The Application Of Thermal Insulation And Its Feasibility On Existing Building Within The Context Of Sustainability: The Case Of Famagusta, Northern Cyprus

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ABSTRACT

In this research, a major global problem the climate change and how to overcome them in construction through sustainable solutions. The worldwide trend is currently to solve the problem of global warming that directly affects climate change and other issues associated with it. Everyone has a responsibility to find lasting solutions to the problem of rising temperatures. From this standpoint, we conclude that not using modern construction methods and not using thermal insulation directly affect the environment. In this research, the focus was on the problem of housing in the city of Famagusta, and the buildings do not meet many engineering standards, which causes inconvenience to users and puts pressure on government electricity generators which leads to many power outages in this crowded city. By discussing the main problem, the researcher produced a clear and direct way to confront that problem, as the use of thermal insulation is essential in design and construction and must be considered, as it will reduce electricity consumption, increase thermal comfort inside the building, and contribute to reducing the level of carbon and preserving on the environment. Using simulation programs was made for two cases, and the variable was determined, which is the external walls, specifically the presence of thermal insulation or not. It was confirmed that the presence of thermal insulation contributes to reducing heat and energy losses by between 26% and 30% And here it was emphasized that to obtain a more energy-efficient building, thermal insulation must be used in the external walls of the building because of its positive impact on the thermal comfort inside the building, as well as saving energy and money consuming electricity.

Keywords: External Thermal Insulation, Famagusta, Energy Efficiency, Residential

ÖZ

Bu araştırmada küresel eğilimin sıcaklık artışını doğrudan etkileyen ve bu sorununu çözmek için kalıcı çözümlerle yeni yapılarda üstesinden gelineceği küresel sorunlar ele alınmıştır. Bununla birlikte artan sıcaklık sorununa kalıcı çözümler bulmak herkesin sorumluluğudur. Bu noktadan hareketle , modern inşaat yöntemlerinin ve ısı yalıtımının kullanılmaması çevreyi doğrudan etkilediği sonucuna varıyoruz. Bu araştırmada Gazimağusa kentindeki binaların pek çok mühendislik standardını karşılamaması, konut sorunu, elektrik kesintileri sonucu jeneratörlerin gürültü kirliliği yaratması gibi sorunlar ve çözümleri ele alınmıştır. Araştırmacı ana sorunu tartışarak inşaatta ısı yalıtımı kullanımının elektrik tüketimini azaltığını ve kullanılabilir enerjiyi artırdığını açıklıyor. Ayrıca araştırma ısı yalıtımının bina içinde daha fazla konfor sağladığını, karbon seviyesinin düşürülmesine sebep olduğunu ve çevre korunmasına katkıda bulunduğunu açıklıyor. Revit programı kullanılarak iki durum için simülasyon yapılmış ve değişken olan dış duvarlar , özellikle ısı yalıtımının olup olmadığı belirlenmiş ve ısı yalıtımının varlığının azalmaya katkı sağladığı teyit edilmiştir . % 26 ile % 30 arasında ısı ve enerji kayıpları ve burada daha enerji verimli bir bina elde etmek için ısıl konfor üzerindeki olumlu etkisinden dolayı binanın dış duvarlarında isi yalıtımının kullanılması gerektiği vurgulandı . Binanın içinde , aynı zamanda enerji tasarrufu ve elektrik tüketen para.

Anahtar Kelimeler: Isı Yalıtımı, Gazimağusa, Enerji Verimliliği, Konut

To My Lovely Family

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Chapter 1

INTRODUCTION

Through the research (evaluation of external thermal insulation materials in existing buildings within the context of sustainability: the case of North Cyprus), the researcher will conduct studies on the materials used in thermal insulation currently and their effectiveness in the short and long term, and the reasons for their non-use in buildings and their impact on users will be highlighted. The researcher will, in addition, focus on the best ways to use thermal insulators outside the building, as they have an influential role in reducing energy loss and achieving global sustainability conditions. The researcher, In addition, aims to develop existing facilities and improve the quality of buildings, figuring out how to solve some of the issues that face the user in the current structures, such as (lighting and heat problems), which in turn cause discomfort in the buildings, and the focus will be on materials suitable for the climate in (Famagusta region) in proportion to While preserving the economic side for users, as the most crucial goal is to reach thermal comfort in buildings with less financial consumption and to provide high-quality facilities at reasonable prices that meet the global requirements in sustainable construction, taking into account the economic condition of users.

Building insulation makes use of materials that can be applied as effective insulation for a range of functions. Whereas most insulation in buildings is used for thermal insulation, it can also be utilized for acoustical, fire, and impact protection (e.g., for

vibrations caused by industrial applications). Insulation materials are frequently chosen for their capacity to perform multiple of these roles at the same time.

All insulation methods and processes which prevent heat transfer across areas of various temperatures are known as thermal insulation. Construction thermal performance is generally intended to keep the heat inside colder climates as well as keep heat out of warm climates. Thermal insulation is achieved through the use of heat-insulating features that serve to avoid thermal heat loss and flow externally to inside the construction mostly in the summertime and from inside to outside mostly in wintertime. Compatible constructing technologies, such as compressed soil, sandbags, and wool, produce excellent thermal insulation efficiency.

1.1 Literature Review

Research in a field like this for Northern Cyprus represents an essential challenge for the researcher, as information in this field is scarce due to the lack of community awareness of the importance of sustainable and environmentally friendly construction, and most of the studies and data that exist are from personal research and the endeavours of individuals and researchers in this field, as current sources differ between Research papers and literature for researchers in the field of (Master or PhD), Therefore the scarcity of resources and scientific studies in this field in North Cyprus is due - in my opinion - to the lack of strict laws that contribute to the development of societal thinking in such matters, as information is scarce and individuals do not consider this The deficiency is important, such as the user's preoccupation, the mind is the completion of the construction or construction of his expected home and he cannot consider other matters that consume his material energy during construction, and there are In addition some economic reasons that can be represented by high

electricity prices and the difficulty of importing modern buildings materials and this is another reason to postpone attention to These points, However in this research the researcher will work to fill the void that revolves around the non-use of heat insulators in buildings, as well as about the best possible solutions for Like this greeting. In terms of the societal outlook now and the economic return of individuals considering it. From developing new mechanisms or modifying what is already in place, sustainable solutions focus on finding answers from the heart and paying attention to the economic side because there is no benefit in importing materials whose market price is higher, even if their use is many with sustainable development and reduce energy consumption in buildings.

Housing, public, and commercial constructions (commonly as the constructions) use about 33% of world energy (Al-Homoud, 2005), including space heating, cooling, ventilation, illuminating, cooking, heating water, and cooling process functional electrical and mechanical devices. World Global energy demand in construction is expected to increase as urban centers in agricultural countries' average wages continue to increase as countries develop. Due to their significant power use, private, public, and company entities all provide unrivaled power investment group flexibility. According to the World Energy Council, technologies will account for anywhere between 41% and 43% of global energy reserve funds potential by 2035, compared to the modern space (24%) and the automobile space (21%). This strategy note explains how cities can use a variety of proven innovations, methods, and financing instruments to increase energy efficiency and attract innovative energy investment products into their facilities. It provides urban founders advice on how to get started by providing

power efficiency measures and activities and models from successful programs around the world, (Mayoral , 2014).

A building's energy efficiency is also delivered by the temperature leakage evaluated using a material meter, known as U-Value. The U-value shows how a material transfers heat from one side to the other by categorizing how much heat the piece could withstand. The expression used during construction rules identifies the lowest energy-efficient windows, doors, separators, walls, and other external building elements. The energy efficiency of materials employed in the construction or space is also assessed using U characteristics. A reduced U-value implies a high degree of energy efficiency. Temperature can be gained or lost through glasses, openings, partitions, and the area surrounding windows, increasing the energy required for cooling or heating. As a result, most building codes establish the minimum requirements for thermal insulation in the construction stage (Mayoral , 2014).

Additionally, there are Benefits of Energy proficiency in building, appeared underneath:

1. Structures are enormous, durable ventures. Effective structures give better friendly and monetary returns.
2. Building proficiently the first run through offers immense financial freedoms, especially for non-industrial countries in Asia, Africa, and Latin America.
3. Building effectiveness is the most reasonable approach to control environmental change.
4. Building effectiveness can lessen sickness and demise identified with air contamination, especially in the spots enduring the most (Mackres, Four Surprising Ways Energy-Efficient Buildings Benefit Cities, 2016).

1.2 Problem Statement And Significance Of The Problem

Climate change is a global problem associated with global warming, on which the sustainable studies of current researchers focus by focusing on reducing energy consumption and materials used in construction and replacing them with more sustainable materials to contribute to preserving the surrounding environment, as this problem is considered a global and international problem. All developed countries participate in finding reasonable and appropriate solutions to limit global warming damages and how to control and reduce it to protect the environment from collapse and increase sustainable development. The problem of growing energy consumption is related to building methods that have not been studied or that do not pay attention to many details to reduce the price of the current construction, noting that neglecting such problems has a long-term negative effect as this will affect the quality of life. Problems associated with low-quality materials lead to increased energy consumption, for example, cooling or heating. Increased energy consumption leads to increased electricity demand, especially at peak times, which causes pressure on government generators. The cost is high, and since such a problem has an equal effect, governments (pressure on generators) and individuals (increasing costs) must think of sustainable solutions that can reduce these problems. The existing residential buildings are not energy efficient buildings so this is increasing energy consumption unnecessarily which creates economic, social, and environmental negative impacts. In this context, there is a need to understand if external thermal insulation materials will help to solve this problem in Northern Cyprus according to market conditions or what kind of policies can be proposed to solve the problem.

1.3 Aim Of The Study, Research Question, And Objectives

From the problem statement shown above, the research aims to evaluate the cost and the benefit of the external insulation materials and to understand if it will increase the energy efficiency of the building in a feasible way, (how much the difference in kilo watts and Turkish lira if it will be adoptive in the wall construction of the envelope of the buildings, how much it will increase the energy efficiency if it is adoptive and finding the specific type of insulation that will be feasible) in the case of Famagusta, Northern Cyprus.

1.3.1 Research Questions

To find the information that will support the aim, some questions need to be answered to reach the aim of the research:

Is the external insulation material going to help the users increase the energy efficiency of the existing building?

Do external insulation materials increase the energy efficiency of the building?

How much will it be increased?

Is it feasible to use thermal insulation for a building in Famagusta?

1.3.2 Objectives

- Focus on the problems and effects of losing energy in a building.
- The author informs the relationship between global warming and increased energy consumption in an insightful way.
- Find the appropriate thermal insulation materials to increase energy performance.
- Demonstrate the importance of thermal insulation in buildings by using simulation programs.

1.4 Methodology

The desired results will be obtained through documentary and experimental research of the available books and materials and finding the best and least expensive method for the user. Two cases that support the basic ideas of the researcher will be studied. Then some changes will be simulated using the available programs. It is proposed that preliminary analyses of the idea be obtained using the REVIT program (via the Insight extension and green building studio), which allows the designer to calculate and analyze the building's capacity and simulate the building's future condition. Buildings and BIM is an intelligent method that relies on three-dimensional models compatible with the unique nature of the construction industry, and it provides engineers with the complete visualization and appropriate tools to plan, design, design, and manage buildings and infrastructure more efficiently through a computerized depiction of the facility's physical and functional qualities, thus providing this method Many solutions to different construction problems.

Through the available data, the best in terms of thermal insulation and energy conservation will be determined in the proposed buildings, as well as practical solutions for existing buildings and buildings under construction, which in turn contribute to the sustainable development of the Famagusta Area, and the global trend of sustainability makes it our duty as researchers to reach Applicable solutions that help users reach a prominent level of building comfort. With scientific and technological development, the user can obtain the highest degree of thermal comfort with what is currently available.

1.5 Limitations

The current research is limited to a case study of residential existing buildings in Northern Cyprus, with Famagusta as a case study and representative of the traditional component of construction, while attempting to balance the economic expenditures in construction with the beneficial returns for the users.

External insulation can be the most cost-effective approach for existing structures, and because residential buildings are used both during the day and at night, energy efficiency is more significant.

1.6 Organization Of The Thesis

The current study is divided into four chapters, each of which describes the research process in detail. The statement of the problem, research aim, and objectives, research scope and limitations, research methodology, and thesis organization are presented in the first part of the research to offer background information about the subject, then outline the problem, purpose, and objectives, research scope and constraints, research technique, and thesis organization. Part two of the research is organized extensive, relevant information and definitions in this area through a literature review based on past studies and research. The third part of the research focuses on REVIT and Design builder simulation program , and all results are given, evaluated, and discussed. The fourth part of the research is the conclusion and recommendation for the entire research.

Chapter 2

THEORETICAL BACKGROUND

2.1 Thermal Insulation

The addition of materials or cladding to a building's external wall to help prevent heat movement from the internal of the building to the external and vice versa is known as thermal insulation, and the thermal energy is usually lost through conduction, convection, and radiation. Providing thermal insulation is going to help in controlling the temperature of the building, as well as indirectly affecting the movement of moisture in the built-up space. Thermal insulation in the building is done by using heat-insulating materials such as flexible materials, bulk packing, and spraying. Flexible materials are the most common, and by using insulating materials, the building is thermally insulated most optimally since each site has its unique climate and topographical characteristics (Akash Singh, 2006).

Furthermore, façade insulation panels are one of the most essential methods of insulating a building from the outside, particularly in the case of remodeling, as they are installed directly on the external walls of the building and can be installed on all types of construction systems. This type of panel is covered with materials to protect it from external factors. These panels do not carry any load from the building, and in addition, using these panels as cladding can add a special touch to the facade of the building and can act as a shield. For the building, therefore, service applications can

be covered in the facade. The most critical point is to add thermal and acoustic insulation to the building and reduce carbon embodied in the walls.

Thus, according to research studies by Architecture 2030, the construction sector is responsible for 39 percent of worldwide greenhouse gas emissions, with 28 percent attributed to construction operations and 11 percent attributable to inefficient building and construction material selection. Construction-related energy consumption can be lowered by overage. Energy efficiency retrofits, switches to renewable energy procurement, on-site renewable energy installations, embodied carbon from building and construction materials that are immovable once the building is created, and the closed embodied nature are all examples of measurements and responses. As the increase in carbon content demonstrates, it is necessary, to begin with, a well-considered selection of materials and specific requirements (Group, Reducing Embodied Carbon, 2020).

Each element in a project used as protection for any cause is referred to as thermal insulation or building protection. While most insulation in structures is for thermal reasons, the phrase can also refer to hearing, fire, and effect protection (for example, for vibrations brought about by modern applications). Typically, a protective material is selected because of its ability to perform a few of these functions simultaneously (Wilson, 2020).

Protection is a significant monetary and ecological venture for structures. When protection is installed, buildings use less energy for heating and cooling, and residents feel less warm fluctuation. In geologies where energy creation is carbon accelerated, retrofitting structures with more excellent protection is a crucial environmental change

relief technique (Hawken, 2017). As part of productivity programs to reduce network power use, regional and public organizations and utility usually have included a mix of motivations and guidelines to energize protection efforts on renewed and redesigned structures; it is linked to environmental consequences and structural expenses.

Thermal insulation is the technology of insulating the buildings from inside, outside, or both (inside and outside). This technology reduces the consumption of energy in buildings using the idea of avoiding heat gain and loss in the building envelope. It is a construction material that can be added during the construction period or after that, and this low thermal conductivity material helps the building to reduce the heat gain and loss in the buildings. It is often less than 0.1W/mK (CTCN, 2020). The only important purpose of these materials is to save energy and protect the building from gaining and losing heat.

2.2 Thermal Insulation's History

Compared to other materials, thermal insulation has a short history; yet, man is a researcher by nature, and through his ongoing research, he has made significant advances, he reached solutions to certain problems he was facing, as the ancient man knew the importance of thermal insulation from the beginning, in prehistoric times, we find that man has begun His activities are in the search for a shelter to protect him from predators and the external environment, as the weather is often not suitable for living in the open, hence the discovery of thermal insulation by primitive man. Primitive populations of ancient peoples employed a variety of materials for protection, including animal skins, fur, and plant materials, and man initially used these materials as clothing that protects him from weather changes due to constant movement and instability in a building. Commence here. These materials that were

used (animal fur, plant materials) contain air between the molecules, which in turn creates an insulating layer that reduces heat exchange, (Masters, 2020).

The human desire for stability began after the development of man and his learning of agriculture and land reclamation, where they reached the importance of residing in a fixed place, and here began to appear houses of different shapes, for example, stone and rocky, and because of the density of these materials, the process of heat transfer takes a longer time, and this, in turn, helps It maintains the internal temperature and slows its change, which in turn helps to maintain the appropriate temperature in the internal environment, In the winter, it is warm, and in the summer, it is cold (Bozsaky, 2010).

Organic materials were the first to be used in the construction of shelters and homes since humans used them to protect themselves from harsh weather and keep their bodies warm. However, these materials will not last for a long time and will not be able to supply humanity's ongoing requirement for thermal insulation. Therefore, the search for more effective materials began. And continuity. In the nineteenth century, the processing of organic materials and the production of the first insulating panels began, as people were no longer satisfied with the primitive and simple service provided by natural materials, the emergence of synthetic materials and the development of many synthetic insulation materials, for example, rock wool, fiberglass, and foam glass Hollow brick, (Kienzlen , et al., 2014).

2.3 Thermal Insulation Types

Thermal insulation is divided into two types:

- The first is to insulate the wall of the building (by adding thermal insulation materials inside the wall during the construction process)
- The second is to add Façade insulation panels or materials outside the wall (the outer building envelope), where this method is used in the event of a desire to restore the building and increase its efficiency without the need to demolish it.

2.3.1 Wall Thermal Insulation

Thermal insulation is one of the basic ways to increase the efficiency of buildings, as the use of insulation materials helps to make buildings more energy-efficient, amongst the most essential types of building thermal insulation is the use of negative wall systems, as many methods can be used in such type of systems such as Trombe walls, double-skin facades, and green walls system, (Omrany, Ghaffarianhoseini, Ghaffarianhoseini, Raahemifar, & Tookey, 2016).

1. Insulation: Slab or Block

Mineral wool, corkboard, foam glass, and cellular rubber or sawdust, among other materials, are used in the manufacture of blocks shown in figure 1. These are affixed to the walls and roofs to prevent heat loss and maintain the proper temperature. The size of these boards is 60 cm by 120 cm (or larger) and 2.5 cm thick, (Constractors, 2020).

Figure 1: Insulation Type: Slab Or Block (Warmup Insulation Boards, 2022)

2. Blanket Insulation

Insulation mats come in the form of blankets or paper rolls as shown in figure 2 that are attached directly to walls or ceiling roofs. They are adaptable and versatile ranging in thickness from 12 to 80mm. Animal hair, cotton, wood fibers, and other materials are used to make these blankets (Constractors, 2020).

