

Recent Energy Policy Regulation on Solar Energy Systems in Turkey: Impact on the Economy and the Environment

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Abstract

The main objective of this report is to give detail information regarding the capacity of Turkish electricity market as well as taking into consideration the country's economic situation all over the world. Following by this, the demand and consumption of Turkey's electricity capacity is given by associated with its economical growth and dependence on energy from abroad. It is pointed out that Turkey is the one of the biggest fossil fuel consumers. The fact of the time line of Turkey's energy status is highlighted by given actual data comparing last three decades. The effect of utilizing of fossil energy source on country's economical and environmental welfare is discussed. There is a wide consensus on existing un-reversible climate change due to increased CO₂ emissions so in order to reduce emission the benefit of utilizing solar energy system is explained in accord with country's solar energy policy up to date as well as additional incentives granted by Turkish government for installation. The country great solar energy potential and installed photovoltaic capacity are also given by comparing other countries.

1 Introduction

Turkish electricity market is one of the most promising markets in Europe. Turkey's economy has been developing significantly for the last years. From economical point of view Turkey is considered to be 17th biggest economy all over the World and as given in Figure 1 (Arıkanlı Holding Presentation, 2012). Next 15 years with 6.7 % GDP (Gross Domestic Product) growth forecast Turkish Economy will be the fastest growing economy among the OECD (Organization for Economic Co-operation and Development) countries (see Figure 2). According to report published in 2012, it is the fastest growing third economy following China and Argentina, the sixth biggest economy of Europe, the biggest sixth electricity market of Europe. The demand on annual electricity has been increasing 6-7 % every year and 4.6 % average demand since 1990 which is 3 times more than Europe's average 1.6 %. It has been anticipated that by 2020 the demand on annual electricity will be increased by 7.5 % (Chamber of Mechanical Engineering Overlook of Turkey's Energy Profile, 2012). In the current situation, Turkey is one of the biggest fossil fuel consumers. The rank of consumptions can be given as follows; the seventh biggest coal, eight natural gas and twenty-fifth petroleum importation of the World. Consumption in fossil fuels induces two negative effects on economy and environment. From economical point of view energy imports of Turkey in 2012 amounted to \$ 60 billion which corresponds to 2/3 of the country's current deficits, and is estimated to reach U.S. \$ 120 billion in 2023. 2011 to 2012 has been an increase of 12.3 % in the cost of imported energy. Investors and governments which play important role in directing the economic growth especially in developing economies neglect the environmental issue as a result of using fossil fuels (Alawaji, 2001). There is a wide consensus on existing about un-reversible climate change due to use of classical energy resources (Badran, 2001).

