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Potential and utilization of solar energy policies in Turkey

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Abstract
Energy is an indispensable element for the survival and development of modern society. From the use of heat in industries to the heating of a house, from feeding a freighter to fueling a motorcycle, from automating an entire production process to lighting an office lamp, energy use is an essential part of our everyday life across different scales and forms of utilizing it. With the development of new technologies, coupled with the exorbitant growth of the world population and the emergence of new needs, one of the great challenges we currently face is the uncertainty of energy availability in the future given its current demand, primarily due to the extensive use of nonrenewable sources and the large-scale exploitation of the planet's natural resources. Turkey's carbon dioxide emissions have grown along with its energy consumption. States have played a leading role in protecting the environment by reducing emissions of greenhouse gases. In this regard, renewable energy resources appear to be the one of the most efficient and effective solutions for sustainable energy development in Turkey. Turkey's geographical location has several advantages for extensive use of most of these renewable energy sources. This study shows that there is enough renewable energy potential in Turkey for heat and electricity generation. Especially hydropower, biomass, solar and wind are very well.

Keywords: energy utilization; sustainable development; renewable energy; Turkey

1. Introduction

Energy is an indispensable element for the survival and development of modern society. From the use of heat in industries to the heating of a house, from feeding a freighter to fueling a motorcycle, from automating an entire production process to lighting an office lamp, energy use is an essential part of our everyday life across different scales and forms of utilizing it. With the development of new technologies, coupled with the exorbitant growth of the world population and the emergence of new needs, one of the great challenges we currently face is the uncertainty of energy availability in the future given its current demand, primarily due to the extensive use of nonrenewable sources and the large-scale exploitation of the planet's natural resources [1].

Since the advent of the Industrial Revolution, energy has become intrinsically associated with the economic competitiveness of nations and their quality of life [2, 3]. In this context, economies with greater access to inexpensive energy resources, with low environmental impact, guarantee significant market advantages [4]. Therefore, the search for new renewable energy sources reflects not only the current need for diversifying the world energy matrix, but also the inevitability of developing alternatives that can reduce the impacts caused by the generation, distribution, and consumption of energy [5]. It is from this perspective that discussions arise regarding technical, economic, environmental, and social feasibility for implementing renewable energy systems [2-5].

Energy in modern society is an essential ingredient for a wealth economy, like the blood circulating in our arteries. Since the beginning of civilization, humans have learned how to use biomass combustion for cooking and heating, the wind force for navigation, and the rivers flow to move mills [2]. With increasing world population, material progress in various parts of the world, and, especially, with the formation of large cities, new sources of energy have become necessary as coal, oil, and gas and more recently nuclear power [1].

In the early twentieth century, electricity production moved to the forefront as it can be converted to work with greater efficiency than coal, oil, and gas [1-3]. In this century, the electrification of the world economy is intensifying significantly, since electricity

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consumption is increasing about 4–5% per year while the energy consumption as a whole is only growing about 2% per year. Hydroelectric, wind, and photovoltaic energy—which are renewable in contrast to electricity produced by fossil fuels—have become a priority [4,5].

In 2017, the world investment in energy production was just over US$ 1.7 trillion. US$ 718 billion was invested in the production of electricity and the remainder in the production of oil, gas, coal, and energy efficiency. Of these US$ 718 billion, US$ 277 billion was invested in power grids, US$ 193 billion in electricity generated from fossil fuels, and US$ 297 billion in renewable energy, which in 2016 were distributed as follows: wind power (39%), photovoltaics (28%), hydroelectric (26%), and nuclear (7%) [1-5].

The usage of renewable energy resources shows a promising prospect in Turkey in the future as an alternative to the conventional energy. In the past decade, wind energy has become a valuable and dependable source of electricity worldwide. There is a promising potential in Turkey for both wind and solar energy. In Turkey, several research institutions have initiated research at various stages on the applications of solar energy. The estimated wind and solar energy potentials: 48,000 MW for wind and 80 Million tons of oil equivalent (Mtoe) for solar. Turkey has a considerably high level of renewable energy resources that can be utilized to satisfy a part of the total energy demand in the country. Present applications have shown that renewable energy sources in Turkey are a promising alternative [6-10].

The aim of this study is to propose criteria that help public or private investors in prioritizing these investments for Turkey. As an example of the application of these criteria, the author evaluated existing energy situation. Turkey's geographical location has several advantages for extensive use of most of these renewable energy sources. This study shows that there is enough renewable energy potential in Turkey for heat and electricity generation. Especially hydropower, biomass, solar and wind are very well.

