OPPORTUNITIES AND BARRIERS FOR THE APPLICATION OF SOLAR HEAT FOR INDUSTRIAL PROCESSES TECHNOLOGIES TO TURKISH INDUSTRIAL PARKS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

SEVGİ DENİZ AKDEMİR

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
EARTH SYSTEM SCIENCE

JANUARY 2021

Approval of the thesis:

OPPORTUNITIES AND BARRIERS FOR THE APPLICATION OF SOLAR HEAT FOR INDUSTRIAL PROCESSES TECHNOLOGIES TO TURKISH INDUSTRIAL PARKS

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ABSTRACT

OPPORTUNITIES AND BARRIERS FOR THE APPLICATION OF SOLAR HEAT FOR INDUSTRIAL PROCESSES TECHNOLOGIES TO TURKISH INDUSTRIAL PARKS

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January 2021, 111 pages

Establishing alternative energy sources is one of Turkey's main goals, as stated by the Eleventh Development Plan (2019-2023). Therefore, understanding the possibility of applying such options is a need in the field. The thesis focuses on identifying the non-technical barriers and solar heat opportunities for industrial processes (SHIP) in Turkish industrial parks (IP). The thesis is expressly framed to support the definition of a European Common Research and Innovation Agenda (ECRIA) on SHIP as part of the European Horizon 2020 project Integrating National Research Agendas on Solar Heat for Industrial Processes (INSHIP). Firstly, the renewable energy (RE) technology potentials and the RE political and regulatory framework of Turkey is summarised. After setting the background, the research continues with two methods of field research in the Kayseri IP. By looking at the current prosumer models, driving, and the barriers to adopting SHIP technologies are examined. These factors feed into a discussion on what is required for prosumer models to increase and be sustainable in the long term. Therefore, they aim to generate a more robust policy discussion on future prosumer models for SHIP technology. The objective is to use the prosumer expertise in developing, producing, and applying SHIP technologies to drive growth in Turkey's renewable energy capacities and markets, and be a major supplier for these domestic and export SHIP markets.

In the existing situation, the most popular project is PV rooftop systems with Feed-in-tariff (FiT) for prosumer in the IP. The thesis results show that the lead investor created a virtuous cycle and synergy, whereby word-of-mouth marketing by existing investors can complement and amplify the governmental investment promotion activity. According to the collected data set, incentives and financial support are top drivers for industries' self-production and consumption choice. Industries are interested in solar thermal energy for their heating and cooling demand. They have a desire to be energy self-sufficient and have a secure energy supply. However, the identified barriers, such as lack of clear policy and regulatory framework, lack of awareness about SHIP technologies, inhibit the deployment of solar thermal usage in the IP.

To sum up, the outcomes indicate that the potential of SHIP exists and requires enterprises willing to take a step forward and move into a potentially innovative industry. By taking into account barriers and opportunities, there is an opportunity for the government to promote the growth of industrial prosumers and deployment of SHIP technology. On the whole, solar thermal offers a win-win approach for companies and also governments to boost their industry and at the same time contributing to both decarbonisation of the energy sector and sustainable development by bringing clean energy sources into their power supply while meeting heating and cooling needs.

Keywords: Renewable energy, Solar thermal energy, Industrial zones, Energy efficiency

ÖZ

TÜRKIYE’DE BULUNAN ORGANİZE SANAYİ BÖLGELERİNDE TERMAL GÜNEŞ ENERJİSİ UYGULANMASINA YÖNELIK OLANAKLAR VE ENGELLER

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Ulusal On Birinci Kalkınma Planında (2019-2023) belirtildiği üzere Türkiye'de alternatif enerji kaynakları oluşturulması ve kullanılması temel hedeflerden biridir. Bu kapsamı destekleyecek şekilde kurgulanan tez çalışması, Türkiye’deki organize sanayi bölgelerindeki (OSB) güneş enerjsinin endüstriyel kazan ve proses ısıtma sistemlerinde kullanımına yönelik imkân ve engelleri araştırmaktadır. Çalışma, Avrupa Birliği UFUK 2020- Integrating National Research Agendas on Solar Heat for Industrial Processes (INSHIP) projesinin bir parçası olarak, endüstride güneş enerjisi ile çalışan ısıtma-soğutma teknolojileri üzerine ECRIA’yı (Avrupa Ortak Araştırma ve Yenilik Gündemi) desteklemek için tasarlanmıştır. İlk olarak, güneş enerjisi başta olmak üzere ulusal yenilenebilir enerji (YE) potansiyeli ve bu teknolojilerin politik ve yasal çerçevesi özetlenmiştir. Sonrasında Kayseri OSB'de gerçekleştirilen iki adet saha araştırması ile devam edilmiştir. Mevcut üreten tüketici modellerindeki (YE teknolojisine sahip sanayi kuruluşu) temel eğilimlere bakarak teknolojik gelişimin itici güçleri ve güneş enerjili ısıtma-soğutma teknolojilerinin önündeki imkan ve engelleri incelenmektedir. Bu faktörler baz alınarak, OSB’deki

üreten tüketici, modellerinin uzun vadede artması ve sürdürülebilir bir enerji kullanımı için nelerin gerekli olduğu konusunda bir tartışmanın altyapısını oluşturur. Endüstriyel proseslerde kullanılacak termal güneş sistemleri ile çalışma, gelecekteki tüketici modelleri hakkında daha sağlam bir politika ve yasal çerçeve oluşturmayı hedefler ve öneriler sunar. Bu bağlamda genel gaye Türkiye'nin yenilenebilir enerji kaynaklarını çeşitlendirmek, kapasiteyi arttırmak ve bu teknolojilerin uygulanması ve yaygınlaştırılması ile tüketiciyi bilinçlendirme ve ulusal ve uluslararası pazarda önemli bir tedarikçi olmaktır.

Mevcut durum analizine bakıldığında OSB bölgelerinde en çok tercih edilen opsiyon Tarife Garantisinden (FiT) yararlanılarak kullanılan Fotovoltaik çatı sistemleridir. Mevcut tüketici modeli incelendiğinde; öncü/girişimci bir yatırımcının oluşturduğu sinerji ve döngü sayesinde, diyer bir deyişle mevcut yatırımcılar (üreten tüketici) tarafından yapılan sözlü pazarlama ile yayıldığı gözlenmiştir. Bu durum, devletin sunduğu yatırım teşvik faaliyetleri ile birleştirildiğinde yeni teknolojiler için en etkili itici güç haline gelmektedir. Toplanan veri setine göre, teşvikler ve finansal destek, endüstrilerin kendi kendine üretici-tüketici tercihlerinde en önemli faktördür. Endüstriyel kuruluşlar bariz bir şekilde ısıtma ve soğutma talepleri için güneş enerjisinin kullanımı ile ilgilenmektedirler ve kendi kendine yeterli enerji ve güvenli bir enerji arzına sahip olma arzuları mevcuttur. Fakat bu teknolojiye ait bir politika, düzenleyici çerçevenin olmaması ve farkındalık eksikliği gibi belirlenen engeller, OSB'de güneş termal enerji sistemlerinin kullanımının yaygınlaşmasını engellemektedir.

Genel olarak sonuçlar, sanayileşmenin yoğunlaştığı bölgelerde güneş enerjisinin kullanım potansiyelinin ve pazarlama imkanın varlığını ve ileriye doğru bir adım atmaya hevesli potansiyel yatırımcıların varlığını göstermektedir. Engelleri ve imkanları hesaba katarak, hükümetin endüstriyel tüketicilerin büyümesini ve bu teknolojinin yayılmasını teşvik etme fırsatları vardır. Güneş enerjisinin endüstriyel kazan ve proses ısıtma sistemlerinde kullanımı hükümet ve sanayi için bir kazan-kazan yaklaşımı sunar. Sanayi kaynaklı enerji sektörünün ısıtma ve soğutma

ihtiyaçlarını karşılarken ulusal temiz enerji kaynaklarını kullanarak sürdürülebilir kalkınma ile beraber dekarbonizasyona da katkıda bulunur.

Anahtar Kelimeler: Yenilenebilir Enerji, Termal Güneş Enerjisi, Organize Sanayi Bölgesi, Enerji tüketimi

To Mom and Dad

ACKNOWLEDGMENTS

A variety of people have contributed to this thesis, both directly or indirectly, and it is a pleasure to thank them. In the first place, I would like to thank the people who supported this thesis with structure, content and ideas for improvement:

- Prof. Dr. Derek Baker – for humanistic attitude and understanding helped me to accomplish my aim. I do not think that there is one single week that passes without my feeling like the luckiest MSc student for having you as my supervisor
- Asst. Prof. Dr. Zöhre Kurt – for your positive approach and guidance throughout the long research and writing period of this thesis from Panama to Turkey
- Res. Assist. Yelda Erden Topal – for giving me wise advice whenever I came to you with thoughts about career, research or academia in general.

Second, I would like to thank the people who have been in general supportive and who stopped me from going out of my senses when writing this thesis:

- My family – for you love, care and support helped me to finish this piece of work, and my aunt, Nesrin Güngör – for super warmth and compassion throughout my life,
- My foodie friends: Taner Berk Bulut, Anıl Eray, Mustafa Can Terzi – for the laughs, the fun and growing up together.
- My sisters: Bengisu Güneş, Ece İbanoğlu , Ece Bozkır, Nil Koza, Fulden Eskidelvan, Filiz Ayaz – for accompanying me on a long, winding journey.

Last but not least, my cousin, Ahmet Emir Güngör, thank you for making me believe that I can handle anything. I'm so lucky and blessed to have such amazing peoples in my life. Hopefully, this is only the beginning!

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LIST OF ABBREVIATIONS

ABBREVIATIONS

CSP	Concentrated Solar Power
EIP	Eco-Industrial Park
EPA	The Environmental Protection Agency
EPC	Engineering, Procurement and Construction
ETCs	Evacuated Tube Collectors
FiT	Feed-In-Tariff
FPCs	Flat Plate Collectors
GHG	Greenhouse Gas
GÜNAM	The Center For Solar Energy Research and Applications
HVAC	Heating, Ventilating and Air Conditioning
IP	Industrial Park
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
KOSGEB	Small and Medium Industry Development and Support Administration
LCOE	Levelized Cost of Energy
O&M	Operation and Maintenance
OECD	Organisation for Economic Co-Operation And Development
OSB	Organised Industrial Zone
PSH	Pumped-Storage Hydropower
PTCs	Compound Parabolic Collectors
PV	Photovoltaics
PV/T	Photovoltaic and Thermal Hybrid Collector
PWEM	Potential Wind Energy Map
R&D	Research and Development
RE	Renewable Energy
RoR	Rate of Return

RSPV	Rooftop Solar Photovoltaic
SHIP	Solar Thermal Energy for Industrial Processes
SME	Small and Medium-Sized Enterprises
SPP	Solar Power Plant
STE	Solar Thermal Energy
STS	Solar Thermal Systems
TEIAŞ	Turkish Electricity Transmission Company
TTGV	Technology Development Foundation of Turkey
TURKSTAT	Turkey Statistical Institute
TÜBİTAK	Scientific and Technical Research Institute of Turkey
TWEA	Turkish Wind Energy Association
UNIDO	United Nations Industrial Development Organization
WWTP	Wastewater Treatment Plant
YEKA	Renewable Energy Designated Areas
YEKDEM	Renewable Energy Resources Support Mechanism

CHAPTER 1

INTRODUCTION

1.1 Thesis Overview

IP is a specific geographic area designated to produce goods, industrial development, infrastructure, and utility services. The word "industrial parks" in the literature and other publications refers to several co-located industrial activities. Related words, such as industrial zones, parks, organised industrial zones, industrial investment regions, special economic zones, and investment districts, vary only slightly in their IP (UNIDO) use. In Turkey, the term generally is defined as "organised industrial zone".

Governments have long used these parks to improve and promote industrial activities and production. Moreover, the parks typically excluded from many of a country's business laws relating to taxation, tariffs, limitations and others, allowing goods produced in the parks. These zones have generated significant benefits for some developing countries. However, on the other hand, these areas also consume vast quantities of all kinds of energy within a relatively limited. The well-defined geographical area makes them significant emitters of greenhouse gases (GHGs), making a significant contribution to climate change. With climate change being one of our time's core development challenges, these problems have assumed rising urgency and requiring immediate consideration and response.

On the other hand, IPs face a series of challenges and opportunities in this evolving global economic, political, and social environment. One of them is growing energy insecurity. These parks are the major consumer of electricity and other sources of energy. A steady and reliable supply of energy, particularly electricity, is a challenge. Also, energy costs are typically a significant part of the total cost incurred by industries operating within parks. These parks are tools that the government can use to drive manufacturing industry. They can also act as a catalyst to facilitate industrial development through renewable energy production and further the Eco-Industrial Park (EIP) concept. In this regard, IPs reflect a potential opportunity to produce renewable energy and climate change mitigation and green and circular economy.

1.1.1 Objectives

Turkey has a good start on transitioning to RE, but still needs to increase its efforts and investment in renewable energy sources. According to Solar Heat Worldwide Report, solar thermal is under constant growth in two major sectors; industrial processes and district heating. Although Turkey is in one of the top 5 countries with solar thermal total capacity, the solar heat for industrial processes is one of the not fully discovered sources (IEA SHC, 2020). Despite this high potential, solar energy is not currently commonly used. There is an exception for flat-plate solar collectors, which are only used for domestic hot water generation, mainly in sunny coastal cities. When considering industrial needs for heating and cooling, solar thermal energy for industrial processes (SHIP) is an up-and-coming market. This master study aims to establish and analyse non-technical SHIP implementation barriers in existing industrial processes in IP. The thesis's general strategy is to examine disseminating SHIP technologies and identify and increase these technologies' market potential under the policies, regulations, and incentive perspective. That provides energy efficiency measures to reduce energy consumption at all stages of the process before considering solar process heat. The main reason for this strategy is not only to minimise industrial energy and, but also to increase in RE's share in energy supply, to help to achieve a diverse energy mix. On the whole, energy security, reduction of energy-related CO_2 emissions from the industry, should be the overall target at the country level.

1.1.2 Research Question

The master project was one part of the larger research project, and the main questions were, thus, virtually the same. The INSHIP Project analyses current implementation barriers for solar integration in industrial processes. It explores the possibilities emerging technologies hold to overcome those limitations. On the other hand, Turkey includes small amounts of solar thermal application and high amount of PV energy used in the industrial sector. Opportunities and barriers of the SHIP technology and differences between the PV, need to identify these gaps that help provide policy recommendations for facilitating successful commercialisation of new and renewable energy technologies. This study is developed according to a list of questions to assess the non-technical barriers of SHIP technology. This master study's research question is "What are the opportunities and barriers to disseminating SHIP technology for an IP in Turkey?".

1.1.3 The organisation of the thesis

The thesis is organised as follows: The next chapter introduces a brief theoretical background on industrial energy consumption and an overview of solar technologies. At the end of the second chapter, the main research goals have been delineated. In the third chapter, RE outlook of Turkey and the selected location, Kayseri is summarised. In the following chapter, qualitative methods that are used to help identify critical barriers are outlined. Then the process of organisation and interpretation of data is explained. The results are drawn from data generated by surveys and interviews. In the following chapter, the overall findings and policy suggestions are presented about barriers, and supporting solutions are established for industrial sectors through a structured framework guided by the method chosen from the literature and best practices of the industry for the evaluation process. Chapter 7 concludes that the limitations of the study are provided, and future research is presented.

1.2 Brief Information of INSHIP Project in Turkey

The purpose of INSHIP is to encourage and organise international cooperation in SHIP research while implementing structured R&D activities: more straightforward integration of low-and medium-temperature technology adapted to the operation, stability and reliability requirements of industrial end-users; expanding the scale of SHIP applications, overcoming the current barriers and increasing synergies within IPs (EC, n.d.). The project consortium consists of 28 members, including The Center for Solar Energy Research and Applications (GÜNAM) where Derek Baker is one of the researchers and representing from Turkey. The project has funded by the Horizon 2020 R&D program of the European Union (under Grant Agreement No 731287).

The thesis has an intention to engaged and align with the proposed SHIP mission and vision for the Kayseri IP and not to frame this research by attempting to respond to a long list of limited and potentially poorly defined objectives derived from the INSHIP proposal. Based on the researcher's background, interests, and experiences and the context defined above, the research would concentrate narrowly on the INSHIP project's objectives. Within the project's frame, the thesis analyses the capacity of SHIP launched by analysing current industrial areas. Factors such as the legal, regulatory and procedural, economic and financial, socio-cultural and technological status of technology are considered to indicate the overall potential and challenges of technology.

CHAPTER 2

ENERGY USAGE IN INDUSTRY AND SOLAR (RENEWABLE) ENERGY TECHNOLOGIES

A literature review was carried out, presenting a more theoretical perspective, providing an outline of the related barriers, drivers, and important actors in implementing sustainable heating and cooling technology. After the overview, more specific details of desktop research are described in Chapter 3, according to this chapter's framework.

The energy market has begun to transform in positive ways, with the widespread implementation of renewables and related technologies opening the way for a sustainable future. Renewable technologies dominate the global market for new energy generation capacity. Solar PV and wind are rapidly becoming the cheapest RE source in many countries. Perhaps most renewable energy sources will be cost-effective over the next decade. It is estimated that renewable power will grow at the highest rate in four years in 2019. Around 2019 and 2024, renewable energy potential will increase by 50%, as a frontrunner under solar photovoltaics growth. Solar PV accounts for nearly 60% of the expected increase alone, and offshore wind contributes 4% to the total rise. Bioenergy capacity is rising as well as offshore wind. Hydropower expansion also constitutes one-tenth of the overall renewable capacity increase (IRENA, 2019).

From 200, to 2019, global renewable power generation has increased 3.4-fold, from 754 gigawatts (GW) to 2,537 GW (IRENA, 2020). Indeed, renewables are rising quite slowly in large energy-intensive sectors, such as buildings and industry. Installation in these sectors stands far below the level required to achieve a climate-safe energy supply. The slow improvement in energy efficiency and renewable energy growth must be quickly reversed (IRENA, 2019). A wide range of classifications can be found in the literature on barriers and drivers for renewable energy technologies. Moreover, there are several interpretations of barriers, with emphasis on various dimensions and specific categories. In this study, barriers are identified as negative factors/disincentive for using and deploying solar heating and cooling technologies for the IP's industrial sectors.

2.1 Industrial Energy Usage and Renewable Energy

Energy consumption in the industry represents approximately 37% of the global overall energy consumption in 2018. Energy-related, direct industrial CO_2 emissions responsible for some 23 per cent of the world's total. According to International Energy Agency, the energy mix transition, especially the move from coal to natural gas, bioenergy and electricity, results in a decrease in the direct level of CO_2 emissions from industrial energy usage. Currently, at total, only 14.5% of that industrial energy demand has come from renewable energy in global. It is estimated that demand for industrial products, relationally and industrial energy consumption increased in the past two decades. Although improvements have also been taken, progress is far too slow (International Energy Agency, 2020).

These industrial energy consumption changes by region, depending on the differences in industrial productivity, energy intensity (as determined by the energy consumed per unit of gross output), and the industries' size. In the industrial sector sub-categories, their energy use is also different and will also be affected differently. As some sectors have higher energy consumption, their impact on output, density and structural impact will be more significant. However, companies can minimise energy use in a variety of ways. Some examples are improving processes to minimise/recover energy (often process heat), and recycling materials and fuel to minimise cost and increase efficiency. In terms of industrial fuel consumption, natural gas, and electricity are the fastest-growing industrial energy use types the OECD (Organisation for Economic Co-operation and Development) region (EIA, 2016).

Industrial energy use includes both electrical and thermal demand. Almost 75% of the industry's energy is for thermal applications, including steam, drying, cooling and other energy needs for industrial processes. The rest is for electrical end-user application, containing the operation of machines and lighting.

The share of renewables plays a small but crucial role, both for electrical and thermal usage. According to the EPA (The Environmental Protection Agency), industrial process heating is ideal for renewable heating and cooling projects (EPA, 2020). Indeed, all low-carbon technologies, including renewable energy and energy efficiency, will play an essential role in moving forward for the low carbon industry. 90% of the demand for renewable heat in industry, comes from bioenergy. Although bioenergy is used in a process that utilises low-temperature heat, such as in pulp and paper production, its consumption in other energy-intense industries is very limited.

