Turkish Studies

Volume 14 Issue 6, 2019, p. 3547-3562

DOI: 10.29228/TurkishStudies.36845

ISSN: 1308-2140

Skopje/MACEDONIA-Ankara/TURKEY

INTERNATIONAL
BALKAN
UNIVERSITY

EXCELLENCE FOR THE FUTURE
IBU.EDU.MK

Research Article / Araştırma Makalesi

Article Info / Makale Bilgisi

✍ *Received/Geliş:* 02.09.2019

✓ *Accepted/Kabul:* 15.10.2019

✍ *Report Dates/Rapor Tarihleri:* Referee 1 (20.09.2019)-Referee 2 (18.09.2019)

This article was checked by iThenticate.

TURKEY'S INCENTIVE POLICIES IN ELECTRICITY PRODUCTION

*Hasan YILDIZHAN**

ABSTRACT

The electricity demand of Turkey is increasing rapidly for the last two decades due to the fast industrialization, population growth, urbanization and economic development. For this reason, it is compulsory that Turkey must adopt the most suitable incentive policy for energy resources towards the goal of increasing electricity production amount to meet its demand. In this study, incentives for different energy resources (natural gas assisted thermal power plants, coal assisted thermal power plants, renewable energy resources, nuclear energy) that Turkey adopts in the production of electricity and propositions have been provided. In the study, Turkey's current energy potential has been determined and; these resources' share values and potentials for development have been given within the total energy production. After evaluation, it has been determined that - in order to enable coal assisted thermal power plants' getting developed more and faster compared to other energy resources; giving various incentives and promotion privileges by the public is better. In addition to this, according to the information given in 2015-2019 Strategical Plan of Energy and Natural Resources Ministry; it has been notified that domestic coal usage in the electricity production will increase in the era to come. Incentives given for renewable energy resources in the electricity production are less than the incentives provided for coal assisted thermal power plants and nuclear energy, in proportion. Due to environmental problems and its being a domestic resource, Turkey should increase the incentives it implements for renewable energy resources. Turkey should practise effective incentive policies prioritizing production from its own energy resources. Within this context, it is necessary for Turkey to limit thermal power plants operating on natural gas for the electricity production purpose. Because it is compulsory for Turkey's energy supply security and in terms of foreign trade.

* Dr. Öğr. Üyesi Adana Alparslan Türkeş Bilim ve Teknoloji Üniversitesi, Mühendislik Fakültesi, Enerji Sistemleri Mühendisliği, E-posta: hasanydhn@hotmail.com

STRUCTURED ABSTRACT

The electricity demand of Turkey is increasing rapidly for the last two decades due to the fast industrialization, population growth, urbanization and economic development. No doubt, the energy policies adopted by policy-makers whom we call decision-makers have been shaping the electricity production in Turkey. For this reason, incentive laws for the installation of electricity production facilities, in order for Turkey not to face with problems regarding electricity demand in the years to come have been promulgated, by the policy-makers.

Currently; Turkey is not in a sufficient level in terms of the variety of the resources Turkey uses in electricity production, energy supply security, procuring energy cheaply and attaining the energy from diversified resources. Thus, the purpose of this study is to evaluate current electricity production policies and to indicate the optimum incentive policies Turkey should act.

Turkey's demand of electricity production is ever-increasing. The fact that electricity should be attained from diversified resources without a delay, reliably and cheaply – is a necessity. Currently, Turkey's electricity production supply security, the cost of production, diversification of the resources – compel the electricity generation's sustainability. For this reason, it is compulsory that Turkey must adopt the most suitable incentive policy for energy resources towards the goal of increasing electricity production amount to meet its demand. In this study, incentives for different energy resources (natural gas assisted thermal power plants, coal assisted thermal power plants, renewable energy resources, nuclear energy) that Turkey adopts in the production of electricity and propositions have been provided. In the study, Turkey's current energy potential has been determined and; these resources' share values and potentials for development have been given within the total energy production.

After evaluation, it has been determined that - in order to enable coal assisted thermal power plants' getting developed more and faster compared to other energy resources; giving various incentives and promotion privileges by the public is better. Turkey has started to emphasize domestic resources for the purpose of electricity production. Especially, very big incentives are given for coal power stations. The incentives in question are bigger than other electricity production resources. Turkey is in a very good situation, in terms of lignite coal reserves. But its anthracite coal reserves are little. At the same time, in the power stations using anthracite coal as resource, the performance is better; compared to power stations using lignite coal. The same amount of anthracite coal produces more electricity than that of power stations using same amount of lignite coal. Because the heating value of anthracite coal is much better than that of lignite coal. Turkey can increase the heating value of the lignite coal by prioritizing Research and Development activities towards betterment of the lignite coal. Moreover, it is a necessity for Turkey to make it mandatory for the new coal based power stations to be installed as lignite based power stations. Because Turkey does not have enough anthracite coal reserves, the anthracite coal will be imported for the coal power stations to be installed with anthracite

basis. This situation will pose problems for the sustainability of the electricity production.

Incentives given for renewable energy resources in the electricity production are less than the incentives provided for coal assisted thermal power plants and nuclear energy, in proportion. Due to environmental problems and its being a domestic resource, Turkey should increase the incentives it implements for renewable energy resources. Turkey should practise effective incentive policies prioritizing production from its own energy resources. Within this context, it is necessary for Turkey to limit thermal power plants operating on natural gas for the electricity production purpose. For the electricity production, there exist a foreign-resource dependency. Because a significant percentage of the total electricity production is procured from natural gas power stations. Turkey does not have natural gas resources. For this reason, imported natural gas is used in natural gas power stations. This situation is a problem in terms of energy supply security. At the same time, importing natural gas will pose a problem, also, in terms of cost of production. Because the cost of imported natural gas will increase depending on a change upwards in the currency exchange rates. As a solution, Turkey should provide more incentives for domestic resources for the production of electricity and Turkey should limit natural gas power stations. Such limitations must be done in a way that they should not pose problems for Turkey's electricity demand. So, such limitations must be done in a long period of time.