2. Energy consumption in Turkey

Turkey is an energy importing country; more than half of the energy requirement has been supplied by imports [6, 7]. Oil, coal and gas have the biggest share in total primary energy consumption [7-10]. Turkey, with its young population and growing energy demand per person, its fast growing urbanization, and its economic development, has been one of the fast growing power markets of the world for the last two decades [11]. It is expected that the demand for electric energy in Turkey will be 573 billion kWh by the year 2020 and 760 billion kWh by the year 2030 [12-16]. Turkey's electric energy demand is growing about 4-6% yearly due to fast economic growing [17-28].

In 2017, primary energy production and consumption has reached 36 and 145 Mtoe as shown in Table 1 and 2 [12]. The most significant developments in production are observed in hydropower, geothermal, solar energy and coal production. Turkey's use of hydropower, geothermal and solar thermal energy has increased since 1990 [12-14]. However, the total share of renewable energy sources in total final energy consumption (TFEC) has declined, owing to the declining use of non-commercial biomass and the growing role of natural gas in the system. Turkey has recently announced that it will reopen its nuclear programme in order to respond to the growing electricity demand while avoiding increasing dependence on energy imports [29-35]. Figure 1 shows the installed power capacity in Turkey by energy source

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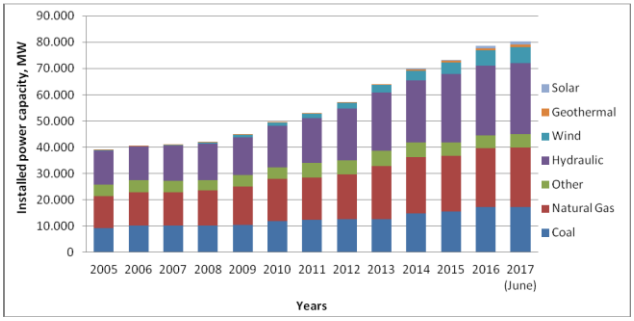

Figure 1. Turkey's Installed capacity (MW).

Table 1. Total energy supply in Turkey (Mtoe).

Energy Sources	2017
Coal and Lignite	**14.47**
Oil	**2.68**
Gas	**0.29**
Nuclear	**0.00**
Hydropower	**5.00**
Geothermal	**7.12**
Wood and Biomass	**2.53**
Solar/Wind/Other	**2.75**
Total production	**35.36**

Mtoe: Million tons of oil equivalent

Table 2. Total energy demand in Turkey (Mtoe).

Energy Sources	2017
Coal and Lignite	**38.82**
Oil	**44.53**
Gas	**45.87**
Nuclear	**0.00**
Hydropower	**5.00**
Geothermal	**7.12**
Wood and Biomass	**2.53**
Solar/Wind/Other	**2.75**
Total consumption	**145.30**

In Turkey, electricity is mainly produced by thermal power plants, by consuming coal, lignite, natural gas, fuel-oil and geothermal energy, wind energy (recently) and hydropower plants [20-22]. The electricity requirement was reported as 264 000 GWh in 2017 [21]. The electricity is mainly produced by thermal power plants and accounted for 74,82 % of the total, while hydro power energy was 25,11 % and the wind power energy was 0,07 %. In the thermal electricity production, the lignite part was 18,37 % and natural gas was 44 %. Compared to other energy sources, PV systems don't have sufficient contributions to gross electricity demand. There are no sufficient governmental driving forces to support PV systems in Turkey yet. Turkey's annual solar energy potential is estimated to be 1015 kWh, which is more than 5 700 times of the present electricity consumption [12-15].

Along with the economic growth and population increase, significant increases were observed both in primary energy and electricity consumption [14]. Consumption of primary energy reached 146 Mtoe as of the end of 2017 with an annual average increase of 3.1% while electricity consumption reached 276 billion kWh with an annual average increase of 5.2% during this period. Figure 2 shows Turkey's electricity power generation (GWh). Table 3 also shows breakdown of installed capacity in Turkey (MW) [12-14].

Table 3. Installed power capacity of Turkey in 2017.

Power resources	Installed capacity (MW)
Thermal power plants	46,926.5
Hydroelectric	27,273.1
Wind	6,516.2
Solar PV	3,420.7
Geothermal	1,063.7
Total	85,200.2

