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Review Article

Thermal Solar Energy Use and Turkey Analysis

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Abstract

Energy is an important problem in Turkey as well as the whole world. Since Turkey has insufficient sources in terms of fossil energy sources, it is dependent on foreign. However, Turkey has rich resources in terms of solar energy (SE). The European Union countries (EU) try to generalize solar energy through promotions performing studies for raising awareness for generation of electricity from the sun. In Turkey, required importance is not given to the studies to raise the awareness and promotions In this study, the SE investments that will be made in the long turn, the promotions that can be given by the public and the economic contributions made to the country are examined by comparing the SE potential of the world countries. Assessments on the fact that Spain, as a sample, which has made a move benefitting from heat source SE with CSP systems in the last decade and which ranks the 4th in this field in the world can be a model for Turkey is included. As a result, analysis and assessments have been made on that Stirling Engine Solar Systems that are appropriate for using and generating electricity individually among CSP systems should be generalized in Turkey.

Keywords: Solar energy, Stirling engine, Thermal energy, CSP.

1. Introduction

Ever-growing energy demand over world and as parallel to this, quick consumption of current energy sources have forced world countries to find new energy sources. According to expectations of World Energy Form: fossil energy-sourced petrol, coal and natural gas' reserves will have been consumed in the following century in the event that these fuels are used with today's methods (Efe 2015: Rüstemli et. al. 2015). Moreover, toxic gas emission with the consumption of fossil energy-sourced fuels creates negative effects on atmosphere. These effects cause global warming in long-term and also they cause weather pollution, occurring of acid rains, ozone layer depletion, destruction of forests (Efe & Cebeci 2013; Efe & Cebeci 2015;204: Efe & Cebeci 2015;42: Efe & Cebeci 2015;evk; Efe & Cebeci 2013;icemes). While CO_2 emission was 2.6 billion ton in 2002, it has been foreseen that this amount will reach to 6.8 billion ton as annual (Kumar at. al. 2010;Solar Energy 2015:03.04.2015).

Development of energy efficiency has become an obligation in order to prevent these effects (Cengiz & Karakaş 2015; Ceylan 2015; Cengiz & Aydoğdu 2008; Danış & Aydoğdu 2008; Parlakyıldız & Hardalaç 2013). In this sense, precautions related to decrease consumption of fossil energy-sourced fuels and to extend conservation energy sources. While production of electric was 17,450 TWh over world in 2004, it is thought that this production will reach 31,657 TWh in 2030. Its meaning is to be thousands of new power plants made in order to meet energy demand (Güler 2009). Thus countries should support RES-based energy production and electric production from these sources should ve extended. Turkey's main energy sources are based on fossil (Solar Energy 2015:03.04.2015). While our country's electric production corresponded to 52% of all our energy need in 2009, energy produced from domestic resources went back to 29% with developed industry potential in 2014 just after 5 years. Our country which has little reserve in terms of fossil sources make importation of natural gas, petrol and coal for electric production.

2. Thermal solar systems

CPS systems are most important solay technology which can be used in energy consumption in large scale. Solar power is exactly nonconsumable. 1.080.000.000 TWh power which corresponds to world's electric consumption in 60.000 times reaches to world from sun in each year. According to European CSP Union (ESTELA), 62.000 MW CSP can be established in South Europe in 2030. Production amount can be 176 TWh/year which corresponds to nearly 5% of foreseen amount to be produced in EU in 2030. CSP plants produce electric as they take solar power into high-temperature heat , using reflective mirrors. Heat is conveyed to a traditinal generator.

CSP systems are modular, they can be manufactured from small-sized systems to grid-tie large systems. They are compatible with distributed electric production systems. They contribute to continuity of energy during all day by working in synchro with hybrid applications. They are economical in terms of expense of company. Energy produced by CSP is based directly to sunshine (Cengiz et al. 2015; Norm Energy 2014:04.04.2015). Concentrated solar systems used commonly over world can be ordered like that;

- Parabolic trough systems

Solar power is focused on a receiver pipe with reflector in the form of parabolic trough. This power heats oil flowing through the pipe and this heat is used in order to produce electric in a traditional-streamy generator.

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Trough designs can work with thermal storage as making electric production possible in a few hour at nights. Available all parabolic trough plants are hybrid plants. Hybrid plants use fosil fuels in order to meet the deficit in the case of low solar radiation. Typically, a natural gas-fired heat or gas stream heater is used, at the same time, it can be integrated in current coal-burned plants (Norm Energy 2014:04.04.2015). Parabolic trough system application is indicated on Figure 1.

