

Recent renewable energy developments, studies, incentives in Turkey

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Abstract

Energy is indispensable for human life. Energy is not only a measurement for economical and social improvement but also a fundamental human necessity. Every country in the planet are trying to find a way to solve energy problems such as depending on energy importation, all kind of environmental pollution, global warming, increasing cost of energy, and energy inefficiency. Industrial and technologic developments are continuing rapidly, the need of energy consuming is increasing accordingly, and also concerning the population increase; the governments are given vast amount of incentives for renewable energy for the solutions to these kinds of problems and for the aims to be realized, which are saving money, saving energy and therefore saving the world. In this study, recent renewable energy developments, the evaluation of renewable energy, the importance of renewable energy use, the incentives and subsidies, the renewable energy policies in Turkey are investigated. In this regard some barriers and recommendations are submitted.

Keywords: Renewable energy; Renewable energy incentives; Renewable energy policies; Turkey
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1. Introduction

In Turkey energy consumption is heavily depending on primary energies which can be described as an energy form found in nature that has not been subjected to any conversion or transformation process, such as oil, lignite, hard coal, natural gas. The amount foreign dependency of this is about 75%, and also electric energy consumption is 60%. In the year of 2008, energy importing expenses has reached to over 48.2 billion US Dollars [1]. This number can make an attention that Turkey must come up with the solution to reduce the energy bills of energy importation. It should need inexpensive, permanent, reliable and sustainable energy solutions, for this purpose Turkey need to design new and well considered energy policies, strategies, and programs. From this point of view, the incentives given to the renewable energy sources are compulsory until energy sectors come to a competitive point with other energy sectors. Every country in the world has its own incentive mechanisms for renewable energies. These incentives can be classified under three groups [2]:

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1. Financial incentives, 2. Tax incentives, 3. Production incentives.

For example in England at solar thermal technology, the ECA (The Enhanced Capital Allowance) scheme provides businesses with 100% first year tax relief on their qualifying capital expenditure, and the ETL (the Energy Technology List) specifies the energy saving technologies that are supported by the ECA scheme. This means that businesses can write off the whole cost of the equipment against taxable profits in the year of purchase. This can provide a cash flow boost and an incentive to invest in energy saving equipment that normally carries a price premium when compared to less efficient alternatives [3-4]. Evidentially, this will help saving energy and money.

This study examines that recent renewable energy developments evaluation of renewable energy, the renewable energy policies, the importance of renewable energy use, the incentives, and subsidies which have been given by the government and related institutions in Turkey. In concern with the topic some barriers and recommendations are submitted to help for better understanding about the importance of renewable energies.

2. Current and next general energy situation and policies in Turkey

Turkey's geopolitical situation is very important and it can be defined as a bridge for energy connection from Europe to Asia and the Middle East. Of late years, Turkey has improved its economy significantly, so the need for energy causes more consumptions and that means more imports. The total energy consumption is 37% in domestic portion, and considering the years 2000-2010 the cost for needed energy has reached around 55 billion US Dollars [5]. Table 1 shows the population, economy and energy relations in Turkey from the years 1973 to 2020 [6].

Table 1. Population, economy and energy in Turkey between the years 1973-2020

Years	Population (000s)	GNP/Capita	Total GNP	Total Energy Demand (Mtoe)	Energy Capita (Kep)	Energy Intensity
1973	38072	1994	75915568	24.6	646	81
1990	56098	2674	150006052	53.7	957	50
1995	62171	2861	177871231	64.6	1039	44
2000	67618	3303	223342254	82.6	1218	40
2010	78459	5366	421010994	153.9	1962	35
2020	87759	9261	812736099	282.2	3216	33

GNP: Gross National Product.

The primary energy consumption of Turkey can be seen in Table 2 [7], the demand of energy has been doubled, in 2000-2010, and will be five fold until 2025.

Table 2. Present and future (estimated) primary energy consumption of Turkey between the years 2000-2025 in million tons of oil equivalents (Mtoe)

Energy source	2000	2005	2010	2015	2020	2025
Coal	20.3	30.5	50.3	83.3	129.1	297.7
Oil and natural gas	59.3	73.2	92.6	113.0	136.4	179.8
Wood an waste	7.0	6.9	6.5	6.0	5.7	5.4
Hydropower	3.8	5.9	7.5	8.9	9.5	10.5
Geothermal	0.4	1.4	3.8	4.9	4.9	5.4
Nuclear	0	0	3.7	9.1	18.3	29.2
Solar	0.2	0.5	0.9	1.5	2.3	3.3
Central heating	0.3	0.5	0.9	1.3	2.0	2.8
Wind	0.1	0.3	0.6	1.0	1.4	2.1

Considering the last decade transmission and distribution facilities have required approximately 10 billion US Dollar. In Turkey the demand for electricity is augmenting at a ratio of 8–10% yearly. That is to say, by the year 2020 Turkey will need 5 billions US Dollars in a year for investment of power generation, transmission and distribution. The Turkish Government emboldens foreign and domestic private sectors to carry out these power generation projects on a build-operate-transfer basis. The 23,300 MW installed capacity as in 1998 will have to be fivefold by the year 2020 [7].

The fundamental energy resources of Turkey are hard coal, lignite, asphaltite, petroleum, natural gas, hydroelectric energy, and geothermal energy. Table 3 shows the amount of fossil energy resources in Turkey [2].