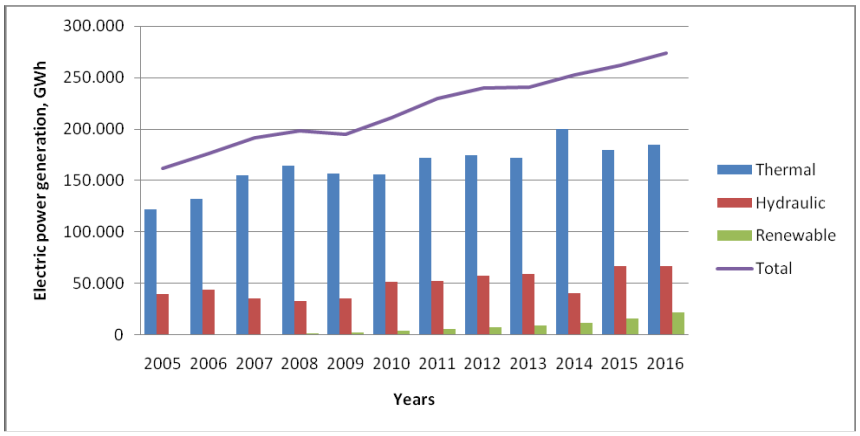

Figure 2. Turkey's electric power generation (GWh)

3. Renewable energy in Turkey

3.1. Overview

Turkey is one of the fastest growing energy markets in the world. Turkey's total energy demand has been increasing rapidly. imported fossil fuels dominate Turkey's total primary energy consumption by 75%. However, one of the government's priorities is to increase the ratio of renewable energy resources to 30 % of total energy generation by 2023. As seen in Table 3, Turkey had 85.2 GW of installed electricity generation capacity end of 2017. The breakdown by generation sources is as follows: 55.08% fossil fuels (natural gas, coal, liquid fuels etc.), 32.01% hydro, 7.65% wind, 4.01% solar and 1.25% geothermal. Almost all natural gas and around 40% of coal were imported. Therefore, Turkey needs to boost its power self-sufficiency by handling its rich potential of renewable energy sources [10-16].

Renewable energy supply in Turkey is dominated by hydro and biomass, but environmental and scarcity-of-supply concerns have led to a decline in biomass use, mainly for residential heating [5, 19]. Total renewable energy supply declined from 1990 to 2017, due to a decrease in biomass supply [18, 19]. As a result, the composition of renewable energy supply has changed and wind power is beginning to claim market share [12-15]. As a contributor of air pollution and deforestation, the share of biomass in the renewable energy share is expected to decrease with the expansion of other renewable energy sources. Table 4 also shows the potentials for investment of the renewable energies in Turkey. Figure 3 shows expected installed capacity by renewable energies in Turkey [31-35].

Table 4. Potentials for investment for renewable energy technologies in Turkey

Sectors	Million $	Remarks
Hydroelectric	120	Economical development potential of 28,400 MW, Corresponding 100,000 GWh/a
Wind power	72	Economical development potential of 48,000 MW With wind speed > 7 m/s
Solar thermal	170	Economical development potential of 131,000 GWh/a, Corresponding to approx. 300 million m^2 collector area
Bioenergy	15	Agricultural residual material and dung, when used for electricity generation, 1,000 MWe and 7,000 GWh/a
Total	377	

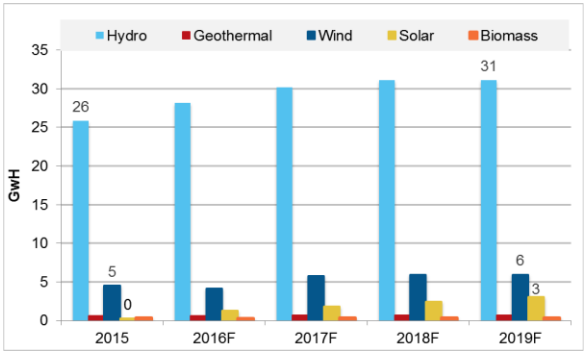

Figure 3. Turkey's expected installed capacity by renewables (GW)

Total gross hydropower potential and total energy production capacity of Turkey are nearly 70 GW and 142 TWh/yr, respectively and about 30% of the total gross potential may be economically exploitable [13, 14]. At present, only about 35 % of the total hydroelectric power potential is in operation [19]. The national development plan aims to harvest all of the hydroelectric potential by 2020 [20].

The contribution of small hydroelectric plants to total electricity generation is estimated to be % 5-10 [22]. On the other hand, the Southeastern Anatolia Project (GAP) is one of the largest power generating, irrigation, and development projects of its kind in the world, covering 3.0 million ha of agricultural land [27]. This is over 10 % of the cultivable land in Turkey; the land to be irrigated is more than half of the presently irrigated are in Turkey. The GAP project on the Euphrates and Tıgris Rivers encompasses 22 dams and 19 hydroelectric power plants. Once completed, 27 billion kWh of electricity will be generated and irrigating 1.7 million hectares [13, 14, 19, 20, 22].