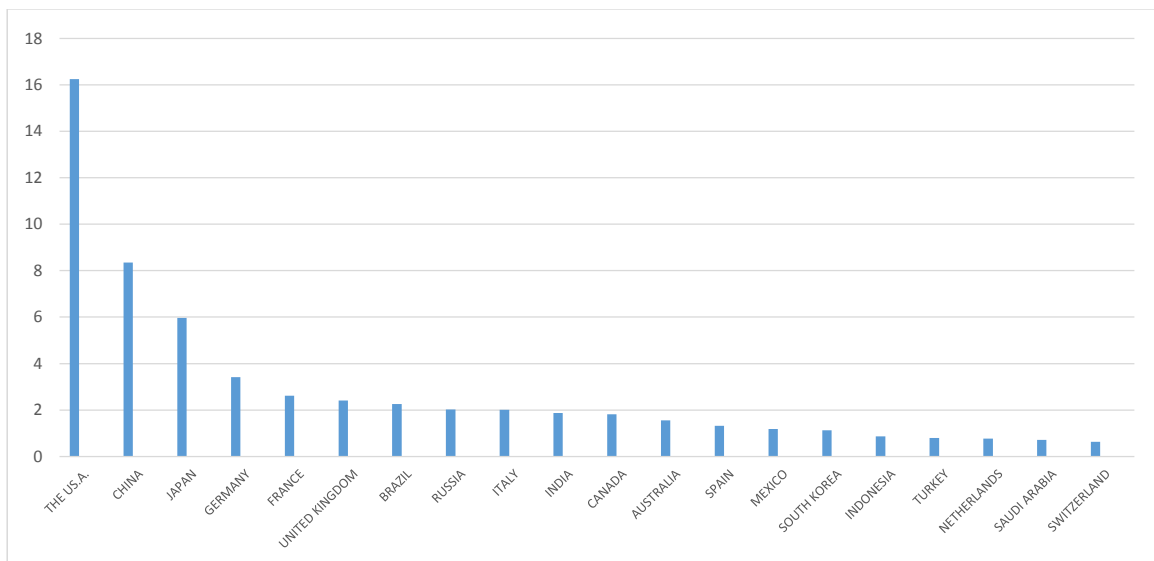


Figure 1: World's Biggest Economies GDP Millions of '000 USD

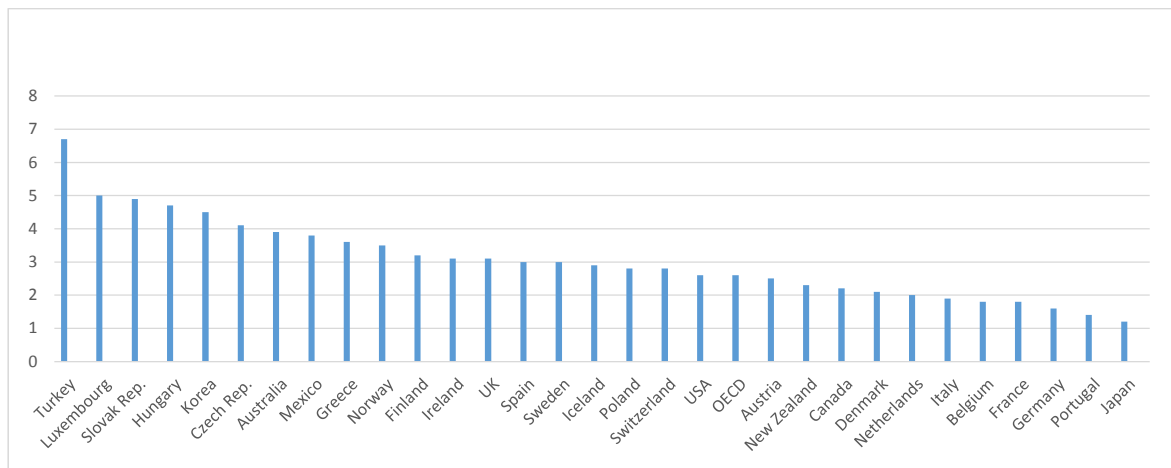


Figure 2: Annual Average Real GDP Growth (%) Forecast in OECD Countries 2011-2017

The new policy should be introduced in order to regulate CO₂ emission (World Bank Annual Report, 2013). Otherwise releasing emission will lead to global temperature increases that are measured about of 3.6 °C for this century as well as sera effect, acid rain and dirty fogs (Lehtovaara, et. al, 2013). These issues can be solved by shifting use of sustainable renewable energy resources limiting the global warming and countries' deficits. Huge amounts of investments for energy production has been made between 2004 and 2011 reaching USD 260 billion with 30 % annual increment (World Bank Annual Report, 2013).

In this work, the case study has been conducted on renewable energy potential of Turkey as well as how the diffusion of solar energy efficiently promoted in Turkey. The main focus of the study is on recent and future expectation of solar power that is expected to contribute the biggest share of the increase of renewable energy in Turkey. Turkey's solar power production and installation performance is determined and is compared with the other countries.

2 The Timeline of the Turkey's Energy Status

Turkey is a founding member country of International Energy Agency (IEA) among 28 member countries. To be a member country of the IEA, a country must be a member country of the OECD. However, membership in the OECD does not automatically result in membership in the IEA. For instance, Chile, Estonia, Iceland, Israel, Mexico and Slovenia are OECD Member countries but currently not IEA Member countries. Chile and Estonia, however, are currently candidate countries of the IEA. The main benefit of being part of such organization is to create sufficient condition in energy sectors and obtain sustainable economic development and environment. To achieve such goals and enter international energy markets, IEA ministers congregate once every two years at IEA Ministerial Meeting. During the IEA Ministerial meeting the issues come along according to the member country's priority about energy and ideas for existing or new work programmers (Energy Policy Highlights, 2013).

