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Renewable Energy: Policy Issues and Economic Implications in Turkey

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ABSTRACT: Current energy policy of Turkey is to increase the renewable energy share in total energy and to maximize benefit from existing potential until next 15 years. It was planed that the share of renewable energy resources in electricity production would be at least 30% by 2023 and government ensured some incentives such as feed-in tariff, investment incentives etc. for renewable energy. Moreover Turkish Energy Regulatory Agency (EMRA) announced that biofuel blending would be mandatory starting from 2013 and 2014 for bioethanol (2%) and biodiesel (1%), respectively. This study examines the current situation and potential of renewable resources and evaluates the impacts of renewable energy policy both on the energy sector and whole national economy. Renewable energy targets can generate around 275-545 thousand direct jobs possibilities in energy sector and 7.9 thousand tones natural gas and 464 thousand cubic meters fossil fuel saving by 2023. Net trade impact of renewable energy targets will be aggravated due to mandatory biodiesel blending since Turkey has oilseed deficit. In Turkey, utilization of all type of resources will contribute to economy but most feasible and sustainable renewable energy is biomass. Between the other renewables, biomass would provide highest social well-being in the country.

Keywords: Turkey; renewable energy policy; sustainable development
JEL Classifications: Q16; Q20; Q42

1. Introduction

In recent years, growing volatility in global crude oil markets and concerns over climate change have become major challenges all over the world. In this regard, energy is considered as a key issue for sustainable economic development. As in many countries, energy is one of the Turkey's most important issues for economic growth and social progress.

Turkish economy has been rapidly growing during the past decades. Turkey also faced growing demand for energy in last two decades and furthermore primary energy demand was projected to reach 220 mtoe in 2020 which means 92 percent increase from current level (114.5 mtoe) (MFA, 2006, DEKTMK, 2012). Turkey has an economy challenging by growing demand for energy while its self-sufficiency rate in primary energy sources is very low. Total primary energy production met about 28 percent of total primary energy demand in 2011.

Turkey is heavily dependent on expensive energy imports which impose significant burden on the current account deficit and price stability. According to the TurkStat (2012a), total energy import reached to 60,112 million USD and it constituted about 25.4 percent of the total import bill in 2012. As a result of increasing energy consumption, air pollution has been causing severe environmental issues in the country. In 2010, Turkey's GHG emissions (CO2 equivalent) increased 115 percent in last decade and approximately 85 percent of total emissions emitted from energy sector (TurkStat, 2012b). Furthermore, to comply with Kyoto Protocol, consumption pattern needs to be modified which further require reducing share of coal in primary energy consumption. As a candidate country, Turkey will also have to adopt the bioenergy and biofuel directives of the EU in case of membership. Utilization of domestic renewable energy sources such as biofuels, hydro, wind is key issue for Turkey to reduce its dependence on import energy supplies, provide supply security and prevent the increase in greenhouse emissions.

Promoting renewable energy resources seems to be one of the effective energy policies in Turkey which also entails substantial investments. Turkey's energy policy targets to increase the share of renewable energy in final energy use in near future. In this regard, for example, it is planned that the share of renewable energy sources in electricity production will be at least 30 % while decreasing the

share of natural gas below 30 % by 2023. Moreover, The Turkish Energy Regulatory Agency (EMRA) put in place a new regulation that biofuel blending would be mandatory starting from 2013 and 2014 respectively for bioethanol (2%) and biodiesel (1%). The blending ratio will be increased to 3% for bioethanol in 2014 and biodiesel in 2016, respectively (EMRA, 2011).

Renewable energy sources such as hydro, wind and biomass started to become a challenging alternative to fossil fuels over the past few years in Turkey. The aim of this article is to examine the current situation and potential of renewable energy and evaluate the impacts of renewable energy policies both on energy sector and macroeconomic balance. The paper is organized as follows. In the second section, macroeconomic drivers of energy demand and current energy situation in Turkey are presented. In the third section national renewable energy policy is reviewed. In the fourth section potential and developments in renewable energy is presented. In the fifth section implications of renewable energy policies on energy sector and the macroeconomic balance are evaluated. Final section concludes important results.

2. Economic Profile and Current Energy Situation in Turkey

Turkey's has 779,452 km^2 land size and about 75.6 million populations in 2012 (TurkStat, 2013). Economic growth, increasing population, migration from rural regions to urban and/or tourism regions has been leading more energy consumption. Over the past decade Turkish Gross Domestic Product (GDP) has increased an exceptional rate compared to other OECD countries. According to the World Bank (2011), Turkey is one of the fastest growing country among emerging economies and 15th largest economy in the world with GDP of 1,259 billion international USD (in terms of GDP-PPP) and 17th largest economy in terms of Nominal GDP in the world (WB, 2011, WB, 2010). Turkey had expanded by 4.3 percent annual average growth rate during 2000-2010 (IEA, 2010). In Turkey, per capita income reached 10.4 thousand USD (at current prices) in 2011 (TurkStat, 2012c).

Table 1. Population, Economy and Energy in Turkey, 1973-2020

Year	Population (1000)[a]	Population Increase, (‰)	GDP per capita, ($)[b]	GDP, at current prices, (billon USD)	Total Energy Consumption, (Mtoe)
1973	38,073	20.7	2,369.00	90.2	20.0
1990	55,120	17.0	3,859.52	202.38	40.6
1995	59,756	15.4	6,693.43	223.74	63.2
2000	64,259	13.8	7,750.35	265.18	82.2
2005	67,903	13,0	11,116.95	482.78	92.5
2010	73,722	15.0	13,577.10	729.05	97.3
2020	80,257	8.8	19,748.55	1,344.29	220.0

[a] Mid-year population data
[b] IMF, International USD PPP equivalent
Sources: Boluk and Koc (2011).

Growth rate of GDP in Turkey was 8.5 percent in 2011 and GDP was expected to grow at a rate 4 percent in 2013 and 5 percent in 2014 and 2015 (SPO, 2012). Turkey is also expected to have fastest medium-long term growth in energy demand among the IEA counties. The total energy consumption is expected to reach 220 mtoe by the year 2020 (MFA, 2006).

Table 2. Primary Energy Consumption and Production, 2009-2011

Energy Consumption & Production/Year	**2009**	**2010**	**2011**
Primary Energy Consumption, (thousand tep)	106.138	109.266	114.480
Primary Energy Production (million tep)	30.2	32.5	32.2

Source: DEKTMK (2012).

Primary energy production meets only 28 % of consumption in Turkey. Statistics of The Ministry of Energy and Natural Resources show that natural gas, coal and petroleum products constitutes the main bulk of the energy consumption (89.3 %). Turkey has no significant oil and natural gas reserves and the country is highly dependent on imported primary energy resources.

Dependency rate for natural gas, oil and hard coal has been 98 %, 92 % and 91 %, respectively (MENR, 2011).