Table 3. The amount of fossil energy resources in Turkey

Sources	Apparent	Probably	Possible	Total
Hard coal (Million tons)	428	449	249	1126
Lignite (Million tons)	7339	626	110	8075
Asphaltite (Million tons)	45	29	8	82
Bituminous schist (Million tons)	555	1086	269	1641
Oil (Million tons)	36	-	-	36
Natural gas (Billion cubic meter)	8,8	-	-	8

In Turkey, electricity is produced by thermal power plants (TPPs), consuming coal, lignite, natural gas, fuel oil and geothermal energy, and hydropower plants (HPPs). The development of nuclear power in Turkey is so new and limited. Present and future total final energy production and consumption in Turkey are shown in Table 4 [6].

Turkey has been working on increasing competition and overall economic efficiency and reforming tariffs since 2001. Turkey's grow rate requires large investments and also measures to ensure energy security, especially in the electricity sector. Turkey has large coal reserves and it expects to multiply their use over the next decade to provide electricity.

Table 4. Present and future (estimated) total energy consumption in Turkey (Mtoe)

Energy Sources	1990	2000	2005	2010	2020	2030
Coal and Lignite	16.94	23.32	35.46	39.70	107.57	198.34
Oil	23.61	31.08	40.01	51.17	71.89	102.38
N. Gas	2.86	12.63	42.21	49.58	74.51	126.25
Com. Renewables and Wastes *	7.21	6.56	5.33	4.42	3.93	3.75
Nuclear	-	-	-	-	7.30	14.60
Hydropower	1.99	2.66	4.16	5.34	10.00	10.00
Geothermal	0.43	0.68	1.89	0.97	1.71	3.64
Solar/Wind/Other	0.03	0.27	0.22	1.05	2.27	4.28
Total primary energy consumption	53.01	77.49	129.63	152.22	279.18	463.24

*Comprises Solid biomass, biogas, industrial waste and municipal waste.

Turkey has a very fast growing energy demand among the IEA member countries. The country's main policy goal is ensuring sufficient energy supply to a developing economy. As one of the government's primary policy goals, energy security has attracted more focus than market reform and environmental protection. Still, Turkey has progressed greatly in all areas of energy policy since the 2005 in-depth overview and there are obvious signs of a better future balance among the three primary energy policy goals [8]. In this respect energy sustainability country index leaders by economic groupings can be seen in Table 5 [9].

Wide investments in energy infrastructure, especially in electricity and natural gas, are needed over in the next years to evade from hurdles in supply and sustain rapid economic

Table 5. Energy sustainability country index leaders (by economic groupings)

GDP/capita (USD)	> 33,500	14,300 – 33,500	6,000 – 14,300	< 6,000
Positioning				
1	Switzerland	Spain	Colombia*	Indonesia*
2	Sweden	Portugal	Argentina	Egypt
3	France	Slovenia	Brazil	Cameroon
4	Norway*	Italy	Mexico*	Philippines
5	Germany	New Zealand	Turkey	Swaziland

GDP: Gross Domestic Product. (*) = net energy exporters (Others) = net energy importers.

advancement. To attract investments, Turkey needs to continue reforming its energy market. In the last few years, power sector reform has improved dramatically and comprised moving to cost-reflective wholesale tariffs; privatizing distribution companies; beginning a program for privatizing generation assets; and setting a date for full market opening.

3. The overview of renewable energy in Turkey

Renewable energies can be described as energy which comes from natural resources such as sunlight, geothermal heat, wind, rain, tides, vegetation and animal waste, they are naturally regenerated. Renewable energy replaces conventional fuels in four distinct areas: (a) Power generation, (b) Hot water/space heating, (c) Transport fuels, (d) Rural (off-grid) energy services [10].

Due to the increasing fossil fuel prices and decreasing natural resources, there are numerous researches have been carrying out in Turkey, as in similar case in the world. Turkey has a very good number of renewable energy resources, such as hydroelectric, solar, wind, biomass, geothermal energy etc. The importance is renewable energy is evidential. Especially it is not harmful to the environment, very safe for the soil, making it much cleaner than oil or hard coal. Moreover renewable energy sources shall not become scarce or be in danger of exhausted supply as fossil fuels.

Renewable energies make the second largest contribution to energy production after coal in Turkey. Energy from renewables was 10 Mtoe which is 12% of TPES (total primary energy supply) in 2003. More than half of the Turkey's renewable energies are comprised of combustible renewables and waste, such as wood and animal products used in heating [11]. The contribution of wind and solar amount is very low, but promising for the near future. Renewable energy sources and their usage forms are given in Table 6 [7].

Table 6. Renewable energy sources and their usage forms

Source	Usage
Hydropower	Electric generation
Wind energy	Electric generation, wind generators, wind mills
Solar energy	Solar home system, solar dryers, solar cookers, photovoltaic cells
Geothermal energy	Urban heating, electric generation, power central
Modern Biomass	Electric generation, biogasoline, chemicals, urban heating

Some foreign experts have seen Turkey's renewable energy potential as a great opportunity from an economic, environmental and national security perspective [12]. According to one of them, the importance of renewable energy resources for national security

has the main part. Similar to the USA's dependency on external resources for oil, Turkey's dependency on foreign resources for heating and electricity should be lessened. Developing and using domestic alternative energy resources enhances a country's geopolitical safety. Moreover, renewable energy resources encourage economic growth. Renewable energy resources in Turkey are in Table 7 [6].