Biomass is the major source of energy in rural Turkey. Among the biomass energy sources, woody biomass seems to be the most interesting because its share of the total energy production of Turkey is high at 11 %. Turkey's annual biomass potential is about 120 million tons and the total biomass energy potential is about 36 Mtoe [5]. The amount of usable biomass potential of Turkey is approximately 18 Mtoe. Turkey has the potential to produce 4.0 million tons of wood pellet has approximately 780 million dollars of market value by the help of existing woody biomass [12]. Producible wood pellet could account to 1.4% of total primary energy consumption in 2014 and 1.38% of imported energy. If Turkey utilized existing woody biomass as wood pellet, this would represent a saving of 340 million dollars from energy imported in 2014. The capacity for wood pellet production in Turkey is quite low, due to its high cost [13]. Therefore, relevant institutions should launch more projects to promote the production and consumption of wood pellet. International pellet standards should be adopted, and private sector should be encouraged by government [14].

There are a number of cities in Turkey with relatively high wind speeds [27]. These have been classified into six wind regions, with a low of about 3.5 m/s and a high of 5 m/s at 10 m altitude, corresponding to a theoretical power production between 1000-3000 kWh/(m^2.yr) . The most attractive sites are the Marmara Sea region, Mediterranean Coast, Agean Sea Coast, and the Anatolia inland. Capacity is likely to grow rapidly, as plans have been submitted for just under a further 600 MW of independent facilities. At start 2014, total installed wind energy capacity of Turkey is only 1900 MW [12-14].

Turkey added 766 MW in 2017, bringing the country's total wind power capacity to 6,857MW. 2017 marked a turning point for Turkey's wind industry: in December, 2.11 GW were issued preliminary licences for 67 wind projects by Turkey's electricity transmission operator TEIAS. This completed a round which had started in June 2017 with the assignment of 710 MW of so called pre-licences, issued to projects meeting specific criteria and participating in grid capacity auctions. In addition, the country's first wind tender was held in August, where 2.0 GW of onshore wind capacity was allocated under Turkey's YEKA renewable energy programme. Recently Turkey's energy and natural resources ministry also announced its plans to start offshore wind development to boost the country's renewable energy capacity. The ministry has identified potential zones for the country's first offshore wind tender [12-14]. Figure 4. Turkey's renewable energy targets for 2023 in Turkey.

Turkey is one of the countries with significant potential in geothermal energy and there may exist about 2000 MWe of geothermal energy usable for electrical power generation in high enthalpy zones. Turkey's total geothermal heating capacity is about 31,500 MWth. At present, heating capacity in the

country runs at 1240 MWth equivalent to 150,000 households. These numbers can be heightened some seven-fold to 7,180 MWth equal to 800, 000 households through a proven and exhaustible potential in 2014. Turkey must target 1.2 million house holds equivalent 7,700 MWth in 2020 [12, 13, 25].

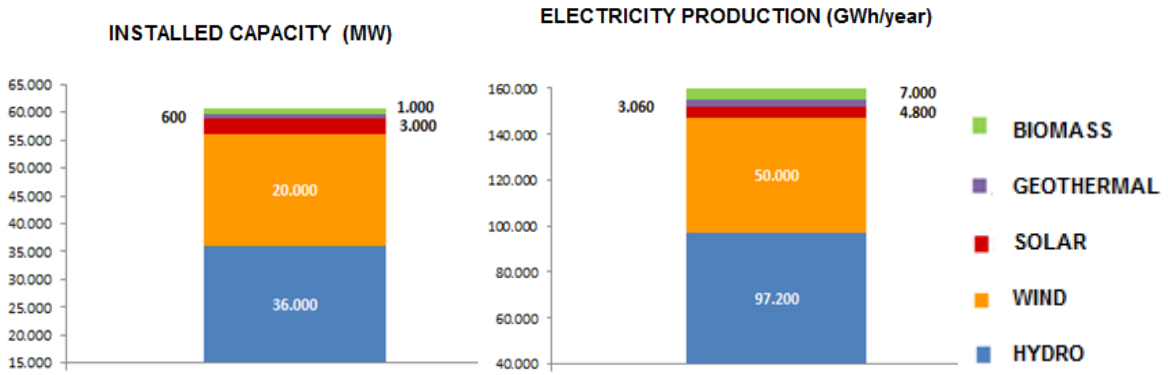

Figure 4. Turkey's renewable energy targets for 2023

4. Solar energy for sustainable development

4.1. Global solar energy

Installed solar thermal capacity grew by 10% around the world in 2017. Solar thermal power output reached 88,845 GWh, resulting in the avoidance of 40 million tons of CO_2 emissions. At the end of 2017, the installed solar thermal capacity worldwide equalled 246.8 GW_{th}. The breakdown by collector type is: 120.5 GW_{th} - flat-plate and evacuated tube collectors, 25.1 GW_{th} - unglazed plastic collectors and 1.2 GW_{th} – air collectors.