3. **Assessment of Renewable Energy Policies in Turkey**

After the foundation of Turkey in 1923, fundamentals of the policies were determined for 1920-1960 periods. Economic policy of the years 1950-1960 based on mixed economy system tried to encourage the private sector and foreign investors' participation but public sector developed rather than private sector. In this period domestic primary energy sources (water and coal) were tried to be increased to meet demand. But this target could not be realized consistently (Yilmaz and Uslu, 2007). There was no considerable development in renewable energy such as wind, solar and bio-fuel but some efforts were observed for hydro power in this period. Government has tried to develop electricity production via hydro plants since 1930. While the installed capacity of hydro for electricity production was 3.2 MW in 1931, hydro capacity increased nearly 100 folds in 1959 (TEIAS, 2001).

The period after 1980 can be said liberal period and in this period public investments were gradually cut down to reduce the public share in the economy. Moreover, Turkish government initiated some legal regulations to attract the private investors to the economy (Ozkivrak, 2005). By the end of the 1990s, it was understood that quasi-privatization policies were not functioning efficiently given the rapidly deteriorating fiscal situation. Thus, Turkey adopted a radically different framework for the design of energy markets. In 2001, Electricity Market Law (EML, No:4628) came into force. The EML was designed to establish a competitive electricity market, to stimulate private participation and improve the efficiency in electricity supply (Ozkivrak, 2005; Erdogdu, 2007). In parallel with the electricity market reform, some other reforms were also initiated in other segments of market. In 2001, Natural Gas Market Law (NGML, No: 4646) also came into force to achieve similar goals in natural gas industry (Erdogdu, 2007).

Basic market based or non-market based promotion mechanisms for renewable energy all over the world are feed-in tariff, premium, quota based green certificate, bidding incentives, incentives for investment, tax exemptions and discounts (Deloitte, 2011). First promotion instrument for renewable energy was the Electricity Market Law Turkey in 2001. 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 by EML (Kucukali and Baris, 2011). Legislation activities in renewable energy have intensified over the past decade. The cornerstone of these activities was The Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (No: 5346) was accepted in May, 2005. The main objective of the this Law was to increase the use of renewable energy sources for generating electrical energy, as well as to diversify energy resources, reduce greenhouse emissions, assess waste products, protect the environment, and develop the necessary manufacturing sector to realize these objectives. This Law includes some incentives such as licensing, land appropriation and purchase guarantee by a constant feed-in tariff (Budak, 2009).

Turkey targets to exploit its energy potential, including renewable sources in a cost-effective manner. In this context, it tries to promote renewable energy in electricity production but has recently started to pay more attention to solar and geothermal energy. Turkey adopted several targets for electricity from renewable sources by Electricity Market and Security of Supply Strategy in 2009. In this regard, Turkey targets the share of renewable resources in electricity generation to be at least 30% by 2023. Furthermore, the country's all technically and economically available hydroelectric potential will be utilized by 2023. Wind power capacity was planned to increase to 20 GW (20 000 MW) and whole 600 MW economical potential for geothermal power capacity are planned to exploited. Solar energy use for power generation will be developed as well (YPK, 2009).

The EML was amended by Law no: 5784 in 2008 and this New EML regulates that production of electricity from renewable energy up to capacity of 0.5 MW was exempted from the production license (exemptions from license obligation). The Law on the Utilization of Renewable energy Resources for the Purpose of Generating Electricity (No: 5436) was enacted in 2005. This Law aimed to expand the use of renewable energy sources to produce electricity in an economic manner to increase the diversification of energy sources, to reduce GHG emissions, to utilize and develop the related manufacturing sector to realize these objectives. According to the Law (No: 5436) retail electricity licensees have to purchase at least 8% of their annual electricity sales from renewable

energy sources. Moreover, research, development and production investments regarding solar energy units and research and development investments for biomass energy can benefit from the incentives determined by the Council of Ministers. By this Law, it was stated that municipalities and governorates with sufficient geothermal energy resources should meet their heat energy primarily by geothermal and solar thermal energy resources (Tukenmez and Demireli, 2012).

Law was amended by Law Regarding the Amendment in the Law of Utilization of Renewable Energy Resources for the Purpose of Generating Electricity (Law no: 6094) in December 2010. Within this law, principles of "Wind Power Plant Supporting Mechanism" such as price, time and payments were determined. The new Law changed the feed-in tariffs for each renewable energy sources. Moreover, General Directorate of Electrical Power Resources Survey and Development Administration (EIEI) was repealed. Instead of this institution, General Directorate of Renewable Energy (YEGM) was established in November, 2011. YEGM, will execute researches and projects on development of domestic renewable resources. Finally, The Turkish Energy Regulatory Agency (EMRA) put in place a new regulation that biofuel blending will be mandatory starting from 2013 and 2014 respectively for bioethanol (2%) and biodiesel (1%). The blending ratio will be increased to 3% respectively for bioethanol in 2014 and biodiesel in 2016 (EMRA, 2011).

Table 3. Incentive mechanisms ruled out by Law No: 4628, 5346, 6094 and 4760

Incentive Mechanism	Incentives	
Investment incentive	*Licensing* i) Installed capacity of 500 kW is exempted from licensing and setting up a company ii) Only 1 % of 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. iii) Priority is ensured for system connection	
	Land appropriation i) Real properties either regarded as forest or private property of Treasury are leased or right of easement or usage permits are given to such properties ii) 85 % of discount is given 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	
Feed-in Tariff	Government guarantees to buy electricity generated for 10 years offering a feed-in Tariff. Feed-in Tariff Amounts: USD $ cent	
	Hydropower	7.3
	Wind Energy	7.3
	Geothermal	10.5
	Biomass	13.3
	Solar Radiation	13.3
Tax exemptions and cuts	Special consumption tax exemption is applied for 2% biodiesel blending.	
Premium	Premium is given for oil seeds.	

Source: Table was prepared by author based on the related regulations.

When renewable energy support policies are compared to other countries (USA, China, EU countries), it can be said that Turkey has just regulatory policies such feed-in tariff and biofuel obligations. Although other support tools such as fiscal incentives (capital subsidy, grant or rebate, energy production payment) and public finances (public investment loans or grants and competitive public bidding) are widely used to support renewable energy in those countries, these devices have not been employed in Turkey yet (PWC, 2012).

4. Potential and Developments of Renewable Energy in Turkey

Since Turkey has considerably large import dependency on fossil fuels and rapidly growing energy demand, the greater utilization of renewable energy resources and investments in renewable energy technologies are very important in Turkey. Main renewable energy resources for Turkey are hydro, wind, solar, biomass (including biogas) and geothermal. Renewable energy is the second major domestic energy source following the coal. According to the MENR (2011) data, however, renewable

energy resources met only 6.3 % of primary energy supply in Turkey. Installed capacity just constituted of 40 % of economical potential in hydro power. This ratio for wind and geothermal is 9 % and 19 %, respectively. Turkey has still economical potential to be exploited in renewable resources (See Table 4).

Table 4. The situation of renewable energy in Turkey, (the end of 2011)

Type of Energy	Technical Potential (MW)	Economical Potential (MW)	Installed Capacity (MW)
Hydropower	54,000	42,000	17,137
Wind	114,000	20,000	1,806
Geothermal	2,000	600	114.2
Wastes (Biogas+Biomass)	4,000	-	125.7
Solar	56,000	-	-

Source: Kucukali and Baris (2011), TEIAS (2011a), TUREB (2012).