Improving energy efficiency is essential for responding to Turkey's energy policy challenges and considerable potential in all sectors. In a country like Turkey where private sectors are rapidly becoming more common and where significant new construction is foreseen, transport and buildings related energy consumption is significantly increased inducing CO₂ emissions. Energy-related CO₂ emissions in Turkey have more than doubled since 1990 and are likely to continue to increase rapidly over the medium and long term, in parallel with energy demand. The IEA urges Turkey to intensify efforts to further develop its approach concerning its post-2012 regime to combat climate change, and to consider setting a quantitative overall target for limiting emissions. Table 1 shows present and future estimated energy balances and key statistical data in Turkey between 1973 and 2020. In the same table, the amount of each production supply such as coal, oil, gas are compared to show tendency of usage trend. As it is seen that the total energy productions in Turkey are estimated to be 65.99 Mtoe by the year 2020. However, total energy consumptions are estimated to be 163.26 Mtoe by the year 2020 as seen in Table 2.

Total net imports compared to exports in coal, oil, gas are significantly increased year by year which makes Turkey energy depend country. Turkey depends on imports for 72 % of its total primary energy supply (TPES) that can be accounted as mainly oil and natural gas and coal. Oil, coal and natural gas together held 30 % of the total while renewable energy sources is less than 10 %. According to IEA report regarding Turkey's energy potential, the increase in TPES more pronounced by only two fuels; natural gas and coal which are 18 Mtoe and 7 Mtoe, respectively since 2000 (International Energy Agency Report, 2009). However, the other energy sources have not showed significant change although the economic development. Since natural gas and coal are used as

one of main sources for power generation for last two decades, 48 TWh which corresponds to 72 % of total power generation between 2000 and 2010 while 17 TWh are provided from coal. Energy production based on oil-fired has been steadily decreased since 2002 while Hydropower generation tends to increase by 5 TWh from 2000. Turkey has made huge investment on nuclear power so the total energy production form nuclear sources are going to be increased by 2020 up to 8 Mtoe. On the other hand, renewable energy sources such as wind, solar energy production are expected to increase by 3.64% and 4.28% which is not enough to provide Turkey's energy demand as it is estimated to be 250 Mtoe (International Energy Agency Report, 2009).

