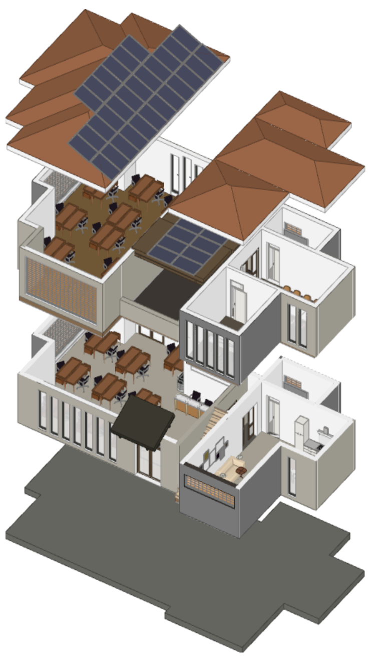


Figure 79 3D Photos.

Material layers from Ter-Mus PLUS:

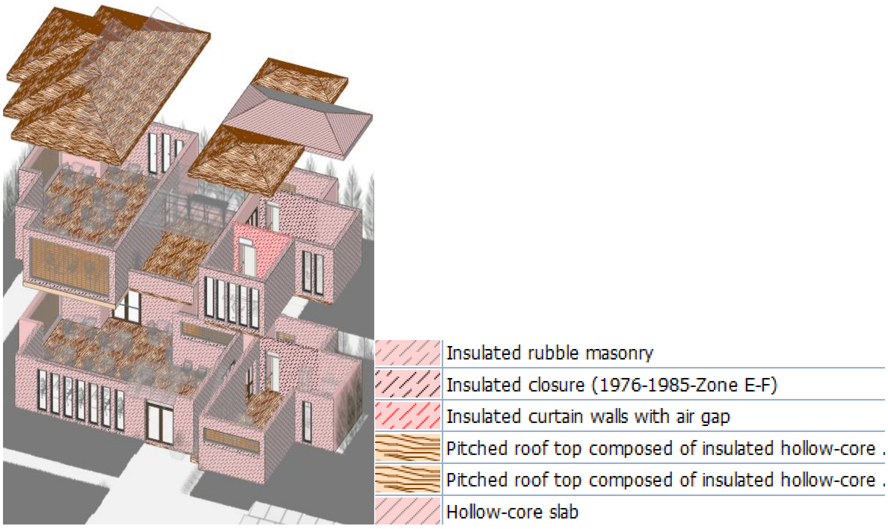


Figure 80 Material layers 3D.

Insulated rubble masonry wall section:

U: 0.55W/M2K THIKNISS: 290MM

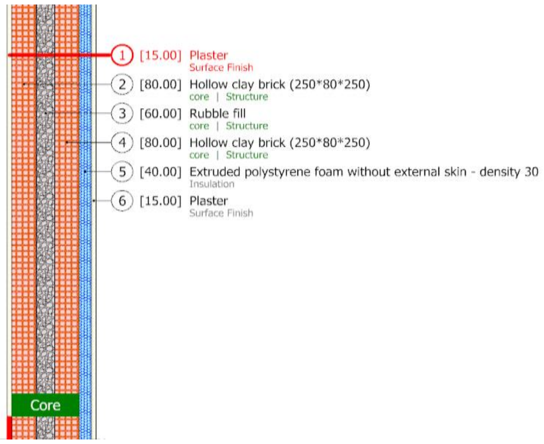


Figure 81 Insulated rubble masonry wall section.

Insulated curtain walls with air gap:

U: 0.85W/M2K THIKNISS: 200MM

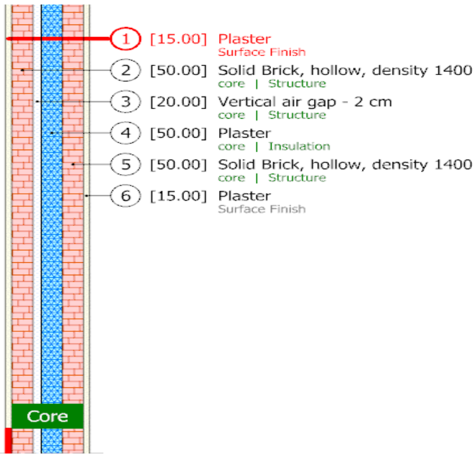


Figure 82 Insulated curtain walls with air gap.

Hollow clay brick:

Clay is a natural, abundant, and renewable material, and the production process does not require the use of any harmful chemicals or toxins. Additionally, because clay bricks are durable and long-lasting, they can reduce the need for frequent replacement, which can ultimately reduce waste.

While hollow clay brick is not considered the most environmentally friendly building material, in terms of its production and manufacture, it does have some positive qualities and can be a sensible choice for construction projects when used in a responsible and sustainable manner. *Or can be used rammed earth:* Considered an environmentally friendly building material. Low embodied energy, Thermal mass, Local sourcing, Durability. However, as with any construction material, the environmental impact of rammed earth depends on factors such as its production process, transportation, and disposal.

Rubble fil: Refers to the use of broken or irregular pieces of concrete, bricks, stones, or other materials as a filling material in construction projects. Sustainability, Cost-effectiveness, Stability, Drainage, Insulation, Aesthetics.

Extruded polystyrene foam without external skin: XPS foam is highly efficient as insulation and can help reduce energy consumption and carbon emissions in buildings. It is also durable and long-lasting, which can reduce the need for replacement or maintenance over time. But has some environmental impacts, in terms of its production and manufacture, not a renewable resource, like its shade disposed of correctly, it can be contributed to litter and pollution if it not disposed of correctly. It can still be used in environmentally conscious ways and has benefits in certain applications. There are several alternatives, Mineral wool, Cellulose insulation, Polyisocyanurate foam (polyiso), Expanded polystyrene foam (EPS). *Or Mineral wool is more environmentally friendly.*

Hempcrete: Environmentally friendly building material. This is because it is made from natural and renewable materials, including hemp and a lime binder. Hempcrete also has good insulation properties, which can help to reduce the energy needed to heat and cool buildings. This can help to lower greenhouse gas emissions and reduce energy costs.

Structural steel: Structural steel can be considered environmentally friendly in some respects, most recycled materials in the world, can help to conserve natural resources, reduce energy consumption, and minimize waste. Reducing the need for replacement and thereby conserving resources. But has some environmental impacts, in terms of its production and manufacture. To minimize the environmental impact of structural steel, it is important to use recycled steel whenever possible and to ensure that the production process is as efficient and sustainable as possible. Additionally, the design and construction of steel structures should be optimized to minimize material usage and waste. *OR Wood frame.*

Clay tiles: Environmentally friendly, Production process, Durability, Recyclability, Recyclability, Transportation. clay tiles can be environmentally friendly if they are produced and used responsibly. Choosing a manufacturer that prioritizes sustainability, using recycled or salvaged tiles, and minimizing transportation-related emissions can all help reduce the environmental impact of clay tiles.