On the other hand, solar thermal and geothermal resources continue to grow. They cannot yet supply large-scale high-temperature heat. They cannot cover an essential part of industrial process heat. Solar thermal and geothermal heat are used mainly for heating water, drying, and generating low-temperature heat/steam for industries such as mining, food and beverage production, textiles and agriculture. There is another option that is to use of renewable electricity for thermal heat in the industrial process. Direct use of renewables for thermal demand will satisfy low to medium temperature demands, representing approximately 50% of the industrial heat. To overcome that limitation, a new method is needed to increase renewables and expand the use of a broad range of industrial processes, for high-temperature heat (REN21, 2020).

Overall, the industry sector has a smaller contribution to new installed renewable energy generation capacity. Although energy-intensive industries are expected to be more resistant to emission reduction restrictions and commitment, RE power plants will have much more to benefit from access to compliance-based markets. Moreover, RE concept aims to achieve a well-functioning system and many advantages when joining the Turkish industrial energy market. Mostly, specific industrialised zones or areas play a significant role in the Turkish market's successful growth and provide an attractive framework for investors to start their business efficiently.

2.2 Renewable Energy in Industrial Parks

In Turkey, the IPs are a specific area for goods and services production operated by OSB Law provisions No 4562. They located inside the same industrial areas sharing similar infrastructure, logistics and resources (Ministry Funds for Industry and Trade, 2000).

These parks are tools that the government can use to drive manufacturing industry. Also, they can act as a catalyst to facilitate industrial development through the eco-IP concept. In this regard, IPs reflect a potential opportunity to produce renewable energy and climate change mitigation. These parks usually occupy wide spaces in non-residential areas compared to commercial sites in urban areas. Because they need open space for manufacturing equipment, parking facilities, adequate supply and transportation networks, have deeply committed connections to the national utility network. Although the effect of on-site generation in residential and commercial applications has been extensively studied from a technological and economic point of view, for industrial on-site generation, it is not (Sgobba & Meskell, 2019).

Conversely, the site's power demand can be generated on-site by an adequately sized renewable energy plant. It can be immediately and locally consumed, minimising transmission and distribution losses. On-site generation can help procrastinate or avoid the construction of new generation capacity and distribution infrastructure. It offers rural electrification in off-grid and remote regions. As for large groups involved in various industries, including clean energy, they will also have the ability to decrease their carbon emissions, generate their electricity and sell the surplus from their renewable power plants. The high density of industrial production can also be economically viable for developing common CO_2 infrastructure to capture and useO_2 even from installations with low emissions (EC communication COM, 2018).

On the whole, "industrial prosumers" term comes up. United Nations Industrial Development Organization (UNIDO) describes "Industrial Prosumers of Renewable Energy" as an industry that generates and utilises renewable energy sources such as sun, wind, bioenergy, and other RE sources (UNIDO, 2015). Moreover, it supplies a part or all of its on-site electricity demand. In some of these cases, this refers to the sale of excess energy or electricity to the national/local grid or share surrounding community.

2.3 Definition and classification of Solar Thermal Technologies

Solar energy is one of the significant alternative energy resources due to its low price, and it is carbon-free. Two primary methods are used under the solar energy applications: the 'Photovoltaic' solar cell and the solar thermal collector (CSP included). The first system transforms sunlight into electrical energy. The second heated liquids use the sunlight's heat to generate thermal energy. Both methods use solar energy; however, each system covers a different part of the spectrum; PV covers the visible light spectrum, while the solar thermal collector covers the whole. Solar thermal conversion efficiency is about 70 % compared to PV panels, which has an efficiency of just 17 %. Despite a high conversion rate and a wide variety of uses, solar PV expanded considerably, and solar thermal energy is practically absent, especially from the industrial sector (ESSI, 2011).

Additionally, hybrid renewable energy systems are another emerging trend, such as solar PV with wind power/SHIP/CSP/fossil fuel or renewables with energy storage. For example, solar thermal-photovoltaic (PV-T), a solar hybrid photovoltaic system with solar thermal collectors placed under photovoltaic modules to transform solar radiation into electric and thermal energy. The solar collector eliminates waste heat from the photovoltaic module, making it to work more efficient.

Obtaining direct heat from solar energy with a solar thermal collector is called "Solar Thermal Systems" (STS). The solar energy collected is either directly used by the heating or cooling equipment or collected during the day in a thermal energy storage tank from which it can be used either at evening or on cloudy days. Also, with high-temperature solar thermal collectors, this heat can be used to produce electricity indirectly by coupling the system with a turbine (World Energy Council, 2013).

As a significant component of solar thermal energy generation systems, solar thermal collectors are categorised as low, medium and high-temperature collectors. Low-temperature collectors are flat-plate types can produce temperature up to 100 ºC. They can be commonly used for many applications, such as building heating and cooling, domestic hot water and industrial process heat. Medium-temperature, such as parabolic troughs and parabolic dishes, collectors have a temperature range from about 100ºC to 500ºC. These systems are used for different purposes from heating/cooling for domestic and industrial use to electricity generation. High-temperature collectors, in other words, central-receiver types focus sunlight using mirrors or lenses. They are typically used for electrical power generation. They are capable of generating temperatures as much as 1000 ºC or even higher. They are used to produce electrical power and as high-temperature furnaces in industrial processes. In several countries, including the USA, Spain, India, China, Australia and South Africa, solar thermal power plants based on these concentrated solar collectors, also known as Concentrating Solar Power or CSP, are now being considered and installed by electrical utilities in the range of 1 MW to 300 MW (World Energy Council, 2013). Therefore, STS is different from photovoltaics, which converts solar energy directly to electricity (Bhatia, 2014).

This subtitle 2.3 aims to present briefly the different types of collectors used in industrial applications. In this research, STS is specified as an innovative idea of industrial applications integrated solar thermal collectors, rather than just the basic configurations of space heating and cooling systems and the current trends.

2.3.1 Solar Heat Technologies

The solar thermal system absorbs solar radiation (thermal energy) and converts the heat. The system is used to increase the temperature of a heat transfer fluid used directly as hot water needs or space heating-cooling needs or to transfer thermal energy to the final application through a heat exchanger. The generated heat can also be preserved in a proper storage tank when there is no sun.

The solar heating system is the leading technology for solar thermal heating and cooling system. In 2019, solar thermal heating and cooling systems were used by millions of domestic and industrial consumers. By the end of the year, systems had been sold in at least 134 countries, such as space heating-cooling, hot water and drying products and desalination of water for a wide range of applications and other variety of applications (ETSAP & IRENA, 2015). The most appropriate applications and processes involve cleaning, drying, evaporation and distillation, whitening, pasteurisation, sterilisation, heating, melting, painting and surface treatment. Solar thermal or STE may also be used for the space heating and cooling of factory buildings (ESTELA & Greenpeace International & SolarPACES, 2016).

The global interest in solar thermal systems for industrial processes has gradually increased significantly in recent years. Various successful projects initiated during the last few years range from small demonstration plants to extensive systems. Many industrial processes need large quantities of heat, making the industrial sector a promising market for solar thermal applications.

Temperatures up to 400°C can be supplied with these technologies theoretically fulfilling roughly 50% of the industrial thermal demands. Based on the required heat's temperature level, different types of solar thermal collectors are used (AEE INTEC, 2020).

Solar collectors can capture and transfer solar radiation to the working fluid by converting it to heat. Various fluids, such as water, air, oil or other organic solvents, can be used as a working fluid in solar collectors. The absorbed heat energy in the working fluid can be used immediately for many applications. Solar collectors are generally categorised as non-tracking collectors, which are fixed collectors, which are also known as stationary collectors, and tracking collectors, which are equipped as one-axis tracking, or two-axis tracking collectors, continuously tracking the movements of the sun in order to capture the incoming solar radiation perpendicularly. Evacuated Tube Collectors (ETCs), Compound Parabolic Collectors (CPCs) and Flat Plate Collectors (FPCs) are known as non-tracking collectors. Parabolic trough collectors (PTCs), linear Fresnel reflectors and cylindrical trough collectors are known as single-axis solar tracking systems. Parabolic reflectors, central tower receivers and circular Fresnel lenses are classified as dual-axis solar tracking systems (Suman, Khan, & Pathak, 2015).

Depending on environmental conditions, heat and cooling demands, load profiles and costs, they vary significantly in size and their designs. Solar process heat installations used for the industrial purpose are similar to those used in residential buildings, especially for those applications where only low (<150°C) to medium (150°C– 400°C) temperatures are needed. More advanced or concentrated solar collectors are needed for higher temperatures (>400°C). Heat in the lower temperature range (<120°C) can easily be supplied with commercially available systems such as FPCs and ETCs. The key technology used for medium temperature heat is thermal concentrator technology. Ultra-high-vacuum FPC, ETC with concentrators can be quickly supplied heat in the medium-temperature range (<200°C). Tacking solar concentrators, including parabolic dish collectors, parabolic trough collectors and Linear Fresnel collectors can produce high-pressure steam at temperatures of up to 400°C (ETSAP & IRENA, 2015).

2.3.2 CSP / STE Information

Solar Thermal Energy (STE), also known as Concentrated Solar Power (CSP), is a technique that generates energy by using mirrors to focus direct solar irradiance on heating liquid, solid or gas that is then used in the downstream process for the production of electricity. In contrast to photovoltaic technology, STE provides significant advantages from a system viewpoint, due to its built-in thermal storage capability. Solar thermal power plants can work either by storing heat or in combination with fossil fuel plants, providing secure and dispatchable power at the request of power grid operators, mainly when the demand with peaks in the late afternoon, evening or early morning, or when the sun is not shining (ESTELA & Greenpeace International & SolarPACES, 2016).

For the entire life cycle of the plant, approximately 80 per cent of the cost is from construction and related debt. The rest is from operation and maintenance (O&M). Confidence in technological innovations is essential for financial institutions. It is valid when funds are available without high-risk charges that solar thermal power plant technology can compete with medium-charge fossil fuel plants. However, solar thermal power plants' expense is more challenging to track precisely since there are very few new large-scale projects. Besides, projects designed in recent years differ significantly in terms of architecture, configuration, size and form of thermal storage used, dispatch profile, support structures and financing requirements. These factors affect cost analysis and make comparisons between projects difficult. Unlike in wind or PV, the simple correlation to a solar thermal power plant's power capacity does not give adequate details to calculate either the investment cost or the cost of the kWh generated (ESTELA & Greenpeace International & SolarPACES, 2016).

According to CSP technology's financial situation, solar thermal power plants have achieved significant cost reductions in recent years. According to International Renewable Energy Agency (IRENA), solar and wind power costs have continued to decrease, complementing the more mature bioenergy, geothermal and hydropower technologies. Solar photovoltaics shows the sharpest cost decline over 2010-2019 at 82 per cent, led by CSP at 47 per cent, onshore wind at 40 per cent and offshore wind at 29 per cent (IRENA, 2020).

As for all solar thermal power plants, a large initial investment in new plants is expected. CSP is capable of producing bulk power, and many developed nations are investing heavily in CSP technologies. There are currently four different types of CSP technology deployed in various countries, such as Spain, the USA, China and India. Study and publications on CSP are expanding at an exponential pace. However, there are very few publications on CSP Technologies or industrial usage of CSP Technologies for Turkey in the literature.

For CSP technologies, Turkey has an advantage due to direct solar radiation for the generation of electricity and thermal heat. Moreover, the feed-in tariff is valid for STE technologies (ESTELA & Greenpeace International & SolarPACES, 2016). There is one indication of an unlicensed project in Mersin. Greenway has installed a 5MW CSP tower plant which has been in operation since 2013. This plant was a first of its kind in Turkey and is also the only example of STE working in Turkey today.

2.3.3 Concluding Remarks

In a recent analysis of RE's industry developments, The IEA Solar Heating and Cooling Programme (IEA SHC) note that some technologies have shown stable growth in the last years. In contrast, others tend to have followed a decelerated pattern in previous years. That is especially the case with solar thermal energy also. Partially, these effects seem to have been caused by competition between technologies. In most cases, PV and solar thermal collectors compete for newly installed capacities, with photovoltaic collectors have a commanding lead over in this competition (AEE INTEC, 2019). On the one hand, it is related to the relatively low investment costs and photovoltaic collectors' technological requirements. On the other hand, the economic effects of learning in solar thermal collectors' production have still not been passed onto consumers.

Solar thermal has been the leading emerging technology for renewable energy in total installed power in use for many years. Wind energy reached the same level as solar thermal in 2015 and has been competitive in solar thermal since 2016. In 2018, photovoltaics took over the total capacity of solar thermal. Compared to other forms of RE, the positive contribution of solar thermal energy to meeting global energy demand is now on the side of traditional renewable energy sources such as biomass and hydropower, third by wind power and PV (AEE INTEC, 2019). This thesis is limited to solar thermal energy systems ideal for space heating and cooling systems industrial process heat.

CHAPTER 3

CONTEXT FOR APPLICATION RENEWABLE ENERGY TECHNOLOGIES TO INDUSTRY IN KAYSERI, TURKEY

Supply, trade and secure transmission of energy have always been the leading global concern subjects over the last few decades. Efforts to reduce poverty have increased wellbeing worldwide. In contrast, per capita, energy usage has grown in line with the extensive use of utilities, services and products, such as clean water supply, essential health services, modern agricultural products, machinery and electrical home equipment requirements for a basic welfare level.

In recent years, the energy sector has played a crucial role in shaping foreign policies and regional developments and promoting and enforcing economic decisions with global effects. That affects all business units and sectors, namely agriculture, transport, industry and services, and highly multi-layer and multi-dimensional frameworks. Sufficient and stable energy is the primary driver of the welfare and economic progress of society. As energy-related activities have serious environmental effects, it is essential to have an energy supply that addresses the economy's needs and protects the environment. Therefore, the energy sector has been closely monitored, updated and discussed both in our country and worldwide. While industrial processes worldwide are entering a new and more digital phase, and the primary role of energy in industrial production also undergo fundamental changes. Industrial processes have become more intense all over the world.

Figure 3.1. Global Greenhouse Gas Emissions by Sectors (Climate Watch, n.d.)

Figure 3.1 shows sectoral GHG emissions in presenting sector data in CAIT, from 2016. Some industries account for most energy use in the industry: iron and steel, non-ferrous metals, chemicals and petrochemicals, and non-metallic minerals (Ritchie & Roser, Emissions by sector, 2020). The source of these emissions can be separated into two-source, direct and indirect emissions. Direct emissions are created by burning fuel for power or heat, by chemical reactions, and by leaks from manufacturing processes or machinery shown as %6 per cent globally. Most direct emissions come from energy production from consumption of fossil fuels. Indirect emissions are generated by burning fossil fuels in an electricity generation plant, which is then used by industry to operate industrial buildings and machinery (EPA). In parallel with this development, the energy sector is responsible % 73 per cent of total GHG emissions, and other sectors were summarised in Figure 3.1 in 2016. It would be fair to say that energy is the most significant factor with three-quarters of total emissions. The Energy sector in CAIT includes of several subsectors. Most energy emissions come from the primary producer electricity generation, combined heat and power generation, and heat plants. Another important subsector is Manufacturing/Construction refers to emission from fossil fuel combustion in industrial activities. Overall, the industry is the most significant source of global energy and industrial process-related CO2 emissions with its direct and indirect emissions.

Over the last few decades, substantial progress has been made in reducing industrial emissions of ozone-depleting substances. These are highlighted in the Montreal Protocol, as greenhouse gasses such as nitrous oxide (N_2O), sulphur hexafluoride (SF_6) and others (UNEP, 2020). This reduction shows that reductions in industrial emissions are possible under the right regulatory circumstances. Especially, CO_2 is the dominant residual of industrial greenhouse gas emissions. As seen in Figure 3.1, the main reason for the high level of emissions produced by this sector is the massive electric and thermal energy demand to manufacture consumer products. The primary reason for the high level of emissions caused by this sector is the massive demand for electrical and thermal energy to produce goods and services. A viable solution to reduce the energy sector's environmental impact is to focus more on low-carbon energy sources such as hydro, solar, wind, biomass, geothermal, wave and tide.

The worlds' energy market has begun to transform in positive ways, with the widespread implementation of renewables and related technologies opening the way for a sustainable future. Even though the global financial crisis, the renewable energy sector has achieved significant advances in technology development and power generation project over the past few years. Strong governmental support plays a significant role in shielding the sector from the crisis and propelling its growth. Accordingly, renewable technologies can dominate the global market for new energy generation capacity. Solar and wind technology are the cheapest among the other RE types in many countries. Perhaps, most renewable energy sources will be cost-effective over the next decade. Indeed, renewables are rising quite slowly in large energy-intensive sectors such as buildings and industry. Installation in these areas stands far below the level required to achieve a climate-safe energy supply. The slow improvement in energy efficiency and renewable energy growth must be quickly reversed (IRENA, 2019). While some renewable energy innovations are diffusing rapidly on the market, the energy system is still far from being completely changed.

The restricted supply of total stocks can be seen as a significant future opportunity for companies wishing to develop new growth industries around new technologies.

3.1 Turkey Renewable Energy Outlook

Taking advantage of Turkey's geostrategic location between the regions of production and consumption, efforts have been undertaken to make the country a global hub centre in the energy sector. However, Turkey has a heavy reliance on energy imports. Because of its growing economy, our country ranks among the top countries in terms of energy consumption. Turkey has the highest rate of growing energy demand among the OECD countries in the last fifteen years. While primary energy consumption increased by an average of 6.4 per cent over the period 2014-2017, demand for electrical energy rose by an average of 3.9 per cent over the period 2014-2018 (Presidency of the Republic of Turkey, 2019). Therefore, it aims to become a key energy trading hub in its region by using its energy market size and strategic and economic position. Turkey continues its efforts to expand the share of renewable energy sources to minimise its reliance on energy imports, expand the use of indigenous resources and mitigate climate change (Ministry of Foreign Affairs Turkey, 2020).

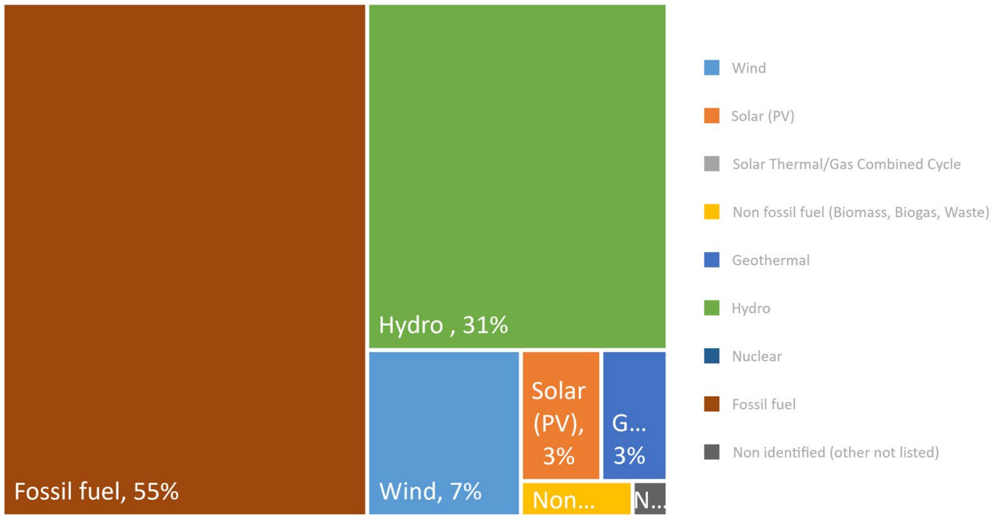

Figure 3.2. Distribution of Energy sources of Turkey According to Net Generation in 2019 (TEIAS, 2020)

Hydraulic, wind, solar, geothermal and biomass (wood, animal and plant residues) energy are the most popular renewable energy sources in Turkey. In the visualisations, Figure 3.2 shows the proportions of energy production in terms of the source. As reported by the Turkish Electricity Transmission Company (TEIAŞ), the largest share is fossil fuels. The second one is hydropower from renewable energy resources. Hydro continue to play a crucial role in the performance of the country's renewable energy success. Also, other technologies, such as geothermal and wind, solar energy have begun to make an impact on the Turkish energy sector. As non-fossil fuel biomass is used for heating and electricity, it can be classified as scarce resources. The pressure can increase in the future to meet national demand.In comparison, Solar Thermal/Gas Combined Cycle and Nuclear energy generation have the label. They cannot be seen in Figure 3.2 because of zero per cent share. When looking at solar energy, the thesis's research subject, PV seems to be the only source.