Turkey has huge hydro potential and the second largest energy resource after coal is hydro. Turkey's gross and technical hydropower potential has the highest potential in Europe with 433 TWh/year and 266 TWh/year, respectively. It is forecasted that hydro potential can meet 33-46 % of country's electricity demand in 2020. Turkey is one of the countries with the best wind maps among European countries following the United Kingdom (Yarbay et al., 2011). It is estimated that Turkey's technical wind energy potential is 114,000 MW but 20,000 MW of this potential is economically feasible. Although Turkey has the highest technical hydro and wind power potential among the European countries, only very small portion of this potential is used when compared to those countries (Kucukali and Baris, 2011).

Turkey also is geographically well positioned for the abundance of sunlight but she doesn't use this resource effectively. Although Turkey is among the world's pioneering solar energy users with the 18 million of flat-plate solar collectors, still there is a considerably large solar power potential to be exploited. Annual solar collector production capacity is nearly 1 million square meters in Turkey (Asker, 2012). There is also a good potential for PV applications in the local market since the country is substantially suitable due to high rates of solar radiation and available land for PV applications but electricity generation from solar by photovoltaic's (PV) has high installing costs. Unfortunately, economic usage of PVs is not available in Turkey (Yarbay et al., 2011).

Turkey's total capacity is around %0.20 of the total which has an important place among the richest countries in geothermal capacity (fifth place in the world and first place in Europe) (MENR, 2012, Deloitte, 2011). Geothermal energy has the potential to play an important role in energy supply of Turkey. There has been progress in geothermal power in electricity installed capacity since 2008 (See Table 7). Turkey has very high geothermal energy potential but only 13 % of total potential has been utilized (MENR, 2012). When all of this potential is used, it can be meet 14% of total energy in Turkey (Yarbay et al., 2011).

Biomass is abundant and substantial potential is available in Turkey. The existing biomass amount is around 117 million tones and if this potential is used it can be met around 32 mtoe of consumption annually. Total recoverable bioenergy potential is about 17.2 Mtoe (Baycelebi, 2008). Utilization of biomass energy in Turkey has gained importance as a renewable energy source in last decades.

Table 5. Biomass energy potential in Turkey, 2008

	Agricultural Waste	Animal Waste	Urban Waste
Quantity (Mt/year)	37-48	10.8	21
Low heating value (MJ/kg)	17.5	22.7	15
Produced energy(PJ.year)	653-839	49	315

Source: Onal and Yarbay (2010:90).

Interest in biofuels in Turkey has been increasing as well. Currently, there are more than 100 biodiesel facilities and 56 of these facilities were licensed. Moreover ALBIYOBIR (Alternative Energy and Biodiesel Producers Association) continues to produce biodiesel

from waste oil. It is stated that, 9 waste oil plants have annually 230 thousand tones biodiesel capacity (Hatunoglu, 2010). It is estimated that capacity of the installed biodiesel plant is around 1,5 million tones. Although biodiesel blended oil produced from domestic crops production has exempted from the Specific Consumption Tax (OTV in Turkish), the existing production capacity in biodiesel has not been fully used. Moreover, since Turkey has foreign trade deficit in oil seed sector, processing imported oilseed to produce biodiesel was not found feasible (Boluk and Koc, 2008). Hence, capacity of biodiesel facilities has not been utilized and many factories have closed down (Ar et al., 2010; EMRA, 2011). The major ethanol production plants are Konya Sugar Corporation (Cumra Sugar Facility) which established under the PANKOBIRLIK (cooperative union). Although Turkey has bioethanol capacity and supply, traded bioethanol quantity is quite low compared to capacity (Ar et al., 2010). Biogas potential in Turkey is estimated to be 1.5-2 million TEP. Moreover, bioethanol installed capacity is 160,000 tones and total potential (sugar beet based ethanol) is estimated as 2.5 million tons in Turkey (Boluk and Koc, 2008).

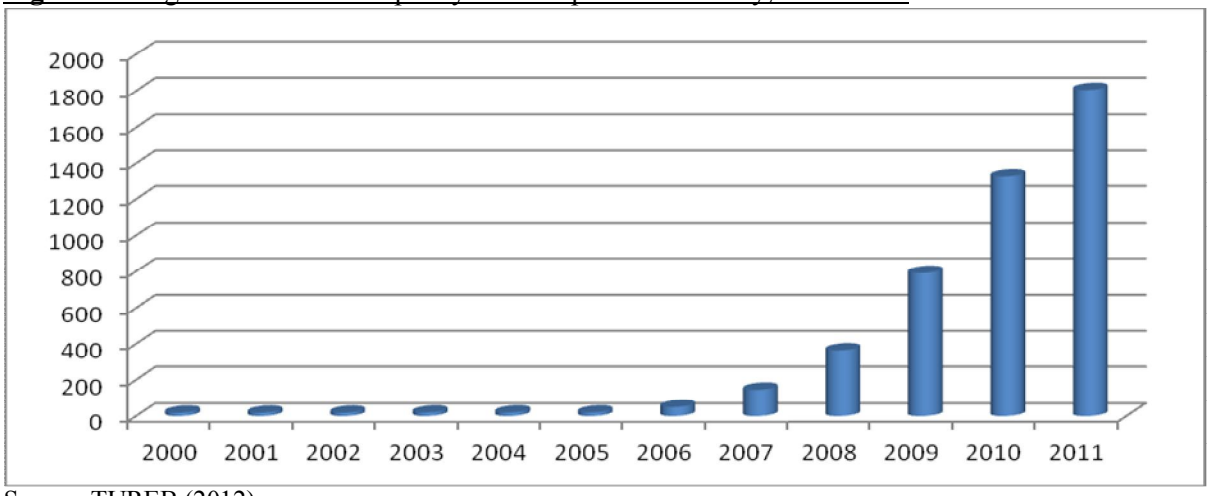
Table 6. Progress in hydropower plants after publication of REL in Turkey

	In Operation				Under Construction				Planned			
	2006	2007	2011	2012	2006	2007	2011	2012	2006	2007	2011	2012
Number of Projects	142	148	172	303	40	158	148	256	573	977	1418	1084
Installed Capacity(MW)	12788	13306	13700	17372	3197	6564	8600	10590	20765	22260	22700	19535

Source: Kucukali and Baris (2011), DSI (2012).

Enactment of Renewable Energy Law (REL) in 2005 has positive effect on hydro power development as well as the installed capacity of wind power. Hydro power potential increased by 39.5 % in 2011 as compared to 2006 (Table 6). Installed capacity in operation and under construction increased by 27 % and 23 % in 2012 compared to previous year, respectively. Small hydropower projects consists bulk of the planned installed capacity projects (Kucukali and Baris, 2011).

