NEAR EAST UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

DEPARTMENT OF ARCHITECTURE

A Study on the Knowledge, Awareness, and Preferences of Residential Users

Regarding Photovoltaic Systems in Nicosia Region

MA THESIS

Seval POLAT

Nicosia

Fabruary,2024

SEVAL POLAT

A STUDY ON THE KNOWLEDGE, AWARENESS, AND PREFERENCES OF RESIDENTIAL USERS REGARDING PHOTOVOLTAIC SYSTEMS IN NICOSIA REGION

MATHESIS

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Supervisor

Prof. Dr. Özge ÖZDEN

Fabruary, 2024

Approval

We certify that we have read the thesis submitted by Seval Polat titled "**A Study on the Knowledge, Awareness, and Preferences of Residential Users Regarding Photovoltaic Systems in Nicosia Region**" and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

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Declaration

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

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ABSTRACT

A Study on the Knowledge, Awareness, and Preferences of Residential Users Regarding Photovoltaic Systems in Nicosia Region

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Upon examining the fundamental basis of prevalent energy sources in contemporary times, it is evident that they predominantly consist of fossil-based resources, including coal, petroleum, and natural gas. The escalated utilization of fossil-based energy sources, notably during the Industrial Revolution, is widely acknowledged. There is a real rapid urban growth has precipitated an upsurge in the utilization of fossil-based energy sources, resulting in environmental issues. It is well-documented that such practices adversely impact human health, thus prompting a substantial inclination towards eco-friendly energy alternatives in developed nations, owing to the adverse environmental ramifications associated with fossil-based energy sources in contemporary times. The inherent structural flexibility of photovoltaic panels facilitates their seamless adaptation across a spectrum of energy outputs, rendering them a preferred component in contemporary architectural design. Particularly prevalent in developed nations, these panels are increasingly integrated into new constructions or incorporated during the initial design phases. Their intrinsic compatibility with existing structures positions them as indispensable elements within the realm of ecological architecture. The geographical positioning of Cyprus affords a significant advantage for the widespread implementation of photovoltaic systems, owing to its abundant and intense insolation. In this context, an analytical evaluation will be undertaken to assess the utilization of photovoltaic systems within both extant and forthcoming architectural projects in the Nicosia region. The forthcoming literature review and ensuing data analysis are poised to illuminate pathways for the broader integration of photovoltaic systems in architectural practice, thereby informing future developments in sustainable building technologies.

Keywords: cyprus, energy, photovoltaic, solar energy

ÖZET

Lefkoşa Bölgesinde Fotovoltaik Sistemlerin Konut Kullanıcılarının Bilgi,Farkındalık Ve İstekleri Üzerine Bir İnceleme

Polat, Seval

Yüksek Lisans Mimarlık Bilim Dalı

Şubat,2024, ..94... sayfa

Günümüzde yaygın olarak kullanılmakta olan enerji kaynaklarının temeline bakıldığında kömür, petrol, doğal gaz gibi fosil tabanlı enerji kaynakları olduğu göze çarpmaktadır. Fosil tabanlı enerji kaynaklarının özellikle sanayi devrimi sonrasın da kullanımının arttığı bilinmektedir. Artan nüfus yoğunluğu nedeniyle dünyanın birçok bölgesinde, köylerden şehirlere göç gerçekleştiği gözlenmiş bu da kentsel alanlarda yapılaşmanın artmasına sebep olmuştur. Dolayısı ile bu hızlı kentleşme yaygın fosil tabanlı enerji kullanımının artmasına çevre sorunlarının oluşmasına neden olmuştur. Bu durumun insan sağlığını da olumsuz etkilediği bilinmekte olup, fosil tabanlı enerji kaynaklarının yaratmakta olduğu olumsuz çevre sorunları nedeni ile günümüzde gelişmiş ülkelerde çevre dostu enerji kaynaklarına büyük oranda yönelim olmuştur. Fotovolatik paneller yapısı itibariyle en düşük enerjiden en yüksek enerjiye kadar kolaylıkla tasarlanıp kullanılmaktadır. Özellikle gelişmiş ülkelerde yeni yapılarda veya tasarım aşamasında, yapının bir parçası olarak düşünülüp kullanılmaktadır. Sistem mevcut yapılara entegre edilmesi kolaylığı sayesinde gün geçtikçe ekolojik mimaride vazgeçilmez bir unsur halini almıştır. Kıbrıs'ın konumu itibariyle yoğun şekilde güneşlenme oranının yüksek olması bu sistemin kullanımı için büyük bir avantaj sağlamaktadır. Bu bağlamda, sistemin hâlihazırda kullanılmakta olan Lefkoşa bölgesinde yer alan mevcut ve yeni tasarlanacak yapılarda kullanımına ilişkin değerlendirme ile birlikte analizi yapılacaktır. Yürütülecek olan literatür taraması ve elde edilecek veriler fotovolatik sistemlerin geleceğe yönelik daha yaygın kullanımına ışık tutacaktır.

Anahtar Kelimeler: enerji, fotovolatik, solar enerji, kıbrıs

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Abbreviations

TRNC	Turkish Republic of Northern Cyprus
KIB-TEK	Cyprus Turkish Electricity Authority
RES	Supporting Renewable Energy Sources
RERA	Renewable Energy Resource Areas
PV	Photovoltaic System
MW	Megawatt
KW	Kilowatt
EIA	Environmental Impact Assessment
SDE+	Stimulering Duurzame Energi

CHAPTER I

Introduction

This section is given general information about the thesis,In this chapter; the problem statement, purpose of the study, research questions and hypothesis, significance of the study, and the limitations of the study were also explained.

In today's World the Solar energy has emerged as a significant alternative energy source to fossil fuels, positioned as an unlimited and environmentally friendly energy reservoir. Its clean, enduring, and cost-effective nature has rendered it a preferred energy form in contemporary times. Recent technological advancements and cost reductions are further propelling the utilization of solar energy. Among its advantages are its abundance and inexhaustibility, minimal environmental footprint, and suitability for local applications. However, notable drawbacks include high initial investment costs, the necessity for heat storage, dependence on open environments, requirement of large surface areas, need for advanced technology, variability in intensity, and insufficiency of sunlight during winter months.

The history of photovoltaic systems traces back to 1839 with the inception of the term "photovoltaic" of Greek origin. The pivotal moment in this field came with Becquerel's discovery of light-dependent voltage in electrodes, leading to the seminal silicon crystal experiment in 1954. Photovoltaic technology gained prominence through endeavors to provide energy for space vehicles, especially accentuated during the 1973 oil crisis. The involvement of major corporations is accelerating technological advancements, rendering photovoltaic systems an economically viable and attractive energy option.

Presently, a significant portion of the energy demand is met by fossil-based sources, leading to environmental issues and climate change. The limited nature of fossil resources and the increasing demand for eco-friendly energy have propelled interest in renewable energy sources. In this context, solar energy stands out as a clean and sustainable energy source. Photovoltaic (solar) systems hold a prominent position among technologies that convert sunlight into electrical energy.

Environmental issues stemming from greenhouse gas emissions by fossil fuels and concerns regarding energy security have incentivized the widespread adoption of photovoltaic systems. Advancements in technology and decreasing costs have contributed to making photovoltaic systems economically more attractive. These systems are particularly preferred as environmentally friendly energy sources and form the focal point of energy policies in many countries.

The integration of photovoltaic panels into architectural designs has become a significant aspect of ecological architecture. Widely employed in the design of new structures in developed countries, this system ensures maximum energy efficiency with minimal environmental impact. The orientation towards renewable energy sources aims at reducing environmental impacts in energy production and creating a sustainable energy future. In this context, the utilization of photovoltaic systems represents a shift towards an environmentally friendly and sustainable transformation in the energy sector.

Photovoltaic (PV) systems stand out as a significant technology that converts solar energy into electricity to meet energy demands. These systems are typically electronic systems positioned on the roofs of buildings, either fixed or movable, on different facades. Grid-connected systems or off-grid systems in areas without electricity allow for the utilization of the energy obtained. The main components of the system include solar panels, inverters, mounting structures, and energy storage systems. The effective integration of these basic elements ensures the optimal utilization of solar energy potential.

The various uses of solar panels offer various advantages in terms of innovation in architectural design and energy production. Solar panels integrated into building facades not only provide an aesthetic appearance but also offer energy production, presenting an eco-friendly approach. Moreover, using solar panels as shading elements ensures energy efficiency while protecting indoor spaces from the harmful effects of the sun. Specifically designed solar panels, integrated into building roofs, minimize environmental impact while contributing to energy production. Photovoltaic glass or panels integrated into windowpanes not only directly capture sunlight but also enhance energy production, supporting sustainable energy use in buildings. These different uses demonstrate the wider range of applications and effective integration of photovoltaic systems in various applications.

In Europe, the usage of solar energy has been progressively advancing, with various incentives, investments, and support steering society towards renewable energy. For instance, Germany stands out with its leading position in solar energy technologies and sustainable energy policies. Particularly through significant initiatives such as the "1000 Roofs Program" and the Renewable Energy Sources Act (EEG), Germany has incentivized the adoption of photovoltaic systems and has emerged globally successful in this field. Despite the considerable position Germany holds in terms of its solar energy policies, incentives, legal regulations, and technological advancements, it continues to make numerous investments in this sector. Moreover, compared to many other countries, the processes concerning settlement, planning, structural safety, electrical connection, aesthetic considerations, permits, and certification of photovoltaic systems are relatively easier in Germany.

The Netherlands, on the other hand, is a country distinguished by its steadfast commitment to sustainable energy and rapid growth in the solar energy sector. Particularly owing to state-supported incentive programs and legal regulations, the adoption of photovoltaic systems in the Netherlands has gained significant momentum. This study aims to examine the Netherlands' solar energy policies, incentives, and legal framework, aiming to understand the evolution and achievements of the solar energy infrastructure in the country. Additionally, by addressing the Netherlands' technological advancements in photovoltaic systems, local regulations, permit processes, and environmental impact assessments, this study will discuss the significant lessons to be learned from the country's experiences in this field.

Turkey encourages the use of solar energy with its strategic steps in the field of energy and focuses on sustainable energy sources. Incentive measures such as tax reductions, insurance premium support, policies that prioritize domestic production, and mechanisms such as purchase guarantees provided for solar energy projects have increased interest in the sector. Support mechanisms such as YEKDEM and RERA show Turkey's commitment to renewable energy projects. Building thermal insulation regulations and environmental impact assessment show that a sustainability-oriented approach is adopted in the planning and implementation of solar power plants. Turkey's focus on safe, environmentally friendly and effective solar energy projects in this energy transformation process shapes the country's future in the energy sector.

In the Turkish Republic of Northern Cyprus (TRNC), the majority of energy resources are based on fossil fuels, but solar energy potential is high. The renewable energy law that came into force in 2011 supports the generation of electricity through solar panels, but there are no specific incentives for photovoltaic energy. There are no specific regulations on structural safety and environmental impact assessment. The application and inspection processes of solar energy projects are determined in accordance with the Renewable Energy Law, but the slowness of the procedure is an obstacle in the processes related to system installation.

In this research, qualitative research method was adopted for the method. Survey technique was used as a data collection tool and the research evaluates the results of a detailed research carried out to analyze the potential of households in the Nicosia region of Northern Cyprus to use solar (photovoltaic) energy systems. The data reveals participants' experiences, satisfaction levels and knowledge levels about the system. It was observed that the majority of the participants used the system for 1-5 years and generally found the system easy to access and safe. Additionally, the majority of participants are of the opinion that solar energy systems are not sufficiently supported by the state. However, a positive trend was observed regarding the overall usefulness of the system, and participants generally tended to recommend the system. Participant suggestions and expectations in the open-ended section of the survey provide important clues on increasing users' knowledge levels, strengthening government supports and raising awareness of alternative energy sources. In this context, the study constitutes a valuable resource for policy makers, energy companies and householders for the expansion of solar energy systems in Northern Cyprus.

The advancing technology and increasing energy demand have led to a growing interest in alternative energy sources in contemporary times. In this context, the Turkish Republic of Northern Cyprus (TRNC) draws attention with its solar energy potential. However, survey results indicate that solar energy systems are not widely utilized in the TRNC due to a generally low level of awareness and limited government support. He emphasized the need for the government participants to promote solar energy through campaigns and funding. Additionally, they highlighted the importance of awareness campaigns by local authorities and the promotion of photovoltaic system integration into buildings.

Frequently expressed concerns about the costliness of photovoltaic systems in the TRNC and the cumbersome bureaucratic processes in this field, which leads to potential users hesitating participants to adopt the technology. Nevertheless, participants suggested the implementation of various incentives to increase government support and reduce installation costs.

Survey results indicate a lack of oversight and control mechanisms that could affect the sustainability of solar energy projects in the TRNC. In this context, participants emphasized the need for the development of these mechanisms and regular inspections for long-term success.

In conclusion, effective collaboration and solution strategies among the government, local authorities, and civil society organizations are crucial for fully exploiting the solar energy potential of the TRNC. In this regard, raising public awareness about solar energy, increasing government support, and promoting the integration of photovoltaic systems are important steps towards a sustainable energy future for the TRNC.

Statement of the Problem

In terms of latitude, North Cyprus, where sunlight duration is plentiful and solar energy is abundant, experiences approximately 12 hours of sunshine per day during the summer months. This duration decreases to around 5-6 hours during the winter months. Cyprus has a Mediterranean climate with continental characteristics. Summers are hot, and winters are mild. In Nicosia the coldest month averages 12.8°C, while the hottest month averages 29°C" (Alagöz, 2014).

In the Turkish Republic of Northern Cyprus (TRNC), there is no general research and resources on the use of solar energy systems, users' knowledge about the system, problems and solutions. The lack of a systematic research on identifying and resolving the factors that prevent the effective use of this potential in the TRNC makes it difficult for the energy sector to achieve future sustainability goals. The potential of solar energy is often poorly understood due to insufficient or misinformation among the public. Many individuals do not have basic knowledge about solar energy. The cost of the equipment required for the installation of solar energy systems can be quite high for people, and the current lack of government incentives for solar energy causes potential investors to step back instead of attracting them to this field. This paradox limits the widespread adoption of solar energy and sustainable energy conversion. Bureaucratic obstacles, especially for the initial system installation, make the process difficult and complex. This deficiency restricts the development of environmental sustainability and energy policies and stands out as a major problem in the development of solar energy in the TRNC today

Purpose of the Study

This study aims to examine the historical status of photovoltaic systems, legal regulations, and their environmental impacts, and to evaluate the existing photovoltaic systems ready for installation in the region, which has the potential for self-electricity generation due to the majority of sunny days Throughout the year, particularly in the Nicosia region. Evaluation data from users of these systems in the region are obtained through a survey, and statistical analysis is conducted on the collected data. In this context, the survey data, conducted to assess the experiences of photovoltaic system users in the region, are combined with statistical analyses to provide a comprehensive evaluation of the system's local effectiveness and user satisfaction and issues. Furthermore, conducting a situational analysis of the region regarding this system and outlining potential measures to promote the efficient proliferation of photovoltaic systems, particularly, are among the objectives of this study. Recommendations for increasing the use of photovoltaic systems specific to the region will be proposed through the study's findings, aiming to contribute to the promotion of sustainable energy usage. A comprehensive literature review will be conducted on the general characteristics and applications of photovoltaic panel systems used in many countries, including Cyprus, and will be supported by various examples.

