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A REVIEW ON DEVELOPMENT OF RENEWABLE ENERGY SECTOR IN TURKEY IN LIGHT OF PUBLIC POLICIES AND EVALUATION OF YEKDEM MECHANISM EFFECTIVENESS

Master Thesis

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ABSTRACT

A REVIEW ON DEVELOPMENT OF RENEWABLE ENERGY SECTOR IN TURKEY IN LIGHT OF PUBLIC POLICIES AND EVALUATION OF YEKDEM MECHANISM EFFECTIVENESS

Kutay Ayberk ÇUN

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Energy consumption in the world increases every year in parallel with the increasing world population. Today, there is an increase in the demand for energy and electricity in parallel with the world. In order to meet this increase in demand, significant investments are being made in the world and in our country regarding energy production. In recent years, renewable energy sources are the major part of these investments in line with the two issues on the agenda of the world; global warming and air pollution.

Turkey needs all manner of resources for a rapidly growing economic position. Because of the restricted domestic reserves, the public sector is undertaking various studies on the stability of the deficit in our country's current account balance, which is dependent on external resources ever though we are close to fossil fuels, because of the geopolitical challenges in these areas, energy supply is one of the most difficult issues for our country.

In this study, information about energy types and renewable energy is given. Been analyzed historical reasons for the steps taken towards renewable energy in the world, and investments in renewable energy sources and due to this investment in world and the production figures presented in the perspective of Turkey were discussed.

Examined the formation of the electricity market since the 1980s-1990s years in Turkey, with development taking place in the electricity market in the world long-term action plans to be made within the framework of Turkey's energy policies are discussed, action plans and impact of the supporting mechanisms were assessed in general terms.

In the last part of the study, the effects of the Renewable Energy Support Mechanism (YEKDEM), which plays an important role in the rapidly increasing renewable energy investments in our country, are examined and their contribution is revealed. The variables that were analyzed were subjected to ADF unit root test first, then cointegration test, Granger causality test were made with stationary series and correlation matrix was formed. In the light of the results, the effects of YEKDEM incentive have been examined.

Key words: Climate Change, Kyoto Protocol, Paris Agreement, Renewable Energy, YEKDEM.

ÖZET

KAMU UYGULAMALARI IŞIĞINDA TÜRKİYE'DEKİ YENİLENEBİLİR ENERJİ SEKTÖRÜNÜN GELİŞİMİ ÜZERİNE İNCELEME VE YEKDEM UYGULAMASININ ETKİNLİĞİNİN DEĞERLENDİRİLMESİ

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Dünya üzerindeki enerji tüketimi artan Dünya nüfusuna paralel olarak her geçen yıl artmaktadır. Bugün ülkemizde de Dünya ile paralel enerji ve elektrik talebinde artış gözlenmektedir. Söz konusu talep artışını karşılamak için Dünya genelinde ve ülkemizde enerji üretimine ilişkin önemli yatırımlar yapılmaktadır. Geçtiğimiz yıllarda küresel ısınma ve hava kirliliği gibi Dünya'nın gündeminde olan iki konu paralelinde de bu yatırımların büyük bir bölümünü yenilenebilir enerji kaynakları oluşturmaktadır.

Türkiye, hızla büyüyen bir ekonomik konum için her türlü enerji kaynağına ihtiyaç duymaktadır. Yetersiz enerji rezervleri sebebiyle devlet, cari işlemler dengesindeki dış kaynaklara bağımlılık sebebiyle oluşan açığın azaltılması için çeşitli çalışmalar yürütmektedir. Fosil yakıt rezervlerine yakın olmamıza rağmen yaşanan, jeopolitik zorluklar sebebiyle enerji arzı ülkemiz için en önemli konulardan biri haline gelmektedir.

Bu çalışma kapsamında, enerji çeşitleri, yenilenebilir enerji hakkında bilgilere yer verilmiştir. Dünya'da yenilenebilir enerjiye yönelik atılan adımların tarihsel sebepleri irdelenmiş, yenilenebilir enerji kaynaklarına yapılan yatırımlar ve bu yatırımların sonucunda Dünya ve Türkiye perspektifinde ortaya çıkan üretim rakamları irdelenmiştir.

Türkiye'de 1980-90'lı yıllardan itibaren Elektrik Piyasası oluşumu incelenmiş ve Dünya'da elektrik piyasasında yaşanan gelişim ile Türkiye'nin enerji politikaları çerçevesinde yapmış olduğu uzun vadeli aksiyon planları ele alınmış, bu aksiyon planları içerisinde yer alan destek mekanizmalarının etkileri genel itibariyle değerlendirilmiştir.

Çalışmanın son bölümünde, ülkemizde son yıllarda yüksek bir ivme ile artan yenilenebilir enerji yatırımların da önemli rolü olan Yenilenebilir Enerji Destekleme Mekanizmasının (YEKDEM) etkileri farklı açılardan incelenerek katkısı ortaya koyulma çalışmıştır. Analize konu edilen değişkenler öncelikle ADF birim kök sınamasına tabi tutulmuş, ardından durağan hale getirilmiş seriler ile eşbütünleşme testi, Granger nedensellik testi yapılmış ve korelasyon matrisi oluşturulmuştur. Sonuçlar ışığında, YEKDEM teşvikinin yenilenebilir enerji kurulu gücü üzerindeki etkileri incelenmiştir.

Anahtar Kelimeler: İklim Değişikliği, Kyoto Protokolü, Paris Anlaşması, YEKDEM, Yenilenebilir Enerji.

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ABBREVIATIONS

BOT / ORT	: Build Operate Transfer (BOT) / Operational Right Transfer (ORT)
BPP	: Biomass Power Plant
DSİ	: State Hydraulic Works
EC	: European Commission
EIA	: U.S Energy Information Administration
EMRA	: Electricity Market Regulatory Authority
FiT	: Feed in Tariff
GPP	: Geothermal Power Plant
HPP	: Hydro Power Plant
IEA	: International Energy Agency
MENR	: Ministry of Energy and Natural Resources
MTEP	: Million Ton Equivalent Petrol
NGL	: Natural Gas Liquids
NGS	: Nuclear Gas Station
NREAP	: National Renewable Action Plan
RE	: Renewable Energy
RES	: Renewable Energy Sources
SPP	: Solar Power Plant
TEAŞ	: Turkey Electricity Generation and Transmission Company
TEDAŞ	: Turkey Electricity Distribution Company
TEK	: Turkey Electricity Authority
TFEC	: Total First Energy Consumption
UNFCCC	: United Nations Framework Convention on Climate Change
WPP	: Wind Power Plant
YEK	: Renewable Energy Law
YEKA	: Renewable Energy Resource Areas
YEKDEM	: Renewable Energy Support Mechanism

1. INTRODUCTION

In terms of Economic and social issues, energy is the most important factor in the development of world standards of living and country development. Along with the great developments and changes in the field of industry, the increase of the world population brings out the need for energy.

The content of energy, which is one of the foundations of life, is shaped by the historical and economic evolution of human beings. In the early years, energy (basic materials such as fire and water) was dealt with in the context of human vital needs, while at the same time a divine dimension was gained. With the development of humanity and its reflection on the material environment (such as the presence of electricity), the content and the value of the energy concept began to change.

In the past, the effects of the processes used to generate energy in the environmental sense have been ignored for a long time and adopted as the cheapest, and later, with the help of nuclear technology, high capacity production facilities and central production have been strengthened, but these two approaches cost heavily.

Even though the negative effects of nuclear power plants on the environment are low, uninterrupted energy production, low operating costs and high amounts of energy production in these plants, even if they have positive characteristics, the emergence of a large number of radioactive materials in these power The fact that uranium and thorium reserves used in these plants are limited and the accidents in Three Mile (USA), Chernobyl (Ukraine) and Fukushima (Japan) cause reactions to generate electricity from nuclear power plants.

On the other hand, carbon dioxide emitted as a result of the use of fossil energy sources creates a greenhouse effect in the atmosphere and the temperature of the Earth increases every year. This increase in temperature is called global warming. Climate change as a

result of global warming causes flooding in some countries and causes drought in some countries.

All these developments narrow the living spaces of living things and as a result of the weather events, the loss of lives increases every year. The Kyoto Protocol adopted in 1997 was the first of two important steps taken to combat global warming and climate change. The second important step is the Paris Agreement signed in 2015. The Kyoto Protocol and the Paris Agreement set out targets to reduce greenhouse gas emissions. One of the most important objectives is to increase the use of renewable energy technologies. From an economic point of view, although not every country has sufficient and high-quality natural resources, solutions that will not disturb the security of supply and economic balance have been a necessity in meeting the continuously increasing energy needs.

Renewable energy sources, which emerged as an alternative to fossil and nuclear energy, have been extensively discussed in the world energy agenda since the early 1990s. The fact that renewable energy sources are domestic, more compatible with the environment and inexhaustible compared to other energy sources has made these resources more advantageous than other energy sources.

However, there are some obstacles to the development of renewable energy technologies. These are divided into five: market barriers, economic and financial barriers, technical barriers, administrative barriers and socio-cultural barriers.

The private sector alone is not sufficient to overcome the obstacles faced by renewable energy technologies, and public intervention is needed. The most important tools used by the public for intervention are incentives. Incentives for improving the use of renewable energy technologies are divided into two as non-tax and tax incentives.

The tariff guarantee and the renewable portfolio standard are the most widely used non-tax incentive mechanisms in the world. Tax incentives are generally complementary.

Incentives for renewable energy technologies in Turkey started to be implemented in 2005, though investment has gained momentum after the arrangements made in 2010.

Today, in countries that use renewable energies most efficiently, the regulations made to support these technologies are constantly following the market and technology, and their policies are updated frequently according to the location, use of the local resources and the state of the physical infrastructure for transmission. On the other hand, this regulation is too long for Turkey, which is the most important mechanism at the end of 2020. While it is hard fixed price guarantee application will end and there is no official information about the support to be applied for the post. Since uncertainty in incentive applications is always perceived as risk by the investor, this situation adversely affects the use of new capacities.

In the first chapter of this thesis, energy sources definitions, development in World and Turkey and renewable energy outlook in the world will be examined. In the second section, Turkish electricity market evaluation, implied policies in turkey in the scope of the renewable energy and Turkey's renewable energy targets will be examined. In the third part of the study, the effects of the Renewable Energy Support Mechanism (YEKDEM), will be examined in two different model. First model will explain the renewable energy installed capacity development in Turkey with the result of this increase, the effect of electricity produced from renewable energy on current account balance will be tested in model-2. The variables that were analyzed were subjected to ADF unit root test first, then cointegration test, Granger causality test were made with stationary series and correlation matrix was formed.

1.1 DEFINITION OF ENERGY AND ENERGY SOURCES

In its broadest definition, "energy" is used to describe the capacity of the system to operate. With the transition from craftsmanship to industrial production, the concept of energy has become the most important of the production inputs and is one of the main factors shaping the economic policy of the last three centuries.

The concept of energy is defined in the simplest way as the ability of a body or system of bodies to function physically. Energy is present in nature and, according to physical rules, cannot be created from nothing and existing energy cannot be destroyed. However, it can be converted from one form to another form (Sancar 1992). German mathematician Leibnitz also described energy as a living force and explained it as the mathematical relationship between a person's speed and weight.

Energy is a production factor in which technological changes are added to the economy in addition to labor, land and capital. It is a necessary and effective factor in achieving output by combining economic development with production factors. However, there are also approaches that see energy as a contemporary production factor. It has been possible to deal with the phenomenon of energy from being a vital need and tool in a political and economic dimension, especially with the emergence of capitalism. Geographical discoveries and the industrial revolution behind it have made the issue of energy the main agenda of societies and states. The discovery of steam engines, industrialization and technological innovations have marked the last 200 years of the world. Factories, production processes as well as the spread of automobiles, aircraft and similar means of transport, especially oil, are an important energy element.

The energy we use is classified according to the sources from which it is obtained. Energy sources according to the most basic classification; primary and secondary energy sources. Primary energy sources refer to the energy sources used as they originate from the source. Secondary energy sources are used to specify the resources that need to go through several processes in order to be ready for use.

The first group includes non-renewable substances such as coal, lignite, oil and nuclear isotopes, which are available as raw materials in nature, and renewable resources such as solar, wind and water. Although the use of primary energy resources is very common in the context of energy classification in terms of resources, the emphasis is on the use of non-renewable resources among these resources.

Secondary energy sources are made up of electricity, liquid petroleum gas and gasoline, which are processed through various processes. The striking point in this classification is the direct use of fossil fuels such as coal to obtain energy types such as heat and light, and the same sources are transformed to obtain electricity from secondary energy sources. The use of both primary and secondary energy sources has increased with the expansion of production activities and the intensification of industrial branches, which has led to various resource searches.

Electrical energy is a kind of secondary energy source that is used most extensively in households and production. The distinction between non-renewable (conventional) and renewable energy has also emerged in terms of the resources used to obtain electricity. Table 1 presents the distinction between conventional and renewable energy and types of resources are listed.

Table 1.1: Non-Renewable and Renewable Energy Sources

Non-Renewable Energy Sources	Renewable Energy Sources
1. Fossil Fuels a. Petroleum b. Coal & Lignite c. Natural Gas 2. Radioactive Nuclear Fuels	1. Hydraulic Energy 2. Wind Energy 3. Solar Energy 4. Geothermal Energy 5. Biomass Energy 6. Wave and Tide Energy

Source: Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/ [accessed date 24.11.2019].

1.2 NON-RENEWABLE ENERGY

Fossil fuels, which constitute the main source of the transition to industrial society, are natural energy sources containing hydrocarbons such as oil, natural gas and coal. It is known that fossil fuels, which are an indispensable part of the industry (in terms of world history), will soon be exhausted. Oil has a life of ~ 51 years, natural gas has a life of ~ 53

years, and coal has a life of ~ 114 years.[1] In our world, where the energy demand and population are rapidly increasing, energy resources are rapidly depleted, and the shift to alternative energy sources is of great importance.

1.2.1 Petroleum

Petroleum is a very complicated element, consisting mainly of hydrogen and carbon, and limited amounts of nitrogen, oxygen and sulphur. This can be discovered in gaseous, fluid and solid form under normal circumstances. It is generally recognized as natural gas in order to enable to distinguish oil, which is in the form of gas derived by fuels. Those are known as "hydrocarbons" as the main elements of crude oil and natural gas are hydrogen and carbon.[2] Petrol is the most demanded fossil fuel in the world as a result of the discovery of steam-powered machines and the widespread use of internal combustion engines in vehicles.

The planet had 1.73 trillion barrels of oil for 2018. That's enough to last another half century as 95 million barrels are used every day by the nation. For total world reserves, only proven reserves are registered. Every year, this figure only changes slightly. 836.1 billion barrels (48.3 percent) of oil reserves are in the Middle East, 325.1 billion barrels (18.8 percent) in the South and Middle America, 236.7 billion barrels (13.7 percent) in North America. As of 2018, crude oil, which is strategically positioned among primary energy sources, has reached 33.6 percent of global energy consumption.[3]

Approximately 70 percent of global oil and natural gas reserves are located in nearby geographic regions of Turkey. With its geo-political position, Turkey's participate in numerous very major projects as a natural "Energy Center" between energy-rich Caspian, Central Asian and Middle Eastern countries and Europe's consumer markets, supporting these projects.[4]

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[1] T.C. Enerji ve Tabi Kaynaklar Bakanlığı. 2017. Dünya ve Türkiye Enerji ve Tabii Kaynaklar Görünümü. Ankara

[2] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Petroleum [accessed date 24.11.2019].

[3] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Petroleum [accessed date 24.11.2019].

[4] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Petroleum [accessed date 24.11.2019].