As a research subject, until 2019, the solar revolution occurred in Turkey that has mostly been limited to photovoltaic systems. In rooftop implementation, most of them are less than 1 MW in size to take advantage of unlicensed FiT schemes. There are licenced and unlicensed ground-based systems also. The electrical energy produced from the renewable energy resources stated in this law was officially guaranteed to be purchased. By comparison, in countries with more mature solar markets, such as Germany, US and Japan, a significant portion of solar power is produced by rooftop solar photovoltaic (RSPV) applications with 1 kW to 10 MW capacity. Given the rapid speed of urbanisation and related residential, commercial and industrial markets, the study concluded that there is significant potential and planned legal framework for PV installation in Turkey (World Bank Group, 2018). In comparison, this rapid solar energy production growth is just valid for only one segment of the solar technologies: the production from PV with high solar energy potential.

3.2 Turkey Renewable Energy Production of Industry

Since the industrial sector has a significant share of energy consumption, it will be one of the critical sectors most affected by energy supply variation. Changes in energy use in the industrial and energy consumption patterns will affect overall energy consumption and economic growth.

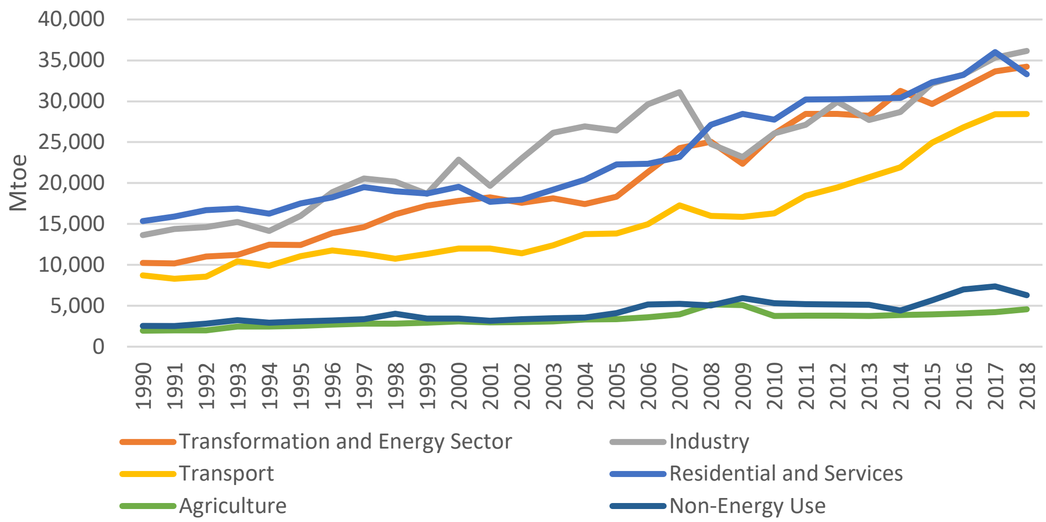

Figure 3.3. Total Energy Consumption by Sectors (Mtoe) (Republic of Turkey Ministry of Energy and Natural Resources, 2018)

For comparison purposes, between 1990 and 2019, sectors' total energy consumption is plotted in Figure 3.2. "Non-energy use" refers predominantly as feedstocks for petrochemicals, and "Transformation and Energy Sector" include heat and electricity generation, petroleum refineries, furnaces, internal consumption, loss. In terms of energy consumption, all sectors have increasing trends. In 2018, energy consumed within industry, transformation and energy sector and residential and services accounted for more than three-quarters of total consumption. At the same time, the government gives priority to production-based economic development in Turkey. It is expected that the ratio of energy use in industry is higher due to rapid industrialisation and also urbanisation. Although several national energy-efficient improvements affect these demands, the current pattern shows that the continuities of these growing in the following years. However, the pattern of these energy uses within the industry can shift domestic energy consumption and renewable energy production to contribute to the Turkish economy's energy security and growth.

As explained in the previous paragraph, to secure and accessible industrial energy and decrease environmental pressure, the contribution of renewable energy technologies can be the solution for Turkey. The existence of "prosumers have supported the rapid expansion of the RE sector with the governmental investment". However, there is no exact data on industrial prosumer or any investment to encourage possible investor from the industry. RE technology is currently an investment to be made voluntarily. However, industries have the most prominent role. They can be a candidate for industrial prosumers who both consume energy and produce energy. Current research shows that the primary renewable energy sources suitable for industrial use are biomass, solar (thermal or PV), ground heat and wind. The development and cost reduction of RE technologies, in which sources are widespread, and the cost of energy provided by RES are moving closer to fossil fuels' competitiveness, make RES a viable option.

Likewise, sustainable strategies and energy management approach at the district level will encourage the implementation of inter-company initiatives that enable energy sharing and joint projects to minimise the use of fossil fuels. Additionally, the IP also has some unique opportunities related to the choice of located in the same area and geographical location that deserve more attention (Butturi, Lolli, Sellitto, & Balugani, 2019). The sharing of the same geographical and organisational environments (climate, energy stakeholders, municipal policies and networks) would be advantageous in adopting renewable technologies aimed at rationalising demand and maximising supply systems. In Turkey, establishing an IP to accelerate industrial investment and encourage technology-oriented development are prioritised by the government with 347 IPs in 80 provinces (Organized Industrial Zones Supreme Organization, n.d.).

3.3 Solar Energy Target and Policies of Turkey

In recent years, new investment models have been applied with frameworks including domestic equipment, R&D, technology development, and public procurement in the field of renewable energy. Furthermore, the country established new targets on RE, and also measures were taken to strengthen the security of energy supply. Although solar power has been used for a long time for water heating purposes in Turkey, its use in power production is relatively new. Turkey prepared Energy Efficiency Strategy Paper in 2015 and determined clear targets for renewable energy-based power production. For the energy utilisation, the target for 2023 is to increase the share of renewables in power generation to 30%. Toward this end, Turkey intends to utilise all technically and economically feasible hydropower capacity (around 36GW) and reach 20GW wind, 3GW solar and 600MW geothermal installed capacity.

Electricity Market Law and Renewable Energy Law are two fundamental laws. Various legislation supports energy provision, moving forward private entities' participation and creating a more competitive electricity market. The Electricity Market Law is the central electricity market legislation that regulates all licensed activities. The Renewable Energy Law is related to renewable energy and, in particular, regulates several incentives for the generation of electricity from RE sources. In addition to these, several incentives are available under laws.

Thanks to Turkey's Renewable Energy Resources Support Mechanism (YEKDEM), since 2011, it was commissioned to make renewable energy technologies more attractive to investors who will invest in renewable energy. A significant benefit of this is that renewable energy plants can sell electricity at feed-in tariffs for ten years after commissioning under the Renewable Energy Law. Incentives are changed depending on the type of equipment used. The improvement of the renewable energy sector and investor supporter opportunities and mechanisms, such as FiT in many renewable energy subsectors, is attractive for the local and international industries and RE companies. Mostly, due to more affordable technology costs, the wind and solar are expected to continue increasing. An unlicensed generation has developed even further than the licensed generation. The benefit of unlicensed projects is to improve power production to satisfy its energy demands (self-consumption).

Additionally, companies must indicate a consumption point to comply with the regulation below 5 MW. Indeed, the regulation does not define any minimum criteria for the point of consumption. The FiT established by the government has been the most significant driver in the RE sector. The support scheme for PV plants has the highest tariff rate and guarantees to pay for ten years. Also, low energy prices for industries cause the use of PV less financially attractive for self-consumption.

A large part of the consumer electricity market in Turkey is to supply energy subject to price regulation. On the other hand, The Energy Market Act allows a market structure based on bilateral arrangements. The price of electricity on the market is decided by mutual agreement between investors and the seller/producer. Consequently, the bilateral arrangements' prices are in the knowledge of the parties involved and are not discussed with the public. The figure below shows a variation in retail energy tariffs (includes system fees, taxes and funds, includes Pumped-Storage Hydropower (PSH)) by tariff types by year in the absence transmission and distribution cost.

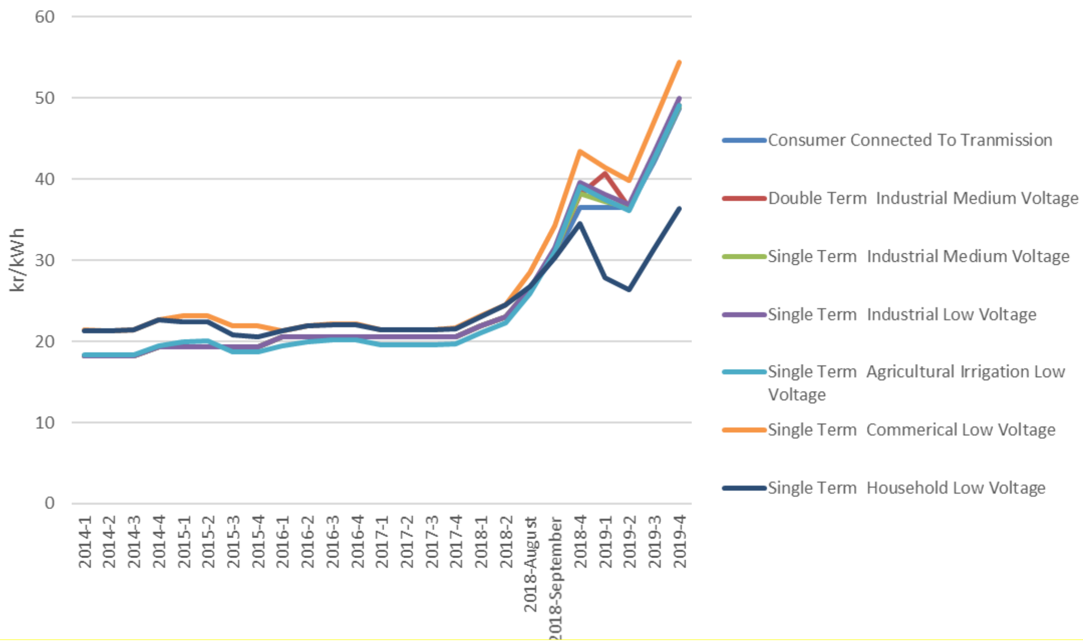

Figure 3.4. Retail Price Excluding Taxes and Funds by Years (Energy+PSH) (kr/kWh) (EPDK, 2020)

Comparatively, the price of electricity in Turkey is not high and is even lower for agricultural and industrial consumers. Additionally, due to the depreciation of the Turkish Lira against foreign currencies, tariffs proved more attractive. The number of renewable energy plants seeking to benefit from USD-denominated feed-in tariffs. As shown in the following parts of this study, these gap causes energy producers to keep their self-consumption at the minimum level (because mandatory) and sell the rest to the government. However, the feed-in tariff covers PV and CSP/STE plants and will be commissioned by the end of 2020. Previously, it was announced that the YEKDEM process would be deactivated by the end of 2020. Turkey's Energy and Natural Resources Ministry announced to end YEKDEM by 2020. It is yet an uncertain replacement for the scheme.

On the other hand, the government has no special attention or incentive to use solar thermal systems, apart from households living in rural areas. As well as, solar thermal energy that is used for water heating does not require any special license or permit. The recent Legislation on the use of renewable energies and energy efficiency requirements (BEPD of Turkey) has provided a set of openings for the solar and HVAC markets. Turkey's National Energy Action Plan has promoted this development and set a new target for the share of renewables in the overall final consumption of heating and cooling at 14.16% from 12.54% (IEA, 2020).

Several incentives/grants are supported by public and private entities under energy efficiency related to solar heating-cooling. Small and Medium Industry Development and Support Administration (KOSGEB) provide appropriate funds for giving training and consulting services to SMEs in energy efficiency. Besides, Turkish Scientific and Technical Research Institute (TÜBITAK) established a different support program to improve R&D under environmental management. The Technology Development Foundation of Turkey (TTGV) offers repaid funding assistance to R&D ventures in environmentally friendly goods, sustainable manufacturing processes, and clean energy subjects (IEA, 2020).

The development in RE production has not yet been followed by large-scale plans to create low-carbon transportation, heating and cooling technologies (Saygin, Hoffman, & Godron, How Turkey Can Ensure a, 2018). In brief, Turkey's clean energy and environment policies are ambitious. Its strategic goal is to minimise energy imports by local usage. Energy efficiency, renewable energy resources and others are the component of reducing the current account deficit. Although Turkey aims to do this, considering the cost-effectiveness of clean energies, such as wind and solar PV, it continues to invest in recent tenders' coal-fired generation. Therefore, new actions are needed to be done, and practices need to be changed to resolve this gap and problem. For example, overlapping and strategies and a limited focus on 2023 can hold back initiatives to create a long-term strategy. In Turkey, where has a great solar energy potential, and many industrial clusters, industrial prosumer can be a solution to create low carbon zones.

3.4 Renewable Energy Potential of Kayseri

Kayseri, located in the south part of Central Anatolia, the area of the city is 16.917 km^2. Approximately 40% of the provincial territory is formed of agricultural lands. According to the 2019 Turkey Statistical Institute (TURKSTAT) data, the province's population is 407,409, and it has a metropolitan status (TUIK, 2019). The industry sector plays a significant role in the economic activities of the region. However, the agricultural sector continues to maintain its importance as an economic activity.

Since the incentive program implemented after 1985, the number of people making incentive investments in Kayseri has risen. Several major companies have been set. Especially with the establishment of the IP and the infrastructure's construction, the priority is given to the region's status. Moreover, there is a rapid rise in the number of large enterprises in Kayseri. Organised IPs and small industrial sites Kayseri is the core of the manufacturing sector. Approximately 47 million industrial areas are planned in Kayseri. Kayseri ranked 6th in terms of the number of industrial enterprises listed in the industrial database (3,645 companies as of 01.02.2017) after Istanbul, Bursa, Ankara, İzmir and Konya. 64% of the industries in the industrial regions of Kayseri are micro-scale, 26 per cent small-scale, 8 per cent medium-scale and 2% large-scale industries (Kayseri Investment Support Office, 2018).

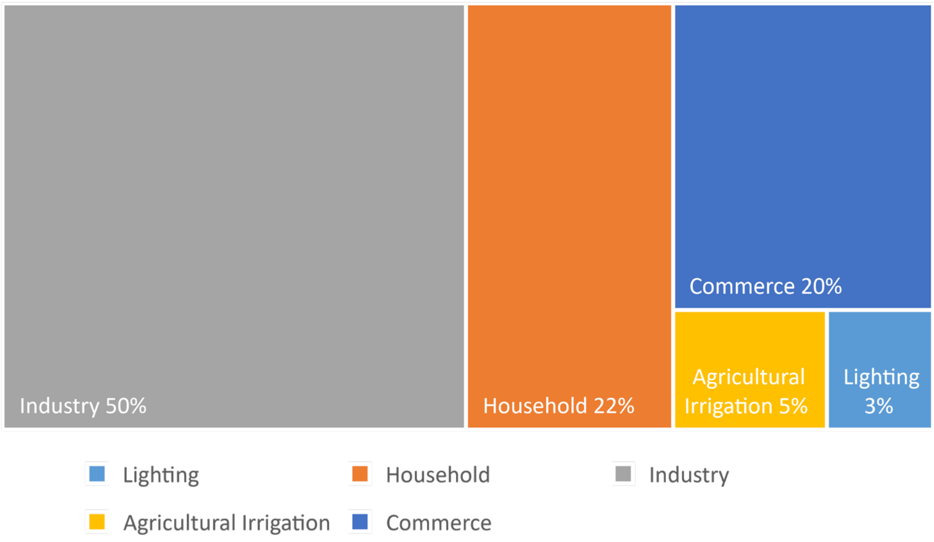

Figure 3.5. Electricity consumption of Kayseri by Consumer (EPDK, 2020)

According to the National Energy Market Regulatory Authority, the province's invoiced consumption distribution is shown in Figure 3.5. Kayseri electricity use in industrial enterprises is a significant share (50%), whereas Turkey, in general, observed that this rate is 41.14% (EPDK, 2020). The development of the province in the industrial sector is directly proportional to industrial enterprises' share in the total electricity consumption. As a whole industry with IP in Kayseri is the large consumer of the electricity and other forms of energy. With increasing, electricity prices and the need for reliable energy supply can become a core challenge for industries and the government.

In the brief environmental analysis of the region can be summarised as follows:

- Emission: According to the evaluations made at the end of 2015 in Kayseri Province Environmental Status Report for 2015, sources causing air pollution are emissions from heating with a rate of 40%.
- Industrial electricity consumption: Kayseri's industrial electricity consumption is 50% of the province's total. All electricity consumption of the province is of the form 1.6% of the country.

- Renewable Energy: According to DSI data, Kayseri has 21 hydroelectric power plants with a total of 483 MWh installed power. In terms of wind, Kayseri province ranks 7th with 4.09% in terms of installed power. Considering the duration and solar radiation values, it is understood from the data that solar energy potential is high in the province (Türkiye Kalkınma Bankası). The most compelling example is solar potential and investment in the Kayseri IP region with 55 MW PV power plant (Kayseri OIZ, 2020).
- Energy Equipment Production (Energy equipment manufacturer SME cluster): According to Regional Development Agency- ORAN, as a city with a developed industry, the current energy equipment productions can be potential for a cluster of energy equipment producers (cable, battery, solar panel, panel carrier, electrical panel, etc.) can be formed in Kayseri, which will be established in the future (ORAN, 2015).

Over the last years, the results of global warming, acidification and environmental disasters have emphasised the need to change the existing world's energy system, particularly as energy demand continues to rise. A significant amount of money has been spent worldwide on RE technologies' developments to ensure continuous energy access without overloading the environment. These technologies could replace conventional energy technologies and are a critical element in reducing energy demand and emissions from energy consumption.

Kayseri is a city with massive industry and suitable for renewable energy technologies in a geographical location in the big city category. Industrial systems have a high potential for energy efficiency and a reduction emission from energy usage. However, energy-savings potentials are not always easy to analyse or implement, even if applied. There are substantial market opportunities for industrial companies in Kayseri to reduce energy demand in new technologies and appliances.

In terms of renewable energy production, the number of active power plants is 84, and the installed power is 835 MW. Annual power generation of these power plants is 2168 GWh. Twenty-four of the power plants are licensed, and 60 of them are unlicensed. The installed power of wind power plants among the power plants located in the province of Kayseri is the second hydroelectric energy and in the third-place are solar power plants. (Enerji Atlası, n.d.)

The selection of technologies was focused on interest and particular relevance for the thesis. Five RE technologies were chosen: wind power, hydro, geothermal, biomass, solar energy technologies (solar collectors and photovoltaic cells). In parallel, a basic understanding of the technologies and the implementation was developed by means literature studies and field studies. Based on these activities, the researcher reformulated research questions for a research project.

3.4.1 Wind Energy Potential

It has been established that wind power plants with a capacity of 5 MW can be installed in Turkey at the height of 50 meters above ground level in fields and with a wind speed of more than 7.5 m/s. Given this admission, a Potential Wind Energy Map (PWEM) was prepared where the source wind information obtained using the weather forecast model. The wind flow model is given (Republic of Turkey Ministry of Energy and Natural Resources). According to PWEM, the wind energy power capacity to be installed in Kayseri has been seen in table:

Table 3.1 Power capacity of wind power plant that can be installed in Kayseri

Wind Power at 50 m (W/m^2)	Wind Speed at 50 m (m/s)	Total area (km^2)	Total Installed Power (MW)
300 – 400	6.8 – 7.5	276.69	1,383.44
400 – 500	7.5 – 8.1	95.20	476.00
500 – 600	8.1 – 8.6	4.85	24.24
600 – 800	8.6 - 9.5	0.32	1.60
> 800	> 9.5	0.00	0.00
		377.06	1,885.28

In January 2020, Turkish Wind Energy Association (TWEA) published Wind Statistic Report that stated that the ranking based on cities, Kayseri is the eighties city out of eighty-one, within 275.10 MWm (installed capacity) wind power installed capacities. Turkey energy capacity is specified to be installed 8.056 MW over the year 2019 by taking 687 MW of plants into operation. (Turkish Wind Energy Association (TWEA), 2020). Although this potential cannot be fully utilised due to technical and economic reasons, the existing installed power can be increased with new investments. Besides, auto producers using renewable energy sources in Kayseri can be encouraged.