Table 7. Renewable energy potential in Turkey

Energy type	Usage purpose	Natural capacity	Technical	Economical
Solar energy	Electric (billion kWh)	977.000	6.105	305
	Thermal (Mtoe)	80.000	500	25
Hydropower	Electric (billion kWh)	430	215	124.5
Wind Direct energy-land	Electric (billion kWh)	400	110	50
Direct energy-off shore	Electric (billion kWh)	-	180	-
Wave energy	(billion kWh)	150	18	-
Geothermal energy	Electric (10 ⁹ kWh)	-	-	1.4
	Thermal (Mtoe)	31.500	7.500	2.843
Biomass energy	Total (Mtoe)	120	50	32

As summarized in Table 8 [11], the government estimates renewable energy supply to increase from 12 Mtoe by 2010 to 20 Mtoe by 2020. While the volume of renewable energy use grows, its portion of the TPES declines. This means outrun by rapid growth of fossil energy use. Electricity generation from renewables is expected to increase from 35.5 TWh in 2003 to 62 TWh by 2010 and 118 TWh by 2020. Use of renewables for heat production is estimated to drop from 6.9 Mtoe in 2003 to 6.6 Mtoe by 2010 but to grow to 9.3 Mtoe by 2020.

Table 8. Renewable energy projections in Turkey

	2003	2005	2010	2015	2020
Primary Energy Supply					
Hydro (ktoe)	3038	4067	4903	7060	9419
Geothermal, solar and wind (ktoe)	1215	1683	2896	4242	6397
Biomass and waste (ktoe)	5748	5325	4416	4001	3925
Renewable energy production	10002	11074	12215	15303	19741
Share of total domestic production (%)	42	48	33	29	30
Share of TPES (%)	12	12	10	9	9
Generation					
Hydro (GWh)	35330	47287	57009	82095	109524
Geothermal, solar and wind (GWh)	150	490	5274	7020	8766
Biomass and waste (GWh)	35480	47777	62283	89115	118290
Share of total generation (%)	25	29	26	25	25
Total final consumption					
Geothermal, solar and wind (ktoe)	1134	1385	2145	3341	5346
Biomass and waste (ktoe)*	5748	5325	4416	4001	3925
Renewable energy TFC (ktoe)	6882	6710	6561	7342	9271
Share of TFC (%)	11	9	7	6	6

*Fuel consumption of autoproducers used to generate electricity on site.

Presently 650 MW of wind capacity are established in Turkey and 40 MW of geothermal capacity. Turkey is using its geothermal resources mainly in tourism sector. Turkey's hydro power capacity is around 14000 MW. Turkey's solar capacity is 12 million sq-m of as collector areas. The PV (The "photovoltaic effect" is the basic physical process through which a PV cell converts sunlight into electricity [13]) industry is in initial stage [14].

The Renewable Energy Law, passed in 2005, was the first step towards utilizing Turkey's own resources. Renewable energy resources, including hydro power, were seen as an important but not urgent alternative to the country's dependency on foreign gas. Turkey uses 50% of total imported natural gas for 45% of the country's total electricity production and the other 50% in industry and residential heating [14].

Table 9 summarizes [11] the licenses declared by the Energy Market Regulatory Authority (EMRA) for renewable energy generating facilities since the beginning of the electricity market reform in 2001. Licensed new generating capacity reached 1 408 MW in July 2004.

Table 9. Renewable Electricity Generation Licenses as of November 2004.

Fuel	Licenses For new installation		Licenses for existing installation	
	Number	Capacity (MW)	Number	Capacity (MW)
Wind	37	1408	1	1.5
Hydropower	12	172	27	906
Geothermal	4	46	-	-
Biogas	1	1	2	5
Landfill gas	2	16	1	4
Total	56	1643	31	916

Turkey in the tenth position among the 28 IEA countries, for comparison, renewable energy sources account for more than 40% of TPES in Norway which is basically hydropower, and around 1/3 in New Zealand and Sweden. In Turkey recent statistics has showed that biomass has reached half of the total renewable energy the rest has been hydropower mostly, and the rate of wind and solar has promised to rise more rapidly.

Allowing for the electricity generation, in 2009, renewable sources provided 37.8 TWh of electricity, or 19.6% of the total power generation in Turkey, which is the 12th highest portion among the 28 IEA countries. Hydropower accounted for 95% (35.9 TWh) of this total and wind power for 4% (1.5 TWh). The remaining 1% came from biomass (0.3 TWh) and geothermal energy (0.5 TWh). Hydropower generation varies according to rainfall. The government outlines an overall target for renewable sources to provide at least 30% of electricity generation by the year 2023, in its Electricity Market and Security of Supply Strategy, approved on 18 May 2009 [8].

As for heat, firewood is the largest source of heat from renewable sources. In 2008, 5.0 Mtoe of firewood was used for heating in rural areas. Other forms of biomass are negligible. The second-largest source of heat from renewable sources is geothermal, 0.9 Mtoe of which was used in 2008.

3. 1. Renewable energy policies, institutions and R&D in Turkey

The Ministry of Energy and Natural Resources (MENR) launched the "Energy Research-ENAR" programme in 2008. The basic aim of this programme is funding research institutions, universities and private-sector research firms to develop new technologies and innovative equipment, particularly in the areas of renewable energy and renewable energy efficiency. The programme initiatives are research on energy conversion, transmission and distribution. Its budget for 2010 is USD 1.5 million. The institutional strategic plan 2010-2014 of the ministry indicates that the budget of the ENAR programme will increase gradually to TRL 50 million by 2014. This plan also includes a vision to double the spending on R&D by the related and affiliated institutions of MENR from 2009 to 2015. The plan points out the importance of technology development centres and their role in bridging universities and policy makers. The ENAR programme is hoped to create technology-oriented

synergies in fostering energy policy goals, especially those relevant to the sustainability of the national energy sector [8].

Turkey has the world's 15th largest GDP-PPP and 17th largest Nominal GDP. The country is a founding member of the OECD (1961) and G-20 major economies (1999). Since December 31, 1995, Turkey is also part of the EU (European Union) Customs Union. Mean wages were 8.71 US dollars per man hour in 2009 [15-16].