The use of solar thermal energy varies greatly by country. In China and Taiwan (80.8 GW_{th}), Europe (15.9 GW_{th}) and Japan (4.9 GW_{th}), plants with flat-plate and evacuated tube collectors are mainly used to prepare hot water and to provide space heating while in North America (USA and Canada) swimming pool heating is still the dominant application with an installed capacity of 19.8 GW_{th} of unglazed plastic collectors. It should be noted that there is a growing unglazed solar air heating market in Canada and the USA aside from pool heating. Unglazed collectors are also used for commercial and industrial building ventilation, air heating and agricultural applications. Europe has the most sophisticated market for different solar thermal applications. It includes systems for hot water preparation, plants for space heating of single and multi-family houses and hotels, large-scale plants for district heating as well as a growing number of systems for air conditioning, cooling and industrial applications.

From the worldwide collectors capacity in operation (2007) are 50% evacuated tube collectors, 32% flat-plate collectors, 17% unglazed collectors and 1% air collectors (mainly from the Solarwall-type). The main markets for evacuated tube collectors are in China, the most flat-plate collectors are found in Europe. In USA and Australia unglazed collectors are dominating. But in recent years, the worldwide market for new installed glazed collectors has been significantly growing, in Europe with growth rates near and above 100% compared to the capacity installed in 2006.

Solar thermal energy has the potential to meet the complete heating and cooling demand in the residential sector and to contribute significantly to the energy supply of the commercial and industrial sector (see Figs. 5-7) The potential of solar thermal technologies for the heat supply (hot water and space heat) in housing is large. Passive solar heating in combination with energy-efficient building construction and practices can reduce the demand for space heating up to 30%. Active solar can reduce the fuel demand for hot water and space heating: 50% to 70% for hot water preparation and 40% to 60% for space heating in energy-efficient houses. Day-lighting can reduce the electricity demand for lighting up to 50%.

The potential for solar thermal applications in the housing sector will increase dramatically once suitable technical solutions are available to store the thermal heat for the medium to longer (seasonal) term. Such advanced storage systems could utilise chemical and physical processes to reduce the total storage volume and the related costs. On the other hand, solar assisted cooling is an extremely promising technology

as peak cooling consumption coincides with peak solar radiation. A number of large-scale solar cooling systems have been successfully demonstrated, and it is now necessary to support wide market introduction. With increasing demand for higher comfort levels in offices and houses, the market for cooling has been increasing steadily over the past years. Today, solar assisted cooling is most promising for large buildings with central air-conditioning systems. However, the growing demand for air-conditioned homes and small office buildings is opening new sectors for this technology.

In many regions of the world, air-conditioning represents the dominate share of electricity consumption in buildings, and will only continue to grow. The current technology, electrically driven chillers, unfortunately do not offer a solution as they create high electricity peak loads even if the system has a relatively high energy efficiency standard. In particular, in Mediterranean countries sales of air-conditioning equipment are dramatically increasing, and leading to electricity shortages in some areas during peak summer conditions. The obvious link, to provide the primary energy for these cooling applications using solar thermal energy, is still under development. Over the past ten years, the development of technical solutions has been strongly stimulated, mainly by small and medium-scale enterprises. In the range of small capacity water chillers using sorption technology very promising new products came up, which open a new market for use of solar thermal energy as a driving heat source for summer air conditioning. And, in the range of large capacity chillers many new solutions on the system level were developed and provide the opportunity for solar heat driven building airconditioning.

4.2. Solar energy in Turkey

4.2.1 Potential

The solar radiation potential in different cities has been performed by Turkish Meteorological Office with using different methodologies in Turkey. Turkey's solar energy potential is quite high because of its geographical position, which offers it an annual sunshine duration of 2640h and an average radiance of 1.311 kWh/m^2 per year (3.6 kWh/m^2 per day), according to Turkish Renewable Energy Association (TREA). Turkey's annual solar energy potential and sunshine duration changes from May to August, and the potential is calculated around 380 billion kWh. The southeastern Anatolian region has the highest amount of solar energy, followed by the Mediterranean Region (URL-2, 2011). One can see the solar potential map of World and Turkey in Figure 5 and 6.