Figure 2: Blanket Insulation (Thermo-Tek insulation lamella mats, 2022)

3. Loose Fill Insulation

When it comes to installing windows and doors, a stud space is provided in the wall. In this stud gap inside the wall, a loose-fill of insulation material is applied figure 3. Rock wool, wood Fibre wool, cellulose, and other materials are used (Constractors, 2020).

Figure 3: Loose Fill Insulation (Brooks, 2018)

4. Insulating Materials with Batts

In addition, blanket rolls are available. However, the thickness of bat insulation rolls is greater than that of blanket materials shown in figure 4. These can, in addition, be used to cover walls or ceilings (Constractors, 2020).


Figure 4: Batt Insulating Materials (When to Use Foil-Faced Batt Insulation, 2018)

5. Insulating Boards

Cellulose, sugar cane, and other materials are used to make insulating boards. To make solid boards, at a suitable temperature, the pulp is squeezed with some strain shown in figure 5. They are available in a variety of sizes in the market. And they are widely used for lining interior walls and partitions (Constractors, 2020).

Figure 5: Insulating Boards (Heat Insulation Board, 2021)

6. Reflective Sheet Materials

Reflective sheet materials include aluminum sheets figure 6, gypsum board, and steel sheets. Materials with higher reflectance and lower emissivity are used. This makes these materials extremely heat resistant. When solar energy hits and is reflected, the heat is reduced. They are placed on the outside of the building to prevent heat from entering (Constractors, 2020).

Figure 6: Reflective Sheet Materials (Reflective, 2022)

7. Lightweight Materials

The use of lightweight particles in the manufacture of concrete mixtures, in addition, helps to prevent heat loss. As shown in figure 7 lightweight aggregates such as blast

furnace slag, vermiculite, burnt clay aggregates, and others increase the heat resistance of concrete (Constractors, 2020).

Figure 7: Lightweight Materials (Lightweight Insulation Materials, 2022)

The Most Common Thermal Insulation Materials:

The abundance and diversity of thermal insulation materials are often dispersed; there are many points to be considered when choosing thermal insulation. For example, what is the value of R, and what are the characteristics of sound and thermal insulation? As well what is the environmental impact of the use of such materials in the building? Figure 8 will summarize the five best insulating materials and the most common and widely used with the advantages of each in Northern Cyprus (The five common Thermal Insulation materials, 2017).

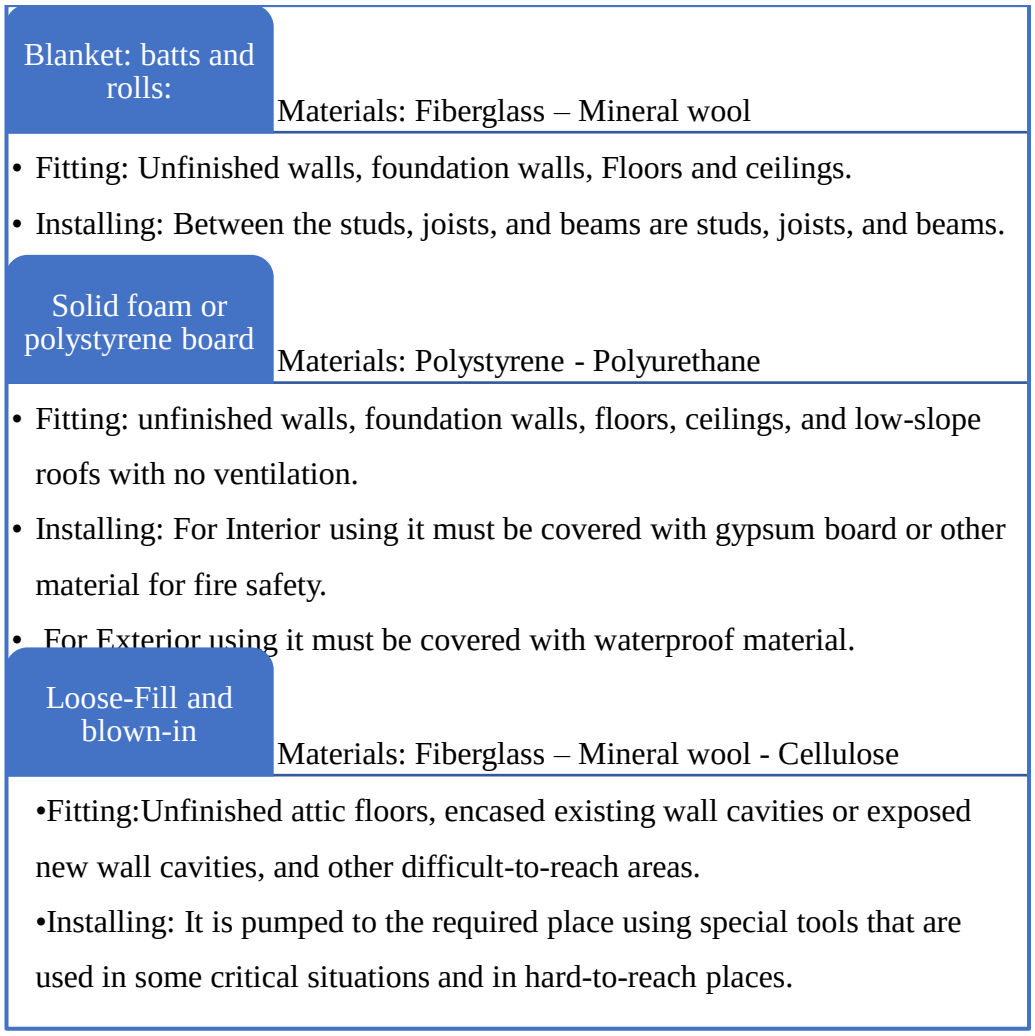

Figure 8: Types Of Insulation (Types of Insulation, 2021)

2.3.2 Façade Insulation Panels

Types of Facade Insulation Panels.

- Insulated roof panels

Rooftop boards have two uses: material protection and material. They can be perceived initially by their standard heights on the sandwich component. These heights are known as high edges and serve to harden the board. Great security is imperative – particularly on account of rooftop boards – since they should take care of their fair share, yet additionally need to withstand potential snow loads or wind loads. The space between the two high edges is known as the low edge. This is the place where the center thickness is estimated. To guarantee a consistent change between two rooftop

boards, there is a covering fold on one side of the board. This lies on top of the connecting board, (Sell, 2019).

- ECO roof panels

A unique kind of rooftop board is the ECO rooftop board. They are covered on the underside with aluminum foil instead of steel. Therefore, they are classed as single-use items as indicated by building guidelines and don't should be supported. Notwithstanding this legitimate benefit, ECO rooftop boards have a lot more in addition to focuses. The aluminum foil dependably secures against items like smelling salts, which can negatively affect the climate. Thus, ECO rooftop boards are especially reasonable for use in farming structures, like pens and stables, (Al-Homoud, 2005).

- Insulated wall panels

Protected divider boards have a lined profile for strength, rather than the high beadings on the rooftop boards. Since there is no covering fold because of the absence of a high edge, the boards are associated with one another by utilizing a tongue and furrow joint, which is more articulated than on the rooftop boards. Alternatively, it is additionally conceivable to utilize securing screws, which are imperceptible from an external perspective, utilizing a mysterious fixing framework, (Sell, 2019).

- Cold room panels

Cold room boards are an exceptional type of divider board. They are typically more protected than ordinary protected boards and have better nature of joints. This makes them ideal for the development of refrigerated rooms. Cold room boards frequently additionally arrive in a food-safe covering, (Al-Homoud, 2005).

2.3.3 Cladding Options For Façade Insulation Panels

The types, shapes, sizes, and quality of the insulation system vary using the facade cladding, and the most important of these types are the following.

- Rainscreen cladding.

A rain-screen cladding system is a kind of double-wall construction system, where an outer layer is used to prevent rain, and another inner layer is used to provide thermal insulation, as well as help, prevent air leakage and wind resistance, the outer layer is like a shield while the inner layer reduces energy consumption and loss, This type is characterized by keeping the basic structure of the building completely dry, because it is designed not to reach water or thermal insulation layers, as it is equipped with a cavity that helps the evaporation of water that penetrates the joints of the external cladding, (Facades", 2021).

- Vinyl cladding

Vinyl cladding is a type of cladding made of PVC in addition to other materials, the panels are available in vertical or horizontal sheet shapes, available for use in various types of buildings, foam insulation is added to the back of the board to install it on the external structure of the building, and this, in turn, provides greater insulation from various materials. Available in the market, (What is Vinyl Cladding?, 2018).

- Timber cladding.

Timber is one of the distinct and comfortable materials throughout the year, it is distinguished by its beauty, whether it is painted or in its natural state, and it is a multi-use material, and provides an opportunity for diversity in construction, due to its lightweight and ease of carrying, as well as the ease of installation, so it does not need

tools or complicated methods for Installation and installation, which all contribute to reducing the energy required for the building.

Although timber is considered a lightweight material, it is of high quality and strong, and from an economic point of view it can be considered a renewable natural resource, due to the ease of its cultivation and growth, in addition to all this, timber is considered an environmentally friendly material as it is 100% natural. Timber is considered a natural thermal insulator, due to its composition, as there are air pockets inside its cellular structure, as well as has a positive economic and environmental impact as it contributes to saving the additional cost because the energy required is less inside the building, and timber is classified as a load-bearing material in the building because it does not corrode. In addition, it is not conductive of electricity, and this has a clear effect on electrical safety, (Buildings, 2021).

- Stone cladding

Stone cladding is one of the types of natural insulators that can contribute significantly to maintaining the internal temperatures of the building, which contributes to the thermal comfort of users, and is also considered an excellent sound insulator, and this means if it is used in the building, it will contribute to preventing external noise, and the building will be quieter and more stable. From the thermal and acoustic sides, in addition to the aesthetic aspect that natural stones provide to the facade of the building, and their ability to endure for many years and remain at the same distinguished aesthetic level, (Solutions", 2021).

- Metal panels

Metal cladding is one of the most beautiful and elegant types of exterior cladding for buildings, in addition to many effective and ideal qualities for all different requirements for all types of buildings. This cladding is resistant to corrosion in addition to bearing the external factors of buildings and various weather factors and also withstands ultraviolet rays the possibility of reflecting heat in the metal cladding is high, and one of the properties of metal is flexibility, as it allows the shrimps to form and manufacture it in different and varied forms that are compatible with modern designs and cladding systems, The metal cladding also provides a lot of strong capabilities in addition to the outstanding performance, as well as the strength of metal, its light weight, and its aesthetics, are among its advantages as it is not considered an additional load for the building due to its light weight and it also provides superior strength to the external facade, in addition to its aesthetics and ease of formation that gives a distinct touch. On the external facade, in terms of thermal efficiency, metal sheets significantly reduce heat gain in buildings through the air space underneath, unpainted metal reduces heat transfer by more than 9.5 ° C, due to its high thermal insulation properties, and on painted surfaces. Lighter colors help reduce heat absorption to 30 ° C, between light and dark and are more sustainable in your mind the metal is recycled by 100% and consumes no more than 5% of the energy used in new production. Almost all metal used in the exterior cladding of buildings can be recycled, (Solutions, 2021).

Insulated Metal Panels (IMPs) are exterior wall and ceiling panels with steel skins and an insulating foam core, Insulated Metal Panels not only look great but also provide unmatched R-values and energy efficiency The insulated metal panels are known for

their superior thermal properties, design flexibility and fast installation time - as well as to her gorgeous appearance. It is very popular in European markets; Architects are beginning to discover why IMPs are a great choice for office buildings, stadiums, arenas, airports, and more. Insulated sheet metal also usually contains less carbon than other building materials, it is weatherproof and provides a strong barrier to heat and moisture. Panel joints protect from wind, rain, and moisture and allow for the aesthetic integration of many types of profiles. Insulated metal panels are available in a wide range of textures and finishes to suit any project. Some companies offer the highest insulation and best-in-class R-value, with Thermal performance being 11 percent better than conventional PIR core and up to 60 percent improved over conventional PUR core, (Group, Insulated Metal Panels, 2020).

There are four main categories of thermal insulation, which are:

External thermal insulation composite systems, for external walls and cladding, this form of thermal insulation is the greatest solution for enhancing energy efficiency and providing long-term thermal insulation.; it can apply for new construction or renovation (ETICS, 2020). The insulating material, the reinforcing layer, and the finishing layer make up this sort of thermal insulation It can adhere to the wall with adhesive or a combination of adhesive and mechanical fasteners. Without any air holes between the layers, the outer layer with rendering, reinforcement, and surface treatment is put directly into the insulating layer (Part B – General refurbishment, 2012).

Ventilated Façade system, this system is in addition known as (a double-skin Façade or Rain-screens Façade), can protect the buildings against the combined actions of the rain and wind, bearing in mind that the orientation of the interface will be important to

achieve the desired results. This system consists of two main layers of different facades. In the middle of them, there is an air cavity. This cavity prevents rainwater penetration into the building and spreads water vapor from the inside to the outside. The external cladding protects from external influences such as rain and wind, and the air passage between the supporting structure and the external cladding plays a significant role in the ventilated facade system. The temperature difference between the exterior panel and the air cavity behind this is what allows the façade to be naturally ventilated. As with the chimney effect, a variation in the air density causes the air to flow upward into the cavity. The airflow transfers heat from the cavity to the outside via high-level exhausts, which helps in drying out the convection of any remaining amounts of moisture that have accumulated within the air cavity (Part B – General refurbishment, 2012).

Panel systems for external thermal insulation this type of external thermal insulation is based on a panel system that consists of an insulation material inside the panel. The panels are made from metal material, and they can be filled with thermal insulation, for example, EPS or mineral wool. This system is used in more than 10% of façade renovations in France (Part B – General refurbishment, 2012).

Insulating plasters are a type of insulation that involves spraying insulation material directly onto the existing wall structure, the distinction of this system is that it can help in repairing defects and irregularities in the wall or the outer layer of the building and is in addition characterized by the ease of application on irregular or complex facades, and in addition, they do not require additional adhesive for fixation, (John Emmanuel Ogbeba, The Evaluation of Single-Family Detached Housing Units in terms of Integrated Photovoltaic Shading Devices: The Case of Northern Cyprus, 2019).

The insulation materials for construction are classified according to their characteristics and the difference in types to:

As per heat trade properties: Protectors can be divided into mass protection and intelligent protection for each of their capacities in controlling the warmth movement. Intelligent protections reduce the amount of warmth transported by radiation, whereas mass protections reduce the warmth moved by conduction (Close, 1952).

As per structure: Several producers have introduced the execution of manufacturing material protection qualities by their structure. The four types of protection include loose-fillers, splashy froth, batts, covers, and rigid board. When choosing a security solution, many factors should be considered, including the development type, recovery plan, and code requirements (Aditya, et al., 2017).

As per the piece: the arrangement of protection material shows the protection attributes which straightforwardly connected to its substance and actual construction. It arranged protection materials dependent on their synthesis, which are natural, inorganic, consolidated material, and innovative material, primarily (Papadopoulos, 2005).

The energy efficiency of thermal insulation is the priority for any architect working in this field, even if it is for a new construction building or renovating an existing building (ETI, 2020).

External thermal insulation means adding a thermal insulation layer to the external surface of the wall. All these types of thermal insulation can be added to the top of the existing wall structure, and in some cases need to remove the cladding and the old

thermal insulation for the wall structure before using the new techniques for building renovation (Part B – General refurbishment, 2012).

Explanation of how it works:

A façade insulation system is done by using insulation panels that are installed directly on the exterior walls of the building before finishing, and some of them can be covered with materials to protect them from shocks and external factors such as shocks and weather. All types of walls, whether solid or hollow, can be isolated from the outside, (External wall insulation, 2021).

A facade cladding system is a non-bearing panel that is installed on the external structure of the building in various ways, as these panels do not carry any weight or load from the building, they can only bear their weight, no weight other than their own can be added to it because it is designed not to carry any load. They are often used to add aesthetics to the exterior of a building, as many faults can be hidden from the façades. Its main task is to add thermal and sound insulation to the building, especially if it is added in an engineering way combined with the insulation in the structure behind it. In general, insulating cladding can be installed on all types of steel, timber, or cement support structures, (Fitzgerald, 2018).

The façade insulation panels are fixed on the walls using plastic anchors to ensure that the heat is not conducted, and sometimes mortar deposits can be used, and the two can also be mixed, depending on the type used in the external insulation, sometimes some problems arise such as a burst state, which requires some modifications to the materials used. For the original wall finishes to ensure smoothness during the construction application, after completing the application of the external insulation panels, a variety

of finishes are available that allow the selection and repetition of all kinds of shapes for the exterior finishing of the building facade, as it does not cause any kind of effect on the building facade or the internal environment, On the contrary, the thermal comfort inside the building will increase without affecting in any way the aesthetics of the building, (Habitat", 2018).

Protected boards are utilized in numerous enterprises, like aviation, auto, and development. This content spotlights the utilization of protected boards as instant components for the development business. Protected boards are ideal for the structure area: You save time, cut expenses and decrease weight and they can be utilized as dividers, roofs, and rooftops. On the off chance that the boards come directly from the production line, they are promptly prepared for use. In one simple advance, they can be connected to a help structure and are all the while stable dividers or rooftops with astounding protection properties. As a result of the above-named properties, today protected boards are especially well known for lightweight development of lobbies, and rooftops for private structures, yet additionally as protection boards for protecting or likewise as solid sealing in drywall development. Protected boards with a flame-resistant center are likewise regularly utilized as fire security boards, (Mohammad Panjehpour, 2013).

2.4 Thermal Insulation Important

Building insulation is a wise financial and environmental investment. The building needs less energy for heating and cooling, and the occupants feel less thermal variability due to the insulation. More isolated buildings are an essential climate change mitigation strategy, especially in carbon-intensive locations. Insulation efforts in new and refurbished buildings are frequently encouraged by local and national

governments and utilities as part of efficiency programs to minimize grid energy use, associated environmental impacts, and infrastructure costs.

In building research, it was discovered that 66 %of the electrical energy consumed in the summer is used to cool the structure (Shan & Hwang, 2018), implying that most of this energy is used to remove heat from the walls and ceilings. As a result, thermal insulation is critical, as it helps to reduce the amount of electrical energy consumed for air conditioning by limiting heat leakage through walls and ceilings, resulting in significant cost savings. Thermal insulation is particularly significant in the construction of buildings for several reasons, including the following:

Reducing the capacity and capacity of air conditioners: Thermal insulation, which works to limit heat leakage through walls and roofing, aids in reducing the electrical energy consumed in air conditioning units at large rates ranging between 40 and 30 percent. It is applied on a good scientific and technological foundation (last, 2020).

Building protection: Thermal insulation protects building construction materials from external weather changes that occur because of considerable temperature fluctuations throughout the day, causing continual thermal strains on the materials and the formation of fractures and cracks.