In Turkey, hydroelectric power stations has a big percentage for the electricity production based on renewable energy resources. Moreover, there has been a considerable increase for the electricity production with the wind power. But Turkey's electricity productions with solar, biomass and geothermal resources are at very low levels. At the same time, the incentives Turkey provides for renewable energy resources are not at a sufficient levels. Especially, these incentives are much less than provided for coal based power stations. Turkey is in a very good state for the potential of the renewable energy resources. Furthermore, the fact that renewable energy resources are clean, cheap and sustainable requires Turkey's allocation of more incentives for these resources. For this, first of all, increase in the fixed guarantee tariff costs is a necessity.

Keywords: Incentive, Turkey, Renewable Energy Resource, Coal, Electricity Production

TÜRKİYE'NİN ELEKTRİK ÜRETİMİNDE TEŞVİK POLİTİKALARI

ÖZ

Hızlı sanayileşme, nüfus artışı, kentleşme ve ekonomik gelişme nedeniyle Türkiye'nin elektrik talebi son yirmi yılda hızla artmaktadır. Bu sebeple Türkiye'nin elektrik üretimi miktarını artırmaya yönelik enerji kaynaklarında en uygun teşvik politikasını uygulaması zorunludur. Bu çalışmada Türkiye'nin farklı enerji kaynakları (doğal gaz destekli termik santralleri, kömür destekli termik santralleri, yenilenebilir enerji kaynakları, nükleer enerji) ile elektrik üretiminde uyguladığı teşvik

politikaları değerlendirilmiş ve öneriler sunulmuştur. Çalışmada Türkiye'nin mevcut enerji potansiyeli ortaya konmuş ve bu enerji kaynaklarının elektrik enerjisi üretimi içindeki payları ve gelişimi verilmiştir. Değerlendirme sonucunda kömür destekli termik santrallere diğer enerji kaynaklarına oranla daha fazla ve hızlı gelişmesini sağlamak amacıyla, kamu tarafından çeşitli yöntemlerle verilen teşvik ve özendirmelemlerin daha iyi olduğu tespit edilmiştir. Buna ek olarak, Enerji ve Tabii Kaynaklar Bakanlığı'nın 2015-2019 Stratejik Planı'nda verilen bilgilere göre, elektrik üretiminde yerli kömür kullanımının önümüzdeki dönemde arttırılacağı belirtilmektedir. Elektrik üretiminde yenilenebilir enerji kaynaklarına verilen teşvikler kömür destekli termik santrallere ve nükleer enerjiye oranla azdır. Hem çevresel sorunlardan dolayı hem de yerli kaynak oluşundan, Türkiye'nin yenilenebilir enerji kaynaklarına uyguladığı teşvikleri arttırması gerekmektedir. Türkiye kendi enerji kaynaklarının üretimine ağırlık veren etkin teşvik politikaları uygulamalıdır. Bu kapsamda Türkiye'nin elektrik üretim maksatlı doğal gaz destekli termik santrallere sınırlama getirmesi gereklidir. Çünkü Türkiye'nin enerji arz güvenirliliği ve dış ticaret açısından zorunludur.

Anahtar Kelimeler: Teşvik, Türkiye, Yenilenebilir Enerji Kaynağı, Kömür, Elektrik Üretimi

1. Introduction

Energy's being reliable, cheap and sufficient is necessary; not only for industrial and transactional development of countries, but also for well-being and welfare of the people of the countries (Acaroglu, 2008). Due to rapid urbanization stemming from young and increasing population of Turkey and its enlarging economy; the electricity demand is rapidly augmenting. For this reason, it is imperative that Turkey execute optimum incentive policy in order to meet Turkey's electricity demand. This situation is important in terms of Turkey's energy supply security, energy dependency and pulling energy costs down.

No doubt, the energy policies adopted by policy-makers whom we call decision-makers have been shaping the electricity production in Turkey. For this reason, incentive laws for the installation of electricity production facilities, in order for Turkey not to face with problems regarding electricity demand in the years to come have been promulgated, by the policy-makers.

Currently; Turkey is not in a sufficient level in terms of the variety of the resources Turkey uses in electricity production, energy supply security, procuring energy cheaply and attaining the energy from diversified resources. Thus, the purpose of this study is to evaluate current electricity production policies and to indicate the optimum incentive policies Turkey should act.

2. World's Electricity Production Outlook

According to the report issued by U.S. Energy Information Administration (EIA, 2013), the electricity produced in the world will reach the capacity of 39.0 trillion kWh hour in the year 2040. In this report also, the distribution of the electricity produced in the world between the years 2010 and 2040 according to the resources is given in Table 1. When Table 1 is analyzed, it is seen that coal is the mostly used resource in the production of electricity in the world and natural gas is the second one. That being said, electricity production from liquid fuels such as petroleum is at low levels. Moreover, electricity production from the liquid resources will gradually fall until the year 2040. On the other hand, due to environmental conditions, there happen leanings towards the electricity productions based on renewable energy resources and nuclear energy. For this reason, there has been a continual increase in electricity

production from these resources, worldwide. Especially, renewable energy resources are increasing more rapidly in the developing countries in the electricity production process.

Table 1: World net electricity generation by energy source, 2010-2040 (trillion kilowatt-hours) (EIA, 2013).

