

## Renewable energy policy in Turkey

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**Abstract:** This study aims to explore the availability and potential of renewable energy sources in Turkey and discuss the government policies and economic aspects. Turkey is a country which has the highest hydropower and wind energy potential among European countries. Current energy policy of Turkey primarily aims to maximize geothermal, wind and hydropower potential of the country in next 15 years. In Several incentives were developed for electricity generation from renewable energy sources by the publication of Law No. 5346 in 2005. The most important ones are: ease of land acquisition and feed-in-tariffs which promises purchasing of electricity generated by legal entities with a price of 5-5.5 €/kWh. Since Turkey is a European Union (EU) candidate its laws and regulations must be compatible with EU. As the legislation in EU member states is investigated it is apparent that Law No. 5346 should be restructured. This should include: (i) redetermination of feed-in-tariff amount according to type and capacity of renewable energy source, (ii) taking installed capacity into account instead of reservoir area for hydroelectric power plants as renewable energy source, (iii) making detailed Environmental Impact Assessment (EIA) report obligatory for renewable energy plants. The emphasis has been given on hydropower and wind energy. The renewable energy policy of Turkey has been compared with the advanced economies in Europe like Germany and Norway

**Keywords:** *Renewable energy, EU policy, Turkey.*

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### 1. Introduction

Energy is one of Turkey's most important development priorities. Hence, utilization of domestic renewable energy sources is of vital importance for Turkey to reduce its dependence on foreign energy supplies, provide supply security and prevent the increase in greenhouse gas emission. Turkey's energy policy targets to increase the current share of renewable energy which is 20% to 30% in coming years. Turkey has quite miscellaneous energy resources including hard coal, lignite, oil, hydropower, natural gas, geothermal, wood, animal and plant wastes and solar. However, utilization of these resources is not adequate to meet the demand of the country. The energy demand of Turkey has been growing more rapidly than the energy production since it is a socially and economically developing country (Fig. 1).

Insufficient government efforts have forced Turkey to increase its dependence on foreign energy supplies. Instead of sufficiently promoting the usage of domestic energy resources and taking necessary precautions governments has relied highly on foreign energy supplies.

Thus, for example, the share of natural gas by the year 2005 as a thermal power plant fuel reached to 60% though Turkey has insufficient natural gas reserves [1]. It was reported that 74% of Turkey's total energy demand was met by imported energy in 2007. In Turkey, natural gas and electricity prices for residential and industrial use have increased by almost 8 and 7 times, respectively between 1999 and 2010. Thus, renewable energy sources have become a challenging alternative to fossil fuels for the country. In this study, current situation of renewable energy sources was investigated in detail and energy policies applied in Turkey was scrutinized by taking EU policy into account. The promotion of electricity from renewable energy sources (RES) is a high European Union (EU) priority.

The RES Directive (2009/28/EC) concerns electricity produced from non-fossil renewable energy sources and it states that the share of renewable energy in the total energy consumption of the EU must increase to %20.