Protection of furniture inside the building: If there is no proper air conditioning, uninsulated buildings are impacted fast and directly by external temperatures, making the heat inside the building unstable, and thus the furniture materials are affected and disintegrate, and some resort to leaving the air conditioning devices in continuous operation while leaving the house for extended periods, to maintain Furniture safety, which means unjustified waste of energy.

Raising the level of comfort: Thermal insulation in buildings serves to enhance the degree of comfort by maintaining a consistent temperature inside the building throughout the year, and thermal insulation makes the air inside the building tolerable without air conditioning.

Fire resistance: The ability of heat insulators to resist fire varies. Some heat insulators, such as rock wool, glass wool, and (perlite), can withstand elevated temperatures, whereas others melt, burn, or smoke at specific degrees, such as (polystyrene) and (polycarbonate).

Reducing the value of peak loads: This results in reducing pressure on the generation units and transmission and distribution networks, which leads to reducing the operation of air conditioning during peak hours.

Environmental protection: It is known that the use of mechanical means of adaptation helps to emit harmful gases to the environment, such as carbon dioxide and nitrogen oxides, which are produced when the energy needed to run air conditioners is used and can be significantly reduced by using heat insulators (Ibrahim, 2019).

2.5 Climate and Thermal Comfort of Famagusta

2.5.1 Climate of Famagusta, Cyprus

Famagusta is located on the island of Cyprus between longitude 33.9382° and latitude 35.1206°as shown in figure 9, and altitude above sea level 14 m (Suncalc, 2020), and it is in the Mediterranean Sea Cyprus has a Mediterranean climate. The Mediterranean climate is characterized by hot summers, and rainy winters often found on the coasts of 40° latitude from the equator. Most of the coasts of California and the Mediterranean region are located within this climate. The Mediterranean climate extends on the

western facades of the continents between latitudes 30 and 40 north and south, including the vicinity of the Mediterranean Sea, however in addition to other areas of other continents, including the American continent, where it is located on the western coasts For the United States of America, California, and the western coasts of central Chile. In addition, it extends over parts of western and southern Australia and southwestern and southern Africa (Howeidi & Heikal, 2004). The characteristics of the Mediterranean climate are a transitional climate between a temperate climate and a dry subtropical climate shown in Figures 10,11. Summers are hot and dry, and the winters are rainy and cold. In summer, temperatures exceed 22° on the coasts and 30° in the interior and sometimes approach 40°. In winter, the monthly average for the coldest month is more than 10°, However in the north of the Mediterranean basin, these rates decrease and always remain above zero degrees Celsius, and snow, in addition, falls in this climate.

Between the driest and wettest months, there is a 67 mm difference in precipitation. The average temperature varies by 15.4 °C throughout the year. April is the month with the highest relative humidity (67.60 percent), November is the month with the lowest relative humidity (63.59 percent), January is the month with the largest amount of rainy days (7.97 days). June is the month with the fewest number of rainy days (0.07 days), Summer begins at the end of June and lasts until the end of September. Summer is divided into four months: June, July, August, and September, the most comfort months are May, June, July, September, and October, (Climate Data ,Famagusta (CYPRUS), 2022), showen in table 1.

Figure 9: Location Of Famagusta, Cyprus (WeatherSpark, 2021)

What distinguishes the Mediterranean climate is the presence of two central seasons during the year: winter and summer. Winter is a season of rain and cold temperatures, with short daylight hours and clouds covering the sky. The summer season is the season of the sun and high and dry temperatures. The day is long, and the sky is clear blue.

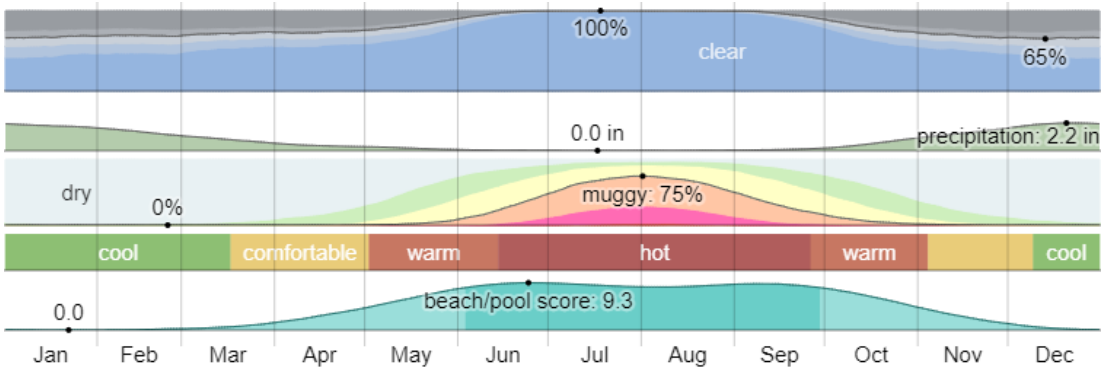

Figure 10: Famagusta Climate Summary (WeatherSpark, 2021)

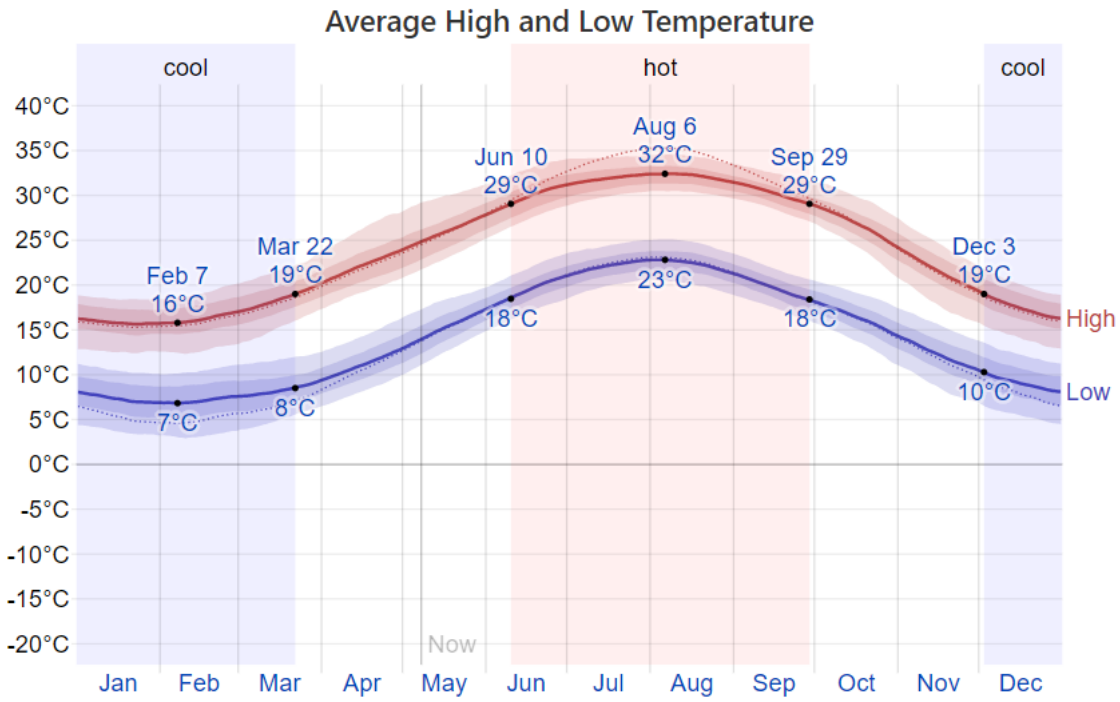

Figure 11: Famagusta Average High And Low Temperature (WeatherSpark, 2021)

Table 1: Weather Averages Famagusta, (Climate Data ,Famagusta (CYPRUS), 2022)

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	13.5 °C	13.8 °C	15.6 °C	18.1 °C	21.8 °C	25.7 °C	28.4 °C	28.9 °C	26.8 °C	23.5 °C	19.2 °C	15.3 °C
Min. Temperature °C	11.5 °C	11.6 °C	12.8 °C	15 °C	18.3 °C	22.1 °C	24.9 °C	25.6 °C	23.7 °C	20.9 °C	17.1 °C	13.4 °C
Max. Temperature °C	15.5 °C	16.1 °C	18.4 °C	21 °C	24.7 °C	28.5 °C	31.3 °C	31.7 °C	29.8 °C	26.2 °C	21.4 °C	17.3 °C
Precipitation / Rainfall mm	53	37	18	9	6	0	0	0	2	16	35	67
Humidity(%)	66%	66%	66%	68%	67%	65%	66%	67%	64%	65%	64%	66%
Rainy days (d)	6	4	2	2	1	0	0	0	0	2	4	6
avg. Sun hours (hours)	7.9	8.8	10.1	11.2	12.3	12.8	12.6	11.9	10.9	9.8	8.8	7.8

2.5.2 Thermal Comfort In Famagusta, Cyprus

There are six basic factors to reach thermal comfort: shown in figure 12 (Executive, 2020).

Factors For Thermal Comfort		
	Environmental factors	Air temperature
		Radiant temperature
		Air velocity
		Humidity
	Personal factors	Clothing Insulation
		Metabolic heat

Figure 12: There Are Six Basic Factors To Reach Thermal Comfort, By The Author

The most pleasant months in Famagusta are (April, May, October, and November), whereas the winter months (December, January, February, and March) are cold and require heating. The summer in Famagusta (June, July, August, and September) was hot and humid, necessitating air conditioning and ventilation (Lapithis, 2009).

Famagusta solar energy in winter reaches 5.26 kWh/m2/day, and however, in summer, it increases to 7.12 kWh/m2/day. Add to that, the total solar radiation from 6 MJ/m2 in December to a high of about 24 MJ/m2 in June and July, and in addition, the energy generation rises from 70 W/m2 in December to 280 W/m2 in June and July, (John Emmanuel Ogbeba, The Evaluation of Single-Family Detached Housing Units in terms of Integrated Photovoltaic Shading Devices: The Case of Northern Cyprus, 2019). Figures 15 and 16 illustrate the heat and the thermal comforts. The dark places in the figures illustrate the highest thermal comfort in that location. The charts can find the comfort zone in Famagusta.

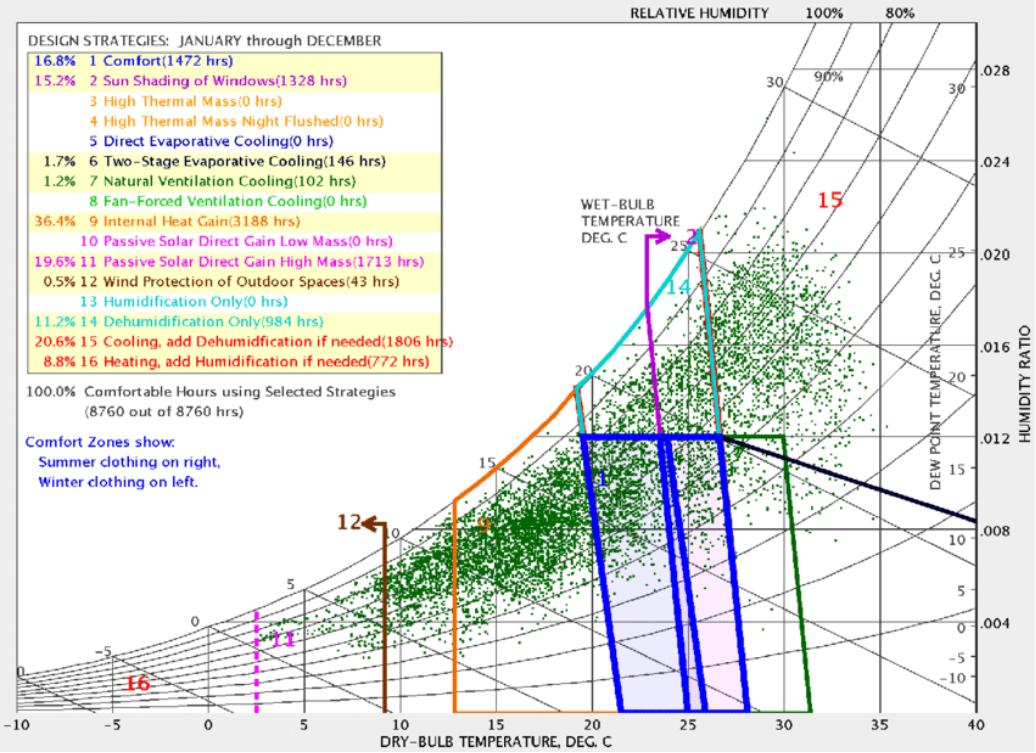

Figure 13: Weather Data From 2004 – 2018, (John Emmanuel Ogbeba, 2019)

Chapter 3

THERMAL INSULATION AND SUSTAINABILITY

3.1 Steps to Design and Build an Energy-Efficient Building

This can be accomplished by achieving the following points:

1. Climatic architecture: building form and orientation, solar shading, passive solar systems.
2. High-performance building envelope: comprehensive insulation, high-performance glass, and windows, air-tight construction, avoiding thermal bridges.
3. High performance-controlled ventilation: mechanical insulation, heat recovery.

This principle focuses on saving energy in buildings through three steps: (Staal, 2022)

1. First, reduce the demand for non-renewable energy by avoiding waste and inquiry for measuring energy saving.
2. Second, is the trend toward the use of renewable and sustainable energy in the state of non-renewable energy sources.
3. Third, use fossil fuels more efficiently, and reduce the use of fossil energy as possible.

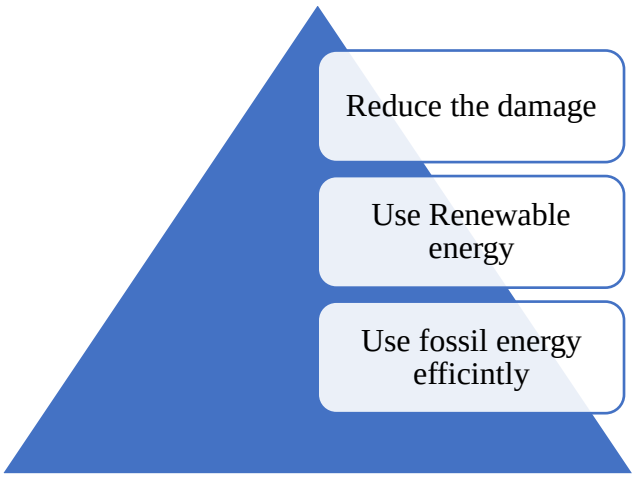

Figure 14: The Tries Energetical Concept, (Staal, 2022)

The design of energy-saving buildings includes constructing or renovating existing buildings to obtain the greatest amount of energy performance used through some solutions to reduce consumption and energy loss from the building. The most important solutions include reducing heat loss from the building envelope, (LEED, 2022). This type of building saves energy, whether it is renovated and restored to be more efficient or built from the beginning, with the interest in providing maximum energy efficiency into consideration from the beginning of the project, and attention to energy efficiency provides a large number of benefits, as energy-saving buildings are considered to be less costly to operate in addition to It is more comfortable for users, and more environmentally friendly, (NRCAN, Energy Efficiency, 2022).

The first and the most important step to improve energy efficiency in the building is to insulate the envelope, the good insulation for the thermal bridges (floor, walls, roof, windows, and doors), using thermal insulation will increase the performance of the building and that will help to reduce the heat lose and ensure the summer comfort.

Neglecting energy efficiency can cause many problems and last for years, however, maintaining the design of energy-efficient buildings at the beginning of construction is the most effective way to deal with construction and make it more efficient, in addition to being less costly in the long run, (NRCAN, Energy efficiency for buildings, 2022). Many countries and governments put Building laws to provide buildings with energy efficiency in one way or another, but you must think above these recommendations, as these recommendations and standards set the minimum in construction, and to get the highest efficiency, you must think completely of the building because the building works as a single system, for example, The use of high-quality and expensive heating and cooling tools does not lead to the required result to improve the building's temperature if the thermal insulation of the building is neglected, as it does not preserve heat during the winter or cold in the summer, (NRCAN, Energy efficiency in existing buildings, 2022), (NRCAN, Energy efficiency in new buildings, 2022).

3.2 Energy Efficiency Strategy in Existing Residential Buildings

Every home may be made to be more energy-efficient, any home, regardless of its age, may be energy efficient. Modern building codes require new homes to be more energy efficient, but existing homes can be updated to be more energy efficient. People who live in these dwellings can also practice energy-saving habits.

It's well insulated and airtight, and it has high-efficiency heating and cooling technology, which helps keep utility bills low. Low-flow accessories are installed to reduce water use and water heating costs. The residents of this home maintain a comfortable indoor temperature by using energy efficiently and using only certified

products and appliances, as shown in figure 15, (What is an energy-efficient home?, 2020).

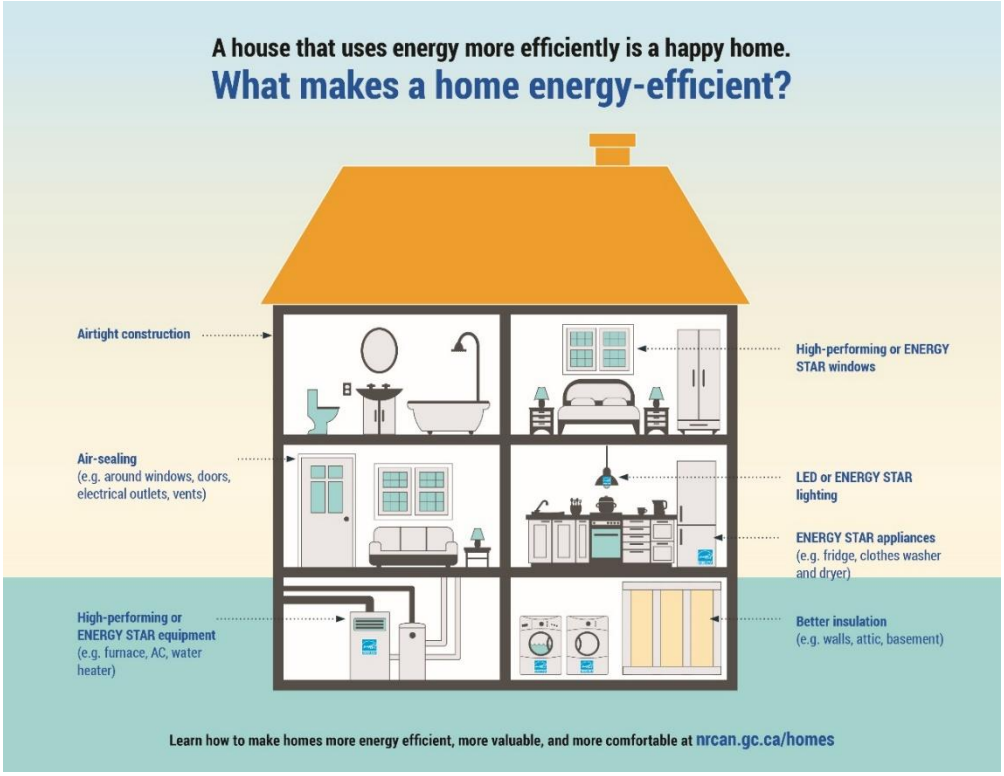

Figure 15: Strategies For Energy Efficiency In Existing Residential Buildings, (What is an energy-efficient home?, 2020)

3.3 Increasing Building Energy Efficiency: Obstacles

There are many common barriers to increasing the energy efficiency of buildings. In this research, we focus on several main axes from which other obstacles branch off. The beginning is the lack of knowledge, as the lack of reliable information about energy as well as performance, costs, and the importance of efficiency directly affects the lack of orientation to improve energy efficiency. In addition, institutional and regulatory, as governmental legislation and laws cause a lack of interest in energy efficiency, knowing that it affects the users in buildings directly.