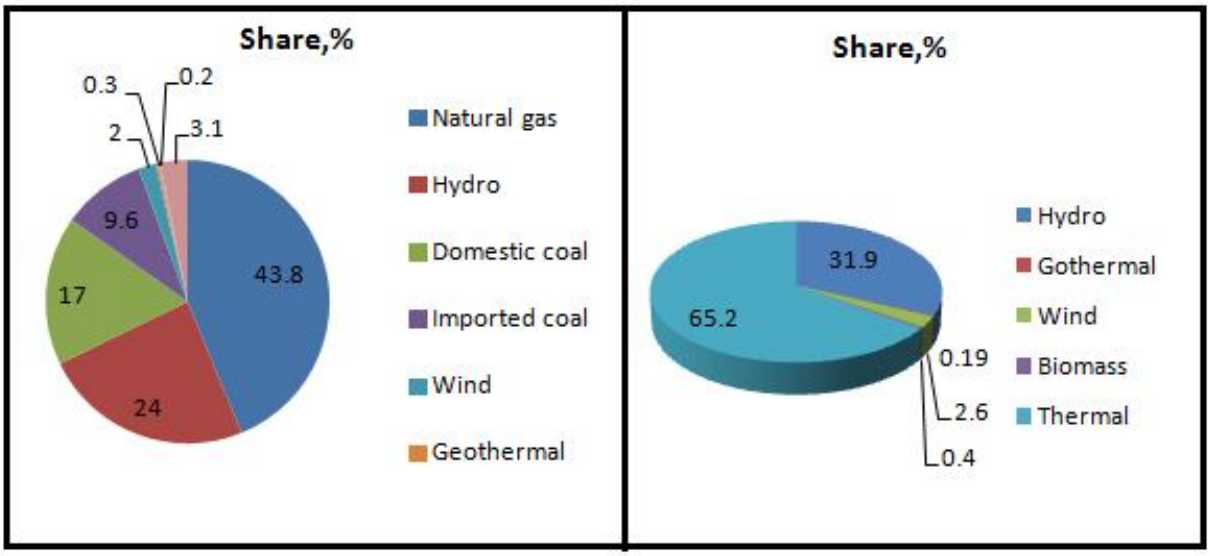
Figure 1. Progress in installed capacity of wind power in Turkey, 2000-2011



Source: TUREB (2012).

Figure 1 presents the developments of wind power in Turkey. While the installed capacity on wind power was 20 MW in 2005, total installed capacity reached 1805.8 MW at the end of the 2011 (TUREB, 2012). According to the data arranged from EMRA (2012) statistics, while 6 production licenses were approved in 2010, 187 production licenses were approved by the EMRA for additional 6354.6 Mwe capacities in wind power for 2011-2013 periods.

Figure 2. Share of resource type in electricity production and installed capacity, 2011



If the renewable energy based installed capacity is compared to renewable energy capacity it can be said that still Turkey can't exploit its potential (figure 2). For example, although most part of Turkey is suitable for the utilization of solar energy still there is no licensed production activity of solar energy for electricity.

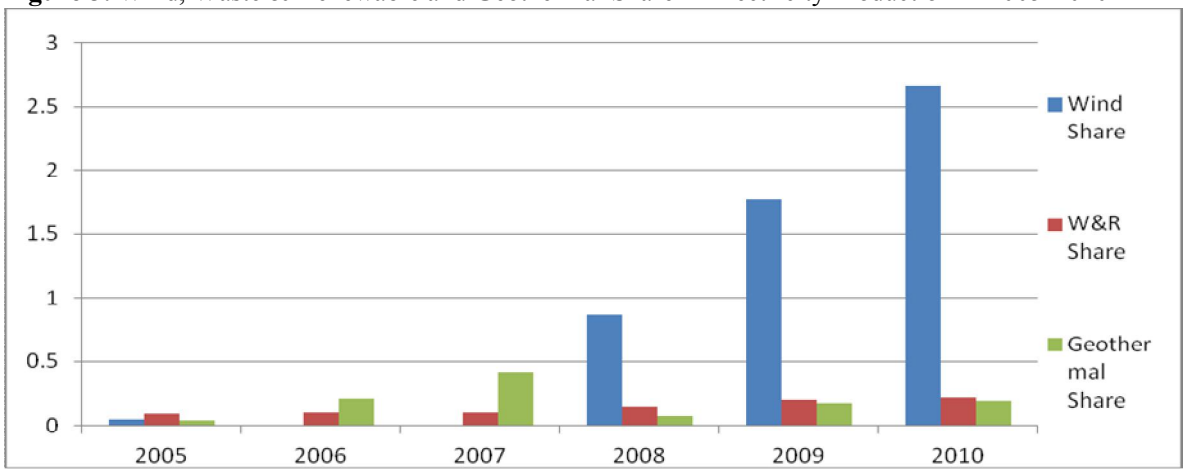
Table 7. Installed capacity for electricity power from hydro, wind and biomass, 2005-2011.

MW	2005	2006	2007	2008	2009	2010	2011
Hydro	12906.1	13062.7	13394.9	13828.7	14553.3	15831.2	17137.1
Wind	20.1	-([a])	-	363.7	791.6	1320.2	1728.7
Biomass	35.3	41.3	42.7	59.7	86.5	107.2	125.7
Geothermal	15	81.9	169.2	29.8	77.2	94.2	114.2

[a] Wind capacity was included in geothermal in 2006 and 2007.
Source: TEIAS, 2011a.

There has been also progress in biomass capacity in electricity production. While biomass capacity increased by 24 % in 2010 as compared to 2009, this increase rate was 17 % in 2011 (figure 3). It is predicted that the agricultural and animal waste can meet 22-27% of the total energy consumption of Turkey (Bascetincelik et al., 2010).

Figure 3. Wind, Waste & Renewable and Geothermal Share in Electricity Production in 2005-2010



In Turkey, electricity generation plans is prepared by the TEIAS. TEIAS prepares this report taking in to account of Model of Analysis of Energy Demand (MAED) of MENR. Last report "Electricity Power Production Projection of Turkish Electricity Energy 2011-2021" was published in 2012. TEIAS proposes two scenarios for electricity generation: High and Low Demand Scenarios. Based on High Demand Scenario, Table 8 shows renewable energy share in total electricity generation for 2015 and 2021 based on projected and reliable capacity.

Table 8. Renewable Energy Share in Total Projected Electricity Generation for 2015 and 2021

Renewable Energy (RE) Source	SCENARIO 1				SCENARIO 2			
	Project Production Capacity (GWh)		*Reliable Production Capacity (GWh)*		*Project Production Capacity (GWh)*		*Reliable Production Capacity (GWh)*	
	2015	2021	2015	2021	2015	2021	2015	2021
Hydro	90522	116558	54932	69386	84380	116558	51459	69386
Wind	9208	9208	7644	7644	8790	9208	7288	7644
Biogas+waste	1196	1196	1196	1196	1196	1196	1196	1196
Total	375619	434670	325031	380774	360009	439620	312151	377324
RE Share in Electricity Generation, %	26.8	29.2	19.6	20.5	26.2	28.2	19.2	20.7

Source: TEIAS, 2012.

Electricity generation plan for 2012-2021 of TEIAS, includes hydro, wind, biogas and wastes for 2015 and 2021 period. Under Scenario 1, based on project capacity and reliable capacity renewable energy share will be 26.8 % and 19.6 % by 2015, 29.2 % and 20.5 by 2021 respectively. Under Scenario 2, based on project and reliable capacity, renewable energy share will be 26.2 % and 19.2 % by 2015, 28.2 % and 20.7 by 2021 respectively. As seen in Table 8, renewable energy share will be under 30 % by the 2023. According to the TEIAS (2012), there will be a gap in electricity power supply in 2017 and afterwards in Turkey.