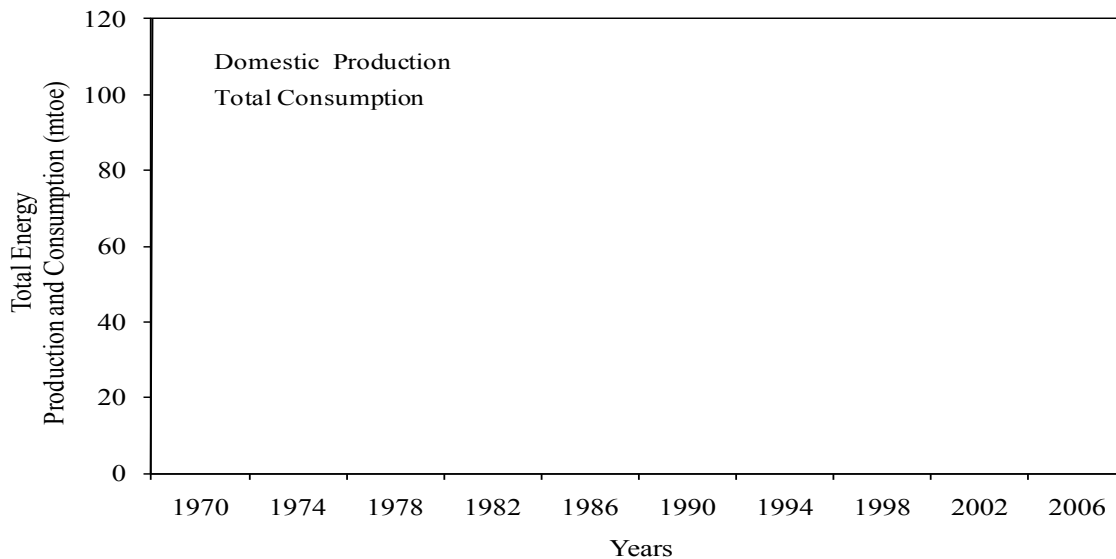


Fig. 1. Trends in total energy production and consumption of Turkey between 1970 and 2006 (data source: [1]).

## 2. Current Energy Trends and Economic Profile of Turkey

Monopoly of public sector was finished in 1982 in Turkey and private sector was allowed to build power plants and sell the electricity generated to Turkish Electricity Administration. The first law (Law No. 3096) that formed the frame for the participation of private sector in electricity industry was published in 1984. This law constituted the legal basis for private entrepreneurs to build new generation plants by means of Build-Operate-Transfer (BOT) contracts. Law No. 4283 (Law on Building and Operating of Electricity Generation Plants by BOT Model and Regulation of Energy Marketing) which provided the participation of private sector in building and operating of energy plants inured in 1997.

Turkey has become one of the biggest economies around Europe and the world within last 30 years with rapid increase in population and industrialization. According to International Monetary Fund (IMF), by the year 2008, Turkey was 15th biggest economy of the world and 6th biggest economy of Europe with a GDP (based on purchasing power parity) of 915.4 billion USD. In addition, average annual growth of GDP (based on current prices) is 4.3% in last 20 years [2]. Economic growth and increase in population, of course, has brought more energy demand. Annual growth rate and population increase projections show that this trend will continue in coming years. In addition to a number of forecast models developed for Turkey, current authors also proposed a model based on fuzzy logic methodology to forecast gross electricity demand of Turkey [3]. In the model proposed gross electricity demand was predicted only using GDP data. The fuzzy logic model proposed has showed that there is a direct relationship between GDP and gross electricity demand. This finding is also consistent with the literature. Mahadevan and Asafu-Adjaye (2007) stated that for electricity importing countries there is a mutual causality between GDP and energy consumption.

## 3. Renewable Energy Potential of Turkey and Current Situation

Turkey is quite a rich country in terms of renewable energy potential. Turkey has a significant hydropower and wind energy potential with its coastal line of 7200 km and an average

elevation of 1132 m . Turkey's wind energy potential is primarily focused in Aegean, Marmara and Mediterranean regions from higher to lower, respectively. Since Turkey's geological structure has volcanic origin the existence of more than 600 hot water sources whose temperature reach almost 100°C makes the country very rich in terms of geothermal energy. By the year 2009, hydropower, wind, geothermal and wastes (biogas +biomass) is used in electricity production (Table 1).

*Table 1. Potential of renewable energy sources in Turkey and current situation in 2009.*

Type of Energy	Technical Potential (MW)	Economical Potential (MW)	Installed Capacity (MW) <sup>a</sup>
Hydropower	54,000	42,000	14,553
Wind	114,000	20,000	802.8
Geothermal	1,500	600	77.2
Wastes (Biogas +Biomass)	-	-	81.2
Solar	56,000	-	-

<sup>a</sup>Data source: [5]

Although Turkey has the highest technical hydro and wind power potential in Europe, only very small portion of this potential is used when compared to those countries (Table 2). It can be easily seen that Germany, Spain and Austria is leader countries in developing their wind power potential. This is mainly due to incentive policies that government of these countries implement towards promoting the utilization of renewable energy sources.