In addition to the funding challenges, the presence of budget constraints and the lack of funding as well as the high transaction costs, in addition, affect the overcoming of some important points in energy efficiency, including thermal insulation.

On the other hand, market failure and product inefficiency, in addition, affect energy efficiency in buildings, as decisions to invest in energy efficiency are taken by those who do not receive direct benefit, in addition to the inability to provide products with ambitious standards in the market, and the difficulty of providing insulation materials, for example, or the prohibitive cost of Their price directly affects the energy efficiency of buildings, (Mayoral , 2014).

On the other hand, the control of some contractors in the construction market affects the control over the available materials, as well as the manipulation of prices and quality; when the engineer designs a certain point, it comes from experience, knowledge, and practical study, However, some contractors manipulate the investor in terms of reducing the price and Therefore This will bring material benefit to the contractor, however, it will cause long-term harm to the investor and the user.

The economic evaluation of insulation materials depends on the performance and the combined effect of the materials in addition to the materials cost and the annual heating or cooling expense (according to the location and the user's need), in a study prepared by "*T. Dickson and S. Pavía*" (Dickson & Pavía, 2021) The data and results of the study were collected, which concluded that the best materials are cellulose, glass wool, and recycled cotton. These materials are characterized by a lower manufacturing cost with positive results for the building, as the operating costs of heating and cooling are lower compared to other insulating materials, in addition to the fact that the use of air

as a thermal insulator is, in addition, positive because it provides results without material cost. No project can choose building materials based on an economic evaluation only; however, these grades give a clear and complete picture of materials that cost less while maintaining the desired and desired result in terms of electrical consumption for heating or cooling in the building.

3.4 Sustainability And Energy Efficiency

The breadth of the stated energy consumption standards determines a building's energy efficiency. Common building types and building performance comparison. Instructions for several types of buildings within a specific country. First price-performance model presentation. The appropriate word for energy use per square meter of floor area or floor area (kWh/m²/year) is a tool for evaluating energy efficiency and other business aspects. This creates blank space basics on blank space. The types of wines vary by country and type of building (UNIDO, pp. 18.4-18.5).

U-Value, or heat loss via a material meter, is also used to describe a building's energy performance. The U-value classifies how much heat a component can travel through and reflects how well it conducts heat from side to side. It is the industry standard for defining minimum energy efficiency values for windows, doors, walls, and other exterior building components in building regulations. Furthermore, U values assess the energy efficiency of materials used in a construction component or section. Positive energy efficiency is indicated by a reduced U-value. Heat can be gained or lost through windows, doors, walls, and skylights, increasing the amount of energy required for cooling or heating. As a result, most building codes establish minimum energy efficiency guidelines for these components (UNIDO, pp. 18.4-18.5).

In addition, there are Benefits of Energy efficiency in building (Mackres, Four Surprising Ways Energy-Efficient Buildings Benefit Cities, 2016), shown below:

1. Structures are significant, long-term investments. Buildings that are more energy efficient generate better social and financial returns.

2. Building efficiently provides enormous economic benefits for the first time, especially for emerging countries in Asia, Africa, and Latin America.

3. One of the most cost-effective ways to tackle climate change is to improve energy efficiency in buildings.

4. Improving building efficiency can significantly reduce illness and death caused by air pollution, especially in areas where it is most severe.

3.5 Standards and Energy Certificate Systems

After the first oil crisis in 1973, Europe and North America tended to consider energy-saving requirements mandatory, as energy efficiency requirements for new buildings have been defined since 2006, separate energy efficiency requirements known as the directive code, and energy performance requirements known as the performance code, are the most standards Codes used in buildings for higher energy efficiency, (UNESCAP, 2022). It considers one of the legal and legislative requirements is the enactment of laws and standards regulating energy performance in buildings and constructions, and addressing energy consumption problems by knowing the weaknesses in the building, for example, the outer shell of the building and inappropriate building materials, and among the problems arising from this increase the need for cooling and heating, which increases due to Choosing inappropriate materials or not using energy-saving construction methods, (EIA, 2022).

Through research and classification, the methods of building evaluation were divided into two parts: the first is the rating tools, and the second is the standards, since the first is optional and voluntary and the other is mandatory, but the main goal remains to reach sustainability in buildings, convenience and comfort for users while preserving the external environment and reduce carbon emissions. Environmentally friendly building rating tools (certificate systems) are used to evaluate buildings in terms of meeting the requirements and standards for green buildings. Their work is often voluntary, giving recognition to and rewarding institutions that contribute to the establishment of environmentally friendly buildings through the rating tools available to them, and this contributes to encouraging, motivating, and raising the level of Sustainability for companies and institutions. Rating tools and methods differ in their method and approach, as they can be used from the beginning of the project until it is put into operation, as well as in the event of buildings being renovated or demolished. In addition, they also differ according to the type of building, as their use with residential buildings differs from commercial buildings or large areas. There are more than 40 global rating tools currently in use, according to the statistics of the Global Green Building Survey, among them BREEAM, LEED, BEAM Plus, GREEN BUILDING, and others, (Rating tools, 2022). Most rating systems are concerned with evaluating building performance in terms of some common points, including water, resources, energy, internal environment, location, external and ground environment, innovation, waste, and construction management, (Shan & Hwang, 2018).

As for the second type, which is building codes and standards, minimum requirements are set for the design, construction, and operation of environmentally friendly buildings. Therefore, management plays a key role in achieving energy efficiency in

the building, (Lai, 2015). Energy standards are a description of how buildings can be constructed while saving energy as well as the true cost-effectiveness of a building. Building energy efficiency standards are obtained from international and national organizations publications by a variety of different global organizations, for example, the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), Building Officials and Code Administrators International (BOCA), International Code Council (ICC), International Conference of Building Officials (ICBO), Southern Building Code Congress International (SBCCI)M and Building Energy Codes Program. These rules and standards are not mandatory but are recommendations for Global and local to obtain the highest level of energy efficiency in the construction of buildings, and standards differ according to the climate, and region, (Bartlett, Halverson, & Shankle, 2003). And the focus will be on the two most important global organizations ASHRAE and ISO, (Harish Kanneganti, et al., 2017). These organizations periodically publish information and standards that allow officials to access and achieve the best results in terms of energy savings. There are more than 155 standards related to energy efficiency from ISO, an example of this (ISO 50001 clarifies the requirements for an energy management system for organizations to achieve energy reduction and cost savings, while ISO 50002 provides energy audit procedures for public organizations), (Jovanović & Filipović, 2016). In ISO 52016, the focus is on the energy performance of buildings and determining how to calculate the energy rating of the building. In ISO 16745 focused on carbon audits for buildings, the study of ISO 50001 and 50002 is repeated continuously and repeatedly by researchers, (Jacopo Vivian, Angelo Zarrella, Giuseppe Emmi, & Michele De Carli, 2017). Moving on to ASHRAE, Standard 90.1 is the most popular building energy

standard and has been cited a lot, especially in studies focusing on commercial buildings and computer simulations, (Melo, Sorgato, & Lamberts, 2014).

3.5.1 American Society Of Heating, Refrigerating, And Air Conditioning Engineers (ASHRAE)

This professional association focuses on building development and construction of heating, ventilation, air conditioning, and refrigeration systems. This organization involves more than 132 countries around the world and has more than 50,000 members from many different disciplines (building services engineers, architects, contractors, mechanics, building owners, equipment manufacturing personnel, and many other disciplines concerned with heating, cooling, ventilation, and air conditioning systems in Buildings, focuses on the dissemination of building services engineering standards and energy efficiency, and is also concerned with indoor air quality, (ASHRAE, ABOUT ASHRAE, 2022).

3.5.2 International Organization for Standardization (IOS)

It is a non-governmental (independent) organization headquartered in Geneva, Switzerland, and its members are standard organizations in the 167 member states. It is the largest developer of international standards globally and contributes to facilitating global trade by providing common standards among member states. More than 24,000 active technical standards have been set, covering everything from manufactured products and technology to food safety, agriculture, and healthcare. Standards work to protect manufacturers as well as users of services and products, and this, in turn, contributes to obtaining the minimum international standards, as the use of standards helps in producing products and providing safe services with the highest possible quality, in addition to those standards help companies increase productivity,

reduce errors, and access to the extent recommended in the standards in all disciplines and orientations, (IOS, 2022).

3.5.3 Regulations And Standards For Buildings Energy Performance

The following are the current primary technical requirements for conformance to the standard: (Causone, Pietrobon, Pagliano, & Erba, 2017)

- Annual energy consumption for space heating is less than 15 kWh/m2.
- Annual energy consumption for cooling and dehumidification is less than 15 kWh/m2.
- Annual primary energy consumption of less than 120 kWh/m2 for all domestic applications (heating, hot water, and domestic electricity).
- At 50 Pa (n50), air tightness is less than 0.6 air change per hour (ACH).

Through the global ASHRAE standards, the standards that should be applied in Cyprus have been reached. First, the ASHRAE Standards Book contains 12 different chapters covering most building systems. The focus of this research study is the building envelope. So, the fifth chapter was directed to the Climate section, Where there are two main sections, the first is the sites belonging to the United States of America, and the second is the international sites, where we move to Annex B to obtain the required information, as the sites were divided into three sections A, B, C, and to different numbers according to geographical areas, since Cyprus was in Section B and Zone 3, (ASHRAE, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2013).

TABLE B1-4 International Climate Zone Definitions

Zone Number	Name	Thermal Criteria
1	Very Hot–Humid (1A), Dry (1B)	5000 < CDD10°C
2	Hot–Humid (2A), Dry (2B)	3500 < CDD10°C ≤ 5000
3A and 3B	Warm–Humid (3A), Dry (3B)	2500 < CDD10°C ≤ 3500
3C	Warm–Marine	CDD10°C ≤ 2500 and HDD18°C ≤ 2000
4A and 4B	Mixed–Humid (4A), Dry (4B)	CDD10°C ≤ 2500 and 2000 < HDD18°C ≤ 3000
4C	Mixed–Marine	2000 < HDD18°C ≤ 3000
5A, 5B and 5C	Cool–Humid (5A), Dry (5B), Marine (5C)	3000 < HDD18°C ≤ 4000
6A and 6B	Cold–Humid (6A), Dry (6B)	4000 < HDD18°C ≤ 5000
7	Very Cold	5000 < HDD18°C ≤ 7000
8	Subarctic	7000 < HDD18°C

Figure 16: International Climate Zone Definition, (ASHRAE, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2013)

As shown in the above figure 16, the Republic of Cyprus is within Group 3 B, the thermal standards by location are 2500 < CDD10°C < 3500, and based on that the building envelope requirements by area are as shown in figure 17 below, where the minimum insulation. R- The value of each part of the building envelope.

Table 5.5-3 Building Envelope Requirements for Climate Zone 3 (A,B,C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.220	R-4.4 c.i.	U-0.220	R-4.4 c.i.	U-0.677	R-1.3 c.i.
Metal Building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.545	R-2.8
Attic and Other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.300	R-3.3
Walls, above Grade						
Mass	U-0.701	R-1.3 c.i.	U-0.592	R-1.7 c.i.	U-3.293	NR
Metal Building	U-0.533	R-0 + R-1.7 c.i.	U-0.410	R-0 + R-2.3 c.i.	U-0.920	R-2.3
Steel Framed	U-0.435	R-2.3 + R-0.9 c.i.	U-0.365	R-2.3 + R-1.3 c.i.	U-0.705	R-2.3
Wood Framed and Other	U-0.504	R-2.3	U-0.365	R-2.3 + R-0.7 c.i. or R-3.5	U-0.504	R-2.3
Wall, below Grade						
Below Grade Wall	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-0.420	R-1.8 c.i.	U-0.420	R-1.8 c.i.	U-0.780	R-0.7 c.i.
Steel Joist	U-0.214	R-5.3	U-0.214	R-5.3	U-0.296	R-3.3
Wood Framed and Other	U-0.188	R-5.3	U-0.188	R-5.3	U-0.288	R-3.3
Slab-on-Grade Floors						
Unheated	F-1.264	NR	F-0.935	R-1.8 for 600 mm	F-1.264	NR
Heated	F-1.489	R-2.6 for 600 mm	F-1.489	R-2.6 for 600 mm	F-1.766	R-1.3 for 300 mm
Opaque Doors						
Swinging	U-3.975		U-2.839		U-3.975	
Nonswinging	U-2.839		U-2.839		U-8.233	

Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
Vertical Fenestration, 0%–40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.99			U-1.99			U-4.94		
Metal framing, fixed	U-2.84			U-2.84			U-6.81		
Metal framing, operable	U-3.41	SHGC-0.25	1.10	U-3.41	SHGC-0.25	1.10	U-6.81	NR	NR
Metal framing, entrance door	U-4.37			U-3.86			U-4.37		
Skylight, 0%–3% of Roof									
All types	U-3.12	SHGC-0.35	NR	U-3.12	SHGC-0.35	NR	U-9.65	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

ANSI/ASHRAE/IES Standard 90.1-2013 (SI Edition) 29

Figure 17: Building Envelop Requirments For Climate Zone 3 (A, B, C), (ASHRAE, Energy Standard for Buildings Except Low-Rise Residential Buildings, 2013)

3.6 Market Analysis For Available Materials, Types, And Prices

Through a local search in the Northern Cyprus market, limited types were obtained that are not of the required quality to provide adequate thermal insulation for buildings, in addition to the lack of heat-insulating facades.

The famous in Northern Cyprus currently is the use of paint as a thermal insulator for buildings, knowing that it does not suffice with the heat of Northern Cyprus, the use of paint can be useful in different regions of the world, IRONMAN thermal paint is available in abundance, the price per square meter of this paint is 5.25 $ per square meter.

Because of the difficulty in finding the materials required for my study in Northern Cyprus, I looked to Turkey, where there are many factories and companies interested in all kinds of thermal insulation due to the wide geographical nature of the Republic of Turkey. More than one company was obtained that provides the insulating materials required for the study with a wider range of prices. The focus will be on three companies that most important leading companies in this field located in the Republic of Turkey, with an explanation of prices and options available to assist in the renaissance in the field of construction in Northern Cyprus.

ÖZPOR Company, its manufacture started in 1985 and seven factories were set up respectively in Ankara, Bursa, and Izmir until 1988, ÖZPOR focuses on thermal insulation only, as the manufacturing has been going on for more than thirty years. It has achieved great success at all levels, as ÖZPOR company has established Seventeen factories and its achievement did not stop on the local side only. Unique and distinguished in Turkey and has produced the most efficient types of rock wool

with advanced technology in the sector, ÖZPOR is focused on providing the best environmentally friendly, fully renewable products, (ÖZPOR Company, 2022).

Founded in 2004, Panels an AŞ started the production of rock wool, glass wool, and EPS insulated sandwich panels, after analyzing the need and clarifying the awareness of construction investors and developers. The company's development continued in this period until 2014, when customer confidence reached high levels through the establishment of high-quality, safe, economical, aesthetic, and comfortable living areas, and polyurethane (insulating panels (PIR) and Polyisocyanurate (PIR) production line were launched, thus becoming the first factory He has a side profile and is interested in manufacturing a different range of products that respond to the needs of users in many regions, not only in Turkey but also in more than 20 countries in the Balkans, the Middle East, Africa, and Europe. These regions import from the company many types, the most important of which are polyurethane and polyisocyanurate Rock wool, glass wool, polystyrene insulated sandwich panels, and EPS insulated products, (Panelsan, 2022).

Kingspan Facades was incorporated in Ireland in 1965, and is now a global company spanning 70 different countries, this company provides several types, sizes, and models of sheet metal used in different parts of buildings, but the focus will be on walls and precisely flat wall panels. The company is interested in providing distinct designs for five basic sections that make up the entire envelope of the building. This company is concerned with the field of sustainability and environmental preservation, and they have many innovative solutions and ideas that contribute to increasing the level of sustainability in buildings, and their policy is concerned with reducing emissions from buildings, and their ultimate goal is to provide a free future. of

emissions, (Kingspan, About Kingspan, 2022). And prices in general in all companies do not differ much, as well as the final quality of the product, so the matter remains to choose the owner of the building and the users for which company or type is available to them and according to the type of building, is its restoration or the beginning of construction. It mentions here a summary of the prices for the two types of thermal insulation, Wall Thermal Insulation, and Façade Insulation Panels, which are at the exchange rates on May 30, 2022.

The wall Thermal Insulation prices per square meter range between $7.8 and $10, in addition to value-added prices and shipping prices, according to the latest price updates 2021, (Isı Yalıtımı Metrekare Fiyatları, 2022) . On the other hand, The prices of Façade Insulation Panels per square meter range between $9.7 and $12.9, In addition the labour prices and shipping prices According to the latest price updates for 2022 is between 11$ and 12$, (Dış Cephe Strafor Panel Fiyatları, 2022).

The materials were provided in Northern Cyprus at comparable prices, and for this reason, Chain Parts Limited will be dealt with in the Famagusta region, and the prices range between $9 and $12, Due to the similarity of prices and quality, the products available in the Cypriot market were used, (Chain Parts Limited, 2022).

Here are some examples of insulators suggested by Kingspan Insulation LLC. The first proposal for Wall Thermal Insulation is Kingspan KoolthermTM K5 External Wall Board, and the second proposal for Façade Insulation Panels is also from the same company as Quad-Core Evolution Axis. Several types and designs are available with the same quality and features.

3.6.1 External Wall Thermal Insulation

This product is a heat-insulating board that is added during the construction process and can also be added in renovations using a steel structure, its outer shell is made of fiberglass that is automatically attached to the insulation molds during manufacture, and it provides excellent performance in thermal insulation as it has low thermal conductivity and also because it does not It contains CFCs and HCFCs and GWP ≤5, shown in figure 18, as it maintains and increases the sustainability of buildings. This insulator consists of a closed-cell fiber-free insulation core, manufactured with zero ODP and low GWP, this gives us excellent thermal performance because of the high Specifications, shown in table 2, (Kingspan, Kingspan KoolthermTM K5 External Wall Board, 2022).