Table 1.2: Top 10 Crude Oil Reserve Country

Rank	Country	Reserve (Billion Barrels
#1	Venezuela	298
#2	Saudi Arabia	268
#3	Canada	172
#4	Iran	158
#5	Iraq	144
#6	Kuwait	104
#7	United Arab Emirates	98
#8	Russian Federation	80
#9	Libya	48
#10	Nigeria	37

Source: U.S Energy Information Administration, EIA. International Energy Statistics, Web Page: https://www.eia.gov/beta/international/data/browser/#/?pa=0000000000000000000008&c=ruvvvvvfvtvnvv1urvvvvfvvvvvvfvvvou20evvvvvvvvvvnvvuvo&ct=0&tl_id=5-A&vs=INTL.57-6-AFG-BB.A&cy=2017&vo=0&v=H&start=1980 [accessed date 24.11.2019].

1.2.2 Coal & Lignite

Coal is a black or brownish-black sedimentary rock with a high carbon and hydrocarbon content. Coal is known as a type of non-renewable energy as it requires thousands of years to develop. Coal includes the fuel that plants have accumulated that existed in marshy forests tens of billions of years ago. For millions of years, sheets of dirt and rock coated the crops. The resultant heat and pressure made the crops the material we name carbon.[5]

The World Energy Council has reported that the world coal reserves are present in around 80 countries, and the greatest part of the reserves is in the USA with 250.9 gigaton. The USA is pursued by 160.4 gigaton from the Russian Federation and 144.8 gigaton from Australia. Rich coal nations include: China (138.8 gigatons), India (97.7 gigatons),

[5] International Energy Agency, IEA. Renewable Energy, Web Page: http://www.iea.org/about/glossary/ [accessed date 24.11.2019].

Germany (36.1 gigatons), Ukraine (34.4 gigatons), Poland (25.8 gigatons), Kazakhstan (25.6 gigatons) and Indonesia (22.6 gigatons). More than 90 percent of the world's coal reserves are therefore located among these nine countries' territories.[6]

Our nation is considered to be intermediate in terms of lignite deposits and amounts of output but also to be poor in charcoal. About 3.2% of the global lignite / sub-bituminous carbon resources are in our nation. However, because the content of a large amount of our lignite is poor, its use has arisen in thermal plants. In Afsin, Elbistan, about 46 per cent of our country's lignite deposits are based. Zonguldak and the nearby regions are by far the most significant anthracite deposits in our nation. In the Zonguldak Basin there are 1,30 gigatons of total anthracite reserves, but visible reserves are around 506 million tons.[7]

Lignite / sub-bituminous coal fields are spread across all regions of our country, and the grade of lignite / sub-bituminous coal in these fields varies between 1000-5000 kcal / kg. According to data from Ministry of Energy and Natural Resources (MENR), the calorific value of lignite in Turkey changes between 1000 to 5000 kcal / kg. 68 percent of the total lignite / sub-bituminous coal in Turkey is low calorie, 23.5 percent is between 2,000-3,000 kcal / kg, 5.1 percent is between 3,000-4,000 kcal / kg and 3.4 percent is higher than 4,000 kcal / kg.[8]

Turkey produced 145.3 million tons of petroleum equivalent (MTEP) at the end of 2017, with a carbon proportion of the total primary energy usage of 27%. As of the end of 2018, our country's coal-based power plants installed capacity was 18,997 MW, representing 21,5% of the global total capacity. The installed capacity of 10.203 MW (11.5%) using domestic coal and 8.794 MW (10.0%) using imported coal.[9]

[6] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Coal [accessed date 24.11.2019].
[7] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Coal [accessed date 24.11.2019].
[8] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Coal [accessed date 24.11.2019].
[9] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Coal [accessed date 24.11.2019].

1.2.3 Natural Gas

Natural gas is a source of fossil energy that produced below the surface of the earth. Gas includes a number of substances. Methane, a combination of one carbon atom and four hydrogen atoms (CH4), is the most essential part of natural gas. Natural gas also includes fewer natural gas (NGL) liquids and nonhydrocarbon gasses, such as carbon and water vapor, as well. Natural gas also contains lower levels of natural gas liquids. We use natural gas for fuel and produce chemical compounds and components.[10]

In the Middle Eastern states are located 75.5 trillion m3 of gas reserves (38.4 percent), in Europe & Euroasia 66.7 trillion m3 (33,9 percent) and in African / Asian / Pazifical nations 32.5 trillion m3 (16,5 percent).[11]

Although the most recent use of fossil fuels, it is the fastest spreading source. It is difficult to obtain like oil and is limited to various geographical areas. The reason for its widespread use is the high calorie nature and the fact that countries have made huge investments for transcontinental transfer in recent years (Ablabekova 2014).

Gas is used for the production of electricity and heating purposes in our country. Due to the lack of natural gas deposits in our country, all of the natural gas used is imported. The Table 1.3 below shows the import figures for the last 10 years.

Table 1.3: Imports of Natural Gas for the Years 2008-2018 (Million Sm3)

Country	Russia		Iran		Azerbaijan		Algeria		Nigeria		Other*		Total	Change YoY
Years	Amount	Share (%)	Amount	Share (%)	Amount	Share (%)	Amount	Share (%)	Amount	Share (%)	Amount	Share (%)	Amount	
2008	23.159	62,0	4.113	11,0	4.580	12,3	4.148	11,1	1.017	2,7	333	0,9	**37.350**	**4,2**
2009	19.473	54,3	5.252	14,7	4.960	13,8	4.487	12,5	903	2,5	781	2,2	**35.856**	**-4,0**
2010	17.576	46,2	7.765	20,4	4.521	11,9	3.906	10,3	1.189	3,1	3.079	8,1	**38.036**	**6,1**
2011	25.406	57,9	8.190	18,7	3.806	8,7	4.156	9,5	1.248	2,8	1.069	2,4	**43.874**	**15,4**
2012	26.491	57,7	8.215	17,9	3.354	7,3	4.076	8,9	1.322	2,9	2.464	5,4	**45.922**	**4,7**

[10] International Energy Agency, IEA. Renewable Energy, Web Page: http://www.iea.org/about/glossary/ [accessed date 24.11.2019].
[11] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Natural-Gas [accessed date 24.11.2019].

2013	26.212	57,9	8.730	19,3	4.245	9,4	3.917	8,7	1.274	2,8	892	2,0	**45.269**	**-1,4**
2014	26.975	54,8	8.932	18,1	6.074	12,3	4.179	8,5	1.414	2,9	1.689	3,4	**49.262**	**8,8**
2015	26.783	55,3	7.826	16,2	6.169	12,7	3.916	8,1	1.240	2,6	2.493	5,2	**48.427**	**-1,7**
2016	24.540	52,9	7.705	16,6	6.480	14,0	4.284	9,2	1.220	2,6	2.124	4,6	**46.352**	**-4,3**
2017	28.690	51,9	9.251	16,7	6.544	11,9	4.617	8,4	1.344	2,4	4.804	8,7	**55.250**	**19,2**
2018	23.642	47,0	7.863	15,6	7.527	15,0	4.521	9,0	1.668	3,3	5.140	10,2	**50.361**	**-8,9**

Source: T.C. EPDK. 2018. *2018 Yılı Doğal Gaz Piyasası Sektör Raporu*

1.2.4 Nuclear

Nuclear reaction occurs when any nucleus of an atom is altered by collision with another physical entity such as alpha particles, gamma rays, neutrons, protons, or any atom. Two of these nuclear reactions, *fission* and *fusion*, are of particular interest because they release large amounts of energy. Today, only the fission reaction of these two is used for electricity generation.[12] As with many other advances in technology, studies started in security and defense first and later provided industrial efficiency. Several nations, especially the United States and Russia, undertook extensive studies to use nuclear power, and systems for transforming the nuclear reaction thermal energy into electricity were developed as a consequence of these studies. In other words, these programs provide a reliable, regulated and efficient way of obtaining nuclear energy.[13]

With the signing of the Intergovernmental Cooperating Agreement on the Construction and Development of the Akkuyu site between the Turkish Republic government and the Russian Federation on 12 May 2010, our nation's target of a half-century nuclear power station started upgrading. The project firm in Ankara was formed in the framework of the above-mentioned arrangement procedure with the title Akkuyu Nükleer A.Ş on 13 December 2010.

A Nuclear Power Plant Partnership and Intergovernmental Agreement for Sinop was established with Japan on 3 May 2013, making it our nation's second nuclear power

[12] Türkiye Atom Enerjisi Kurumu, TAEK, Webpage: https://www.taek.gov.tr/tr/2016-06-09-00-43-55/135-gunumuzde-nukleer-enerji-rapor/838-bolum-02-nukleer-enerjinin-temel-prensipleri.html [accessed date 05.12.2019]

[13] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Nuclear [accessed date 24.11.2019].

station. The aim is to build 2 nuclear power plants by 2023 and begin construction on the 3rd power station in order to achieve the rapidly rising demand for electricity and to minimize the risk associated with import dependencies.[14]

Through August 2019, 450 nuclear reactors are operational in 31 countries and the development of 52 nuclear reactors in 19 countries. 10% of the world's electricity sources compensate from these facilities. Nuclear power is used country by country; France provides about 72 percent, Ukraine 53 percent, Sweden 40 percent, Belgium 39 percent, European Union 28 percent, South Korea 24 percent and USA 19 percent of its electricity consumption.[15] Below Table 1.4 shows Nuclear Energy capacity and reactor numbers of countries.

Table 1.4: Distribution of Reactors by Country, Total Power and Shares in Electricity Generation

Country	Number of Operated Reactors	Total Net Electrical Capacity [MW]	Nuclear Electricity Supplied [GWh]	Nuclear Share [%]
ARGENTINA	3	1.633	6.452,97	4,70
ARMENIA	1	375	1.898,08	25,60
BELGIUM	7	5.918	27.251,38	39.0
BRAZIL	2	1.884	14.786,95	2,70
BULGARIA	2	1.966	15.444,71	34,70
CANADA	19	13.554	94.449,51	14,90
CHINA	46	42.858	277.055,93	4,20
CZECH REPUBLIC	6	3.932	28.255,79	34,50
FRANCE	58	63.130	395.908,34	71,70
FINLAND	4	2.784	21.880,84	32,40
GERMANY	7	9.515	71.866,45	11,70
HUNGARY	4	1.902	14.857,26	50,60
JAPAN	42	39.752	49.330,13	6,20
KOREA, REPUBLIC OF	24	22.444	127.077,41	23,70
MEXICO	2	1.552	13.200,33	5,30
NETHERLANDS	1	482	3.340,53	3,00

[14] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Nuclear [accessed date 24.11.2019].
[15] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Nuclear [accessed date 24.11.2019].

PAKISTAN	5	1.318	9.289,67	6,80
ROMANIA	2	1.300	10.459,34	17,20
RUSSIA	37	28.177	191.340,03	17,90
SLOVAKIA	4	1.814	13.788,90	55,00
SLOVENIA	1	688	5.489,91	35,90
SOUTH AFRICA	2	1.860	10.587,11	4,70
SPAIN	7	7.121	53.363,83	20,40
SWEDEN	8	8.613	65.868,10	40,30
SWITZERLAND	5	3.333	24.496,46	37,70
UKRAINE	15	13.107	79.532,01	53,00
UNITED KINGDOM	15	8.923	59.112,26	17,70
UNITED STATES OF AMERICA	99	99.680	808.028,33	19,30
INDIA	22	6.255	35.388,66	3,10
IRAN, ISLAMIC REPUBLIC OF	1	915	6.300,12	2,10
Total	**457**	**401.837**	**2.562.757,77**	

Source: World Nuclear Association, Webpage: https://www.world-nuclear.org/information-library/facts-and-figures/world-nuclear-power-reactors-and-uranium-requireme.aspx [accessed date 25.11.2019]

1.3 RENEWABLE ENERGY

Renewable energy (RE) sources defined by the International Energy Agency (IEA) as "energy derived from natural processes (such as sunlight, wind), which can renew themselves at a faster rate than their consumption"; wind, solar, biomass, geothermal, hydraulic and marine sources.[16] These resources are environmentally friendly, clean, provide energy security and are useful resources for the national economy.

Renewable Energy Sources (RES) are energy sources that are directly renewed from the sun (thermal, photo-chemical and photo-electricity), indirect use of the sun (photosynthetic energy stored in wind, waterpower or biomass) or from other movements and mechanisms of nature (tides and geothermal) and continuously renewed (Ellabban, Abu-Rub and Blaabjerg 2014).

As it can be understood from the definition, renewable energy has three main characteristics which are separated from fossil energy.

[16] International Energy Agency, IEA. Renewable Energy, Web Page: http://www.iea.org/about/glossary/ [accessed date 24.11.2019].

a. Renewable energy sources have an unlimited reserve. In other words, renewable energy sources are almost inexhaustible. However, fossil fuel stocks are very limited. In addition, especially since the Industrial Revolution, fossil fuels are not renewed to the extent that they are depleted.
b. Renewable energy sources are completely environmentally friendly and do not result in a direct increase in the carbon dioxide level of the atmosphere. Therefore, as renewable energy usage increases, dependence on fossil fuels and its harmful effects on climate will decrease.
c. RES are domestic and natural resources. Thanks to that important advantage, the import of fuel from the dominant fossil fuel producers will be reduced and the supply security problem will be solved. In other words, the use of RES will escalate supply diversity and reduce risks arising from volatility in oil prices and increase supply security. This will also significantly contribute to the development of the national economy by reducing significant foreign exchange transfers to fossil fuels (Çelikkaya 2017).

1.3.1 Hydraulic Energy

Hydraulic energy is the indirect energy produced by the evaporation of the water in the sea, lakes and rivers and the return of water vapor to the earth as a result of the hydrological cycle caused by the drift and condensation of the wind (Dalkır and Şeşen 2011). Hydro energy can be defined as energy obtained by using the energy of mobile water (Ellabban, Abu-Rub and Blaabjerg 2014), or it can be defined as energy obtained by converting the potential energy of water to kinetic energy. The potential of hydro energy varies depending on the precipitation regime (Bozkurt and Tür 2015).

It is known that people have benefited from the energy of water since ancient times. While the energy of water is initially utilized in water mills, nowadays electricity is produced by the energy of water (Dalkır and Şeşen, 2011). On September 30, When operations began in 1882, a plant on the Fox River in Appleton, Wisconsin was the first hydropower

plant. Since that day, the Fox River has been dotted with dam and other equipment and several hundred other rivers world-wide.[17]

Hydro power has been a cost-effective source of production since its introduction, due to its proven, mature technology and predictable production characteristics. The wide investment range is determined by field variables and conditions rather than technology. According to the IRENA Renewable Energy Data Bank, Brazil has the lowest costs with USD 0.04 / kWh, while the highest cost is observed in Europe with USD 0.11 / kWh.[18]

1.3.2 Wind Energy

Wind comes from the varying temperatures on the Surface of the earth produced by solar radiation. Such various temperatures can produce varying levels of humidity and pressure, and the change in levels of pressure allows the air to pass. About 2% of the solar power reaching the Earth is transformed into wind power.[19]

Wind power; is the fastest energy sub-sector in the world. Because of the advantages such as no need for any raw material source, no pollutant effect, no need for cooling liquid, the Wind Power Plants (WPP) installation can be done in all places with sufficient wind current. In addition; Thanks to the rapid development of wind turbine technology, it has become possible to generate more electrical energy with lower wind force.[20]

The wind turbines in commercially operated WPP generally operate at a speed of 5-6 m/s (18-21.6 km / h) and generally cut-off at a wind speed of 25-30 m/s (90-108 km/h). Smaller wind turbines can also operate at a wind speed of 2 m/s. Wind turbines used in wind farms in operation in Turkey, has been developed in United States, Germany, Spain, China, India, Denmark, France and Turkey and the supplier firms are GE, Siemens, Nordex, Enercon, Sinovel, Alstom, Vestas Suzlon, Vira and Milres (Gültekin 2019).