3.4.2 Hydro Energy Potential

Hydroelectric power plants are the leading providers of renewable energy capacity and investment in Turkey. As of 2019, hydropower installed capacity reaches to 28.503,00 MW that is 63,9 % of the total installed renewable energy capacity (IRENA, 2019) Kayseri, is located in the Red River Seyhan and is a wealthy province in the river basin. It is possible to use stream resources more efficiently. Currently, Kayseri has installed capacity is 266,748 MWe, 260,585 MWe of it in operation (EPDK, 2020).

3.4.3 Geothermal Energy Potential

Geothermal energy is clean, cheap and environmentally friendly, one of the domestic sources of energy. Turkey is situated in an active tectonic zone as a geological and geographical place. Thus, the country is rich in geothermal energy resources and that have widespread use in Turkey. Today, geothermal energy is mostly used to produce electricity, heating (greenhouses and buildings), thermal and health tourism, industrial purposes, fish farming, drying, etc. (Republic of Turkey Ministry of Energy and Natural Resources, n.d.).

According to IRENA, it possesses the fourth rank of the world's total geothermal installed capacity in 2019. The overall geothermal Installed capacity is about 1.514,70 MW (electric and thermal), 3,4 % of Turkey's total installed renewable energy capacity. In Kayseri, the important geothermal areas in the province are Himmetdede, Bayramhacılı, Kuşçu and Erciyes geothermal areas, and the temperature of the hot water sources varies between 25ºC and 45ºC. However, both sources are used only in tourism, and there is no geothermal energy production (MTA).

3.4.4 Biomass Potential

Biogas is a type of combustible gas that is used to heating up and generate electricity. Biogas is produced as a result of the processing of raw materials from animals and agriculture residues. Various biological substances and residues, such as farm, animal wastes, industrial food waste, degraded plant products, high-energy plants (such as corn or beet) and oils, can be used as input, biomass biogas plants.

The performance of biogas depends on the ratios of methane gas per biogas. Gasifiers convert biomass into biogas converted to electricity by burning it in a cogeneration machine (combined-cycle gas turbine). There is only one biogas plant in Kayseri belonging to the private energy company that generates biogas from these wastes from Kayseri Metropolitan Municipality (from landfill) with a tender. The capability of this plant is reported to be 5.78 MW.

There is significant potential in Kayseri for animal waste and agricultural substrates to create a biogas facility. According to the Assessment of Actual Framework Conditions and Potentials for Biogas İnvestments in Turkey Report, the waste from the Kayseri Sugar Factory and the Fruit Juice Plant have a significant biogas capacity. Regarding the potential biogas analysis of agricultural residues, sugar beet leaves are suitable for biogas production. Kayseri could provide the highest potential. Theoretical biogas potential of agricultural substrates is calculated as 25.233

(TJ/year) for Kayseri (DBFZ, 2011). Livestock farms are dominated by livestock activities that are highly suitable for biogas plants in terms of animals. In addition to these, due to high population of the province, Survival and Sustainability: Environmental concerns in the 21st Century mentioned that Kayseri Wastewater Treatment Plant (WWTP) has high amounts of produced solid wastes and treatment sludges that can be considered as potential (Gökçekus, Türker, & LaMoreaux, 2011).

3.4.5 Solar Energy Potential

Solar energy technologies need adequate, long-term, extensive knowledge of available regional solar radiation data in different forms, depending on the application. Turkey has an enormous solar energy capacity relative to other European countries. According to a study by the Electrical Power Resources and Development Administration, the average daily radiation time is 7.5 hours. The total solar beam radiations per year are 1,527 kWh/m^2 per year. Turkey is never in a weak position to use solar energy. Solar energy water heating is prevalent in Turkey (Republic of Turkey Ministry of Energy and Natural Resources)

The solar-energy potential is very high in Turkey. Especially in the south part of Central Anatolia where Kayseri located and is dominant in the steppe climate. While summers are hot and dry, winters are snowy and cold, in the winter night, temperatures are below 0ºC.

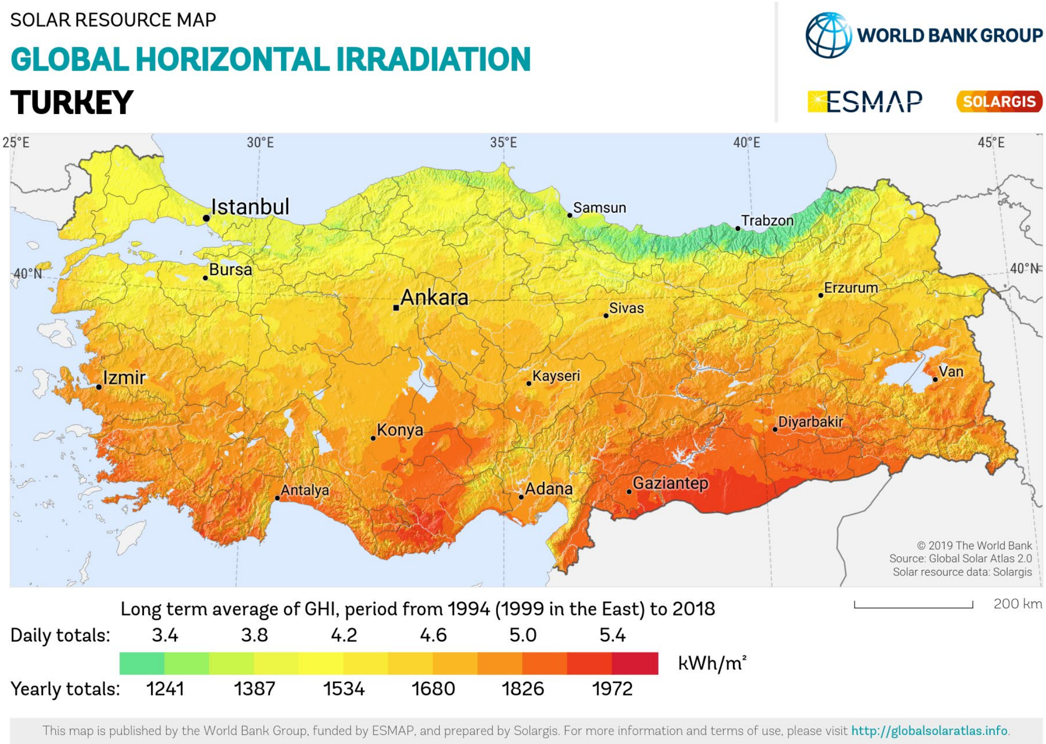

Figure 3.6. Estimated Solar Energy for Power Generation/Other Energy Application (Solargis, 2019)

According to the World Bank, direct average irradiation is the essential parameter for the assessment and efficiency calculation of solar energy projects. Under this context, although Turkey is one of the high solar potentials among EU countries, it cannot use this potential effectively. According to current research, although Spain prefers CSP system as solar energy whereas Germany mostly prefer to produce electricity from PV. Although Spain is similar to Turkey's climate condition, the national policy focuses on PV technology for electricity production, just like Germany (Cengiz & Mamis, 2015). According to the country report prepared under the Horizon STE Project (Grant No: 838514), for Turkey, the critical benefit of concentrated solar energy technology and not so well recognised or known is a solution to storage problems and supply security. Often because the technology is not well known, it is essential to diffuse technologies and become aware of its advantages. New ideas should be made to facilitate this spread, and new systems should be produced. The energy issue is favoured for complementary and combined strategies. Instead of individual CSP plants, hybridisation is critical to diffusion (Ancelle, et al., 2020).

Depending on the local requirements, solar thermal technologies and PV are suitable for renewable resources in Kayseri with enough solar insolation. Within this study gives the potential for the utilisation of solar thermal energy for the selected IPs. Studies on solar heat potential in industrial processes have increasingly gained importance. Many studies have been carried out in different countries. In Turkey, it is not common to use solar thermal energy by industries. Based on those energy values, savings for using solar thermal in the industry are calculated. Kayseri province and regions where the properties industry is dense have high sunbathing. When looking at Kayseri IP, manufacturing industry branches: Many branches can use solar energy, and industries tend to use renewable energy in the organised IP.

3.5 Kayseri Industrial Park

3.5.1 Overview of Kayseri IP

The zone is one of the leading Organised IPs in TR72 Region and the country with its 65 thousand employees in 1166 factories on an area of 22 million m^2 that has been established as IP specialised in energy which will be provided further incentives in addition to the current national incentive mechanisms, will be available to potential investors. Kayseri IP ranks among the top 10 among the country's 298 IPs with its investment, production, employment, and export.

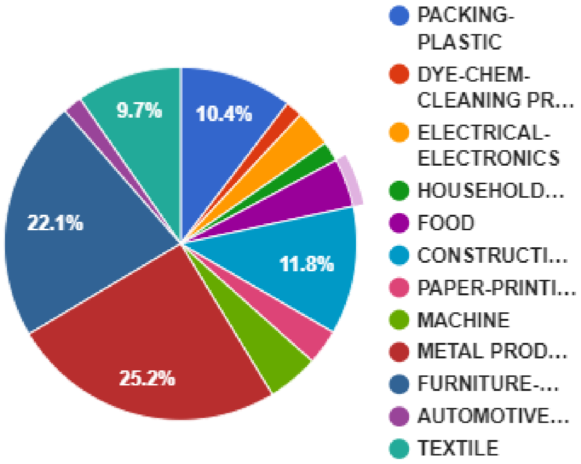

Figure 3.7. Distribution of Companies by Sectors (Kayseri OIZ, 2020)

Industrial manufacturing companies and facilities provide jobs, supplies and new investment essential for an area or a community. Industrial facilities in Turkey have not been evenly spread due to issues such as transport options, terror, population and land. The Black Sea, Central Anatolia and Eastern Anatolia areas have seen a rise in large companies. It is the second-most populated city in the area with extended manufacturing facilities and developed IPs. Moreover, the area includes a furniture industry centre and is home to several manufacturers (Yucekaya, 2018). However, as shown in Figure 3.7, the metal products and furniture-product manufacturing have a high rate.

3.5.2 Renewable Energy Production

One of the critical reasons to make a solar energy investment is the guarantee of purchasing the produced electricity by the government for ten years. It has been confirmed by the Ministry of Energy and Natural Resources and analyses in the previous titles that Kayseri is the region having the excellent potential for solar energy investments in Turkey. There are extensive and nonarable lands in the IP, 930.000 square meters of the area declared as a solar power plant. Moreover, Turkey's Largest Solar Power Plant (SPP) plants with 50.6 MWp the installed with a total of 930.000 m² is located in IP. This project was important because it showed for the first time that solar power plants in Turkey could use central inverters rather than string inverters. SPP facilities are built on IP that does not apply to an industrial parcel due to its natural ground structure and without an opportunity cost. Thus, the idle/inactive area was restructured, and long-term income generation was gained (Kayseri OIZ, 2020).

The energy produced is sold for 13.3 € / cent per KWh with a 10-year purchase guarantee of the state. At the end of this period, electricity will be sold to IP enterprises, and revenue will continue to be obtained. In addition to the unit energy price, IP income will include the amounts collected as "distribution share". The electricity produced at the SPP facilities can meet 20% of the daytime consumption of Kayseri IP. In other words, SPP facilities; It is equivalent to the amount of energy used by 60,000 residences and means saving 187,608 trees annually. In the following years, the solar rooftop PV system is installed on the wastewater treatment facility.

The energy produced in SPP facilities does not create carbon emissions as an edible source. There is no raw material cost, and the supply capacity is not limited. Most importantly, while ensuring the efficient use of national resources, it prevents energy imports. With numerical expressions, Kayseri IP SPP Plants prevent 49,200 tons of CO_2 emission annually and reduce annual natural gas imports by 7,706,766 m³ (Kayseri OIZ, 2017).

In Kayseri, the photovoltaic system is not only attractive for the Directorate, but industries have solar PV rooftop applications. They promise exciting investment opportunities also for the private sector. According to Kayseri IP's website, 18 different companies located in the zone have installed solar panels on the rooftop and produce electricity and feed the grid and use for self-consumption. They benefit from variable outcomes, such as reducing carbon emissions, reducing electricity bill, and generating valuable returns from the FiT using solar power. The region will continue to attract investors by being the most intense region in terms of solar energy plants soon. Another factor that makes the region most suitable is, for sure, ready infrastructure and available land facilities to energy investments.

3.6 Statement of the SHIP Mission and Vision for the Kayseri IP

Solar power has been one of the hot topics in the Turkish energy market in recent years. Given the massive potential of solar energy, particularly in Turkey's southern part, the emphasis on solar energy has stood to reason. Domestic and international companies are continuing to invest in the growing Turkish solar industry. Industrial clusters play a crucial role in meeting both Turkey and European energy. Climate goals and especially manufacturing companies are settled in the same area. In their industrial process, high demand for fossil fuels for heat generation is one of the most significant greenhouse gases emission sources. Specifically, process heating and cooling require a high amount of energy, and fossil fuels generally are the first choice of the industries. As mentioned in the previous part, it is commonly possible to work on an action plan showing the potential of emerging process technologies motivated by renewable energy. Turkey has a good start on shifting to RE; however, it still needs to increase its efforts and investment in cleaner energy sources. The SHIP is one of the not fully discovered sources. In previous episodes, through Kayseri IP, renewable technologies' potential is explained as the pilot case. The inference is that solar thermal heat is a viable technique; however, it has not been widely used.

The master project was one part of the larger research project, and the main questions were, thus, virtually the same. The INSHIP Project analyses current implementation barriers for solar integration in industrial processes. It explores the possibilities emerging technologies hold to overcome those limitations. To facilitate the understanding, these barriers are generally categorised into five different categories related to legal, regulatory & procedural, climatic, economic and financial, socio-cultural and technical aspects. This master study aims to establish and analyse only the list of regulatory barriers of SHIP implementation in existing industrial processes.

This study is developed according to a list of questions to assess the barriers of SHIP in Turkey. The study helps their analysis, choices of appropriate design options and, eventually, decision-making for the demonstration. Depending on the differences between different demonstration site, some barriers can be more relevant than others, and a selection is to be done. At this step, it will be useful to define the gap under the market potential takes policies, regulations, and incentive into account.

The set of questions developed during this analysis will enable assessing impacts related to solar heat technology implementation. The primary and sub research questions are tried to answer through qualitative research through desk research and field research. In the following parts, this study provides a visualisation of the limitations of the regulatory potential.

3.7 Concluding Remarks

According to OECD studies, Turkey has the highest regional disparity among 30 OECD countries. One of the intended outcomes can be ensured the elimination of regional disparities, the development of local and regional potentials and caused the understanding of sustainable development to gain importance in Turkey. Overall, it is crucial to ease the pressure on scarce resources and investigate alternative sources. The first step is evaluating IPs in territories, and more specifically, by looking at provinces. The tendency on RE technology of the parks is the main factor of selection field study. Furthermore, since the Kayseri has the biggest SPP, it can be a perfect fit.

According to the comparison between the different provinces, Kayseri has a performance usage of solar energy technology. In the second step, the thesis moves one step forward. It sheds light on potential solar thermal technologies integration in industrial processes. The researcher did the viability study on solar heat usage and looked at the allocation of public resources and private sector investments with incentives and other support instruments.

The field study aims to analyse the enabling factors for the implementation of the SHIP technology. The selection of the field was made in a participatory way in line with the project objectives. Some factors that led us to choose Kayseri IP:

- Geographic location,

When solar energy maps are examined, it is seen that primarily southern and eastern parts of Kayseri province are suitable for electricity generation from solar energy. Central Anatolia is Turkey’s fourth critical region for solar energy. Kayseri is one of Turkey’s high potential cities with an average insolation time of 7.8 hours a day (Kayseri Investment Support Office, 2018).

- High Production, Investment and Export Density,

Kayseri IP ranks among the top 10 among the 298-IP in the country with its investment, production, employment and export. It is located in the top 10 with investment, production, employment and exports among the approximately 300 IPs in Turkey. Kayseri is the second incentive region; to reduce the development gap between provinces and boost its production and export potential in the national and global market. Investment Rate (%) is higher for the second region than in many cities, such as Ankara, İzmir, Antalya (Kayseri Investment Support Office, 2018).

- Innovation Capability of Companies/ Entrepreneurship,

As a reference point, Kayseri IP has the highest SPP in Turkey and the IP, ten companies, have a solar rooftop system. Accordingly, companies and Directorate are open to new technology. Furthermore, in 2018, 15 private companies have a solar rooftop power plant. In other words, the IP include 15 different prosumers. According to the first survey, the use of PV panels in IP started with a company's initiative. In line with this company, 15 companies installed PV panels.

CHAPTER 4

METHODOLOGY AND DATA COLLECTION

Previous studies related to the current situation analysis and resource allocation were discussed under the third chapter with the best practices globally. Then, “Background Information” is identified regarding Turkey's situation analysis and outlook of renewable energy potential. It is continued with priority-setting strategies and prioritisation policies of renewable energy technologies conducted by desktop research. These give an explanatory statement on the genesis and justification of “the raison d ‘être” of the thesis. The industries’ attitude towards solar energy, and the reasons for using PV panels instead of solar thermal, need to be identified. Moreover, the analytical framework used for data analysis is explained.

Under the fourth chapter, the research strategy and then, data collection methods of the field studies are introduced based on renewable energy technologies. After these desktop research, the field study administered two steps and consequently, the two different data sets. As this thesis is based on two types of data sources, related data in the different collection ways were applied. The thesis draws on data from industries' attitude and behaviour in Kayseri IP that analyse the industry's current and potential solar energy usage.

The first subheadings explained the statement of the methodology and followed by the field research. Then, in the second, the interview with who have already purchased solar power systems are given. This first field research enables the theoretical framework on which the study is based to become operational during the field research phase is examined in detail. As second field research, the survey is used to learn more detail and project-specific response about the solar thermal integration in industrial processes. The sources of the data produced and the data collection process are described.

The fourth chapter of the thesis aims to support desktop research to understand the IP's current status. The conclusions obtained from the previous study, correlating with the results coming out with information gathered in the research field, are to identify the main problem areas are the subject of study.

4.1 Statement of the Proposed Methodology and a Viability Study

This study focuses on the role of non-technical factors for solar integration in industrial processes and factors in the diffusion of emerging technologies PV. In the end, recommendations concerning the marketing and development of solar technologies are identified. For this purpose, the research's primary motivation is to examine the dynamics of the key actors in the field of solar-based energy generation IPs. The study sought to answer fundamental research questions "what are the barriers behind of the solar heat integration in industrial processes in Turkey" is the question.

The data were collected in two stages: "Personal Interview" and "Survey towards Solar Energy Usage". In the previous parts, collected data from written sources (thesis, documents, reports) helps to select the field as Kayseri IP. Conduct field studies are essential as they are the extension of written sources into real-life situations of organisations and society.

The first data set was collected from the personal interview of the solar power "prosumer" (who have already purchased solar power systems~PV). For this study, six different prosumers of twelve were interviewed to identify the current barriers and drivers in decision-making and the installation and maintenance process. The purpose is to learn about market barriers, opportunities, and requirements from people knowledgeable about PV.

The second data set was collected by the survey administered to 68 members and the IP Directorate. Answers of the survey indicate barriers to solar power adoption and the awareness and viability assessment of solar thermal technology.

Both photovoltaic and solar-thermal systems have great potential for expansion and development. However, Turkey includes small amounts of solar thermal application and high amount of PV energy used in the industrial sector. Barriers of the SHIP technology and differences between the PV, need to identify these gaps that help provide recommendations for facilitating successful commercialisation of new and renewable energy technologies. For these reasons, data collected from industries who are target group are analysed to understand the role of institutions and organisations in the diffusion of renewable energy technologies.

4.2 Interviews

The Kayseri IP is a unique IP in Turkey that generates a large proportion of its energy needs from local resources. According to Kayseri IP Regional Directorate, as of 2017, with additional investments, the land-based plant's installed capacity is 50.6 MWp, the largest solar power plant in Turkey. This fact can be a start of how renewables can fuel the industrial area. According to Kayseri IPs' web site, in 2018, there were 15 private rooftop solar power plants, and more were under the application and design stage (Kayseri OIZ, 2020). Even if there are investments in solar power, all mentioned plants are one type of solar power system that is PV. With this knowledge, field research was structured as follows:

The main field research objective is to collect information of companies, products and applications in PV systems and outline the "lesson learned" from the solar energy implementation. In other words, to identify the drivers of PV systems and the current barrier for RE in the decision-making. These can help set up a standard to assess current SPP users' Turkey market dynamics in the IP.