*Table 2. Comparison of wind and hydropower potential of Turkey to some European countries.*

Country	Land Area (x10 <sup>3</sup> km <sup>2</sup> )	Technical Hydropower Potential (TWh/yil) <sup>a</sup>	Technical Wind Power Potential (TWh/yil) <sup>b</sup>	Developed Hydropower Potential by 2006 (%) <sup>c</sup>	Developed Wind Power Potential by 2006 (%) <sup>c</sup>
Turkey	781	216	166	20.5%	0.1%
Norway	324	200	76	59.7%	0.9%
Sweden	450	100	41	72.8%	2.4%
France	547	100	85	56.3%	2.5%
Italy	301	105	69	35.2%	4.3%
Austria	84	75	3	46.5%	57.4%
Switzerland	41	43	1	71.9%	1.5%
Spain	505	66	24	38.8%	95.9%
Germany	357	25	24	79.6%	128.0%
England	244	3	114	153.3%	3.7%

Data sources: <sup>a</sup>[6], <sup>b</sup>[7], <sup>c</sup>[8]

#### 4. Assessment of Renewable Energy Policies in Turkey in EU Policy Perspective

Renewable energy sources have gained importance in last decades due to growing energy demand. It can clearly be seen that policies applied by governments towards the utilization of renewable energy sources have a pronounced importance on the promotion of the utilization of these resources. Thus, though their financial and environmental disadvantages, incentive policies and privileges foster the utilization of renewable energy sources. In this context, it is

considered that the increase of the utilization of renewable energy sources strongly depends on government policies.

A total of 64 countries are supporting electricity generation from renewable energy sources and 45 countries are offering purchase guarantee by feed-in-tariffs for electricity generated from renewables in the world by the year 2009 [9]. As a result of these policies installed capacities of solar battery and wind power plants increased by 6 and 2.5 times, respectively. For example, after the publication of Renewable Energy Law in Germany in 2000 electricity generation from wind and solar energy in 2007 increased by 5 and 50 times, respectively.

Turkish government primarily targets to increase the share of renewable energy sources in electricity generation to at least 30% while decreasing the share of natural gas below 30%. In this context, Turkish government has planned to make the required changes in Law No. 5346 in 2010 to (i) utilize the whole economically feasible hydropower potential in electricity generation, (ii) utilize the whole economically feasible wind energy potential in electricity generation, (iii) provide full utilization of economically feasible geothermal energy potential of 600 M W, (iv) encourage and expand the utilization of solar energy for electricity generation until 2023. In order to achieve these targets Turkey needs to increase the installed capacities of hydropower and wind power plants to 20000 MW and 19200 MW, respectively within the next 15 years [10].

Since Turkey is an EU candidate its laws and policies are expected to be consistent with those of EU. In terms of energy production EU is promoting electricity production from renewable energy sources to decrease energy import and reduce greenhouse gas emissions throughout the union. Main instruments used in promoting renewable energy in EU are; purchase guarantees by feed-in-tariffs, quota applications and energy tax exemptions. In Turkey first promotion instrument towards electricity generation from renewable energy sources was the publication of Electricity Market Law (Law. No. 4628) in March 2001. In the context of this law, individual and corporate entities built electricity generation facilities from renewable energy sources having maximum installed capacity of 500 kW were exempted from licensing obligations and setting up a company. Moreover, by this law Energy Market Regulatory Authority (EMRA) was founded and private sector entrepreneurs were allowed to build and operate power plants by taking out a license from EMRA. In May 2005, Law on the Utilization of Renewable Energy Sources for Electricity Generation (Law No. 5346) was published in official gazette in Turkey. Renewable energy sources included in the context of this law were; wind, solar, geothermal, biomass, biogas, wave, stream energy and tide, channel, SHP or hydropower production facilities having a reservoir area less than 15 km<sup>2</sup>. Some incentive mechanisms were introduced to Turkish market for electricity generation from renewable energy sources by Law No. 4628 and 5346. These mechanisms can be classified as licensing, land appropriation and purchase guarantee by a constant feed-in tariff. Table 3 presents the details of these mechanisms developed in Turkey. Even though these mechanisms were introduced in Turkey markets they are still inadequate when compared to EU countries leading the utilization of renewable energy sources. For example, Germany offers different feed-in tariff amounts for different energy sources specified in German Renewable Energy Law (Table 4). Nevertheless, in Turkey, a feed-in tariff of 5.5 €/kWh is applied without taking energy source into account and any installed capacity limitations. This issue is considered to cause a serious conflict to EU.