World	2010	2015	2020	2025	2030	2035	2040	Average annual percent change, 2010-2040
Liquids	0.9	0.9	0.8	0.8	0.7	0.7	0.7	-1.0
Natural gas	4.5	5.0	5.5	6.2	7.2	8.3	9.4	2.5
Coal	8.1	9.2	10.1	11.3	12.3	13.2	13.9	1.8
Nuclear	2.6	2.9	3.6	4.3	4.8	5.1	5.5	2.5
Renewables	4.2	5.3	6.5	7.2	7.9	8.8	9.6	2.8

The distribution of the those used from the renewable energy resources is given in Table 2. Currently, the hydrolic resources among the renewable resources are the most frequently used type in the electricity production worldwide. This situation will continue until the year 2040. Electricity production with the wind energy ranks second amongst the renewable energy resources.

Table 2: World net renewable electricity generation by energy source, 2010-2040 (billion kilowatthours) (EIA, 2013).

World	2010	2015	2020	2025	2030	2035	2040	Average annual percent change, 2010-2040
Hydroelectric	3,402	3,805	4,452	4,762	5,177	5,692	6,232	2.0
Wind	342	767	1,136	1,383	1,544	1,694	1,839	5.8
Geothermal	66	112	133	146	171	195	220	4.1
Solar	34	157	240	288	327	394	452	9.1
Other	332	427	549	643	729	800	858	3.2

According to the data provided by International Energy Agency (IEA), approximately % 40 percent of the electricity generated in the world is procured from China and USA (IEA, 2014). Furthermore, the country which generates the most electricity is China and than USA. In China, the resource which has the largest share in the production of electricity is the coal. Other countries having the largest share in the production of electricity with coal are USA, India and Germany. On the other hand, the country which has the largest share in the electricity production with natural gas is Russia. The country which meets most of its electricity demand with nuclear power stations is France. Sweden, Canada, Brazil and Norway are the countries which meet their electricity production demands' largest share with hydrolic power plants.

3. Turkey's Electricity Energy Outlook

According to the data of Energy and Natural Resources Ministry (ENRM), Turkey's electricity production is 250,4 billion kWh and consumption is 255,5 billion kWh in 2014 (ENRM, 2015a). In parallel with the high economic enlargement ratio of Turkey in recent years, annual electricity energy consumption increase ratio has occurred at around the levels of % 5,59 approximately in the last 11 years - and the electricity consumption which was 150 billion kWh in the year 2004 increased 1,70 times in the year 2014 and reached 255,5 billion kWh. At the same time; due to the economic crisis in 2009 (Table 3).

Table 3: Electricity Energy Outlook of Turkey (GWh) (ENRM, 2015a).

YEAR	PRODUCTION	IMPORT	EXPORT	CONSUMPTION	Production Increase Ratio	Consumption Increase Ratio
2004	150.698	464	1.144	150.018	7,2%	6,3%
2005	161.956	636	1.798	160.794	7,5%	7,2%
2006	176.300	573	2.236	174.637	8,9%	8,6%
2007	191.558	864	2.422	190.000	8,7%	8,8%
2008	198.418	789	1.122	198.085	3,6%	4,3%
2009	194.813	812	1.546	194.079	-1,8%	-2,0%
2010	211.208	1.144	1.918	210.434	8,4%	8,4%
2011	229.395	4.556	3.645	230.306	8,6%	9,4%
2012	239.497	5.826	2.954	242.370	4,4%	5,2%
2013	240.154	7.429	1.227	246.357	0,3%	1,6%
2014	250.435	7.805	2.696	255.545	4,3%	3,7%

3.1. Production of Electricity Energy

Turkey's electricity production in 2014 was 250.435 GWh; 199.404 GWh of it was attained from thermal power plants; 40.396 GWh from hydro-electric power plants and 10.635 GWh from other renewable energy resources (Table 4). Significant increases in electricity production from the renewable energy resources have been observed since the year 2009. Of renewable energy sources the geothermal and wind energy based electricity production increased 70 times since 2004. The 151 GWh energy produced in 2004 reached 10.635 GWh levels. While the electricity energy produced in 2004 from thermal power plants was 104.464 GWh ; this amount rose to 199.404 GWh in 2014.

Table 4: Turkey's Electricity Energy Production Based On Resources (GWh) (ENRM, 2015a).

YEAR	THERMAL	HYDROLIC	GEOTHERMAL + WIND	TOTAL	INCREASE (%)
2004	104.464	46.084	151	150.698	7,2%
2005	122.242	39.561	153	161.956	7,5%
2006	131.835	44.244	221	176.300	8,9%
2007	155.196	35.851	511	191.558	8,7%
2008	164.139	33.270	1.009	198.418	3,6%
2009	156.923	35.958	1.931	194.813	-1,8%
2010	155.828	51.796	3.585	211.208	8,4%
2011	171.638	52.339	5.418	229.395	8,6%
2012	174.872	57.865	6.760	239.497	4,4%
2013	171.812	59.420	8.921	240.154	0,3%
2014	199.404	40.396	10.635	250.435	4,3%
RATIO (2014)	79,6%	16,1%	4,2%	100%	-

As seen in Table 5, 79,6 percent of the electricity production of Turkey was attained from thermal power plants; 16,1 percent from hydrolic power plants and 4,3 percent from the other renewable energy resources. During the period 2004-2014; while the percentages of electricity production from thermal and hydrolic resources in comparison with the current ratios did not change much; the ratio of geothermal and wind based electricity production was %0,1 in 2004 and this amount rose 4,2 percent in 2014.

Table 5: Turkey's Electricity Energy Production Ratios Based On Resources (ENRM, 2015a).