Ceramic tiles: An environmentally friendly option for flooring and wall coverings. Durability, Low Maintenance, Natural materials, Recyclable, Energy-efficient production.

Ordinary screed: known as traditional sand and cement screed, is not considered an environmentally friendly option for flooring. High carbon footprint, Waste generation, Poor thermal properties, Limited lifespan.

Composed of insulated lightweight infill blocks: Considered an environmentally friendly option for construction, particularly for wall insulation. Energy efficiency, Renewable materials, Reduced waste, Low embodied energy, long lifespan.

Plaster: Plaster made from natural materials can be considered eco-friendly, it's important to consider the specific materials and manufacturing processes involved to fully understand the environmental impact of any given plaster product.

Paint: Bio Shield's Clay Paint is environmentally friendly, made of sustainable and renewable materials, and provides good insulation properties. Breathable, which means it allows moisture to pass through the walls. This can help prevent mold and mildew growth and improve indoor air quality [bioshieldpaint.com].

Floor composed of insulated hollow-core slabs section:
U: 0.60W/M2K THIKNISS: 290MM

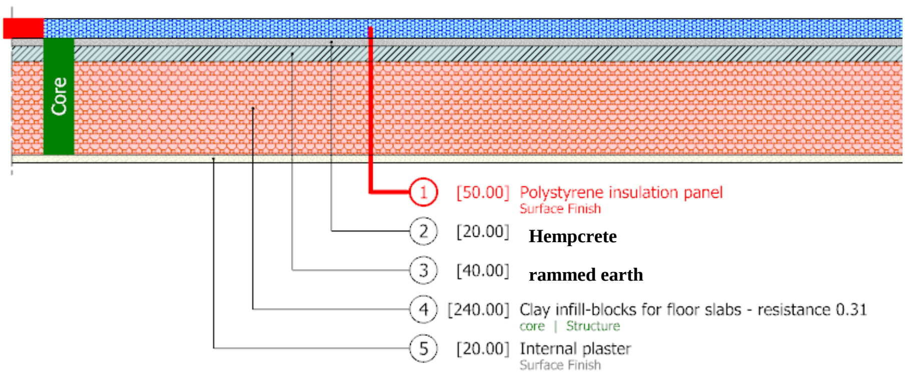


Figure 83 Floor composed of insulated hollow-core slabs section.

Roof HOLLOW CORE SLAP 29CM:
U: 1.19W/M2K THIKNISS: 290MM

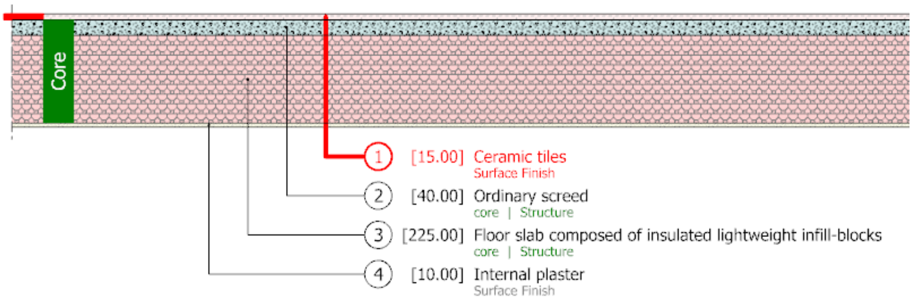


Figure 84 Roof HOLLOW CORE SLAP 29CM

Pitched roof top composed of insulated hollow-core slabs section:
U: 0.60W/M2K THIKNISS: 290MM

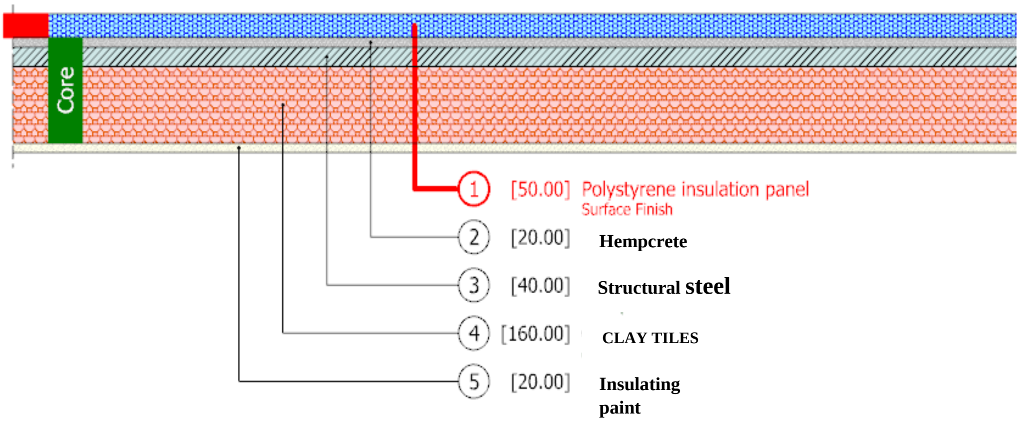


Figure 85 Pitched roof top composed of insulated hollow-core slabs section.

Glass used in Windows and Doors:

Triple glazing with two low-e coatings and inert gas filling. Prevents significant heat loss is window frames are well insulated. Excellent sound insulation, meaning that you cannot sense changes in weather outside, which is very comforting to the user.

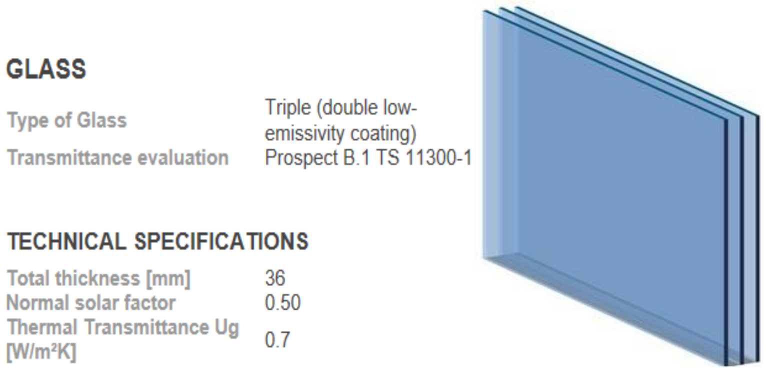


Figure 86 Triple glazing.