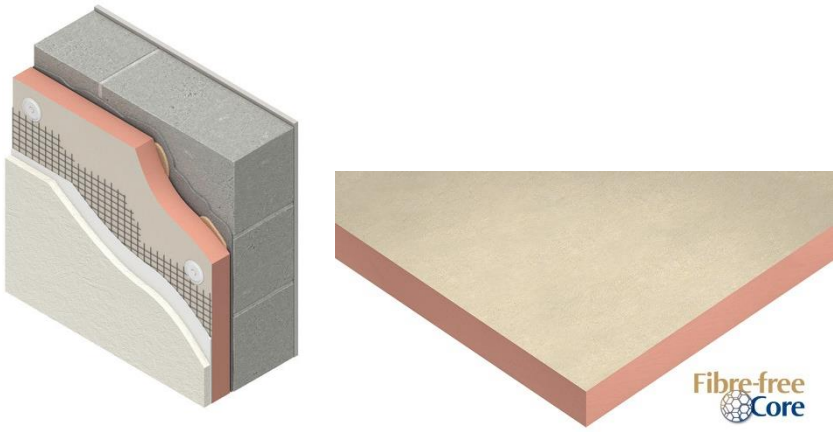

Figure 18: Kooltherm K5 External Wall Thermal Insulation, (Kingspan, Kingspan KoolthermTM K5 External Wall Board, 2022)

Table 2: Technical Specifications, (Kingspan, Kingspan KoolthermTM K5 External Wall Board, 2022)

Property	Value
Thermal Conductivity (ASTM C 518)	0.020 W/mK at 23°C mean temperature.
Product Thickness	Refer to a local distributor for current stock and non–stock sizes

Board Size	Refer to Kingspan Insulation for current stock and non-stock sizes (see rear cover)
Compressive Strength (BS EN 826: 2013)	Typically exceeds 100 kPa at 10% compression
Apparent Density (BS EN 1602: 2013)	35 kg/m3
Fire Performance	Further details of the fire performance of Kingspan Insulation products may be obtained from the updated brochure on our website (see rear cover

3.6.2 Façade Insulation Panels

It is a completely insulated exterior facade cladding panel system that provides more thermal comfort to the building, in addition to providing an elegant look to the outer envelope, in addition to its easy integration with buildings and facades due to the availability of a large number of colors and textures to achieve satisfactory results for customers. The Quad-Core Evolution Axis is a very simple, elegant, and non-integrated building insulated panel system that is only an external cladding added to the building facade or envelope; The ideal solution if a simplified facade is required in buildings with large flat areas. It gives us a smooth and flawless appearance of the outer casing. Single panel lengths range from 1.8 to 17 m in width from 600 to 1000 - in 1 mm increments and are also available in standard sizes, figure 19. These insulated cladding panels are the next generation of insulation technology, providing superior fire protection and thermal insulation of more than 20% with an unbeatable thermal performance profile $\lambda = 0.018W$ compared to previous generation panels, in addition to the outstanding and high environmental performance that contributes to in the company's vision in terms of sustainability and environmental preservation with ease of installation, figure 20, (Kingspan, QuadCore Evolution Axis, 2022).

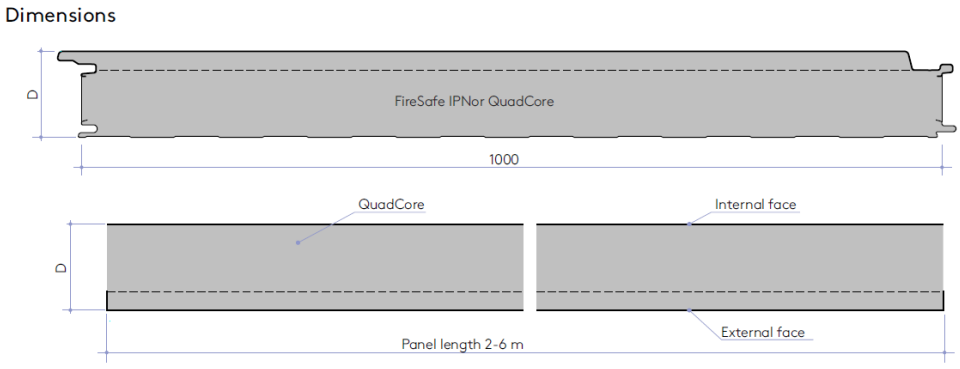

Figure 19: Dimensions of Quad-Core Evolution Axis, (Kingspan, QuadCore Evolution Axis, 2022)

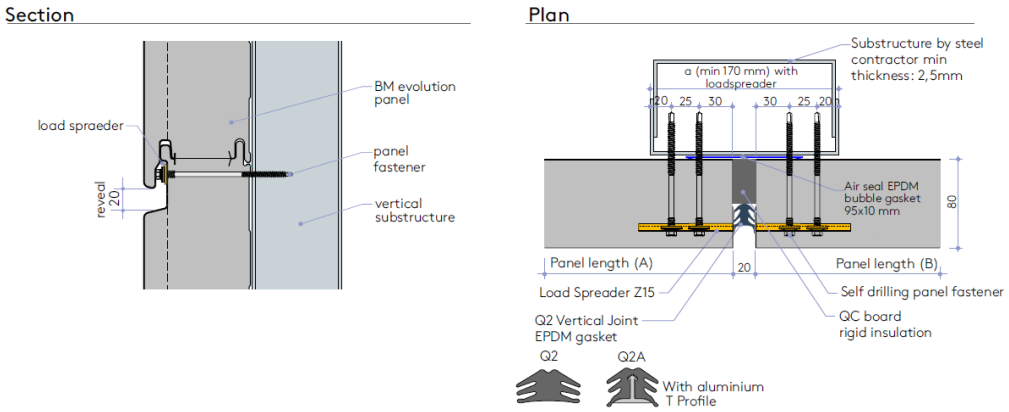

Figure 20: Section And Plan For Quad-Core Evolution Axis, (Kingspan, QuadCore Evolution Axis, 2022)

3.7 Economic Evaluation

Now turn to the economy, through this study it was concluded that the building's energy consumption will be significantly reduced when using thermal insulators, which positively affects the material returns to the user, as when using thermal insulators, electricity consumption will be reduced for cooling and heating as previously explained in the previous cases.

Many people, especially some contractors and those interested in construction, believe that the costs spent on thermal insulation are exceptionally large, and from their point

of view, there is no justification for this. We see many of them use low-density polystyrene for thermal insulation due to its low price without thinking or looking at the fatigue that will cost users and the amount The electric bill that users will pay monthly for heating and cooling purposes (Dylewski & Adamczyk, 2011).

Hence, it is necessary to alert and prove to everyone that thermal insulation in the building is a profitable investment and provides monthly amounts of money to users that extend over the years of the building's life, in addition to the psychological comfort and well-being of users in the internal surroundings of the building, as well as increasing the lifespan of the building and reducing the costs of continuous maintenance of the building and heating devices and cooling.

Total convection is divided into two main parts: external convection and internal convection. The external heat load is the load resulting from the heat leakage into the building through the walls, ceiling, floor, windows, and gates into the building, while the internal heat load is the load resulting from the internal movement of people, tools, electrical appliances, lighting, and other heat sources inside the building, in this research, we will delve only in the external load because the internal load is present in all cases. However, the external load is what we can control and control (Dylewski & Adamczyk, 2011).

Therefore, the use of thermal insulation in buildings reduces the external load and the external heat acquired in the building, as studies have shown that electricity consumption increases with the absence of thermal insulation for heating and cooling, as the coldness that is generated by cooling devices is rapidly leaked to the outside as well as the arrival of the building is heated from the outside, it will be heated from the

inside. thermal insulation is not used, and therefore the use of thermal insulation, even if its immediate financial value appears to be exaggerated. However, its positive impact overall and reducing electricity consumption in buildings will positively affect the financial income of users.

Chapter 4

RESULTS AND ANALYSIS OF EXTERNAL THERMAL INSULATION IN RESEDAINTAIL BUILDINGS

4.1 Introduction

Revit collects and analyzes data in intelligent ways using BIM technology. It can design and document: intelligent objects such as walls, doors, and windows can be placed, floor plans, elevations, partitions, and tables can be created, and 3D renderings images or films can be created, visualization: create realistic renderings, and analyze: To increase the performance of buildings in the initial stages of design, run cost estimates, track performance across the project's and building's lifespans, and more. Because REVIT is a multidisciplinary BIM platform, it can share model data with engineers and contractors right within REVIT, cutting down on coordination time, (Autodesk, 2021).

In this chapter, a study was made for an existing building selected by the researcher, and tests are conducted on it by changing the type of external walls and changing the thickness and type of thermal insulation, and the results will be limited, and the best will be clarified after making a comparison in terms of the greatest benefit at the most reasonable cost. Foam board was used in the simulation as a medium-efficiency heat insulator, and its price is affordable shown in figure 21.

Figure 21: The Proposal Of The Thermal Insulation Used In The Simulation, (Foam Board, 2020)

From the table of requirements from ASHRAE, some data have been identified that should be taken care of, where R value should not be more than 1.7 and U value should not be more than 0.5, and where these requirements are found in an article to be selected with Appropriate thickness, and in this case study information was extracted from Kingspan Company and both R and V values of the recommended insulator were indicated.

4.1.1 Factors Which Influence Thermal Insulation

Heat is defined as the energy transferred from one medium to another because the temperature differential between these two mediums is significant. Heat is usually transferred from a hot medium to a cold one in three diverse ways, namely: thermal conduction, convection, and thermal radiation. Thermal insulation reduces the contribution of these methods together or each of them separately in the process of heat transfer from the hot medium to the cold medium as follows:

- **Thermal conduction** is the main method of heat transfer through a flat solid wall whose inner and outer surfaces are of different temperatures.

- **Convection** It is known that the air in contact with a cold surface decrease in temperature, and its density increases downwards. The opposite occurs when the air touches a hot surface, its temperature rises, and its density decreases, thus generating upward air currents called convection currents.

- **Heat radiation** The method of heat transfer by radiation differs from the two previous methods of heat transfer, as there is no need for a medium or substance to transfer heat by radiation, the sun sends to Earth approximately 1600 k (Wm-2), despite the presence of an almost complete vacuum between them, and the intensity of thermal radiation is related to the area of the radiant surface, with its absolute temperature, with the modulus, and with the emissivity coefficient that is related to the nature and color of the surface, and its largest value is one.

Heat enters the building through the wall in three diverse ways:

1. The first type of wall is heat conductors, which have low heat permeability resistance. The materials in this collection have high thermal conductivity, for example, glass and metal, as they are fast conductors of heat and cold, and the temperature is the same on the outer and inner sides.
2. The second type of wall is a thermal insulator, as it prevents heat transfer from one side to the other. The conductivity of these materials is low or high in thermal resistance. It can be known through the temperature difference on both sides. Materials that can vent can be used as materials. Insulation, (Kumar & Suman, 2013).

3. The third type is the walls that act as a condenser and heat saver, as this group of materials saves heat and releases it with time delay, and this can be seen on both sides of the walls as the temperature varies inside and outside, for example, heavy materials such as bricks and concrete, they have This feature, (Kontoleon, Theodosiou, & Tsikaloudaki, 2013).

4.1.2 Factors Affecting The Selection Of Suitable Thermal Insulation Materials

To obtain the maximum result and benefit from the thermal insulation, the appropriate insulation materials must be chosen, and these materials vary according to the geographical location of the building. We mention here the most crucial factors that affect the selection of the appropriate materials for thermal insulation, as shown:

- The insulating substance should have a low thermal conductivity coefficient.
- To be resistant to water permeability and radiation permeability to a high degree.
- To be highly resistant to the absorption of water vapor.
- An elevated level of tolerance to shocks is caused by large temperature changes.
- It should have favorable mechanical qualities, such as a high modulus of compressive strength and a low fracture resistance coefficient.
- To be resistant to germs, mold, and fire, especially in areas where the fire is a frequent occurrence.
- To be extremely durable with a low coefficient of thermal expansion eventually.
- To be able to withstand chemical reactions.
- It has no negative impact on one's health.

4.2 Case Study: Single-Detached House

This residential villa was drawn in conformity with reality. The author took permission from the architect; The program has been redrawn, and the three-dimensional design shown below is the result of an approach to reality, and the aim was to conduct a study and comparison. A standard wall with a finishing thickness of 20 mm on both sides, a thickness of 200 mm, and a heat insulation thickness of 50 mm will use in the design. First, the wall without insulation will be studied, and then the three types of insulation will be compared to see which is better, the type of external wall without thermal insulation, the shape, figures 22 and 23 shows the 3d modeling of the villa.

Figure 22: Single-Detached House Model, by author

Figure 23: Single-Detached House Model, by author

Figures 24,25,26, and 27 show the plan view for each floor of the Single-detached house.

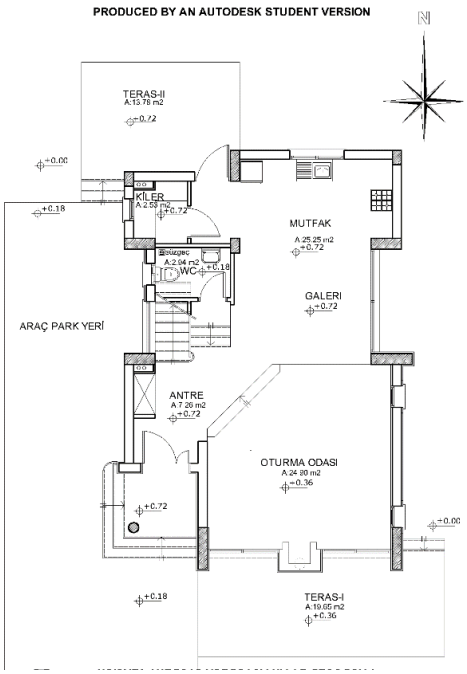

Figure 24: Ground Floor, by author

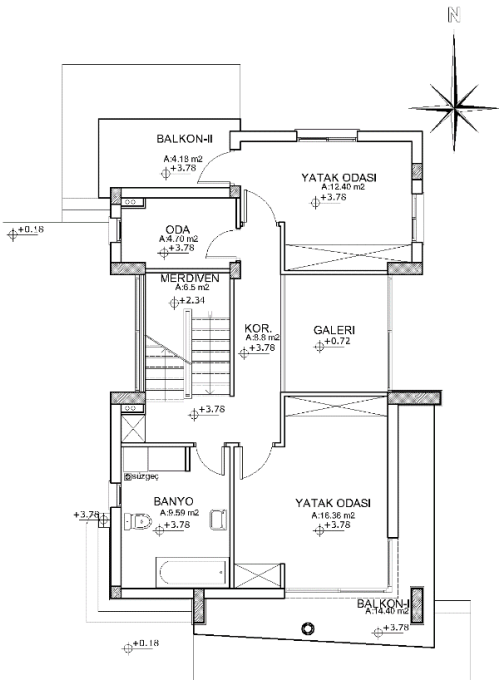

Figure 25: First Floor, by author

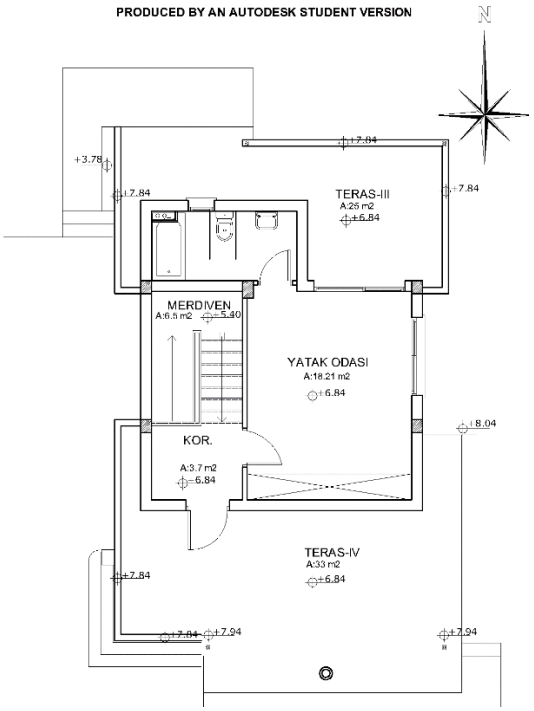

Figure 26: Second Floor , by author

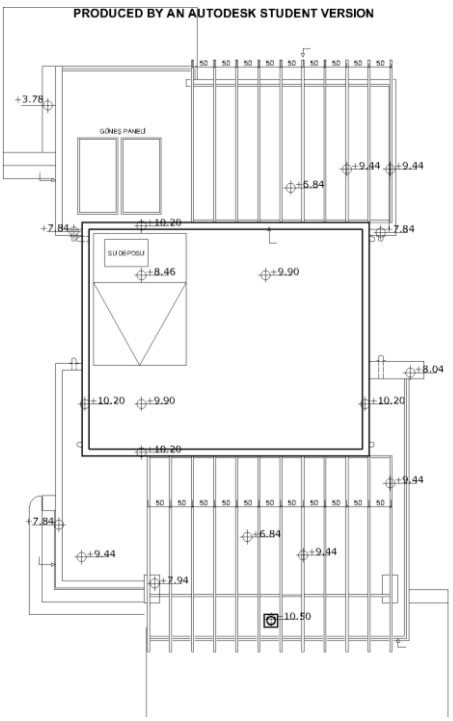

Figure 27: Third Floor , by author

4.2.1 Analysis Of REVIT Simulation For Housing Building

4.2.2 Building Design Information

Figure 28: Location Of The Single-Detached House, (maps)

The coordinate of the single-family villa is 35°09'17.8"N 33°53'05.6" E (35.154896, 33.884889) and the location is Cyprus, Famagusta (Gazimağusa), babağura sokak, shown in figure 28.

In theis case, the study was conducted on a family villa, and this villa containing three floors, the ground floor contains the living room and the kitchen, and on the second floor, there are two rooms, one of which is a master bedroom, and the third floor contains an additional bedroom. The total area of the villa is (210 m²); it contains a ground floor and two upper floors, located in the Famagusta district in North Cyprus, specifically in a modern residential complex at Hasan Güvenir Cd. Figure 29 shows the setup of the location with REVIT using the coordination for the villa.