5. Implications of Renewable Energy Policies on Economy

Renewable energy has a key role to play in shifting dependency away from volatile fuels. The development of renewable energy technologies ensures more sustainable economic growth (sometimes summarized by the term "green growth) (Müller et al., 2011). Renewable energy can contribute to sustainable economic development by ensuring exploitation of natural and replenishing resources, providing new natural capital. Green growth is a valuable tool for continued prosperity, which is evident in the billions spent on green infrastructure investments. Experiences in China and USA, show that key sectors benefitting from renewable are rail transportation, water infrastructure, power grid expansion and improving building efficiency. These transformative technologies could substantially change production chains, patterns of urbanization, agricultural practices and the transportation sector bringing with them opportunities, new investments and entrepreneurship. Renewable energy technologies may allow countries to exploit renewable energy resources with long term export potential (Müller etc, 2001, Dervis et al., 2009). For example, Brazilian ethanol export is expected to increase to about 0.5 bnl in 2020 (OECD-FAO, 2011, 86).

Employment sectors has been benefitting from processing of renewable energy as well. More than 5 million green jobs have been created directly or indirectly[1] in renewable sector globally in 2011 (See Table 9). In Germany, for example, the number of jobs nearly quadrupled to 260.000 in last 10 years. China's recent success in developing renewable technologies shows that emerging economies can also use green growth strategies towards more sustainable growth (Müller etc, 2011). Globally majority of renewable jobs has been created in bioenergy and solar hot water industries. Especially bioenergy sector is very labor intensive due to growing, harvesting and distribution process of

[1] Jobs those related to a sector's core activities such as manufacturing, equipment distribution and site preparation and installation are called "direct jobs". Indirect jobs are jobs in industries that provide goods and services to renewable energy sector (REN21, 2012).

bioenergy feed stocks (REN21, 2012). Key region for biofuels is Brazil (sugarcane for ethanol production).

Table 9. Estimated employment in the renewable energy sector, 2011, (thousand)

Technology	**Global**	China	India	Brazil	USA	EU	Germany	Spain	Others
Biofuels	1,500			889	47-160	151	23	2	194
Biomass	750	266	58		152	273	51	14	2
Biogas	230	90	85			53	51	1.4	
Geothermal	90				10	53	14	0.6	
Solar PV	820	300							
Solar Heating/Cooling	900	800	41		9	50	12	10	1
Wind power	670	150	42	14	75	253	101	55	33
Hydropower (small)	40		12		8	16	7	1.6	1
CSP-Concentrating Solar Power)	40				9		2	24	
Total	***5000***	***1,606***	***350***	***889***	***392-505***	***1,117***	***372***	***137***	***291***

Source: REN21, 2012.

Turkey's renewable energy policy objectives are outlined in the institutional strategic plan for 2010-2014 and Electricity Energy Market and Supply Security Strategy Paper of Ministry and Energy and Natural Resources. Another main document is Electricity Energy Market and Supply Security Strategy Paper (2009) of Undersecretariat of High Planning Organization. Moreover, EMRA (Turkish Energy Regulatory Agency) announced that biofuel blending will be mandatory starting from 2013. Additionally, Turkey's energy policy targets to increase the share of renewable in electricity to 30 % in 2023. As a result of supporting policies, electricity production from renewable resources has gained attention in recent years in Turkey and investments on renewable resources have accelerated as well.
In this section, impacts of renewable energy policies both on energy sector and macro economy will be discussed. Based on the targets determined by Papers, two main policy scenarios can be constituted for short term (Policy Scenario I-PS 1) and mid-term (Policy Scenario II-PS 2).
Policy Scenario 1 (for 2013-2015): 5,000 MW hydropower, 10,000 MW wind power, 600 MW solar, 300 MW geothermal, 185 MW biomass+biogas[2], 3 % bio-ethanol&2% bio-diesel blending (76.2 thousand tones bio-ethanol and 330 thousand tones bio-diesel).
Policy Scenario 2 (for 2023 term): 10,000 MW hydropower, 20,000 MW wind power, 1,200 MW solar, 600 MW geothermal, 185 MW biomass+biogas, %10 bio-fuel blending target (EU biofuel target, 254 thousand tones bio-ethanol and 1,650 thousand tones bio-diesel).

Turkey has growing and young population (youth population share is around 62 %). Turkey has been struggling with unemployment issue for a long time. According to the TurkStat (2013b), unemployment rate was 9.2 % in 2012. Youth unemployment rate was nearly two folds of average (17.5 %). Despite the high economic growth rate since 2002, Turkish economy has failed to create job opportunities. *Jobless growth* still constitutes a dilemma for the Turkish stabilization program (Eser and Terzi, 2008).

As seen in Table 10, highest employment ratio per MW among the renewable energy resources is solar PV. While hydro power and wind power has nearly same employment ratio for operation and maintenance stage, hydro creates more job possibilities than wind power in construction and installation. Following the hydro power geothermal is the third employment creative renewable resource in construction and installation. Biogas creates the highest employment possibilities per MW in operation and maintenance stage among the other resources followed by the geothermal. However, biomass is closely linked to agriculture (farming and harvesting), manufacture (installation and heating i.e.) and service sectors (transportation, storing i.e.) (Brouwer et al, 2009). Hence indirect job creation effect would be the largest among the other renewables. A study in India (See Pardwardhen, 2001) shows that, total job ratio (direct and indirect) per MW for biomass is 43 (this ratio for wind is

[2] There is no specific target for biomass in official policy documents, but TEIAS gives place to biomass for additional 185 MW capacities (waste+biogass) in production plan by 2021.

just 4). Indeed, a report of EU on renewable energy sources (RES) states that, more than 60 percent of total RES sector employment generation is due to biomass technologies in EU (EC, 2009).

Table 10. Employment ratios for renewable energy sources of life of facility

Renewable Energy	Unit	Construction & installation	Operation& maintenance
Wind	MW	2.57-13	0.1-1.4
Solar-photovoltaic	MW	7.1-34.6	0.1
Hydroelectric	MW	18.6	1.4
Geothermal	MW	4-17.5	1.7
Biomass (electric)	MW	4	0.14
Biogas	MW	25	6

Source: Moreno and Lopez, 2008, p.742-743, Wei et al, 2010.

Based on the literature employment ratios (See Table 10) for renewable energy sources and PS1 and PS 2 targets, employment effect for Turkey was summarized in Table 11[3].

Table 11. Job creation possibilities from renewable energy development in Turkey over the period 2013-2023 under policy scenarios (PS 1 and PS 2)

Renewable Source	Construction & installation		Operation & maintenance		Total	
	Policy Scenario 1	Policy Scenario 2	Policy Scenario 1	Policy Scenario 2	Policy Scenario 1	Policy Scenario 2
Wind	25.700-130.000	51.400-260.000	1.000-14.000	2.000-28.000	26.700-144.000	53.400-288.000
Hydro	93.000	186.000	7.000	14.000	100.000	200.000
Solar PV	4.250-20.760	8.520-41.520	60	120	4,310-20.820	8,640-41.640
Geothermal	1,200-5,260	2,400-10,500	510	1,020	1,710-5,770	3,420-11,520
Biomass	740-4,625	740-4,625	25-1,110	25-1,110	765-5,735	765-5,735
Total					***133,485-276,325***	***266,225-546,895***

According to the calculated job possibilities, most employment in renewable energy sector will be created by wind power with 144-288 thousand. Following the wind, hydro power can create more job possibilities among the other renewable energy resource alternatives with 200,000 thousand jobs. If Turkey realizes its renewable targets, solar PV will create more employment possibilities than geothermal power in both construction & installation and operation & maintenance stages. Based on capacity targets, biomass will create 596-4,464 direct jobs in renewable sector. But, as mentioned before biomass is the most indirect job creative renewable energy resource between others. Hence, biomass can create around 5.7 thousand direct jobs and around 8 thousand direct and indirect jobs in macro-economic level in the country. It should be noticed that, greater use renewable resources may harm fossil fuel employment. But as stated in Wei et al (2010), renewable resources create more job positions than fossil fuels. Therefore, renewable energy targets will positively contribute to the employment in Turkey.