Some climate strategies have been considered for landscape:

Turkey's climate is mild, with warm summers, cold winters, and moderate rainfall throughout the year or a certain period of the year.

There are some climate strategies that have been considered. During the summer, the building was designed to protect it from the hot sun, and trees were planted. During the winter period, the building was designed to reduce the force of cold winds using evergreen shrubs, which helps reduce heat loss in the winter. Moisture insulators were placed in the ground and low vegetation cover to prevent moisture and the passage of breezes. The use of paving materials and building materials of dark and light colors to moderately absorb heat, maintain cool air temperature in hot weather, and reduce glare.

Systems has been used in our design from Ter-Mus PLUS:

Heating system: heat pump.

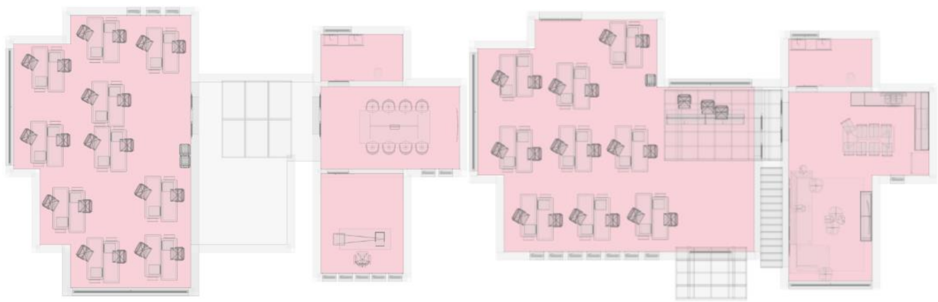


Figure 87 and 88 Heating system.

Cooling system area:

Cooling system: heat pump, air condition electricity.

Figure 89 and 90 Cooling system.

Hot water system: heat pump.

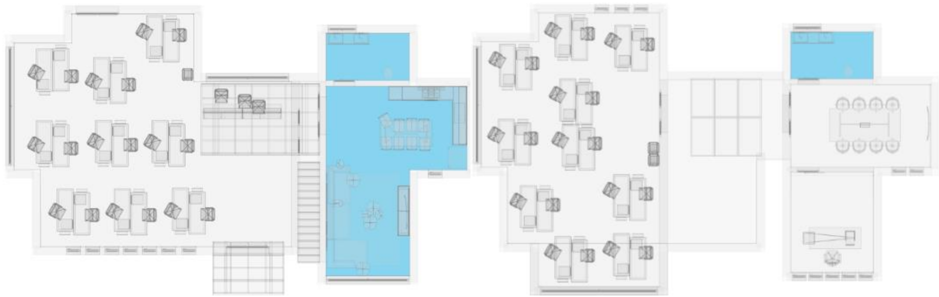


Figure 91 and 92 Hot water system.

Ventilation system: Nocturnal ventilation.

Figure 93 and 94 Ventilation system.

Renewable systems: Solar photovoltaic.

Recycling Wastewater: Drinking water is provided by treating rainwater on site. from sinks and kitchen sinks, gray water is slightly polluted, non-potable after treatment at the source, can be used in toilets, watering landscaping after treatment. The local aquifer is reintroduced after on-site water treatment. Storm water for watering landscaping. Excess water is returned to the original water source.

Conductance [material, class, frames, and panels] U FACTOR from Ter-Mus PLUS:

Each material has a different conductance respond to the weather around it this simulation showing the different colors material reacts to the *weather, the darker blue in walls U: 0.55W/M2K, flooring U:* 0.60W/M2K, and roof U: 0.60W/M2K it contains a heat insulation material which *transfer almost zero heat. The light to blue* *in interior walls* U: 0.85W/M2K which *transfer very low heat. The green and light green in the roof and the doors U:* 1.19W/M2K which *transfer medium heat. The red in the interior doors U:* 1.89W/M2K which *transfers very high heat.*