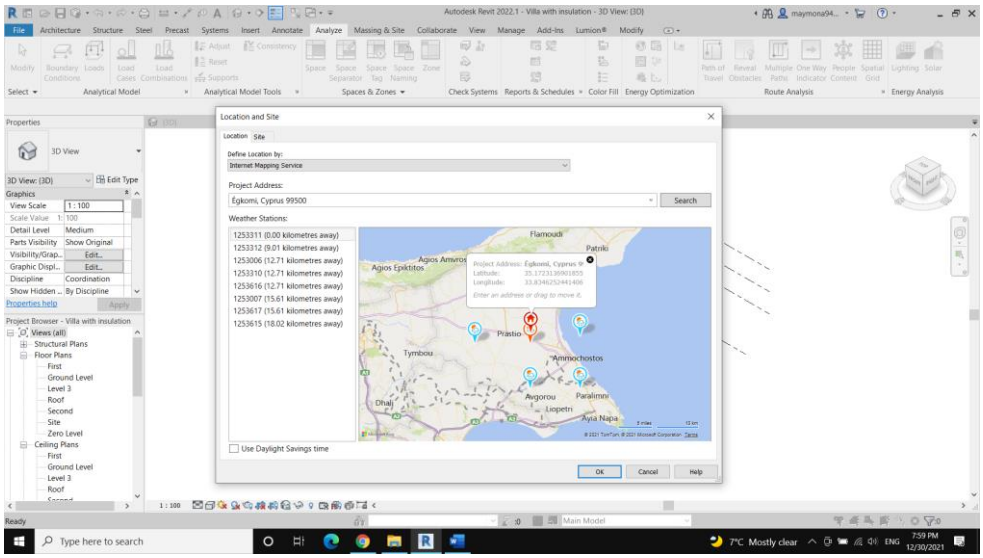

Figure 29: Setup The Location With Revit For The Single-Family Villa

4.2.3 Design Builder Simulation For The Building

To obtain the accurate data, the Design-Builder program was used with Energy Plus simulation, where the data that was installed in the Revit program was merged and transferred to the design-builder program to investigate the accuracy of the results. The simulation was applied to the two types of thermal insulators.

1. Without thermal insulation

Through the simulation that was done, figure 30 below shows the amount of carbon emitted without the use of thermal insulation, and the following figure 31 shows us the amount of fuel used also without the use of thermal insulation.

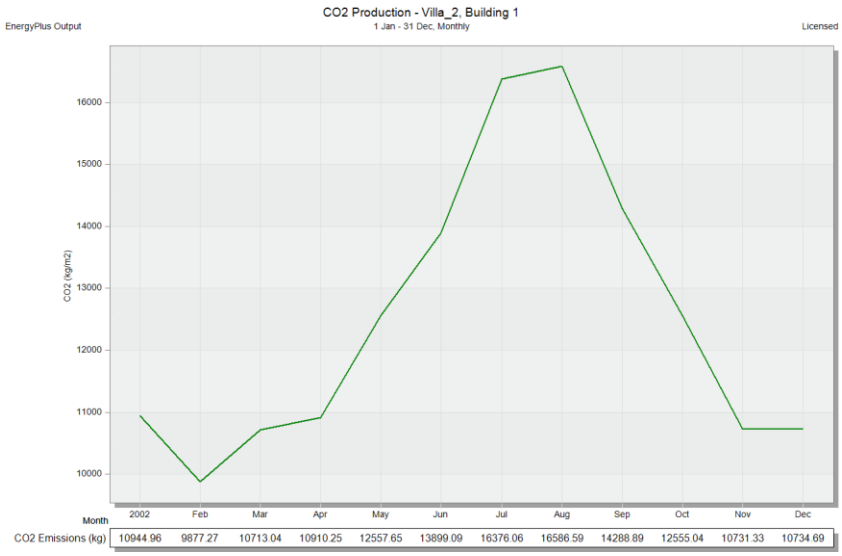

Figure 30: Carbon Production Without Using External Wall Thermal Insulation

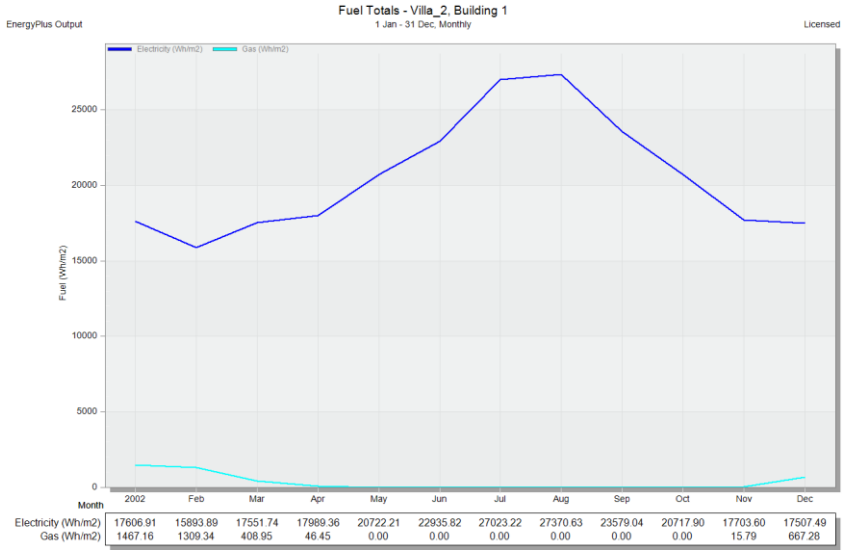

Figure 31: Fuel Total Without Using External Wall Thermal Insulation

2. External Wall Thermal Insulation

In the following case, the thermal insulation of the building was used following ASHRAE standard 90.1, and the following figure 32 shows the amount of carbon as well as the amounts of fuel consumed in the building in figure 33, and it is noted that it is higher than the second case, it is lower compared to the first case, and the following figure 34 shows a comparison between the baseline example and the proposed. The following results were obtained after the simulation:

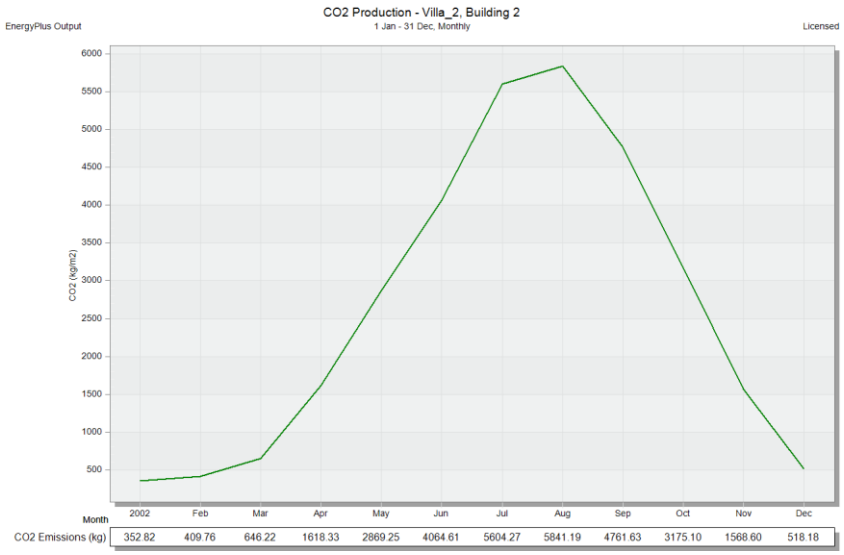

Figure 32: Carbon Production After Using External Wall Thermal Insulation

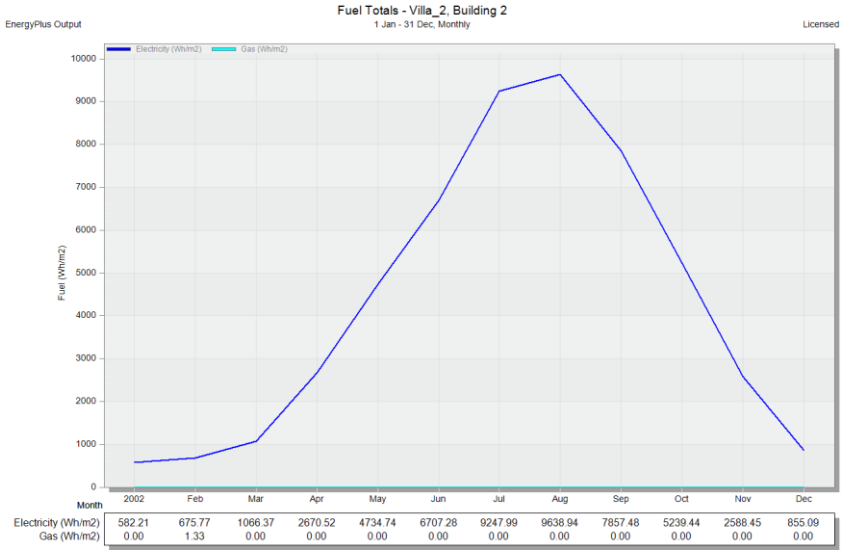

Figure 33: Fuel Total After Using External Wall Thermal Insulation

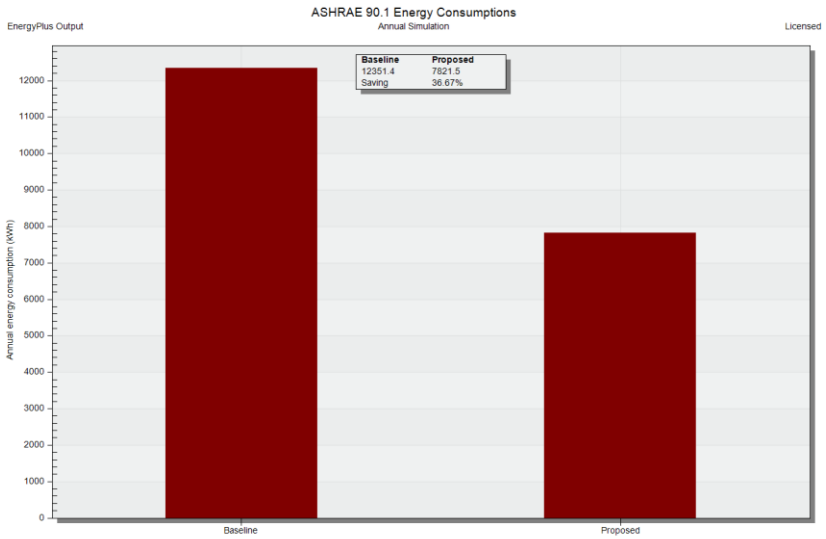

Figure 34: Energy Consumption Comparison Between Without Insulation And External Wall Thermal Insulation

In table 3, simulations are summarized with available real data to show whether the use of wall thermal insulation is a feasible option in the North Cyprus region.

The result is reached in four steps: The first is the insulation cost (shell area * material cost), the second is the energy savings from the simulation results, the third is the total annual savings from the simulation results as well, and the fourth is the tariff for how much energy is used. Through these calculations, it was concluded that the cost of thermal insulation will be covered within 4.93 years, and this is an acceptable and feasible option in this study.

Table 3: Wall Thermal Insulation Calculation

Area		Material cost (m^2)	Total
300 m^2		$ 10.00	$ 3,000.00
Energy Consumption	34.00%		
	Area m2	Implementation cost per m2	$
Investment Cost	300	$ (10.00)	$ (3,000.00)
Electricity Saving	4,000 kwh/yr	$ 0.16	$ 640.00
Operation Cost	$ -		

Interest Rate		5%					$ 1.05				
Saving ($)		640	640	640	640	640	640	640	640	640	640
Years	0	1	2	3	4	5	6	7	8	9	10
Cost ($)	-3000	-3150.0	-2635.5	-2095.3	-1528.0	-932.4	-307.1	349.6	1039.1	1763.0	2523.2
Net Profit ($)	-3000	-2510.0	-1995.5	-1455.3	-888.0	-292.4	332.9	989.6	1679.1	2403.0	3163.2
Feasability		5.69 years									

3. Façade Insulation Panels

In the last case, Façade insulation panels were used according to ASHRAE standard 90.1, and we see in the first figure 35 the amount of carbon consumed, and in the following figure 36 the amount of fuel consumed in the building, and during that we notice a significant decrease compared to the first case, and the last figure 37 shows a comparison between the baseline example and the proposed, and we note the amount of savings in the energy obtained. The following results were obtained after the simulation:

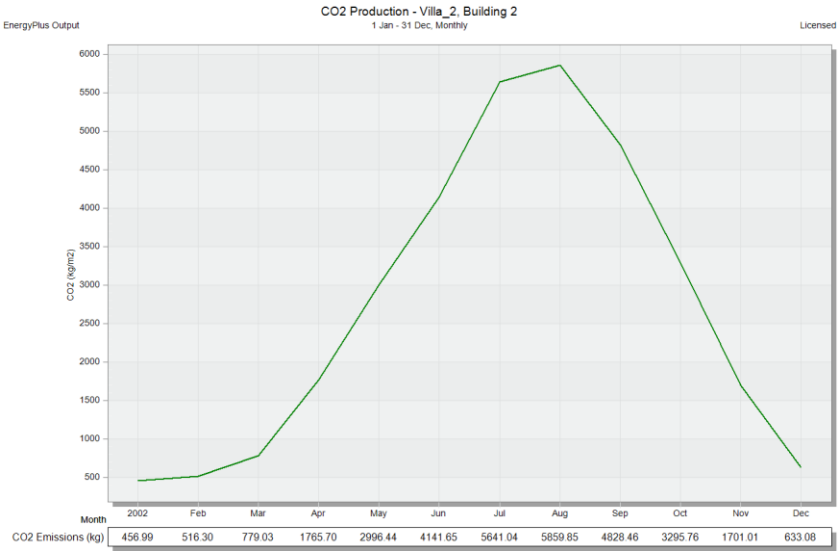

Figure 35: Carbon Production After Façade Insulation Panels

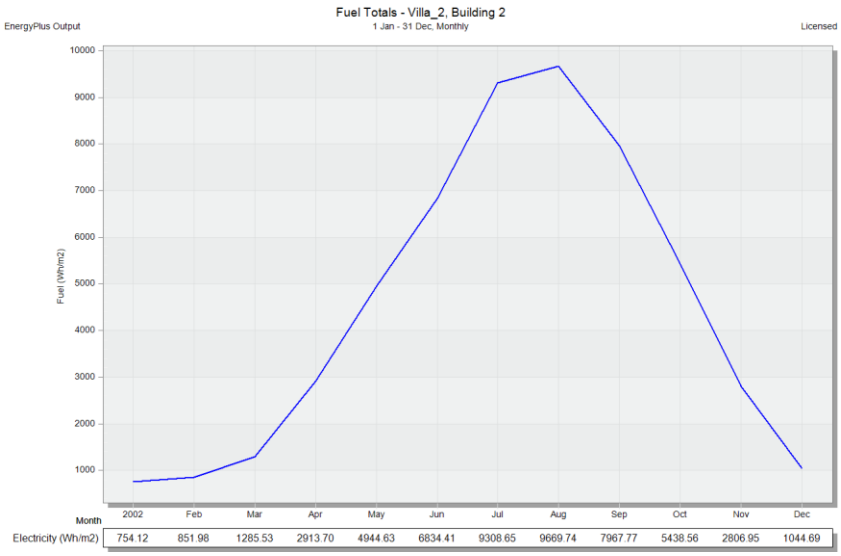

Figure 36: Fuel Total After Using Façade Insulation Panels

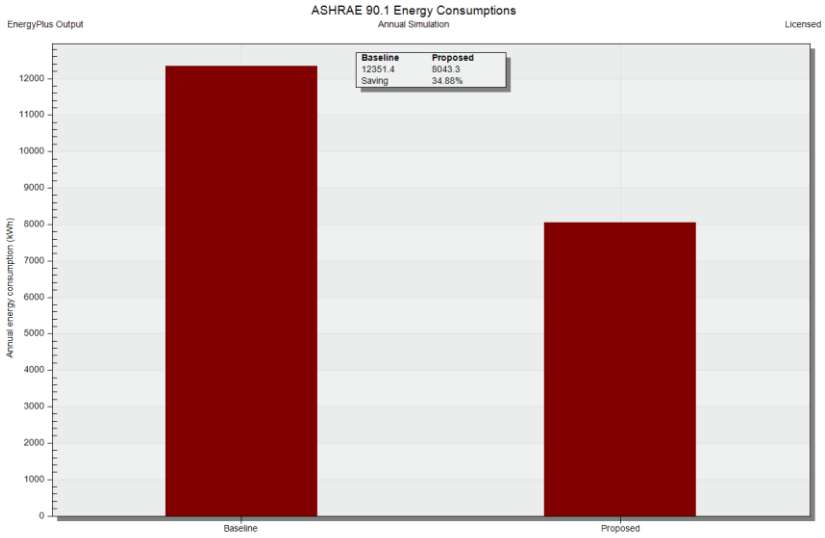

Figure 37: Energy Consumption Comparison Between Without Insulation And Façade Insulation Panels

In table 4, the same previous steps were repeated to reach the final result of the study in terms of the possibility of using Façade Insulation Panels in Northern Cyprus, and through calculations and simulations, it was concluded that the cost of thermal insulation will be covered within 5.35 years, and this is an unacceptable and unacceptable option possible in this study.

Table 4: Façade Insulation Panels Calculation

Area		Material cost (m²)					Total				
300 m²		$ 12.00					$ 3,600.00				
Energy Consumption		35.00%									
		Area m2			Implementation cost per m2				$		
Investment Cost		300			$ (12.00)				$ (3,600.00)		
Electricity Saving		4,200 kwh/yr			$ 0.16				$ 672.00		
Operation Cost		$ -									
Interest Rate		5%					$ 1.05				
Saving ($)		672	672	672	672	672	672	672	672	672	672
Years	0	1	2	3	4	5	6	7	8	9	10
Cost ($)	-3600	-3780	-3263.4	-2721	-2151.4	-1553.4	-925.5	-266.1	426.2	1153.1	1916.3
Net Profit ($)	-3600	-3108.0	-2591.4	-2049.0	-1479.4	-881.4	-253.5	405.9	1098.2	1825.1	2588.3
Feasability		6.36 years									

4.2.4 Results and Discussions

At the end of the detached house evaluation, the simulation proved to us that approximately 34% and 36% of the energy will be reduced annually when thermal insulation is used, which will directly affect the comfort of users in addition to reducing monthly bills, and this is an important and clear change for the building in terms of energy consumed, It is reflected on the users in material terms, in addition to saving fuel, which contributes to preserving the environment and developing and transforming cities. in sustainable cities.

It is taken into account that the annual interest is 5%, and through the results of calculations and simulations, it was concluded that the cost of the two types of thermal insulation will be covered within 6 to 7 years, and this relates to the current electricity tariff, where the average price per kilowatt is 0.16 dollars, and through it we conclude

that the return The fiscal will start after covering the costs, and if the electricity tariff is proven, it will be after 6 to 7 years.

Through the study and the results that were reached after the simulation of the buildings, in addition to the calculations that were made to clarify the lowest prices and the highest quality, several recommendations were reached the research, Thermal insulation is particularly important, especially in the ceilings and external walls, as it is the building envelope and the areas most affected by the external weather, some recommendations were reached as shown below:

- Thermal insulation is considered the best investment for buildings, especially residential buildings, as the use of residential buildings lasts 24 hours throughout the week, and attention to residential units is one of the key factors of comfort in developed societies.
- Thermal insulator will provide the material amounts that will be doubled on electricity for cooling and heating in the absence of thermal insulation.
- Thermal insulation is one of the best ways to transform a building into a highly energy-efficient building.
- Thermal insulation is the building's main barrier from heat and cold and will contribute to a higher level of comfort for users inside the building.
- The use of thermal insulation will increase the cost of building the building. However, the amounts used in thermal insulation will be recovered within less than 7 years as a maximum, If the electricity tariff price is fixed.
- The use of thermal insulators will directly reflect on the environment and reduce carbon, as it will limit the use of heating and cooling for long hours, which in turn will

reduce carbon emissions and harmful substances that in turn affect the external environment, and this, in turn, will increase the problem of global warming.