Research Questions / Hypotheses

This study aims to investigate the historical status, legal regulations, and environmental impacts of photovoltaic systems in the Nicosia region, particularly due to its potential for self-electricity generation with the prevalence of sunny days throughout the year. The evaluation will extend to assessing the suitability of existing photovoltaic systems for installation in the region. Data from users of these systems will be collected through a survey, and statistical analyses will be conducted to comprehensively evaluate the local effectiveness, user satisfaction, and associated issues. Additionally, conducting a situational analysis of the region concerning these systems and outlining potential measures to promote the efficient proliferation of photovoltaic systems are among the study's objectives. Recommendations aimed at increasing the use of photovoltaic systems specific to the region will be proposed based on the study's findings, with the aim of contributing to the promotion of sustainable energy usage. A comprehensive literature review will be conducted on the general characteristics and applications of photovoltaic panel systems used in many countries, including Cyprus, and will be supported by various examples.

Significance of the Study

As is known, the production of photovoltaic systems entails exceptionally high costs. However, reducing these costs would lead to increased efficiency. This enhanced efficiency would not only reduce external dependency but also diminish the necessity of consuming non-renewable fossil fuels by utilizing renewable energy sources. In this context, a topic of such significance, being studied for the first time in the Turkish Republic of Northern Cyprus, will not only demonstrate user satisfaction in the TRNC but also facilitate discussions on the obstacles to its further adoption. Therefore, this study gains importance both at the micro and macro levels.

Limitations

This study has the following limitations. These;

- The research was measured only within the borders of TRNC.
- The research was conducted only in places where solar energy is used in TRNC and the users were randomly selected.

• The survey conducted in the research was evaluated only by photovoltaic system users covering residential type use.
• In the research survey, roof type installation of the system was preferred in residences.

Definition of Terms

Photovoltaic: represents the technology that converts sunlight into electrical energy. Solar cells, generating electricity through the impact of light, provide an eco-friendly energy source.

Megawatt (MW) : Mw is a unit of energy measurement equal to one million watts. This unit is commonly used for large-scale measurement of electrical power.

KW : a unit of energy measurement representing kilowatt. It is used for small-scale energy measurements.

Milieu Effectrapportage :It is called environmental impact assessment report.

W/m2: It is the value that shows how much heat the material conducts, and therefore the insulation level, which varies in each material.

Ar-Ge: is research and development

Inverters: Inverters convert battery and PV voltages with different direct current values into 220V or 380V alternating current at a frequency of 50Hz.

GW: Gigawatt is used for indicators of electrical power and a clearer understanding of its current potential.

DC: Direct current is the constant flow of electric charges from higher potential to lower potential.

CHAPTER II

Literature Review

Theoretical Framework

This chapter presents a comprehensive examination of the advantages and disadvantages of photovoltaic systems, drawing upon scientific studies from the literature. Furthermore, an in-depth historical overview of photovoltaic systems is provided. Additionally, various connection types and the fundamental components of solar energy and photovoltaic systems are elucidated. A comparative analysis of countries, considering all pertinent factors, is meticulously conducted and organized into detailed tables. The study also offers insights into the current status of photovoltaic systems in the Turkish Republic of Northern Cyprus, featuring examples of installed systems and user references.

Solar Energy

Sunlight is one of the most abundant and inexhaustible energy sources, is an energy source that generates no waste. It is readily available virtually everywhere when needed. In this context, solar energy, due to its cleanliness, longevity, and affordability, is increasingly being used as a viable alternative to fossil fuels wherever feasible in today's world (Eldem, 2017).

Solar energy, in brief, is defined as the radiant energy emitted during the fusion process (conversion of hydrogen gas into helium) in the core of the sun. The intensity of solar energy outside the Earth's atmosphere is approximately 1370 W/m^2, while it varies between 0-1100 W/m^2 by the time it reaches the Earth's surface due to atmospheric effects. A very small fraction of solar energy reaching the Earth is significantly greater than humanity's current energy consumption. It is observed that efforts to harness solar energy gained momentum after the 1970s. Technological advancements and cost reductions have been among the most prominent reasons for the recent trends toward solar energy. Additionally, it has established itself as an environmentally clean energy source.

In this case, photovoltaic systems used to generate electricity from solar energy in the Nicosia region will be examined. Briefly, photovoltaic systems are defined as systems that convert energy particles from sunlight into electrical energy.

These systems include photovoltaic panels, within which a high number of photovoltaic cells are utilized (Öztürk, 2021).

Figure 2.1

Solar Energy Panels (photovoltaic panels)

(URL1)

Advantages of Solar Energy;

- Solar energy is abundant. It is also among the inexhaustible renewable energy sources.
- Solar energy is clean. It does not pollute the environment. Additionally, there are no wastes such as smoke, gaseous carbon monoxide, sulfur and radiation.
- It is suitable for local applications. It can be found almost anywhere energy is needed.
- It has no external dependency; therefore, it is independent of any economic crisis that may arise.
- Its expenses are extremely low.

Disadvantages of Solar Energy:

- Many systems that harness solar radiation have long payback periods due to high initial investment costs.
- Heat storage is required due to the continuous fluctuation of sunlight. However, the cost of storage is high and therefore limited.
- To continuously receive sunlight, the surrounding environment must be open and free from shading.

- There is a need for surfaces that collect sunlight because the amount of sunlight per unit area is low.
- Technology is crucial and necessary for the implementation of solar energy.
- Solar energy, being intermittent, may not always be available at the desired intensity.
- Energy demand is high during winter months when sunlight is scarce and absent at night (Eldem, 2017).

History of Photovoltaic Systems

When explaining the history of photovoltaic systems, it would be appropriate for the narrative to begin with the term "photovoltaic." The word is derived from Greek, with "photos," meaning light, and "voltaic," originating from Alessandro Volta, who is regarded as the pioneer of electricity, combined to form "photovoltaic." Photovoltaics were first discovered by Becquerel in 1839. The discovery was made through the observation that the voltage in the electrodes immersed in the electrolyte was dependent on the incident light (Sayın & Koç, 2011).

In subsequent years, studies based on copper oxide and selenium photodiodes brought them along with light meters widely into the field of photography. The efficiency of photovoltaic diodes reached 1% in 1914. However, photovoltaic diodes that could significantly convert solar energy into electricity with 6% efficiency were first achieved on silicon crystals in 1954. This is considered a milestone for photovoltaic power systems. Following this milestone, initial designs in the years that followed were geared toward power systems to be used for spacecraft. Moreover, photovoltaic power systems have been serving as a reliable source in space missions since the early 1960s. With the "First Oil Crisis" in 1973, research and development efforts began towards the utilization of solar panels as electrical power systems. Initiated by significant budget allocations, the United States, Europe, and Japan launched comprehensive projects. Efforts were intensified both to increase the efficiency of solar panels, proven in space missions with silicon crystals and to focus on thinner solar panels requiring less costly semiconductor materials as an alternative (Karamanav, 2007).

In the first 10-15 years after 1975, silicon solar panels for space programs averaged around 100 kW per year. By 1986, this capacity had reached 28.6 MW annually. As the importance given to renewable energy consumption increased, efforts to convert solar energy into electricity and reduce costs became a priority task, primarily undertaken by universities. Hence, it has always been perceived as a study confined to laboratory settings in the public eye. However, in recent years, particularly in the last two decades, growing environmental awareness has led to increased pressure from the public. Ultimately, multinational corporations have found it imperative to engage in research on non-fossil fuel-based, renewable energy sources. The involvement of large corporations has led to technological advancements in this field and a reduction in production costs. Lastly, until the recent past, photovoltaic systems were considered very expensive among electricity generation methods. However, it is a fact that the initial cost, which was previously considered expensive, is outweighed by the long-term benefits, making PV systems more economical than fossil fuel-based systems in the long run (Karamanav, 2007)

Photovoltaic (Solar Energy)

When examining the foundation of commonly used energy sources today, it is apparent that they are based on fossil fuels such as coal, oil, and natural gas. Energy consumption has been felt since existence, and from that day to the present, it has been expanded in its usage scale, becoming an indispensable necessity for humanity (Koç & Şenel, 2013).

It is known that the use of fossil-based energy sources increased significantly following the Industrial Revolution, accompanied by population growth, technological advancements, industrialization, and improvements in human living standards. Due to the increasing population density, migration from rural areas to urban centers has been observed in many parts of the world, leading to urbanization and increased construction in cities. The need for energy is increasing day by day and the gap between production and consumption is widening day by day. 90% of the energies currently used in the world are fossil-based conventional energy sources. These energy sources are coal, oil and natural gas. Fossil-based energies are not infinite and it is a fixed fact that they will one day run out. This can truly be understood that many technological systems based on the working principle of fossil resources will also become inoperable. The consequences of this may be large enough to affect the entire world economy (Karaca, 2012).

For various reasons, the widespread use of fossil-based energy in cities has caused environmental problems and is even known to negatively affect human health. Nearly 85% of the world uses fossil-based fuels, so the gas emitted into the atmosphere greatly affects both human health and climate (Polat & Kılınç, 2007).

With increasing energy consumption, the productivity of agricultural lands, which form the basis of nutrition, will decrease. The nutrients and minerals in the soil will change. Water scarcity can bring life to a standstill, leading to significant harm to living organisms. Global climate changes can disrupt ecosystems, causing setbacks in the world economy. Soil accumulation in mining areas leads to a reduction in agricultural land. Such a trend will result in drought in some fertile agricultural areas while rendering others unusable due to water scarcity (Doğan & Tüzer, 2011).

The increase in energy use has also led to an increase in environmental problems. Due to the negative environmental problems caused by fossil-based energy sources, environmentally friendly energy sources are preferred in developed countries today (Şenpınar & Gençoğlu, 2006).

There are two sources for providing energy: renewable sources and fossil fuels. In industrialized countries, energy is primarily derived from fossil fuels such as coal and natural gas. However, the environmental damage caused by the use of these energy sources is often overlooked. The emphasis is placed on the accessibility of energy in our lives. The characteristic that reflects the lifestyle in developed countries and distinguishes it from traditional ways of living, thereby giving it superiority, is largely due to the abundance of energy. (Çukurçayır & Sağır, 2008).

In this context, it attracts international attention due to reasons such as the development of renewable energy resources, related technologies and energy security. Excessive consumption of non-renewable energy has made renewable energy very important (Özşahin et al., 2016).

There is a cycle wherein greenhouse gases are accumulated in the atmosphere due to the burning of fossil fuels and industrialization processes. The atmospheric balance within the climate system is disrupted by these emissions. It is observed that 58.8% of greenhouse gases are contributed by fossil fuels, thereby strengthening the greenhouse effect. This effect has led to further urbanization and has raised questions and criticism about the relationship between the environment and growth. As a result, there has been a trend towards energy sources that have minimal impact on nature, such as wind, water, and solar power, which are among the renewable energies. Energy resources will be seen as playing an important role in shaping the future of the world (Demirbaş and Aydın, 2020).

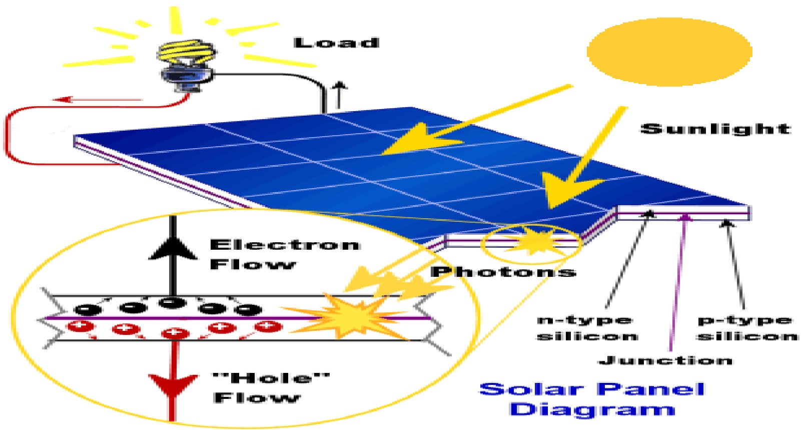
In the process of reaching the 21st century, some developed countries have aimed to produce solutions that minimally harm the environment. In this context, emphasis has been placed on photovoltaic panels, which harness the high energy from the sun, and now many buildings benefit from this system. The photovoltaic system is one of the most important renewable energy systems. Thanks to the structure of photovoltaic panels, which allows for easy transition from low to high energy, they have become an indispensable element in ecological architecture over time. Especially in developed countries, they are considered and used as part of new buildings and in the design phase. The ease of integrating photovoltaic systems into existing structures has led them to play a more prominent role in architectural designs (Özcan, 2013).

Photovoltaic Systems and Connection Types

Photovoltaic (PV) systems, which convert solar lights directly into electricity without the need for movable mechanisms, are typically installed on building facades, rooftops, and similar stationary locations. These systems consist of electronic components and panels that capture sunlight and convert it into electricity, which is then fed into the grid for utilization. Panel surfaces are commonly square or rectangular in shape, and their efficiency ranges between 5% and 20%, depending on factors such as cell attachment (Çalapkulu, 2023)

Figure 2.2

Solar Panel General Diagram



(URL2)

Grid Connected Systems. Although there are many details to the implementation of grid-connected solar energy systems, one of the most well-known features is the system's ability to connect to the grid, allowing for electricity production when needed and making it a widely widespread system. The most important characteristic is the absence of the need for energy storage. This system can generally be categorized into two distinct types: supplying electricity to the grid or selling the generated energy. Due to the direct connection or selling purposes to the grid, it can vary in scale. Additionally, distribution can be facilitated in any area covered by the grid. The second type of system is established to meet the user's electricity demand and sell excess electricity to the grid during low consumption periods or high production capacity times, enabling users to profit (Arıcı & İskender, 2019).

In grid-connected energy systems, solar energy is converted into direct current (DC) electricity by photovoltaic panels and then directed to an inverter. The inverter is an electronic device that converts DC into alternating current (AC) and serves as the central unit for controlling grid conditions. Grid conditions refer to ensuring that the voltage and frequency are within the desired limits according to national standards. The AC obtained from the output of the grid-connected inverter is utilized to power loads and any excess energy can be fed back into the interconnected grid through a method known as net metering. Grid-connected systems should be evaluated across a wide range of scales, from small residential installations to centralized power plants (Karataş, 2018).