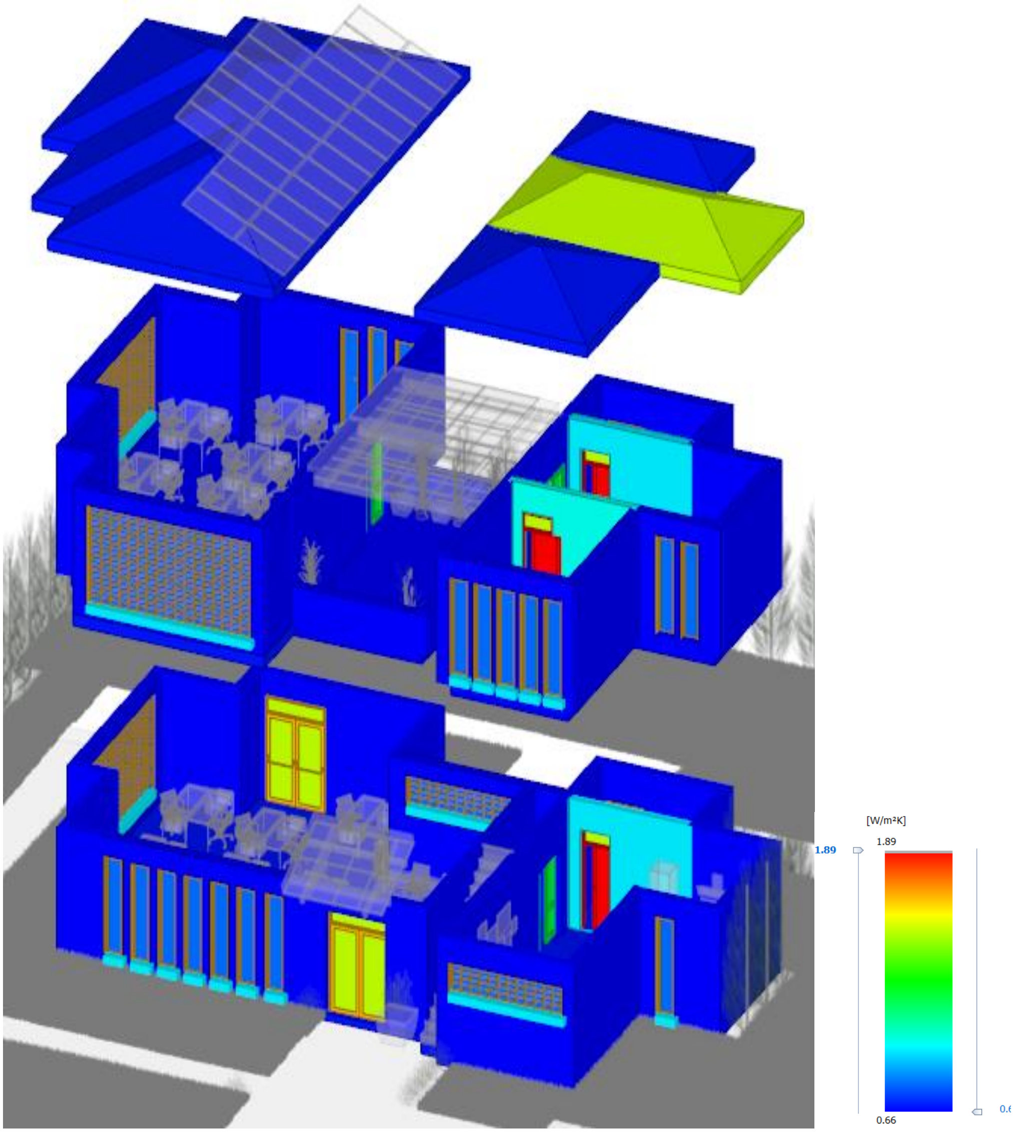


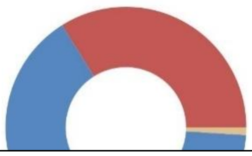
Figure 95 Conductance.

Simulation Results for Calculated Building from Ter-Mus PLUS:

Building energy simulation results and office Building sub-division units.

Requirements Ground Floor:

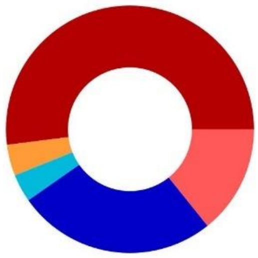
Table 2 Requirements ground floor.

	Requirements	Requirements	%
	Heating	4´353.27 kWh	33.90%
	Cooling	8´360.30 kWh	65.10%
	Domestic Hot Water	129.41 kWh	1.01%

	Total	12´842.98 kWh	100.00%

Losses Ground Floor:

Table 3 Losses ground floor.



Losses	Losses KWH	%
Opaque casing	11´088.72 kWh	52.01%
Glazed surfaces	867.80 kWh	4.07%
Losses due to infiltrations and natural ventilation	778.99 kWh	3.65%
Mechanical ventilation	5´546.91 kWh	26.02%
Outdoor air total cooling energy	3´036.77 kWh	14.24%
Total	21´319.19 kWh	100.00%

Gains Ground Floor:

Table 4 Gains ground floor.

Gains	Gains KWH	%
Solar	7´244.64 kWh	44.49%
Occupants	8´980.50 kWh	55.15%
Lights	59.16 kWh	0.36%
Generic	0.00 kWh	0.00%
Total	16´284.30 kWh	100.00%

Rooms/Compartments ground floor:

Results broken down for each room present in the sub-unit being analyzed.

Heating: Global findings

Results of the entire simulation period.

Table 5 Heating.

Room name	Total thermal energy requirement for heating	
	[kWh]	[kWh/m²]
wc a	516.86	73.73
food area	1´196.70	31.78
work shope	2´639.71	27.06

Cooling: Global findings

Results of the entire simulation period.

Table 6 Cooling.

Room name	Total thermal energy requirement for cooling	
	[kWh]	[kWh/m²]
wc A	468.24	66.80
food area	2´504.27	66.51
work shope	5´387.79	55.23

Domestic hot water: Global findings Results of the entire simulation period.

Table 7 Domestic hot water.

Room name	**Total thermal energy requirement for cooling**	
	[kWh]	**[kWh/m²]**
wc A	64.70	9.23
food area	64.70	1.72

Requirements First Floor:

Table 8 Requirements First Floor.

Losses	Losses KWH	%
Opaque casing	10´274.18 kWh	67.66%
Glazed surfaces	1´102.77 kWh	7.26%
Losses due to infiltrations and natural ventilation	1´149.32 kWh	7.57%
Mechanical ventilation	631.11 kWh	4.16%
Outdoor air total cooling energy	2´027.69 kWh	13.35%
Total	15´185.07 kWh	100.00%

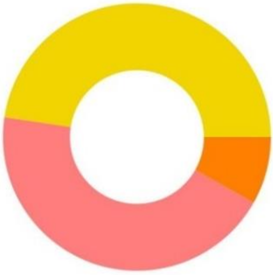
Losses First Floor:

Table 9 Losses First Floor.

Requirements	Requirements	%
Heating	4´759.08 kWh	29.92%
Cooling	9´651.78 kWh	60.67%
Domestic Hot Water	1´497.71 kWh	9.41%
Total	15´908.57 kWh	100.00%

Gains First Floor:

Table 10 Gains First Floor.



Gains	Gains KWH	%
Solar	9´350.33 kWh	47.63%
Occupants	8´678.78 kWh	44.21%
Lights	1´602.65 kWh	8.16%
Generic	0.00 kWh	0.00%
Total	19´631.76 kWh	100.00%

Rooms/Compartments First Floor:

Results broken down for each room present in the sub-unit being analyzed.

Heating: Global findings

Results of the entire simulation period.

Table 11 Heating.

Room name	**Total thermal energy requirement for heating**	
	[kWh]	**[kWh/m²]**
manger	611.58	40.18
meeting	1´170.25	53.90
wc b	541.91	77.31
work area b	2´435.33	31.11

Cooling: Global Findings. Results of the entire simulation period.

Table 12 Cooling.

Room name	Total thermal energy requirement for cooling	
	[kWh]	[kWh/m²]
manger	1´221.49	80.26
meeting	2´784.22	128.25
wc B	384.15	54.80
work area B	5´261.92	67.23

Table 13 Domestic hot water.

Room name	**Total thermal energy requirement for domestic hot water**	
	[kWh]	**[kWh/m²]**
wc B	1´497.71	213.65

Domestic hot water: Global findings Results of the entire simulation period.

The heating and cooling system: In the heat pump underground Horizontal heat exchanger, I used the automatic temperature controller efficiency of heat pump**.** For the Single mode, the heat pump is the only energy source covering 100% of the annual thermal energy demand [Geothermal Heating and **Cooling,u.s** department of energy, (2023), How Much Land Do You Need for a Ground Source Heat Pump?].