YEAR	THERMAL	HYDROLIC	GEOTHERMAL + WIND
2004	69,3%	30,6%	0,1%
2005	75,5%	24,4%	0,1%
2006	74,8%	25,1%	0,1%
2007	81,0%	18,7%	0,3%
2008	82,7%	16,8%	0,5%
2009	80,6%	18,5%	1,0%
2010	73,8%	24,5%	1,7%
2011	74,8%	22,8%	2,4%
2012	73,0%	24,2%	2,8%
2013	71,5%	24,7%	3,7%
2014	79,6%	16,1%	4,2%

3.2. Electricity Installed Power Capacity

According to Table 6, Turkey's electricity installed power capacity was 36.824 MW in the year 2004 and 69.520 MW in 2014. Turkey's current installed power capacity is made of %34,6 from hydrolic resources, % 30,5 from natural gas, %20,8 from coal, % 5,3 from wind and % 8,2 from other resources..

Table 6: Turkey Electricity Installed Power Capacity (MW) (ENRM, 2015a).

YEAR	THERMAL			Hydrolic	Wind	Geothermal	Solar	Total	Increase (%)
	Coal	Natural Gas	Other						
2004	8.296	11.349	4.500	12.645	18,9	15	-	36.824	3,5
2005	9.117	12.275	4.487	12.906	20,1	15	-	38.820	5,4
2006	10.197	12.641	4.520	13.063	59	23	-	40.502	4,3
2007	10.097	12.853	4.322	13.395	146,3	23	-	40.836	0,8
2008	10.095	13.428	4.072	13.829	363,65	29,8	-	41.817	2,4
2009	10.501	14.555	4.284	14.553	791,6	77,2	-	44.761	7,0
2010	11.891	16.112	4.276	15.831	1.320	94,2	-	49.524	10,6
2011	12.491	16.003	5.438	17.137	1.729	114,2	-	52.911	6,8
2012	12.530	17.162	5.337	19.620	2.261	162,2	-	57.072	7,9
2013	12.428	20.253	5.967	22.289	2.760	310,8	-	64.007	12,2
2014	14.636	21.474	5.692	23.643	3.630	404,9	40,2	69.520	8,6
RATIO	20,8%	30,5%	8,2%	34,6%	5,3%	0,6%	0,09%	100%	-

In Table 7, the ratios of Turkey's electricity installed power capacity are given. Turkey's total electricity energy installed power capacity for the year 2004, hydrolic resources rank first with the share of 34,3 percentage, it is followed by natural gas with the share of % 30,8 percentage, and coal follows them with the share of %22,5 and geothermal + wind resources follow them with the percentage of % 0,1 share. The remaining 12,2 percentage is attained from other resources. When we do a similar evaluation for the 2014, the resources' quantitive rank for Turkey's installed power capacity do not change. The only change is the increasing of geothermal+wind+solar capacity from 0,1% to 5,9%. During 2004-2014 period, the largest increase ratio is observed in wind and geothermal based installed power capacity percentage. Moreover, the solar based installed power capacity's starting its operating and the private sector's preparation for big investments in this field is important for Turkey's security of supply and diversifying the resources.

Table 7: The Ratios of Electricity Installed Power Capacity of Turkey (ENRM, 2015a).

YEAR	THERMAL			HYDROLIC	GEOTHERMAL + WIND + SOLAR
	Coal	Natural Gas	Other		
2004	22,5%	30,8%	12,2%	34,3%	0,1%
2005	23,5%	31,6%	11,6%	33,2%	0,1%
2006	25,2%	31,2%	11,2%	32,3%	0,2%
2007	24,7%	31,5%	10,6%	32,8%	0,4%
2008	24,1%	32,1%	9,7%	33,1%	0,9%
2009	23,5%	32,5%	9,6%	32,5%	1,9%
2010	24,0%	32,5%	8,6%	32,0%	2,9%
2011	23,6%	30,2%	10,3%	32,4%	3,5%
2012	22,0%	30,1%	9,4%	34,4%	4,2%
2013	19,6%	31,6%	9,2%	34,8%	4,8%
2014	21,1%	30,9%	8,2%	34,0%	5,9%

4. National Strategy Plan

Turkey's Energy and Natural Resources Ministry has prepared a strategical planning to be followed in the field of energy, within the 5 year period (2015-2019) (ENRM, 2015b). The strategical planning concerns about Turkey's strategies and initiatives in energy policies; and it has the property of supporting national economical goals.

The amount of %98,5 of the natural gas consumed in Turkey is supplied from foreign resources. For this reason, a significant foreign-sourced dependency for natural gas is a fact. At the same time, most of the electricity generated in Turkey is attained from natural gas. Therefore, it has been notified in the strategical plan that the electricity production manner based on natural gas carries a significant risk. In the strategical planning, it has been indicated that the percentage of the electricity production based on natural gas will be decreased. In this context, until the end of 2019, it has been aimed at that the percentage of the electricity production based on natural gas in the total production will be diminished to %38.

Turkey has great potential for the electricity production from the renewable energy resources such as solar energy, wind, hydroelectric, geothermal and biomass resources. This potential is very significant in terms of Turkey's actualizing its diversifying the resources in electricity energy production, the effective utilization of the resources and decreasing the foreign-sourced dependency. Because the effective use of the resources such as hydroelectric, wind, solar, geothermal, biomass and wave that Turkey has, and their effective utilization for the economy – have strategical significance in terms of enabling the diversification of the resources. For this reason, within the “Strategical Plan”, increasing the percentage the renewable resources in the electricity energy production has been aimed.

Availing from the domestic coal resources, Turkey has in an effective manner - has been set as one of the fundamental targets; and it has been aimed at that with the investments to be done, until the end of the strategical plan era (2015-2019), the 60 billion kWh of production level will be reached in the electricity energy production based on domestic coal. In order to reach this target, there exist the accelerate of these investments and the prospection of new coal fields - as goals. To accomplish these, it has been indicated in the strategical planning that there will be improvements that will lead an increase in the production in the electricity energy generation power plants operating with the current coal reserves under the responsibility of public and private sector and there will be modernisation projects to be achieved.