- It must look beyond the idea of the instantaneous price, as most contractors are interested in completing the construction without thinking about the problems that will be caused by neglecting some points that they consider unimportant in the future, and they will be directly reflected on the user and the environment.

Chapter 5

CONCLUSIONS

In this study, The Application of Thermal Insulation and its Feasibility on Existing Building Within the Context of Sustainability: The Case of Northern Cyprus , the study in Famagusta and it is in Northern Cyprus, where temperatures vary in summer and winter, located in the Mediterranean Sea. Cyprus is one of the countries with a Mediterranean climate, with long, dry summers and mild, mild winters. The Mediterranean climate is characterized by hot summers and rainy winters and is often found on the coasts of latitude 40 degrees from the equator. The characteristics of the Mediterranean climate are a transitional climate between a temperate climate and a dry subtropical climate. The sum of the thermal resistance of the wall without the usage of thermal insulation was used to determine thermal transmittance. In summer, temperatures exceed 22 degrees on the coasts and 30 degrees in the interior, sometimes approaching 40 degrees. In winter, the monthly average of the coldest month is more than 10 degrees, however in the north of the Mediterranean basin, these rates drop and always remain above zero degrees Celsius, and it snows in this climate.

In the first chapter, the focus is on the introduction and details of the preliminary research in terms of reviewing the literature, identifying and highlighting the main problem in the research, which is the problem of buildings being affected by not using thermal insulation, as rising temperatures are a global problem related to global warming, which the sustainable studies of current researchers focus on. By focusing

on reducing energy consumption and materials used in construction and replacing them with more sustainable materials to contribute to preserving the surrounding environment, this problem is considered a global and international problem. The problems associated with the use of low-quality materials increase energy consumption, and the cost is In addition high, since such a problem has an equal impact, governments (pressure on generators) and individuals (increased costs) must think of sustainable solutions that have the potential to reduce this problem, how to obtain the highest energy efficiency of the building, The researcher stated the aim of the study is to understand whether the external insulation materials will increase the energy efficiency of the building, how much they will increase energy efficiency and whether it will appear in the case of Famagusta, North Cyprus.

In the second chapter, the focus was on the theoretical background of thermal insulators, where all types were listed, and the best types used in the Mediterranean and hot climates were listed, which are polystyrene, glass wool, and fiberglass. Thermal insulation is one of the basic ways to increase the efficiency of buildings, as the use of insulation materials helps to reduce the energy consumed in buildings, and one of the most important types of thermal insulation for buildings is the use of passive wall systems, as many methods can be used in this type of systems such as Trombe walls, double-skin facades, green wall system, in addition to other common techniques for thermal insulation of buildings where the following methods of thermal insulation can be used with less need to use thermal insulation materials Roof shading, correct roof height, the orientation of the building. In addition to the classification of thermal insulation materials, according to the characteristics of thermal trade, according the structure, and according to the piece.

Insulating buildings to reduce grid energy use, associated environmental impacts and infrastructure costs is an important climate change mitigation strategy, and there is often a mix of incentives and regulations in place to encourage insulation efforts in new and renovated buildings as part of efficiency programs to reduce grid energy use, associated environmental impacts, and infrastructure costs. Building insulation is a wise financial and environmental investment. The building needs less energy for heating and cooling, and the occupants feel less thermal variability due to the insulation According to a study conducted on a building, 66 percent of the electrical energy consumed in the summer is used to cool the structure, which indicates that most of this energy is used to remove heat from the walls. As a result, thermal insulation is important because it helps to reduce the amount of electrical energy consumed for air conditioning by limiting heat leakage through walls, which results in a profit by lowering consumption.

As mentioned earlier in chapter three, the construction sector affects a very high percentage of gas emissions that affect the problem of global warming, and this represents a great responsibility for engineers and workers in the construction sector, where appropriate solutions to such a problem can be found by reducing the energy use associated with construction operations. Through measures and solutions such as energy efficiency retrofits, shifts towards renewable energy use, and on-site renewable energy installations, the increase in atmospheric carbon content assures us of the importance of a well-thought-out selection of materials and knowledge of detailed specifications from the inception of the project.

The facade cladding system is one of the possible solutions to such a problem, as this system is a non-loadable panel that is installed on the external structure of the building

in different ways, as these panels do not carry any weight or load from the building that bears its weight only, in addition, it can Hiding many defects from the facades by using this system in addition to its primary task in adding thermal and sound insulation to the building, especially if it is added in an engineering way combined with the insulation in the structure behind it. Facade insulation panels are fixed to the walls using plastic fasteners to ensure no thermal conductivity depending on the type. The structure used, the facade cladding system does not cause any kind of impact on the building facade or the internal environment, on the contrary, the thermal comfort inside the building will increase without affecting in any way the aesthetics of the building.

In addition to all these features, this system has flexibility and is considered easy to use with modern architecture, as it can be available in different shapes and types in addition to its attractive colors that are in harmony with the progress of modern architecture, as well as its advantages compatible with the global trend of energy conservation and sustainability in construction, and this makes this considered This system is an aesthetic and engineering solution at the same time.

In addition, a comparison was made between the use of and without thermal insulation in the case study, with different simulations in Chapter 4; Through this research, many results and outputs were reached. First, it has been confirmed that 30% of the building's energy can be saved by using thermal insulation in the walls, in addition to the fact that thermal insulation quantifies or saves energy and reduces budget consumption as shown in simulation studies. Which occurred in the case mentioned in Chapter Four, and the difference between the non-use of thermal insulation and its use in the buildings in which the study was conducted was documented. Secondly, energy efficiency is related to the use of materials in construction at all its stages, from the

construction stage to the completion stage, as the selection of materials of excellent quality helps to reduce the building's energy consumption when used, as well as reduce the energy consumption of the building. Thermal energy can be lost through walls and ceilings if the thermal insulators are not taken care of and are suitable for the climate and area in which the building will be constructed. Third, the amounts needed to use the heat insulator are covered within a maximum of 6 to 7 years, and then the financial return associated with reducing electricity consumption on a monthly basis begins, Since the selling price of electricity is directly related to the number of years needed to cover the investment, this relationship in our case that was studied is considered successful, as the average price of electricity per kilowatt-hour is $0.16. As a result, the use of thermal insulators whose value per square meter is 10-12 $ will contribute to reducing the heat and the costs will be covered within a maximum of 6 years, and this is what was reached in this research.

To conclude, thermal insulation is the addition of materials or cladding to an external wall to reduce heat transfer from outside to inside and vice versa. The materials used in thermal insulation favorably vary in moisture control as well as sound insulation, and this enables the user to choose what suits his budget.

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APPENDICES

Appendix A: Thermal Insulation Prices

ÖZPOR

www.ozpor.com.tr
444 9 414

Özpor Stonewool EURO Price List 1 January 2019

Product Type and Features	Thickness (cm)	Package Width x Length (cm)	Package Board / Package	Package (m2)	Package / Pallet	h:2,75-L:7,30 Truck Loading Amount Pallet	Truck Loading Amount Package	Truck Loading Amount (m2)	h:2,75-L:13,60 TIR Loading Amount Pallet	TIR Loading Amount Package	TIR Loading Amount (m2)	Unit Price €/m² Exworks Ozpor Ankara	Unit Price €/m² Ankara Local Delivery 30 Km
Roof Insulation Rolls λ ≤ 0.040 W/mK 40 kg/m3	8	120 x 500	Roll	6,00	20	12	240	1.440	22	440	2.640	2,67	2,75
	10	120 x 500	Roll	6,00	20	12	240	1.440	22	440	2.640	3,33	3,44
	12	120 x 500	Roll	6,00	20	12	240	1.440	22	440	2.640	4,00	4,13
	14	120 x 500	Roll	6,00	20	12	240	1.440	22	440	2.640	4,67	4,81
Partition Inuslation Board λ ≤ 0.040 W/mK 40 kg/m3	4	60 x 120	10	7,20	12	12	144	1.037	22	264	1.901	1,23	1,32
	5	60 x 120	8	5,76	16	12	192	1.106	22	352	2.028	1,54	1,65
	6	60 x 120	8	5,76	12	12	144	829	22	264	1.521	1,85	1,98
	8	60 x 120	6	4,32	12	12	144	622	22	264	1.140	2,46	2,64
	10	60 x 120	4	2,88	16	12	192	553	22	352	1.014	3,08	3,29
Exterior Wall Board λ ≤ 0.038 W/mK 50 kg/m3	3	60 x 120	16	11,52	12	12	144	1.659	22	264	3.041	1,15	1,22
	4	60 x 120	10	7,20	16	12	192	1.382	22	352	2.534	1,53	1,62
	5	60 x 120	8	5,76	16	12	192	1.106	22	352	2.028	1,92	2,03
	6	60 x 120	8	5,76	12	12	144	829	22	264	1.521	2,30	2,43
	8	60 x 120	6	4,32	12	12	144	622	22	264	1.140	3,07	3,24
	10	60 x 120	4	2,88	16	12	192	553	22	352	1.014	3,83	4,05
Industrial Insulation Board 70 kg/m3	3	60 x 120	14	10,08	12	12	144	1.452	22	264	2.661	1,60	1,69
	4	60 x 120	10	7,20	12	12	144	1.037	22	264	1.901	2,14	2,25
	5	60 x 120	8	5,76	12	12	144	829	22	264	1.521	2,67	2,82
	6	60 x 120	8	5,76	10	12	120	691	22	220	1.267	3,21	3,38
	8	60 x 120	6	4,32	10	12	120	518	22	220	950	4,28	4,51
	10	60 x 120	4	2,88	12	12	144	415	22	264	760	5,34	5,63
Industrial Insulation Board 110 kg/m3	3	60 x 120	8	5,76	20	12	240	1.382	22	440	2.534	2,50	2,58
	4	60 x 120	6	4,32	20	12	240	1.037	22	440	1.901	3,33	3,45
	5	60 x 120	6	4,32	16	12	192	829	22	352	1.521	4,16	4,31
	6	60 x 120	5	3,60	16	12	192	691	22	352	1.267	4,99	5,17
	7	60 x 120	5	3,60	12	12	144	518	22	264	950	5,83	6,03
	8	60 x 120	5	3,60	12	12	144	518	22	264	950	6,66	6,89
	10	60 x 120	4	2,88	12	12	144	415	22	264	760	8,32	8,61
Facade Insulation Board TR ≥ 7,5 kPa 120 kg/m3	5	60 x 120	6	4,32	16	12	192	829	22	352	1.521	4,50	4,64
	6	60 x 120	5	3,60	16	12	192	691	22	352	1.267	5,40	5,57
	7	60 x 120	5	3,60	12	12	144	518	22	264	950	6,30	6,50
	8	60 x 120	5	3,60	12	12	144	518	22	264	950	7,20	7,43
	10	60 x 120	4	2,88	12	12	144	415	22	264	760	9,00	9,29
Facade Insulation Board TR ≥ 7,5 kPa 150 kg/m3	4	60 x 120	6	4,32	20	12	240	1.037	22	440	1.901	4,46	4,58
	5	60 x 120	6	4,32	16	12	192	829	22	352	1.521	5,58	5,72
	6	60 x 120	5	3,60	16	12	192	691	22	352	1.267	6,69	6,86
	7	60 x 120	4	2,88	16	12	192	553	22	352	1.014	7,81	8,01
	8	60 x 120	3	2,16	20	12	240	518	22	440	950	8,92	9,15
	10	60 x 120	3	2,16	16	12	192	415	22	352	760	11,15	11,44
Bulk			Şilte		24	10	240	4.800 Kg	20	480	9.600 Kg	0,80	0,82
Sandwich Pannel						Please contact us for detailed prices							

Özpor Stonewool EURO Price List 1 January 2019

Product Type and Features	Thickness (cm)	Package: Width x Length (cm)	Package: Board / Package	Package: (m2)	Package / Pallet	h:2,75-L:7,30 Truck Loading Amount: Pallet	Truck Loading Amount: Package	Truck Loading Amount: (m2)	h:2,75-L:13,60 TIR Loading Amount: Pallet	TIR Loading Amount: Package	TIR Loading Amount: (m2)	Unit Price €/m² Exworks Özpor Ankara	Unit Price €/m² Ankara Local Delivery 30 Km
Terrace Roof Insulation Board CS ≥ 25 kPa 120 kg/m3	5	60 x 120	6	4,32	16	12	192	829	22	352	1.521	4,44	4,58
	6	60 x 120	5	3,60	16	12	192	691	22	352	1.267	5,33	5,50
	7	60 x 120	5	3,60	12	12	144	518	22	264	950	6,22	6,42
	8	60 x 120	5	3,60	12	12	144	518	22	264	950	7,10	7,34
	10	60 x 120	4	2,88	12	12	144	415	22	264	760	8,88	9,17
Terrace Roof Insulation Board CS ≥ 25 kPa 150 kg/m3	4	60 x 120	6	4,32	20	12	240	1.037	22	440	1.901	4,42	4,56
	5	60 x 120	6	4,32	16	12	192	829	22	352	1.521	5,53	5,70
	6	60 x 120	5	3,60	16	12	192	691	22	352	1.267	6,63	6,84
	7	60 x 120	4	2,88	16	12	192	553	22	352	1.014	7,74	7,98
	8	60 x 120	3	2,16	20	12	240	518	22	440	950	8,84	9,12
	10	60 x 120	3	2,16	16	12	192	415	22	352	760	11,05	11,40
Industrial Rolls w/Rabitz Wire 80 kg/m3	4	100 x 800	Roll	8,00	20	12	240	1.920	22	440	3.520	2,99	3,05
	5	100 x 600	Roll	6,00	20	12	240	1.440	22	440	2.640	3,73	3,82
	6	100 x 600	Roll	6,00	20	12	240	1.440	22	440	2.640	4,48	4,58
	8	100 x 300	Roll	3,00	20	12	240	720	22	440	1.320	5,87	5,95
	10	100 x 300	Roll	3,00	20	12	240	720	22	440	1.320	7,20	7,28
	12	100 x 300	Roll	3,00	20	12	240	720	22	440	1.320	8,64	8,74
Industrial Rolls w/Rabitz Wire 100 kg/m3	4	100 x 800	Roll	8,00	20	12	240	1.920	22	440	3.520	3,73	3,82
	5	100 x 600	Roll	6,00	20	12	240	1.440	22	440	2.640	4,67	4,77
	6	100 x 600	Roll	6,00	20	12	240	1.440	22	440	2.640	5,60	5,73
	8	100 x 300	Roll	3,00	20	12	240	720	22	440	1.320	7,33	7,44
	10	100 x 300	Roll	3,00	20	12	240	720	22	440	1.320	9,00	9,10
Industrial Rolls w/Rabitz Wire 125 kg/m3	4	100 x 600	Roll	6,00	20	12	240	1.440	22	440	2.640	4,58	4,65
	5	100 x 500	Roll	5,00	20	12	240	1.200	22	440	2.200	5,83	5,96
	6	100 x 400	Roll	4,00	20	12	240	960	22	440	1.760	6,88	6,97
	8	100 x 300	Roll	3,00	20	12	240	720	22	440	1.320	9,17	9,30
	10	100 x 240	Roll	2,40	20	12	240	576	22	440	1.056	11,46	11,62
Exterior Wall Board w/Aluminum Foil λ ≤ 0.040 W/Mk 50 kg/m3	5	60 x 120	8	5,76	12	12	144	829	22	264	1.521	2,92	4,06
	8	60 x 120	6	4,32	10	12	120	518	22	220	950	4,07	5,90
	10	60 x 120	4	2,88	12	12	144	415	22	264	760	4,83	7,12
Exterior Wall Board w/Black Glassweil λ ≤ 0.040 W/Mk 50 kg/m3	5	60 x 120	8	5,76	12	12	144	829	22	264	1.521	2,75	3,89
	8	60 x 120	6	4,32	10	12	120	518	22	220	950	3,90	5,73
	10	60 x 120	4	2,88	12	12	144	415	22	264	760	4,67	6,96
Exterior Wall Board w/Yellow Glassweil λ ≤ 0.040 W/Mk 50 kg/m3	5	60 x 120	8	5,76	16	12	192	1.106	22	352	2.028	2,58	3,73
	8	60 x 120	6	4,32	12	12	144	622	22	264	1.140	3,73	5,56
	10	60 x 120	4	2,88	12	12	144	415	22	264	760	4,50	6,79

- VAT is not included into the pricess
- Pricess are given as delivery to city centers by Truck or TIR.
- Additional Pricess for Facing ; Aluminum Foil : 1 €/ m2 - Black Glassweil : 0,85 €/ m2 - Yellow Glasweil : 0,65 €/ m2 gross, and will be added to above prices.
- For delivery with Truck, %3 will be added to above prices.
- For 2,5 cm and 3 cm thicknesses: %3 will be added to above prices.
- For deliveries not to city centers such as villages etc. Additional delivery amount will be added to prices.
- Our products have TSE and CE certificates. (Due to standarts +/- %10 density tolerance may be applied.)
- Our company is not responsible for any print or issuing faults.
- Özpor may change these prices at any time without any declerations.
- This price list is copyrighted to Özpor and without written permission it is unlegal to copy, multiply or sharing with 3rd parties.

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Mrs. Damla Ersözlü	damla@ozpor.com.tr	+ 90 532 333 83 15

ÖMER BEY MANTOLAMA FİYATLANDIRILMASI				
YAL 011	6 CM KALINLIKTA YÜZEYİ PÜRÜZLÜ VEYA PÜRÜZLÜ KANALLI EXTRÜDE POLİSTREN LEVHALAR (XPS - 200 KPA BASINÇ DAYANIMLI) İLE DIŞ DUVARLARDA DIŞTAN ISI YALITIMI VE ÜZERİNE ISI YALITIM SIVASI YAPILMASI (MANTOLAMA)	M2	₺ 149,00	9 $
YAL 012	8 CM KALINLIKTA TAŞYÜNÜ LEVHALAR (MİN. 120 KG/M³ YOĞUNLUKTA) İLE DIŞ DUVARLARDA DIŞTAN ISI YALITIMI VE ÜZERİNE ISI YALITIM SIVASI YAPILMASI (MANTOLAMA)	M2	₺ 212,00	13 $
YAL 013	BİR YÜZEYİ SİYAH CAMTÜLÜ KAPLI, TAŞ YÜNÜ LEVHALAR (LEVHA KALINLIĞI İÇİN MEKANİK HESAPLAR ESASTIR. MİN. 90KG/M3 YOĞUNLUKTA) İLE DIŞ DUVARLARDA DIŞTAN ISI YALITIMI YAPILMASI	M2	₺ 158,00	10 $
NOT: 1 NİSAN 2022 TARİHLİ FİYATLARDIR.				