Figure 1. Parabolic trough system application

- Tower systems

Sun radiation stays focused on a receiver on the top of tower as many large-scaled mirrors are used in a power tower. A heat in receiver is used to produce electric on a traditional turbine-generator by heating as to produce transfer-flow stream. Sample Tower system application is indicated on Figure 2.

Figure 2. Tower System Application

- Stirling motorized calix systems

A calix focuses solar radiation to receiver. System follows sun. Heat which is gathered is used by a heat motor directly on receiver. There are application with the purpose of small-sized individual used or larger plant. Stirling motorized parabolic calix system applications are seen on Figure 3 (Cengiz at al. 2015:8; Cengiz at al. 2015:300).

Figure 1. Stirling motorized parabolic calix system

World's CSP installed power is 430 MW, there are 45 CSP projects with 5500 MW capacity on available planning stage. Leader countries over world are USA and Spain (Norm Energy 2014:04.04.2015).

3. Potential of solar power

Our country's solar power potential is equal nearly with Spain and more than sun potential of all other European countries, it has average 1000–1450 kWh/m^2.year value. Thus Turkey's solay energy potential is more than 10.000 times of fossil energy sources. Solar energy potential which is equal with all surface of world is equal with 50 times of known coal reserves and 800 times of known petrol reserves.

International Energy Agency has foreseen that great amount of global electric energy production such as 11% will be provided from solar power in 2050 (Bilgin 2015). Amount of electric energy production from solar power over world reached to 139 GW level at the end of 2013. Today, Germany, Italy, Czech Republic and other EU countries became FV markets (Bilgin 2015).

According to sunshine duration and radiation level measured between 1966-1982, it has been determined that average annual total sunshine duration of Turkey is 2640 hours (daily total 7.2 hours), average total radiation level is 1.311 kWh/ m^2-year (daily total 3,6 kWh/m^2). Turkey has got annualy 110 days- solar energy potential, it has position to able to produce 1.100 kWh per square meter.

Solar energy capacity which is equivalent to 56.000 MW thermic plant capacity is in Turkey and annual almost 380 billion kWh electric can be produced. But total solar cell capacity used in Turkey is nearly 1MW. Electric plants are more than 5000 times of our installed power. On figure 4, according to researches of European Union Energy Commission, Turkey's solar radiation intensity is indicated (Kaya 2006).

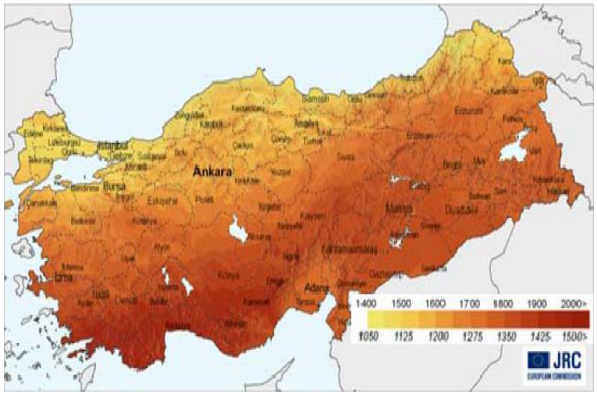

Figure 4. Solar radiation intensity by cities of Turkey

Our country is luck rather than many countries in terms of solar energy potential that it has got with its geographical position. The region which gets most solar energy in Turkey is Southern East Anatolia Region, Mediterrian Region follows it. Turkey is at fourth position in world as following China, USA and Japan in terms of thermal solar energy production and use.

Turkey's gross solar energy potential is equivalent with 87.5 million ton petrol. 26.5 million ton of this value is appropriate for heat use, 8.75 million ton is appropriate for producing electric. Turkey gets benefit from two in a hundred thousand only of this potential today.

Solar energy plant intensified as tower type which its installment has been completed in Mersin by concentrated solar energy technology in Turkey and has got 5 MW power has been installed on 100 decare- land and 30 decare- part of this land is used by reflective mirrors. In this plant, high-temperature and pressed stream is obtained as 510 helyostat reflectors follow sun with appropriate angles in day, as reflecting solar rays to receiver on 50 meter-high tower. Electric can be produced by high-temperature stream obtained.

4. Solar energy incentives over World

EU countries are at first on energy importation and at second order for energy consumption in world energy market. EU aims to raise its renowable energy share on energy sector to 20% in 2020, to 50% in 2040. European Union countries give various financial incentives, tax incentives and production incentives in order to increase use of RES. After 1980, projects related to production of renowable energy has been supported, investment and tax incentives have been made.