As mentioned before, demand for energy has been rapidly increasing. But Turkey's self sufficiency rate in primary energy source is very low. Total primary energy production met about 28 percent of total primary energy demand in 2011 and Turkey has no significant oil and natural gas reserves. Hence the first inevitable result of energy consumption in Turkey is energy security issue. Turkey is heavily dependent on expensive energy imports which impose significant burden on the current account deficit and price stability. The highest dependency rate with 98 percent is in natural gas. Dependency rate for oil and hard coal are 92 % and 91 % respectively. It is projected that the

[3] This paper compares the renewable energy resources such as wind, solar, hydro and biomass and evaluates the implications of the renewable energy policy's implications on economy in Turkey. Although biofuel is a type of biomass, job and income effects of this energy source entails much more detailed and complicated analysis and constitutes other paper's research. For this reason, job and income effects of biofuels in both rural and economy wide were ignored in this study.

production will decrease and meet the 23 % of total energy demand in 2020 which was 29 percent in 2010. The oil and natural gas import is expected to substantially increase over the next decade. The natural gas share in total import is expected to be 33 % in 2020 (IEA, 2010, DTM, 2010). Turkey's total energy import has increased nearly six folds for last 15 years and reached to 60,112 million US Dollar in 2012. Energy import bill has nearly grown with annual average 12 percent except 2009. Energy bill constituted about 7 % of country's GDP in 2011.

Based on the PS1 and PS 2, total 16,085 MW additional capacities will be created by 2015 and 31,985 MW by 2023 in Turkey. Using the conversion ratio (1 m^3 natural gas can produce 4 kWh electricity)[4], natural gas saving quantity was calculated. Moreover, based on the civil gasoline and diesel consumption quantities data of PETDER (2012), bio-diesel and bio-fuel necessity was determined under the PS1 and PS2 as well (See Table 12).

Table 12. Fossil fuel saving from renewable energy development in Turkey over the period 2013-2023 under policy scenarios

Policy Scenarios	Total MW from renewable energy development	Natural gas saving quantity (thousand tones)	Bio-fuel quantity (thousand tones)
Policy Scenario 1	16,085	4.02	76.2 (bio-ethanol) 330 (bio-diesel)
Policy Scenario 2	31,985	7.99	254 (bio-ethanol) 1,650 (bio-diesel)

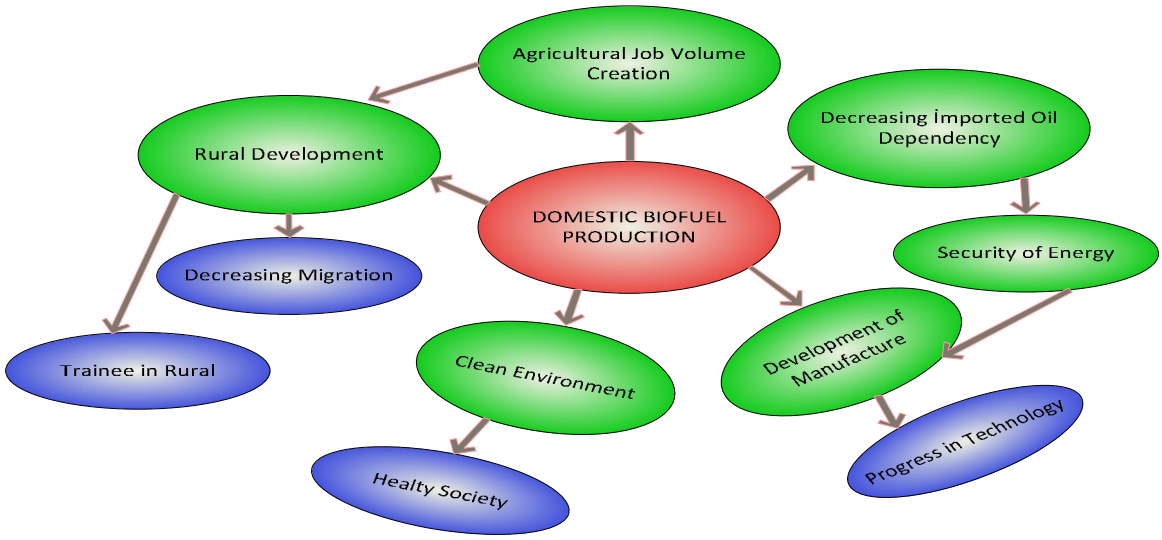
According to the calculated natural gas saving quantities, when PS1 and PS 2 realized, nearly 8 thousand tones natural gas will be saved due to hydro, wind, solar, geothermal and biomass based electricity production. And this gas saving nearly constitutes 20 % of current natural gas consumption in Turkey. According to the total projected electricity generation for 2010-2019 periods by TEIAS (2011b), 41.6-45.7 billion USD saving can be saved by utilization of renewable energy sources as well (Baris and Kucukali, 2012). Based on the mandatory blending ratio (3 %) which will be implemented by 2014, 76.2 million liters of bioethanol will result roughly 464 thousand cubic meters of oil replacement and this will mean US $ 380 million of reduction in oil import. Since Turkey has oil seed deficit, mandatory blending will be met by imported oil seeds. As a result, mandatory blending will exacerbate the current account deficit of country. But ethanol production from sugar beet is more sustainable in Turkey (Boluk and Koc, 2008).

Net trade impact of renewable targets will be aggravated due to mandatory biodiesel blending, however, developments of biofuels will provide investments in innovation, protecting of economy from political and economic risks, energy security and job creation as well. Bio-fuels and job possibilities in rural areas will have significant impacts through linkages to sections of the economy. Increasing production of biofuels will create high value added in main sectors such as agriculture, manufacture and service in Turkey. When energy import bill is managed to decrease, saved money can be spent on other goods and services thus economic well-being can be enhanced (See Figure 4).

Energy resource utilization and its impacts on the environment are important elements in the achieving sustainable development (Rosen and Dincer, 2001). Exploiting of domestic renewable energy resources is of great significance for Turkey to reduce dependency on imported energy supplies ensure supply security and prevent the increasing GHGs. As a result of increasing energy consumption, air pollution has been causing severe environmental issues in the country. In 2011, Turkey's greenhouse gas emissions as CO_2 equivalent increased 115 % compared to 1990's emissions. Approximately 85% of total CO_2 emission has been emitted from energy sector. GHG has been expected to increase in short and medium term because of the increasing energy demand (TurkStat, 2012b). Reducing emissions by developing renewables will have far-reaching implications for economic and social development, for production and consumption patterns and thus for job opportunities, incomes and poverty reduction in Turkey (UNEP, 2008).