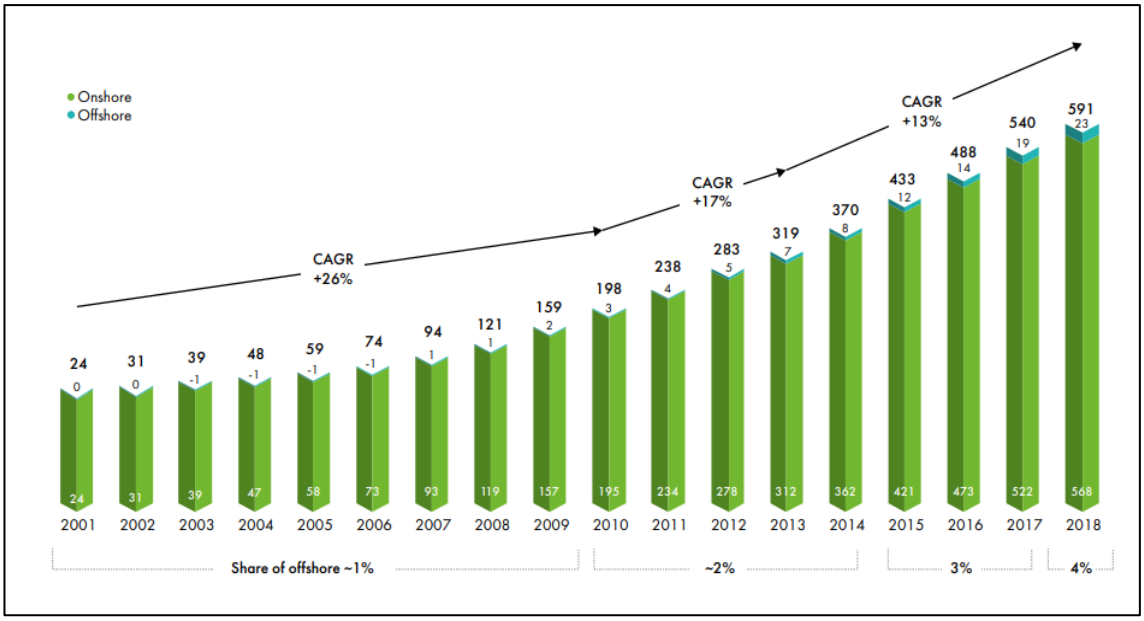
[17] National Geographic. Web page: https://www.nationalgeographic.org/thisday/sep30/first-hydroelectric-plant-opens/ [accessed date 24.11.2019].
[18] IRENA, Renewable Cost Database. Web Page: http://resourceirena.irena.org/gateway/dashboard/?topic=3&subTopic=1066 [accessed date 9.12.2019].
[19] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Wind [accessed date 24.11.2019].
[20] International Energy Agency, IEA. Renewable Energy, Web Page: https://www.iea.org/fuels-and-technologies/wind [accessed date 24.11.2019].

The first wind farm in Turkey was founded in 1998 in Izmir. In the first year, starting with the first wind power production in Turkey in 1998 was close to 6 million kWh. The production increased by 250% to 21 million kWh in the following year. In 2018 Turkey reach 7,2 GW installed capacity in WPP and produced 9,9 GWh electricity from wind energy.

2018 was a good year with 51.3 GW deployed–a 4.0 percent decrease compared to the past year and a total installed capacity of 591 GW (9 percent increase compared to 2017). New onshore wind turbines exceeded 46.8 GW and the international offshore sector deployed 4.5 GW, taking global market share to 8%.[21]

The installed capacity, which was 91,657 MW in 2007, reached 513,939 MW at the end of 2017. China, which ranks first in the world with 164,060 MW in installed capacity, has almost twice the capacity of its closest competitor with 87,543 MW installed capacity, but due to the impact of the capacity factor, the electricity generated by the US today is higher than China's.[22]

Figure 1.1: Installed Wind Power Plant in World from 2001 to 2018 (GW)



Source: GWEC Global Wind Report 2019.

[21] Global Wind Energy Council, GWEC, 2019. Global Wind Energy Report.
[22] IRENA, Web Page: https://www.irena.org/wind [accessed date 25.11.2019].

1.3.3 Solar Energy

Solar energy is a RE resource with such features as ease of deployment and use, environmental pollution and no toxic waste generation.

These are the photosynthesis reactions that occur as a result of solar energy reaching the earth, which is the source of biological life in the earth. In this context, the sun is seen as a self-existent energy source long before human beings started to obtain energy from the sun. Efforts to obtain electricity from the sun started at the end of the 1970s, and with the advances in technology and the reduction of costs, the use of solar energy for electricity generation has accelerated in recent years (Bayraktar 2016).

Solar photovoltaic (PV) devices transform solar energy directly into electricity. Solar PV puts together two advantages. On the one side, in big plants, modular manufacturing can be carried out to save space. PV is a highly flexible design, on the other hand. It may be used at a time in very small amounts. This difference makes a variety of implementations possible. Platforms may be very small, for example, in computers or off-grid systems, for utilities.[23]

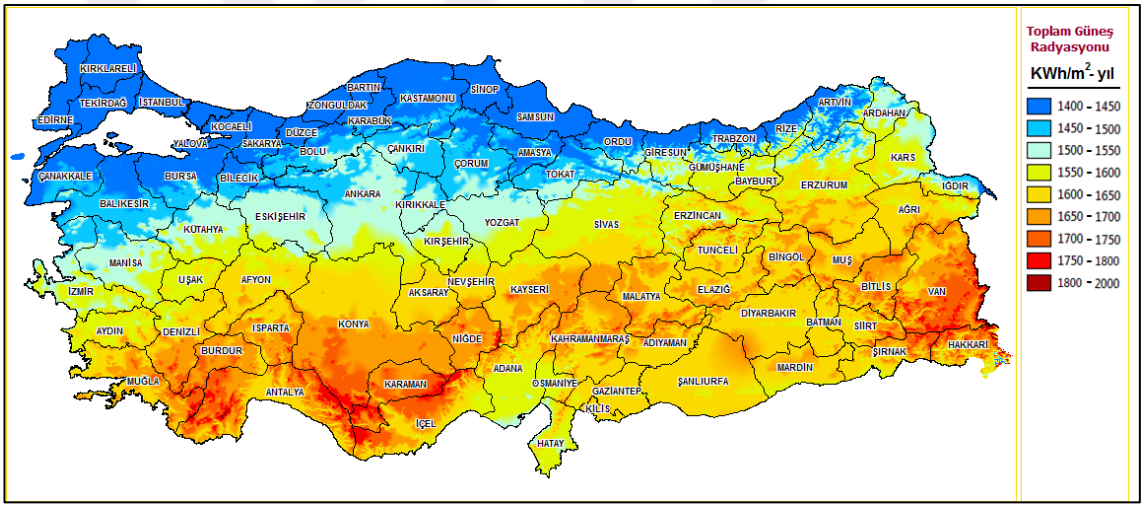
As per the Turkish Solar Energy Map (SEM) prepared by the MENR, the total yearly insolation time is 2.741 hours (a total of 7.5 hours per day) and the total yearly solar energy produced is 1.527 kWh / m2 (a total of 4.18 kWh / m2 per day). These day, two new technologies are using very different shapes and areas in which solar electricity is produced. Even though solar power technology varies in method, components and tech, it can be divided into two main groups: photovoltaic technology: the sun light can be converted directly into electricity by semi-conductive materials, also called photovoltaic solar energy systems. Solar photo-emissive technologies and solar concentrate power (CSP): heat from solar energy is produced throughout this structure which is either directly or indirectly electricity can be generated. The development of a 1,000 MWe solar power power plant, which will be one of the largest solar power power plants in the world, is now underway within the scope of the YEKA competition, which is held

[23] International Energy Agency, IEA. Renewable Energy, Web Page: https://www.iea.org/fuels-and-technologies/solar [accessed date 24.11.2019].

on 20/03/2017. In addition, the setting-up of 60% local solar modules to be utilized in the solar power plant is being carried on and the set-up of a solar energy R&D center.[24]

Turkey also in electricity generation, which is designed to use solar energy Solar Power Plant (SPP) investment has increased in the last 5 years, this increase is the most important trigger of the purchase guarantee for 10 years for unlicensed electricity production is understood that provision. Turkey's solar energy potential sunshine duration and the angle of incidence of the sun's rays are in Figure-2. According to this map, it can be concluded that investments in electricity production from solar energy will be more efficient in the southern parts of our country.

Figure 1.2: Solar Energy Potential in Turkey



Source: Yenilenebilir Enerji Genel Müdürlüğü, YEGM, Güneş Enerjisi Potansiyeli Atlası Webpage: http://www.yegm.gov.tr/MyCalculator/ [accessed date 25.11.2019]

1.3.4 Geothermal Energy

Geothermal energy is the source of the magma layer in the nucleus of the earth approaching to the surface and heating the groundwater around it, and it is used for the production of electricity by using the heat of the heated water and sometimes by natural means and sometimes by means of exploration (Arslantaş 2019).

[24] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Solar [accessed date 24.11.2019].

Geothermal energy, which is one of our domestic energy supply, is clean, inexpensive and environmentally friendly. Our nation has a high geothermal potential. In Western Anatolia, 78% of these geothermal areas, 9% in central Anatolia, 7% in the region of Marmara, 5% in Eastern Anatolia and 1% in other areas are located. The low-and medium-enthalpy geothermal places of 90 percent of our geothermal resources are appropriate for direct applications (heating, hot spring, industrial usage, etc.), and ten percent for indirect uses (electric generation).[25]

In Turkey, geothermal sources are widely used. Geothermal energy is used today in the electricity generation, heating (greenhouses and houses), thermal tourism and education, agricultural use, fishery, drying, etc. MTA's first geothermal electric generation in Kızıldere in 1975 with Kızıldere power plant of 0,5 MWe of energy began in Kızıldere.[26]

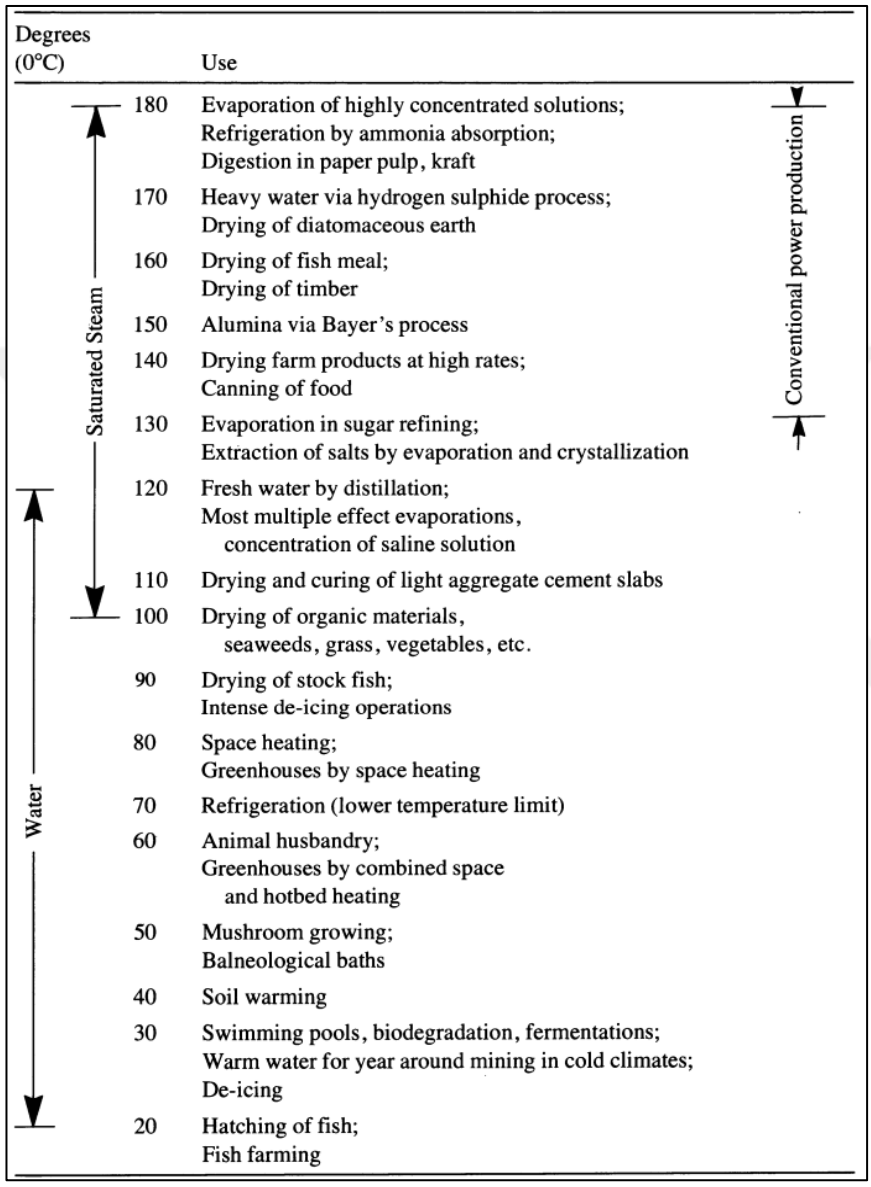
The most important factor in the rapid increase of geothermal resource exploration activities in our country since 2004 is the new field exploration activities and investments for the development of existing fields. The initiation of high-cost drilling activities by the public sector and the determination of water resources at suitable temperatures for electricity generation as a result of these searches have been guided by the direction of private sector investors in this area (Kavcıoğlu 2015).

Geothermal energy is not severely limited to the generation of electricity. These different uses depend on the temperature of the geothermal fluid and are shown in Figure 1.3. According to the temperature of the water obtained from geothermal sources, usage areas differ. While electricity production is possible only with the use of thermal water having a temperature of 170 ° C, it is possible to benefit from geothermal source in different production areas with the decrease of temperature. If the temperature of the remaining water is sufficient after the use of water in geothermal power plants, additional economic contribution can be obtained for greenhouse heating or different industrial purposes. With

[25] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Geothermal [accessed date 24.11.2019].
[26] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Geothermal [accessed date 24.11.2019].

this method, self-sufficient integrated agricultural production facilities can be installed (Arslantaş 2019).