In the strategical planning, it has been indicated that nuclear energy will be included to the electricity energy production portfolio in the year 2018. Within this context, Akkuyu NGS (natural gas station) is expected to start electricity energy production (test generation) on 31.12.2018. Also, it is aimed that the construction for Sinop NGS is to start on 31.12.2018. It has been notified in the strategical planning that the exploration and prospection for domestic uranium and thorium resources to be used as fuel at nuclear power plants will be attained.

On the other hand, "Strategical Document for Electricity Energy Market and Supply Security" adopted by Turkish Republic Prime Ministry State Planning Organisation High Planning Council with the decree dated 18.05.2009 and numbered 2009-11 was promulgated (ENRM, 2009). With the document in question, it has been set as a prioritized goal that the percentage of domestic resources in the electricity energy generation should be increased. Within this framework, it has been aimed that the percentage of renewable energy resources in the electricity energy generation in the year 2023 should be at least %30. At the same time, it has been notified that all of all known lignite and anthracite coal resources will be availed until 2023 for the purpose of electricity energy generation. Within the same document, it has been aimed that the percentage of natural gas in the electricity generation will be reduced under %30. Moreover, it has been aimed that the percentage of electricity generation from nuclear power stations in the total electricity production will reach at least % 5 until 2020 and on the long run, more capacity is expected.

5. Energy Resources and Reserves of Turkey

Turkey's primarily energy resources are the coal and renewable energy resources. Furthermore, Turkey has a good potential for the ore of thorium which is used as raw material in nuclear energy power stations. In addition to this, it is important for Turkey to avail its primary energy resources sufficiently, due to the increases in the electricity generation costs.

5.1. Coal

According to the data of Turkish General Directorate of Mineral Research and Exploration (MTA), proved coal reserves are around 14 430 000 000 tons. Most of these reserves (13 300 000 000 ton) is comprised of lignite (MTA, 2015). The remaining proved reserves are comprised of (1 130 000 000 ton) anthracite coal. In Turkey, the electricity generation coal-based power stations use both anthracite coal and lignite. While the fuel needs lignite based power stations are met from domestic resources, frequently the fuel needs of the power stations using anthracite coal are met from imported coals. On the other hand, the heating value of the lignite is lower than anthracite coal (Acar, et al., 2015). For this reason, the electricity generation potentials of the power stations using anthracite coal is better than that of using lignite (Yildizhan, 2017).

5.2. Natural gas

Turkey is a country which imports almost %95 of the natural gas. According to the data of Turkey General Directorate For Petroleum Affairs (TGDPA), Turkey's natural gas reserves are 24 359 724 923 m³, as of the end of the year 2013 (TGDPA, 2013). That being said, the amount of natural gas produced in 2013 is 561 million m³. Turkey's total consumption exceeded the 45 billion m³ level as of 2012. Moreover, when the distribution ratios for natural gas consumption of the year 2012 are investigated, the biggest percentage belongs to natural gas used in the electricity generation with the ratio of % 48 (TGDPA, 2015). On the other hand, in line with the observations of International Energy Agency, whether the targets of climate change are decisive or flexible, it has been predicted that the share of electricity in natural gas consumption worldwide will increase in all policy scenarios (IEA, 2012).

5.3. Hydroelectric

Hydroelectric resources have an important place among Turkey's renewable energy resources. Because among the renewable resources of Turkey, with the hydrolic resources the most electricity production is made. According to General Directorate of Electric Power Resources Survey And Development Administration (EİE), in Turkey, theoretical hydroelectric potential is 433 billion kWh, and technically assessable potential is 216 billion kWh. Economical hydroelectric energy potential is 140 billion kWh/year (EİE, 2015). That being said, according to the data given by Turkish General Directorate Of State Hydraulic Works (DSİ), there are 303 hydroelectric power stations which are in operation and their total installed power capacity is 17.372 MW, their average annual production is 62.000 GWh and this value corresponds to % 28,7 of the total technical potential (DSİ, 2015).

5.4. Wind

Turkey has important wind potential due to the climate traits it has (Erdoğan, 2009). In addition to this, the wind power potential in Turkey varies between the regions depending on wind speed and continuity of the wind. Atlas for Turkey's Wind Potential (REPA) has been prepared by General Directorate of Electric Power Resources Survey and Development Administration (EİE). In the light of these works, when the wind energy potential wind speed that can produce electricity is calculated with the values 7,0 m/sn or above; sea capacity is thought to be 10.463 MW and land capacity is thought to be 37.386 MW and total capacity is thought to be 47.849 MW (YEGM, 2013). According to REPA, the coasts of Aegean and Marmara regions are the areas with the best wind potential.

5.5. Solar energy

According to Solar Energy Potential Atlas of Turkey (GEPA) prepared by The General Directorate of Renewable Energy, it has been determined that the annual sunshine time is 2.737 hours (a total of 7,5 hours per day), the total annual solar energy is 1.527 kWh/m².year (a total of 4,2 kWh/m² per day) (EİE, 2010; Yildizhan and Sivrioğlu, 2015).

5.6. Geothermal energy

According to the data of Turkish General Directorate of Electric Power Resources Survey and Development Administration; Turkey's geothermal energy potential is 31 500 MW. That being said, West Anatolia has the largest geothermal potential (% 79). Central Anatolia follows it (% 8,5) , Marmara region follows it (% 7,5) ; East Anatolia follows it (% 4,5) and other regions follow with the ratio of % 0,5 (EİE, 2016). % 94 of geothermal resources in Turkey are at low or middle level heat and these resources are suitable for direct applications (heating, thermal tourism, gaining minerals etc) and % 6 of the geothermal resources are suitable for indirect applications (electricity energy generation) (Koçak, 2001; Korkmaz, et al., 2009). Total geothermal electricity production potential in the country is 640 MW and 162,2 MW (of the year 2012) of this potential is in the state of being operated (Yılmaz, 2012). Turkey ranks 12th place in the world in terms of electricity energy production from geothermal energy (GEA, 2013).