Power quality is a crucial aspect of grid-connected photovoltaic (PV) systems. Grid-connected PV panels operate at the highest power mode to deliver maximum power to the grid. In this mode, the inverter aims to provide the highest quality and quantity of energy based on solar irradiance and temperature conditions. Therefore, power quality is one of the most important considerations in grid-connected PV electricity generation systems. It is essential to assess how these systems will impact the grid before connecting them. Electrical utility companies provide specific guidelines and requirements for compliance. These considerations include:

Excessive and Low Voltage **,**Changes in the output power of photovoltaic systems typically result in fluctuations in grid voltage, both decreasing and increasing. According to the EN50160 standard, voltage variations in medium-voltage grids should not exceed +/- 10% of the Vrms value.

Voltage Fluctuations *,*In situations of sudden short circuits or similar occurrences within the grid, existing protective relays promptly detect the issue. Protective relays are activated, causing grid instability until circuit breakers intervene and disconnect the grid power. The duration of voltage disruptions is contingent upon the activation time of the protective relays.

Harmonics **,**In grid-connected systems, harmonic waves occur as multiples of the fundamental frequency. In photovoltaic (PV) systems, this occurrence is primarily attributed to the non-linear characteristics of semiconductor switches.

Islanding**,** In grid-connected photovoltaic (PV) systems, if there is an interruption in the grid for any reason, the PV system continues to generate electricity. However, during continued PV system operation, it may fail to detect a grid outage. A grid-connected PV system may continue to supply power to the load even if it is disconnected from the grid. In such cases, the PV inverter should be disconnected to prevent electricity from being fed back into the grid. Otherwise, if power is cut off in any part of the grid, it could potentially cause damage to the entire grid.

Short Circuit Capacity,According to the connection criteria for renewable energy power plants, the circuit power should not exceed 5%. This value is calculated based on the average global grid definition and is generally accepted. However, the short circuit capacity for a newly established renewable energy power plant may vary depending on the specific point of connection to the grid.

Interconnection Fault Duration ,In systems with transformer-based modules, the direct current obtained is converted to alternating current by an inverter after being filtered through a capacitor. The transformers have independent insulation between the low and high-voltage sides. In the event of any issue such as lightning strikes compromising this insulation, causing a fault, the operation of the power plant should be halted, and the grid connection severed.

Frequency Variation**,**Fluctuations in frequency within the system result from imbalances between supply and demand. Frequency variation can impact the rotation speed and efficiency of motors, potentially leading to a deterioration in product quality and even causing interruptions. Therefore, it is essential to maintain system frequency equal to the grid frequency.

DC Component,The DC component creates deviations in the positive or negative direction from the fundamental waveform of alternating current. In photovoltaic (PV) power systems, DC component sensors are employed in converters to prevent the leakage of the DC component to the grid side in transformers and inverters utilization.

High-Frequency Carriage**,**Converters, which are essential components of PV systems, convert the direct current generated in the system into alternating current. Electromagnetic noise is generated due to high-frequency switching, which can affect communication devices such as radios and televisions as it is carried through cables.

Line Transmission Capacity ,The transmission capacity of the grid plays a role in determining the power of the renewable energy power plant. It is essential to ensure that there is no overloading on the line where the PV system will be connected to any point of the grid, and the type of distribution line and distribution transformer determines the limit to be transmitted to other parts of the grid.

Reduction of Communication and Distribution Losses,Large-scale PV systems are typically constructed in remote areas far from consumption points. As the distance of power distribution increases, significant losses can occur in both transmission and distribution. While varying regionally, in industrialized countries, this loss rate ranges from 3% to 9%. Installing PV systems in areas with sunlight while conducting long-distance transmission can mitigate adverse conditions.

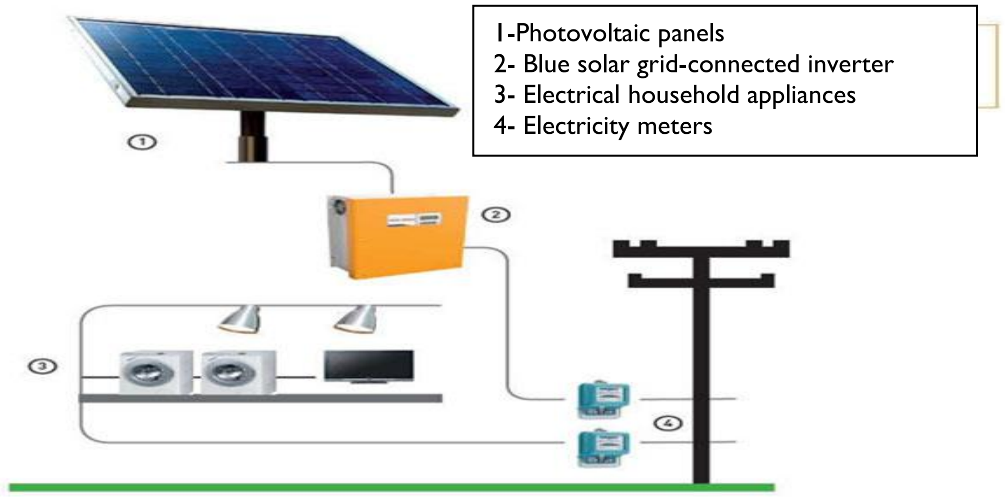
Supply Security,PV systems are designed to ensure uninterrupted power transfer in case of accidents or natural disasters in the areas where they are installed, to prevent disruptions in energy supply. The PV system should be switched from normal mode to island mode, and the battery group should be included in the system to maintain continued operation.

Maximum Power Demand,Although electricity consumption varies depending on factors such as region, industrial activity, and solar conditions, energy consumption tends to increase during daylight hours and decrease at night. The available electricity supply must meet this demand. In regions where nighttime electricity usage is high and there is no production during the night, storage systems support to prevent energy shortages. When PV systems generate high power output, they store energy in batteries and use it for load requirements, resulting in a reduction in peak power values drawn from the grid.

Power Quality**,**Negative effects such as voltage fluctuation, short circuit capacity and harmonics in PV systems can be transformed into positive effects if a high-performance power converter is used. It is possible to obtain a quality power converter with an active filter and static Var compensation unit (Çalıkoğlu et al., 2011).

Figure 2.3.

Grid Connected System Diagram



(URL3)

Off-Grid Systems. Off-grid energy systems are designed for energy production, storage, and usage in areas where there is no grid infrastructure. Off-grid systems are the oldest PV hardware systems. These systems are typically used in small-scale operations such as home lighting, small businesses, boats, and yachts. The generated electrical energy is used either for storage or for direct consumption. This system is specifically designed for storage and later use in areas without electricity. Since the system is independent of the grid, there are no frequency compatibility issues. In terms of connection, it is quite simple, especially suitable for rural areas, and does not incur any maintenance costs after the initial investment. One disadvantage may be voltage suitability issues; the system's output voltage needs to be balanced and equal. Areas of application include lighting, railway pedestrian crossing lights, residential lighting in small sun-exposed dwellings, corrosion protection for metal facilities such as bridges and towers, lighthouses, houses in mountainous areas or remote settlements, television, radio, refrigerator, washing machine, etc. in residences far from water and electricity networks, telemetry measurements used in distribution structures of water and electricity networks, weather observation fields, etc. (Kantaroğlu, 2010).

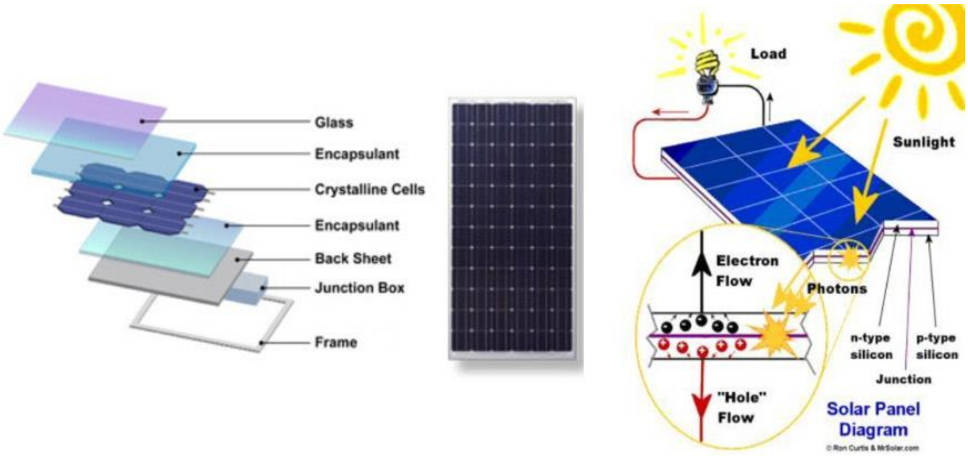
Basic Components of Photovoltaic Systems

Photovoltaic Panel

Sunlight heats and illuminates our planet. Solar rays are converted into electrical energy using PV cell systems. As efficiency cannot be achieved with a single panel connected by cables, this system typically comprises multiple panels. Modules can be manufactured using various materials (Baş, 2016)

Figure 2.4.

Solar Panel Detailed Diagram



(URL4)

They are the most commonly used panels in industrial settings, with an approximate lifespan of 90 years. Monocrystalline and polycrystalline panels are known to be the most widely used types worldwide. In addition to these, options such as thin-film and flexible panels are also available (Baş, 2016).

Types of Photovoltaic Panels

Photovoltaic systems vary in materials used, differing from batteries, etc. The materials constituting the panel structure directly impact efficiency. They are primarily categorized into groups based on their fundamental structures.

Crystal Panels. Silicon is the second most abundant material in the world after oxygen. Industries worldwide extensively use silicon, including in the production of PV panels. This panel type is known as the most commonly used panel type globally (Gül, 2021).

Monocrystalline. These panels consist of highly efficient monocrystalline cells. Similar to polycrystalline panels, these panels produce comparable power but have slightly lower efficiency, around 1.2% less, depending on panel structure and installation capacity. The production of monocrystalline panels takes longer due to the technological materials involved. Despite this issue, they are a good long-term investment. Generally, they are black or dark blue and offer the highest efficiency rate of around 20%. However, they are known to be much more expensive compared to other types. Due to the technology used in production, the production time is also longer. The crystalline structure of the cells allows for high efficiency even with low energy input, making monocrystalline panels a lucrative long-term investment (Baş, 2016).

Figure 2.5

Monocrystalline Example

(URL5)

Monocrystalline panels are still widely used in industry and are produced using the crystal drawing technique. First of all, the silicon used in its production is passed through various processes to obtain pure silicon, and then a single crystal silicon piece is obtained from this molten material. Then, when the cooled silicon takes the shape of an ingot, it is divided into slices. Its biggest disadvantage is the high material loss (Taşçıoğlu,2015).

Polycrystalline (Multi-Crystalline) Solar Panel. It was introduced to the market in 1981. Since silicon is used as the ingredient, it has become available on the market in a simpler and less costly manner. Although low heat loss is seen as an advantage, the 13% efficiency rate causes lower efficiency compared to monocrystalline. Despite this negative situation, its use has more users and is more common around the world. The fact that it is more accessible in terms of the material content produced and that the price is affordable has increased its popularity (Baş, 2016).

Figure 2.6

Polycrystalline Example

(URL6)

Polycrystalline cells are cast from pure molten silicon into cylinder or block molds and sliced into multiple crystal blocks. Crystal cells with a dark blue structure have lower costs due to less material loss in production. The electrical properties of polycrystalline materials deteriorate in proportion to the size of the narrowed vessel. In this case, the gain from the polycrystalline structure will be less than the monocrystalline structure. Compared to monocrystals with a single crystal structure, polycrystalline cells consisting of multiple crystals decrease slightly in terms of efficiency. Efficiency range is 13%-16%. Its share in the world market. Low cost is high due to ease of product supply (Taşçıoğlu,2015).

Thin Film. Although this panel type has the capacity to absorb a lot of light, its efficiency is very low compared to others. The efficiency rate is between 7%-14%. Therefore, it is not a widely preferred panel type in the market. It is especially used to operate small devices (Baş, 2016).

Figure 2.7

Thin Film Example

(URL7)

Despite their high heat and light absorption capacities, thin-film solar panels exhibit relatively low efficiency. Their thin structure, which enables light reflection, poses challenges in power generation. On average, thin-film panels produce 10% to 15% more energy annually compared to crystalline panels. Their primary advantage lies in their simple structure and thinner composition compared to monocrystalline cells. The ease of installation allows for their deployment even on exterior building surfaces, such as windows, providing energy supply flexibility. While the thicker structure of crystalline panels may limit their usage areas, the ease of use of thin-film panels enables their installation even on exterior building pockets and glass surfaces, allowing for energy generation (Gül,2021).

Flexible Panel. The main feature of this type of panel is its portability and flexibility. It is specially designed for installation in areas such as roofs, thanks to its flexible structure. The flexibility of these panels allows for ease of use in various applications, and their installation does not require any construction, minimizing damage to the installation site. They can be easily installed in challenging building facades and structures. Since they do not contain glass, there is no risk of breakage.

Figure 2.8

Flexible Panel Example

(URL8)

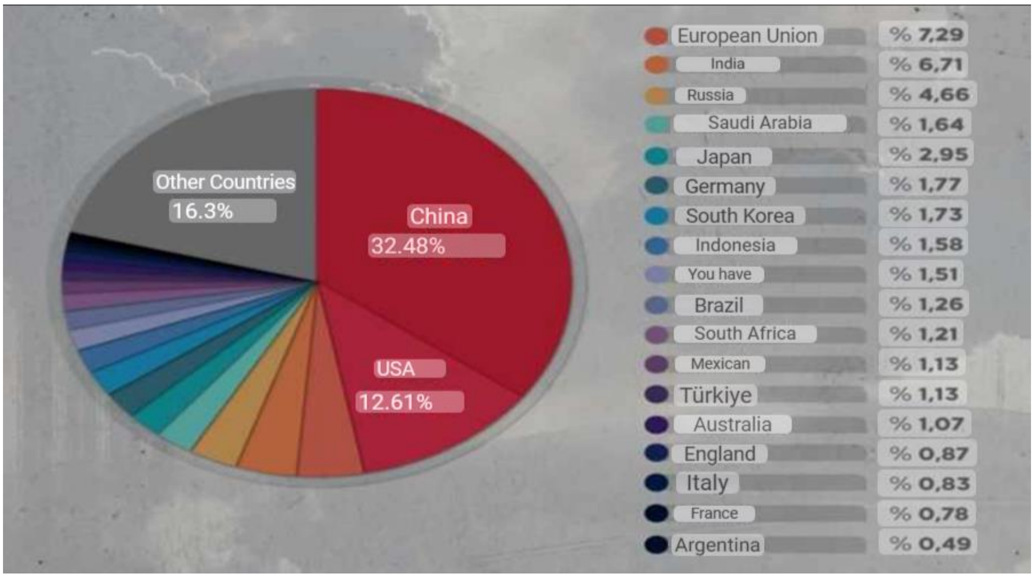
There are many potential applications for these panels. They possess a highly flexible structure, allowing for easy use in challenging installation areas. Due to their flexibility, they can be conveniently utilized in areas that are difficult to mount. Moreover, since they do not contain glass, they are not fragile. They can be either monocrystalline or polycrystalline in structure, expanding their range of applications. Their lightweight and portability also contribute to their ease of use.