Target Group and Data Type: After the research has set purpose, and the primary research question has been decided, the researcher continues with the data-gathering phase. This study's first data source is the interview conducted with our first target group who have already purchased solar power systems in the IP. The working group consists of 6 prosumer that are knowledgeable about solar technologies and willing to interview. Since, the data represent experiences, perceptions, opinions, feelings, and knowledge of the target group, the interview method, is considered the most appropriate. In the interpretation, these data can clarify the local companies' problems and solution for the solar system (Patton, 2014).

Furthermore, the potential number of prosumers that could be interviewed was limited by 12 companies with solar rooftop PV plants in the Kayseri IP. Because this number is relatively small, all the prosumers are targeted in this interview.

Data Gathering: According to Patton (2014), open-ended interviews is of way to gather qualitative data, end to learn people perceptions, opinions and knowledge. The design of the interview form enables the researcher to follow the questions in a specific order. It makes the theoretical framework operational in field research. This guidance helps the researcher to see and concretise the conceptual framework in the field. As guidance, Patton (2014) suggests three approaches for the production of qualitative data through the interview method: Informal conversation interview, and interview guide approach, and standardised open-ended interview. Researcher adopts two types; informal conversation and standardised open-ended interviews. Since open-ended interviewing is aimed at capturing interviewees' experiences with and perspectives being evaluated to facilitate interview participants expressing their experiences and judgments in their terms, standardised questions to provide each with the interviewee the same stimulus and to coordinate interviewing and minimal changes help to make the interview questions more understandable for each interviewee. In each interview, the researcher makes sure that all questions are covered, and keywords are captured from the responses. (Patton, 2014)

Interview Team and Schedule: The researcher conducted interviews from the 10th of December to the 14th of January 2018.

Interview panel: In 2018, apart from the Directorate SPPs, 15 plants and 12 different companies, prosumers identified from the Kayseri IP website are also confirmed by the Directorate. To help mitigate some of the bias and validity threats inherent in qualitative research, it tried to obtain the maximum number of prosumers.

Dissemination and application methods:

Interviews were conducted in Turkish, and all interviews were tape-recorded transcribed by the researcher. In the standardised open-ended interview, the standardised questions are asked to all interviewees in the same order. In total, the interview has 20 questions. The interview guide consists of three standardised demographic questions and five questions about the solar PV installation's details. Moreover, it continues with four questions about reasons to install a solar photovoltaic power system. Later, three questions are about supports received. Lastly, five questions are searching for barriers and drivers to increasing RE in the IP. Sub-questions were only asked if the interviewee's answer to the initial question did not cover specific topics of interest. To get core responses, interviewer stuck inductive way of asking. The interview was divided into the following six parts of the investigation:

I. Background information on the Interviewee and the Organisation /Demographic Information
II. Existing Solar Power System
III. Perception in RE Incentives and supports
IV. Barriers and Drivers of RE Technology based on solar energy

The question form is given in Appendix 1. All of the companies that have solar rooftop PV plants in the Kayseri IP were called and asked them willing to be interviewed would be available at suitable times. Also, they should have the necessary experience about the systems to be involved in the study. In line with the answers, interviews were conducted with six different companies. Researcher arranged the interview date, time, and topic beforehand with an email that contained the consent form and research preamble and questions. In each interview, the consent form was shared and signed by the interviewees, involves the researcher’s name and institutional identity, and the research's nature and scope. The interviews have been handled with complete confidentiality. The researcher sustains their confidentiality in the study, assigning each of them the number that the researcher uses to identify the respondent. If subjects approve it, the researcher took the notes or a copy of the interview tape. After each interview was completed, and while the thesis was written, the resulting notes/records and data files were kept in a protected lockbox. The interviews' raw materials (notes, recordings) will only be held until the thesis has been successfully defended. At that point, all supporting materials will be destroyed.

4.3 Survey

The second data source used in field study is the distributed industries located at the Kayseri IP. The survey was developed and distributed to industries to identify the most significant soft decision factors, obstacles and drivers in implementing solar energy and the SHIP technology.

Target Group and Data Type: The survey was handed out to companies located at the Kayseri IP. The first segment industry was the food sector segment, followed by textile and machine segments in parallel, then finalised with the IP Directorate. According to Directorate, the IP had more than 1,118 companies, and among them, 68 were fully completed. Additionally, the survey was filled by the Directorate of the IP.

It is necessary to have a group of people who will participate in the survey and the whole target population. This group is called a “sample”, and the sampling is the process of selecting the sample from a larger population (Churton & Brown, 2009). The sample frame is representing all population that is all companies in the IP. Purpose sampling is a technique commonly used in qualitative research to analyse and select information-rich situations for the most efficient use of limited resources (Patton, 2014). In this sampling type, participants are chosen from the target population based on a specific purpose with the study objective and relevant criteria.

With purpose sampling, the researcher believes that some subjects are more fit for the research than other individuals (Daniel, 2011).

The survey aims to identify barriers and drivers of integrating a solar thermal plant into the industrial process, elaborated in detail in the following paragraphs. Moreover, the results will allow designing policies to support the market's formation to ensure the deployment of renewable energy technologies. In this fieldwork, the researcher is strategic in selecting a limited number of industries to produce the most useful information for the study's aim. To illustrate the characteristics of particular subgroups of interest and to reach information-rich situations, stratified purposeful sampling is used. (Patton, 2014). Since, prime application areas for solar thermal systems are in the food, beverage, textiles, paper, metal treatment, machinery, these sectors were given priority in the survey application (ETSAP & IRENA, 2015). Due to process heating requirements, these sectors have a potential opportunity for integrating solar thermal process. This exploratory survey work gives way to reliability and validity fieldwork in this well-ordered analysis of the research process. After these selected sectors, the survey continued without criteria with other industrialists in the IP.

Data Gathering: Although Taylor-Powell & Hermann (2000) mentioned five survey methods; email, telephone, face to face, handout, electronic, they highlight that there is no perfect way and each type needs analyse in terms of the content, participant, timeline and resources. During the survey period, due to Covid-19, face to face and handout methods were eliminated. Moreover, because of time constraints and working single people, an electronic survey was chosen at the beginning of the fieldwork, web-based survey sent by email to communicate industries. A web-based survey was designed and requested companies to respond to the survey. However, the survey was emailed to more than two hundred organisations, and thirteen companies respond. Therefore, it was decided that the survey team would grow by adding two more university students (graduate-level field researchers).

Later on, the method was to switch to the telephone survey, which was chosen because the survey was short, time was limited, and telephone numbers were easy to reach (Taylor-Powell & Hermann, 2000). Eventually, the survey was reached 69 response at total. The highest response rate was collected from a telephone call, and survey questions asked on the phone.

The main survey objective: The main survey objective is to collect information for viability assessment of solar thermal technology to make a general recommendation to embrace the applications. Both photovoltaic and solar-thermal systems have great potential for expansion and development. However, Turkey includes small amounts of solar thermal application and high amount of PV energy used in the industrial sector. Barriers of the SHIP technology and differences between the PV, need to identify these gaps that help provide policy recommendations for facilitating successful commercialisation of new and renewable energy technologies.

Survey team and schedule: The survey team was composed of the researcher and two university students. The 69 surveys were conducted from the 28th of August up to the 30th of November 2020.

Survey panel: According to the company list on the IP website, there are 1,118 companies in the region. As summarized in Figure 3.7, 25 per cent belong to the metal sector, 22 per cent to furniture, then it continues with construction, textile and food. In terms of the ST application, these sectors are promising and suitable for the application.

Dissemination and application methods: Using the websites of the IP, a list of companies was compiled. Those that provided email addresses and telephone number on their websites were contacted. Initially, the project information was given, and they were asked to complete the questionnaire. Then, to get more response, the questions were tried to be answered over the phone.

The first part of the survey is the introduction. The preliminary questions were asked about the profile of the participant and the institution. After the introduction, the survey form was established on base on four main topics. These topics shape the sections' contents in the survey form and constitute the data analysis process's meta-analysis categories. These sections were:

I. Background information of the Respondents and the Companies
II. The Potential of Solar Thermal Technology
III. Companies’ the Perception of Renewable Energy and Knowledge
IV. Renewable Energy Use in Kayseri IP

Three types of questions were used. Multiple-choice questions were used to compare various RE technologies and obtain the participant's perception of currents systems and factors. Also known as the yes-or-no question, closed-ended questions were used to explain how participants view things and their experiences. Numeric open-ended and open text questions were used to know the electricity usage and temperature level of heat required in the industrial process. An open-ended question gives people the chance to answer in their own words to provide details. Some respondents provided multiple responses. Not all respondents answered every question in the questionnaire. The total number of responses varied from one question to another. For each of these field researches, further headings of the study provide data display and analysis. The thesis shares the essential findings on the level of awareness, consumption patterns, consumer behaviour, market trends and growth, and market challenges and performance from the field researchers.

CHAPTER 5

DATA DESCRIPTION AND ANALYSIS

5.1 Description of Informants – Profile Study

The research methodology's proper planning is a significant step from the early stages to the final phase. Data collection, data storage and data management are essential for every analysis. The data are back from the interview and surveys. It is time to begin the process of organisation and interpretation of data. After all, data have been collected and categorised. Generally, it is analysed using techniques available to researchers to ensure that they support the final research objective.

After the collection, it is time to data description. The differentiation of description from the interpretation of data is a core principle of science. Interpretation includes explaining the data, answering “why” questions, adding value to data, and setting trends in an analytical context. It is desirable to move into the displaying and interpreting data before the description of data in a properly designed format. First, it comes to the description (Patton, 2014). Display and description of data are essential parts of every research project that help distribute data, identify errors, miss data, and outliers. At the end of the period, the data should be understandable and more meaningful. Moreover, the data description can allow understanding the data and best extract useful information from both objectively and subjectively provided data.

In this chapter, the description of data and display of results from the interview and survey are given. Tables and graphics are widely used to illustrate all quantitative data in this study. Also, graphs are used for displaying data and then analysing data variations and patterns. In the subchapter, organising and reporting data are covered in detail to analyse both field studies data as a typical investigator would. The goal is to create a report that would allow us to best extract useful information from objectively and subjectively provided data.

The list of questions was categorised into sections and subsections worked out before fieldworks when it comes to organisation. Researchers grouped questions related to the same topic under four parts (I, II, III and IV). The parts represent general topics, and subsections focus in on more particular ones. Thus, these parts represented the main description categories for reporting the data analysis. The categorised questions were transferred into an Excel sheet. Using a few standard Excel functions, the categories were organised for coding. After coding in Excel, the data from fieldwork can be entered and sorted by content.

According to Ose (2016), there can be a need for an inductive approach in applied social sciences, whereby the researcher does not have an explicit theory or hypothesis to test. Instead, the findings should be focused on the experiences reported by several respondents who have first-hand knowledge of the analysis subject. Since the results should not be focused on just a few voices, it might be appropriate to perform multiple interviews or surveys. Many social scientists are unwilling to include many interviews due to the vast amount of qualitative information collected. Efficient methods for organising and structuring data are required in such projects. The method of using Excel and Word is structured but not very complicated or time-consuming. It is suitable for coding and structuring answers to open-ended questions in Web-based surveys (Ose, 2016).

5.2 Interviews Results

Qualitative data was collected from interviews with current prosumers. During the interview, the researcher set up a recording device to capture all of the conversations. Then, interviews were transcribed and typed into an Excel sheet prepared before and explained in the previous title. Consequently, electronic data was prepared and ready to be described and analysed. Using standard Excel functions, the researcher extracts the summary answers for each question, describing the summary statistics for numeric data. A list of verbatim responses to the open-ended questions.

Researcher checked the data to see if something needs to be corrected. In the interview, description and analysis use data from all six interviews. If there was missing data for questions, each question's actual number of responses could be varied. In a principle of study, for handling missing response, the data is ignored. However, in this fieldwork, there is no missing data or missing response of questions.

The purpose of the interviews is to determine the subjects' motivations in contributing to the PV power system and the experiences and perception of early adopters, in other words, prosumers, about the solar energy power system. Because prosumers are only 12 companies, this field study involves interviewing these people who know the current system in these companies. The number of interviewees is quite limited. The researcher asked the same questions in the same order. These questions are categorised under the following parts:

I. Background information on the Interviewee and the Organisation /Demographic Information
II. Existing Solar Power System
III. Perception in RE Incentives and supports
IV. Barriers and Drivers of RE Technology based on solar energy

Part I: The first part of the interview aims to create an atmosphere conducive to an open and free-flowing discussion. To reach the interviewee again when needed contact information of the person (name, phone, email, position) is asked. Furthermore, the conversation continues with information about the company (name, address, phone, product). This information can be used for the demographic segmentation of the audience.

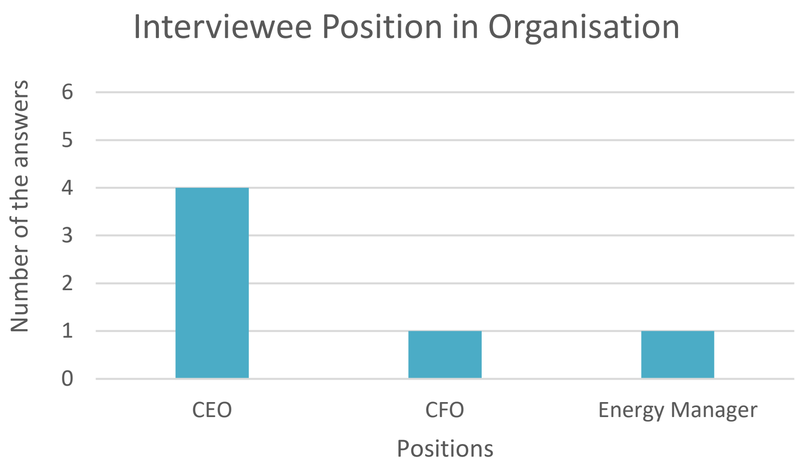

Figure 5.1. Overview of Interviewee Occupation in Organization

Figure 5.1 summarized that the majority of the interviewees are their chief executive officers (CEOs). According to the Directorate, 90% of the 12 companies are small and medium-sized enterprises (SMEs). In the SMEs where usually, the decision-making process is highly centralised. Critical decisions, such adoption and implementation of innovation will be strongly influenced by CEOs interest and perception (Mortara, Minshall, & Ahn, 2014). After the personal information, the researcher asked information about the company such as sector and leading products. When we asked how they decided to implement, the answers were that they were affected by another company's implementation.

Table 5.1 Interviewing Company Coding and Industry

	Industrial Sector
Company 1	Steel Wire and Cable Sector
Company 2	Food
Company 3	Construction Materials Manufacturer
Company 4	Textile
Company 5	Metal Production
Company 6	Mining (Marble)

Part II: The second part of the interview examined the existing installed RE systems and capacities. It was no surprise that the solar panel is the most popular technology. Until the publication of the new Regulation on Unlicensed Electricity Production in Electricity Market (dated the 10th of May 2019), the upper capacity limit of unlicensed RE system was 1 MW. Therefore, they chose to benefit from an unlicensed generation at that time. The installation of generation and consumption facilities for unlicensed generation in the same distribution area is still mandatory. It must be noted that after the new regulation, the unlicensed limit has been increased to 5 MW only for roof or façade application (Energy Market Regulatory Authority, 2019).

Table 5.2 Overview of Existing and Operating Solar Power Plant

	Installed Systems	**Capacities**	**Current Uses for RE**
Company 1	Unlicensed Solar Rooftop	0,8 MW	Feed-in tariff + Self-consumption
Company 2	Unlicensed Solar Rooftop	1MW & 0,5MW	Feed-in tariff + Self-consumption
Company 3	Unlicensed Solar Rooftop	1MW	Feed-in tariff + Self-consumption
Company 4	Unlicensed Solar Rooftop	1MW & 0,5 MW	Feed-in tariff + Self-consumption
Company 5	Unlicensed Solar Rooftop	0,42 & 0,36 MW	Feed-in tariff + Self-consumption
Company 6	Unlicensed Solar Rooftop	0,8 MW	Feed-in tariff + Self-consumption

In 2018: According to Directorate of IP, there were 12 different companies as prosumers. Furthermore, all they had unlicensed rooftop PV systems. Interviews data can be verified PV as a popular and dominant solar technology type. The unlicensed market regulation applies the self-consumption requirements. Production and consumption must be at the same point. Whereas, there is no lower limit for consumption. All companies interviewed stated that they give almost all of their energy to the grid and fulfil the minimum consumption requirement.

Part III: The discussion moves on to the interviewees' attitudes, opinions and experiences of the existing system, incentives, supports, and perceived support from central government, local, and provincial governments. Furthermore, the part identifies non-technical barriers and drivers of RE Technology based on solar energy. When it comes to financial support during the investment, 83% received a bank loan, 0.17% used private equity. Only one company benefited from the fund of Regional (Oran) Development Agency that was valid for a short time and received 1/3 of sources from the fund and 2/3 from a bank loan. The other type of support was the technical support, %100 received support from Engineering, Procurement and Construction (EPC) Companies. When the researcher asked the received training or any other informative activity, there were no effective awareness programs or capacity building activities. These activities can educate customers about the real feasibility or implementation of solar technologies.

Part IV: The fourth part of the interview asked interviewee the detailed question from early users' perspective. Turkey offers investors favourable incentives, such as feed-in-tariffs, purchase guarantees, connection priorities, and license exemptions.

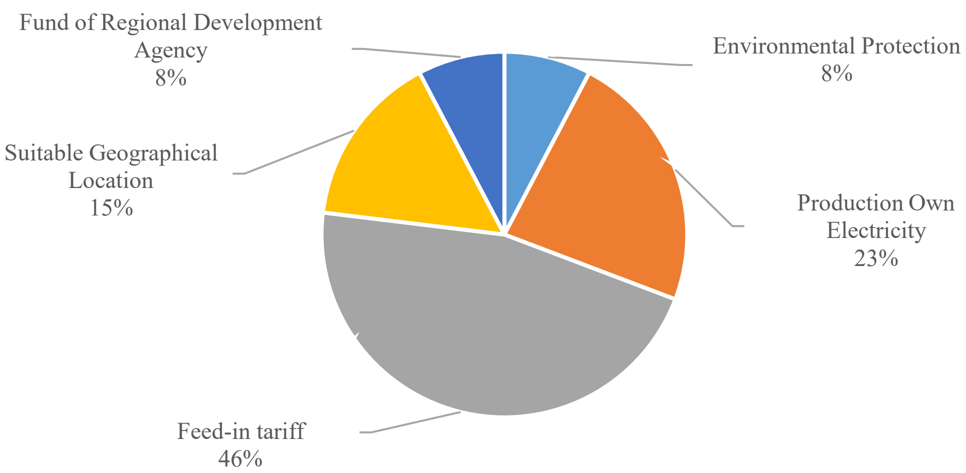

Figure 5.2. Motivating Reasons for Choosing PV Technology

Figure 5.2 show the distribution of the driver of PV. The feed-in tariff is the significant reasons for the massive growth of the Turkey RE market and increases the number of on-grid systems installed. The second most common reason is

"Production own electricity" that refers to having an opportunity to generate their electricity. In the following questions, the interview asked willingness to invest more renewable energy technologies. Within six responses, 50 % say "yes" prefer PV field application, %50 unwilling to invest.