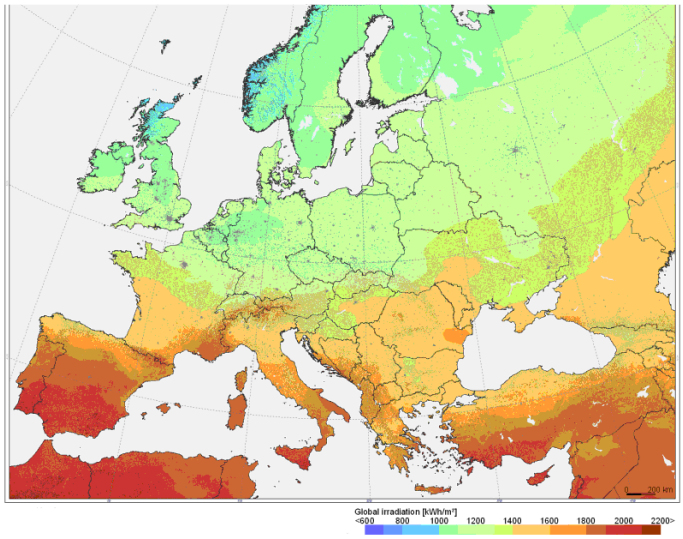

Figure 5. Solar electricity potential in European countries

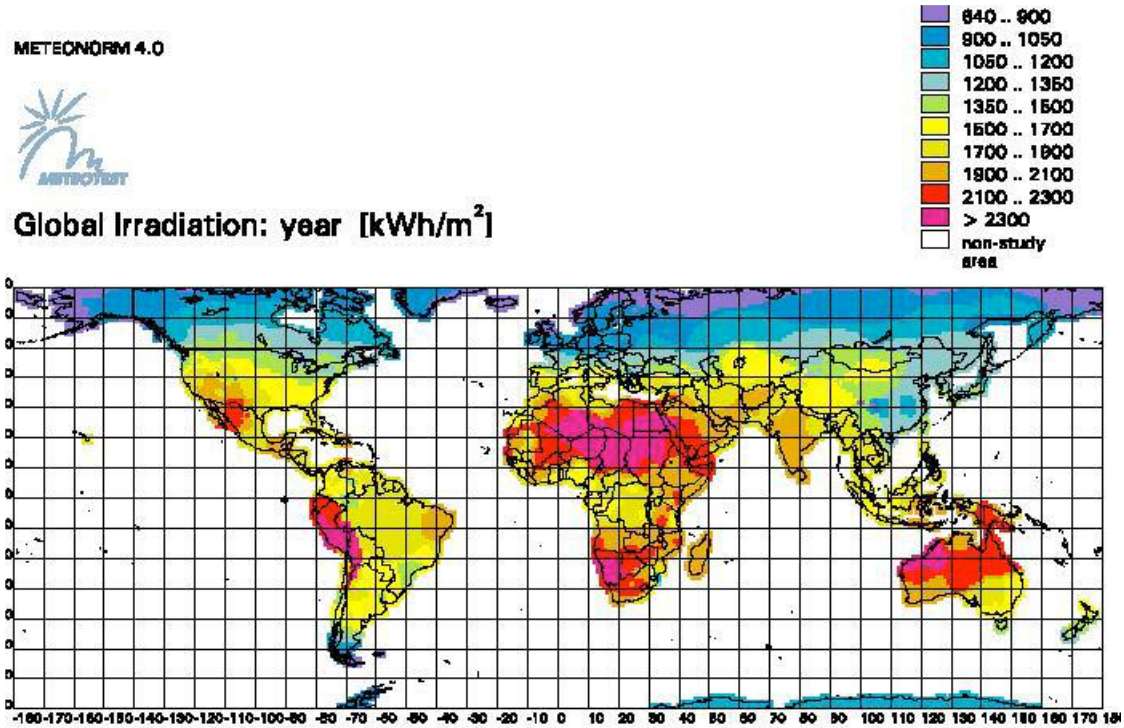

Figure 6. Annual global solar radiation.

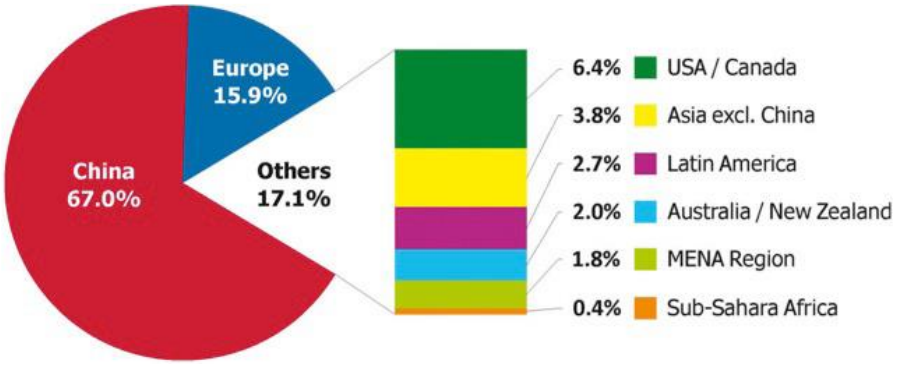

Figure 7.Share of the total installed capacity in operation (glazed and unglazed water and air collectors) by economic region at the end of 2012.