Working method:

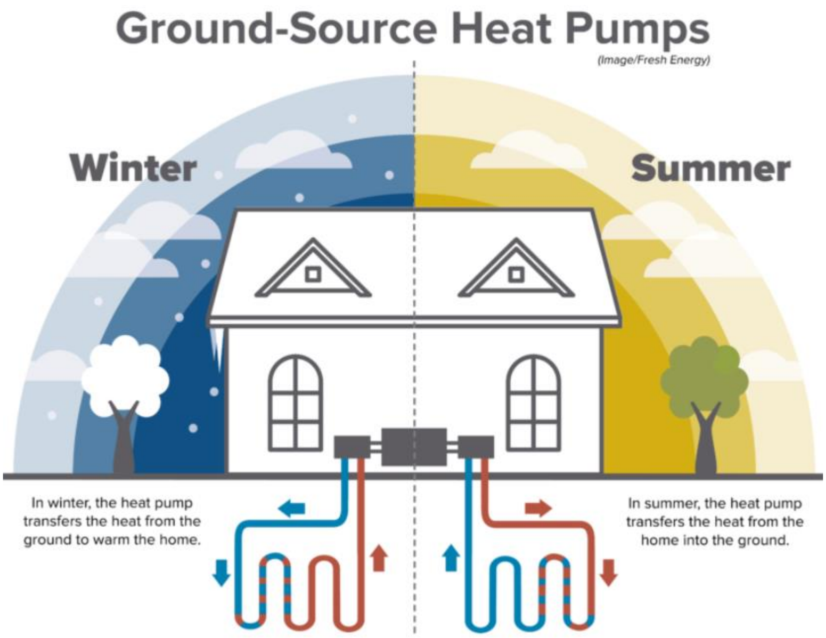


Figure 96 Ground-source heat pumps take heat from a fluid—usually water—that is being transported through pipes and move it into the air. [BRIANA KERBER, (26 July 2021)]

Heat Pump Capacity: Total Load = 28,751.55 kWh Assuming a *COP* (coefficient of performance) of 4.5 for the heat pump, the required heating/cooling capacity is Capacity = Total Load / COP = 28,751.55 kWh / 4.5 = 6,389 kW

Ground Loop System: To determine the size of the ground loop system required to support the heat pump, we can use the recommended rule of thumb of 10m of trenching with slinkies for each 1kW of heat. Therefore, the length of the ground loop system required is Length = Capacity / 10 = 6389 kW / 10 =638.9 meters. Copper with insulation material [MUHAMAD HABBOUSH, (2018)].

Depth and length of the geothermal network:

Trench length ranges from 30 to 100 meters, depth from 2 to 6 m, width 2to 3 feet = 0.7 to 0.9 m, it will accommodate about 200 meters of pipe. Slinky™ method This method gives more pipes, a shorter trench, and reduces installation costs. It extends 20 m from the office. It is generally recommended that for each 1kW of heat you will need 10m of trenching with slinkies. Trench 4, length 60m, depth 4m, width 0.9 m, extends 20 m from the office.

Loop pipe number material and diameter of the pipe:

Between loops 18”, average ground temperature data for sizing the ground loop system: Average Ground Temperature = 15°C. The length of the ground loop system required is Length = 638.9 meters. Trench 4, length 60m, depth 4m, width 0.9 m, extends 20 m from the office.

Refrigerant 600a (Isobutane): density= At 25°C and 1 atm pressure: 550 kg/m^3. The specific heat capacity of refrigerant 600a (Isobutane) at 25°C is approximately 2.29 kJ/kg·K. [(2023), GROUND SOURCE HEAT PUMPS: HOW MUCH SPACE DO YOU NEED*]*

R-600a advantages:

- Zero ozone depletion potential.
- Very low global warming potential (<4).
- High thermodynamic properties leading to high energy efficiency.
- Good compatibility with components.
- Low charges allowing smaller heat exchangers and piping dimensions.

Space needed for horizontal ground loops:

The average surface area of land required is approximately 2.5 times the square meterage of the building.

Ground floor walkable surface: 139.80 m2.

First Floor walkable surface: 119.96 $m^{2.}$

The total: 139.80+119.96=259.76=260 $m^{2.}$ 260*10.764=2798.640square feet.

office Size = 2798.640. sq ft * 2.5 = 6996.6 sq ft

land require 6996.6/10.764=650 $m^{2.}$ [https://zero-code.org/zero-code/.]

Heat loss and loads through (ceiling, floor, wall, glass and door) By the Simulation program from Ter-Mus PLUS:

Table 14 Heat loss and loads through.

Floor	Q load kWh	Q load w	Q load TR
Losses ground floor	21319.19	21319190	6063.48
Losses First Floor	15185.07	15185070	4318.85
Total	36504.26	36504260	**10382.33**

Radiation System in the room:

1. cast iron radiators Two water columns per section Height: 630 mm Depth: 65 mm output per section (w) = 90.4w.

2. Underfloor heating systems using cross-linked polyethylene pipes (PEX)length: m. Thermal conductivity=0.35-0.46W/m*k, 18mm.

Table 15 Radiation System in the room.

Rooms	Type1	Type2	NO. OF Radiator1	NO. OF Radiator2
ground floor				
Workshop A	yes	yes	5	2
Food area	no	yes	0	2
1Wc	yes	no	1	0
First Floor				
Workshop B	yes	yes	4	1
Manger	no	yes	0	1
Meeting	no	yes	0	1
2Wc	yes	no	1	0

Table 16 Pipe design Type1.

Rooms	RAD. FLOW RATE(l/s)	Pipe Diameter (mm)	Velocity (m/s)	PIPES LENGTH (m)
Workshop A	0.043	18	1.15	30
1Wc	0.043	18	1.15	3
Workshop B	0.043	18	1.15	26
2Wc	0.043	18	1.15	3
Total				**62**

Calculation of ground force Type2:

Identify the cross-section of the power cable by calculating the power of electric underfloor heating. A useful area that will be heated by heating elements should not be taken all, but only part of it. P = PM * S. Rooms

Pm: rated power per square meter of the heating element 1m2= 2 w/m2, S: room is the area of the heated room. length*width.

Rooms	pm	S= length*width	p
Workshop A	2	11*8	176
Food area	2	3*3/ 4*3	18/ 24
Workshop B	2	5*8	80
Manger	2	3*3	18
Meeting	2	4*3	24

Calculation of the required length of PP pipes Type2:

Here is an approximate formula for calculating (regardless of the laying method): l = (n - k) * (m - k) / k

n: length of the heated floor section, m.: width of the heated floor area, k: step between the pipes, l: total length of the pipes.

Table 18 Calculation of the required length of pipes Type2.