Figure 1.3: Usage Areas of Geothermal Fluid

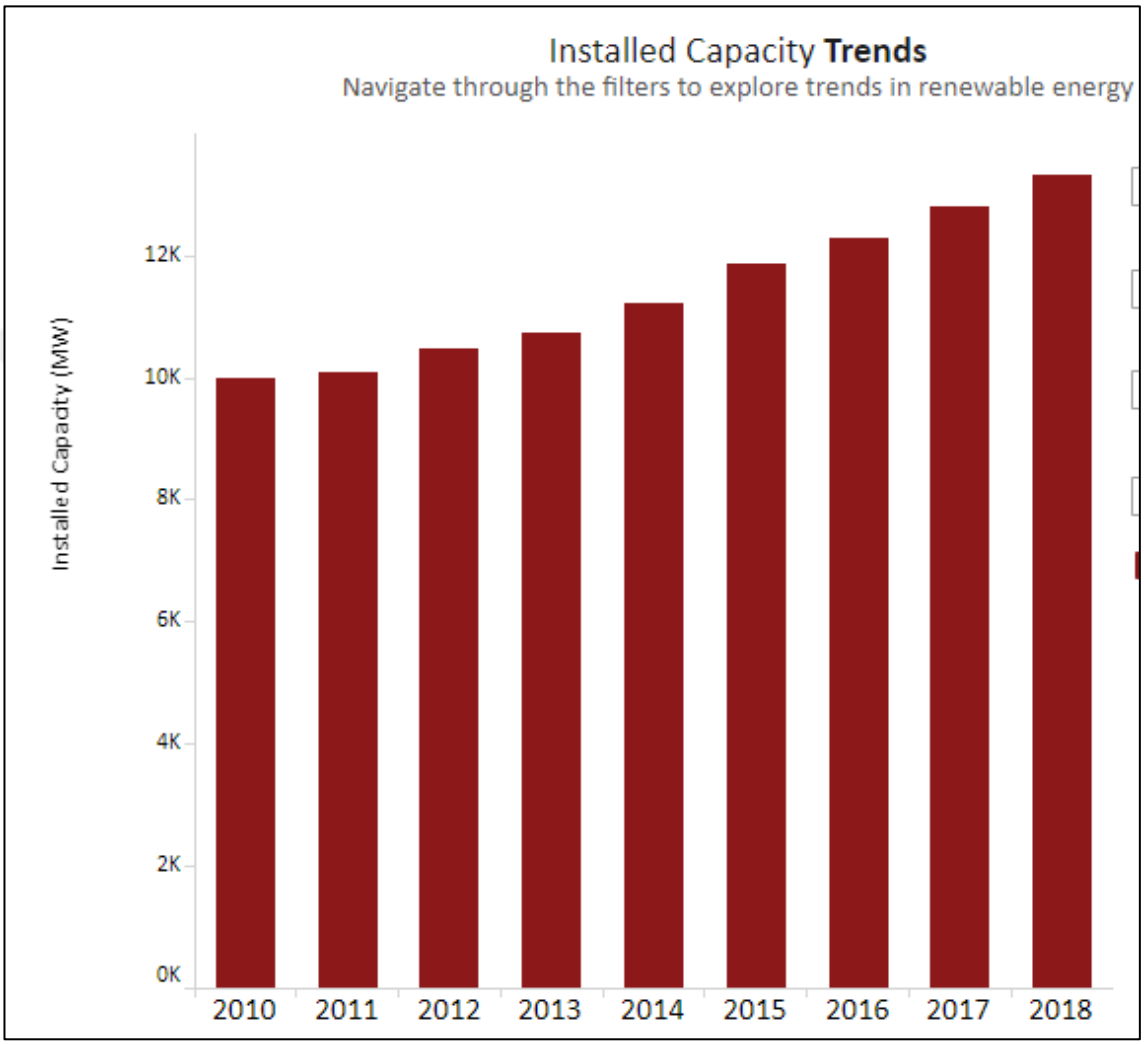


Source: Rinehart, J. S. 1980. Geysers and Geothermal Energy, New York: Springer-Verlag, p:176

As of 2018, geothermal energy capacity had been installed around 14.9 GWe. The USA, the Philippines, Indonesia, Turkey and New Zealand are among the top five nations in this field. The world's total direct use of geothermal energy is above 70,000 MWt in 2018.

USA, China, Sweden, Belarus, and Norway are the top five economies in direct applications.[27] Installed capacity development can be seen at below Figure 1.4.

Figure 1.4: Installed Capacity Increase for Geothermal Power Plant in World



Source: IRENA, Geothermal Energy. Web Page: https://www.irena.org/geothermal [accessed date 24.11.2019].

1.3.5 Biomass Energy

Although biomass means the total mass of the living organism in a given period, it is possible to evaluate it as an energy source because of the hydrocarbons it contains. Biomass energy can be obtained in many different forms and can occur in more than one

[27] Republic of Turkey Ministry of Energy and Natural Resources, MENR. Energy Sources, Web Page: https://www.enerji.gov.tr/en-US/Pages/Geothermal [accessed date 24.11.2019].

form. Wood in its simplest form combustion is the use of biomass energy. Today, biomass energy is utilized in many fields such as vehicle fuel, electricity production, residential heating and fertilizer production. However, the use of this type of energy at electricity generation has become increasingly in recent years. Biomass Power Plants (BPP) lets us the disposal of domestic wastes due to increasing urbanization, the use of wastes generated by livestock activities and the use of wastes generated by various industrial production activities in electricity generation. In this way, both electricity generation and recycling of wastes are achieved, and economic input is obtained.

In addition, when the power plants established in our country are examined, generally airless digestion method; fermentation through bacteria. With this method, electricity is produced by methane gas obtained from wastes; As a result of fermentation, very valuable liquid fertilizer is obtained. In addition, the negative effects of animal manure on human health and the pollutant effect of groundwater are prevented in the regions where animal husbandry is concentrated. On the other hand, since the production process has a more complex structure than other renewable energy sources, it contributes to employment more (Arslantaş 2019).

Modern bioenergy is an important resource for renewable energy and it is 5 times better than the combination of wind and solar PV in terms of the overall generation capacity in all industries, even though conventional biomass is omitted. In 2015, about 13 EJs in bioenergy are used to produce heat which constitute around 6% of total heat usage. Bioenergy in power and transport biofuels has grown rapidly over the past years, due primarily to increased support in policy areas.[28]

1.3.6 Wave and Tide Energy

In addition to its plentiful solar, wind and geothermal reserves, the energy of the Wave and Tide is also remarkable for capturing the ocean's renewable energy. The energy of waves and tides can be absorbed and turned into renewable, carbon free electricity through special buoys, generators and other technology. Wave energy and tidal power are

[28] International Energy Agency, IEA. Renewable Energy, Web Page: https://www.iea.org/fuels-and-technologies/bioenergy [accessed date 24.11.2019].

variable in nature as with other renewable energy sources. Waves are generated by winds that blow throughout the ocean's surface. Because waves cross the sea, they will, however, be more predictable than wind once they arrive on the wave power plant. By addition, tidal power, driven by the forces of the moon and sun, can be expected hundreds of years by advance. Emerging technology, wave energy systems, are not comparable with other renewable energy technologies; however, authorities and industry are continuously growing in involvement in wave energy technologies with the highest concentration of renewable energy sources.

Wave and tidal actions as a hydro energy source also have potentially enormous energy capacity. The energy from the fluctuations on the ocean surface and the energy from the tides are both very popular sources of energy, but they have not yet become fully commercialized. R & D technologies in this area are at an early stage. There are currently three tidal plants in the world. These; It also operates in France, Russia and Noca Scotai (since 1984) (Linscott 2011).

1.4 RENEWABLE ENERGY OUTLOOK IN THE WORLD AND TURKEY

With the increase of industrialization in the world, the need for energy has increased in parallel with this. The use of fossil fuels to meet energy needs causes climate change. Increasing greenhouse gas emissions as a result of energy consumption from fossil fuels has made global warming inevitable. The United Nations took the first step towards reducing greenhouse gases by signing the Kyoto Protocol in 1998. The functionality of the Kyoto Protocol and the financial obligations that countries that cause high carbon emissions play a deterrent role.

1.4.1 Kyoto Protocol and Paris Agreement

In 1997, in Kyoto, Japan, the Protocol was adopted when greenhouse gasses started to threaten our climate, our planet and life on the ground alone. The Kyoto Protocol is still being discussed publicly in other aspects.[29] The Kyoto Protocol is an international consensus aiming at reducing emissions of carbon dioxide (CO2) and greenhouse gasses

[29] Investopedia, Web Page: https://www.investopedia.com/terms/k/kyoto.asp [accessed date 24.11.2019].

(GHGs) in atmospheric conditions. The vital principle of the Kyoto Protocol was to lower the amount of CO2 emissions of industrialized countries.[30]

The arrangement has been accepted in relation to the United Nations Framework Convention on Climate Change (UNFCCC), which was established at the Rio de Janeiro 1992 World Forum. Also, UNFCCC Member States and not non-members will join the Kyoto Protocol.

The nations that have signed the Protocol to eliminate carbon dioxide emissions and five other greenhouse effect gasses or raise their rights by carbon taxes, although they are unable to do so. The Protocol expects countries to reduce carbon emissions to 1990 levels in the atmosphere.[31]

Many articles of the Kyoto Protocol apply to the developed countries referred to in Annex 1 to the UNFCCC. (Table1.5) The UNFCCC defines "common but differentiated" responsibilities.

i. Partner countries
ii. The historical and current global greenhouse gas emissions are realized by developed countries.
iii. Per capita emissions of developing countries are still low.
iv. Recognize that the global emissions of developing countries will increase according to their social and developmental needs.

In other words, China, India and other developing countries are exempt from agreement requirements because they are not the main responsible for the emissions causing current climate change.

[30] Investopedia, Web Page: https://www.investopedia.com/terms/k/kyoto.asp [accessed date 24.11.2019].
[31] Devlet Su İşleri Genel Müdürlüğü. 2014. İklim Değişikliği Çerçeve Sözleşmesi, Kyoto Protokolü ve Türkiye, http://www.dsi.gov.tr/docs/iklim-degisikligi/iklim_degisikligi_cerceve_sozlesmesi_ve_turkiye.pdf?sfvrsn=2 [accessed Date: 27.11.2019].

Table 1.5: UNFCCC, Annex-I and Annex-II Country lists

ANNEX-I Countries (40 + EU) Industrialized Countries (26 + EU) + TMEC (14)	**Annex-II Countries (23 + EU)**
Industrialized Countries: Austria, Austria, Finland, France, Ireland, Spain, Sweden, Switzerland, Iceland, Japan, Luxembourg, Canada, Norway, Portugal, New Zealand, Greece, the Netherlands, the USA, EU, Switzerland. Austria, Sweden, Sweden, Germany. England, Monaco, Lichtenstein. **Transition to Market Economy Countries (TMEC):** The Czech Republic, Latvia, Lithuania, Hungary, Romania, Poland, Russia, Slovakia, Croatia, Belarus, Bulgaria.	**Industrialized Countries:** The Usa, the Netherlands, Spain, Ireland, Sweden, Switzerland, Italy, Iceland Japan Japan, Luxembourg, Netherlands, Canada, Norway, Portugal, New Zealand, Greece, United States of America, Australia, Denmark, Finland, Austria.

Source: Devlet Su İşleri Genel Müdürlüğü. 2014. İklim Değişikliği Çerçeve Sözleşmesi, Kyoto Protokolü ve Türkiye

Turkey, which was opened for signature in 1992, was included in the list as Annex 1 to the original document (historical responsibility) and Annex 2 (financial responsibility). Turkey has made efforts form the first Conference of Parties(COP 1) carried out in 1995 to the COP 6 held in 2000 has made efforts to exit the Annex to the UNFCCC because although an OECD member, it is a developing country rather than a develop country, but couldn't achieve its target.[32] In 2000, we made a change in attitude and proposed to leave Annex II and take part in Annex I with special status. 29 October to 6 November 2001 in Morocco in the 7th Conference of the Parties in the city of Marrakech (COP 7), Turkey's Departing from Appendix II, was adopted Yearning UNFCCC parties as Annex I countries with special conditions.[33] May 24, 2004 Turkey also has involved in the agreement formally as 189th party. Turkey became party the UNFCCC, which in 2004

[32] Devlet Su İşleri Genel Müdürlüğü. 2014. İklim Değişikliği Çerçeve Sözleşmesi, Kyoto Protokolü ve Türkiye, http://www.dsi.gov.tr/docs/iklim-degisikligi/iklim_degisikligi_cerceve_sozlesmesi_ve_turkiye.pdf?sfvrsn=2 [accessed Date: 27.11.2019].
[33] Devlet Su İşleri Genel Müdürlüğü. 2014. İklim Değişikliği Çerçeve Sözleşmesi, Kyoto Protokolü ve Türkiye, http://www.dsi.gov.tr/docs/iklim-degisikligi/iklim_degisikligi_cerceve_sozlesmesi_ve_turkiye.pdf?sfvrsn=2 [accessed Date: 27.11.2019].

but did not signed the Kyoto Protocol but for a long time, Turkey has officially announced at May 30, 2008 “Protocol would be signed”. Turkey, in accordance with the Kyoto Protocol 25th article of the "Certificate of Participation" is the ninetieth day following the date of 26 August 2009 has been officially party to the Protocol[34]

Global emissions remained on the rise until 2005, when the Kyoto Protocol became international law, even if it was enacted in 1997. For many nations, such as those in the EU, things seemed to be going well. Under the treaty, they arranged to meet or surpass their goals by 2011. But others kept falling short. Take the U.S. and China, two of the largest emitters in the world. They also created sufficiently greenhouse gasses to offset the gains made by countries that have reached their goals. In principle, between 1990 and 2009, emissions worldwide increased by about 40 percent.[35]

Parties to the Kyoto Protocol met in Doha, Qatar in December 2012. This so-called Doha Amendment added new targets for participating countries to reduce emissions for the second commitment period, 2012–2020. The amendment to Doha had a short life. At the 2015 Paris Sustainable Development summit, the Paris Climate Agreement, that effectively replaced the Kyoto Protocol, was submitted by all UNFCCC attendees.[36]

The Paris Agreement, which constitutes the framework of the post-2020 climate change regime, was adopted in 2015 at the 21st Conference of the UNFCCC in Paris. The agreement entered into force as of November 4, 2016 as of 5 October 2016 as a result of meeting the condition that at least 55 parties constituting 55% of global greenhouse gas emissions have been approved [37]

The objective of the Paris Agreement is to increase global social and economic resilience to the post-2020 climate change risk. For comparison with the time of pre-industrialization, the Paris Agreement's long-term aim is to keep planet temperatures as

[34] Devlet Su İşleri Genel Müdürlüğü. 2014. İklim Değişikliği Çerçeve Sözleşmesi, Kyoto Protokolü ve Türkiye, http://www.dsi.gov.tr/docs/iklim-degisikligi/iklim_degisikligi_cerceve_sozlesmesi_ve_turkiye.pdf?sfvrsn=2 [accessed Date: 27.11.2019].
[35] Investopedia, Web Page: https://www.investopedia.com/terms/k/kyoto.asp [accessed date 24.11.2019].
[36] Investopedia, Web Page: https://www.investopedia.com/terms/k/kyoto.asp [accessed date 24.11.2019].
[37] Investopedia, Web Page: https://www.investopedia.com/terms/k/kyoto.asp [accessed date 24.11.2019].

close as possible to 2 ° C. To achieve this, fossil fuel (oil, coal) usage is gradually reduced.[38]

In order to increase the adaptation and resistance capabilities of the countries exposed to the negative impacts of climate change and to increase their greenhouse gas emission reduction capacities, the agreement provides financing, technology transfer and capacity building to developing countries, especially to the least developed countries and small island states from the developed countries. As far as the elimination of pollution is concerned, the agreement allows the developed countries to follow their absolute emission goals; it also allow emerging countries to adopt existing, expanded objectives, including all industries in accordance with their various national requirements, raising their emission reduction targets over time. [39]

National contributions to the implementation of these objectives constitute one of the important pillars of the Agreement. On 20 September 2015, Turkey announced the Intended Nationally Determined Contribution (INDC) statement, which is expected to be realized by 2030, as a reduction from an increase of up to 21%. According to the evaluations made by the scientific world, it is pointed out that even if all the reported national contributions are realized, it will be insufficient to reach the 2 ° C target and efforts should be increased. As a matter of fact, the Paris Agreement provides for a periodic review of the National Declaration of Contributions (NDCs) and the gradual increase of the objectives.