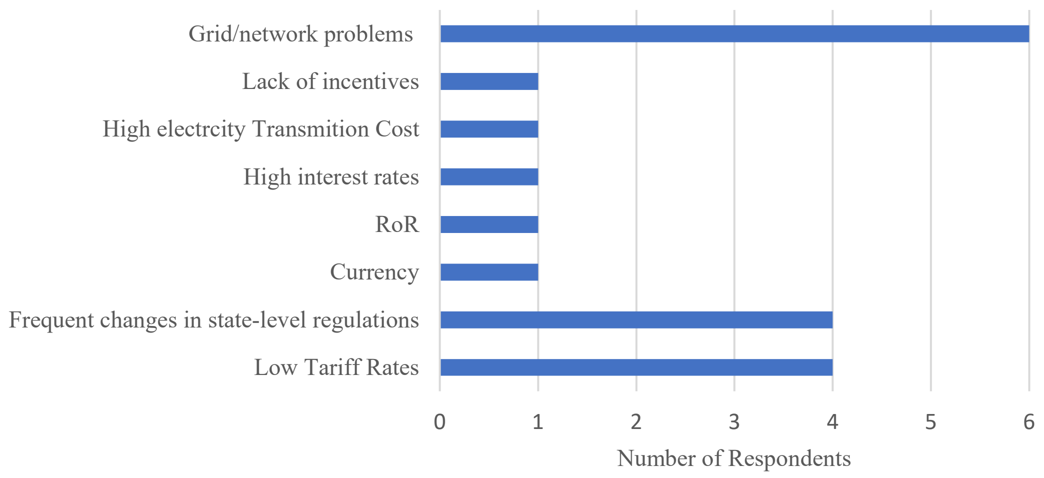

Figure 5.3. Barriers for Increasing the Use of RE Power Generation

After conducting the barrier analyses part of the desktop study, it was time to measure and observe these factors in the field research. A researcher asked them what barriers for increasing the use of RE systems in Kayseri IP were, and all answers were given with the frequency of each given answer in Figure 5.3. "Grid and Network problem" is a problem for all respondent, continue with low tariff rates, frequent changes and other word fluctuations in the renewable policy. Due to the reduction in solar power systems, especially for PV, the high feed-in tariff rate is no longer in place. Low tariff rate could not be counted as a barrier for the solar thermal system. The solar power system is a financial product, and investors would like to obtain profit. These programs' investment potential was compared and evaluated based on the RoR index, which is described to assess economic profitability. Fluctuations in policy can create an investment risk and uncertainties for a potential investor.

After identifying barriers, the interview was outlined solutions for dissemination and deployment of RE technology in the IP. In the next questions, the researcher asked their recommendation as a driver of the increase in solar rooftop application in Kayseri IP. The common and the only answer was “governmental incentive and financial support”. In other words, to encourage industries in Kayseri IP, some kind of incentives is needed. In the last question, the researcher asks, “would you like to apply and use solar thermal systems”. All of them were open to new technologies within these responses, but they did not have enough knowledge to invest.

5.3 Survey Result

The survey was handed out of the companies located in the Kayseri IP. Before proceeding, there is an essential point that among these companies, in 2018, there was 12. As of 2020, 38 companies have PV solar power system. Despite the industrial sector consuming a large amount of energy in Turkey, and the tremendous opportunity solar thermal technology presents, it has been unexplored. This subchapter summarises and clarifies the liabilities of solar thermal technology in IPs and appropriate mechanisms to eliminate barriers and pave the way for new actions.

In Kayseri IP, the dominant companies' main sectors are the Metal Products, Furniture Wood Products, Construction Building, Packing-Plastic and Textile. In the second field research, the target groups served by the organisations surveyed were typical applications and the most promising sectors of industry suitable for solar thermal systems for industrial applications: food-beverages, paper industry, metal, construction building materials, textile, chemical and plastic (Kalogirou, 2003). The first step is to reach the target market viable for solar thermal system usage in their process. Consequently, a proposal sampling technique was adopted and started with priority sectors for the survey.

Some respondents have answered selectively leaving some of the questions unanswered. This study was an opinion survey. The responses were analysed to provide the respondents' percentage agreeing/supporting a particular viewpoint for each item included in the questionnaire. Same as the interview, the survey questions are categorised under the four parts.

Part I: The survey starts with personal information of participant (name, contact address, and position) and organisational information (sector classification, NACE code, address and number of employees) A detailed profile of the respondents and companies are given in the below.

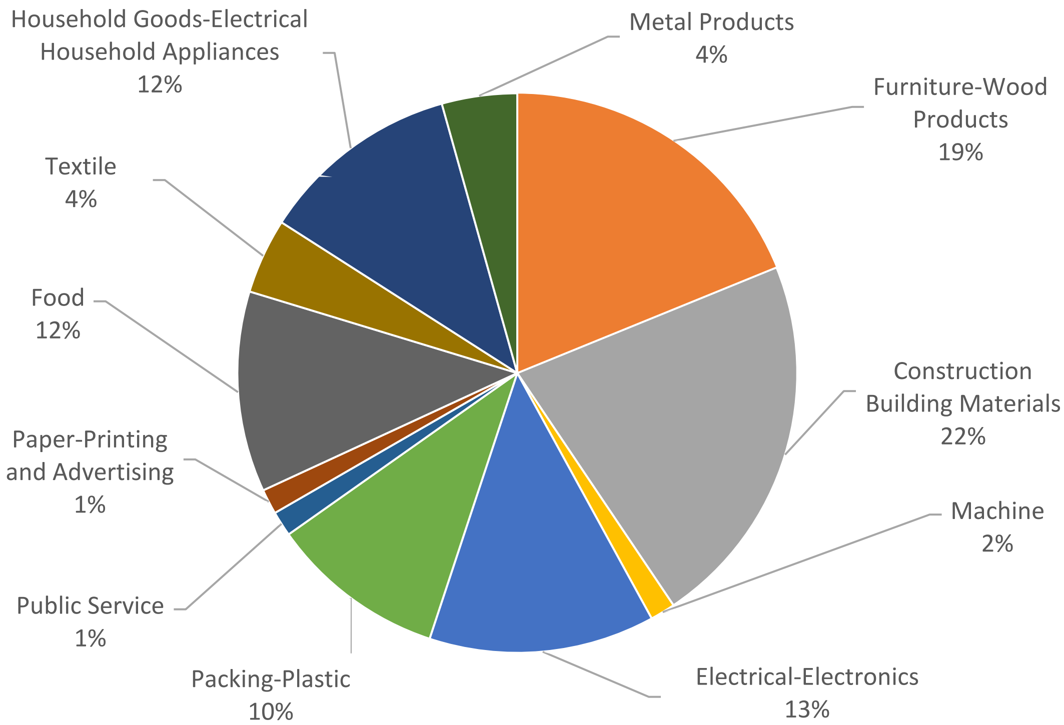

Figure 5.4. Distribution Ratios of the Companies in the Sectors

The respondents represented various industries with, as we would expect, the largest group from the Construction Building Materials. Furniture and Wood Product, Food and Electrical-Electronics sectors are the other majority of the respondents. The largest group from the Construction Building Materials. Construction sector is one of the major players of the Turkish economy, so they represent a large scale of group and more realistic overview across to Turkey. Kayseri IP Directorate representer also filled the survey and IP is classified under the "Public Service" sector in Figure 5.4.

The other classification way of companies to identify company business size, the following question asked to select the range of several people employed.

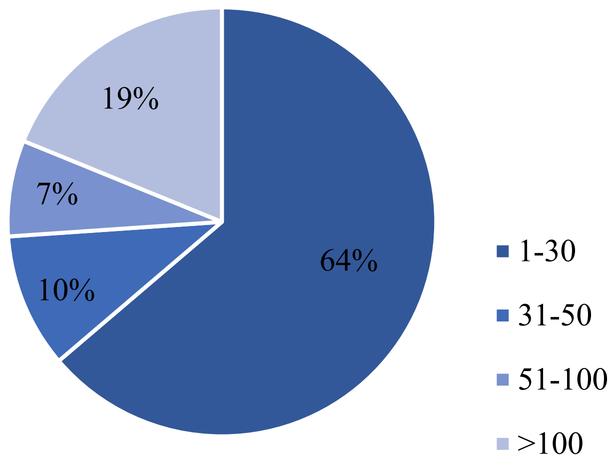

Figure 5.5 Distribution of Companies by Number of Employees

In the general definition, SMEs have less than 250 employees. SMEs are further subdivided into micro-enterprises: (up to 10), small enterprises (between 10 and 50), and medium-sized enterprises (between 50 and 250). Large companies recruit 250 or more employees (OECD, 2020). Figure 5.5 stated that about more than half of the respondents are SMEs (64 per cent).

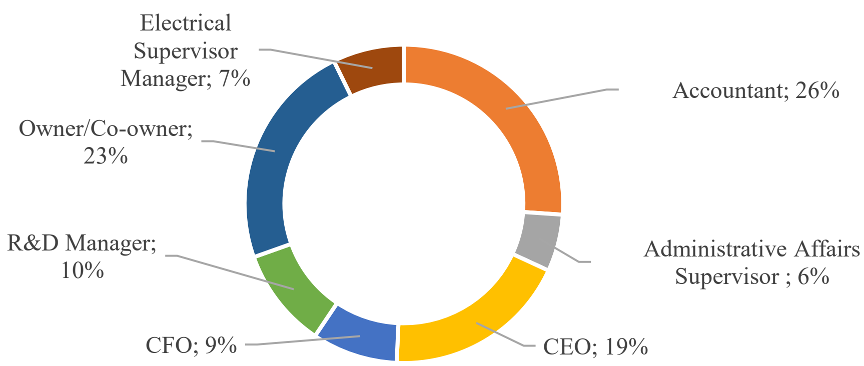

Figure 5.6. Distribution of Respondent Position in Organisation

One of the survey's first steps is to ask specific questions to find the right people to take the survey. Overall, the respondents were highly top executives. The largest groups are surveys decision-makers and specialists in those organisations' energy fields.

Part II: This part evaluates the viability of solar thermal technology; in other words, measure thermal energy consumption patterns and willingness to pay. It should be underlined that according to Directorate, all of the companies prefer using electric heating units for space heating. This situation is mainly driven by the low electricity tariff making electric heating more feasible than other options. Furthermore, there is no central heating system in the IP.

Table 5.3 Percentual Answers of Industries in Solar Thermal Energy and Technology (Based on 69 responses)

Question	Yes (%)	No (%)	Number of respondents
Knowledge Of "Solar Powered Heating and Cooling Systems"	13	62	69
Willingness to Use Solar Thermal Technology	81	17	69
Having a Solar Thermal Energy system	1,45	98,6	69

Furthermore, the fact is that the majority of industries have never thought of any solution to reduce their heat demand. In the survey, when looking at SHIP technology's awareness, many industries are not informed about solar thermal technology and implementation (62 %). In comparison, the number of industries has partial information (25 %). As mentioned before, at the beginning of the thesis, SHIP implementation is almost negligible. One of the reasons behind this poor implementation can be an information gap verified in the survey results. Although the highest percentage are not aware, the ratio of willingness to use these technologies is almost all (81 %). There is a small portion which is tentative and marked “Maybe” (1 %). One of the most important details is that only one company surveyed have already a solar thermal system in their facility.

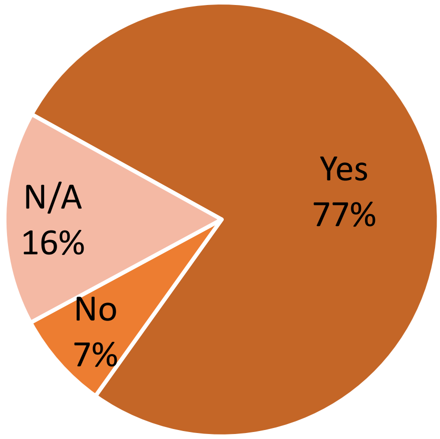

Figure 5.7. The Use of Heat in Industrial Processes

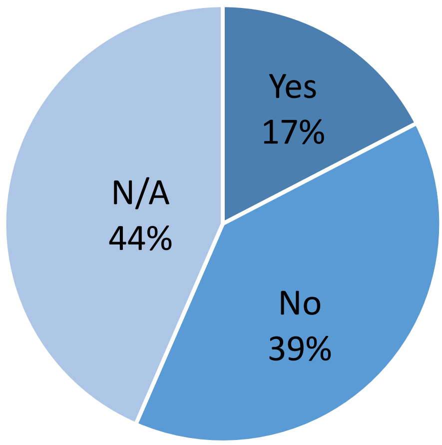

Figure 5.8. The Use of Cooling System in Industrial Processes

Meanwhile, solar heat and cooling for industrial processes are an increasingly attractive market in the EU. When considering industrial heat needs, some industrial processes need very high temperatures and low or medium temperature heat. Moreover, solar-powered cooling is one of the technologies that significantly saves energy compared to conventional air-conditioning plants using renewable energy sources. The present study's objective has been to analyse the non-technical feasibility of solar absorption heating and cooling systems. The possibility of replacing or integrating the existing plants was studied by considering their companies' processes requirements located in Kayseri IP. In the survey, the demand for active heating-cooling was investigated and asked them processes needing heat. According to results, in Kayseri IP, 77% of companies need heat in their industrial processes. When asked which processes, they need heat, food sector marked boiling, pasteurising, drying and heating. For packing-plastic and house appliances, operations are pressing, boiling, heating, casting and more.

On the other hand, the survey flow on cooling demand that all half of the respondent did not respond and 39 % did not need, and 17% needed a cooling system in the industrial process. In the above, figures show summary assessments of needs for heating and cooling system. For cooling process, respondents from the food sector marked operation. The cooling tunnel and soaking pit, are the most frequently mentioned processes.

Part II also discussed the parameters that are important for companies to invest and use SHIP system. The multiple-choice question was asked the researcher to define active driver and barriers for SHIP technology.

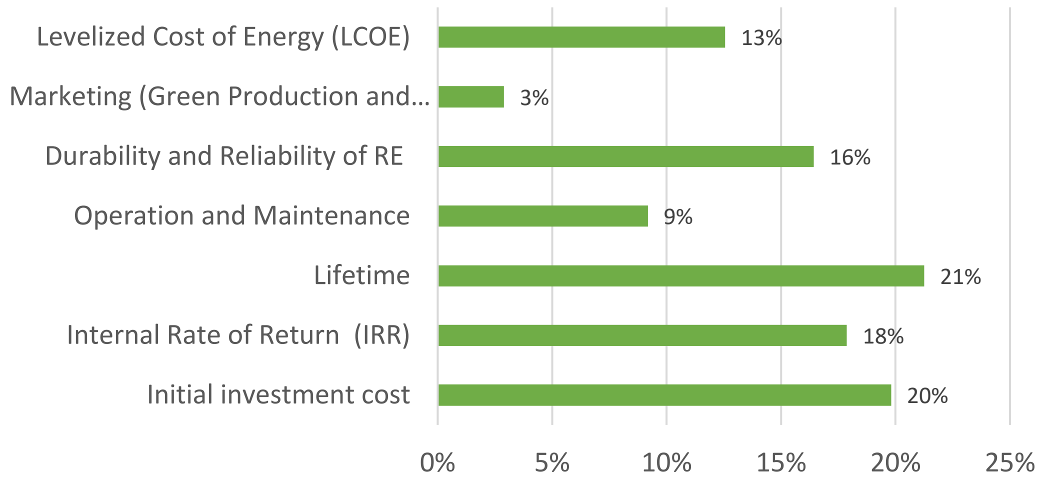

Figure 5.9. Parameters for SHIP Investment

The options were determined as a result of desktop research, and Figure 5.9 shows the distribution of parameters. Multiple option questions could lead respondents toward a specific answer. However, there was also an "Other" response option. The survey respondent could contribute their input and shed light on new factors that a company may want to observe. For this question, there are no extra additions from the respondents. Regarding the decision-making, a lifetime of the technology, initial investment cost, and the IRR came out to be a critical consideration for companies.

Part III: The third part of the survey examined companies' the perception of renewable energy and knowledge. Kayseri has an abundant in order to supply of renewable energy resources. The survey design also allows us to check the scope sensitivity of renewable energy which can help guide the future renewable energy policy.

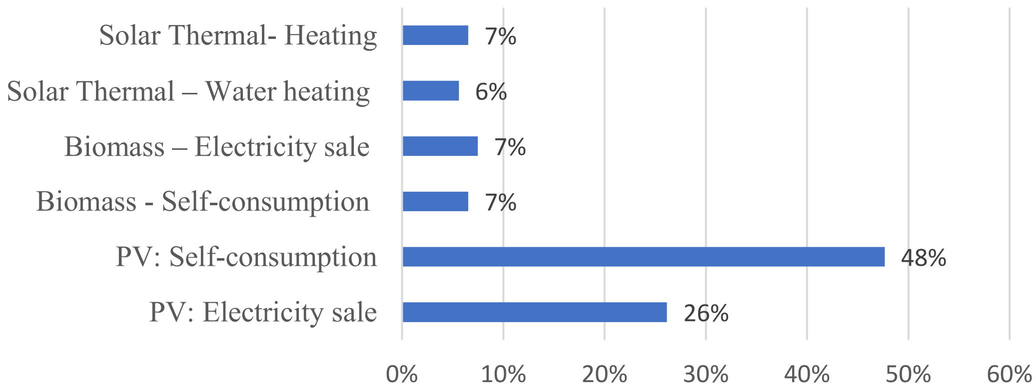

Figure 5.10. Preferences for Investments in Renewable Energy Production

It really should be unsurprising that the PV system for self-consumption is most preferred. The PV system for electricity sale (feed-in tariff) is the closest choice in line with the number of companies with PV systems in Kayseri IP. The other option is 0 %; in other words, there is no extra option added by the respondent.

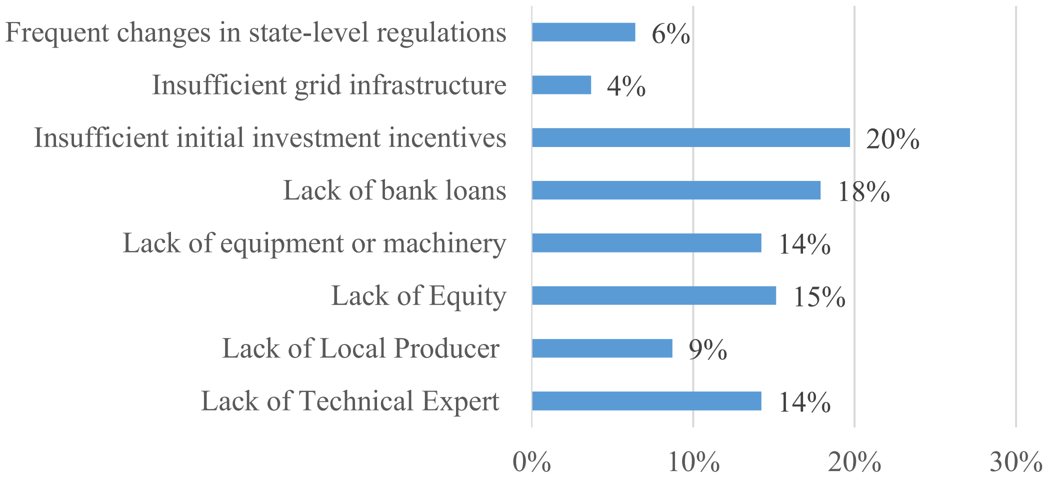

Figure 5.11. Barriers for Increasing the Use of RE systems in IP

The survey continues with the main barriers for each type of RE technology in Kayseri IP that is visualized with Figure 5.11. %20 of the respondents see insufficient "Initial Investment Incentives" as a significant barrier to RE development in the IP. The corresponding percentages are 18% and 15% in the "Lack of bank Loans" and "Lack of bank Equity", respectively.

Subsequently, respondents were asked a follow-up binary question about RE technology drivers; in other words, the survey respondents chose the factors for good integration of the variable RES. Not all respondents answered this question, and some respondents indicated that they considered more than one driver to be necessary.

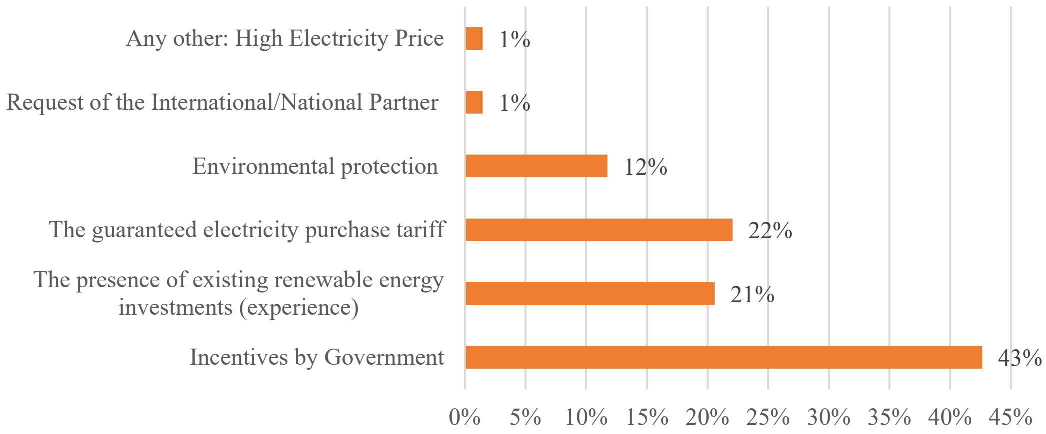

Figure 5.12. The factors that Influence Organizations' Investment in RE

The results indicated that RE's most popular and desirable driver is “Incentives by Government”, nearly half of the total rating. The guaranteed electricity purchase tariff and existing renewable energy investments (experience) are also seen as essential factors and were mentioned by 43% of respondents.