Rooms	N: length	-k m	*M: width	-k	/k	I (m)
Workshop A	28	0.25	11	0.25	0.25	75
Food area	16	0.25	8	0.25	0.25	31
Workshop B	32	0.25	15	0.25	0.25	117
Manger	17	0.25	8	0.25	0.25	32
Meeting	28	0.25	5	0.25	0.25	33
			Total			**288**

Boiler water Pump calculation:

$r=9*10^{'-3}$, $r2= 2.5*10^{-4}$ m

r: Pipeline radius in meter

volume = l*a= $686*2.5*10^{-4}$=1.715

V: the total volume of $Pipeline^3$ in meter

m= **ρ** * V= 550*1.715=943.25 where m refers to the fluid mass in kg

Pressure Head:

1- Static (elevation) = zero

2- Dynamic (Velocity)

= $1/2 * \boldsymbol{\rho} * V^2 = 1/2 * 1000\ kg/m^3 * (0.88m/s)^2 = 213Pa$

ρ: fluid density (kg/m^3), V: Fluid velocity (kg/s)

3- Friction losses =$L*\Delta p/m *2 + L_{eq}*\Delta p/m$

L: total pipe length (m), Δp: pressure drops in pipelines (pascal), M: mas flow rate across the system (kg/s),

L_{eq}: total length of valves and fittings across the system (m).

= 350*53830/0.121 *2+356.12*53830/0.121 = 3141355864.5 pa

L= 62+288= 350m

mass flow rate = m = ρ * A * V

= 550 (kg/m^3) *$2.5*10^{-4}$ (m^2) * 0.88 (m/s) = 0.121 kg/s

L_{eq}= Length equivalent= no. of curves= 17*0.018 =0.306 m

0.306 * (20) = 6.12m, L_{eq}= 350+6.12=356.12m

f = 0.013Δp= f x (Leq/ Diameter) x (fluid density * V^2)/2 = 0.013(350/0.018) (550*0.88) /2= 53830pa

Power of pump:

M = Q load/ cp∗ Ts−Tr= 36504.26/2.29 kJ/kg·K* 10= 159407248.9 Kg/s

V = M. W/ **ρ***1000= 0.121*58.12/550*1000=0.0127

P pump = Δp ∗V/ ἠ pump=53830*0.0127/.8= 854.551w

Select Boiler= P pump*S. F=36504.26*1.15=*41979.899kw*

Q Boiler=Q Heating. [bsl.name products hladagent-600a-izobutan, baltic sea logistic.] *41979.899kw year/12=3498.32kwmonth/30=116.61kw per day.*

Total Requirements ground floor: 12842.98 kWh

Total Requirements First Floor: 15908.57 kWh

Total Requirements for heating, cooling and hot water: 28751.55 kWh

41979.899 - 28751.55 = 13228.349kw=13228kw the remain results it's for losses of the building.

Calculation of monthly consumption:

Consumed energy (monthly) = load capacity * number of daily operating hours * number of operating days per month: Ratio of load to total consumption = energy consumed per month (per load) / total monthly consumption [“Do a Study for Your Facility”].

Table 19 Calculation of monthly consumption.

Device	Number	device Capacity W	Work Hours	Number of Operating Days	Energy consumed per month (watt hours)	Load ratio of total consumption
Light LED	200	10	6	6	72000	9.5%
Computer office	20	450	7	6	378000	49.8%
Laptop	21	40	3	4	10080	1.3%
Printer	2	1000	.5	6	6000	0.7%
Projector	1	100	.25	3	75	0.009%

Table 19 (cont.) Calculation of monthly consumption.

Device	Number	device Capacity W	Work Hours	Number of Operating Days	Energy consumed per month (watt hours)	Load ratio of total consumption
Router	2	25	8	6	2400	0.3%
TV50LED	2	35	5	6	2100	0.2%
Telephone Charger	40	30	1.5	6	10800	1.4%
Refrigerator	1	130	24	6	18720	2.4 %
Boiler	2	700	3	7	29400	3.8%
Oven	1	1000	1	6	6000	0.7%
Microwaves	1	1000	2	6	12000	1.5%
Air Condition 3 ton	8	1000	4	6	192000	25.3
Total	757575					97%

1. Calculation of the amount of energy consumed per day:

Number*device capacity x working hours = energy consumed by the device per day [(2021), "On the program for calculating solar objects,"].

Table 20 Calculation of the amount of energy consumed per day.

Device	Number	device Capacity W/h	Work Hours	Calculate the amount of energy consumed per day w
Light LED	200	10	6	12000
Computer office	20	450	7	63000
Laptop	21	40	3	2520
Printer	2	1000	.5	1000
Projector	1	100	.25	25
Router	2	25	8	400
TV50LED	2	35	5	350
Telephone Charger	40	30	1.5	1800
Refrigerator	1	130	24	3120
Boiler	2	700	3	4200
Oven	1	1000	1	4000
Microwaves	1	1000	2	1400
Air Condition 3 ton	8	1000	4	32000
Total			**125815 wh**	

Calculation of loss during installation 30%:

Installation of any electrical system results in a loss, and that loss may reach 30% depending on the connection, wire quality, battery resistance, and efficiency of the solar panels. As a result, the following equation must be applied to the daily energy consumption: [(2021), “On the program for calculating solar objects,”] Energy required = Total energy consumed per day *1.3

Energy required = 125815* 1.3= 163559.5 WH.

2. Calculating the number of solar panels:

The power to be generated depends on the average solar radiation per day for the area in which the panels will be installed, between 4 to 7.

The average number of sunrises per day in Istanbul, Turkey is 6 hours.

The total energy required per hour = 163559.5 ÷ 6 = 27259.9 w.

Number of panels = The total energy required per hour / Power of a single solar panel, the capacity of the panel we want to buy, we wanted to buy a 360w panel: The number of solar panels = 27259.9 ÷ 360 = 75.7 equal to approx 76

The energy used = 27259.9 w, 27259.9 W ÷ 1000 = 27.2599 kW.

To reach ZEB we will install 85 solar panels 360 w.

Actual out pout power = 85 x 360 =30600-watt, 30600 W ÷ 1000 = 30.6 kW.

Annual production of 30.6*30=918 kwh / month*12=11016 kwh / year.

PV description:

Power (Pmax): 360W. Short Circuit Current (Isc): 9.7A. Length, width, and thickness: 3 * 1.6 * 4. Light Intensity : 1000W/M. Battery Temperature : 25oC. Air quality=1.5. ["Rigid solar model"]

3. Calculating the number of batteries:

Inverter: It is a device that converts direct current (DC) into alternating current (AC). 48volt DC “direct current’’ will be 220-volt AC” alternating current”.