Turkey signed the Paris Agreement with the representatives of 175 countries on April 22, 2016 in New York. The Paris Agreement is the first global agreement that came into force less than a year after its adoption.[40] Turkey stays one of the only two G20 nations not signed into law by the Paris Agreement (Russian Federation is the second).[41]

[38] T.C Dış İşleri Bakanlığı, Paris Anlaşması , Webpage: http://www.mfa.gov.tr/paris-anlasmasi.tr.mfa [accessed date 27.11.2019].
[39] T.C Dış İşleri Bakanlığı, Paris Anlaşması , Webpage: http://www.mfa.gov.tr/paris-anlasmasi.tr.mfa [accessed date 27.11.2019].
[40] T.C Dış İşleri Bakanlığı, Paris Anlaşması , Webpage: http://www.mfa.gov.tr/paris-anlasmasi.tr.mfa [accessed date 27.11.2019].
[41] Climate Action Tracker, Webpage: https://climateactiontracker.org/countries/ [accessed date 27.11.2019].

1.4.2 Increase in Renewable Energy Investments

In line with the fight against climate change, which started with the Kyoto Protocol and continued with the Paris Agreement, the World has taken important steps to reduce the use of fossil fuels. In order to reduce the use of fossil resources, action plans have been developed on issues such as transportation, heating and electricity generation. One of the main action plans is to increase electricity generation from renewable energy and increase its share in total energy consumption. Accordingly, investments in renewable energy resources have been increased. Significant incentives have been provided by governments to promote renewable energy investments. The following table lists the incentive mechanisms provided worldwide.

Table 1.6: Classification of Renewable Energy Support and Incentive Mechanisms

Regulatory Policies	**Financial Incentives and Public Authority Finance**
Feed in Tariffs	Taxation and Exemptions
Quota obligations / Renewable Portfolio Standards	Tax Credits (Investment and Production Tax Credits)
Renewable Energy Certificates	Pricing of Environmental Negative Externalities
Auction Methods	Public Investments, Credits, Grants, Capital subsidies and discounts
Net Measurement System	
Biomass Obligations	
Heat Obligations	

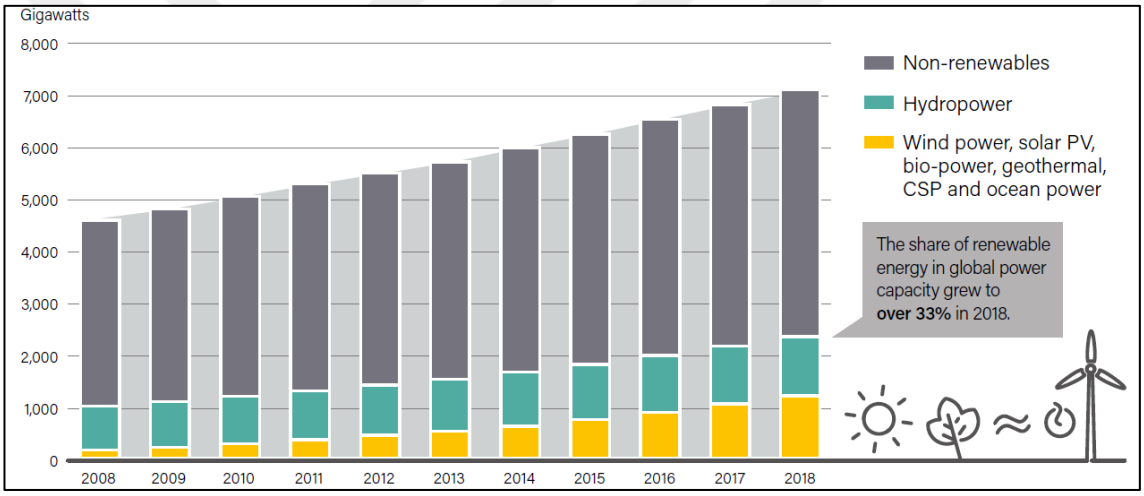
Source: REN21, 2017. Renewables 2017 Global Status Report. Webpage: http://www.ren21.net/gsr-2017/ [accessed date 25.11.2019].

Figure 1.5 shows the increasing installed power development in the world in the last 10 years. Renewable energy resources (Excluding Hydro), which had a very low share compared to the total installed power at the end of 2008, exceeded the installed power of hydro energy at the end of 2018 with significant steps taken. Hydropower is no longer

half its cumulative capacity for renewables, which fell below 48 percent at the end of the year. The rate of new capacity adds were slowing off throughout the year following years of continuous development and global renewable power production by the end of 2018 totaled about 2,378 GW.

Though in many nations, renewable electricity is gaining in popularity rapidly, the dilemma is to achieve a greater share on the global capacity. This is mainly due to ongoing strong growth (up to 4.0% in 2018) and continued increases in the capability and subsidies for fossil fuels (and nuclear).

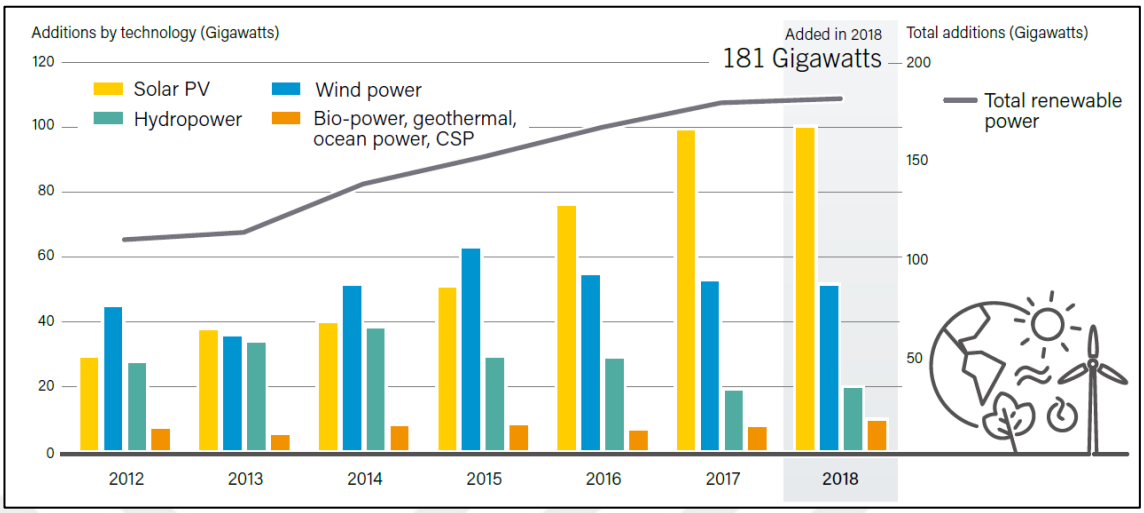
Figure 1.5: Global Power Generating Capacity, by Source 2008-2018



Source: REN21, 2019, Renewables 2019 Global Status Report

At the beginning of 2010, new renewable energy capacities were mainly provided by wind power. However, as of 2016, especially in China, solar power plant investments and increases in solar energy capacity have exceeded the increases in wind energy. In 2018, a total of 181 GW renewable energy capacity increase was experienced worldwide.

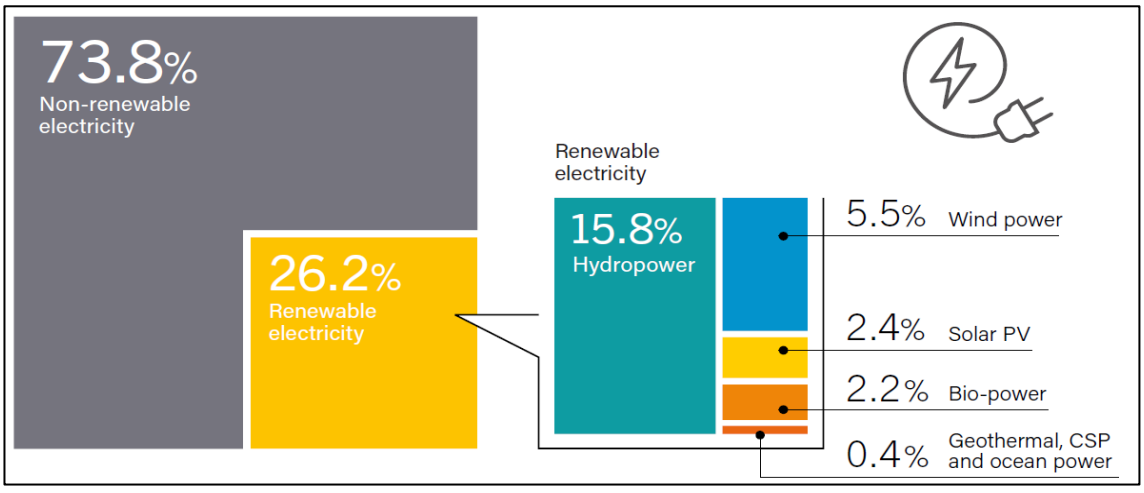
Figure 1.6: Annual Increase on RE Capacity, by Technology and Total



Source: REN21, 2019, Renewables 2019 Global Status Report

Every year renewable energy produces more electric power than last year. Hydropower also contributed for some 60 percent of RE output in 2018, followed by wind 21 percent, solar photovoltaic 9 percent and bio-power 8% percent. The installed RE capacity at the end of this year was sufficient to provide about 26 percent of world's energy generation.[42]

Figure 1.7: End-2018, Projected Share of World Power Output In Renewable Energies

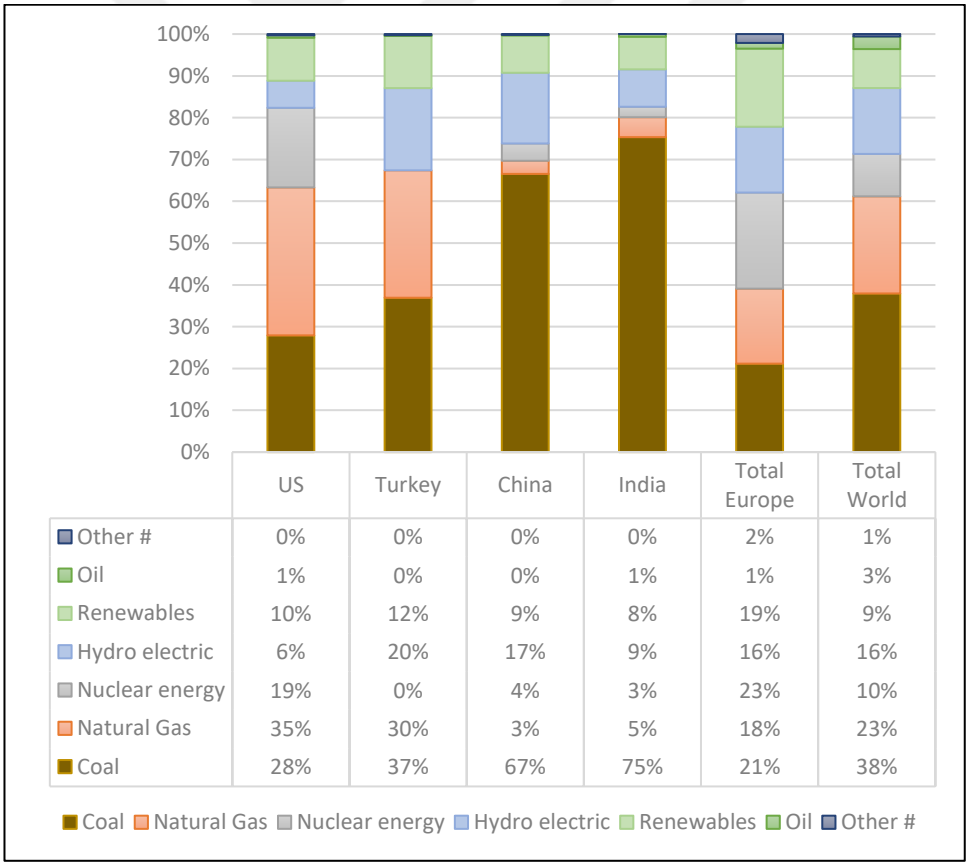


Source: REN21, 2019, Renewables 2019 Global Status Report

[42] REN21, 2019, Renewables 2019 Global Status Report, Webpage: http://www.ren21.net/gsr-2019/ [accessed date 25.11.2019].

As of the end of 2018, we can see the electricity generation sources in Europe and selected countries in the world as follows. By the end of 2018, 38% of the world's electricity demand was provided by coal. The main reason for this is that electricity in countries such as China and India, where electricity consumption is very high, is supplied from coal in the range of 60-70%. Turkey is also used in the world as well as 37% of coal for electricity production. Coal energy usage has increased with the investments made after 2010 in Turkey. In our country, RES are the second source of production. Important arrangements have been made since 2010 in order to increase the electricity obtained from renewable energy sources in our country and as a result of these regulations, 32% of total electricity production (including hydro) as of 2018 has been provided from renewable energy sources. This rate is 7% higher than the world average.

Figure 1.8: 2018 YE Electricity Production by Fuel

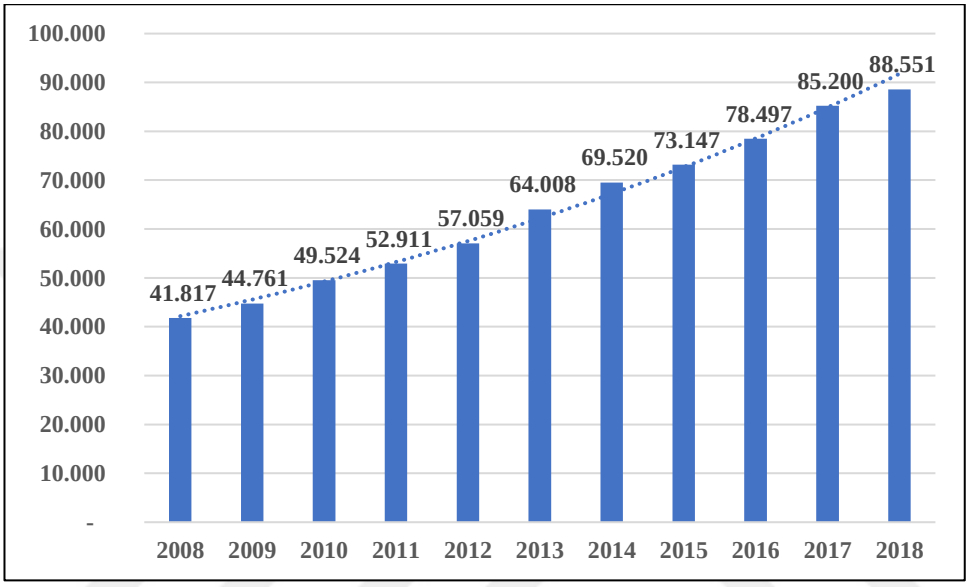


	US	Turkey	China	India	Total Europe	Total World
Other #	0%	0%	0%	0%	2%	1%
Oil	1%	0%	0%	1%	1%	3%
Renewables	10%	12%	9%	8%	19%	9%
Hydro electric	6%	20%	17%	9%	16%	16%
Nuclear energy	19%	0%	4%	3%	23%	10%
Natural Gas	35%	30%	3%	5%	18%	23%
Coal	28%	37%	67%	75%	21%	38%

Source: BP, Statistical Review of World Energy Webpage: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html [accessed date 27.11.2019].

As of the end of 2018 Turkey has reached 88 550 MW of installed capacity (Figure 1.9). 49% of the installed power in our country constitutes renewable energy sources. Comments on the specific situation underlying the rise in renewable energy sources in Turkey will be detailed later in the study.

Figure 1.9: Turkey Installed Capacity Increase in 10 years



Source: Türkiye Elektrik İletim A.Ş (TEİAŞ), Sector Publications, Webpage: https://www.teias.gov.tr/tr/sektor-raporlari [accessed date 3.12.2019]

1.4.3 Where the World stands upon Paris Agreement

After Paris Agreement establishment, the studies conducted since 2016 are closely monitored.