The next question is about the perception of public incentives for RE usage. The preferences were stated on a discrete scale with three levels: “Enough”, “Not Enough” and “Partially Enough”. The questions allow us to investigate sensitivity further to see whether users' preferences are aligned with Turkey's current energy support schemes and subsidies.

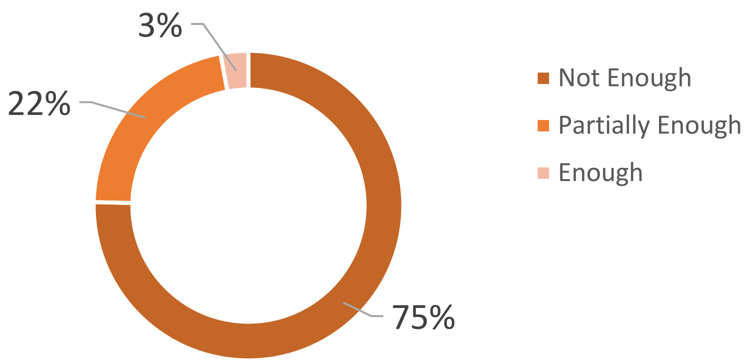

Figure 5.13. Perception of Public Incentives

The success of government support was tried to measure and verified by customer satisfaction. About more than half of the respondents are not satisfied (75 per cent), with existing incentives.

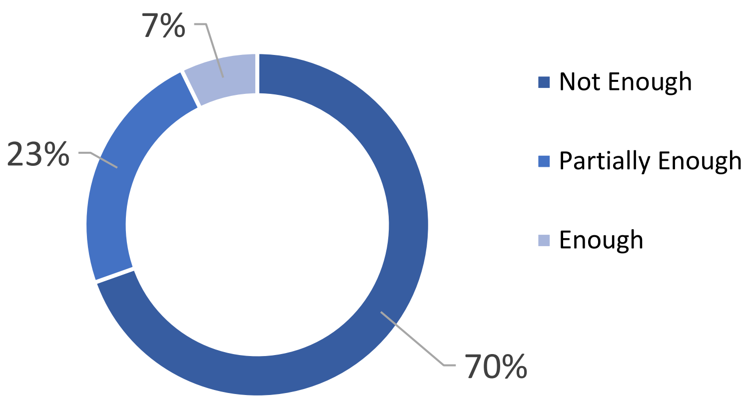

Figure 5.14. Perception of the Purchase Guarantee and Unit Price

The electricity feed-in tariff law in Turkey, and similar policies in other European countries, set a fixed price for utility purchases of renewable energy. When moving on more deeply to incentives and perception on purchase guarantee, 70 % thinks that the current price is not enough. Moreover, 7% are satisfied with this performance by selecting “Enough”. This satisfaction rate was outstanding, whereby up to 30% seem to be satisfied with very satisfied.

Part IV: This part of the survey aim is to identify who are the current RE system users, what is the most preferred RE system and mechanisms by the user, and the reasons behind to invest these systems. With the first question, the researcher distinguished existing users and non-users.

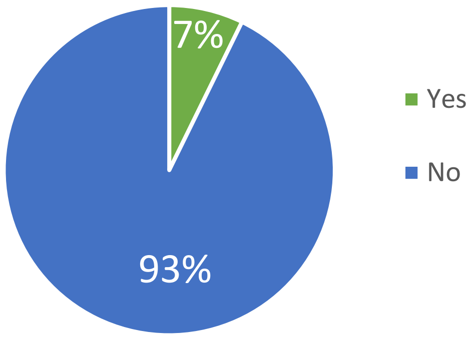

Figure 5.15. Distribution of Users/Non-Users of Renewable Energy

The next question is the "Does the organisation have an RE system in the facility?". Only five positive responses from 69 organisations indicated that they have RE systems with 7 %. If the answer was positive, respondents were asked what the type of existing systems and capacity are.

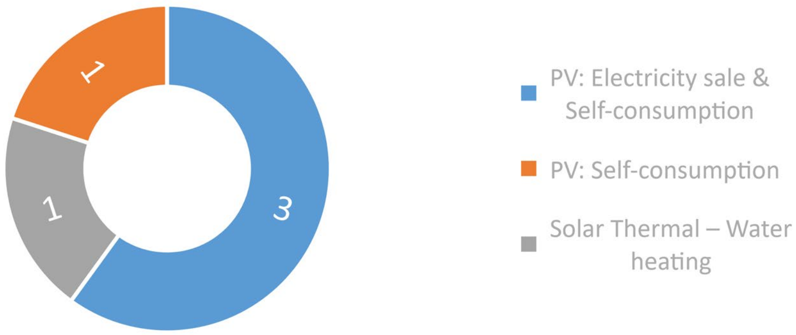

Figure 5.16. Type of RE Systems Used in the Organization

More than half of them choose PV systems for electricity sale and self-consumption. One answer was received on just for self-consumption. Also, there is only one respondent who has a solar thermal water heating system in the facility. The further questions are open-ended. The survey request indicates reasons for investing and currents barriers/difficulties during the installation phase. The stated reasons were Purchasing Guarantees for Electricity Generation and Production Own Electricity.

On the other hand, all PV users indicated the same difficulty, paperwork and bureaucratic procedures being too long and complicated.

The survey asked respondents about their current energy consumption, environmental preferences and attitudes, and socio-demographic characteristics. The survey design also allows us to check the scope sensitivity of renewable energy which can help guide the future renewable energy policy. In the next chapter, this context is described in more detail. We hope results from this study offer useful insights to energy regulators and consumers and increase RE supply share.

5.4 Analysis of Main Findings

As concluded in the previous titles, this study presents the findings of a systematic assessment of the barrier for solar-driven industrial heating-cooling systems. It identifies options (drivers) to overcome the barriers. The goal of the study is also to diagnose the most significant supporting system for SHIP technology. In the following paragraphs, barriers and supporting solutions will be established for industrial sectors through a structured framework guided by the method chosen from the industry's literature and best practices for the evaluation process. In this subtitle, the analytical framework is summarised. The most critical analytical concepts are described as a result of desktop and field research. It covers barrier analysis on transfer and diffusion of the solar technologies for climate change adaptation. By doing this, the researcher has been able to reframe the problems and help the industry identify the main obstacles for SHIP technology integration.

In the review and analysis of data, barriers outside the nation's influence (Turkey) would be identified and considered. However, they should not be further analysed since they are not subject to any country's policy intervention. Main steps to define and assess barriers and to establish solutions to resolve them:

1. Identify all possible barriers through literature research,
2. Screening and selecting essential barriers according to survey and interviews,

3. Categorising of barriers into major thematic categories,
4. Proposing recommendation on SHIP implementation in existing industrial processes,

The first step is to identify and analyse barriers in developing actions to the transfer and diffusion of SHIP technology. The methods described in the Guide to Overcoming the Barriers to Transition and Diffusion of Climate Technologies was implemented in the thesis study (Nygaard & Elmer, Overcoming Barriers to the Transfer and Diffusion of Climate Technologies, 2015). Before the research, the method suggests to identify and decide on the technology and the sectoral group. In this study, IPs and SHIP technologies were chosen already. Then, as a first step, barrier analysis of SHIP technologies was done based on detailed desk study and literature review summarized in the second and third chapters. The analysis of policy papers and reports and other related documents was evaluated. Because to determine the primary reasons why SHIP technologies in the selected target field are not currently in widespread used and why neither the private nor public sectors have invested in them (Nygaard & Elmer, Overcoming Barriers to the Transfer and Diffusion of Climate Technologies, 2015).

Table 5.4 Description of Barriers for Industrial Prosumers

	No	Barrier	Reference
Legal, Regulatory & Procedural	B_1	Absence of technology-specific initiatives	Desktop research
	B_2	Future Policy Framework	Desktop research
	B_3	Regional Policy Framework	Desktop research & Field Research
Economic & Financial	B_4	Lack of Affordable Financing Options	Desktop research & Field Research
Socio-cultural	B_5	Lack of awareness for solar thermal technology	Desktop research & Field Researches
	B_6	Lack of awareness programs conducted locally	Interview & Survey
Technical	B_7	Lack of trained people and training institutes	Desktop research & Field Researches
	B_8	Lack of Adequate Energy Infrastructure	Desktop research & Field Researches

The second step helps to screen the gross list of barriers and determine which barriers are essential and which are to be discarded. In this step, drivers of PV technology and barriers of PV and solar thermal technologies are compared. The final decision is usually based on the individual's perception who is supposed to make the final decision and assess priorities, emphasizing the importance of consistency and correlation of the alternatives compared in the whole decision-making process. Legal, regulatory and procedural, economic and financial, socio-cultural and technical barriers and sub-barriers were evaluated in line with residents and private sector representatives' opinions. As a decision support tool, survey and interview were used, and participation ranks various barriers to adopting renewable or sustainable energy technologies in the IP context.

Field studies; survey and interview were carried out among the sample (industries located at IP) to rank and eliminate the barriers. With in-depth qualitative interviews, drivers and barriers of PV technology; a popular and dominant solar technology type; were identified. Then, surveys were conducted with information taken from interviews (lessons learned) to determine why there is no improvement in solar thermal systems. The conducted survey gives volunteers hands-on experience and practice working on a barrier analysis. After all these steps, the barriers were listed and eliminated according to field researches. As a third step, essential barriers and opportunities are classified; Legal, Regulatory and Procedural, Economic and Financial, Socio-cultural and Technical (Nygaard & Elmer, 2015). Table 5.4 illustrates the essential barriers with their description.

The analysis focuses mainly on similarities and differences in PV and solar thermal systems' implementation process. It examines the difficulties experienced and benefits achieved by the various industry sectors. Further, the level of solar thermal integration with internal business processes is investigated. A framework is described based on an interview, a field study of successful PV implementation and interviews with users, and the survey with the potential users. It provides a potential tool for practitioners covering essential aspects of solar systems implementation and integration. The drivers of PV and barriers of solar thermal and solar technologies on the IPs are analysed in this part. Besides, where there is any difference, the degree of the difference in these technologies also is evaluated. This research would also allow business leaders, government, and other decision-makers to consider the problems facing solar thermal technology deployment in industrial processes.

In the following chapter, the essential barriers are performed in this chapter are described, and ends with setting up recommendation. It provides recommendations to improve the conditions for achieving renewable energy development based on Step 2.

CHAPTER 6

DATA ANALYSIS

In Chapter 2 and 3, the overview of the energy background worldwide and Turkey is summarized. Several interviews with selected regions have established the significant obstacles currently prohibiting renewable energy and more specifically, solar technologies from meeting a substantial portion of final energy demand. To investigate industries' innovation tendency, field study approached is followed and conducted in-depth interviews with six prosumer industry and survey with 69 members of the IP located in Kayseri.

The interviews and survey analysis revealed valuable outcome on the effect of a succession of solar thermal energy usage and RE innovation patterns and individual tendency and knowledge. The purpose of this chapter is to describe the results of a comprehensive and in-depth assessment of barriers in Turkey and explore opportunities to resolve the defined barriers of solar thermal technology usage by industries. The possible barriers were identified with using the collected data and presents with this chapter. The actions and strategies to overcome those barriers are recommended in the subtitles. In light of data analysis, desktop research results are updated and refined based on barrier analysis and supporting opportunities. The critical results of data analysis, are summarized below, and the policy recommendations are detailed in the subheadings. The goals of this chapter are (1) to the response to the research question by addressing the key conclusions (2) to draw attention to the contribution of this study and (3) to define some topics for further research.

6.1 Barriers and Opportunities for Adoption of Solar Power Technology in IP

6.1.1 Legal, Regulatory & Procedural

6.1.1.1 Absence of technology-specific initiatives:

The national renewable energy policy is one of the key elements for turning consumer choice into a more significant market share for renewable energy. Based on the desktop research on assessment of regulatory framework and current incentives, in Turkey, several incentives were developed for electricity generation from RE sources and energy efficiency in the building sector. Undertaking a literature review is often seen as evidence that there is no wide enough information on SHIP in Turkey. Although SHIP technology can expand renewable energy penetration in industries, substantial industrial thermal energy demand continues its dependence on fossil fuels. In the meantime, no policy framework is tailored and applicable to increase solar heating and cooling technologies and especially for industrial processes. This gap indicates that constraints need to be addressed to accelerate SHIPs' acceptance, including cost-effectiveness, knowledge of technical capabilities, etc. Since solar thermal is a cost-effective technology, a first step government can support SHIP application with technology-specific energy policy programs.

According to chapter 3, Turkey's strategic goals are based on the power market, and solar, wind, hydraulic that dominate the sector. Furthermore, the country took another step and announced the new Unlicensed Electricity Market Regulation has published to increase solar panel application, and YEKA (Renewable Energy Designated Areas). The latest rooftop legislation has been a promising development for 'prosumers'.

Turkey's Energy and Natural Resources Minister also mentioned that "696 industrial institutions applied to build rooftop plants corresponding to 432 megawatts" (Kaya, 2019). Kayseri IP is one of the examples of these applications. However, this interest remains single-acting, and it is not equally distributed all type of solar energy technologies. Even though a new era for PV and CSP/STE has begun with this legislation and incentive, the situation is stable and kept in SHIP technology's background.

Where they should also exist, more specific policies in the heating, cooling sectors have played a vital role in the development of RE at the local level, especially for industries. Thousands of industrial production sites are distributed across Turkey, with several energy-intensive manufacturing industries such as iron and steel, cement, ceramics and glass. Some of these sectors need much more thermal energy than electricity. Unlike the building, transport sector, the manufacturing sector is defined by the drive for profitability to maximize heating and cooling appliances' energy efficiency improvements. If there are enough awareness and policies to encourage and follow-up financing for guaranteed, we would expect investors freer to invest in portfolios of industrial rooftop installations like solar thermal.

Furthermore, the governmental strategy on the relationship between the heat and heat prices would be led to market development on solar thermal technology. In 69 different survey answer, 77 % said they needed heat in their processes. Although space heating and cooling data were not collected and analysed, it would increase per cent and support energy demand if it were.

In a nutshell, these facts are critical to the Turkish Government's efforts to take action on the industry's various renewable energy choices. Although there is a target for emissions reductions for industries, there is no clear path to decarbonize their thermal energy demands. The government lacks any heating decarbonization policy. While many initiatives could be applied to industrial purposes, technology-specific initiatives can promote solar thermal and advocate for favourable policies. Thus, the producer can focus on production and consumption and dependence on the grid is reduced. As shown in surveys and interviews, technology and resource dependence can be reduced, and diversity on energy sources can be achieved.

When the research asked “would you like to apply and use solar thermal systems”, all of them were open to new technologies. However, the common and the only answer is not enough knowledge about technology and insufficient governmental incentive and financial support. In other words, to encourage industries in the IP, some incentives are needed. SHIP technologies are still new for the country; it would be sensible for the government to provide specific incentives for industrial installations, including tax exemptions, grants, reduced or no application fees, domestic products incentives.

It can be expected that companies can benefit from:

- Promotion to the use of solar thermal energy for the industries and establish new energy policies and administrative interventions about heating-cooling demand from solar resources,
- Regulations and obligations to purchase a heating and cooling from renewable sources or to install renewable energy systems for new and/or existing buildings,
- Provide grant, tax reduction or exemptions for the install/use of solar heating-cooling systems,
- Support heterogeneity in preferences and experience of RES in the IP to reduce the use of fossil fuels and each industry's demand.

Energy management of IPs should be implemented into the entire phase of development and park management. Maximizing productivity is a promising local iterative method on which enterprises can be involved, encouraged and facilitated. A zone-level strategy that encourages industry best practices for low-carbon growth will resolve inefficiencies and deficiencies found in current national energy and environmental policies and seek to encourage closer coordination of energy and environmental regulations.

6.1.1.2 Future Policy Framework:

In the first field study, the interview shows that “Frequent change in state-level regulation” is one of the highest-ranking barriers for increasing the use of RE generation for the prosumer. There is currently a feeling among investors and potential investors that regulations change rapidly. Their experience with personal projects may differ. Especially, in the renewable energy investment, these policy changes can result in essential changes on cost structure, profitability and the most investment. Regulatory mechanisms should be established in collaboration with users to ensure some minimum standard of service and improve trust in the regulatory framework. Such a step would bring a compelling benefit, as further projects would be built in a new set of certainty. Knowledge of the regulations and their effect on the industry allows enterprises and their companies to prepare themselves, reduce future losses, and benefit from benefits to improve enforcement profitability.

Polzin et al. (2015) support technology-specific policies, and considering the current business dynamics and technology position to establish a supportive policy mix. His findings also recommend the development of a reliable framework with a clear vision and long-term policy plans (strategic planning) for the RE capacity to be deployed in the future and simultaneous developments in the energy sector. Possible risks, due to regulatory uncertainty, directly affect investor risk projections and investment decisions. Ex-post adjustments in the remuneration of current programs should be stopped. However, as technological change continues, the actions taken need to be changed, considering the market and technological conditions (Polzin, Migendt, Täube, & von Flotow, 2015). Different support schemes should be unified, and the financing should have long-term viability.

In Denmark, Aalborg University studies predict that solar thermal can achieve 3 to 12% of global heat generation in 2050. This study's primary objective is to investigate the potential for solar thermal installation in energy systems and whether solar thermal is a feasible option for Europe to meet its energy goals or whether there are better alternatives. The research is focused on developing scenarios for selected countries. It represents the combined view of power, heat and transport at the same time with a horizon of 2050. The study's general conclusion is that solar thermal may help improve the security of supply by increasing local energy production and reducing reliance on fuel imports and policy frameworks and has a significant effect on the spread of solar thermal technologies.

Integrative policy implementation and support would be essential for the long-term viability of solar thermal as a heat decarbonisation source. These results indicate that solar thermal industries and technologies may be desirable to achieve climatic objectives (Mathiesen & Hansen, 2017). Overall, Turkey's industrial sector provides the market potential for renewable energies but must overcome the difficulty of distributed geography and heavy competitive pressures. Under the new plans, there is a need for guarantees for investment in the long-run.

According to field studies, companies tend to profit by generating energy rather than concentrating on energy efficiency. The new reforms in strategy should also promote solar energy's self-consumption and shine the light for Turkey. In fact, in the case of the sale of electricity from the PV grid at a feed-in tariff, the PV option is exceptionally desirable from the industry's point of view. However, these circumstances can change in the future – also in countries that already have a high feed-in tariff. On the one hand, reasons are tariff burden on governments and the other hand, a rise in grid capability and operating issues for grids with a high and growing amount of fluctuating power production from renewable sources.

6.1.1.3 Regional Policy Framework:

Turkey has set higher targets for renewable energy and energy efficiency to accelerate the transition to a clean, modern national energy system and ensure supply security. As a consequence, there is a legislative and regulatory structure for climate change at the national level. Recently, all Turkish municipalities have taken action to address the climate problem. Rather than being a systematic and structural solution, they are often stand-alone interventions in selected sectors. Besides, connections between climate change responses and critical local planning systems have yet to be developed. In that way, it can be claimed that the primary attitude to local climate policy in Turkey is regional voluntarism. As regional programs are not yet ongoing, municipalities can lead themselves if they plan to fix climate problems (Gedikli, 2017).

The literature points out that the position of regions and cities is essential to making energy transformation possible. The highest priority of city types of energy will change, such as gas supply, heat supply, power and fuel. Also, the geographical location and natural conditions in a region can be useful in renewable energy development. For the SHIP technology, solar radiation of the selected region is essential.