5.7. Biomass

All natural substances the main constituents of which are carbohydrates components with plant or animal basis are defined as biomass energy resource; and the energy attained from these resources is defined as biomass energy (Acaroglu, 2008). Biomass energy turns into energy sources such as biogas, bioethanol, biodiesel, biomenthanol, biodimetiler, biooil through the applications in modern sense (Akova, 2008). Biomass Potential Atlas (BEPA) has been prepared by Renewable Energy General Directorate. With this study, Turkey's biomass potential has been published as resource basis TEP/year. The data of this study is shown in Table 8. As seen in the table, the highest potential belongs to vegetative based waste resources (BEPA, 2015).

Table 8: Turkey's Biomass Potential on the Basis of Resources (BEPA, 2015).

Resource	Potential (TEP/year)
Energy Value of Animal Wastes	1.323.714
Energy Equivalent Value of Vegetative Wastes	15.941.321
Energy Values of Urban Organic Wastes	2.186.228
Energy Value of Forestry Wastes	855. 805
Total	20.307.069

5.8. Nuclear

Nuclear energy has a big role for diminishing the greenhouse gas in the atmosphere which causes climate change (EIE, 2017). That being said, very great electricity energy has been attained from nuclear power plants. For this reason, especially developed countries procure most of their electricity energy needs from nuclear energy. Nuclear power stations are the power stations which produce electricity by using the heat generated through nuclear energy reaction. Thorium and uranium are the minerals for nuclear energy production. The mineral most prevalently used as the raw material for nuclear energy is uranium. Because in terms of nuclear energy production, the energy attained from the thorium is more expensive than uranium and the technological processes involving thorium are harder. For this reason, thorium is used in energy production after some technological processes (Temurçin, and Aliagaoglu, 2003). According to the data given by Turkish Directorate of Mineral Research and Exploration; Turkey's thorium reserve is 380,000 ton and uranium reserve is 9,129 ton (MTA, 2015). Turkey does not have enough uranium reserves for nuclear power stations. But in terms of thorium reserve, it has the richest reserve of the world.

6. Incentives

Turkey provides incentives towards the electricity production facilities in order to meet its ever-increasing electricity demand and energy supply security. Provided incentives vary depending on the electricity production resource.

6.1. Incentive for Electricity Generation Based on Natural Gas

Electricity production based on natural gas was classified among the investments which will never be incentivized in no way with the 2012/3305 numbered decree of Turkish Republic's Council of Ministers. But with the 15/02/2013 dated and 2013/4288 numbered decree of the Council of Ministers, a privilege was attested to this. According to this change, the electricity production investments based on natural gas which gained their licences from the Energy Market Supervision Institute (EMSI) before the date 19/06/2012 – have been included in the general incentive system (EMSI, 2015). General incentive system is one of the incentive applications related to the supporting of the investments carried out by Turkish Republic Economy Ministry. For the investments covered by the general incentive system, Customs Tarrif Exemption and VAT Exemption – are provided (INVEST, 2015a).

6.2. Incentive For Electricity Production Based on Coal

Turkey has been divided into 6 regions according to the regional investment incentive applications carried out by the Economy Ministry. Within the scope of regional investment incentive applications, Turkey has been divided into 6 different economy regions, in terms of status of economical development. Among the regions divided into 6, the highest incentives have been prepared for the 6th region.

That being said, with the decree of Council of Ministers numbered 2013/4288 which was promulgated and published in the Official Gazette on the date 15 February 2013 with the number 28560, which has been in effect – investments of electricity production based on coal have been included among prioritized investment affairs. Thus, the investment for electricity production based on coal will be

applied the ratio of 5th Region incentive – no matter at which region the investment is done. The incentives of 5th Region are as follows: Customs tax exemption, VAT exemption, tax decrease, support for the employer about the insurance premium, allocation of investment area, and interest assist. Moreover, alongside these incentives, in case that the investment for the electricity production based on coal is done in the 6th region, in addition to other incentives; the income tax withholding support and insurance premium assistance will be provided (INVEST, 2015b). Thus, for the investors who will invest in electricity production based on coal – significant assistance conditions to be availed have been provided.

6.3. Incentive for electricity production based on nuclear energy

Turkey pursues the goal of installing Nuclear Energy Power Plants in order to enable its resource diversification in electricity production, and due to energy supply security. Currently, there are two obvious nuclear power station projects. The first of the nuclear power station projects is the agreement with Russia. According to the international agreement signed between Turkish and Russian governments; it has been planned that in the Mersin Akkuyu region, nuclear energy power stations made up 4 units totally will be installed. With the project, the construction of which is continuing; the nuclear energy power stations will generate 40 billion kWh electricity with approximately 4,800 MW installed power capacity. With the nuclear energy power station in question, according to the electricity purchase agreement; Turkey guaranteed to buy electricity to be produced from the nuclear power station from the ratio of 12.35 USA cent/kWh (excluding Value Added Tax) for 15 years (Official Gazette, 2015a).

Turkey planned its second nuclear energy power station project with Japan. The nuclear energy power stations project to be done by Japan will be constructed on the peninsula of Inceburun in Sinop. The nuclear energy power stations to be built at Inceburun, Sinop – will be made up with 4 units and will have 4,800 MW installed power capacity. Furthermore, after sinop nuclear energy power station will be installed, in line with the electricity purchase agreement, Turkey guaranteed to buy the electricity to be produced from the rate of 10.83 USA cent/kWh (excluding the VAT) for 20 years (Official Gazette, 2015b). Fuel costs are not part of this tariff. When the fuel cost is evaluated from the rate of 1 USA cent/kWh (excluding VAT), Turkey will pay 11.83 USA cent/kWh (excluding VAT) for 20 years for the electricity to be produced from the Sinop nuclear energy power stations.