Batteries capacity (ampere per hour) = {(energy to be generated x number of cloudy days (in which the panels will not be charged) x 1.3 x (30% of the capacity of the batteries must be kept maintaining them)} ÷ voltage. ["China Henan Hengming Fengyun Power Source Co"] Assuming the system voltage will be 220 volts = (163559.5 *10 “assuming it will be cloudy for two days” * 1.3) ÷ 220 = 2126273.5 ÷ 220 = 9664.88 amp-hours.

To find out the number of batteries we apply the following relation: The number of batteries = the capacity of the batteries ÷ the size of the battery to be purchased So. [(2021), “On the program for calculating solar objects,”] The number of batteries = 9664.88 ÷ 500 amps = 19.3, which is approximately equal to 20 batteries of 500 amps or 20 batteries of 1000 amps per hour. It is better that the type of battery be a gel deep cycle.

Battery description: Nickel batteries of 48v 500ah for solar energy storage battery. Type: Ni-Fe 1.2V 500Ah. storage battery Dimensions: 285 * 172 * 490 mm. Weight: 22.5 kg. Assembly: Hanging. Application: UPS, solar energy. ["China Henan Hengming Fengyun Power Source Co"]

4. Solar regulator size: It is calculated as follows: The number of panels to be installed in the system x Isc (the highest charging ampere of the panel). [(2021), “On the program for calculating solar objects,”] The size of the solar regulator = 85 * 9.7 = approximately 824.5 amps. And the voltage is 48 volts. It is preferable to double the size to take precautions in the future if we want to expand the system to work for a longer time or to add other devices.

5. Calculate the size of the transformer: The size of the inverter depends on the total power of the devices at peak time. [(2021), “On the program for calculating solar objects,”] Calculate the size of the transformer= (Number* device Capacity W/h) $_1$ + (Number* device Capacity W/h) $_2$ +…+ (Number* device Capacity W/h)

Table 21 The size of the transformer

Device	Number	device Capacity W/h	Total Power
Light LED	200	10	2000
Computer office	20	450	9000
Laptop	21	40	840
Printer	2	1000	2000
Projector	1	100	100
Router	2	25	50
TV50LED	2	35	70
Telephone Charger	40	30	1200
Refrigerator	1	130	130
Boiler	2	700	1400
Oven	1	1000	1000
Microwaves	1	1000	1000
Air Condition 3 ton	8	1000	8000
Total			26790W

30% should be taken as an efficiency factor for the performance of the transformer as a precaution, and it varies according to the manufacturing company and its efficiency: So, the size of the inverter = 26790* 1.3 = 34827watts approximately.

Calculate the energy efficiency of a building:

Energy Efficiency (%) = (Total useful energy output / Total energy input) x 100

Energy efficiency = (27259.9 /30600) *100=89.1%

Diagram of PV off grid AC system (with inverter):

An inverter is added to this system. The generated energy is directed to the in inverter that converts DC to AC electricity for conventional electric appliances. Excess energy is stored in batteries and an optional backup generator can be added. [HASAN AL-PAY HEPERKAN , OTHERS(2022)]

Smart Building has been used in our design:

Building manager system:

Controlling building system on cloud, which allows the changes according to natural light, the temperature control light, temperature of the rooms.

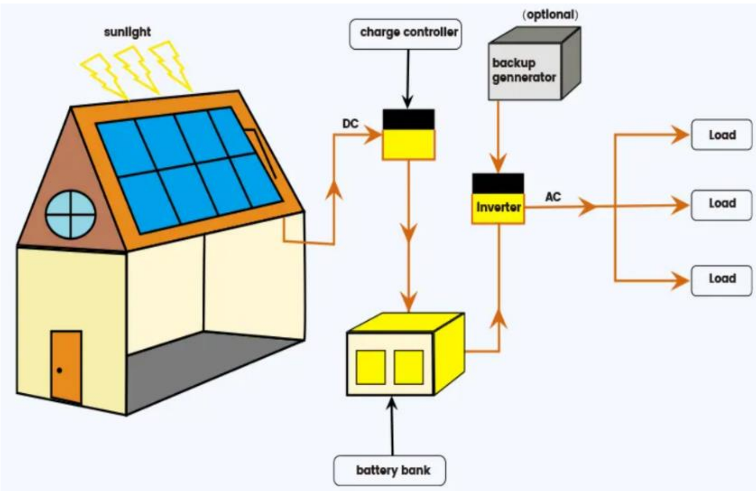


Figure 97 Diagram of PV off grid AC system (with inverter). ["Rigid solar model"]

Results:

A zero-energy office building with a comfortable environment is the aim of this study because it is the second place, after the home, where a person spends most of his time. The building environment is calculated so that it is sufficient to provide the energy required by the user without the need for external energy sources, taking into consideration the comfort of the user, as well as the impact of the building environment on the user. There are times when weather conditions and maintenance periods prevent the generation of power, however there is always an alternative utilizing the energy stored in the batteries or another form of alternative energy. It is important to note that alternative energy sources produce energy regardless of the weather. As part of this study, we intend to design a zero-energy office using the strategies described in Section 3, page (23), with the objective of becoming self-sufficient in terms of energy consumption.

The strategies that were applied in the study of the site, Istanbul, Turkey, climate is classified as Csa, "According to Köppen and Geiger". ["KÜÇÜKÇEKMECE CLIMATE (TURKEY) DATA AND GRAPHS FOR WEATHER & CLIMATE IN KÜÇÜKÇEKMECE"], The building is a two-storey office:

first floor: office area, dining area and bathroom.

Second floor: office - meeting room - manager's room - bathroom.

A building's north and south directions are determined by the movement of the sun, so that it receives as much sunlight as possible to conserve energy. As part of the design process, environmentally friendly building materials were utilized such as wood, iron, green cement and can be returned to their original condition or recycled. Shade was provided to reduce the intensity of the rays.