Public spending on energy R&D is expected to continue to grow, as the Vision 2023 Programme, which contains several energy R&D priorities, is supported by an increase in financing. The government plans to increase total funding (public and private) for all R&D to 2% of GDP (gross domestic product) by 2023 from 0.7% in 2007.

As for funding, compared to other developed countries, public funding for energy R&D remains limited in Turkey. In 2008, it was at 0.001% of GDP, while most IEA member countries spent more than ten times that share. The following government bodies provide funding or financial incentives for R&D:

- The Ministry of Finance provides tax reduction for the R&D expenditures of private firms by a ratio of 40%.
- TÜBİTAK provides grant funds for the private sector with the Under-Secretariat of Foreign Trade.
- The Technology Development Foundation of Turkey (TTGV) provides soft loans for technology development (R&D) projects in the private sector. It also provides support for commercialization projects and for technological entrepreneurship. Through its Environmental Support Programme, TTGV provides soft loans to companies with implementation projects in the fields of renewable energy, energy efficiency and cleaner energy production.
- The Under-Secretariat of Foreign Trade (DTM) provides grant funds for the private sector. The support is on project base and DTM takes consultation from TTGV and TÜBİTAK on the selection of projects.
- The Ministry of Industry and Trade, through its bounded institution KOSGEB, provides funds for small and medium-sized enterprises (SMEs).
- The Ministry of Energy and Natural Resources provides funding for energy related R&D projects within its ENAR programme.
- The Credit Guarantee Fund (KGF) provides guarantees on loans to SMEs for facilitating risk-sharing and lending among Turkish banks [8].

There are 38 regional development agencies (RDA) have been established in different places in Turkey by January 2011. These are all supported and provided with the grant aids. The regional development agencies are helping and encouraging the improvement of renewable energies in Turkey [17].

Regional Development Agencies have independent non-departmental public personalities. These business-led organizations are accountable to the central government. RDAs develop regional economic policies depending on region's strategic priorities and regional needs. Essential for economic growth, RDAs aim to reduce the imbalance that exists within and between the regions. The grant of economic and technical aid of the EU for regional development during the pre-accession process is increasingly challenging Turkey's traditional state-centered politics and regional policy [18].

The institutional structure of DAs in Turkey would benefit a great deal from the existence of a local/regional intermediary Development Support Offices, i.e. to operate in coordination with the Investment Support and Promotion Agency, between the General Secretariat and Investment Support Offices. Technical staff of the local/regional Development Support

Offices could undertake significant tasks not only in the process of strategic plan making, but also in that of project management in the framework of strategic plans. These activities constitute the most fundamental tasks of DAs in conducting their development programmes; that is, if they are to be effective local/regional institutions that are designed to implement regional policies with horizontal dimension [19].

3. 2. Legislation about renewable energy resources in Turkey

Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy - No. 5346 is the main legislation on electricity from renewable energy resources; this law and its subsequent amendments is enacted in 18th May 2005. "This law aims to expand the use of renewable energy sources for generating electrical energy by establishing the necessary legal and regulatory framework while ensuring increase in the use of renewable energy sources without disturbing free market conditions". This law Turkey's first in regards to renewable energy authorized the Energy Market Regulatory Authority (EMRA) to take the necessary measures to promote the utilization of renewable energy resources [20].

The law provided that companies wishing to become involved in renewable energy projects could obtain a license from the EMRA to generate electricity from renewable sources and as a result only pay 1 % of the license acquisition fee; and be exempted from paying an annual license fee for a period of 8 years from the date of completion of their renewable electricity generating projects. A number of renewable energy sources are mentioned in the law, including solar, wind, geothermal, biogas, wave and tidal, and stream and river; including producing electricity from reservoirs of less than 15 sq kilometers.

The potential to produce large amounts of energy from renewable sources is very evident in Turkey, and at the time the above law went into effect, it was estimated that the potential of creating energy from biomass alone was more than 430,000 GWh or about 1% of total world energy production. Significant amounts of electricity from wind, solar and geothermal sources were also estimated.

Law on Geothermal Resources and Natural Mineral Waters-No:5686 is also for electricity generation. It is enacted in 3rd June 2007. "This Law sets forth the rules and principles for exploring, producing and protecting geothermal and natural mineral water resources".

Energy Efficiency Law- No:5627 is enacted 2nd May 2007. "The Energy Efficiency Law (EE Law) aims to increase the efficient use of energy and energy resources for reducing the burden of energy costs on the economy and protecting the environment. This law comprises the organization, principals and procedures for increasing energy efficiency in industry, electrical power plants, transmission and distribution systems, building service and transport sectors. It sets the rules for energy management in industry and in big buildings, project supports, energy efficiency consultancy companies, voluntary agreements and so on."

Energy efficiency measures in industry are based on the 2007 Energy Efficiency Law and two related by-laws published in October 2008: the By-law on Improving Energy Efficiency for the Utilization of Energy Resources and Energy, and the By-law on Supporting Energy Efficiency of Small and Medium-sized Enterprises (SMEs) including Training, Audit and Consultancy Services. Energy efficiency measures in manufacturing industry focus on energy management, financial support, voluntary agreements, monitoring, and training and awareness. In power generation, the measures focus on managing demand; improving efficiency of power plants (moreover by setting minimum efficiency requirements for new

plants), transmission, distribution and public lighting; utilizing waste heat of thermal power plants; and utilizing alternative fuels [8].

The EE Law also amended Law no.5346 dated 10.05.2005 on Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy.