IRENA's Global Energy Transformation report published in 2019 shows that the The mean temperature was about 0.93 ° C beyond the maximum and was 1.04 ° C above the base point over the last five years (2014-2018). Throughout all four Northern Hemisphere basins in 2018, tropical cyclone numbers were higher than ordinary, and 70 cyclones documented up to 20 November of that year, given the long-term average of 53 cyclones per year.

After the establishment of Kyoto Protocol, the global share of Electricity in Total First Energy Consumption (TFEC) was 17% and global renewable share in electricity 18%.

One of the targets was increasing these two shares to certain levels. According to IRENA the aim should be reach 49% electricity share in TFEC and 86% renewable share in electricity. (Table 1.7)

Table 1.7: Electricity in TFEC and Renewable Share in Electricity

	1999	**2010**	**2017**	**2030**	**2040**	**2050**
Share of electricity in final energy Consumption (TFEC)	17%	18%	20%	29%	38%	49%
Renewable energy share in power generation	18%	20%	25%	57%	75%	86%

Source: IRENA, 2019. Global Energy Transformation A Road Map to 2050.

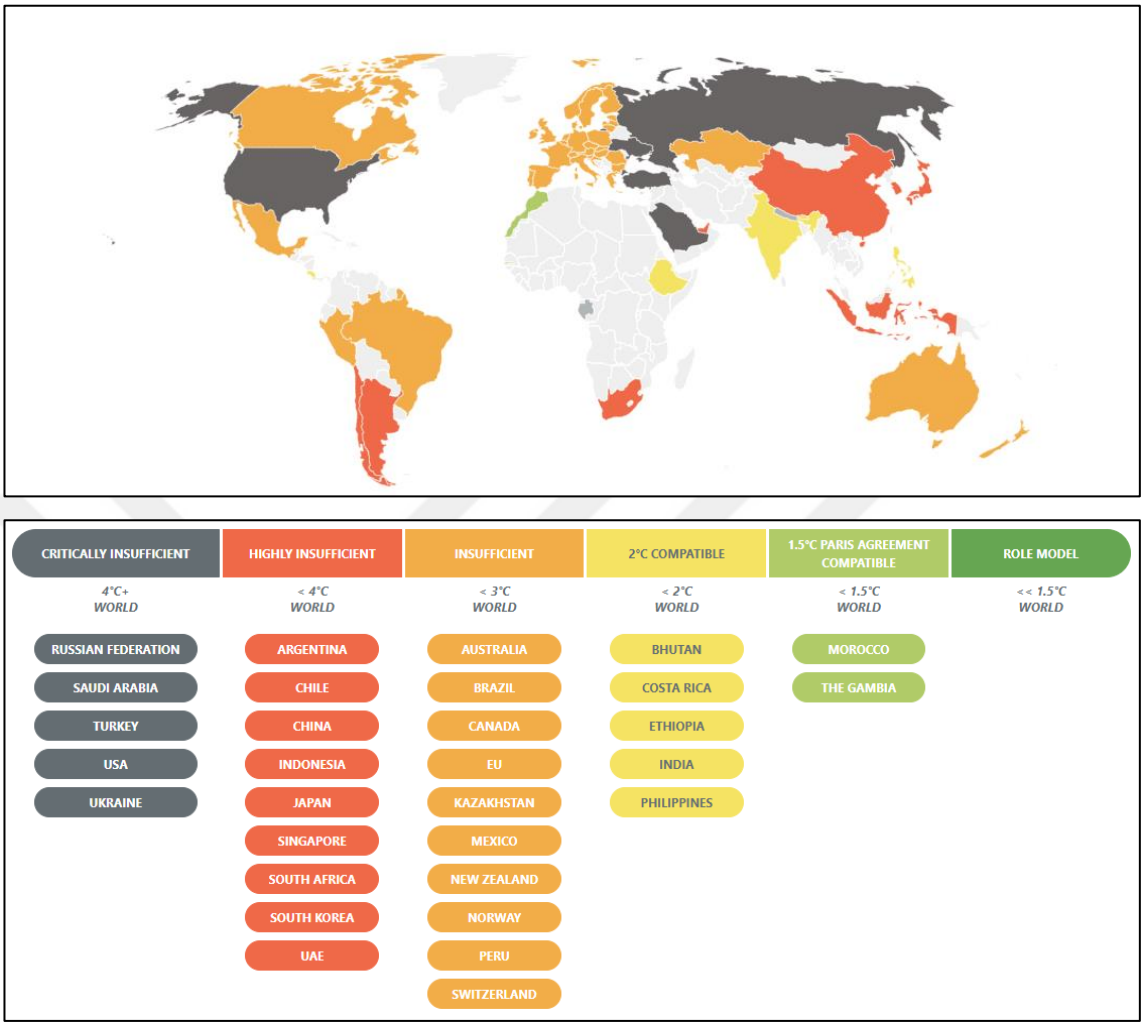
In order to fulfill the objectives of the Paris agreement, the transformation of the global energy system must be significantly accelerated. These goals are to maintain the rise in world average temperatures well below 2 ° C and probably in comparison with pre-industrial levels to limit temperature increase to 1,5 ° C in the present year.[43]

According to another study published by The Climate Action Tracker, it is observed that not all countries except the 7 countries act in accordance with the actions they undertake to keep global warming below 2 degrees under the Paris Agreement.[44]

Turkey is included in the "Critically Insufficient" classification together with Russia, USA, Ukraine and Saudi Arabia. One of the reasons for this classification is shown as ongoing coal investments. This is strongly opposed to the requirement to reduce the worldwide use of coal in power by 2/3 over 2020-2030 and by 2050 to nil.

[43] IRENA, 2019. Global Energy Transformation A Road Map to 2050.
[44] Climate Action Tracker, Webpage: https://climateactiontracker.org/countries/ [accessed date 27.11.2019].

Figure 1.10 - Climate Action Tracker Evaluation for Paris Agreement Countries



Source: Climate Action Tracker, Webpage: https://climateactiontracker.org/countries/ [accessed date 27.11.2019].

2. IMPLIED POLICIES IN TURKEY IN THE SCOPE OF THE RENEWABLE ENERGY TARGETS

Today, political decision makers undertake the regulation of electricity markets, especially through regulators. It can be said that decision makers apply legal regulation in terms of authority certificates, licenses and regulations issued for market actors, administrative regulation in terms of determining their performance and standards and finally price regulations in order to prevent unfair competition. It is important to note that regulation is not only aimed at maximizing consumer benefit, but also to decrease the financial risks, improve quality of services of companies and thus to maximize profit.

In this chapter, information about Turkey electricity market will be compiled, the law that applies to the electricity production from renewable energy will be examined and plans that created in recent years for renewable energy development in Turkey will be examined.

2.1 ELECTRICITY MARKET IN TURKEY

2.1.1 Establishment of Turkey Electricity Authority (TEK) - Law Number 1312

As the key players in the electricity sector in Turkey also in other countries, which is a vertically integrated public company Turkey Electricity Authority (TEK) was created. TEK was established in 1970 with the law numbered -1312 in order to unite the activities of public electricity institutions related to electricity supply under a single roof.[45]

2.1.2 First Indications of Privatization at Energy Sector - Law Number 3096

Turkey's economy is taken within the framework of the promotion of private investment and privatization policies under the liberal policies of the 1980s. 12.04.1984 dated law 3096 has set the first frame of the liberalization of the direction of the energy sector in Turkey and in this period the energy sector traditionally for the activities carried out by

[45] Türkiye Elektrik Kurumu Kanunu, (1312 s.k), Official Gazette, 13559; 25 July 1970.

TEK an administrative monopoly regulating the appointment of private companies has been the main roof of the legislation (Kızıl Voyvoda and Voyvoda 2019). With this law, the production, transmission, distribution and sale of domestic and foreign private companies are made possible through the structure of Build Operate Transfer (BOT) and Operational Right Transfer (ORT). In accordance with the BOT / ORT model defined by Law No. 3096, the ownership of the electricity generation field and facilities remains in the state, and upon the expiration of the authorization period given by the concession agreement, the generation facility and field pass back to the state.[46]

2.1.3 TEAŞ and TEDAŞ Organizations - Law Number 3996

Then TEK, in 1994 Turkey Electricity Generation and Transmission Company (TEAS) and Turkey Electricity Distribution Company (TEDAŞ) is divided into two organizations. However, the Law No. 3996 adopted in 1994 on the establishment of some expenditure and utilities with the BOT Model aims at; In accordance with the Law No. 3096, it is stated to enlarge the BOT model applied in the energy sector to cover other infrastructure projects and services requiring advanced technology and significant financial resources.[47] This law provides for high investment requirements for increasing electricity demand and building the required generation capacity; while reducing public budget commitments.

On the other hand, the methods such as BOT, ORT and Treasury guarantees such as 'buy or pay' and the private investor to guarantee the purchase of goods or services by the government at a certain price are the applications of the state in the process of restructuring the production have been the factors affecting the position of private investors and consumers.

In the end of the 1980s and 1990s, th
ese regulations created a serious organizational and legal confusion in order to overcome the constitutional obstacles to the privatization of vertically segregated activities in the energy sector, which basically identified the owner of the goods and services as the state

[46] Türkiye Elektrik Kurumu Dışındaki Kuruluşların Elektrik Üretimi, İletimi, Dağıtımı ve Ticareti ile Görevlendirilmesi Hakkında Kanun, (3096 s.k), Official Gazette, 18610; 19 December 1984.
[47] Bazı Yatırım ve Hizmetlerin Yap-İşlet-Devret Modeli Çerçevesinde Yaptırılması Hakkında Kanun, (3996 s.k), Official Gazette, 21959; 13 June 1994.

and opened up the right to operate private investors. Not only limited to the liquidation of public entrepreneurship, but also the determination that it would mean the liquidation of public service, which is one of the reasons of existence of the state, these are the evaluations made on this process (Kızıl Voyvoda and Voyvoda 2019).

2.1.4 Build and Operate Model - Law Number 4283

The annulment decision of the Constitutional Court dated 28 June 1995 was published in the Official Gazette on 20 March 1996. The Ministry of Energy introduced the Build-Operate (BO) model this time in order to pursue this cancellation decision. The BO model was first established by the Council of Ministers No. 96/8269 and defined by Law No. 4283 on the "Establishment and Operation of Electricity Generation Plants and Sale of Energy with Build-Operate Model" of 19 July 1997.[48]

The purpose of the Law No. 4283 is stated as "to determine the principles and procedures regarding the electricity sale through the BO model to enable generation firms to establish and run thermal power facilities with their own property in order to generate electricity in accordance with the country's energy plans and policies". Law no. 4283 excludes the generation of energy by hydroelectric, geothermal, nuclear and other RES and regulates the electricity supply for thermal power plants only by allowing the companies to establish and operate facilities under the BO model. Unlike the BOT model, the BO model allows authorized companies to become the owners of the production facilities and does not require the transfer of these facilities to the Ministry of Energy on a specified date.[49]

2.1.5 Change in Constitution - Law Number 4446

On 13 August 1999 with law No. 4446 amended Article 47 of the Constitution, allowing Parliament to transfer or have the services and investments normally required by the Government to be transferred to private institutions, which are not considered as privileges and subject to private law.[50]

[48] Yap-İşlet Modeli ile Elektrik Enerjisi Üretim Tesislerinin Kurulması ve İşletilmesi ile Enerji Satışının Düzenlenmesi Hakkında Kanun, (4283 s.k), Official Gazette, 23054; 19 July 1997.
[49] Yap-İşlet Modeli ile Elektrik Enerjisi Üretim Tesislerinin Kurulması ve İşletilmesi ile Enerji Satışının Düzenlenmesi Hakkında Kanun, (4283 s.k), Official Gazette, 23054; 19 July 1997.
[50] Türkiye Cumhuriyeti Anayasasinin Bazi Maddelerinde Değişiklik Yapilmasina İlişkin Kanun, (4446 s.k), Official Gazette, 23786, 14 Ağustos 2019.

Law No. 4446 also amended Article 125 of the Constitution, paving the way for the disputes arising from licenses, which have the element of foreignness in public service, to be brought to national or international arbitration.[51]

Law No. 4446 amended Article 155 of the Constitution and reduced the position of the Council of State against the concession agreements to the position of the institution giving opinion rather the institution of evaluation. [52]

In the justification of the Law No. 4446, the following statements are included: "various legal issues, foreign capital caused by its still reluctant to invest in Turkey" and "budgetary resources are scarce and needs in countries with unlimited, natural resource expropriation to achieve modern technology economies opportunities for investing in foreign capital. It is an important tool for development" (Kızıl Voyvoda and Voyvoda 2019).

2.1.6 EMRA (EPDK) Establishment - Law Number 4628

In the year 2001 the creation of a strong, financially stable and transparent electricity market which could operate in a competing marketplace in accordance with private law rules, in order to offer consumers sufficient, skilled, ongoing, cheap and environment-friendly electricity; Electricity Market Law no. 4628 has entered into force.[53] In the justification of the Law, 'restructuring the electricity market under free market conditions' is considered as one of the most important reasons for the adoption of this law. For this, it is determined that 'the private sector share in energy investments should increase and a legal and regulatory basis should be established to allow this increase.[54]

[51] Türkiye Cumhuriyeti Anayasasinin Bazi Maddelerinde Değişiklik Yapilmasina İlişkin Kanun, (4446 s.k), Official Gazette, 23786, 14 Ağustos 2019.
[52] Türkiye Cumhuriyeti Anayasasinin Bazi Maddelerinde Değişiklik Yapilmasina İlişkin Kanun, (4446 s.k), Official Gazette, 23786, 14 Ağustos 2019.
[53] Enerji Piyasası Düzenleme Kurumunun Teşkilat ve Görevleri Hakkında Kanun, (4628 s.k), Official Gazette, 24335; 20 February 2001.
[54] Enerji Piyasası Düzenleme Kurumunun Teşkilat ve Görevleri Hakkında Kanun, (4628 s.k), Official Gazette, 24335; 20 February 2001.

Electricity Distribution Service infrastructure, because high investment in infrastructure and require a large amount of financial resources, in Turkey as in many other countries were also occur as a natural monopoly. In this context, the electricity sector was seen as the main element of state-oriented development in the economy in industrial and development plans. Until the adoption of the 2001 Electricity Market Law, problems such as the weak cash flow resulting from the widespread use of illegal electricity and the regulations made to encourage the private sector to produce productive investments may lead to the purchase of expensive electricity by public enterprises. As a mandatory result of this process, a regulator called the Electricity Market Regulatory Authority (EMRA) was established in 2001. Later EMRA was renamed the Energy Market Regulatory Authority with the Natural Gas Market Law no. 4646.

The purpose of the Electricity Market Law is to reduce the share of the public sector in investments and to increase the role of the public sector in supervisory activities effectively; in other words, the division of the electricity sector into sub-sectors at the level of expertise and thus the development of expertise. Therefore, with this law, it is aimed to separate production, transmission, distribution and sales activities from each other in terms of sectoral expertise. In this regard, TEAS, transmission, production and trade activities to be responsible for these activities respectively separated from each other by Turkey Electricity Transmission Co. (TEİAŞ), Electricity Generation Inc. (EGC) Turkey Electricity Trading and Contracting Company (TETAS) has been restructured as divided into three separate State Economic Enterprises.