	1973	1990	2000	2005	2007	2008	2020
TOTAL PRODUCTION	15.53	25.82	25.86	23.93	27.27	29.03	65.99
Coal	5.21	12.37	12.49	10.81	14.79	16.68	37.1
Peat	-	-	-	-	-	-	-
Oil	3.59	3.61	2.73	2.23	2.11	2.13	0.69
Gas	-	0.17	0.53	0.74	0.74	0.84	0.23
Comb.Renewables & Waste	6.45	7.21	6.51	5.36	5.06	4.88	3.93
Nuclear	-	-	-	-	-	-	8.23
Hydro	0.22	1.99	2.66	3.4	3.08	2.86	9.42
Wind	-	-	0	0.01	0.03	0.07	0.72
Geothermal	0.05	0.43	0.68	1.01	1.05	1.15	4.81
Solar	-	0.03	0.26	0.39	0.42	0.42	0.86
TOTAL NET IMPORTS	8.72	27.77	49.98	59.67	73.81	70.57	151.76
Coal Exports	-	-	-	-	-	-	-
Coal Imports	0.01	4.21	9.31	11.72	14.64	12.86	43.5
Coal Net Imports	0.01	4.21	9.31	11.72	14.64	12.86	43.5
Oil Exports	0.84	1.88	1.29	5.41	6.09	6.53	-
Oil Imports	9.68	23.13	30.54	33.48	37.62	35.98	60.23
Oil Net Imports	8.71	20.94	28.33	25.93	29.54	27.49	55.56
Gas Exports	-	-	-	-	0.03	0.36	0.67
Gas Imports	-	2.68	12.05	22.13	29.78	30.6	51.98
Gas Net Imports	-	2.68	12.05	22.13	29.78	30.24	51.31
Electricity Exports	-	0.08	0.04	0.16	0.21	0.1	-
Electricity Imports	-	0.02	0.33	0.06	0.07	0.07	1.4
Electricity Net Imports	-	-0.06	0.29	-0.1	-0.13	-0.03	1.4
TOTAL STOCK CHANGES	0.11	-0.83	0.51	0.77	-1.08	-1.04	-
TOTAL SUPPLY (TPES)	24.36	52.76	76.35	84.38	100.01	98.55	217.75
Coal	5.15	16.91	22.91	22.79	29.39	29.46	80.6
Peat	-	-	-	-	-	-	-
Oil	12.48	23.4	30.4	28.75	30.7	29.55	56.25
Gas	-	2.86	12.63	22.79	30.42	30.18	51.54
Comb.Renewables & Waste	6.45	7.21	6.51	5.36	5.06	4.88	3.93
Nuclear	-	-	-	-	-	-	8.23
Hydro	0.22	1.99	2.66	3.4	3.08	2.86	9.42
Wind	-	-	0	0.01	0.03	0.07	0.72
Geothermal	0.05	0.43	0.68	1.01	1.05	1.15	4.81
Solar	-	0.03	0.26	0.39	0.42	0.42	0.86
Electricity Trade	-	-0.06	0.29	-0.1	-0.13	-0.03	1.4
Shares (%)							
Coal	21.1	32	30	27	29.4	29.9	37
Peat	-	-	-	-	-	-	-
Oil	51.3	44.4	39.8	34.1	30.7	30	25.8
Gas	-	5.4	16.5	27	30.4	30.6	23.7
Comb.Renewables & Waste	26.5	13.7	8.5	6.3	5.1	4.9	1.8
Nuclear	-	-	-	-	-	-	3.8
Hydro	0.9	3.8	3.5	4	3.1	2.9	4.3
Wind	-	-	-	-	-	0.1	0.3
Geothermal	0.2	0.8	0.9	1.2	1	1.2	2.2
Solar	-	0.1	0.3	0.5	0.4	0.4	0.4
Electricity Trade	-	-0.1	0.4	-0.1	-0.1	-	0.6

Table 1: Energy Balances and Key Statistical Data-Supply (Unit: Mtoe) Source: International Energy Agency