The Electricity Market Law of 2001 was also modified by the EE Law, exempting certain categories of power plants from the obligation to obtain licenses and establish companies. The exemption applies to: renewable energy plants with installed capacity of maximum 500kW; cogeneration plants with at least 80% overall efficiency; micro cogeneration plants with 50 kW installed capacity”.

The law (No: 6094) governing the generation of energy from renewable resources has been accepted on December 29th, 2010 and has passed through the Turkish Grand National Assembly (TBMM). It has been announced in Turkish Official Journal on January 8th, 2011 the Issue No: 27809. The Renewable Energy Law aims to encourage energy production from renewable energies by providing incentives. These incentives comprise of energy generation from sources that wind, solar power, biomass, hydropower and geothermals. The legislative framework adjusts the prices for the sale of electricity to the state according to generation method. According to the law renewable energy plants will be subject to prices from 7.3 USD cents to 13.3 USD cents per kWh. A hydroelectric power plant will be able to sell electricity at a cost of 7.3 USD cents (5.6 Euro cents) the same as the amount for a wind farm. The geothermal energy suppliers can sell their electric energy at a higher price of 10.5 USD cents (8.1 Euro cents). Companies that use biomass (including landfill gas) and solar power are subsidized the most at a rate of 13.3 USD cents (10 Euro cents) per kilowatt-hour. The law also features additional support for companies with facilitates that use locally produced equipments and components [21].

The Electricity Market Licensing Regulation of the Electricity Market Law-Law Number 4628, contains two regulations pertaining to the promotion of the use of renewable energy: The legal entities applying for licenses for construction of renewable energy facilities are required to pay only 1% of the total license fee. Also renewables based generation facilities are exempt from paying the annual license fees for the first eight years following the facility completion date as specified in the license. The Turkish Electricity Transmission Company (TEIAS) and/or distribution companies are required to give priority status for systems connection of generating facilities based on renewables” [22].

Together, they set the legal framework for promoting electricity generation from renewable sources and include the following main instruments:

- Feed-in tariffs and purchase obligations;
- Connection priority;
- Reduced license fees;
- Exemptions from license obligation for small-scale generators;
- Reduced fees for project preparation and land acquisition.

Since 2007, all these support mechanisms are in force for ten years, compared to seven years before.

Regulations of the renewable energy resources can be summarized and listed as below [23].

1. Regulation on the Control of Vegetable Waste Oil (9th April 2005, Law No: 25791).
2. Regulation on the Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (10th May 2005, Law No: 5346).
3. Energy Efficiency Law (2nd of May 2007, Law No: 5627).
4. Law on Geothermal Energy Sources and Natural Mineral Water (3rd June 2007, Law No: 5686).
5. Nuclear Energy Law (9th of November 2007, Law No: 5710).

6. Regulation on the Utilization of Geothermal Energy Sources for the Purpose of Electricity Generation (14th of October 2008, Law No: 27024).

7. Regulation on the Technical Evaluation of Wind Based Energy License Applications (8th November 2008, Law No: 27048).

3. 3. Feed-in tariffs and other incentives to the renewable energy sectors in Turkey

At the end of 2010 Turkish Grand National Assembly (TBMM) passed a new renewable energy bill determining regulations and feed-in tariffs in the sector [24]. Under the law, producers of renewable energy who started operation between May 18, 2005 and December 31, 2015 will be guaranteed power purchase prices for a period of ten years. Wind and hydroelectric power will be bought at USD 0.073 (EUR 0.056) per kilowatt-hour (kWh), the price for geothermal energy is defined at USD 0.105 (EUR 0.081) per kilowatt-hour (kWh), and biomass, including landfill gas, and solar energy will be purchased at USD 0.133 (EUR 0.10) per kilowatt-hour (kWh). However, the law limits the solar power capacity eligible for support to 600 MW until December 31, 2013 and entitles the Council of Ministers to determine the capacity after that. The Council of Ministers is also authorized to determine new purchase prices, which should not exceed the current prices, for facilities established after December 31, 2015. Renewable energy producers that got their operation license before December 31, 2015 are entitled to receive additional subsidy ranging from USD 0.004 to USD 0.035 per kWh for a period of five years if they use locally-produced equipment and technology for their plants. License procedures will be handled by the Energy Market Regulatory Authority (EPDK) in cooperation with the Energy Ministry, Interior Ministry and the State Waterworks Authority (DSI).

According to this new Renewable Law incentives can be seen in Table 10 [25].

Table 10. Renewable energy (Law No:6094) incentives

The plant type of the generation of energy from renewable resources	The prices that will be applied (USD cent/kWh)
A hydroelectric power plant	7.3
A wind power plant (A wind farm)	7.3
A Geothermal energy plant	10.5
A biomass supplier (including landfill gas)	13.3
A solar energy plant	13.3

New law also aims to encourage domestic production in the systems that using renewable energies for producing electrical energy. Therefore due to the type of facility will be entitled to receive additional incentives, which can be seen in Table 11 [25]. The incentives will last for ten years from the date of its operation. The prices of renewable energy production in the country that using domestically produced equipments and components, which is called "Local Content Addition" will be as follows (Table 11).

As the liberalization of Turkey continues, a strong interest from the private sector has developed. But there is also pressing interest for Turkey to fully utilize its renewable energy resources. Governments are backing high feed-in tariffs and legislation to promote interest from investors [26]. It has long been in the process of the preparation that giving the incentives to renewable energy producers according to the law that numbered 6094. Turkey offers guaranteed prices for power generated from renewable resources and pays more if the producers use locally-made equipment [27].