Table 3. Incentive mechanisms offered to individuals and corporate entities by Law No. 4628 and 5346.

Incentive Mechanism	Incentives
1) Licensing	a) Installed capacity of 500 kW are exempted from licensing and setting up a company b) Only 1% of the licensing cost is paid by corporate entities applied to get a license and these entities do not pay annual licensing cost for the first eight years. c) Priority is given for system connection.
2) Land Appropriation	a) Real properties which are either regarded as forest or the private property of Treasury are leased or right of easement or usage permits are given to such properties. b) 85% discount is applied to rent, right of easement and usage permits and Forest Villagers Development Revenue, Forestation and Erosion Control Revenues are not demanded during the first 10 years.
3) Purchase Guarantee	a) Government guarantees to buy electricity generated for 10 years offering a feed-in tariff amount of 5-5.5 ¢cent/kWh.

Table 4. Feed-in tariff amounts specified in German Renewable Energy Act 2009.

Type of Energy	Feed-in Tariff Amount
Hydropower	12.67 ¢c/kWh, $P < 500$ kW;
	8.65 ¢c/kWh, $500$ kW $< P < 2$ MW
	7.65 ¢c/kWh, $2$ MW $< P < 5$ MW
Wind Energy	9.2 ¢c/kW, in the first five years after the installation
	5.02 ¢c/kW
Solar Radiation	43.01 ¢c/kWh, $P < 30$ kW;
	40.91 ¢c/kWh, $30$ kW $< P < 100$ kW
	39.58 ¢c/kWh, $100$ kW $< P < 1$ MW
	33 ¢c/kWh, $P > 1$ MW

Publication of Renewable Energy Law in Turkey had a clear effect on hydropower development (Table 5) as well as on the installed capacity of wind power which increased from 20 MW to 802 MW between 2005 and 2009 (Fig. 2). Hydropower potential increased by 15% in 2007 as compared to 2006 and planned plants increased by 4 times in the same year. Furthermore, planned installed capacity increased by 7% in 2007 as compared to 2006 and most of the projects at that year was composed of SHPs [11]. Fig.3 presents the status of hydropower energy in Norway and in Turkey. Norway is a country nearly produced its total electric energy from hydropower. But 22.2% of its hydropower potential is not used in order to preserve protected areas [12]. On the other hand in Turkey, the hydropower policy is based on to develop its all hydropower potential which is not complying with the EU Water Framework Directive. However in the country, ecologically sensitive sites should be preserved like the example of Norway.

Table 5. Progress in hydropower plants after the publication of Renewable Energy Law in Turkey ([13], [14]).

	In Operation (2006)	In Operation (2007)	Under Construction (2006)	Under Construction (2007)	Planned (2006)	Planned (2007)
Number of projects	142	148	40	158	573	977
Installed Capacity (MW)	12788	13306	3197	6564	20765	22260
Energy (GWh/yıl)	45930	47590	10518	23620	73851	79177