	1973	1990	2000	2005	2007	2008	2020
TFC	19.86	40.07	57.85	65.43	76.48	74.38	163.26
Coal	2.93	7.52	10.85	10.74	13.98	12.78	41.73
Peat	-	-	-	-	-	-	-
Oil	9.54	20.37	26.13	26.10	27.95	27.39	50.10
Gas	0.04	0.72	4.91	10.05	14.05	13.23	24.79
Comb.Renewables & Waste	6.45	7.21	6.46	5.32	5.00	4.82	3.93
Geothermal	0.05	0.36	0.62	0.93	0.91	1.01	4.48
Solar	-	0.03	0.26	0.39	0.42	0.42	0.86
Electricity	0.85	3.87	8.25	11.06	13.14	13.71	37.37
Heat	-	-	0.39	0.85	1.03	1.02	-
Shares (%)							
Coal	14.7	18.8	18.7	16.4	18.3	17.2	25.6
Peat	-	-	-	-	-	-	-
Oil	48.0	50.8	45.2	39.9	36.5	36.8	30.7
Gas	0.2	1.8	8.5	15.4	18.4	17.8	15.2
Comb.Renewables & Waste	32.5	18.0	11.2	8.1	6.5	6.5	2.4
Geothermal	0.2	0.9	1.1	1.4	1.2	1.4	2.7
Solar	-	0.1	0.5	0.6	0.5	0.6	0.5
Electricity	4.3	9.6	14.3	16.9	17.2	18.4	22.9
Heat	-	-	0.7	1.3	1.3	1.4	-
Total Industry	4.28	13.71	23.26	25.65	29.50	23.38	79.59
Coal	1.14	4.50	8.83	8.27	11.23	6.12	33.93
Peat	-	-	-	-	-	-	-
Oil	2.59	6.18	8.23	8.01	7.05	6.44	12.17
Gas	0.00	0.67	1.76	3.19	3.92	3.46	13.65
Comb.Renewables & Waste	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-
Solar	-	0.01	0.10	0.12	0.13	0.13	0.26
Electricity	0.55	2.35	3.96	5.22	6.15	6.22	19.59
Heat	-	-	0.39	0.85	1.03	1.02	-
Shares (%)							
Coal	26.6	32.8	38.0	32.2	38.1	26.2	42.6
Peat	-	-	-	-	-	-	-
Oil	60.4	45.1	35.4	31.2	23.9	27.5	15.3
Gas	0.1	4.9	7.6	12.5	13.3	14.8	17.2
Comb.Renewables & Waste	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-
Solar	-	0.1	0.4	0.5	0.4	0.5	0.3
Electricity	12.9	17.2	17.0	20.3	20.8	26.6	24.6
Heat	-	-	1.7	3.3	3.5	4.3	-
Transport	4.38	9.22	11.76	12.43	15.95	15.06	29.37
TOTAL OTHER SECTORS	11.20	17.14	22.83	27.35	31.03	35.93	54.30
Coal	1.27	3.00	2.02	2.47	2.75	6.66	7.81
Peat	-	-	-	-	-	-	-
Oil	3.11	5.02	6.25	5.84	5.20	6.22	8.92
Gas	0.04	0.05	3.11	6.75	9.97	9.59	11.12
Comb.Renewables & Waste	6.45	7.21	6.46	5.32	4.98	4.76	3.93
Geothermal	0.05	0.36	0.62	0.93	0.91	1.01	4.48
Solar	-	0.02	0.17	0.26	0.29	0.29	0.61
Electricity	0.29	1.49	4.22	5.78	6.92	7.41	17.44
Heat	-	-	-	-	-	-	-
Shares (%)							
Coal	11.3	17.5	8.8	9.0	8.9	18.5	14.4
Peat	-	-	-	-	-	-	-
Oil	27.7	29.3	27.4	21.3	16.8	17.3	16.4
Gas	0.3	0.3	13.6	24.7	32.1	26.7	20.5
Comb.Renewables & Waste	57.6	42.0	28.3	19.5	16.1	13.2	7.2
Geothermal	0.4	2.1	2.7	3.4	2.9	2.8	8.3
Solar	-	0.1	0.7	1.0	0.9	0.8	1.1
Electricity	2.6	8.7	18.5	21.1	22.3	20.6	32.1
Heat	-	-	-	-	-	-	-

Table 2: Final Consumption By Sector (Unit: Mtoe) Source: International Energy Agency

Turkey's total final consumption of energy (TFC) is increased by 86 % between 1990 and 2008 and intend to increase by 2020 reaching 163.26 Mtoe. According to IEA Turkey report published in 2009 (International Energy Agency Report 2009) Industry and the residential sector is the leading sector in energy consumption. Transportation and the other sectors consume around 17 % of the total. However, oil is served as 37 %, electricity and natural gas 18 %, coal 17 %, biomass and waste 7 % and the other sources 3 %. The share of natural gas has an incredibly demand since 1990. Electricity has grown 10% since 2000. The final consumption of energy in Turkey is expected to be two fold of TFC compared to 2008.

3 Solar Energy Potential and Installed PV Capacity of Turkey Along With the Recent Energy Policy

Turkey is considered as a non-industrialized country among the EU countries for that reason energy demand of the country much more than the others. The consumption of electricity has been increased two fold between 2001 and 2012 as compared with 1999-2001. In 2012 total energy demand became 241.9 TWh (Trends 2013 In Photovoltaic Applications, 2013). In another word, each decade the demand of the electricity increases 2 times compared to previous decade. By 2030, the estimated demand of the electric energy will be 600 TWh. Turkey has a great potential of indigenous and renewable energy sources such as solar energy with fantastic solar radiation that goes up to 2000 kWh/m²-Year as well as 7.2 hours average daily sunshine duration. Turkey is a powerful candidate for exploiting photovoltaic technology with 4800 km² feasible area and average 2738 hours capacity sunny days in a year. According to the recent report published by Ministry of Energy and Natural Resources, the country's feasible photovoltaic power is 450-500 GW which approximately fulfills the demands of Turkey's 2030 need itself (Mersin Chamber of Mechanical Engineering Presentation, 2013).