Photovoltaic Systems and the Environment

In recent years, with the increasing importance of the environment in human lives, efforts have been made to analyze the direct or indirect negative effects of human activities on the environment. Ultimately, technologies that cause minimal harm to the environment have started to be preferred. Photovoltaic systems, one of these technologies, are initially perceived as costly; However, when examined over a long period, their significant benefits become apparent. The electricity we use in many areas is provided to us by the sun in a very ecological manner, with almost zero harm to the environment. Considering its renewable nature and especially the impact of greenhouse gas emissions from fossil fuels in recent years, we can observe that the shift towards this source is indeed a correct decision.

Figure 2.9

Carbon Dioxide Emissions Between Countries



(URL9)

Figure 2.10

Estimated Global Energy Share

(URL10)

It is evident that PV systems, effectively converting solar energy into electricity, have been rapidly growing in recent years. Some countries worldwide have particularly conducted various studies and implemented initiatives for this system. Investment in this system has significantly increased in Europe and across the globe in recent years (Özcan, 2013).

Usage Methods of Photovoltaic Systems

Covering with Solar Panels,solar panels integrated into building facades can provide an aesthetic appearance by covering the outer surface of the building.

Solar Panels as Shading Elements,Solar panels can be integrated into building facades as shading elements. This not only generates energy but also protects the interior spaces of the building from the harmful effects of the sun.

Roof Covering,Specially designed solar panels can be integrated with the building's roof. These designs offer an aesthetically pleasing solution and are effective in terms of energy production.

Window and Façade-Integrated Panels,Photovoltaic glass or solar panels can be integrated into window glass. This way, they can receive direct sunlight and simultaneously generate energy (Duyan et al., 2022).

Tablo 2.1

Solar Power Plant World List by Installed Capacity

Rank	Country	Update	Installed Power (MW)
1	China	December 2020	254.355
2	United States	December 2020	75.572
3	Japan	December 2020	67.000
4	Germany	December 2020	53.783
5	India	December 2020	39.211
6	Italy	December 2020	21.600
7	Austria	December 2020	17.627
8	Vietnam	December 2020	16.504
9	South Korea	December 2020	14.575
10	Spain	December 2020	14.089
11	United Kingdom	December 2020	13.563
12	France	December 2020	11.733

(Note: The worldwide ranking of installed solar power plants are listed.)

Table 2.2

World List of Installed Power Per Capita by Countries

Rank	Country	Installed Power (MW)	Installed Power Per Capita (Watt)
1	Australia	17.627	716
2	Germany	53.783	650
3	Holland	10.213	596
4	Japan	67.000	529
5	Belgium	5.646	497
6	Switzerland	3.118	370
7	Italy	21.600	357
8	Spain	14.089	303
9	Greece	3.247	301

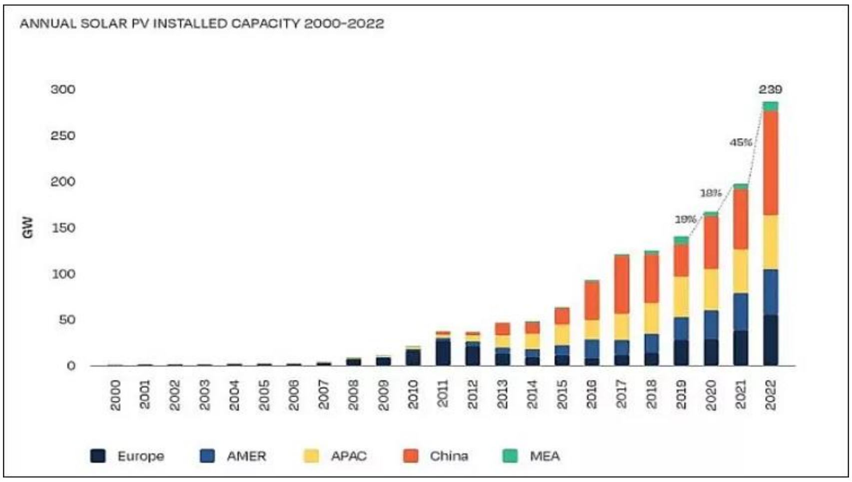
(*Note:* World List of Installed Power Per Capita by Countries around the World.)

Solar Systems in Europe

The energy problem in Europe has increased in consumption between 1990 and 2022, due to the production growth. As a result, there has been a reliance on external sources, leading to the use of imported energy. In the following years, significant energy losses and adverse effects have occurred, primarily due to the environmental problems caused by fossil-based fuels and the fluctuation in energy prices, prompting a search for alternative sources. Especially countries affiliated with the European Union have conducted renewable energy studies in response to these challenges.

Figure 2.11

Photovoltaic (PV) Installed Power Capacity Change of European Countries between 2000-2022



(URL11)

According to the Solar Power Europe report, investments in solar energy in Europe have shown a significant increase. The number of countries installing at least 1 GW per year in 2022 has increased from 12 to 26, and it is expected that the number of countries active in this field will exceed 50 by 2025 (Congar, 2023).

Renewable energy sources appear to be more expensive and costly when compared to fossil-based energies. Therefore, the European Union has undertaken various support and incentive programs for photovoltaic installations. They have particularly provided various opportunities for local and small-scale businesses. The aim of these incentives is actually to reduce global warming and greenhouse gas emissions. In this context, the initiatives of the European Union have yielded positive results. Countries such as the UK, the US, Switzerland, Denmark, and Australia meet their energy needs from this source (Uğurlu, 2006).

In this context, it is aimed to increase the consumption prices of existing energy resources and to make solar energy investments cheaper. And some European countries have presented goals for moving towards solar energy.

The European Union has initiated a new energy policy and presented its goals.

- Achieving a reduction in greenhouse gas emissions
- Converting currently used energy into renewable energy
- To minimize energy use (İraz et al., 2010).

The document “Framework Strategy for a Resilient Energy Union with a Progressive Climate Change Policy” was published on 25 February 2015.

- Ensuring energy supply security, solidarity and trust
- Creation of a fully integrated common European energy market
- Increasing energy efficiency to contribute to reducing energy demand
- Decarbonization of the economy
- Research, innovation and competitiveness (T.R. Ministry of Foreign Affairs, Chapter: 15).

Types of Incentives Applied in Europe

The European Union provides direct or indirect support through various schemes such as premium certificates, guaranteed systems, etc., based on the amount of electricity consumption.

Direct Supports

- Discounts
- Tax incentives
- Rate dependent incentives
- Green tariffs etc.

Indirect Supports

- Environmental taxes
- Voluntary agreements (Akdoğan &Kovancılar, 2022).
- Tariff Guarantee; It requires purchasing electricity from renewable energy sources at market prices for 20-25 years.
- Investment Support; A certain part of the investment cost is provided by the fund institution.

- Quota System; The basic principle is that the state forces producers, suppliers and consumers to obtain a certain portion of the energy used from renewable energy sources (İraz et al., 2010).

Germany-Netherlands-Türkiye-TRNC Review on Photovoltaic Systems

Solar Systems in Germany

Germany is recognized as one of the world leaders in the field of solar energy. Alongside the utilization of solar energy resources and technological advancements in the country, there are also established goals and incentives. In 1990, the German government initiated the "1000 Roofs Program" to encourage individuals to install photovoltaic panels on their rooftops. This program marked the initial steps in the commercial application of solar energy (Uyanık, 2018).

The real big development took place with the Renewable Energy System (EEG) adopted in 2000. This law provides a building block, especially as an example of the use of solar energy. A fixed purchase tariff is determined for photovoltaic systems. This encouraging step has led to Germany accelerating the expansion of solar energy worldwide. In the early 2010s, Germany became the leader in installed solar energy capacity worldwide. Germany's success in solar energy is a product of both technological innovations and correct policies (Erkök,2022).

Photovoltaic System Incentives and Legal Status in Germany

Germany has taken significant steps towards the proliferation of solar energy and these steps constitute the legislative framework. The Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG), enacted in 2000, stands as one of the most crucial regulations in this domain. The EEG facilitates the registered storage of electricity generated from renewable sources into the grid and ensures its purchase at a specified tariff based on distributions. Particularly for solar energy, this law has fostered long-term investment security and stimulated industrial growth. Furthermore, structural regulations concerning energy transition and integration of solar energy have been enhanced through legal frameworks and incentives. Germany's solar energy legislation not only aims at achieving national energy goals but also plays a critical role in combating global climate change (Erkök, 2022).

Settlement and Planning: Solar energy systems are typically mounted on rooftops, although installation on land is also possible. Urban planning and local regulations involve specific rules and restrictions for the installation of solar energy systems, with particular attention given to legal frameworks, especially concerning historical buildings or protected areas.

Structural Safety: Solar panels mounted on building rooftops must adhere to building codes and safety capacities. The roof load capacity is evaluated to ensure it can support the additional load.

Electrical Connection and Integration: Connecting solar energy systems to the electrical grid must be done in accordance with appropriate safety protocols and technical conditions, and certain regulations and protection measures are required for systems that will return to the electrical grid.

Building Thermal Insulation Directive: The German Energy Saving Directive (Energieeinsparverordnung - EnEV) contains detailed provisions on building energy performance, insulation standards and the use of renewable energy. These regulations are designed to control the thermal insulation, heating systems and energy consumption of buildings. Buildings have specifications such as cladding, significant internal storage space and the use of solar energy, as well as controlled house ventilation with heat recovery, providing hot water through ground source heat pumps and a solar energy system (Energieeinsparverordnung – EnEV,2020).

Aesthetic and Visual Considerations: Some systems may include instructions regarding the visual impact of solar systems. In particular, it may be desired that the panels have historical or aesthetic values and that the panels be compatible with the building or environment.

Permit and Certification: It is generally necessary to obtain the necessary permits from local authorities for solar energy system installation. It is also possible to comply with certain specifications and documentation for some federal and state incentives. Environmental Impact Assessment: For large regional land projects, intensified impact assessment can be carried out (Duman,2019).

Solar Energy (Photovoltaic) Examples in Germany

Solarpark Meuro, It is a large solar power plant located in the German state of Brandenburg. Solarpark Meuro is built on a former lignite (brown coal) mine site near Senftenberg in the state of Brandenburg. This power plant has a capacity of 166 megawatts (MW). This makes it one of the largest solar power plants in Germany and even Europe. With a capacity of 166 MW, this plant can meet the annual electricity needs of approximately 50,000 homes. The construction of Solarpark Meuro on a former mining site provides an example of how abandoned mine sites can be used for renewable energy projects (Gulkowski & Skomorowska,2018).

Figure 2.12

Image of Solarpark Meuro

(URL12)

Other solar energy examples that provide regional solar energy sources include Neuhardenberg Solar Park, Solarpark Templin, Lieberose Solar Park, Finsterwalde Solar Park (Kapluhan, 2014).

Vauban. Freiburg is renowned for its sustainable and environmentally friendly neighbourhood. The Vauban district presents an excellent example of sustainable urban planning and green energy technologies. Many buildings in Vauban are equipped with photovoltaic (PV) panels mounted on roofs and sometimes building facades. These panels enable buildings to convert solar energy into electricity, meeting their own electricity needs. Principles such as passive design, which are based on taking advantage of Germany's highest annual solar gain area, have been supported and implemented by local policies. A total of 1,200 m2 of solar photovoltaic systems and solar collectors have been installed as part of the project (Beşiroğlu & Özmen, 2022).

In the region where mandatory enhanced low-energy standards are applied, all new buildings are constructed with a minimum of 65 kWh/m2a. This stringent implementation has minimized energy consumption (Vauban Community, 2009).

Figure 2.13

Image of Solar System Installed in Vauban District

(URL13)

Figure 2.14

Image of Solar System Installed in Vauban District Bus Stop

(URL14)

Solar Systems in the Netherlands

Interest and investments in solar energy in the Netherlands have been rapidly increasing in recent years. The country's progress in the field of solar energy stems from its need for sustainable energy infrastructure due to limited natural resources. In the early 2000s, the Dutch government initiated a series of incentive and subsidy programs to increase the share of renewable energy in the country. Through these programs, the installation of photovoltaic systems has been encouraged both at individual and commercial scales. In the 2010s, significant growth in solar energy capacity was observed in the Netherlands, establishing the country as one of the fastest-growing markets in Europe in this field. By 2020, the Netherlands aimed to further expand its solar energy infrastructure and integrate energy storage solutions to achieve its sustainable energy goals. The country's geographical location, vast flat areas, and dense population offer unique opportunities for the growth and integration of solar energy (Quax et al., 2022).

Photovoltaic System Incentives and Legal Situation in the Netherlands

The Netherlands supports its commitment to achieving sustainable energy goals with incentives and legal regulations for the solar energy sector.

SDE+ (Stimulering Duurzame Energieproductie) Programme: It is the main incentive program implemented by the Netherlands to support renewable energy projects. This program offers financial support for solar energy investments (Netherlands Enterprise Gency,2023).

Net Metering System: This system, adopted for individual energy producers in the Netherlands, ensures that the excess energy produced can be sold back to the grid and save on energy bills (Londo et al., 2020).

Renewable Energy Investment Allowance (EIA): This incentive offered to companies provides support with tax deductions on renewable energy investments.

VAT Discounts: VAT discounts applied to individuals' purchases of solar panel systems and related equipment offer financial advantages to consumers.

Local Supports: Various municipalities and local governments of the Netherlands create unique incentive programs to encourage solar energy projects in their regions.

Building Thermal Insulation Regulation: In the Netherlands, building thermal regulations are generally implemented through systems such as Energielabel. The Energy Label is a system that evaluates and classifies the energy performance of a building. This label is used to measure, compare and improve the energy efficiency of buildings. Additionally, the Netherlands has standards and regulations for new building construction and energy retrofit of existing buildings. These standards contain detailed provisions on topics such as building insulation, heating systems, use of renewable energy and energy performance. These regulations were created to ensure that buildings comply with energy efficiency standards and to aim for sustainable construction (Factsheet Niederlande,2023).

Permits and Certification: In the Netherlands, permission and certification are required for the identification of solar energy projects, but these requirements may vary depending on factors such as temperature dimensions and type. Typically, the process of installing solar panels on rooftops allows for simplified procedures with standardized components. However, in some cases, especially concerning historical buildings or specific areas, permission must be obtained from local authorities (Netherlands Enterprise Agency, 2023).

Permits and Certification: In the Netherlands, permission and certification are required for the establishment and certification of solar energy projects. However, these requirements may vary depending on factors such as temperature dimensions and type. Typically, the installation of solar panels on rooftops allows for simplified procedures with standardized components. However, in certain cases, particularly concerning historical buildings or specific regions, obtaining permission from local authorities is necessary (Netherlands Enterprise Agency, 2023).

Environmental Impact Assessment: In the Netherlands, an Environmental Impact Assessment (CED, or "Milieu effectrapportage" or "MER") as it is known in the Netherlands, is required for certain projects. However, this assessment varies depending on permanent size, location and potential pet (Falenders,t.y).