4.2.2. Policy

The main framework for legislation took place in 2005 with the Law on the Utilization of Renewable Energy Resources for the Purpose of Generating Electricity, and amendments subsequently followed it: the 2001 Electricity Market Law, 2007 Energy Efficiency Law and the 2007 Law on Geothermal Resources and Natural Mineral Waters are relevant legislations.

The current legislation for renewable energy was announced by the Turkish government in December 2010. It regulates the FIT for all forms of renewable energy sources. In regards to solar, the legislation has a cap of 600MW installation until the end of December 31, 2013, and guarantees a price of USD 13.3 cents per kWh. However, the government has commited to buy produced electricity only for 10 years, contrary to the common practice of 20 years in other countries e.g. Germany, Spain. Additionally, a bonus system for using "Made in Turkey" components is in place. The structure of FIT is illustrated at the figure below. Considering the unavailability of cell, inverter and focusing material (relevant for CSP technology anyhow) for suppliers by local manufacturers in Turkey, only a total of an additional 2.1 USD cents can be granted as of 2011 with the composition of elements in new FIT values.

4.2.3. Diffusion

Turkey has abundant solar potential compared to most of the other European countries, but this potential has only been addressed for domestic hot water production, mainly in the sunny coastal areas at the moment. Turkey has the second largest quantity of

installations for water heating systems worldwide, following China. The diffusion of solar powered water heating indicated the potential of the market for electricity generation in Turkey as well [1-4]. In addition to these, the usage of PV batteries is increasing with the implementation of volume heating, also known as solar architecture. On the other hand, although Turkish people are knowledgeable about solar heating collectors and wind energy, widespread knowledge about the potential of solar electricity potential currently does not exist.

According to many environmentalists, market analysts and solar developers, the solar industry in Turkey could become one of the biggest in the world if the government offered solar producers as much regulatory and financial support as the governments of Germany and Spain, which offer solar producers generous feed-in tariffs. Although solar potential exists and significant success has been achieved in the installation of solar water heating systems, similar success in the short to mid-term is not yet forecast for solar energy.

On the other hand, the National PV Technology Platform in Turkey (UFTP) completed a PV roadmap for Turkey in October 2009. The following objectives were identified:

- Establish the first solar energy plant with a capacity of 20 MW by the second quarter of 2014.
- Install a power target of 4.0 GW by 2020, locally produce 50% of panels, cells and inverters by 2020.

There is no official PV installation target communicated as of yet. The Electricity Market and Security of Supply Strategy paper in 2009 only states a target to generalize the use of solar energy for generating electricity, ensuring maximum utilization of the country's potential. However, the following forecasts have been made by various research entities:

- EPIA (2010) forecasted the PV installed base in Turkey 1.7 GW to 5.7 GW by 2020 and 7.3 GW to 24.4 GW by 2030 depending on different development scenarios
- Turkish National PV Platform projects 4.0 GW by 2020 and 8–10 GW by 2023
- The International Center of Applied Thermodynamics (ICAT) estimates 5.0 GW by 2020 and 7.0 GW by 2030.
- The Turkish Renewable Energy Association (TREA) expects a total of 5 GW by 2023 of Solar PV.

Turkey is one of the world's leading countries for solar thermal. Currently, the country has a lot of work to do, like improving the quality of installations and systems on the domestic market. Turkish collector and tank manufacturers want to improve their position on the global market. Broken window panes behind metal bars, rusted company signs extolling the virtues of solar thermal systems, an old rain barrel blocking the entrance – all vague hints at what awaits you inside this small garage company in Konya's Meram industrial area. Scrap metal meets your gaze wherever you look – once, that is, your eyes get accustomed to the dim lighting. Pipe and metal bars stacked or propped against a wall; ladders, sheet metal, containers – much of the stuff rusted – with glass wool, hoses and cables peeking out in between. A shiny metallic water boiler towers up amidst the tan gle. It is the company's newest product, made here amidst a great clatter, and soon it will be installed on one of the large city's many roofs. This is one side of the Turkish solar thermal market.