However, a total capacity of 600 MW solar power plants is going to be licensed by the end of 2013 that corresponds to 1/10 of the annual electric energy capacity of Turkey. The MW-scaled plants will be applied by 2015. In the first application to Energy Market Regulatory Authority (EPDK), the capacity is exceed 15 times to proposed capacity with 8.9 GW and 496 applicants. The Energy and Natural Resources Ministry is expected to determine the new capacity as soon as a total capacity of 600 MW is scheduled as planned. The ministry intends to increase the share of renewable energy sources up to 30 % by 2023. However, in practice Turkey imports 71.5-72.4 % of energy sources from abroad which makes itself energy-dependent country ranking seventh biggest coal, eight natural gas and twenty-fifth petroleum importer of the World. With Turkey as of 2011 to 91 % of the oil it consumes (51% from Iran), to 98% of natural gas (55% from Russia) is imported (Kaya and Kılıç, 2012). Solar energy along with wind, geothermal, hydropower, biomass and indigenous lignite resources obtainable from electrical energy and current installed power facilities well by evaluating foreign energy dependence sensible reduction will come up. Turkey does not have remarkable solar electricity generation. The installed PV grid-connection is about 2.5 MW and 6 MW off-grid applications in 2012. The amount of installed capacity in last years is not enough to be part of a competitive energy market. Thus, the government must take serious steps and launch radical regulation in the energy policy to abolish discrepancy between energy need and production. This is a must in order to keep the energy corridor in secure. The most positive application made by Turkish government is not to require production license under 1 MW production capacity. Additionally, The Renewable Energy Law 6094 has introduced to explain the purchase guarantee of 13.3 USD cent/kWh (9 Euro cent/kWh) for solar electric energy production for ten years while this period is 20 years in EU countries (Grand National Assembly of Turkey, 2010). In case of the use of local components for the PV system, additional incentives can be granted as following; PV module installation and mechanical construction, (0.8 USD cent /kWh), PV modules (1.3 USD cent/kWh), PV cells (3.5 USD cent/kWh), Inverter (0.6 USD cent /kWh), the focusing material on PV modules (0.5 USD cent/kWh) (Trends 2013 In Photovoltaic Applications). Table 3 shows the installed PV capacity of some countries including Turkey. As it can be seen in Table 3 Turkey has the lowest installed PV capacity among the other countries. However, it is worth noting that although the installed PV capacity of Turkey is only limited 8.5 MW in 2012, minimum price of renewable electricity tariff determined by Turkish Electricity Transmission (TEIAS) varies between 5 and 5.5 Euro cent/kWh while it ranges from 6.2-8.5 Euro cent/kWh in Germany with 32461.6 MW installed capacity in the same year. Intense discussion has been made by many years regarding production and usage of renewable energy resources in Turkey, there has not been much progress due to lack of incentives and legal arrangement by authorities. Figure 3 shows the annual Global Radiation Values (kWh/m²-day) and sunshine duration in an hour unit. Most part of Turkey have a great potential of solar radiation values along with sunshine duration time which goes up to 11.31 hour a day in July and 1800 hours/year in total (Turkish State Meteorological Service Report 2013). However, the global radiation is below 900 hours/year in Germany. There is an enormous discrepancy between the installed solar power capacity and solar radiation values in a year. The discrepancy is not only limited by solar radiation values but also the investments have been made by governments. Germany has been invested 17520 ('000) million USD in 2012. However, the investment on solar power generation is made by Turkey is only 4 million USD in 2012 (Trends 2013 In Photovoltaic Applications, 2013).

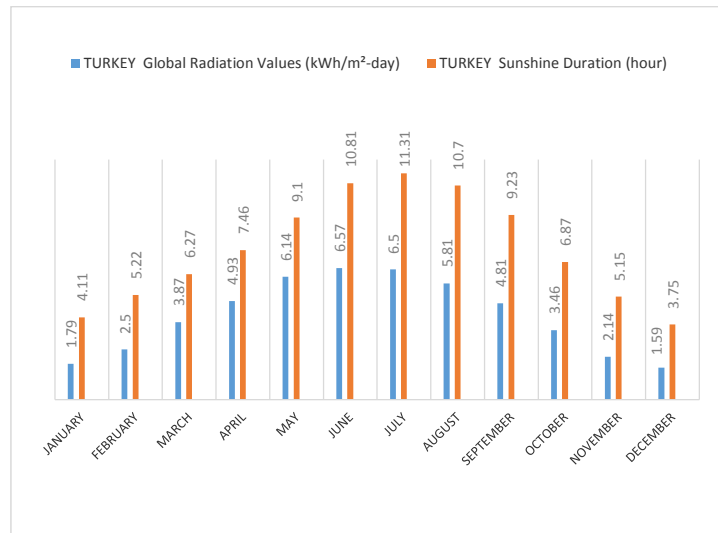


Figure 3: Turkey's Global Radiation Values (kWh/m²-day) and Sunshine Duration (hour) in a year