It can be well known by all the sectors that the incentives can make the influence on starting renewable energies more rapid than any other policies. By enacting this new law,

Table 11. Additional support amounts for companies with facilitates that use locally produced equipments and components

Plant Type	Locally produced equipments and components	Domestic contribution supplement (USD cent/kWh)
A- Hydroelectric power plant	1.Turbine	1.3
	2.Generator and power electronics	1.0
B- A wind power plant (A wind farm)	1.Propeller	0.8
	2. Generator and power electronics	1.0
	3. Turbine Tower	0.6
	4. Rotor and all mechanical components in the naseI group (the exception of payments made for propeller group with generators and power electronics.)	1.3
C- Facilities of photovoltaic solar panels	1.Integration of PV panels and manufacture of the structural mechanics of the solar PV panels	0.8
	2.PV modules	1.3
	3. Cells that make up PV modules	3.5
	4.Inverter	0.6
	5 Beam materials that focusing solar energy on the solar PV module	0.5
D-The plants that based on concentrated solar power	1.Radiation pick-up tube	2.4
	2.Reflective surface plate	0.6
	3.Solar Tracking System	0.6
	4.The mechanical parts of the thermal energy storage system	1.3
	5.Mechanical parts of the steam production system by collecting the solar beam on the tower	2.4
	6. Stirling engine	1.3
	7. The panel integration and structural mechanics of the solar panel	0.6
E- Facilities that based on biomass energy	1. Fluidized-bed steam boiler	0.8
	2. Liquid or gas-fired steam boiler	0.4
	3. Gasification and gas cleaning group	0.6
	4. Steam or gas turbine	2.0
	5. Internal combustion engine, or Stirling engine	0.9
	6. Generator and power electronics	0.5
	7. Cogeneration system	0.4
F- Facilities that based on geothermal energy	1. Steam or gas turbine	1.3
	2. Generator and power electronics	0.7
	3. Steam injector or a vacuum compressor	0.7

Turkey has joined the throng of rapidly developing nations that are offering Feed-in Tariff (FIT) in order to put more renewable power on the grid. A FIT is a guaranteed payment by kWh, for green energy manufacturers who produce renewable energies. Because these pay just for the power produced, they are risk-free policies for the governments to enact, so long as the price is neither so low that they are ineffective, nor so high that the initial investment in building the clean fuel free energy infrastructure costs payers too much [28]. The feed in tariffs have led to more investment in renewable energy generation and increased share of renewables in the electricity mix.

Turkey's greenhouse gas emissions are growing rapidly, and the energy sector is the major contributor, the government is therefore focusing on clean energy development, such as from domestic renewable resources. In this context, The World Bank Board of Executive Directors has approved financing of \$600 million for Turkey's Private Sector Renewable Energy and

Energy Efficiency Project. The objective of the project is to help increase privately owned and operated energy production from indigenous renewable sources within the market-based framework of the Turkish Electricity Market Law.

The financing includes \$500 million from the International Bank for Reconstruction and Development (IBRD) and \$100 million from the Clean Technology Fund (CTF). The Project is the first to use resources from the newly established CTF and has a new \$5.2 billion multilateral fund.

Turkey along with Egypt and Mexico will be among the first to tap a new \$5.2 billion Clean Technology Fund managed by the World Bank, administered through the World Bank Group and other multilateral development banks. The governments of Australia, France, Germany, Japan, Spain, Sweden, United Kingdom, and United States have made pledges or contributions to the fund [27].

In the event that the forests and the lands under private ownership of the Treasury or under the control or disposal of the State are utilized for the generation of electricity from renewables, such lands will be leased to or right of way or usufruct rights thereof will be granted to the relevant entities. The fees to be paid for using such lands will be reduced by 85% for the first ten years of their investment and operation [29].

There are certain incentives concerning the investment periods of the projects. For example, the service fees will not be collected from the individuals or legal entities willing to construct generation facilities to meet their own energy needs from renewables for the preparation of final project, planning, master plans, initial examination, and initial studies to be performed by State Hydraulic Affairs General Directorate or Electricity Affairs General Directorate.

The need for heat energy in the municipalities where there are sufficient geothermal and solar energy resources will be primarily met by these energy resources.

The promotion of renewable energy resources in the generation of electrical energy is particularly important for Turkey in terms of, among others, reduction in the dependence on energy imports, strengthening the supply security, protection of the environment, and creation of job opportunities. The improved laws are likely to be important instruments in the achievement of such goals [30].

Contrary to the expectation of the renewable energy sector, the law did not provide any tax advantage to entities generating electrical energy from renewable energy resources. According to the environmentalists 24 Euro cents feed in tariff is necessary to initiate a strong solar market in Turkey, which is 13.3 USD cents today. In addition to many environmentalists, market analysts, and solar producers, the solar industry in Turkey could become one of the biggest in the world because of the country's incredible solar energy capacity, so the government should offer more generous feed in tariffs to solar producers as much regulatory and financial support as the government of other successful renewable energy producers [31].

The law provides that suppliers of electricity as Electricity Market Law defines, must pay into a pool which PMUM (The Market Financial Settlement Centre-a division of TEIAS-) manages. Renewable energy generators will be able more easily to get their revenues from this pool. The pool will perform to provide an effective off-take guarantee for all renewable energy generators that participate in this system since this will guarantee the sale of that renewable energy generator's electricity.

And also, some small-scale renewable energy generation facilities, whose installed capacity is lower than 500 kWh and micro-cogeneration facilities may transfer their surplus energy to the distribution system and enjoys the pricing incentives of the RES Support

Mechanism. This is true even if they have not opted in. furthermore, depending on the energy transferring to the distribution system, electricity-producing facilities using photovoltaic solar energy will benefit from even more advantageous prices for 15 years from the establishment of the relevant facility [29].