Structural Safety: Flexible safety plays an important role in solar installations in the Netherlands. Especially when it comes to the installation of rooftop solar panels, the structural integrity and capacity of the building are taken into consideration. Prior to installation, a structural assessment by an appropriate structural engineer or qualified professional is mandatory. This is required to indicate whether the roof has the capacity to carry additional weight (Government of the Netherlands,2022).

Netherlands Solar Energy (Photovoltaic) Examples

Midden-Groningen Zonnepark. With a construction period of just eight months, the Midden-Groningen Zonnepark was constructed in almost record time. Netherlands' largest solar energy park was connected to the grid by the end of 2019 and has since been providing green energy to approximately 32,000 households.

Figure 2.15

Image of the installed solar system in Midden-Groningen Zonnepark

(URL15)

At the time of its construction, the designation of the largest solar park in the Netherlands was acknowledged. The Midden-Groningen solar park is designed to meet a significant amount of energy demand and ensures the provision of energy obtainable from the region (Solar Park Central Groningen, n.d.).

PV Solar Village in Amersfoort. An example of a residential type installation is located in Amersfort, the Netherlands. The village was built on the roofs of 500 houses. The village, which is a good example of residential use, was initially calculated as 1,000 KW, but was later increased to 1,323 KW (Koryürek., 2008)

Figure 2.16

Image of the installed solar system of the PV Solar Village in Amersfoort

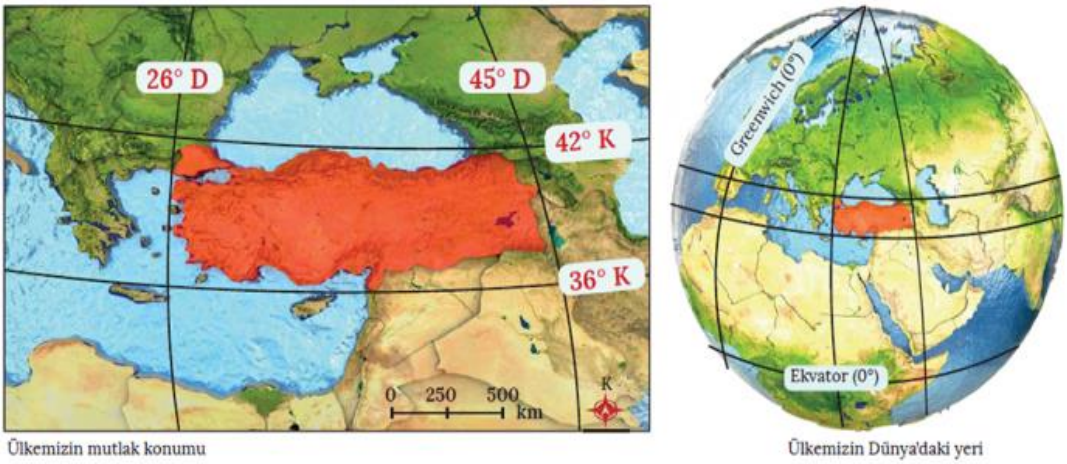
(URL16)

Solar Systems in Türkiye

As can be seen in the figure, Türkiye is geographically located between 36-42 degrees north latitude and 26-45 east longitudes. Its geographical location and its sun exposure are very advantageous compared to many other countries. Türkiye, which has an important place in the sun belt, is much less likely to use this advantage than expected.

Figure 2.17

Turkey's absolute position



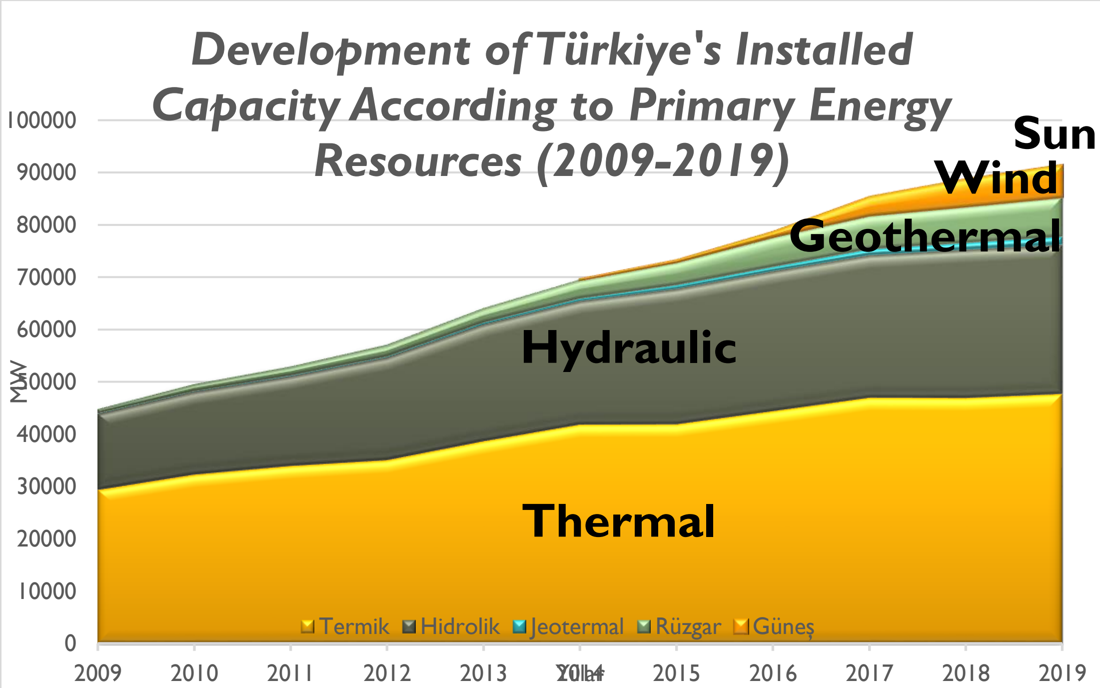
(URL17)

Turkey primarily generates electricity using fossil-based energy sources (such as oil, coal, etc.) or through geothermal, hydroelectric, and wind turbines. Between 2000 and 2022, the energy production rates were as follows: in hydraulic energy, 31,571.50 MW in 2022; wind energy, 11,396.20 MW in 2022; geothermal energy, 1,691.30 MW in 2022. Solar energy production started to develop after 2014, with no production between 2000 and 2013, reaching up to 9,425.44 MW by 2022 (Turkish Electricity Transmission Corporation, 2022).

As observed in this twelve-year analysis, the energy obtained from solar power, as compared to previous years, showed a notable increase in momentum after 2014. Although the increase in solar energy production by 2014 was not exceedingly high in magnitude, it gained significant momentum thereafter.

Figure 2.18

Development of Türkiye's Installed Capacity According to Primary Energy Resources (2009-2019)



(URL18)

In Turkey, the energy demand has not been thoroughly examined and a stable situation has not been established so far. Periodic energy shortages have led to a noticeable reliance on external sources, particularly in energy. This has resulted in higher energy prices compared to other countries. The understanding of solar energy as an alternative energy source began in the early 1960s, with research and studies initiated by some universities and investors. By the 1970s, with the technological advancements in solar energy worldwide, studies gained importance in Turkey as well. The first congress took place in Izmir in 1975, and the first passive solar energy application was implemented at Middle East Technical University (METU) in 1975 (Kapulhan, 2014).

Photovoltaic System Incentives and Legal Situation in Türkiye

General studies on solar energy are extensively conducted by Middle East Technical University (ODTU), Istanbul Technical University (ITU), Yildiz Technical University, and Ege University. In Türkiye, electricity generation from solar energy requires advanced technology and investment, which has led to insufficient investment in this field. Only a few private companies and universities have conducted studies on this subject (Historical Development of Solar Energy Use and Its Place in Turkey, n.d.).

Türkiye has taken various steps towards using energy resources more effectively in recent years. A series of measures have been taken to highlight solar energy as one of these resources and to encourage the government's investments in this region.

Investment Incentives: Türkiye supported local and foreign entrepreneurs planning to invest in solar energy with various incentives. These Incentives can be combined with elements such as tax reductions, insurance premium support, interest rate reduction (Ulusoy & Daştan,2018).

Solar Energy Purchase Guarantee: Türkiye has offered a purchase guarantee per kilowatt-hour for solar energy projects below a certain capacity. This is valid if the price is fixed and the energy is sold on condition.

Domestic Production Incentives: In order to encourage domestic production efforts, projects in domestic products and activities can benefit from extra incentives (Delihasanlar et al., 2018).

YEKDEM: In Türkiye, there is the Renewable Energy Resources Support Mechanism (YEKDEM), which is a mechanism that sells electrical energy produced from separable energy resources to the grid. Within the scope of YEKDEM, a fixed purchase guarantee is provided by the state for the energy produced for a certain period of time.

RERA: Renewable Energy Resources Areas (RERA) tenders are another mechanism, particularly applicable to large-scale wind and solar energy projects. RERA tenders involve efforts to grant rights for establishing and operating wind and solar power plants in large areas (Ardiyok et al., 2017).

Unlicensed Electricity Generation: Türkiye allows for unlicensed electricity generation for solar energy projects below a certain capacity. This facilitates ease of excess electricity generation by allowing the transfer of surplus electricity to the grid, up to 1000 kW (Ministry of Energy and Natural Resources of the Republic of Türkiye, n.d.).

Structural Safety: Structural safety is crucial in solar energy installation in Türkiye. Especially for rooftop installations, the suitability of the roof's load-bearing components is checked. Considering the high seismic activity in the region, panels are required to be earthquake-resistant. Resistance to wind loads, snow loads, and other natural conditions is also prioritized for the safety of installations. Therefore, solar energy installations in Turkey are carried out with flexibility and safety considerations (Sayin & Koç, 2011).

Building Thermal Insulation Regulation: TS 825 "Rules for Thermal Insulation in Buildings" Standard is used in Turkey. This standard determines the minimum requirements regarding thermal insulation in buildings and regulates the use of appropriate materials. It includes a calculation method for determining the heating energy needed by the building. Thermal insulation is an important concept for building owners, designers, and construction professionals, and TS 825 standards aim to encourage appropriate practices in this field (Usta, 2009).

Environmental Impact Assessment: For the installation of solar power plants, an EIA report is required for projects with a certain capacity. However, capacity limits and detailed procedures may vary.

Permit and Certification: General permits are issued by the Ministry of Environment and Urbanization, and various permits are issued by the Energy Market Regulatory Authority, Türkiye Elektrik İletişim A.Ş. and the local government municipality (T.R. Ministry of Energy and Natural Resources,"nd").

Solar Energy (Photovoltaic) Examples in Türkiye

Karapınar Yeka-1 Solar Project. The system established in the Karapınar district of Konya belongs to the Kalyon Holding Energy Group. Upon its initial installation, this system was capable of meeting all the electricity needs of 369,606 people in their daily lives, with a total production of 1,342,409,849 kW. Consumption was calculated considering factors such as industry, commerce, and environmental lighting. However, in the scenario of residential consumption only, the system could provide electricity to approximately 449,417 households. Production continues to increase, and measurements from January 1 to March 10, 2023, indicate a production of 344,088,030 kW within a period of three months. As the system continues to grow, upon completion, with approximately 3.5 million solar panels, it will be able to meet the needs of around 2 million people (Karapınar YEAK-1, n.d.).

Figure 2.19

Image of the Karapınar YEAK-1 SPP installed solar system (1)

(URL19)

Figure 2.20

Image of the Karapınar YEAK-1 SPP installed solar system (2)

(ULR20)

Kayseri OSB Solar Park Project. The system, inaugurated in 2015, is located in the Organized Industrial Zone (OSB) of the Melikgazi district of Kayseri. It was established to meet the energy consumption needs of activities such as lighting, irrigation, wastewater treatment plants, and administrative buildings within the OSB.

With its production of 73,000,000 kilowatt-hours of electricity, it meets the needs of 20,099 individuals for residential, industrial, transportation, street lighting, etc. purposes In the scenario of residential consumption only, it can meet the electricity needs of 24,439 households. Additionally, the power plant contributes significantly to the economy. With the electricity it generates, it provides an annual profit of approximately 75,920,000 TL by offsetting the electricity bills against national electricity prices (Kayseri OSB, n.d.).

Figure 2.21

Image of Kayseri OSB Solar Park installed solar system (1)

(URL21)

Figure 2.22

Image of Kayseri OSB Solar Park installed solar system (2)

(URL22)

ÖzKoyuncu Mining Balıkesir Solar Energy Project. Established by ÖzKoyuncu Mining Metallurgy Construction Industry and Trade Inc. in 2009, the company transitioned to a solar energy-based electricity production system in 2012. As of 2021, the energy production has reached 367,095,066 kWh. This amount roughly equals the annual consumption of 153,000 households and has also prevented the emission of 365,500 tons of carbon. Their primary goal is to provide a safe and environmentally friendly life for future generations (Özkoyuncu, n.d.).

Figure 2.23

Image of ÖzKoyuncu Madencilik Balıkesir Solar system (1)

(URL23)

Edirne Provincial Directorate of Environment and Urbanization Project .The building, consisting of 134 panels placed on the building windows, is an example of buildings with exterior applications. Although it is Turkey's first public building to produce energy, up to 30% profit is made in building energy consumption thanks to the 100-110 kW energy produced (Gunder, 2018).

Figure 2.24

Image of the solar system installed on the exterior of Edirne Provincial Directorate of Environment and Urbanization

(URL24)

In today's world, solar panels have many areas of application. Especially, as seen in examples, large-scale solar power installations significantly contribute to meeting the energy needs of the region and provide great convenience in addressing energy-related issues in rural areas where energy problems are high. Solar energy installations will also provide significant benefits in buildings such as public facilities where energy usage is high.

As can be seen in Turkey, the system is mainly based on the simultaneous use of collective living spaces, and there are no installations such as regional neighborhoods and or villages that come to the fore in the Netherlands and Germany.

Related Research

The Sources related to our research, such as books, articles, theses, etc., have been presented in chronological order.

Kadırgan (2010),In her study stated that when solar system technology is integrated into the building, it can be used not only as a structural element on the roofs of the building, but also functionally when placed on the facades.

Oktik, et al. (2015), In their article, as a result of the data and evaluations they made through the analysis of 75 businesses and 19 residences in Muğla, he concluded that laws that encourage the system are needed, that it should be widespread in the public and private sectors, especially to provide investment opportunities and price compliance to domestic producers.

Erdoğan et al. (2017) state in their article titled "An empirical analysis of renewable energy, environment and economic growth for selected countries" that the increase in renewable energy production will make a significant contribution to reducing environmental pollution.

Taktak et al. (2018), in a study conducted in Uşak, revealed that photovoltaic systems are few, but correctly designed and supported investments can amortize the cost of the system.

Alacam et.al (2018) In their article, they mentioned that although the sunshine duration in European Union countries such as Germany is very low, they use the system actively and more efficiently.

Koç (2019), Mentioned that the beneficial use of solar energy, moving away from fossil fuels, will provide serious profits in both heating and cooling, especially in energy production, unlike other power plants.