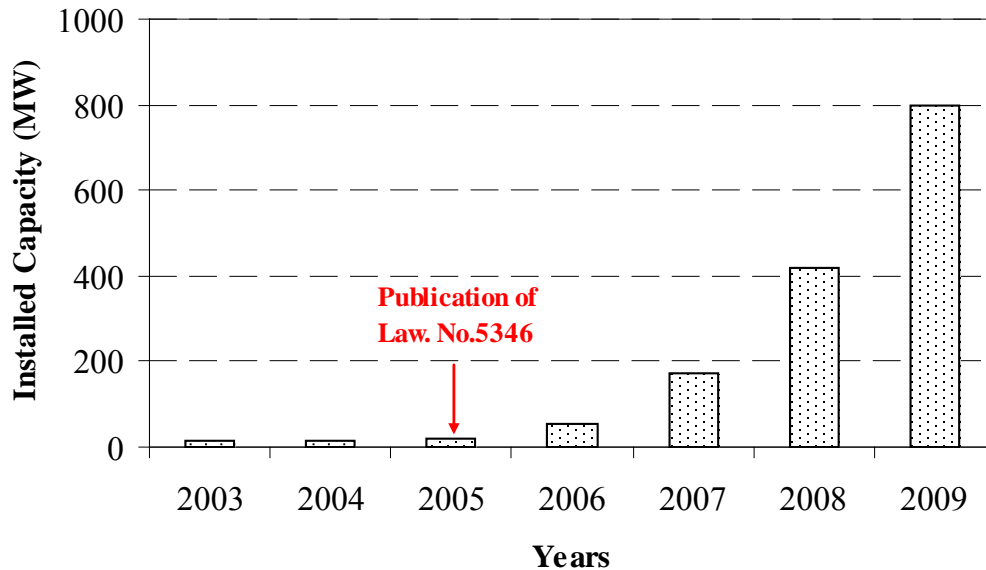


Fig. 2. Progress in installed capacity of wind energy in Turkey between 2003 and 2009.

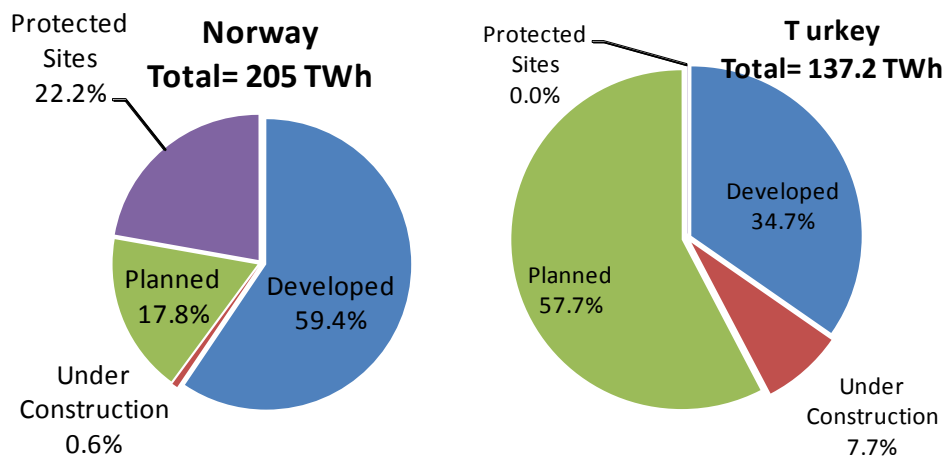


Fig.3 The total hydropower production in Norway and Turkey at the end of 2007 (Data sources: for Norway; [12] and for Turkey; [11]).

## 5. Conclusions

In this study, availability and potentials of renewable energy sources in Turkey was evaluated as well as the effectiveness of government policies focused particularly on Renewable Energy Law (Law No. 5346) and its compatibility to EU policy. Even though Law No. 5346 contradicts with EU legislations, its effect can be clearly seen immediately after it was

published. Nevertheless, conflicts of Renewable Energy Law (Law No. 5346) published to increase the utilization of renewable energy sources with EU policies creates serious obstacles to achieve this target. First confliction is, on the contrary to EU, the constant feed-in tariff amount offered in Turkey without taking capital investments of specific energy sources into account. Second issue considered as a confliction is that hydropower plants with a reservoir area less than 15 km<sup>2</sup> are considered within the definition of renewable energy defined by Law No. 5346, thus shifting private sector interest from SHPs to big hydropower plants. This issue is handled differently in EU in a way that governments take installed capacity of power plants into account and plants with lower installed capacities get higher amount of incentive. The last issue considered as another contradiction to EU legislation is that no detailed Environmental Impact Assessment (EIA) report is required in the construction of power plants utilizing renewable energy sources in Turkey. However, in EU, the organizations such as Europe Investment Bank investigate the probable harms of a project to the environment while considering financing it [15]. This is a serious confliction as more and more attention is being paid to environmental issues in EU as well as the world.

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