There is another side however. The entrance to Baymak in Tuzla, Istanbul is framed by the waving flags of the Turkish republic and those bearing the company logo. Next to these wave flags of the countries of foreign guests. Inside are pleasant open offices where conversations take place in hushed tones. The floor gleams and not a bit of clutter can be seen in the collector production plant, commissioned in 2009. The new laser welding machine works away quietly. The only bit of disorder in the place is where the storage tank enamelling machinery is being rebuilt. A journey through the Turkish solar collector and tank manufacturing industry begins with the "garage companies", which sell collectors and water tanks at very low prices on the domestic market. The journey continues to a dozen-odd established mid-sized manufacturers who produce at Western European standards and export their products around the world. Baymak, of the Baxi Group in the UK, is the gold standard and claims that it runs "one of the most modern facilities in Europe." As much as these companies differ, they all have a share of the solar thermal market. The companies cater to different market segments; some focus on the domestic market, others export to European Union (EU) member states, and still others have their sights set on the rest of the world.

Total solar energy production of 1265 million tons of

oil equivalent (Mtoe) in 2017 increased to 0.827 Mtoe in 2016 and is projected to rise to 5.5 Mtoe (5.5% of primary energy production) by 2025 [14]. Flat plate solar collectors are the most widespread solar thermal application in Turkey, which are generally used for the production of commercial and domestic hot water, especially throughout the coastal regions. In 2017, Turkey had 14 million m^2 of collector surface area installed with a heat output of 0.4 Mtoe contributing to energy production [13].

According to a study by the MENR, in its high demand scenario, Turkey's energy demand will increase by 7% per year by 2030 and will reach 680 TWh. In order to meet these energy deman, the country must be used all domectic energy sources at maximum capacity, especially hydropower, lignite, wind and solar power. On the other hand, solar energy is one of the most valuable renewable energy sources, which is still untapped in Turkey, with an expected potential of at least 500 GW. In 2017, Turkey's installed solar PV capacity was 3421 MW (see Table 3).

4. Conclusions

Almost 50% of the final energy consumption in industrialized countries (OECD) is used for the heating needs of buildings, for domestic hot water production and for heating in industrial processes. Heat is the largest consumer of energy, being greater than electricity or transport. Renewable heating sources (solar thermal, biomass, geothermal) have a huge potential for growth and can replace substantial amounts of fossil fuels and electricity currently used for heating purposes.

Highly efficient, innovative and intelligent solar thermal energy systems providing hot water, space heating and cooling will be available, and will offer a high level of reliability and comfort. It may be estimated, that Active Solar Building - which is 100% heated and cooled by solar thermal energy - will be the building standard for new buildings, Active Solar Renovated Buildings will be heated and cooled by at least 50% with solar thermal energy. And Active Solar Renovation will be the most cost-efficient way to renovate buildings. The vision for the "Building of Tomorrow" is the "Zero-Energy Building", with the building envelope as solar collector and seasonal thermal heat storage. Important limitations to expanding the use of technical potentials of solar resources for heat production are economics as well as the geographic distribution of the resource.

For a wide spread market deployment of solar thermal systems, it is necessary to store heat (or cold) efficiently for longer periods of time in order to reach high solar fractions, and therefore efficient and cost-effective compact storage technologies have to be developed. Alternative storage technologies, such as phase change materials (PCMs) and thermo chemical materials (TCMs), are still in the research and development stage.

Energy production from renewables should be improved in Turkey to reduce the dependency and environmental pollution and increase the development level of the country by increasing the economic level of the country. The author believes that Turkey does not use its clean energy sources efficiently and should promote new technologies and use all its renewable energy potential. According to the government policies, new capacity investments, supply diversity and maximizing energy efficiency are critical points for Turkey in conjunction with the increasing primary energy demand. In order to avoid the risks linked to both energy dependence and developing a sustainable energy model, the government is committed to promoting alternative solutions based mainly on local and renewable energy sources. Therefore, Turkey has initiated a forward looking and innovative energy policy in which renewable energy plays a significant role.

After examining and analyzing renewable energy potential and its current utilization of Turkey, it can be briefly concluded that renewable energy has been more popular. In Turkey, the share of renewable energy in the total electricity generation was 9% while it was over 10% for installed power capacity in 2017. Added to them, essentially wind energy from the available renewables in Turkey has showed significant increase. Wind energy occupies about 82% of the total renewable based installed power capacity of Turkey as of July 2018. Solar and geothermal based installed power capacities take the remaining 30% with the shares of about 18% and 12%, respectively. Turkish governments should be give more and more attention to develop the renewable energy utilization for achieving the 2023 renewable targets. Turkish governments must give more importance to the utilization of its renewable energy resources with the assistance of useful laws and amendments as well as major incentives which can all remove the available barriers to renewable energy investments.

Turkey is one of the world's leading countries for solar thermal. Currently, the country has a lot of work to do, like improving the quality of installations and systems on the domestic market. Turkish collector and tank manufacturers want to improve their position on the global market.

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