[4] This conversion ratio was obtained from energy experts who taking into account the cycling efficiency and capacity ratios of electricity facilities in Turkey.

Figure 4. Social-economic contribution of biofuels



Source: Ar et al., 2010, p.67.

6. Conclusion

Turkey has faced growing energy demand for energy because of the high annual population growth rate, rapid urbanization and relatively high economic growth rate. Current energy policy is to increase the renewable energy share in total energy and maximize benefit from existing potential in order to improve energy security, alleviate the import burden on economy and GHGs effects. It was planned that the share of renewable energy resources will be at least 30 % while decreasing the share of natural gas below 30 % in electricity production by 2023. In this regard government ensures some incentives such as feed-in tariff, investment incentives etc. and EMRA have brought mandatory blending ratios for bio-fuels.

In this paper, policy effectiveness and potential of renewable energy resources in Turkey have been evaluated. Moreover, renewable energy policies have been examined in two policy target scenarios for short and mid-terms. Greater use of renewable energy would contribute in generating capacity, energy security and economic development in Turkey. There has been significant progress in exploiting of renewable energy resources in Turkey but still there is potential to be utilized.

In case of targets for additional renewable energy production by policy Plans were achieved, 266-546 thousand direct job possibilities can be created in energy sector by 2023. Moreover, 7.99 thousand tones natural gas and 464 thousand cubic meters fossil fuel import can be saved by 2023. Based on the policy targets, wind power will create 288 thousand direct job possibilities by 2023. Following the wind hydro will create 200 thousand direct jobs. Utilization of all type of renewable energy resource will contribute to economy but biomass is the most advantageous among the renewable energy alternatives in terms of employment contribution and fossil fuel savings since it can create indirect jobs due to linkages to other sectors. Biofuels will also positive impacts areas in terms of employment and income in rural areas. Since Turkey has oil seed deficit, bioethanol production from sugar beet is more feasible and sustainable. However, net trade impact of renewable targets on current account will be aggravated due to mandatory biodiesel blending,

Energy policies target to increase renewable energy share to 30 % in electricity production but production projections by TEIAS show that renewable share will be under this level. Moreover, although policy documents stated that solar capacity will be 600 MW, production plans do not include any solar PV additional capacity. Again, there is no official policy target for biomass but TEIAS includes 185 MW additional capacities for waste & biogas in production projections. These issues constitute inconsistency between targets and implementation of policies. Studies on renewable energy technologies (See Wei et al., 2010) state that solar PV is one of the most employment creative renewable technology. Hence, solar and biomass may be made more attractive by the incentive mechanisms and some other support tools should be considered for renewables. Otherwise, Turkey

will have a gap in electricity power supply in 2017 and afterwards or solve this problem via nuclear power plants. Moreover, renewable targets seem not enough for natural gas saving target by 2023. Growing energy demand requires additional investments and much more enhancements in domestic renewable energy supply in energy sector. But investment on renewable energy types should be planned attentively taking into account environmental effects and social sensibilities in country. These issues constitute dilemma for energy policy in Turkey. Last but not least renewable energy policy should be supported by energy saving efforts on demand side to achieve sustainable growth.

References

Ar F., Karaosmanoğlu, F., Koç, A.A., Acaroğlu, M., Sarısu, F., Özsöyler, Y., Bölük, G., İşler, A. Aygün, Ö.F. (2010). BİYOYAKITLAR [Biofuels], Ed.Figen Ar, World Energy Council, Turkish National Committee, Ankara.

Asker, M. (2012). Solar Energy Potential of Turkey, http://www.estelasolar.eu/fileadmin/ESTELAdocs/documents/members_only/Workshops_and_Meetings/25.06.2012_ESTELA_WorkShop_BXL/Presentations/ESTELA_SWS_4_MA_Solar_Energy_Turkey_25.06.2012.pdf, (02 March 2013).

Baris, K., Kucukali, S. (2012). Availability of renewable energy sources in Turkey: Current situation, potential, government policies and the EU perspective. Energy Policy, 42, 377-391.

Bascetincelik, A., Oztürk, H., Karaca, C. (2010). Türkiye'de Tarımsal Biyokütleden Enerji Üretimi Olanakları, http://www.mmo.org.tr/resimler/dosya_ekler/32590c74a229a9f_ek.pdf?dergi=563, (3 February 2012).

Baycelebi, S. (2008). From Wood to Energy (Biomass Energy). Conference of the Parties (COP), Fourteenth session. United Nations, Framework Convention on Climate Change. 1-12 December 2008, Poznan, Poland. http://www.ogm.gov.tr/sunumlar/biomass1612%20.ppt, (10/10/2012).

Bölük, G., Koç, A.A. (2008). Dünya ve Türkiye'de biyoyakıtlar: Üretim, politikalar, maliyet ve etkileri. İktisat İşletme ve Finans, 23, 269, 25-50.

Boluk, G., Koc, A.A. (2011). Dynamics of Energy Consumption Patterns in Turkey: Its Drivers and Consequences. World Renewable Energy Congress – Sweden, 8–13 May, 2011, Linköping, Sweden. http://www.ep.liu.se/ecp/057/vol12/061/ecp57vol12_061.pdf.

Brouwer, F., Nowicki, P., Woltjer, G. (2009). Does bionenergy contribute to local added value and can it further anhance future development of rural areas?. Background note on biomass production and future rural development in Europe. Agrinergy, http://agrinergy.ecologic.eu/download/background_note_workgroup1_lei.pdf, (20 January 2012).

Budak, D.B. (2009). Analysis of Renewable Energy and Its Impact on Rural Development in Turkey. AgriPolicy Enlargement Network for Agripolicy Analysis, WP2: Studies, http://euroqualityfiles.net/AgriPolicy/Report%202.2/AgriPolicy%20WP2D2%20Turkey%20Final.pdf, (3 November 2011).

DEKTMK. (2012). World Energy Council Turkish National Committee, http://dektmk.org.tr/upresimler/TURKEYSENERGYFACTSANDFIGURES2012.pdf, (4 February 2013).

Deloitte. (2011). New life for renewable energy resources Renewable energy policies and expectations. http://www.deloitte.com/assets/Dcom-Turkey/Local%20Assets/Documents/turkey_tr_energy_renewableenergy_090611.pdf, (7 August 2011).

Dervis, K., Jones, A., Kornbluh, K., Purit,z S. (2009). Climate Crises, The Quest for Green Growth, Credit Crises, Global Economy and Development. http://www.brookings.edu/reports/2010/0422_climate_change_poverty.aspx, (30 January 2012).

DSI. (2012). General Directorate of State Hydropower Works. Statistics of Turkey Hydropower Plants, http://www.dsi.gov.tr/docs/hizmet-alanlari/enerji.pdf?sfvrsn=2 (7 March 2013).

DTM. (2010). Türkiye'de Enerji Üremi ve Tüketimi. Dış Ticaret Müsteşarlığı, http://www.dtm.gov.tr/dtmadmin/upload/EAD/KonjonkturIzlemeDb/teut.doc, (15 November 2011).