Güneş (2019), In his study, he concluded that when integrating the system into buildings, issues such as engineering analysis, finance and technology should be taken into consideration and a feasibility study should be carried out accordingly.

Baka (2021), In his study in Libya, examined the possibility of using photovoltaic modules in improving existing buildings and applied the survey developed for the study to 114 participants. As a result of the study, it was revealed that the obstacles to the use of photovoltaic systems on existing buildings are lack of awareness, high costs, grants, incentives and loans..

Ince (2021), In his article, he emphasized that the cost of solar energy systems is high in the first place. Still, it will provide financial comfort in the long run and that the system should be widely used by the public, and that the solar system should be encouraged with incentives.

Duyan et al. (2022), In their studies, they pointed out that energy consumption is especially high in buildings today, and that the product diversity and usage areas of the system find a place in sustainable architectural designs.

Bağcı (2022), In his study, stated that the countries within the EU have set targets for themselves in the field of renewable energy and that they are moving towards a green energy policy, especially away from energy sources that harm the environment.

CHAPTER III

Methodology

The qualitative research method has been adopted for the research methodology. In studies utilizing qualitative research methods, obtaining in-depth responses regarding the events and phenomena under investigation is essential (Morgan, 1996). The survey technique has been utilized as the data collection tool. Qualitative research relies on observation, documentation, interviews, and discourse analysis. Additionally, individuals' perceptions and events are examined within social reality and the natural environment (Hatch, 2002).

Research Design

To prepare the research questions, the problem situation of the research was transformed into question sentences. Considering the purpose, significance, and limitations of the study, questions determined by the researcher were randomly posed to participants, and data were collected from the participants with the approval of the advisor. The research questions were divided into four sections. In the first section, demographic information, including age, gender, education level, occupation, and marital status, was collected from the participants. In the second section, a total of 10 questions regarding the usage of Solar Energy (Photovoltaic Systems) were asked. Usage of data was collected from participants by using a multiple-choice method. In the third section, a 5-point Likert scale was utilized to evaluate participants' thoughts on Solar Energy (Photovoltaic Systems). For this scale, statements ranged from 1 "strongly disagree" to 5 "strongly agree." In the final section, participants were asked about their expectations and suggestions regarding Solar Energy (Photovoltaic) systems. Expectations and suggestions were expressed by participants in brief sentences. All questions were provided in the appendix of the thesis.

Participants/Population and Sample

Qualitative research focuses on the details of the sample. Although there are random sampling methods, it is generally aimed to reach the samples that can best clarify the subject of the research and provide the best contribution to the solution of the research problem (Baltacı, 2018).

One important detail here is that the researcher needs to have a good understanding of the area where data will be collected. The reason is that qualitative research is gathered from small groups or a few individuals. For this study, data were collected from randomly selected participants living in the capital city of North Cyprus, Nicosia, who use solar energy (photovoltaic) systems. The most significant limitation of data collection is that participants must be using solar energy (photovoltaic) systems. Therefore, data collection began after determining that participants were using solar energy (photovoltaic) systems, with some of the data collected face-to-face and some online.

Data Collection Tools/Materials

A semi-structured interview technique was used for the study (Marshall, 1996). Various question types commonly used in qualitative research were utilized for each section. Specifically, direct questions were used in Section 2, specialized questions in Section 3, and introductory questions in Section 4. During the interviews, emphasis was placed on not repeating concepts, avoiding redundancy, and not boring the participant, focusing on the research problem. Ultimately, participants were asked 5 questions in the first section, 10 questions in the second section, 7 questions in the third section, and 1 question in the fourth section. The data were collected between 2020 and 2022.

Data Collection Procedures

Table 3.1

Statistical Test of the Difference in Total System Utility Based on Participants' Demographic Characteristics

		x̄ ± SD (Min-Max)	**Mann Whitney U**	
			t	**p**
Gender	Female	4,21 ± 0,43 (2,86 - 4,57)	0,85	0,395
	Male	4,32 ± 0,36 (3,29 - 5)		
			Kruskal Wallis	
			t	**%**
Marital Status	Married	4,33 ± 0,34 (3,29 - 5)	2,592	0,274
	Single	4,13 ± 0,5 (2,86 - 4,43)		
	Widow	4,14 ± 0 (4,14 - 4,14)		
Age	0-14	0 ± 0 (0 - 0)	0,128	0,988
	15-25	4,32 ± 0,14 (4,14 - 4,43)		
	26-40	4,24 ± 0,5 (2,86 - 5)		
	41-65	4,31 ± 0,32 (3,29 - 5)		
	65 and above	4,33 ± 0,16 (4,14 - 4,43)		
Education	Uneducated	0 ± 0 (0 - 0)	2,501	0,286
	primary school	4,37 ± 0,13 (4,14 - 4,43)		
	middle school	0 ± 0 (0 - 0)		
	high school	4,36 ± 0,29 (3,71 - 5)		
	University	4,17 ± 0,51 (2,86 - 5)		
Occupation	Officer	4,36 ± 0,17 (4,14 - 4,57)	8,362	0,213
	Employee	4,43 ± 0 (4,43 - 4,43)		
	self-employment	3,89 ± 0,36 (3,71 - 4,43)		
	private sector	4,33 ± 0,46 (2,86 - 5)		
	Student	0 ± 0 (0 - 0)		
	Academician	0 ± 0 (0 - 0)		
	Retired	4,18 ± 0,24 (3,86 - 4,43)		
	Housewife	4,29 ± 0,2 (4,14 - 4,43)		
	Unemployed	4,14 ± 0 (4,14 - 4,14)		
	Artist	0 ± 0 (0 - 0)		
method of acquaintance with the system.	Internet	4,38 ± 0,28 (3,86 - 5)	2,056	0,562
	newspaper or magazine	4,43 ± 0 (4,43 - 4,43)		
	User recommendation	4,23 ± 0,35 (3,29 - 4,86)		
	Other	4,29 ± 0,63 (2,86 - 5)		

x̄: Mean; SS: Standard Deviation; Min: Minimum; Max: Maximum

*Mann Whitney U test, **Kruskal Wallis, significance level $p<0.05$.

The comparison of participants' demographic characteristics by groups is provided in the table. Statistical analysis was conducted to investigate whether there is a significant difference in the overall utility of the system based on participants' gender, marital status, age, education level, occupation, and method of acquaintance with the system. Overall, there was no statistically significant difference in the overall utility score of the system based on participants' gender, marital status, age, education level, occupation, and method of acquaintance with the system ($p>0.05$; Table 3.1). However, when examined mathematically, it was found that male participants perceived the system to be more useful compared to female participants, married individuals found the system more useful compared to singles, participants aged 65 and over found the system more useful compared to other age groups, participants with a primary school education found the system more useful compared to those with other education levels, and participants who learned about the system through newspapers or magazines reported the system to be more useful compared to those who learned through other channels.

Table 3.2

Descriptive Statistical Analysis of the Scale

Variables	Mean	SS	Minimum	Maximum	Skewness	Kurtosis
The system meets the necessary requirements	4,74	0,660	2,00	5,00	-3,14	10,44
I am pleased with the ease of use of the system.	4,76	0,430	4,00	5,00	-1,26	-0,44
I do not have any repair problems with technical problems.	4,64	0,690	2,00	5,00	-2,06	4,06
I am satisfied that the system is safe.	4,80	0,450	3,00	5,00	-2,21	4,47
I am pleased that the system is easily accessible.	4,60	0,830	2,00	5,00	-1,99	2,83
I think there are enough supplier companies in the Nicosia	4,56	0,790	2,00	5,00	-1,65	1,66
I think the system is supported by the State	1,90	1,390	1,00	5,00	1,19	-0,11
The overall utility of the system	4,29	0,390	2,86	5,00	-1,43	3,61

Descriptive statistics for questions related to the system are presented in Table 3.2. According to these results, participants rated the statement "the system meets necessary requirements" with an average score of 4.74, indicating a response close to "strongly agree." The standard deviation is 0.66, with a minimum score of 2 and a maximum score of 5. For the statement "I am satisfied with the ease of use of the system," participants gave an average score of 4.76, indicating a response close to "strongly agree." The standard deviation is 0.43, with a minimum score of 4 and a maximum score of 5. As seen, all participants responded positively to the statement regarding satisfaction with the ease of use of the system. For the statement "I do not experience repair issues in technical problems," participants gave an average score of 4.64, indicating a response close to "strongly agree. “The standard deviation is 0.69, with a minimum score of 2 and a maximum score of 5. Participants rated the statement "I am satisfied with the security of the system" with an average score of 4.80, indicating a response close to "strongly agree." The standard deviation is 0.45, with a minimum score of 3 and a maximum score of 5. For the statement "I am satisfied with the accessibility of the system," participants gave an average score of 4.60, indicating a response close to "strongly agree”." The standard deviation is 0.83, with a minimum score of 2 and a maximum score of 5. Regarding the statement "I believe there are enough supplier companies in the Nicosia" participants gave an average score of 4.56, indicating a response close to "strongly agree”." The standard deviation is 0.79, with a minimum score of 2 and a maximum score of 5. However, for the statement "I believe the system is supported by the government," participants gave an average score of 1.90, indicating a response of "disagree." The standard deviation is 1.39, with a minimum score of 1 and a maximum score of 5. Especially, the presence of both positive and negative responses regarding the belief that the system is supported by the government is noteworthy. In this context, it is considered remarkable that there are a considerable number of both positive and negative responses. Participants rated the statement "the overall utility of the system" with an average score of 4.29, indicating a response of "agree." The standard deviation is 0.39, with a minimum score of 2.86 and a maximum score of 5. Overall, participants demonstrated a positive perception of the overall utility of the system.

Table 3.3

Frequency analysis of information about the system

Variables		N	P
Method of acquaintance with the system.	Internet	14	28,00%
	newspaper or magazine	1	2,00%
	user recommendation	27	54,00%
	Other	8	16,00%
Knowledge about the system	Little	2	4,00%
	Average	25	50,00%
	Good	17	34,00%
	very good	6	12,00%
Duration of system usage	less than 1 year	15	30,00%
	1-5 year/s	34	68,00%
	6-10 years	0	0,00%
	11-25 years	0	0,00%
	25 years and above	1	2,00%
Knowledge of production income and expenses	Little	5	10,00%
	Average	22	44,00%
	Good	16	32,00%
	very good	7	14,00%
Knowledge about the impacts on the environment	Little	8	16,00%
	Average	12	24,00%
	Good	21	42,00%
	very good	9	18,00%
Knowledge about installation cost	Little	3	6,00%
	Average	12	24,00%
	Good	20	40,00%
	very good	15	30,00%
Suitability for the Nicosia region	Unsuitable	1	2,00%
	Indecisive	3	6,00%
	Suitable	14	28,00%
	absolutely suitable	32	64,00%
Knowledge about legal content	Little	11	22,00%
	Average	18	36,00%
	Good	13	26,00%
	very good	8	16,00%
Knowledge about alternative energy sources	Little	8	16,00%
	Average	17	34,00%
	Good	16	32,00%
	very good	9	18,00%
Recommendation status	I do not recommend	1	2,00%
	I'm undecided	2	4,00%
	I would recommend	14	28.00%

I definitely recommend	16	66.00.%

The frequency analysis of the questions was asked to the participants while measuring the level of knowledge about the system is given in Table 3.3. According to the questions asked; For the question of the way they got acquainted with the system, 14 of the participants stated it as internet (28%), 27 stated it as user recommendation (54%), 8 stated it as other (16%) and 1 person stated it as newspaper and magazine. When the second question examined the knowledge about the system, 25 people (50%) stated that they had moderate knowledge, 17 people (34%) stated that they had good knowledge, 2 people (4%) stated that they had little knowledge, and 6 people (12%) stated that they had very good knowledge. For the question of the duration of using the system, 15 people (30%) reported that they have used this system for less than 1 year, 34 people (68%) reported that they have used this system for 1-5 years, and 1 person reported that they have been using this system for 25 years or more. For the question of knowledge of production income and expenses, 5 people (10%) stated that they have little knowledge, 22 people (44%) have medium knowledge, 16 people (32%) have good knowledge, and 7 people (14%) stated that they have very good knowledge. As a result of the question about knowledge in terms of environmental impacts, 8 people (16%) stated that they have little knowledge, 12 people (24%) have moderate knowledge, 21 people (42%) have good knowledge, and 9 people (18%) stated that they have very good knowledge. In terms of knowledge about the installation cost, 3 people (6%) stated that they have little knowledge, 12 people (24%) have moderate knowledge, 20 people (40%) have good knowledge, and 15 people (30%) stated that they have very good knowledge. In terms of suitability for the Nicosia region, 1 person (2%) stated that he/she did not find it suitable, 3 people (6%) stated that they were undecided, 14 people (28%) found it suitable, and 32 people (64%) stated that they found it definitely suitable. In terms of knowledge about legal content, 11 people (22%) stated that they have little knowledge, 18 people (36%) say they have moderate knowledge, 13 people (26%) say they have good knowledge, and 8 people (16%) say they have very much knowledge. In terms of knowledge about alternative energy sources, 8 people (16%) stated that they have little knowledge, 17 people (34%) have moderate knowledge, 16 people (32%) have good knowledge, and 9 people (18%) stated that they have little knowledge. When it comes to recommending the system, 14 people (28%) stated that they recommend it, 33 people (66%) stated that they definitely recommend it, and 1 person (2%) stated that they do not recommend the system and 2 people (4%) stated that they are undecided.

Table 3.4

Frequency Analysis of Participants' Demographic Characteristics.

Variables		N	%
Age	0-14	0	0,00%
	15-25	4	8,00%
	26-40	21	42,00%
	41-65	22	44,00%
	65 and above	3	6,00%
Gender	Female	16	32,00%
	Male	34	68,00%
Education	uneducated	0	0,00%
	primary school	5	10,00%
	middle school	0	0,00%
	high school	26	52,00%
	university	19	38,00%
Occupation	officer	10	20,00%
	employee	1	2,00%
	self-employment	4	8,00%
	private sector	28	56,00%
	student	0	0,00%
	academician	0	0,00%
	retired	4	8,00%
	housewife	2	4,00%
	unemployed	1	2,00%
Marital Status	Married	38	76,00%
	Single	11	22,00%
	Widow	1	2,00%

The demographic characteristics of the participants in the study are presented in Table 3.4. When the results of frequency analysis are examined, it is observed that no participants within the age range of 0-14 years, while 4 individuals (8%) are in the age range of 15-25 years, 21 individuals (42%) are in the age range of 26-40 years, 22 individuals (44%) are in the age range of 41-65 years, and 3 individuals (6%) are aged 65 and above. In terms of gender, 16 participants are male (32%), and 34 participants are female (68%). When considering their educational levels, there are no participants who are illiterate or have completed only primary school. 5 participants are primary school graduates (10%), 26 are high school graduates (52%), and 19 are university graduates (38%). Regarding their occupational backgrounds, there are no participants from student, academic, or artist professions, while 10 individuals (20%) are officer, 1 individual (2%) is a employee, 4 individuals (8%) are self-employed, 28 individuals (56%) are from the private sector, 4 individuals (8%) are retired, 2 individuals (4%) are homemakers, and 1 individual (2%) is unemployed. In terms of marital status, 38 individuals are married (76%), and 111 individuals are single (22%), with one participant being widowed and not included in the study.