Surplus energy is sold to marketing company as electric production is made by solar panels settled on roof in Germany. Since 2013, 40% of solar panels (1-10 kW) are used on hosues, nearly 50% of them (10-100 kW) are used on commerical roof systems and nearly 10% of them are used on great solar power plants , settled in Germany.

Today, guarantee of purchase is given by states to electric production with solar panels. Even if yield is low, then , electric production from sun has increased. Electric price produced from sun in Germany is 40 €c/kWh and 25% state subvention of investment amount is applied. Total energy consumption's 23% is met from RES in Austuria. In Belgium, state assitance as to 15% is made on RES aids and 0,02449 €/kWh incentive is given to electric producers. Total support amount is restricted with maximum 30% of investment cost. In Denmark, Electric marketing companies get 1,5 €c/kWh incentive in the event that they use energy produced from RES. In France, 25% of total price's tax amount is not taken , used in RES-plant building. In England, laws which oblige use of electric produced from RES are in force. Sweden gives 332€ support per each kW installed as to 25% of capital price. Italy gives suppoty as to 40% for RES-production investments. For solar energy projects, VAT is taken as 10% instead of 20%. Greece pays incentive as to 50% for sun investments on Girit Island (Kaya 2006).

On FV sector, as electric production from solar panel does not meet cost to establishment early on, these type of systems have gotten profit with increase of efficiency today. In 1998, Spain which has not got FV panel has reached a respectable power to produce electric from sun by solar plants that it has established in ten years. Germany, USA, China, Italy and Japan follow it. This quick development is provided by incentives given to consumers. Public incentives fiven for solar energy by countries over world are indicated on Table 1.

Table 1. Public incentives fiven for solar energy by countries over world

Country	Fixed price guarantee	Subsidies (discount)	Investment incentives	Tax relief	Public investment	Energy purchase guarantee public
Germany	x	x	x	x	x	
Austria	x	x	x		x	
Britain	x	x		x	x	
Denmark	x	x	x	x	x	x
Finland	x	x		x		x
France	x	x	x	x	x	x
Netherlands		x	x	x		
Ireland	x	x	x			x
Spain	x	x	x	x	x	
Swedish		x	x	x	x	
Italy	x	x	x	x	x	
Luxembourg	x	x	x	x		
Norway		x		x	x	
Portugal	x	x	x	x	x	x
Greece	x	x	x		x	
Turkey			x			

5. Solar energy incentives over Turkey

Country which has got almost most solar energy potential among EU countries is Turkey . But electric production from solar energy is about a few MW. It is far from targets to reach RES-installed power on levels which have been wanted just now.

Electric market's legislation aims to increase use of RES- electric, there are some incentives and regulation in our country also. But it is seen that incentives are in very low-size when it is compared with European countries. There are incentives such as exemption of licence cost on current incentives and such as not paying licence cost for 8 years after completing production plants using electric produced from RES. 5 cent investment per kWh is given to electric produced from RES for 10 years on the 5346

numbered law which entered into force on 25819 numbered Official Gazete in 2005. Moreover, exemptions to establish company and to obligation of licence were provided to individual users who establish facility to 500 kW as to meet their own needs by the change made on 4628 numbered law.

6. Conclusion

Although our country is at first order among EU countries in terms of solar potential, it misuses this potential and this potential is not efficiently used. For example, while Germany adapts FV-panel solar energy production, Spain which has similar temperature and climate conditions with Turkey prefer CSP system- solar production methods with heat resource which FV panel system is not required. While sample Spain which shows similarity to our country's climate conditions is to be more efficient production method for Turkey, we prefer to produce electric via FV panels of Germany by getting benefit from sun radiation which is method to get benefit from sun. But in our country, places which are appropriate for temperature and altitude values of Germany are a part of East Anatolia region and high-settlement places, aforementioned places meet 20% of all our solar potential. Turkey's real solar potential is based on heat and it is 80% of all our solar potential. So Spain which has similar climate conditions with our country can be selected as model. Spain got 4.order in terms of electric production from sun in wold as using heat-sourced CSP solar potential in last ten years. In our country, some CSP system-production methods such as Stirling motorized systems should be adapted in electric production from sun. Because temperature is disadvantage on stable FV panel-systems and decreases yield and heat-sourced CSP systems such as stirling motorized systems are most important parameter raising efficiency of temperature. As countries such Germany, Spain and France give incentiv to their citizens on many subjects and they make awareness raising studies, they rank first places to produce electric from sun. Although Germany has most solar potential, Turkey is at the last order on this gradation. As it is country which makes least awareness raising and incentive studies.

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