3. 4. Licenses

The enterprises have to obtain a license from EMRA in order to operate in electricity sector. The types of licenses are granted by EMRA as;

- Generation license,
- Auto-generation license,
- Auto generation group license,
- Transmission license,
- Distribution license,
- Wholesale license and
- Retail sale license.

As a consequence of the policy to encourage private investment in the renewable energy projects, the License Regulation guaranties the legal enterprises applying for licenses for the construction of facilities based on domestic natural resources and renewable energy resources will only pay 1% of the total license acquisition fee and do not pay annual license fee for the first 8 years following completion of the construction of the related facilities. The Turkish Electricity Transmission Company (TEIAS) and distribution companies are required to give priority status for renewable energy facilities' systems connection [32].

3. 5. International collaboration

Aiming to increase its national R&D framework, Turkey participates in several international collaborative efforts, including the following IEA Implementing Agreements:

Buildings sector: Buildings and Community Systems

Transport sector: Hybrid and Electric Vehicles

Renewables: Bioenergy, Photovoltaic Power Systems

Energy storage: Advanced Fuel Cells, Energy Storage, Hydrogen

Modelling: Energy Technology Systems Analysis Programme

Turkey is represented in these Implementing Agreements through the TÜBİTAK Marmara Research Centre, the municipality of Ankara and several universities. Turkey has also entered into bilateral agreements with 19 countries to co-operate in the field of science and technology [8].

4. The examination of chief barriers for improvement of renewable energies and recommendations

The barriers for improvement of renewable energies can be count as regulatory and bureaucratic barriers, high taxes, inadequate market and policy tools, and inadequate private sector participation. In addition, the evaluation of renewable energy resources is inefficient and inadequate, same as the detailed database, such as the amount, production rate and properties of renewable resources are not properly recorded. Furthermore, potential benefits of renewable resources energy resources are not wholly recognized. As for small scale

projects, the deficiency of financial resources and suitable lending appliances can be taken into consideration.

Deficiency of harmony in function between various ministries, agencies, institutes and other shareholders is a big hindrance to further promotion renewable energy technology. It should be continued and expanded co-operation with European member countries in all major energy policy areas. The energy supply and demand should be closely monitored and revised. The progress of liberalization, energy efficiency developments, structural changes in industry and other major factors should be immediately revised and improved [2].

Long term planning researches point out that a heavy burden of investments between 1996 and 2010, are reaching to some 68 billion US\$. Turkey's funding needs for the energy sector is the highest of the southern and eastern Mediterranean countries. The needs of each energy sector can be seen as follows:

- Electricity: 56 billion US\$ (82%),
- Gas: 6 billion US\$ (9%),
- Oil: 4 billion US\$ (6%),
- Solid fuels: 1 billion US\$ (1%) [6].

Like other industrializing countries, with the increases in energy consumption and economical growth, energy related environmental problems are rapidly growing in Turkey. In 2003, it is estimated that 36 % of CO₂ emissions occurred due to energy, 34 % due to industry, 15 % due to transportation and 14 % due to other sectors such as housing, agriculture and forestry and in 2020 40 % will occur due to energy, 35 % due to industry, 14 % due to transportation and 11 % due to other sectors. To manage and regulate these problems for sustainable development, energy related policy should be well determined [6].

Energy-related CO₂ emissions have increased since 1990 and probably to continue to increase fast over the long term, in parallel with growth in energy demand. Turkey is a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and became a Party to the Kyoto Protocol in 2009. As a rapidly developing economy with low emissions per capita, Turkey has preferred not to set a quantitative total target to limit emissions. This exemption is based on the decision 26/CP.7 of 2001 by the Parties to the UNFCCC. Turkey is the only Annex-I country that has not (by May 2010) set abatement targets for the post-2012 period or proposed abatement actions to support them, as required under the Copenhagen Accord. It is also the only OECD country that does not have a national emission target for 2020 [8].

Turkey has to commit to the improvement and fulfillment of renewable energy technologies and energy conservation. The performance of renewable energy technologies would lessen the present national and global environmental problems as well as national energy insecurity associated with the production and use of fossil fuels. Unless Turkey does not commit itself to the transition from non-renewable to renewable energy during the next ten years, the environmental quality, economic development, and national security are most likely to be at peril. It is of vital importance that whole responsible institutions work together to conserve energy, land, water, and biological resources. To guarantee a desirable standard of living in the future, there must be an equitable balance between human population density and use of energy, land, water, and biological resources [33].

Turkey has great wind energy potential, so it could be a one of the most powerful producer in the global sector. By encouraging the renewable energy sector new jobs can be created, but according to members of the renewable energy industry the new law does not go nearly far enough to help Turkey reach its green power potential. While Germany is seeking to get 100

percentage of its energy from renewable energies by 2050 and England aims to reduce carbon emission to zero, Turkey's new law should have promoted renewables far more [31].

The passing of the renewables law, while has been welcomed, it seems likely to be insufficient to create that strong solar and wind market in Turkey. Although the Turkish Parliament has approved a renewable energy law that sets short-term standards, leave much about the sector's long-term prospects in the hands of the nation's cabinet. Also Its Feed-in Tariff law actually places a limit on total solar energy projects: of 600 MW yearly, through December 31, 2013, and then authorizes the cabinet to determine the limits afterwards. This limitation can be ineffective for the future that needs to be revised.