Table 3.5

Reliability Analysis of the Scale

Variables	**Cronbach's alpha**	**N**
The total utility of the system	0,72	7

As part of the reliability analysis, the Cronbach's alpha coefficient has been calculated, and the results are presented in Table 3.5. According to this, the Cronbach's alpha value for the scale, calculated over 7 variables, is found to be 0.72, indicating a high level of reliability for the scale. Consequently, the reliability of the scale is deemed to be high, and the research sample is considered adequate.

Table 3.6

Normal Distribution Analysis of the Scale

	Kolmogorov-Smirnova		Shapiro-Wilk		Skewness – Kurtosis	
Variables	**p**	**%**	**p**	**%**	**Skewness**	**Kurtosis**
The system meets the necessary requirements	0,472	0,00	0,442	0,00	-3,14	10,44
I am pleased with the ease of use of the system.	0,471	0,00	0,53	0,00	-1,26	-0,44
I do not have any repair problems with technical problems.	0,438	0,00	0,582	0,00	-2,06	4,06
I am satisfied that the system is safe.						
I am pleased that the system is easily accessible.	0,491	0,00	0,487	0,00	-2,21	4,47
I think there are enough supplier companies in the Nicosia	0,464	0,00	0,541	0,00	-1,99	2,83
I think the system is supported by the State	0,432	0,00	0,612	0,00	-1,65	1,66
The overall utility of the system	0,402	0,00	0,671	0,00	1,19	-0,11
The system meets the necessary requirements	0,265	0,00	0,834	0,00	-1,43	3,61

* (Since $p > 0.05$, it is suitable for normal distribution.)

As a result of the normality tests conducted for both the scale items and the total scale (Total Utility of the System), it was found that the data did not fit a normal distribution according to the Kolmogorov-Smirnov and Shapiro-Wilk tests. However, only the total value of the scale, which is the Total Utility of the System, was found to be suitable for normal distribution. Parametric tests will be applied to this scale.

Data Analysis Plan

The planning of the thesis involves organizing the steps of the research from the beginning to the end in a systematic and effective manner. Initially, work has been conducted on the selection of the topic and defining the problem, focusing on the goals and limitations. During this phase, the central theme of the research was determined, and subsequently, an examination of existing studies in the relevant literature and the assimilation of findings from similar research were carried out. Following this, the formulation of research questions clarified the main objectives of the study. Various data were collected and interpreted using a created survey, and the conclusions and recommendations of the thesis were determined.

CHAPTER IV

A Study on the Knowledge, Awareness, and Preferences of Residential Users Regarding Photovoltaic Systems in Nicosia Region

In this chapter, the findings obtained in the light of the data collected on photovoltaic systems in TRNC are evaluated by comparing them with the examples given in the research.

Solar Energy in TRNC

Today, Cyprus relies heavily on fossil fuels for its energy resources. A significant portion of energy is produced from oil, with the remainder coming from coal and solar energy. It's known that Cyprus does not have natural oil reserves, leading to dependence on imported energy. Cyprus is an island country located in the northeast of the Mediterranean Sea. It lies approximately 338 kilometers east and 358 kilometers north of the Equator. Its strategic location positions it 75 kilometers south of Turkey, 105 kilometers west of Syria, 380 kilometers north of Egypt, and 380 kilometers east of the Greek island of Rhodes. Being the third-largest island in the Mediterranean after Sicily and Sardinia, Cyprus has a land area of 9,251 square kilometers (Korones, Fokaidis & Moussioppulas, 2003).

The island, with a Mediterranean climate, generally experiences sunny weather throughout the year. All regions of Cyprus have abundant sunshine and a mild climate, with significant sunbathing periods in almost every month. Since Cyprus experiences very little winter, with the majority of the year being sunny, it is heavily composed of spring and summer seasons. This provides a significant opportunity to harness solar energy, a natural energy source (Koday, 1995).

Cyprus' encounter with solar energy started with solar water heating in the 60s. Over the years, solar energy used for water heating has increased rapidly and it is estimated that the number of installed systems has exceeded 130,000 today. Although the system is only seen as panels on roofs, especially recently, there has been a trend towards solar systems that provide energy production by taking advantage of the sun. (Korones,Fokaidis & Moussioppulas,2003).

Incentives and Legal Situation in TRNC

With the enactment of the Renewable Energy Law in 2011 in the Turkish Republic of Northern Cyprus (TRNC), the legal use of sources providing both heat and electricity has been ensured, promoting sustainability. Alongside this law, the installation of solar panels on roofs of houses has been legalized, allowing for electricity generation. However, there are no state incentives or support schemes specifically for solar energy (photovoltaic energy). Moreover, there is no oversight by authorized bodies regarding structural safety, nor is there any regulation regarding insulation in buildings. Additionally, no environmental impact assessment reports are required.

The legal provisions, objectives, scope, and penalties associated with the Renewable Energy Law of the Turkish Republic of Northern Cyprus are as follows:

Purpose

The purpose of this Law is to promote the widespread use of renewable energy sources for electricity generation or heating purposes, to integrate these sources into the economy reliably, economically, and in high quality, to increase resource diversity, to reduce greenhouse gas emissions, to protect the environment, to develop the manufacturing sector needed to achieve these goals, to support sustainable energy production, to reduce energy imports, and to ensure supply security (Renewable Energy Law, 2011).

Scope

This law covers the protection of renewable energy resource areas and the application and control of the specified principles in energy production. With the recommendation of the Council of Ministers, a new area for the establishment of renewable energy facilities is declared and published in the Official Gazette. Ministry approval is required for the area designated as a single area. Commercial electricity generation or heating from renewable energy sources is subject to the permission of the ministry in accordance with the current legislation rules and the resources to be used for all kinds of commercial activities (Renewable Energy Law, 2011).

Offenses and Penalties

Using electricity or heat commercially without obtaining the necessary permission from the Council of Ministers falls within the scope of the offense.

Individuals or organizations committing this offense may be subject to both fines and imprisonment as penalties (Renewable Energy Law, 2011).

Application, Inspection, and Design of Photovoltaic Systems in the TRNC

For all types of renewable energy (solar energy) commercial or individual consumption, applications are made individually to the Renewable Energy Authority (REA), which is within the Ministry of Energy, with the necessary documents obtained from the Ministry or the official website of the Ministry of Energy. Applications can be made for grid-connected or off-grid systems. If the application to REA is complete and without any deficiencies, then:

1- For grid-connected systems, if the application is made to the Turkish Cypriot Electricity Authority (KIB-TEK), the application documents are directed to the main center, and guidance is provided to the responsible center of KIB-TEK for field measurement. In this context, if the documents provided to KIB-TEK are complete and in order, KIB-TEK grants approval for the energy coming to the transformer up to 40% of the KW power after the REA approval. If the measurement result is approved, the documents are forwarded to the Ministry for approval, and a project approval request is made from the Chamber of Civil Engineers and Architects (KTEMO) for the approved system, and the installation of the system is proceeded.
2- For off-grid systems, the application process is the same as for grid-connected systems. However, the only difference is that since there will be independent production from the electricity company's grid, no approval is required from the electricity company. A permit is obtained with the approval of the REA board affiliated with the Ministry (TRNC Council of Ministers Decisions, 2017).

Exploratory Phase and Preliminary Study (Project)

In this phase, it is determined whether the system is suitable for installation in the existing project area. Errors in the project to be undertaken are minimized through detailed surveys, and especially the customer should be informed of any additions or changes that may be necessary for the system's installation locations in subsequent stages.

Key points to consider during the exploratory phase:

- Determination of the location for installation, such as roofs or other areas,
- Identification of the requested power or existing energy needs,
- Recommendation for identifying empty spaces on the front facade of areas where installation will take place,
- Mounting locations for generator connection boxes, activation mechanisms, and inverters,
- Selection of various tools for transportation, assembly, etc.
- Selection of panels for optimal efficiency,
- Examination of meteorological data (shade, rain, sun, etc.),
- Determination of suitability for aesthetic appearance (TRNC Renewable Energy Sources Authority, Şenol, "nd").

Examples of Solar Energy (Photovoltaic) in Cyprus

Serhatköy Solar Power Plant Project

Serhatköy Solar Power Plant, funded by the European Union and put into operation before the enactment of the Renewable Energy Law in the TRNC, was launched on May 27, 2011.

The project cost 3.75 million Euros, the solar power plant consists of 6,192 panels and has a system efficiency of 14%. "It is installed on a 20-acre land and approximately meets the annual energy needs of 400 households (Serhatköy Solar Energy Plant, 'nd').

Figure 2.25

Image of the Installed Solar System at Serhatköy SPP

(URL25)

METU Northern Cyprus Campus Solar Energy Project

The system, installed on an area of approximately 6,400 m2 on the METU Northern Cyprus campus, will be able to meet the electricity needs of 540 households per year, based on annual energy production of a family of maximum 4 people. Thanks to this production, it is planned to prevent 1 million kg of carbon dioxide from being burned annually (Oner,"nd").

Figure 2.26

Image of METU Northern Cyprus installed solar system

(URL26)

Ekin Ada Demir Project

In the system implemented as a roof installation, a dual roof facade has been installed on the existing sloped roof. With the current 435 KWp production, it provides electricity to its own facilities such as warehouses and dormitories (Ekin Ada Demir, 'nd').

Figure 2.27

Image of the solar system installed on the roof of the Ekin Ada Demir building

(URL27)

Bel Trd-Bakery Products Project

In terms of building structure, when the existing facade is not suitable, the system installed on the roof of the added shading section of the building provides 100 kW of solar energy. Since the area where the system is installed belongs to the property owner, there will be no issues with future construction (Bel Trd-Bakery Products, 'nd')."

Figure 2.28

Image of Bel Trd-Bakery Products Project

(URL28)

Cyprus International University Project

Figure 2.29

Image of Cyprus International University Building exterior clad solar system

(URL29)

The project, which was applied in a modern way to the exterior of the building as exterior cladding, is the largest solar system project on the island (Cyprus International University,"nd").

Table 4.1

Data Comparison of Germany, Netherlands, Türkiye, and TRNC

	INCENTIVE	STRUCTURAL SECURITY	BUILDING THERMAL INSULATION REGULATION	PERMIT CERTIFICATION	ENVIRONMENTAL IMPACT ASSESSMENT
GERMANY	-EEG (Erneuerbare-Energien-Gesetz,) allows the storage of the produced energy to the registered network and pricing it at a certain tariff.	Checking the suitability of the panels mounted on the building roof	German Energy Saving Regulation (Energieeinsparverordnung - EnEV) is available.	Done by local governments and states.	-EIA Report is required for large projects.
HOLLAND	Financial support through the SDE(Stimulering Duurzame Energieproductie) program -VAT -Tax Deductions and local financial support are provided.	--Before installation, it is checked by an appropriate structural engineer or authorized professional unit.	An energy label is available.	Done by local governments..	- There is a requirement for EIA, or "Milieu effect rapportage" or "MER" as it is known in the Netherlands.
Türkiye	-YEKDEM offers various financial incentives to producers, -RERA (Renewable Energy Fields) provides support for projects to be established in large areas.. -Tax deductions and insurance support are provided.	-The suitability of the panels mounted on the building roof is checked Comprehensive control is carried out, especially in areas with high seismic activity.	TS 825 "Heat Insulation Rules in Buildings" is applied.	Done by the Ministry of Environment and Urbanization, -Turkey Electricity Transmission Corporation Inc., -local governments, and municipalities.	EIA report is mandatory. However, capacity limits and detailed procedures may vary.
TRNC	Not available.	Not available.	Not available.	Done by the Ministry of Energy, REA (Renewable Energy Authority), and Kıb-Tek	Not available.

CHAPTER V

In this chapter, as a result of the literature review, the necessary parameters were evaluated and the opinions and demands of system users were discussed within the framework of the survey research.

Finedesed Discussion

As indicated in the table above, Germany promotes energy production through the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz - EEG), which ensures the connection of energy to the registered grid and its pricing based on a specific tariff. The installation of solar panels on building roofs is overseen by local governments and states, with Environmental Impact Assessment (EIA) components required for large projects. Similarly, in the Netherlands, financial support is provided for renewable energy sources through the SDE program, which can be adjusted. Before installation, inspections are conducted by suitable structural engineers or authorized professional units. In Türkiye, financial incentives for energy efficiency are provided through institutions such as YEKDEM and RERA. Türkiye's high seismic activity underscores the importance of verifying building information, while Environmental Impact Assessment (EIA) reports provide valuable data in this regard. In addition, Germany's Energy Saving Regulation (EnEV) ensures energy control through thermal insulation in buildings, while the Energy Label in the Netherlands evaluates building energy performance and imposes various investment requirements by local governments. In Türkiye, thermal insulation in buildings is regulated by the TS 825 "Heat Insulation Rules in Buildings" standards.

In the Turkish Republic of Northern Cyprus (TRNC), there is no clear legislation or support program regarding this matter, however, energy-related issues are managed by the Ministry of Energy, Renewable Energy Authority, and Kıb-Tek. There is no preliminary feasibility for building safety, etc. This highlights the deficiencies in solar energy in the TRNC. Additionally, there is no specification or review unit regarding building insulation regulations, which leads to an excessive installation of solar panels on buildings. The increasing demand for energy in today's world has become a significant issue. Energy conservation not only meets the energy needs of a country but also preserves global energy resources, reduces energy costs, decreases carbon emissions, and enhances energy security. Particularly in European countries and recently in Türkiye, there have been numerous efforts and support projects in energy policies, ranging from building insulation to raising public awareness through TV programs, seminars, education, and other resources. Adherence to specific rules in buildings can significantly achieve energy savings on a large scale, contributing to a better understanding of the potential for a sustainable energy future for future generations. (Dağsöz, 1995)

From the past to the present, energy consumption generally follows an increasing trend. Therefore, energy conservation stands out as one of the most important potentials of today's world, necessitating numerous studies on this crucial topic. In response to this need, this thesis conducts a detailed study to analyze the potential of households selected from the Nicosia region of Northern Cyprus for the use of solar (photovoltaic) energy systems. In this context, solar energy holds the largest share in electricity production among renewable energy sources. Photovoltaic systems convert solar energy into electricity. There are various factors that affect photovoltaic systems, and extensive research has been conducted on these factors. However, there is limited research focusing on measuring user satisfaction and their levels of knowledge and opinions. In this regard, this research fills an important gap in the literature.

For the study, firstly, a literature review was conducted. Afterwards, the parameters required for the consumption of this energy were explained and evaluated. Then, demographic questions, knowledge levels and opinions about solar (photovoltaic) energy systems were analyzed for various participants living in households using solar (photovoltaic) energy systems in the Nicosia region.