2.1.7 Reforming Energy Sector - Law Number 6446

The Electricity Market Law no. 6446 entered into force by being published in the Official Gazette dated 30 March 2013 for the same purpose as the Law no. 4628 and repealed the provisions of the Law no. 4628 other than the provisions of the Energy Market Regulatory Authority.[55]

The pre-licensing mechanism was introduced by Law No. 6446. Accordingly, first generation license applicants must be given a pre-license and it is obligatory for the

[55] Elektrik Piyasası Kanunu (6446 s.k), Official Gazette, 28603; 14 March 2013.

license holders to fulfill their pre-construction obligations during the pre-license period. This is maximum 24 months (except EMRA has the authority to extend this period by half) except for force majeure conditions and production license will not be granted to the legal entities who do not fulfill their obligations during this period.[56]

Under the law, competition conditions for the allocation of RE resource areas (YEKA) are regulated and the unlicensed activity based on renewable energy resources is increased from 500KWh installed power to 1MWh. On the other hand, it is aimed to increase the use of national and domestic energy resources by ensuring that EÜAŞ will give priority to domestic coal-fired power plants while meeting potential electricity deficits.[57]

Permits, approvals, licenses, licenses and similar documents related to construction permits for construction of nuclear power generation facilities and other legislation as well as documents regarding the acquisition of ownership or use rights of the site where the generation facility will be established are allowed to be obtained after the generation license is granted.

In order to facilitate the privatization transactions, exceptions that are granted to the generation and distribution companies within this scope and that ensure that the merger, division and transfer of shares of these companies are not subject to VAT and corporate tax are extended until 2023 with this Law.

Again, with this Law, the electricity supply and sales restrictions previously determined as 10% for wholesale companies were increased to 20%. Accordingly, as of the effective date of the Law, the amount of electricity that private sector legal entities holding procurement licenses will purchase from generation and import companies will not exceed 20% of the amount of electricity consumed within the country in the previous year; Furthermore, the amount of electricity to be sold by the private sector legal entities

[56] Elektrik Piyasası Kanunu (6446 s.k), Official Gazette, 28603; 14 March 2013.
[57] Elektrik Piyasası Kanunu (6446 s.k), Official Gazette, 28603; 14 March 2013.

to the final consumer shall not exceed 20% of the amount of electricity consumed in the country in the previous year.

In addition to the above regulations, which are considered to be the aim of ensuring that the electricity activities are carried out in a more liberal environment, quickly and easily, the Law No. 6446 enlarged the sanctions applicable to distribution and commissioned supply companies that perform their activities contrary to the legislation or jeopardize the security of supply due to the nature of public service. it also imposed sanctions for the dismissal of some or all members of the board of directors of these companies and the appointment of EMRA in their place.

2.2 RENEWABLE ENERGY RELATED LAWS

Law No. 5346 on the Use of Renewable Energy Resources for the Purpose of Generating Electrical Energy was adopted on May 10, 2005 and was finalized in 2010 with the amendment numbered 6094. By law, it is envisaged that the plants producing electricity from RE will be supported based on the amount of production. The most important support provided by the public sector to electricity generation investments has been provided by the provisions of this law and the legislation that is a continuation of it.

On 1 October 2013, No. 28782 Regulation on the Certification and Support of Renewable Energy Resources was issued and the standard for the implementation of the No. 6094 law was issued. In this part of the study, FiT incentive support and Local Equipment usage contribution support covered by law will be examined.

2.2.1 Use of Renewable Energy Resources for the Purpose of Generating Electrical Energy - Law Number 5346

A first step for the encouragement of electricity generation from RES in Turkey is the No. 5346 'Law on the Use of Renewable Energy Resources for the Purpose of Generating Electrical Energy'. This law also called as Renewable Energy Law (YEK), is the first legislation to Turkey's RE policy. Our country remained very late compared to many countries in the preparation of the legal basis in the RE field for investors. However, in 2005, YEK was an important step. With this Law No. 5346 Turkey has been introduced

with Feed in Tariff (FiT) incentive mechanism. In addition, support mechanisms for land usage for RE generation have been intiated with this law.[58]

With the enactment of this law in 2005, there has been momentum in the field of RE. However, as a result of the absence of secondary legislation and relatively low levels of fixed price guarantee, investment in RE resources stayed limited from 2005 towards to 2010.

2.2.2 Energy Efficiency - Law Number 5627

The target of the Energy Efficiency Law No. 5627; Efficient energy use, pollution control, economic reduction of energy costs, and increased energy resource efficiency and usage for environmental protection. Law; Energy generation, storage, supply, and usage levels, manufacturing enterprises, houses, infrastructure to produce electrical energy, transmission and distribution networks and transport to improve and promote energy efficiency, public energy understanding, RE options to be applied according to standards and values.[59]

This law also expanded the implementation of the FiT incentive mechanism provided by Law 5346 and increased the rate of support for land use.

2.2.3 Change in Law no 5346 - Law Number 6094

Law No. 6094, which includes provisions on the use of RES in energy production, was adopted in the Turkish Grand National Assembly on 29 December 2010. The Law was published in the Official Gazette No. 27809 on 8 January 2011 and entered into force. The RE law aims to encourage electricity generation in RE through various incentives. These incentives; wind, solar, biomass, hydraulic, and geothermal sources.[60] This Law No. 6094 introduced important innovations and incentives to the existing RE Law (5346 no.). If these changes are listed in articles;

[58] Yenilenebilir Enerji Kaynaklarının Elektrik Enerjisi Üretimi Amaçlı Kullanımına İlişkin Kanun (5346 s.k), Official Gazette, 25819; 10 May 2005.
[59] Enerji Verimliliği Kanunu, (5627 s.k), Official Gazette, 26510; 18 Nisan 2007.
[60] Yenilenebilir Enerji Kaynaklarının Elektrik Enerjisi Üretimi Amaçlı Kullanımına İlişkin Kanunda Değişiklik Yapılmasına Dair Kanun (6094 s.k), Official Gazette, 27809; 8 January 2011.

a. While the support mechanism was processed for the facilities commissioned before 31.12.2015 (it was left to the judgement to Council of Ministers for further extension), it was extended until 31.12.2020 with the Council of Ministers ' judgement.
b. A new fixed price guaranteed plan has been introduced per RE source. Real and legal persons maye use the prices which is in table 2.2 for 10 years if they send the electricity, they generate above their needs to the distribution system (Table 2.1).
c. If the mechanical or electromechanical components used in the production facilities commissioned before 31.12.2020 are produced domestically, for the energy supplied from these facilities and sent to the power network, the local equipment additive included in the table no 2.2.
d. Until the year 2020, 85% discount is applied to the permission, rent, easement and usage permission fees from the RES-based generation facilities (Land use incentives) in the first 10 years of the investment and operation periods.[61]

Table 2.1: FiT Incentives per Plants

Type of Production Facility Based on Renewable Energy Source	**Applicable Prices (US Dollars cent/kWh)**
a. Hydroelectric Power Plant	7,3
b. Wind Energy Power Plant	7,3
c. Geothermal Energy Power Plant	10,5
d. Bio-mass Energy Power Plant (including landfill gas)	13,3
e. Solar Energy Power Plant	13,3

Source: Yenilenebilir Enerji Kaynaklarinin Elektrik Enerjisi Üretimi Amaçli Kullanimina İlişkin Kanunda Değişiklik Yapilmasina Dair Kanun (6094 s.k), Official Gazette, 27809; 8 January 2011.

[61] Yenilenebilir Enerji Kaynaklarının Elektrik Enerjisi Üretimi Amaçlı Kullanımına İlişkin Kanunda Değişiklik Yapılmasına Dair Kanun (6094 s.k), Official Gazette, 27809; 8 January 2011.

Table 2.2: Local Equipment Incentives per Plant

Type of Production Facility Based on RE Source	Local Equipment	Local Equipment Additive (ABD Doları cent/kWh)
A- Hydroelectric Power Plant	1- Turbine	1,3
	2- Generator and power electronics	1,0
B- Wind Energy Power Plant	1- Blade	0,8
	2- Generator and power electronics	1,0
	3- Tower	0,6
	4- All mechanical parts in rotor and nasal groups (except for blade and generator and power electronics payments)	1,3
C- Photovoltaic Solar Power Plant	1- PV panel integration and solar structural mechanics manufacturing	0,8
	2- PV modules	1,3
	3- PV module forming cells	3,5
	4- Inverter	0,6
	5- Material focusing the solar radiation on the PV module	0,5
D- Concentrated Solar Energy Power Plant	1- Radiation collection tube	2,4
	2- Reflective surface plate	0,6
	3- Solar Tracking System	0,6
	4- Mechanical components of heat energy storage system	1,3
	5- Mechanical components of the steam generation system by collecting sunlight in the tower	2,4
	6- Stirling engine	1,3
	7- Panel integration and structural mechanics of solar panels	0,6
E- Bio-mass Energy Power Plant	1- Fluidized bed steam boiler	0,8
	2- Liquid or gas fired steam boiler	0,4
	3- Gasification and gas cleaning group	0,6
	4- Steam or gas turbine	2,0
	5- Internal combustion engine or Stirling engine	0,9
	6- Generator and power electronics	0,5
	7- Cogeneration system	0,4

F- Geothermal Energy Power Plant	1- Steam or gas turbine	1,3
	2- Generator and power electronics	0,7
	3- Steam injector or vacuum compressor	0,7

Source: Yenilenebilir Enerji Kaynaklarinin Elektrik Enerjisi Üretimi Amaçli Kullanimina İlişkin Kanunda Değişiklik Yapilmasina Dair Kanun (6094 s.k), Official Gazette, 27809; 8 January 2011.

2.2.4 Reforming Energy Sector - Law Number 6446

Law no. 6446 brought important innovations and incentives to the existing electricity market system. The changes made within the scope of RE are listed as:

a. The installed capacity of the generation facility based on RES has been increased to 1 MW exempted from license and company obligation, and it has been decided that the installed power of these facilities can be increased up to 5 times (5 MW) by the Council of Ministers for the development of competition and supply security.
b. It has been decided not to apply any limit for RE facilities that meet their own consumption without energizing the network.
c. RE plants containing more than one plant can be agreed to be permitted as an one generation plant if linked from the same point to the network.
d. The documents issued by the State Hydraulic Works (DSI) regarding the agreements use of water and the principle of operation shall be exempt from stamp duty and duties.[62]

2.2.5 Regulation on Certification and Support of Renewable Energy Resources

Provided incentives for RE is carried out under Renewable Energy Resources Support Mechanism (YEKDEM in Turkey). In 2011, the Law No. 6094 on the Amendment of the Law on the Use of Renewable Energy Resources for the Generation of Electric Energy was mentioned in the Law on YEKDEM, and the principles regarding the establishment and operation of YEKDEM defined with the Certification and Support of RE Resources Regulation.[63]

[62] Elektrik Piyasası Kanunu (6446 s.k), Official Gazette, 28603; 14 March 2013.
[63] Yenilenebilir Enerji Kaynaklarının Belgelendirilmesi ve Desteklenmesine İlişkin Yönetmelik, Official Gazette, 28001; 21 July 2011.

FiT was introduced in Turkey in 2005 with Law No. 5346. The support period, which was 7 years in 2005, was increased to 10 years with the Law No. 6094 in 2011. Although the duration of the support changed, the expiration date of the incentive is left as 31.12.2015 same as the previous law. This expiration date was extended to 31.12.2020 with the decision of the Council of Ministers in 2013.

In the following Table 2.3, the number of the YEKDEM participants is given by years. In 2018, there were 708 companies with a total installed capacity of 19.266,29 MW operating in the scope of the RES Support.

Table 2.3: YEKDEM Participant Development

Type	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Solar	-	-	-	-	-	-	2	3
Hydraulic	4	44	14	40	126	388	418	447
Wind	9	22	3	21	60	106	141	151
Biomass	3	8	15	23	34	42	57	70
Geothermal	4	4	6	9	14	20	29	37
Total	**20**	**78**	**38**	**93**	**234**	**556**	**647**	**708**

Source: T.C. Enerji Piyasası Düzenleme Kurumu. 2019. 2018 Electricity Market Development Report 2018. Ankara, p.75.

Table 2.4: Installed Capacity of the YEKDEM Participants by Years (MW)

Type	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Solar	-	-	-	-	-	-	12,90	13,90
Hydraulic	21	930	217	598	2.116,33	9.960,00	11.096,26	11.706,41
Wind	469	685	76	825	2.732,14	4.319,83	5.238,70	6.199,99
Biomass	72	72	140	228	389,92	599,16	752,11	996,78
Geothermal	45	73	101	147	185,23	203,72	299,97	349,21
Total	**608**	**1.760**	**534**	**1.798**	**5.423,63**	**15.082,72**	**17.399,94**	**19.266,29**

Source: T.C. Enerji Piyasası Düzenleme Kurumu. 2019. 2018 Electricity Market Development Report 2018. Ankara, p.75.

The numbers are in Table 2.5 shows that hydraulic plants had the highest share with 11.706,41 MW and WPP following it with 6.199,99 MW.

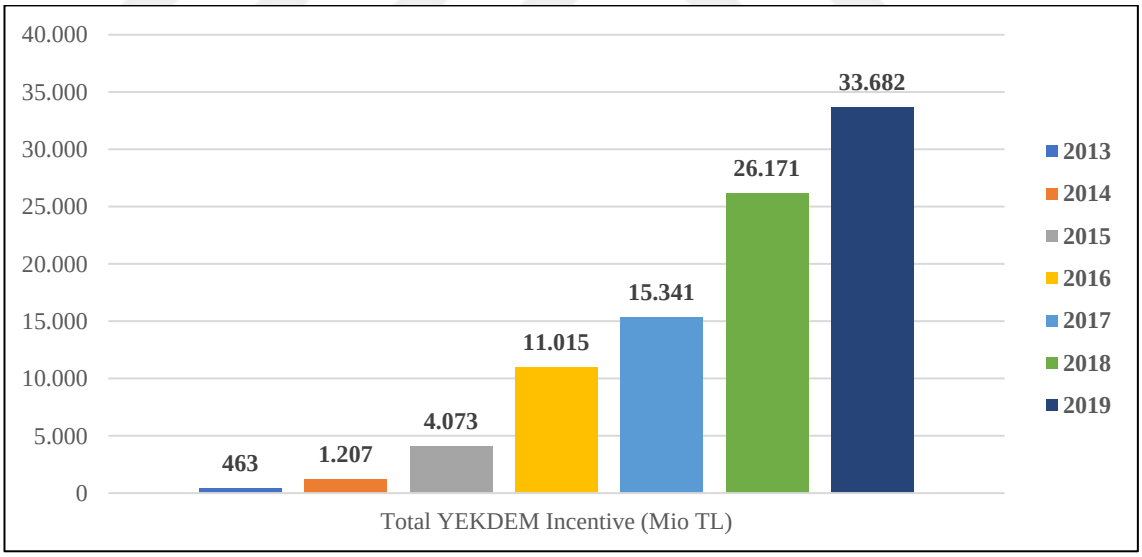
Table 2.5: Yearly generation of YEKDEM participants (MWh)

Type	2012	2013	2014	2015	2016	2017	2018
Solar	-	-	-	-	-	24.268	39.140
Unlicensed	-	-	-	222.724	1.134.024	3.031.558	8.212.478
Hydraulic	2.296.047	528.646	1.072.832	5.683.331	25.520.255	24.417.133	27.338.752
Wind	2.081.745	234.000	2.378.819	8.275.992	14.163.403	16.765.418	19.002.863
Biomass	487.364	857.527	1.436.579	2.710.856	3.706.764	4.503.345	5.968.202
Geothermal	374.002	750.715	925.516	1.050.796	1.306.057	1.789.053	2.047.082
Total	**5.239.158**	**2.370.888**	**5.813.746**	**17.943.699**	**45.830.503**	**50.530.776**	**62.608.517**

Source: T.C. Enerji Piyasası Düzenleme Kurumu. 2019. 2018 Electricity Market Development Report 2018. Ankara, p.76.