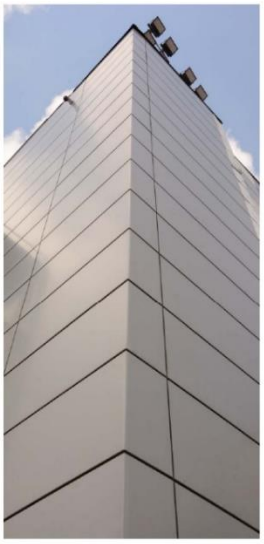
Appendix B: Catalogue

Evolution Panel Turkey

Protected by Kingspan WARRANTY

Benchmark
Evolution - D End Panel
Data Sheet



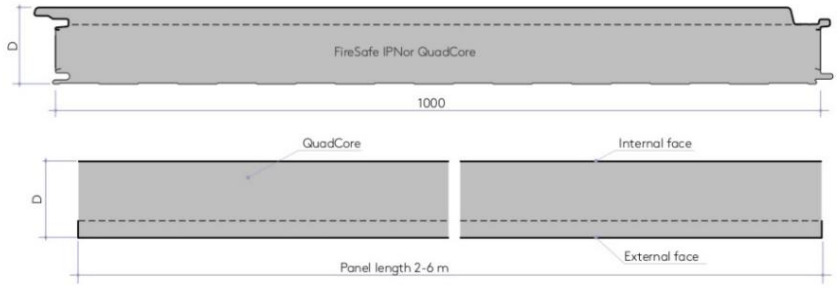



BENCHMARK
By Kingspan

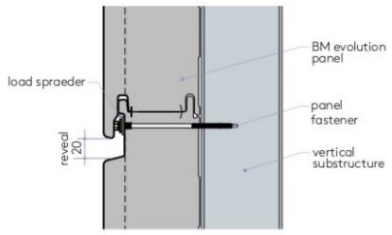
Benchmark
Evolution - D End Panel

Benchmark Evolution is a premium insulated panel system that can be used to create a stylishly sleek look to the building profile. The system is easily integrated into other interfaces allowing variations in colour, texture and profile to be easily achieved

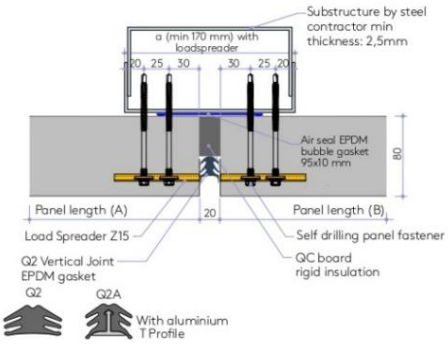
Dimensions



Section



Plan



Dimensions, Weight & Thermal Performance

Panel Properties and Thermal Performance

D – Core thickness (mm)	80	100
U-value (W / m²K)	0,23	0,18
R-value (m²K/W)	4,35	5,55

Product Tolerances

Length ≤ 3 m	±5 mm
Length > 3 m	±10 mm
Width	±2 mm
Thickness ≤ 100 mm	±2 mm
Thickness > 100 mm	±%2 mm
Squarness of the cut end	≤ % 0,6

Dimensions

- Thickness : 80-100 mm
- Width : 1,000 mm
- Lenghts : 2,000-6,000 mm
- Surfaces: Steel: exterior flat Surface / interior profile
- Standard Metal Gauge: 0,7 exterior / 0,5 interior
- Manufacturing Process: Foamed-in-place

Firesafe & Insurance

FM & LPCB approval is under progress.

Acoustic Performance

For sound transmission reduction, Kingspan panels typically have a single figure weighted sound reduction index (SRI) of Rw=24dB.

Frequency (Hz)	125	250	500	1000	2000	4000	Rw
SRI (dB)	17	21	26	26	26	42	24

Materials

Insulation Core : Insulation Core

QuadCore is Kingspan's next generation of hybrid microcell insulation technology. This technological innovation provides superior fire protection, up to 20% thermal enhancement compared to IPN, a higher environmental performance, and is supported by a 40 year building guarantee. QuadCore delivers an unbeaten thermal performance of λ =0.018 W

Steel Substrate Options

The steel used for the skin of the panels conforms to EN 10143 and has a guaranteed minimum yield strength of 220 Mpa. Hot-dip zinc coated with a total of 100, 200, 225 or 275 g/m^2 of zinc. This can be finished with a number of coatings -Polyester, PVDF, Plastisol

Substrate thickness:

External skin: 0.70 mm S280GD
Internal skin: 0.50 mm S280GD
Other thicknesses can be supplied subject to discussion with Kingspan.

Coating Options

Standard Polyester (PES)

The standard surface used for manufacturing sandwich panels is a 25 micron (nominal thickness) polyester coating system with medium term life for worldwide use.

PVDF

PVDF has a smooth, 25 micron (nominal thickness) coating system which offers excellent colour stability. PVDF offers good corrosion resistance in most environments worldwide.

Product Selection Assistance

Sales representatives are available nationwide to answer queries on product options, assist with detailing, spans and other queries.
They can also provide early stage budget estimates and co-ordinate the provision of project specifications.

Guarantees

BENCHMARK Evolution will provide product guarantees on an individual project basis.
Guarantees are typically up to 5 years in a non marine / geothermal environment. All guarantees are subject to maintenance regime.
Specialist coatings are available for marine and other more corrosive areas.

Biological

BENCHMARK Evolution panels are normally immune to attack from mould,
fungi, mildew, and vermin. No urea or formaldehyde is used in the construction, and the panels are not considered deleterious to health.

Quality and Durability

BENCHMARK Evolution panels are manufactured to ISO 9001 & TS EN 14509 standards from the highest quality materials, using state of the art production equipment to rigorous quality control standards, ensuring long term reliability and service life.

Delivery & Packing

Standard Packing

Protective film is applied to the external and internal face.
Kingspan panels are stacked horizontally.
The number of panels in each pack depends on panel thickness.

Delivery

All deliveries (unless indicated otherwise) are by road transport to project site by flat bed truck for off loading by crane or fork hoist.
Off loading is the responsibility of the installer.
Handling guidelines are available from Kingspan Technical Services.

BENCHMARK EVOLUTION LOAD SPAN TABLE

	Core Thickness (mm)	Load Type kN/m²	Span length (m)										
			1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0	5,5	6,0
SINGLE SPAN	80	Pressure	7,68	5,12	3,83	2,47	1,72	1,26	0,96	0,76	0,62	0,51	0,43
		Suction	-7,68	-5,12	-3,15	-2,02	-1,40	-1,03	-0,79	-0,62	-0,51	-0,42	-0,35
	100	Pressure	9,62	6,41	4,45	2,85	1,98	1,45	1,11	0,88	0,71	0,59	0,50
		Suction	-9,61	-6,41	-3,95	-2,53	-1,75	-1,29	-0,98	-0,78	-0,63	-0,52	-0,44

	Core Thickness (mm)	Load Type kN/m²	Span length (m)										
			1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0	5,5	6,0
DOUBLE SPAN	80	Pressure	7,66	5,11	3,83	2,47	1,72	0,92	0,43	0,19	-	-	-
		Suction	-7,66	-5,11	-3,15	-2,02	-1,40	-1,03	-0,79	-0,62	-	-	-
	100	Pressure	9,61	6,41	4,45	2,85	1,98	1,45	0,83	0,42	0,21	-	-
		Suction	-9,61	-6,41	-3,95	-2,53	-1,75	-1,29	-0,98	-0,77	-0,50	-	-

	Core Thickness (mm)	Load Type kN/m²	Span length (m)										
			1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0	5,5	6,0
TRIPLE SPAN	80	Pressure	7,66	5,11	3,83	2,47	1,61	0,89	0,54	0,35	0,24	0,18	0,13
		Suction	-7,66	-5,11	-3,15	-2,02	-1,40	-1,03	-0,79	-0,62	-0,51	-0,42	-0,35
	100	Pressure	9,61	6,41	4,45	2,85	1,98	1,37	0,82	0,53	0,36	0,26	0,19
		Suction	-9,61	-6,41	-3,95	-2,53	-1,75	-1,29	-0,98	-0,78	-0,63	-0,50	-0,40

1. Steel thickness ext/int: 0,7/0,5mm
   The above-mentioned calculations apply to panels with standard steel skin strength specification:
   External metal face fy=280 MPa (S280GD)
   Internal metal face fy=220 MPa (S220GD)
2. Values have been calculated using the method described in EN 14509, for color group 1
3. The following deflection limits have been used:
   Pressure loading L/100
   Suction loading L/100
4. All panel thicknesses have been calculated with a minimum end support width of 40mm and intermediate support width of 60mm.
   Larger support widths are possible.
5. The actual wind suction resisted by the panel is dependent on the number of fasteners.
6. The fastener calculation should be carried out in accordance with the appropriate standards.
7. For intermediate values linear interpolation may be used.
8. The allowable steelwork tolerance between bearing planes of adjacent supports is +/- 5mm.

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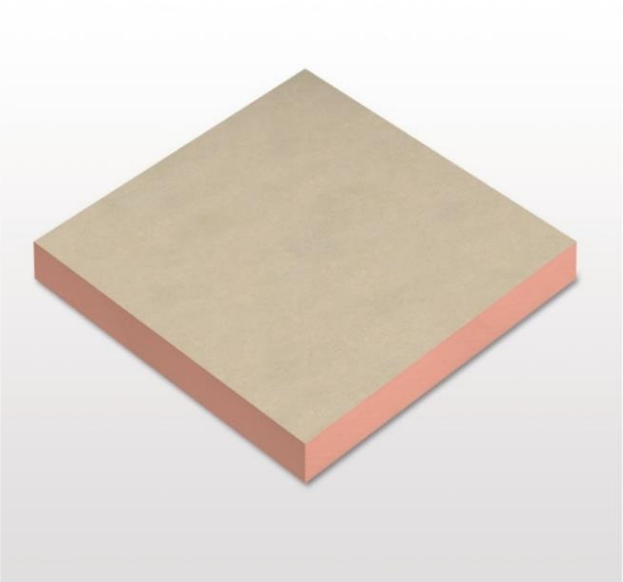
For the product offering in other markets please contact your local sales representative or visit www.kingspanpanels.tc

06/2018

Insulation

Kooltherm™ K5 External Wall Board

External Wall Insulation for Masonry and Steel Frame Walls in both New Build and Refurbishment



- Premium performance rigid thermoset insulation - thermal conductivities as low as 0.020W/m·K
- Certified by Dubai Central Laboratory
- Rated Class A under UL 723/ ASTM E84 Surface Burning Characteristics
- Passed criteria when tested to NFPA 268
- Successfully tested in conjunction with appropriate render system to NFPA 285:2012
- Manufactured with a blowing agent that has zero ODP (contains no CFCs and HCFCs and GWP ≤5.

Fibre-free Core

Kingspan

Product Information

Product Description

Kingspan Kooltherm™ K5 External Wall Board is faced on both sides with a glass tissue based facing, autohesively bonded to the insulation core during manufacture.

General

- Wherever possible, care should be taken to avoid thermal bridging when attaching services and ancillaries to the exterior of the building.
- Depending on the render finish being applied, advice must be sought from the render manufacturer on the EML / glass fibre mesh, adhesive and levelling mortar to be applied.
- In refurbishment projects, sill extenders and flashings should be used around openings, with care taken to avoid thermal bridging.

Cutting

- Cutting should be carried out either by using a fine toothed saw, or by scoring with a sharp knife, snapping the board over a straight edge and then cutting the facing on the other side.
- Ensure accurate trimming to achieve close-butting joints and continuity of insulation.

Daily Working Practice

- At the completion of each day's work, or whenever work is interrupted for extended periods of time, board edges and joints should be protected from inclement weather.

Availability

- Please contact Kingspan Insulation (see rear cover) to enquire about the availability of Kingspan Kooltherm™ K5 External Wall Board.

Packaging and Storage

- The polyethylene packaging of Kingspan Insulation products, which is recyclable, should not be considered adequate for outdoor protection.
- Ideally, boards should be stored inside a building. If, however, outside storage cannot be avoided, then the boards should be stacked clear of the ground and covered with an opaque polythene sheet or weatherproof tarpaulin. Boards that have been allowed to get wet should not be used.

Health and Safety

- Kingspan Insulation products are chemically inert and safe to use.
- A Safety Information Data Sheet for this product is available from the Kingspan Insulation website www.kingspaninsulation.com.

Warning – do not stand on or otherwise support your weight on this product unless it is fully supported by a load bearing surface.

Standards and Approval

Kingspan Kooltherm™ K5 External Wall Board is manufactured to the highest standards under a management system certified to ISO 9001: 2015 (Quality management systems. Requirements), ISO 14001: 2015 (Environmental Management Systems. Requirements), ISO 45001:2018 (Health and Safety Management Systems. Requirements).

Technical Specifications

Property	Value
Thermal Conductivity (ASTM C 518)	0.020 W/mK at 23°C mean temperature.
Product Thickness	Refer to local distributor for current stock and non-stock sizes
Board Size	Refer to Kingspan Insulation for current stock and non-stock sizes (see rear cover)
Compressive Strength (BS EN 826: 2013)	Typically exceeds 100 kPa at 10% compression
Apparent Density (BS EN 1602: 2013)	35 kg/m³
Fire Performance	Further details of the fire performance of Kingspan Insulation products may be obtained from the updated brochure in our website (see rear cover)

Kingspan Insulation LLC
P.O. Box 113826, Dubai Investment Park 2, Dubai, U.A.E.

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12th Issue | 03/2022

Appendix C: Electricity Price in Northern Cyprus

KKTC ELEKTRİK KURUMU

01 Mart 2022 Tarihinden İtibaren Geçerli Tarife Ücretleri

Tarife Kod ve Tarife İsmi		Maktu Ücretler		Tarife Ücretleri
01 Geçici Akım Tarifesi I			Her kWs için	4.0000
102 konut Tarifesi (ilk 500 Kws için) Yoksul muafiyetli		25.00	Her kWs için	0.3442
02 konut Tarifesi (0- 250 Kws)		25.00	Her kWs için	0.9873
02 konut Tarifesi (251-500 Kws)		25.00	Her kWs için	2.7000
02 konut Tarifesi (501-750 Kws)		25.00	Her kWs için	2.9500
02 konut Tarifesi (751-1000 Kws)		25.00	Her kWs için	3.2500
02 konut Tarifesi (1001 Kws üzeri)		25.00	Her kWs için	4.0000
03 Ticari Tarife	Tek faz	35.00	Her kWs için	2.7000
	Çok faz	50.00		
04 Ticari Tarife	Her KVA İçin	8.00	1.Dilim	2.7000
			2.Dilim	2.7000
05 Endüstri Tarife	Tek faz	35.00	Her kWs için	2.7000
	Çok faz	50.00		
06 Endüstri Tarife	Her KVA İçin	8.00	1.Dilim	2.7000
			2.Dilim	2.7000
06 (a) Endüstri Tarife	Her KVA İçin	8.00	1.Dilim	2.7000
			2.Dilim	2.7000
07 Turizm Tarife	Tek faz	35.00	Her kWs için	2.7000
	Çok faz	50.00		
08 Turizm Tarife	Her KVA İçin	8.00	1.Dilim	2.7000
			2.Dilim	2.7000
09 Su Motorları	Tek faz	35.00	Her kWs için	2.7000
	Çok faz	50.00		
10 Sokak Işıkları			Her kWs için	3.5000
12 Savunma Tarifesi			Her kWs için	2.7000
13 Devlet Daireleri Tarifesi	Tek faz	35.00	Her kWs için	3.5000
	Çok faz	50.00		
15 Vakıflar	Tek faz	35.00	Her kWs için	2.7000
	Çok faz	50.00		
16 Üniversiteler	Tek faz	8.00	1.Dilim	2.7000
	Çok faz		2.Dilim	2.7000
17 Casinolar	Tek faz	8.00	1.Dilim	3.5000
	Çok faz		2.Dilim	3.5000

18 Şubat 2022 Tarihinden itibaren Geçerli olan Depozit ve Hizmet Ücretleri

1.Tesisat Kontrol	ÜCRET
a.1. Kontrolda herhangi bir ücrett alınmaz.	**ücretsiz**
b.2.ve daha sonraki her kontrol (Re-Testing) veya teftiş (Re-Inspection) için her defasında, yürürlükte bulunan asgari ücretin %8'i	**560.00**
2.Sayaç Kontrol Ücreti, yürürlükte bulunan asgari ücretin %8'i	**560.00**
3.Ödeme yapılmaması veya tüketicinin kusuru nedeni ile kesilen enerjinin yeniden ulanması ücreti, yürürlükte bulunan asgari ücretin %1'i	**70.00**
4.Sigorta Değişimi :	
a.Kurum hizmet merkezinden 0-4 km arası mesafede bulunan bina veya yerde yapılacak değişimde, yürürlükte bulunan asgari ücretin %3'ü	**210.00**
b.Kurum hizmet merkezinden 4 km'den fazla mesafede bulunan bina veya yerde yapılacak değişimde, yürürlükte bulunan asgari ücretin %5'i	**350.00**

SEÇİLECEK TARİFEYE GÖRE ALINACAK DEPOZİTO ÜÇRETLERİ

Tarife Kod No : 01 uygulamasında alınacak depozito ücreti	**3,500.00**
Tarife Kod No : 02 uygulamasında alınacak depozito ücreti	**1,400.00**
Tarife Kod No : 03 uygulamasında alınacak depozito ücreti	**2,100.00**
Tarife Kod No : 04 uygulamasında alınacak depozito ücreti	**7,000.00**
Tarife Kod No : 05 uygulamasında alınacak depozito ücreti	**1,400.00**
Tarife Kod No : 06 uygulamasında alınacak depozito ücreti	**7,000.00**
Tarife Kod No : 07 uygulamasında alınacak depozito ücreti	**1,400.00**
Tarife Kod No : 08 uygulamasında alınacak depozito ücreti	**7,000.00**
Tarife Kod No : 09 uygulamasında alınacak depozito ücreti	**7,000.00**
Tarife Kod No : 10 uygulamasında alınacak depozito ücreti	**0.00**
Tarife Kod No : 12 uygulamasında alınacak depozito ücreti	**0.00**
Tarife Kod No : 13 uygulamasında alınacak depozito ücreti	**7,000.00**
Tarife Kod No : 15 uygulamasında alınacak depozito ücreti	**0.00**
Tarife Kod No : 16 uygulamasında alınacak depozito ücreti	**7,000.00**
Tarife Kod No : 17 uygulamasında alınacak depozito ücreti	**7,000.00**