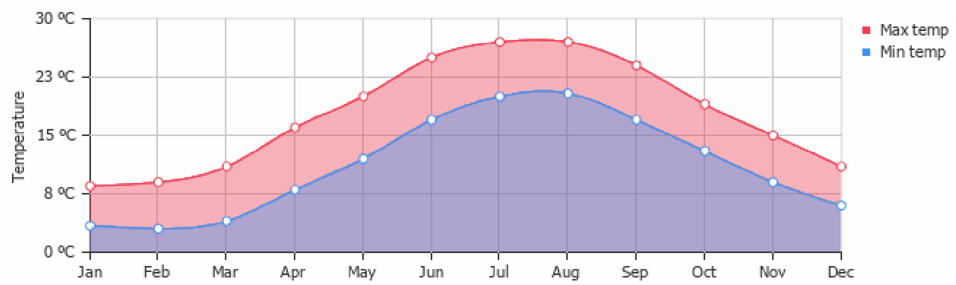


Figure 98 Average day and night temperature in Küçükçekmece Istanbul Turkey. ["Rigid solar model"]

Temperature right = jan +feb +mar +apr +may +jun +jul + aug +sep +oct +mov + dec

12

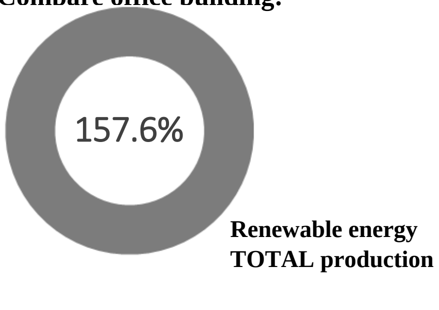
$$=\frac{8.3+8.5+11+15.3+20+25+27+27.5+23.5+18+15+12 \ max}{12} = \frac{211.1}{12} = 17.6$$

$$=\frac{4+3.8+5+8.2+13.8+15.5+18+18.5+16+14.5+9+7.8 \ min}{12} = \frac{134.1}{12} =11.2$$

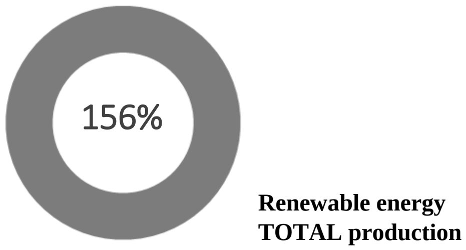
Office building according to the average day and night temperature As for the design max = 17.6 min = 11.2 that is present in the study, we used materials that suit the nature of the climate, pitched roof top composed of insulated hollow-core slabs section: U: 0.60W/M2K Thickness: 290MM, Roof HOLLOW CORE SLAP 29CM, U: 1.19W/M2K Thickness: 290MM, floor composed of insulated hollow-core slabs section: U: 0.60W/M2K Thickness: 290MM, insulated curtain walls with air gap: U: 0.85W/M2K Thickness: 200MM. Insulated rubble masonry wall section: U: 0.55W/M2K Thickness: 290MM.Which provides almost complete isolation of the building. If it is compared with the previously mentioned **Odysseus offices, France** example max= 16.8 min = 9.4 they used insulation materials suitable with the temperature of the area in which the building is located Material: Reinforced concrete walls + 200 mm ITE mineral wool R = 5.7 Aluminum exterior joinery, low-emissive double glazing Uw = 1.6 Polyurethane foam under paving R = 3.7 Rock wool on steel pan R = 5 [PIERRE LARUAZ, (2021)].

Comparison Renewable energy production, Solar photovoltaic + heat Pump geothermal:

Compare office building:



Compare Odysseus offices, France example:



It has been used in the *office building* Case Study 85 solar panels of 360 w for an annual production of 11016 kwh / year. The actual consumption: 27.2599 kWh\day. Case Study office building produces more than enough energy. This energy can be used in many ways, in the heating and cooling system, emergency needs of electricity for the building, government resells it to make money. It has been used in *Odysseus offices, France* example 70 solar panels of 260 Wp for an annual production of 19,000 kwh / year. The actual consumption: 23,560 kWh.

Systems has been used in office building Case Study:

1. Heating system area: Heating system: heat pump.
2. Cooling system: heat pump, air condition electricity.
3. Water system area: Hot water system: heat pump.
4. Ventilation system area: Ventilation system: Nocturnal ventilation.
5. Renewable systems: Solar photovoltaic.

Recycling Wastewater: Drinking water is provided by treating rainwater on site. From sinks and kitchen sinks, gray water is slightly polluted, non-potable after treatment at the source, it can be used in toilets, watering landscaping after treatment.

According to the above study, self-sufficiency was achieved in terms of comfort and safety, as well as cooling and heating energy consumption.

Systems has been used in *Odysseus offices, France* example:

1. Heating system: Geothermal heat pump, water radiator, radiant ceiling.
2. Hot water system: Individual electric boiler.
3. Cooling system: Geothermal heat pump.
4. Ventilation system: Nocturnal over ventilation, double flow heat exchanger.

Of course, the water system, safety, fire, intelligent control, and other systems and requirements must be designed to save energy and reduce costs.

VI. CHAPTER F

A. Conclusion

It is possible that there are many ways to construct buildings, as most people depend on reducing the cost of construction, but on the other hand. They cause long-term damage in terms of high energy consumption and damage to the environment, as well as the negative impact on health in the long term, according to recent studies, and as explained above through the actual study that have been carried out on an office building.

Where used the following zero-energy building strategies: site study, climate study, design study, determining the orientation of the building in relation to sunlight, choosing environmentally friendly building materials intended for recycling, by focusing on the fact that these materials produce a small amount of carbon dioxide reducing the risks of pollution, as well as choosing appropriate insulation materials, as it reduces energy leakage and maintains the temperature of the appropriate place, reducing energy waste.

Choosing sources to produce clean energy, through which we reduce energy consumption, as solar energy was used, and a plan was made for solar panels to generate electrical energy 264384 kw for one year. The office building case study under consideration consumes energy at an average of 97%, but with the application of zero-energy building strategies, we were able to reduce energy consumption from external sources and rely entirely on solar energy panels. Thus, we were able to produce renewable energy at an approximate rate of up to the hypothetical percentage Energy efficiency = (27259.9 /30600) *100=89.1%. This percentage indicates that the building now produces more energy than it uses. This energy can be used in several ways, in the heating and cooling system, the emergency needs of electricity for the building, and reselling it to the government network and making money from it. We also used the heat pump system in the heating and cooling system and hot water production of 41979.899 kw year at a default rate of (28751.55÷ 41979.899) *100=68.5%, which led to self-sufficiency in energy production. On the one hand, other systems such as the gray water recycling system and smart building systems to control temperatures, lighting, and safety system. Engineers focus on these methods and rely on them.

It is also important for governments to focus on supporting these projects, encouraging contractors to work on them, drawing the attention of investors to them. Spreading awareness and campaigns that expand the circle of traditional thinking to save money and current rapid profit and not develop a future for these projects.

If a zero-energy building system and insulation building materials are applied in Istanbul, Turkey, energy can be saved by 81.0% and 8.47Payback period(years) According to "OPTIMUM THERMAL INSULATION THICKNESSES AND PAYBACK PERIODS" FOR BUILDING WALLS IN TURKEY". [Geothermal Heat **Pumps,u.s** department of energy].

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