EC, (2009). The impact of renewable energy policy on economic growth and employment in the European Union. European Commission Directorate General, Energy and Transport,

http://ec.europa.eu/energy/renewables/studies/doc/renewables/2009_employ_res_summary.pdf, (20 January 2012).
EMRA. (2011). Electricity Market Regulatory Agency, www.epdk.gov.tr, (15 November 2011).
EMRA. (2013). Electricity Market Regulatory Agency, Electricity Market Licences, http://www.emra.org.tr/tr/web/electricity-market/licenses, (5 March 2013).
Erdoğdu, E. (2007). Regulatory reform in Turkish energy industry: an analysis. Energy Policy 35, 984-993.
Eser, B.Y., Terzi, H. (2008). Türkiye'de İşsizlik Sorunu ve Avrupa İstihdam Stratejisi, Erciyes Üniversitesi, İİBF Dergisi, 30, 229-250.
Hatunoğlu, E.(2010). Biyoyakıt Politikalarının Tarım Sektörüne Etkileri, DPT, Ankara.
IEA. 2010. Energy Policies of IEA Countries: Turkey 2009 Review. OECD/IEA 2010.France.
Kucukali S. , Baris K. (2011). Renewable energy policy in Turkey, World Renewable Energy Congress 2011, 8-13 May 2011, Linköping, Sweden.
MENR, 2011 Ministry of Energy and Natural Resources, General Energy Balance 2010, www.enerji.gov.tr, (29 January 2011).
MENR. (2012). Geothermal, www.enerji.gov.tr, (11 December 2012).
MFA. (2006). Turkey's Energy Strategy 2006, Ministry of Foreign Affairs (MFA), The Republic of Turkey, http://www.econturk.org/Turkisheconomy/energy_turkey.pdf, (4 December 2010).
Moreno, B., Lopez, A.J. (2008). The effect of renewable energy on employment.the case of Austurias (Spain), Renewable and Sustainable Energy Reviews, 12,732-751.
Müller, S., Brown, A., Ölz, S. (2011). Renewable Energy, Policy Considerations for Deploying Renewables, IEA, Information Paper. http://www.iea.org/papers/2011/Renew_Policies.pdf, (2 January 2012).
OECD-FAO. 2011. OECD-FAO Agricultural Outlook 2011-2020, http://www.agri-outlook.org/dataoecd/23/56/48178823.pdf, (29 January 2012).
Onal, E., Yarbay, R.Z., (2010). Türkiye'de Yenilenebilir Enerji Kaynakları Potansiyeli ve Geleceği, İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi, 8(18), 77-96.
Ozkivrak, O. (2005). Electricity restructuring in Turkey. Energy Policy, 33(10), 1339-1350.
Pardwardhan, A. (2011). New Opportunities of green jobs: Creation of green jobs, Indian Institute of Technology, http://www.gggi.org/files/attachment/20111004ADB/green-jobs-korea-october-2011.pdf, (10 February 2012).
PETDER. (2012). Turkish Petroleum Industry Association (PETDER) Sector Report 2011, http://www.petder.org.tr/admin/my_documents/my_files/CC3_PETDERSektorRaporu2011.pdf, (13 March 2013).
PWC. (2012). Turkey's Renewable Energy Sector from a Global Perspective, http://www.pwc.com.tr/tr_TR/tr/publications/industrial/energy/assets/Renewable-report-11-April-2012.pdf, (11 March 2013).
REN21. (2012). Renewables 2012 Global Status Report 2012, REN21 Secretariat, Paris., http://www.theengineer.co.uk/Journals/2012/06/11/r/o/f/RenewableS-2012-GLOBAL-STATUS-REPORT.pdf, (11 March 2013).
Rosen, M.A., Dincer, I. (2001). Exergy as the confluence of energy, environment and sustainable development, Exergy, An International, 1(1), 3–13.
SPO. (2012). State Planning Organization (SPO), Medium Term Program (2013-2015), Main Macroeconomic and Fiscal Targets, Turkey, 2010, www.dpt.gov.tr, (04 March 2013).
TEIAS. (2001). Electricity Production and Transmission Statistics in Turkey, http://www.teias.gov.tr/istatistikler/I.htm, (24 September 2011).
TEIAS. (2011a). Turkish Electricity Production and Transmission Statistics 2011, www.teias.gov.tr. (2 February 2012).
TEIAS. (2011b). Electricity Power Production Projection for Turkish Electrcity Energy 2011-2020, www.teias.gov.tr. (2 February 2012).
TEIAS. (2012). Türkiye Elektrik Enerjisi 10 Yıllık Üretim Kapasite Projeksiyonu 2012-2021, http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx, (4 March 2013).
Tükenmez M., Demireli E. (2012). Renewable energy policy in Turkey with new legal regulations. Renewable Energy, 39, 1-9.

TUREB. (2012). Turkish Wind Statistics Report, Turkish Wind Energy Association (TUREB). http://www.tureb.com.tr, (6 March 2013).

TurkStat. (2010). Turkish Statistical Institute. Demographic Indicators, www.turkstat.gov.tr, (15 October 2011).

TurkStat. (2012a). Foreign Trade by Standard International Trade Classification. www.tuik.gov.tr (10 December 2012).

TurkStat. (2012b). Greenhouse Gases Emission Inventory Period 1990-2011. http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=10829 , (02 October 2012).

TurkStat. (2012c). Economic Indicators 2012. www.tuik.gov.tr (13 March 2013).

TurkStat. (2013a). Turkish Statistical Institute, Population Statistics and Projections. www.turkstat.gov.tr, (15 November 2012).

TurkStat. (2013b). Household Labor Force, 2012, News Release, No:13455, 6 March 2013, http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=13455, (10/03/2013).

UNEP. (2008). Green Jobs: Towards decent work in a sustainable, low-carbon world. Worldwatch Institute. http://www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf, (1 February 2012).

WB. (2011), Gross domestic product 2010, World Bank (WB). http://siteresources.worldbank.org/DATASTATISTICS/Resources/GDP.pdf (3 December 2012).

WB. (2012), Gross domestic product 2011, PPP, World Bank (WB). http://databank.worldbank.org/databank/download/GDP_PPP.pdf (3 December 2012)

Wei M., Patadia S., Kammen D.M. (2010). Putting renewable and energy efficiency to work:How many jobs can the clean energy industry generate in the US?. Energy Policy, 38, 919-931.

Yarbay, R.Z., Güler, A.Ş., Yaman, E. (2011). Renewable Energy Sources and Policies in Turkey, 6 th International Advanced Technologies Symposium (IATS'11), 16-18 May 2011, Elazığ,Turkey. http://web.firat.edu.tr/iats/cd/subjects/Energy/ETE-33.pdf (5 November 2012).

Yilmaz, A.O., Uslu, T. (2007) .Energy Policies of Turkey during the period 1923 – 2003. Energy Policy, Vol.35, p. 258-264.

YPK. (2009). High Planning Council (YPK), Electricity Market and Security of Supply Strategy, http://www.enerji.gov.tr/yayinlar_raporlar/Arz_Guvenligi_Strateji_Belgesi.pdf, (10 November 2011).