6.4. Incentive for electricity production based on renewable energy

Turkey has been incentivizing electricity production from renewable resources, since 2005, with the laws it introduced. The mechanism for electricity production from renewable resources – has been updated with the decree of Council of Ministers. With the decree of the Council of Ministers YEK – has the authority for the determining the cost, durations and sources to be implemented for the documented production facilities, in line with the law. Council of Ministers has decided by using its authority – with the 18 November 2013 dated and 2013/5625 mubered decree - for the implementation of the costs in Table 9 for 10 years duration; for YEK documented production facilities with licence, which are subjected to YEK support mechanism that will be put into operation from the date 1 January 2016 until 31 December 2020 (Official Gazette, 2015c).

Table 9: Incentives provided for electricity production based on renewable energy resources (Official Gazette, 2015c).

Production Facility Type Based on Renewable Energy Resource	Fixed Costs to be applied (USA Dollar Cent/kWh)	Duration of Guarrante (Year)
a. Hydroelectric production facility	7,3	10
b. Production facility based on wind power	7,3	10
c. Production facility based on geothermal energy	10,5	10
d. Production facility based on biomass (including waste gas)	13,3	10
e. Production facility based on solar energy	13,3	10

When the domestic equipments and machinery tools for YEK facilities in question are installed (production occurring within country), additional support in the amount ranging between 0,4 and 2,4 USA cent/kWh are given, in addition to the amounts given in Table 9.

7. Conclusions and Policy Implications

Turkey's demand of electricity production is ever-increasing. The fact that electricity should be attained from diversified resources without a delay, reliably and cheaply – is a necessity. Currently, Turkey's electricity production supply security, the cost of production, diversification of the resources – compel the electricity generation's sustainability. For this reason, without being late, Turkey is expected to do the required amendments in the electricity production incentives.

For the electricity production, there exist a foreign-resource dependency. Because a significant percentage of the total electricity production is procured from natural gas power stations. Turkey does not have natural gas resources. For this reason, imported natural gas is used in natural gas power stations. This situation is a problem in terms of energy supply security. At the same time, importing natural gas will pose a problem, also, in terms of cost of production. Because the cost of imported natural gas will increase depending on a change upwards in the currency exchange rates. As a solution, Turkey should provide more incentives for domestic resources for the production of electricity and Turkey should limit natural gas power stations. Such limitations must be done in a way that they should not pose problems for Turkey's electricity demand. So, such limitations must be done in a long period of time.

Turkey has started to emphasize domestic resources for the purpose of electricity production. Especially, very big incentives are given for coal power stations. The incentives in question are bigger than other electricity production resources. Turkey is in a very good situation, in terms of lignite coal reserves. But its anthracite coal reserves are little. At the same time, in the power stations using anthracite coal as resource, the performance is better; compared to power stations using lignite coal. The same amount of anthracite coal produces more electricity than that of power stations using same amount of lignite coal. Because the heating value of anthracite coal is much better than that of lignite coal. Turkey can increase the heating value of the lignite coal by prioritizing Research and Development activities towards betterment of the lignite coal. Moreover, it is a necessity for Turkey to make it mandatory for the new coal based power stations to be installed as lignite based power stations. Because Turkey does not have enough anthracite coal reserves, the anthracite coal will be imported for the coal power stations to be installed with anthracite basis. This situation will pose problems for the sustainability of the electricity production.

In Turkey, hydroelectric power stations has a big percentage for the electricity production based on renewable energy resources. Moreover, there has been a considerable increase for the electricity production with the wind power. But Turkey's electricity productions with solar, biomass and geothermal resources are at very low levels. At the same time, the incentives Turkey provides for renewable energy resources are not at a sufficient levels. Especially, these incentives are much less than

provided for coal based power stations. Turkey is in a very good state for the potential of the renewable energy resources. Furthermore, the fact that renewable energy resources are clean, cheap and sustainable requires Turkey's allocation of more incentives for these resources. For this, first of all, increase in the fixed guarantee tariff costs is a necessity.

Turkey has been developing nuclear energy projects in order to attain its energy supply security and resource diversification. Currently, Turkey, separately, has concrete nuclear power stations projects with Russia and Japan. Especially, much progress has been accomplished for the Mersin Akkuyu nuclear power station that will be installed with Russia. That being said, Turkey is not in a good situation for the uranium reserve that is used as fuel at nuclear power stations. But it is in good situation for thorium reserves. Turkey must develop projects for the nuclear fuel production, in the long run. This situation is important for the sustainable energy production from the nuclear power stations.