5. Conclusions

For many years, hydroelectric generation, biomass combustion, solar energy for agricultural grain drying and hot water heating, and geothermal energy have been using in Turkey. Domestic water heating is fundamentally active in solar technology. Nearly 30,000 solar water heating systems have been installed since the 1980s. About 50% of existing dwellings could be fitted effectively with a solar water heater. If this potential were extended to 2025, the placement of around 5 million systems would be required. This could save an estimated 9.0 TWh per year of oil, coal and gas and 2.0 TWh per year of electricity, giving a saving of 5.0 million tones of CO₂ per year, or just under 1% of current Turkey CO₂ production. Agricultural residues have a high promising potential to take the place of the lignite (40 million tons) and hard coal (1.3 million tons) used in electricity generation. Biogas systems are acknowledged to be strong alternatives to the conventional space heating systems in rural Turkey. Although geothermal heat pumps are a comparatively new application of geothermal energy, has grown rapidly in recent years. On the other hand, the biggest benefit of geothermal heat pumps is that they use 25-50% less electricity than conventional heating or cooling systems. Geothermal heat pumps can also lessen energy consumption, and relating air pollution emissions, up to 44% in comparison with air source heat pumps and up to 72% comparatively to electric resistance heating with standard air conditioning equipment [6].

As it is well known the dependency on %70 energy needs is a huge amount for a country, it costs too much not only for the economy but also risky for the security and sustainability if considering how easily political issues can be affected by it. For these reasons Turkey is searching for the solution to improve energy situation by diversifying and increasing as much as possible indigenous renewable energy resources.

To evaluate Turkish renewable energy situation, Turkey's energy aims can be summarized as:

- a) Meeting long-term demand using public, private, and foreign capital,
- b) Speeding up privatization activities in the energy sector,
- c) Evaluation of energy imports supply costs,
- d) Using domestic resources to meet energy demand as much as possible,
- e) Diversifying energy supplies in order to abate dependence on a single source or country,
- f) Enhancing new and renewable sources like geothermal heat, solar, wind, etc., right away,
- g) Guaranteeing sufficient, reliable and economic energy supplies on time,
- h) Guaranteeing energy security of supply,
- i) Executing measures for energy efficiency,
- j) Designing and organizing energy research and development activities to meet requirements,
- k) Minimizing losses in energy production, transmission, distribution and consumption,
- l) Protection of the environment and public health with regard to energy production.

As basic strategy, development of domestic production by augmenting efficiency of plants by rehabilitation, diversification of energy sources to secure fuel supply, accelerating the existing construction programs, initiation of new investments are chosen to achieve these energy aims. As Government's financial resources are not enough to achieve these objectives, acceleration of private investments is crucial [33].

Turkey has a target for more clean and dependable energy production by using renewable energy resources. By signing the Kyoto Protocol Turkey has demonstrated itself that giving much importance to these green energies for its future and the universe's. In 2009, Turkey has announced Electricity Market and Supply Security Strategy Paper, which aiming the share of electricity generated by renewable energy resources amount to a minimum of 30% of total electricity generation [29]. It needs more investments and more laws, which protecting and encouraging investors. This could be happened more carefully and cleverly directed and implemented energy managements and also more control mechanism are needed both investors and pursuers of the government.

Turkey should guarantee security of oil and gas supply. This requires more co-operations with countries and companies in the neighboring area. It is also necessary to speed up attempts to reform the natural gas market.

Energy efficiency has the big importance for economic development, energy security and all kind of environmental protection. As Turkey's economic and technologic development continuing renewables is inevitable solution to environmental pollution and CO₂ emissions. Turkey's aim to have a membership to EU has also requires criteria that environmental protection and solution to the hazardous effects of global warming. That requires the production and usage of renewable energies.

Today around 650 MW of wind capacity are established in Turkey and 40 MW of geothermal capacity. Turkey's hydro power capacity is around 14000 MW. Turkey's solar capacity is 12 million sq-m of as collector areas. The PV industry is in initial stage [14]. Considering that Turkish renewable resources are vast, and Turkey could be a leading role model for other countries in this particular area. In spite of investors are aware of the huge potential, legislation and feed-in-tariff incentives are falling behind and infrastructure is not thriving fast enough [14].

Renewable energy usage is extremely important to reduce the dependence on energy imports, strengthen the energy supply security, protect the environment, and create new job opportunities for many people in Turkey.

The role of the government in formulating and implementing favorable policies for renewable energy development is vital. But the private sector, which has the capacity to mobilize funds, needs to be involved in renewable energy development [33].

The incentives have big importance to accelerate development of renewables in Turkey. Considering the advantages of renewable energy usage public awareness and improvement of conditions should also be increased. It should be noted that most incentives have focused on electricity, and heat has generally been excluded. The dispensation of heat is because of the dispersed and complex nature of heat namely, heat energy efficiencies and the heat market are much more difficult to measure and perceived insignificant. The heat market in Turkey should be considered crucial and given additional importance [34].

Energy efficiency development is one of the most important functions to reduce energy and production cost in the industries. Energy efficiency improvement is the main objective of many national energy policies. Monitoring of the energy consumption and development in energy efficiency is essential in order to control and apply desired policies [35]. In this regard,

the future of renewable energies should be well calculated, designed and evaluated to protect environment, to save energy and to strengthen economy in Turkey [36-40].

It has been long waited; the law governing the generation of energy from renewable resources has been enacted on December 29th, 2010 and taken its place in Turkish Official Journal on January 8th, 2011, finally. However it has not met the expectations, it will definitely help and contribute the development of renewable energies in Turkey.

Turkey is perfectly positioned to benefit from a strong rate that would drive very fast development, as it has a powerhouse economy at home growing at over 5% yearly, and a so many aspects of geographic advantages. The country is well positioned to supply The European Grid.

Furthermore, the law governing the generation of energy from renewable resources will be supported and become prevalent by regional development agencies with the help and encouragement of grant aids programs in Turkey [41-43].

6. Disclaimer

Although some data taken from governmental document, this paper are not necessarily representative of the views of government.

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