	2006	2007	2008	2009	2010	2011	2012
Australia	70.3	82.5	104.5	187.6	570.9	1376.8	2415.0
Austria	25.6	28.7	32.4	52.6	95.5	187.2	362.9
Belgium	0.0	23.7	107.1	635.7	1054.9	2056.9	2698.4
Canada	20.5	25.8	32.7	94.6	281.1	558.3	827.0
China	79.9	99.9	139.9	299.9	799.9	3299.9	6799.9
Denmark	2.9	3.1	3.3	4.6	7.1	16.7	332.2
France	43.9	81.5	185.9	377.2	1194.3	2953.4	4032.6
Germany	2918.4	4195.1	6153.1	9959.0	17372.2	24857.5	32461.6
Israel	1.3	1.8	3.0	24.5	70.1	189.7	236.7
Italy	50.0	120.2	458.3	1181.3	3502.3	12802.9	16450.3
Japan	1708.5	1918.9	2144.2	2627.2	3618.1	4913.9	6631.7
Korea	35.8	81.2	356.8	523.7	650.3	729.2	959.2
Malaysia	5.5	7.0	8.8	11.1	12.6	13.5	34.9
Mexico	19.7	20.7	21.7	25.0	30.6	37.1	51.8
Netherlands	52.7	61.8	65.9	76.8	98.6	150.4	345.4
Norway	7.7	8.0	8.3	8.7	9.1	9.5	10.0
Portugal	3.4	17.9	68.0	102.2	130.8	143.6	209.7
Spain	154.3	739.2	3635.1	3698.1	4103.7	4471.9	4706.1
Sweden	4.3	4.6	4.8	8.8	11.5	15.9	24.3
Switzerland	29.7	36.2	47.9	73.6	110.9	211.1	437.0
Turkey	0.0	0.0	0.0	0.0	0.0	0.0	8.5
UK	14.1	17.9	22.3	25.8	69.6	975.8	1900.8
USA	275.0	427.0	738.0	1172.0	2022.0	3910.0	7272.0
Total IEA PVPS	5523.5	8002.6	14342.0	21169.8	35822.2	63881.1	89207.7
Other Major Countries	9.1	13.4	86.3	526.3	2342.6	3382.4	10054.7
Total	5532.5	8016.1	14428.3	21696.1	38164.8	67263.5	99262.4

Table 3: Cumulative Installed PV Power (MW) in IE PVPS Countries and Major Other Markets: 2006-2012
Perspective Source: International Energy Agency

4 Conclusion

In this study, the timeline of Turkey's energy status is given by tabulating present and future estimated energy balances and key statistical data in Turkey for last three decades to show Turkey's energy dependence to abroad as well as increased energy demand as a result of its growing economy. The negative effect of usage of fossil energy sources are briefly discussed. Following by this, the importance of usage of renewable energy especially solar power generation has been determined in Turkey. The production, consumption, global radiation values, sunshine duration and installed PV capacity of Turkey are tabulated by comparing with the other countries. The recent regulation regarding subsidies are also given. It can be concluded that the current amount of investment and incentives in Turkey are not sufficient to provide energy need for now and the future. To encourage the

photovoltaic installation, the legacy barriers should be removed and investors have to be encouraged to set up grid-connection which will help reduce economic dependence. Last but not least, the world faces a long way to go before it reaches a low-carbon energy system. Private sectors, investors academicians can suggest possible routes to get there, but governments are driving forces to provide energy security thus world's economic and environmental stability and protect ability. It is worth nothing that by 2030 easily accessible supplies of oil and gas probably will no longer keep up with the demand, so there is no other choice than using all renewable energy sources.

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