REFERENCES

- Acar, S. Kitson L. and Bridle, R. (2015). Incentives for Coal and Renewable Energy in Turkey, Published by the International Institute for Sustainable Development.
- Acaroglu M. (2008). Biomass, Bioethanol and Biodiesel Resources in Turkey and Future of Biofuel Energy, 7th National Clean Energy Symposium, UTES 2008, 351-362, 17-19 December 2008, Istanbul.
- Akova, I. (2008). Renewable Energy Resources, Nobel Publications No:1229, Ankara.
- BEPA (2015). Renewable Energy General Directorate, Biomass Potential Atlas (BEPA), http://www.eie.gov.tr/yenilenebilir/tur_tar_biyo_pot.aspx, (Access date: 14.08.2015).
- DSİ (2015). General Directorate for State Hydraulic Works (DSİ), Turkey's Hydroelectric Potential, <http://www.dsi.gov.tr/docs/hizmet-alanlari/enerji.pdf?sfvrsn=2>, (Access date: 01.09.2015).
- EIA (2013). Energy Information Administration, International Energy Outlook, U.S.
- EIE (2010). Solar Energy Potential Atlas (GEPA), 30 November 2010. <http://repa.eie.gov.tr/MyCalculator/Default.aspx>.
- EIE (2015). General Directorate of Electric Power Resources Survey and Development Administration, Turkey's Hydroelectric Potential, http://www.eie.gov.tr/yenilenebilir/h_turkiye_potansiyel.aspx, (Access date: 01.09.2015).
- EIE (2016). Turkish General Directorate of Electric Power Resources Survey and Development Administration, Turkey's Geothermal Energy Potential, http://www.eie.gov.tr/yenilenebilir/turkiyede_jeo.aspx, (20.08.2016).
- EIE (2017). Nuclear power stations to be installed in Turkey, <http://www.enerji.gov.tr/File/?path=ROOT/1/Documents/Sayfalar> (Access date: 15.09.2017).
- EMSI (2015). Deloitte, Tax issues inherent to electricity market, sectorial tax guides serial, February 2015.
- ENRM (2009). Turkish Republic Prime Ministry State Planning Organisation, Electricity Energy Market and Supply Security Strategy Document, 18.05.2009 dated and 2009-11 numbered document.

- ENRM (2015a). Turkish Republic Energy and Natural Resources Ministry Strategy Development Presidency, Outlook for the Natural Resources of the World and Our Country, Issue: 08, 1 April 2015.
- ENRM, (2015b). Turkish Republic Energy and Natural Resources Ministry, 2015-2019 Strategical Plan, www.enerji.gov.tr (Access date: 11.09.2015).
- Erdoğan, E. (2009). On the wind energy in Turkey, *Renewable and Sustainable Energy Reviews*, (13):1361-1371.
- GEA (2013). Geothermal power: International market overview 2013, <http://geo-energy.org/events/2013%20International%20Report%20Final.pdf> (Access date: 02.09.2013).
- IEA (2012). *World Energy Outlook 2012*, International Energy Agency.
- IEA (2014). *International Energy Agency, Key World Energy Statistics*.
- INVEST (2015a). Turkish Republic Prime Ministry Turkey Investment Support and Introduction Agency, Incentives, <http://www.invest.gov.tr/tr-TR/investmentguide/investorsguide/Pages/Incentives.aspx> (Access date: 07.09.2015).
- INVEST (2015b). Turkish Republic Prime Ministry Turkey Investment Support and Introduction Agency, Incentives, <http://www.invest.gov.tr/tr-TR/investmentguide/investorsguide/Pages/Incentives.aspx> (Access date: 07.09.2015).
- Khor, C.S., Lalchand, G. (2014). A review on sustainable power generation in Malaysia to 2030: Historical perspective, current assessment, and future strategies, *Renewable and Sustainable Energy Reviews* 29, 952–960.
- Kocak, A. (2001). Geothermal Energy Explorations in Turkey and Turkey's Potential, 3rd TMMOB Energy Symposium, 217-232, 5-7 December 2001, Ankara.
- Korkmaz Basel, E.D., Satman, A. ve Serpen, Ü. (2009). Turkey's Geothermal Energy Potential, TMMOB Geothermal Congress, 41-53, 23 - 25 December 2009, Ankara.
- MTA (2015). General Directorate for Mineral Research and Exploration, Turkey's Mineral Reserves, http://www.mta.gov.tr/v2.0/default.php?id=maden_rezervleri&m=5 (Access date: 31.08.2015).
- MTA (2015). Turkey's mineral reserves, <http://www.mta.gov.tr/v2.0/default.php?id=madenrezervleri&m=5> (Access date: 15.09.2015).
- Official Gazette (2015a). International agreement text between Turkey and Russia, <http://www.resmigazete.gov.tr/eskiler/2010/10/20101006-6.htm>, (Access date: 08.09.2015).
- Official Gazette (2015b). International agreement text between Turkey and Japan, <http://www.resmigazete.gov.tr/eskiler/2015/05/20150523-1-1.pdf> (Access date: 08.09.2015).
- Official Gazette (2015c). Regulations of electricity production based on renewable energy resources, <http://www.resmigazete.gov.tr/eskiler/2011/01/20110108-3.htm> (Access date: 09.09.2015).
- Temurçin, K., Aliagaoglu, A. (2003). Nuclear energy truth in Turkey in line with nuclear energy and discussions. *Geographical Sciences Journal*, 1(2), 25-29.
- TGDPA (2013). *Natural Gas Market Sector Report*, Turkish Republic Energy Market Regulatory Authority Natural Gas Market Department, Ankara, 2013.

-
- TGDPA (2015). Statistics for Petroleum and Natural Gas Exploration and Production, Turkish Republic General Directorate of Petroleum Affairs, <http://www.pigm.gov.tr/index.php/istatistikler> (Access date: 29.08.2015).
- YEGM (2013). Turkey's Wind Potential, <http://www.eie.gov.tr/yenilenebilir/ruzgar.aspx>, (Access date:10.10.2013).
- Yildizhan, H. (2017). Incentive Policies For Coal Plants In Turkey. *Thermal Science*, 21(5), 1917-1924.
- Yildizhan, H., Sivrioğlu, M. (2015). Solar Energy Policies Of Turkey. *Solar Conference & Exhibition 19-21 November 2014*, Publication year 2015, Pages 236-240.
- Yilmaz, M. (2012). Turkey's Energy Potential and Importance of Renewable Energy Resources In Terms Of Electricity Production. *Ecology Journal*, 4(2), 33-54.