As it summarised in previous, in addition to technology-specific energy policy, there is a need city-level action in order to support SHIP. Driven by the need to reduce energy consumption and air pollution, many municipal governments have scaled up energy efficiency measures and the use of renewables in the power, heating and cooling sectors. For example, Täby, a municipality in the north of Stockholm, Sweden, has committed to using renewable heat to meet the demands of all local government activities and operations by 2020, whereas Stockholm's targets apply city-wide. Besides, more than 110 cities and municipalities have established targets for 100% solar heating and cooling by the end of the year. Curitiba (Brazil) and Msunduzi Municipality (South Africa) all going to reach 100 per cent renewable energy heating and cooling (REN21, 2019). Researches and current cases from abroad indicate that local governments can undertake more strategic pathways are better matched to climate change action plans and successful measures. Local governments should also be responsible for implementing climate change action policies, including mitigation and adaptation steps, with defined shareholders and the budget. The establishment of incentives and grants for cities and municipalities may also trigger local action. Developing renewable energy is the direct implementation of a sustainable energy strategy to fulfil more significant urban planning. The weights of the indicators are subjective and unique urban plans need to be established.

In conclusion, one of the essential points is that the national framework to develop a climate policy strategy should consider decentralization and local governments' participation as a critical priority. City-wide/municipal targets and policies can encourage renewables in the power, heating and cooling, and transport sectors, both for municipal operations and city-wide energy uses. Cost reductions in technologies can allow local authorities to transition to renewables for municipal (or city-wide) energy use. Moreover, the government can create an incentive for local energy consumption to more efficiently mitigate and manage energy prices.

- Regional support scheme for RES heating & cooling systems
- Strengthen the administrative structures for managing regional development.

6.1.2 Economic & Financial

6.1.2.1 Lack of affordable financing options (Credit)

Lack of access to credit to purchase or invest in renewable energy is always a problem for innovations. Need-based allocation of funds at low-interest rates by banking and financial institutes and to offer consumer credit for purchases that supports private entrepreneurs to provide RE products and services. In particular, government participation in the production and adoption of beneficial policies for developing renewable energy is crucial that is summarized already in Section 6.1.1.1. However, the market can also grow independently of the central government's actions if the systems were the most cost-effective option for industries, and there is a financing option.

Initial capital, transaction costs, financial standing and availability of incentives and subsidies influence the implementation of renewable energy technologies. The initial capital cost of renewable energy is comparatively high compared to conventional energy sources, which increases the cost of consuming renewable energy. Since many producers choose to keep their initial investment costs minimal while maximizing profitability, high investment costs remain a significant obstacle to adopting sustainable renewable energy solutions (Luthra, Kumar, Garg, & Haleem, 2015). Furthermore, it can be said that investment is a barrier for RE, but it is not the same for all technologies. According to PV prosumer, FiT mechanisms and bank loans cover all the financial investment. Likewise, these financial supports can be taken as “lesson learned” and all the market stakeholder uptake actions to foster solar energy development in Turkey for electricity generation and industrial process heating or cooling.

Currently, SHIP application can be classified under the voluntary market. Additionally, while solar thermal cooling technology benefits from the right balance between demand and supply of energy, it directly competes with PV systems. Support structures should be in place to allow low-interest loans to help and encourage the industries on the implementation of sustainable thermal technology and demand expansion.

In the solar thermal system, the cost of solar thermal is defined based on application and described in terms of capacity since there are negligible operating costs (Alternative Energy Development, 2002). Initial investment costs are also high and discouraging potential customers, as imported technology from technologically advanced and highly developed countries is more costly than domestically produced technology. Moreover, the survey proves this situation; “lifetime” and then “the initial investment cost” are the most critical parameter to invest RE systems. RE deployment's most common barriers are “Insufficient initial investment incentives” and the second one is “lack of bank loans”. The practical application shows that funding options have a significant impact on broad sections of the population and India. According to country priority, specific goals for the overall amount of credit expended would be set for the banks. As a result, several banks encourage solar water heaters vigorously. For example, Canara Bank, a company based in Bengaluru, one of India's largest cities, has issued over 25 000 loans to individual solar water heaters, with INR 60 million loans for solar heating cooling.

Garanti BBVA is Turkey's only bank that has direct investments in renewables. It relies on generating electricity and promotes production sites' funding (Ancelle, et al., 2020). As described field studies facts, banks do not support SHIP market or any other solar thermal technologies.

6.1.3 Socio-cultural

6.1.3.1 Lack of awareness for solar thermal technology:

According to field studies, CEOs play a central role in shaping the company's values and making strategic decisions. To invest in the RE system, they should possess a solid background in current incentives and support and a good understanding of the renewable energy sector. This indicates that education level is significantly related to innovation investment. As it is evident from the survey results, companies have little or no knowledge of solar power systems. A high proportion of industries in Kayseri is not even aware of the presence of SHIP systems. This can lead to false assumptions and an inadequate capacity to detect and recognize even fundamental defects in the systems' implementation or function.

Low 'information flow and communication' may be one of the biggest obstacles to the industry's technology transition. Information resources are needed to develop connections to develop efficient, clean energy technologies. It is widely accepted that the adoption of renewable energy technology is mostly not due to a lack of information/experience or expertise on the part of the client or a lack of trust in accessing reliable information. In worldwide, many potential users of renewable energy technology have little to no familiarity with their usage. There is insufficient support for the development of that technology (United Nations, 2019).

The visible implementations and knowledge of different solar thermal power technology may be drivers for using conventional energy sources for the industrial sector. Furthermore, financial incentives must be combined with public awareness campaigns and tariffs that promote solar energy potential. If it is complicated for consumers and technology providers to recognize and apply for incentives, they would not be used. These can take the attention of different investors; potential buyers, and also the technology providers. Moreover, disseminating the technology via different channels could be the basis for SHIP and CSP/STE to be adopted. As an example, different solar power technologies can be used more in public sector-owned facilities so that the private sector can be inspired by it. For instance, the Ministry of Energy could use solar power on their facilities to fulfil their own needs. As an example, and good promotion, Porto (Portugal) addressed energy insecurity specifically by renovating public buildings to make them more energy-efficient and by installing renewable heating and cooling technologies and solar hot water systems, resulting in annual energy savings of 286 kilowatt-hours (kWh) per square meter (m^2) (Covenant of Mayors for Climate & Energy, 2019).

6.1.3.2 Lack of awareness programs conducted locally:

It is also necessary to build local capacity to raise awareness and improve expertise to install and sustain renewable energy technology. Solar power systems are high, depending on geographic locations. For industrial energy applications, local authorizes and regional development agencies can develop training and capacity building events. It is vital to build innovative local skills, including adopting and implementing technology customized to local needs. Actions that can enhance those capabilities include encouraging municipalities, universities and research centres to work on solar power technology, in parallel, taking dissemination actions for growth and demonstration in industrial sides. Although national plans and regulation encouraged promotion and subsidized SHIP technology, the market can grow independently due to solar thermal R&D activities and as first movers thriving entrepreneur industries that have a potent influence on development, and exploitation of opportunities SHIP in IP.

6.1.4 Technical

6.1.4.1 Lack of trained people and training institutes:

Employment opportunities are a key issue in planning low-carbon economic growth. Many governments have prioritized renewable energy development, primarily to reduce emissions, achieve international climate targets, and gain broader socio-economic benefits. As a country, Turkey should develop employment policies in this direction and provide supports and incentives to increase employment in renewable energy. Every green job will be a step towards a clean world to be presented to the future.

Global markets for solar heating and cooling, especially China and Brazil, started to decline in 2018. IRENA estimated that global jobs were shrinking in this sector. 93% of all jobs are in the top five countries. Asia has 88% of the overall employment worldwide. Estimates for China indicate that the nation remains dominant in jobs with over 70 per cent of the world's installed capacity. Overall, Turkey is the third biggest national market. Therefore, Turkey can be expected to have one of the largest industrial solar thermal capacities globally. However, there is no available data to calculate workforce by 2020. Furthermore, for the SHIP market, no specific data in this sense are available.

Only two SHIP installations were identified in Turkey. Although, SHIP markets are almost non-existent and Turkey’s provider solar heat for industrial processes are very narrow. It can be said that Turkey's market is unique among large global markets in that it is entirely free and voluntary basis. Moreover, Turkey's markets and capacities are very underdeveloped. As a first step, reliable and detailed national statistics to quantify these markets and capacities are highly needed.

The installation of new generation facilities and related technical assistance projects can be implemented to disseminate solar thermal technologies. Need for skilled labour to support solar technology deployment, including system design, installation, and ongoing operation and maintenance.

Another point is that there is a lack of adequate guidance and technical support for an investor that prevent the efficient exploitation of renewable/sustainable resources. As can be seen from field studies, industries tend to learn and invest by copying rather than training. The local language is used and with a practical “hands-on” approach. However, the sustainable energy technology selection is the first step under economic, social and environmental factors. The expertise to be developed for the renewable energy sector should cover all phases of renewable energy projects. It depends on the type of technologies for the project. For instance, in solar projects, although, engineers and technicians would be expected to cover the entire value chain from solar PV system installation, procurement and marketing professionals should be involved before construction and installation phase for resource assessments, business plans. These factors, coupled together, have slowed down the rate of development, circulation and usage of renewable infrastructure and technological knowledge. For example, according to the interview, all current PV prosumer received support from EPC Companies in the implementation phase. Before that, the inspection and the decision-making were done by investors without any guidance and in the absence of professional cost-benefit calculation.

6.1.4.2 Lack of Adequate Energy Infrastructure:

There is also an increasing emphasis on creating an infrastructure that could increase renewable energy use in the heating-cooling and transport sectors. This involves district thermal networks and EV charging infrastructure, allowing cities to reach higher renewable energy levels (REN21, 2019).

Prosumer highlighted that the existing grid must be upgraded to meet the increasing proportion of decentralised and intermittent renewable power production. The national grid system has to be improved to allow for more renewable power plants to be commissioned. Infrastructure here broadly refers to transmission and distribution networks and necessary equipment and services for power companies. This research does not cover these systems. However, in the case of Photovoltaic and Thermal Hybrid Collector (PV/T) or any other grid-connected renewable energy systems, interviews and survey show that lack of infrastructure necessary to support the technologies may be a problem. As good practice and example, Germany's power system operators have combined more than 22 per cent of fluctuating solar and wind production while keeping global security of supply. This has been accomplished by combining high-quality grid infrastructure and robust connectivity with surrounding countries, more flexible thermal power plants and an innovative approach to developing specific grids. Germany's objectives to further increase this portion, its energy strategy now focus on implementing flexible interventions such as smart grids and metering combining local electricity, heating and transport sectors, and developing cross-border trade and maintaining supply and demand (SHURA Energy Transition Center and Agora Energiewende, 2018). Turkey also needs to step up investment in grid infrastructure and operation transmission and the battery storage systems.

- The collection of the city's heat demand data to allow the development of new district networks
- Supporting physical and social infrastructure, which are essential for new investments and the quality of urban life,

CHAPTER 7

CONLUSION AND RECOMMENDATION

Industrial plants are distributed across Turkey and absorb energy at different forms, demanding specific solutions to provide low-carbon energy solutions. Moreover, the Turkish industry is under heavy pressure to stay cost-competitive internationally, leaving no space for innovation (SHURA Energy Transition Center, 2018). These areas provide synergies between industries, allowing them to share and make productive natural and economic resources. It also offers a useful pattern for promoting the use of renewable energy sources in the industrial sector. Reduction in energy consumption and GHGs can viable within solar heating and cooling applications. The high number of PV prosumers shows a vital driving force that is powerful word-of-mouth movement. It is a well-established fact that companies believe and trust recommendations from investors rather than other forms of advertising. Companies are more likely to buy when referred by other close located company.

Within the scope of INSHIP Project, Kayseri IP, which is the most prominent industrial settlement place of Kayseri and the construction of various service buildings, was targeted to reach the clean and economical energy and support to meet national goals. Three main headings define the research:

i) By using SHIP technology, to meet thermal energy demand for intensive use in the IP,

ii) Establishing the effects of thermal solar energy use in industrial applications that cause excessive energy consumption on the IP,

iii) Investigation of new technologies and applications for efficient use of renewable energy resources.

SHIP technology, in industrial application, faces multiple challenges. Legal, regulatory and procedural, climatic, economic and financial, socio-cultural were evaluated in line with residents and private sector representatives' opinions. As a decision support tool, the field studies were used, and participation ranks various barriers to adopting renewable or sustainable energy technologies in the IP context. As a result of data analysis, insufficient government support, lack of financial support, inadequate capacity and lack of expertise, lack of familiarity with modern technologies and inefficient infrastructure are significant obstacles to the diffusion of SHIP technology.

The solar boom of PV systems in Turkey shows that technological innovations have encouraged enthusiasm for deploying technologies and infrastructure. As a first step, governmental support and mechanisms encourage the consumer to greater awareness of energy usage and generate energy. This research shows that Turkey falls behind with a lack of market in Turkey for SHIP implementation. The government can encourage and expand solar energy utilisation for thermal energy generation in light of the policy framework. To prompt solar thermal energy in the industrial sector, technology-specific policy and regional policy framework can be adopted. The long-term plan should be established. Currently, the SHIP is an open and voluntary investment. These actions should be primarily on self-generation and consumption rather than focusing on financial profits. Additionally, avoiding misunderstanding and confusion amongst the potential investors about the complicated application process and regulation is one of the lessons learned from an interview.

To reduce the non-technical barriers to the broader deployment of solar process heat, it is also vital to establish intense and focused financing and funding options, leading to a significant number of demonstration projects possibly to create critical mass in a specific industrial and/or geographical sectors. In the first years after the investment decision, an enterprise's entry is fundamental to its survival and development, as is its proper management over the entire investment lifecycle and operations. The company's particular interest is encouraged both before and after the establishment of new technology, by adequate investment promotion and aftercare, to ensure effective IP investment promotion programmes. Financial actors, such as government and private institutions, should create innovation choices by their investment choices. Based on the type of renewable energy and purchaser, national renewable energy tax credits, regulations for renewable portfolios and national legislation, green power programs, private loan/financing programs, national financial incentives, and similar options are needed by industries to purchase and implement SHIP technology.

Capacity building at individual and institutional levels plays a critical role in ensuring the sustainability of energy access policies and integrating technological, financial and political activities. In the case of SHIP, the research data can be evidence of a lack of capacity in this sector. There is an enormous requirement to strengthen capacity building for SHIP technology. Training and capacity building programs, implementing real feasibility studies need to be designed and adopted. Interventions should be diversified to meet the diverse expertise requirements at different stages of the energy supply chain and in various local conditions. Capacity development can target various target groups who may have different access to educational programs at the technological, vocational or institutional level.

Consequently, these interventions bridge the gap in technological or commercial expertise and knowledge. These researches do not cover the technical barriers, but some of the analysis is given. Energy infrastructure is one of these technical barriers to the complete application of SHIP technology. District heating and cooling systems, cost-effective option for SHIP technology, are some of the stated requirements during the field research.

Within this scope, literature and two different types of field research are done. The field studies include extensive engagement with key stakeholders for the Kayseri IP. Through this engagement at a minimum, the research is expected to increase awareness of and support for SHIP technologies within the Kayseri IP, including the potential for industries in the IP to be both SHIP technology suppliers and end-users. Suppose the outcomes from the viability study are sufficiently promising. In that case, follow-up activities will focus on developing and demonstrating solar thermal technologies to the maximum possible use technologies developed and produced within the IP.

CHAPTER 8

LIMITATIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

The thesis is the first research to investigate SHIP technologies in industrial areas in Turkey. For an unexplored research field, this thesis acts as a practical guide to future solar thermal technology development. However, being the first in the literature has resulted in a significant constraint and limitations of theoretical foundations' production. International sources constrain the key invention metrics used.

The limitations are due to sampling size, geographical and sector limitations, which indicate generalization over other industries. Even though the industry respondents were limited to a city of Kayseri, the number of responses is reasonably representative of the industry. Beyond economic, regulatory challenges, RE technology's deployment is inhibited by social influences such as acceptance among local communities. The private sector's outlook on RE investments is added through this research, ignoring the possible negative externalities generated by the technology being implemented. Furthermore, concentration on the limited number of Kayseri IP participants, as an urban zone, naturally raises concerns about whether these outcomes will differ in Turkey's other industrialized areas. Similarly, sampling industries from other higher or lower technology sectors will produce various innovation patterns aligned with succession. By depending on these limitations, recommendations for future research on disseminating SHIP in Turkey have been created.

The methodology presented is an initial effort to fill the literature gap and gives space for improvements. As future work, the researcher who intends to follow a similar strategy to this research is aimed to perform for other industrialized regions of Turkey. Furthermore, the application of SHIP in the Kayseri IP specifically and Turkey more broadly is almost non-existent. Although it is not possible to define "new" SHIP technologies, the thesis's ideal outcome is a strategy for both the construction of a pilot solar thermal plant in the Kayseri IP and the creation of industrial capacities allows companies in the IP to use and produce-sell SHIP technologies and extend Turkish SHIP markets. Thus, this thesis will move the SHIP technologies from a very theoretical and little-known concept in Turkey to a more practical and market-ready concept more so than increasing the SHIP potential.

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APPENDICES

A. Interview Question

1. Do you introduce yourself (education/experience/skills)?

2. What are your job/position and duties in the institution/organization?

3. Can I get your contact information (phone/email address)?

4. Could you briefly tell us about your institution/organization's activities in the field of energy and renewable energy?

5. Which electricity generation facilities based on renewable resources exist within your institution/organization?

6. What is the total installed power of electricity generation facilities based on renewable resource energy within your institution/organization?

7. How do you use the electricity generated from renewable sources within your institution/organization in the market?

8. Why did you choose unlicensed electricity production?

9. Do you have self-consumption?

10. What were the reasons for your investment in this field?

11. What are your reasons for choosing this technology?

12. Have you received consultancy support/training on technology selection before the investment?

13. Have you received consultancy/training support during the investment phase?

14. Have you received financial support in the application or installation stage? If so, which supports have been used?

15. Can you talk about the application process? Has there been a problem? What kind of problems did you have?

16. Would you like to make another investment in the field of renewable energy?

17. What are the obstacles to increasing the share of solar energy in electricity generation in the industry?

18. What are the developments that will pave the way for solar energy investments in the industry?

19. Looking at the current situation, do you think the use of renewable energy will increase or decrease?

20. What should be done to pave the way for solar energy applications?

B. Survey Question

1. Name-surname
2. Respondent position in the company
3. Respondent email
4. Address of the company
5. NACE Code
6. Company product(s)
7. Number of employees
8. Approximate annual electricity consumption (MWh\year)
9. Approximate monthly electricity consumption (MWh\monthly)
10. The use of heat in industrial processes
11. Processes that require heat/heating system
12. The temperature level of heat required in the industrial process
13. The use of a cooling system in industrial processes
14. Processes that need a cooling system
15. Knowledge of "solar-powered heating and cooling systems"
16. Willingness to use solar thermal technology
17. Use of solar thermal energy
18. Parameters that are important for the company to use solar heat for industrial processes
19. Preferences for investments in renewable energy production
20. Barriers for increasing the use of RE systems in IP
21. The factors that influence the company's investment in RE
22. Perception of public incentives for RE usage
23. Perception of the purchase guarantee and unit price
24. Drivers of RE production in industry
25. Suggestions for increasing the use of solar energy in the industry
26. Type of RE used in the organization

27. The total installed capacity of power generation facilities based on RE (MW)
28. Reasons for investing in RE
29. Barriers/hindrances in installing solar energy

C. Human Subject Ethics Committee Approvals

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11 ARALIK 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Derek BAKER

Danışmanlığını yaptığınız Sevgi Deniz AKDEMİR'in **"Organize Sanayi Bölgelerinde Güneş Enerjisi Kullanımı"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-FEN-057** protokol numarası ile protokol numarası ile araştırma yapması onaylanmıştır.

Saygılarımla bilgilerinize sunarım.

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02 KASIM 2020

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın *Derek BAKER*

Danışmanlığını yaptığınız Sevgi Deniz AKDEMİR'in "Organize Sanayi Bölgelerinde Güneş Enerjisi Kullanımı " başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve 310-ODTU-2020 protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof.Dr. Mine MISIRLISOY
İAEK Başkanı