According to the data collected from households in the Nicosia region, the majority of respondents expressed their agreement with the idea that "the system meets the necessary requirements," mostly indicating "strongly agree." In this context, the system is evaluated as being easily usable in terms of usage. Additionally, respondents overwhelmingly indicated "strongly agree" to the statement "I do not experience repair issues with technical problems." Based on these results, it can be inferred that households using Solar Energy (Photovoltaic) Systems do not encounter difficulties in repair when technical problems occur.

Participants mostly responded “strongly agree” to the question “I am satisfied with the safety of the system.” In this context, the majority of users are perceived to have confidence in the safety of solar energy (Photovoltaic Systems). Another question is “I am satisfied with the ease of access to the system.” The majority of participants answered “strongly agree” to this question. It can be understood from this that customer satisfaction with solar energy (Photovoltaic Systems) is predominant. Regarding the question “I believe there are enough supplier companies in the Nicosia region,” the majority of responses being “strongly agree” suggests that residents of Nicosia can easily access this system.

Participants have indicated their disagreement with the statement “I believe the system is supported by the government.” However, it is perceived that both positive and negative responses are numerous. In this context, it has been evaluated that the government support for the system is not considered sufficient by the participants.

On the other hand, participants responded mostly “agree” to the statement “Total Utility of the System.” Based on these responses, it is possible to evaluate that the system is considered beneficial.

The third section of the research measures participants’ levels of knowledge regarding solar energy (Photovoltaic Systems). The first of the questions asked to measure the level of knowledge is about the way of getting acquainted with the system. The majority of participants indicated that they became acquainted with the system primarily through user recommendation (54%) and secondarily through the Internet (28%). In response to the question “Knowledge about the system,” they stated that they have moderate knowledge (50%) and good knowledge (34%). This suggests that users have a good level of knowledge about solar energy (Photovoltaic Systems).

30% of the users have used the system for less than 1 year and 68% have used it for 1-5 years. As can be seen in Nicosia, solar energy (Photovoltaic Systems) has only recently begun to be used. The participants’ knowledge level regarding production income and expenses is mostly good or very good. It is considered that most of the participants have a good level of knowledge in terms of the impact of solar energy (Photovoltaic Systems) on the environment in various aspects.

The level of knowledge regarding installation costs was evaluated to be predominantly at a very good level. In response to the question about whether solar energy (Photovoltaic Systems) is suitable in the Nicosia region, the majority of participants answered “definitely suitable,” suggesting that the implementation of the system in this region is deemed appropriate. Regarding legal knowledge, it is observed that nearly 60% have low to moderate levels of knowledge, while over 40% have good to very good knowledge. In terms of knowledge about “alternative energy sources,” the majority of participants have a moderate level of knowledge. Furthermore, regarding the statement “Recommendation of the system,” it is evaluated that the majority of participants strongly recommend it.

In the last part, an open-ended question was asked to the participants (what are your expectations and suggestions about Solar energy (Photovoltaic) systems?) The answers of some randomly selected participants from the survey are as follows: Answers are numbered from 1 to 15 in order to protect the privacy of each participant.

Participant 1: *“I think the system should be supported by the state and I think the system should be introduced and guided to citizens.”*

Participant 2: *“In order for the system to be efficient, the installation was done on the roof, as is the preference of many people. A control unit should be established to ensure the quality of the service received for roofing works and the durability of the work done. “I think impartial people should be approved.”*

“The electrical project is drawn and the installed installation is checked. “This gap in the construction part poses a great danger for the environment and the owner.”

Participant 3: *“They are placed on rooftops in an uncontrolled and unsightly manner. The installation work needs to be of high quality. Just like inspections, (electrical) installation work should also be regulated by the government*.”

Participant 4: “*The system is installed at very high prices compared to Türkiye and European prices. I think the ones that are affordable in the market have low production capacity.”*

Participant 5: “*The system needs to be encouraged by the state.”*

Participant 6: *"My biggest expectation is that it will be made legally mandatory, especially in new buildings."*

Participant 7*: "I have been using it since May 2020. I am very pleased with it. I think it meets my expectations. "I think it would be better if this system was further improved financially (in order for it to become widespread)."*

Participant 8:*"It is a huge mistake not to utilize the sun in a country with like this. Considering there are already few trees in our country, and our air is polluted sunlight, I am at least happy about its contribution. My suggestion is for "Our government to support citizens like in other foreign countries, guiding and encouraging them towards solar panels."*

Participant 9: *"Bureaucratic processes should be simplified and financial incentives increased for those who want to set up the system. I also believe that improvements can be made in terms of pricing."*

Participant 10: *"In my opinion, such institutions should be supported by the government, and the government should cover 50% of the cost for each panel."*

Participant 11*: "The system needs to be supported by the government."*

Participant 12: *"Government support is necessary; intervention in costs is needed."*

Participant 13: *"In a time when everything is very expensive, the government must definitely provide support and encourage the use of solar energy for households and businesses."*

Participant 14: "*State support is necessary, incentives should be given, it should be more widespread, convenience should be made for those who want to install it in their homes. A conference should be given to the public on this subject. "Companies that use a lot of energy should be forced to switch to solar."*

Participant 15: *"The installation must be affordable and government support is required"*

CHAPTER VI

Conclusion and Recommendations

In this section, the results obtained in line with the aims and sub-objectives of the research and the suggestions developed based on these results are included.

Nowadays, it is observed that the energy need has reached the highest levels with the rapidly developing technology. As this progress continues, the need for energy will gain momentum day by day and an energy deficit will occur. It is known that energy resources, the majority of which are provided from underground resources, have come to an end and there is a tendency and search for different energy sources.

TRNC has an extremely important potential in terms of solar energy radiation and, as is known, the fact that the sun is an unlimited and limitless energy source, makes it to have a very important place due to its location in the geography we live in. The situation of photovoltaic systems from past to present, their technical features, advantages and disadvantages, the use and examples of photovoltaic systems in the world and in Turkey are examined and examples of the studies carried out for this system in the world are given.

In this study, surveys were conducted among users of photovoltaic systems from various cities in Northern Cyprus, primarily including Nicosia. Following the evaluation, it was found that the participants' greatest expectation regarding solar energy (photovoltaic) systems was from the government. Although these systems are beneficial, they can pose risks in Northern Cyprus, where the electricity infrastructure is not sufficient. Therefore, there is an expectation for government regulation and supervision to ensure control. Additionally, participants expressed the need for the legalization and mandatory implementation of these systems. They emphasized the importance of solar energy panels and highlighted the significance of proper installation and assembly, calling for attention to be paid to these aspects. Participants also noted that the installation of such systems in Northern Cyprus is more costly compared to other countries, and they highlighted the bureaucratic processes involved in purchasing them.

In today's world, solar energy systems hold a significant position in terms of sustainability. However, in the Turkish Republic of Northern Cyprus (TRNC), factors such as low general awareness among the population, inadequate government and local administration support, lack of incentives, and absence of regulations pose challenges. Randomly conducted survey results reveal the lack of knowledge among the public regarding solar energy and the inadequacy of government support policies in this field. Additionally, the lack of inspection and control mechanisms, which could affect the long-term success of solar energy projects, emerges as a significant issue. In this context, it is crucial for effective solution strategies to be developed through collaboration between local administrations and civil society organizations within the country to fully leverage the potential of solar energy in the TRNC and to ensure a sustainable energy future.

The system in the Turkish Republic of Northern Cyprus (TRNC) should be supported by the government, as it is in other countries, through campaigns and funding. Local administrations should conduct studies on solar energy, and the public should be supported and educated on this issue. Given the recent acceleration in construction activities, especially in new buildings, directing toward solar energy is crucial, and incorporating solar energy systems into designs, such as building facades and roofs, is important. The integration of photovoltaic systems with building insulation should emerge as a strategy adopted for energy efficiency and sustainability in modern construction processes.Building insulation is a critical element aimed at minimizing energy consumption and heating-cooling costs. Integrating photovoltaic panels into roof or facade surfaces combined with these insulation systems will optimize the energy balance within a building. Among the advantages provided by this integration are increased energy efficiency, optimized indoor climate control, and the promotion of environmentally friendly energy production during this process. In this context, the integration of photovoltaic systems with building insulation aims to achieve sustainable construction goals and adopt a more effective approach to energy consumption. Subsequently, uncontrolled installation on building roofs or facades should be prevented to maintain environmental balance. Existing buildings should be designed with the assistance of expert consultants and engineers to ensure the most suitable design, incorporating specifications such as mandatory insulation requirements. During the installation phase, legal regulations should provide facilities to users to reduce the costs of implementing photovoltaic systems. Seminars and training sessions about photovoltaic systems should be organized for the community, particularly focusing on technical aspects, and education on this topic should be provided at primary schools, high schools, and universities, especially at a young age. Due to the high initial installation costs of the system, which could have a negative impact on users, the market situation should be controlled by the government or relevant authorities, or various support packages should be provided to offer financial assistance. Effective standards should be established to guide organizations and even manufacturers involved in implementing the system, and these standards should be monitored, especially through local administrations, similar to the practices in Europe. Given that the Turkish Republic of Northern Cyprus (TRNC) is dependent on external sources in many areas, it should leverage its geographical advantage of receiving sunlight throughout the year to actively utilize the energy system and become capable of producing its own energy.

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Attachments

Annex 1. Survey

Annex 2. Ethics Committee Report

Annex 1

YDÜ MİMARLIK FAKÜLTESİ

MİMARLIK BÖLÜMÜ

MİMARLIK YÜKSEK LİSANS PROGRAMI

SOLAR ENERJİ (FOTOVOLTAİK SİSTEMİ) KULLANICI MEMNUNİYETİ

ANKET FORMU

Sayın Katılımcı :

Bu anket formu, Lefkoşa Bölgesinde halihazır kurulu olana solar enerji (fotovoltaik) sistemleri hakkında veri toplanıp yüksek lisans tezinde kullanılacaktır. Toplanan veriler ile sistemin bölge için gerekliliği incelenecektir. Görüş ve önerileriniz bu yüksek lisans tezine katkı sağlanacaktır.

Zaman ayırdığınız için teşekkürler.

Seval Polat

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1. BÖLÜM

1. **Kaç yaşındasınız?**

☐ 0-14 ☐ 15-25 ☐ 26-40 ☐ 41-65 ☐ 65 ve üzeri

2. **Cinsiyetiniz nedir?**

☐ Kadın ☐ Erkek

3. **Eğitim durumunuz nedir?**

☐ Okumamış ☐ İlkokul ☐ Ortaokul ☐ Lise ☐ Üniversite

4. **Mesleğiniz nedir?**

☐ Memur ☐ İşçi ☐ Serbest meslek (esnaf, zanaatkar, vb.) ☐ Özel sektör

☐Öğrenci ☐ Akademisyen ☐ Emekli ☐ Ev hanımı ☐ İşsiz ☐ Sanatçı

5. **Medeni haliniz nedir?**

☐ Evli ☐Bekar ☐ Dul

2. BÖLÜM

1. **Bu sistemle nasıl taşıntınız?**

☐ İnternet ☐Gazete veya dergi ☐Kullanıcı tavsiyesi ☐ Diğer

2-Bu sistem hakkında bilgi sahibimisiniz?

☐Az ☐Orta ☐ iyi ☐ Çok iyi

3-Bu sistemi ne kadar süredir aktif olarak kullanıyorsunuz?

☐ 1 yıldan az ☐ 1-5 yıl ☐ 6-10 yıl ☐ 11-25 ☐ 25 yıl ve üzeri

4. Yıllık üretim gelir – gideriniz hakkında bilgi sahibimisiniz?

☐Az ☐Orta ☐ iyi ☐ Çok iyi

5- Çevreye olan etkileri hakkında bilgi sahibimisiniz?

☐ Az ☐ Orta ☐ iyi ☐ Çok iyi

6- Kurulum maliyetini hakkında bilgi sahibimisiniz?

☐ Az ☐ Orta ☐ iyi ☐ Çok iyi

7- Bu sistemi lefkoşa bölgesi için uygun buluyormusunuz?

☐ Uygun bulmuyorum ☐ Kararsızım ☐ Uygun buluyorum ☐ Kesinlikle uygun buluyorum

8- Sistemin yasal içeriği hakkında bilgiye sahibimisiniz ?

☐ Az ☐ Orta ☐ iyi ☐ Çok iyi

9- Alternatif enerji kaynakları hakkında bilgi sahibimisiniz?

☐ Az ☐ Orta ☐ iyi ☐ Çok iyi

10- Bu sistemi tavsiye edermisiniz?

☐ Tavsiye etmiyorum ☐ kararsızım ☐ Tavsiye ediyorum ☐ Kesinlikle tavsiye ediyorum

3. BÖLÜM

Solar Enerji (Fotovoltaik sistemler) ile ilgili düşüncelerinizi size en uygun seçeneği işaretleyerek belirtiniz.

Değerlendirme ölçütü olarak :

Kesinlikle katılıyorum=5, Katılıyorum=4, Kararsızım=3, Katılmıyorum=2, Kesinlikle katılmıyorum=1 değerindedir.

	5=Kesinlikle katılıyorum	4=Katılıyorum	3=Kararsızım	2=Katılmıyorum	1=Kesinlikle katılmıyorum
Sistem gerekli gereksinimlerimi karşılamaktadır.					
Sistemin kullanım kolaylılığından memnunum.					
Teknik problemlerde tamir sorunu yaşamıyorum					
Sistemin güvenli oluşanmemnunum					
Sitemin kolay ulaşılabilir olmasından memnunum					
Lefkoşa Bölgesinde yeterince tedarikçi firma olduğunu düşünüyorum					
Sistemin devlet tarafından desteklendiğini düşünüyorum					

4.BÖLÜM

Solar Enerji (fotovolatik) sistemleri hakkında beklenti ve önerileriniz nelerdir?

....

....

Annex 2

YAKIN DOĞU ÜNİVERSİTESİ

BİLİMSEL ARAŞTIRMALAR ETİK KURULU

11.12.2018

Sayın Seval Polat

Bilimsel Araştırmalar Etik Kurulu'na yapmış olduğunuz YDÜ/FB/2018/42 proje numaralı ve **"Kıbrıs Lefkoşa Bölgesinde Fotovoltaik Sistemler"** başlıklı proje önerisi kurulumuzca değerlendirilmiş olup, etik olarak uygun bulunmuştur. Bu yazı ile birlikte, başvuru formunuzda belirttiğiniz bilgilerin dışına çıkmamak suretiyle araştırmaya başlayabilirsiniz.

Doçent Doktor Direnç Kanol

Bilimsel Araştırmalar Etik Kurulu Raportörü

Direnç Kanol

Not: Eğer bir kuruma resmi bir kabul yazısı sunmak istiyorsanız, Yakın Doğu Üniversitesi Bilimsel Araştırmalar Etik Kurulu'na bu yazı ile başvurup, kurulun başkanının imzasını taşıyan resmi bir yazı temin edebilirsiniz.

Appendix

Turnitin Similarity Report