As seen on Table 2.5, yearly generations of YEKDEM participants had been increased year by year. By the 2018 YE, 62,6 GWh electricity has been benefit from YEKDEM. Cost of YEKDEM increase by the participant and generation increase. Below figure shows annual cost of YEKDEM shared.

Figure 2.1: Yearly Payments Made within the Scope of the YEKDEM



Source: EPDK, https://seffaflik.epias.com.tr/transparency/uretim/yekdem/toplam-gider-yektob.xhtml [accesed date: 05.12.2019]

2.2.6 Renewable Energy Resource Areas (YEKA) strategy

Promoting the method of procurement of RES in Turkey "Renewable Energy Resource Areas (YEKA) Regulations" was introduced. With this regulation published in 2016, it is regulated for the production of electrical energy from RES. It is aimed to benefit from the

domestic production of advanced technology tools used in RE generation facilities and to ensure the transfer of technology. Within the scope of this regulation, the competition for the right to use YEKA is held. The tender system is implemented through this competition.[64]

YEKA tenders are hybrid type tenders. Following a closed tender procedure, the minimum five bids are invited to be auctioned. The indoor bidding phase describes the price for a ceiling. To minimize the risk of bidding at the lowest price, all bidders must meet the minimum financial and technical requirements specified in the tender notice. In addition, bidders are required to submit their bid and completion guarantees. The basis of YEKA tenders is an industrial policy motivation. This strategy includes a minimum domestic contribution rate, a mandatory local employment rate, and in some cases, the establishment of production and research and development facilities. The lowest price criterion is used in determining the purchase guarantee. The level of purchase guarantee is determined by the winning bid price. Standard punitive measures such as execution of financial guarantees and cancellation of contracts are considered in YEKA tenders (Sarı and Değer 2019).

YEKA tender winner (s) are given connection capacity usage rights. Furthermore, a 15-year energy purchase agreement is concluded with the tender winners over US $ (this does not include the off-shore YEKA tender, which is guaranteed to purchase for the first 50 billion kWh of electricity generated). The purchase guarantee period starts immediately after the agreement is signed in order to encourage the established installed power to switch to energy production as soon as possible. In addition, the allocation of public and treasury properties, connection capacity allocation and licensing processes are facilitated, and administrative processes are shortened, and these facilities are supported by eliminating the obligation of YEKA tenderers to submit resource evaluation reports.[65]

In March 2017, the first solar YEKA tender was held. The second solar YEKA tender was announced in October 2018, which will take place at the end of January 2019, and

[64] Yenilenebilir Enerji Kaynak Alanları Yönetmeliği, Official Gazette, 29852; 9 October 2016.
[65] Yenilenebilir Enerji Kaynak Alanları Yönetmeliği, Official Gazette, 29852; 9 October 2016.

was recently canceled. In August 2017, the first onshore wind YEKA tender was held. The second YEKA onshore wind competition was revealed in November 2018 and established in May 2019. In addition, the first offshore wind YEKA tender was announced in August 2018 and the link capacity in October 2018 was intended to open to the tender. However, this tender was postponed (Sarı and Değer 2019).

The first onshore wind and solar YEKA tenders took place as single-object tenders where the winning consortium was given the right to develop its full tender capacity (1,000 MW). The main reason for these tenders to be 1000 MW in size and single object was to create economies of scale and develop a domestic renewable energy sector by determining minimum domestic contribution rate. The recently announced second onshore wind YEKA tender, the second solar energy YEKA tender, was canceled and was designed as multi-object tenders. The recently canceled second solar energy tender, YEKA, was announced in 3 different competitions, each in a predetermined connection area. Similarly, the second onshore wind YEKA tender was announced in November 2018 with four separate competitions each with a capacity of 250 MW. In addition, the offshore wind YEKA tender was announced as a single object in August 2018, and it is planned to be held in October 2018. Design elements may vary as this tender has recently been postponed to the earliest in 2019. Moreover, Turkey's planned realization in all geographies, each of which is described as the preparations made for the development of 40-50 MW of new solar tenders YEKA (Sarı and Değer 2019).

With the first solar YEKA tender held in 2017, YEKA aims to realize a total network installation capacity of 1,000 MW in 54 months (until the second quarter of 2022) following the signing of the YEKA Right of Use Agreement (15 September 2017). In January 2019, another solar YEKA tender was planned for a total installed capacity of 1,000 MW and the tender capacity was planned to be operational within five years, but this 2nd YEKA tender was recently canceled. In summary, solar YEKA tenders, which have been realized, announced or canceled so far, are planned to be installed by 1.000 MW solar capacity by the second quarter of 2022 (Sarı and Değer 2019).
Table 2.6 summarizes the design elements of the five YEKA auctions awarded or announced as of December 2018.

Table 2.6: Status of YEKA auction design elements

Design elements	Solar PV 1	Solar PV 2	Wind onshore 1	Wind onshore 2	Wind off shore
Date	Announced: October 2016 Awarded: March 2017	Announced: October 2018 Canceled: 13 January 2019	Announced: April 2017 Awarded: August 2017	Announced: November 2018 Awarded: May 2019	Announced: June 2018 / postponed
Regularity/periodicity	No calendar established.				
Authority	MENR				
Object of auction					
Capacity	1 GW	1 GW	1 GW	1 GW	1,2 GW
Item	Single	Multiple: 500 MW at Şanlıurfa-Viranşehir; 200 MW at Hatay-Erzin; 300 MW at Niğde-Bor.	Single	Multiple 4x250 MW The total installed capacity in each site cannot be lower than 70% (175 MW) of the auctioned item (259 MW).	Single
Power purchase agreement (PPA)	15 years in US$	15 years in US$	15 years in US$	15 years in US$	Power Purchase Guarantees for the first 50 TWh of the electricity produced
Technology	Solar PV	Solar PV	Wind onshore	Wind onshore	Wind offshore
Site	Konya Karapınar	3 regions: Şanlıurfa-Viranşehir, Hatay-Erzin, Niğde-Bor	5 regions: Kayseri-Niğde, Sivas, Edirne-KırklareliTekirdağ, Ankara-Çankırı-Kırıkkale, Bilecik-Kütahya-Eskişehir	4 regions: Balıkesir, Çanakkale, Muğla, Aydın	3 regions: Saros, Gelibolu, Kıyıköy
Project size			At least 50 MW at each pre-defined zone		
Type of auction	Hybrid: Sealed bid, followed by reverse auction. The lowest fi ve bidders are invited to the reverse auction.				
Ceiling prices	US$8 ct/kWh	US$6.50 ct/kWh	US$7 ct/kWh	US$5.5 ct/kWh	US$8 ct/kWh
Requirements	Minimum of financial & technical reputation				Minimum of financial & technical reputation. Minimum requirement for system components

Guarantees	Bid bond (US$10 million) Completion bond (US$50 million)	Bid Bond: Şanlıurfa-Viranşehir (US$3 million); Hatay-Erzin (US$1.5 million); Niğde-Bor (US$2 million). Completion Bond: Şanlıurfa-Viranşehir (US$15 million); Hatay-Erzin (US$8 million); Niğde-Bor (US$12 million).	Bid bond (US$10 million) Completion bond (US$50 million)	Bid bond (US$2.5 million) Completion bond (US$12.5 million)	Bid bond (US$2.5 million) Completion bond (US$12.5 million)
Local content requirements	Not less than 65% local content. The winning bidder will also have to install a solar panel manufacturing plant of at least 500 MW capacity in Turkey, in less than two years (21 months after the contract date). 100 permanent technical personnel will be employed at the Research and Development (R&D) center	Solar panel, not less than 60%. Other system components (cable), not less than 51%. No requirements on local employment.	Not less than 65% local content. 80% of engineers to be employed on the project is required to be Turkish nationals. Developing a local R&D center is mandatory	Minimum 55% for wind turbines. Turbine tower: 65%, Blade: 60%, Other parts: 51%. Wind turbines are to be produced with up-to date technology, IEC 61400 standards series and with 3.0 MW of minimum power.	Not less than 60% local content. 80% of project employees are required to be Turkish nationals.
Selection criteria for winning bids	Lowest price				
Establishing the final price	Paid-as-bid				
Penalties	Execution of the guarantees. Cancellation of the contract (PPA)				
Policy mechanisms	Facilitation of administrative processes, land use rights and connection infrastructures.				
Information and transparency	No official repository containing all official auction information or additional information to facilitate the development of bids.				

Source: SHURA, 2019, Opportunities to strengthen the YEKA auction model for enhancing the regulatory framework of Turkey´s power system transformation, pg. 16-19

2.3 ACTIONS THAT HAVE BEEN TAKEN FOR RENEWABLE ENERGY DEVELOPMENT IN TURKEY

Turkey, after being included in the Kyoto Protocol in 2009, has announced a series of strategy and action plan on climate change and usage of renewable energy. In this section, the strategic plans and targets achieved in relation to renewable energy since 2009 will be evaluated.

2.3.1 Electrical Energy Market and Supply Security Strategy -2009

According to the Electrical Energy Market and Supply Security Strategy document prepared by the Ministry of Energy on May 18, 2009, approved by the High Planning Council, the targets for electricity market operation and supply security were determined until 2023. This strategy carries Turkey's first working document that sets out the nature of the RE target for the year 2023. The scope of the study is given below.

a. The usage of domestic hard coal and lignite for the purpose of generating electricity will continue.
b. Studies on the electric generation from nuclear energy will continue. The electricity produced from nuclear power plants is projected to account for at least 5% of overall production by 2020.
c. The main objective is to ensure that the share of electricity produced from RES in total electricity production is at least 30% in 2023. In this context;
    i. Until 2023, all of the technically and economically feasible hydroelectric potential will be utilized.
    ii. It is aimed to increase the wind power installed capacity to 20,000 MW by 2023.
    iii. The geothermal potential of 600 MW, which is determined to be suitable for generation for electricity, will be put into operation by 2023.
    iv. In order to ensure that solar energy is used in electricity generation, it is aimed to make necessary arrangements, studies and technological developments.
d. As a result of the measures to be taken for the use of domestic and RES, it is aimed to decrease the portion of natural gas in electricity generation to below 30%.

e. The use of domestic resources for electricity production is a priority and taking into consideration the developments in the use of these resources and supply security, high quality imported coal-based power plants will also be utilized.[66]

2.3.2 MENR Strategic Plan – 2010 – 2014

MENR in 2010 has prepared a Strategic Plan for 2010-2014 years energy policies. The five-year strategic objectives and goals for the energy supply, regional and global energy efficiency, in the energy, environmental and natural resources sector, are identified in the Strategic Plan designed with national priorities.[67]

Targets has been determined in this strategic plan, regarding the use of RES and other energy sources, which is the scope of the study, are given below.

a. *Target 1.2***:** 3.500 Megawatt (MW) domestic coal fired thermal power plants will be completed by the end of 2013
b. *Target 1.3:* Until 2014, the construction of the NPP is going to be initiated.
c. *Target 2.1:* The construction of 5000 MW hydroelectric power plants will be completed by the end of 2013.
d. *Target 2.2:* By 2009, installed wind power will rise to 10,000 MW by 2015 from 802.8 MW.
e. *Target 2.3:* The installed geothermal capacity would rise to 300 MW by 2015[68]

When the available data is examined, it is seen that the above targets for electricity generation, only Target 2.1 and Target 2.3 have been completed.

2.3.3 The National Climate Change Adaptation Strategy and Action Plan – 2012

First, the National Climate Change Adaptation Strategy and Action Plan was published in Turkey in 2012. National Climate Change Adaptation Strategy and Action Plan, areas of vulnerability to climate change in Turkey, supported by the technical and scientific studies and focuses on five key areas adopted by the participatory process. These;

[66] T.C. Başbakanlık Devlet Planlama Teşkilatı. 2009. Elektrik Enerjisi Piyasası ve Arz Güvenliği Stratejisi Belgesi. Ankara. https://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FSayfalar%2FElektrik+Enerjisi+Piyasas%C4%B1+ve+Arz+G%C3%BCvenli%C4%9Fi+Strateji+Belgesi.pdf [accessed date 7.12.2019]
[67] T.C. Enerji ve Tabii Kaynaklar Bakanlığı. 2010. 2010–2014 Stratejik Planı. Ankara.
[68] T.C. Enerji ve Tabii Kaynaklar Bakanlığı. 2010. 2010–2014 Stratejik Planı. Ankara.

i. Risk management of natural disasters;
ii. Management of water resources
iii. Human health
iv. Biodiversity and forestry ecosystem services;
v. Assurance of agriculture and food;

One of the goals set in the National Climate Change Strategy is to increase to 30% the share of RE in the total electricity generation in Turkey until 2023. Turkey's indigenous resources of coal, hydroelectric, wind, geothermal and solar energy, mainly variety of energy sources, energy security and climate change objectives in line with the highest level of benefit is planned.[69]

In the field of water resources management, which is one of the five main strategies, one target for RE has been set. "Target 5.1 Planning of hydraulic and geothermal energy resources from the perspective of adaptation to climate change". Within the scope of this objective, the importance of climate risk policies in hydroelectric power plants and geothermal power plants, which play a vital role among RE investments, is emphasized. Environmental, economic and sociocultural effects as well as the effects of climate change should be taken into consideration for the selection and planning of HEPPs.[70]

The Electricity Market and Supply Security Strategy Paper sets various targets to increase the production capacity of geothermal resources to 600 MW. According to the Climate change impacts and mitigation, it is planned to review the Law on Geothermal Resources and Natural Mineral Water No. 5686. Regional heating applications and widespread use of geothermal heat pumps in geothermal energy use are also considered as important tools for adaptation to climate change.[71]

[69] T.C. Çevre ve Şehircilik Bakanlığı. 2012. Turkiye'nin İklim Değişikliği Uyum Stratejisi ve Eylem Planı 2011-2023. Ankara, https://webdosya.csb.gov.tr/db/iklim/editordosya/uyum_stratejisi_eylem_plani_TR.pdf [accessed date 08.12.2019]
[70] T.C. Çevre ve Şehircilik Bakanlığı. 2012. Turkiye'nin İklim Değişikliği Uyum Stratejisi ve Eylem Planı 2011-2023. Ankara, https://webdosya.csb.gov.tr/db/iklim/editordosya/uyum_stratejisi_eylem_plani_TR.pdf [accessed date 08.12.2019]
[71]T.C. Çevre ve Şehircilik Bakanlığı. 2012. Turkiye'nin İklim Değişikliği Uyum Stratejisi ve Eylem Planı 2011-2023. Ankara,

2.3.4 The National Renewable Energy Action Plan – 2014

Turkey is a nominee for European Union membership. Energy was one of the most important sections of the EU acquis. RE Directive,' Directive2009/28/EC on the development of the use of RES encourages every Member country to create and implement a National Renewable Energy Action Plan (NREAP) for the term 2011-2020 to be submitted to the European Commission (EC) by 30 June 2010 with a view to achieving the concrete targets set out in the Directive.[72]

The directive stipulates that, through a Commission Decisión of 30 June 2009 establishing a template for national action plans for renews in line with the National Action Plan 2009/28/EC, the NREAP is supposed to comply with the national action plan template agreed by the European Commission. Turkey has established this action plan as a candidate country as a reflection of its contribution to these renewable energies goals and EU membership.[73]

This action plans offers suggestions relating to Turkey's targets in RE and energy efficiency by. This study rather than a strategic plan, recommend practices by comparing the application in Turkey and EU practices. See below for all suggestions and precautions.

https://webdosya.csb.gov.tr/db/iklim/editordosya/uyum_stratejisi_eylem_plani_TR.pdf [accessed date 08.12.2019]

[72] T.C. Enerji ve Tabi Kaynaklar Bakanlığı. 2014. National Renewable Energy Action Plan for Turkey. December 2014. Ankara

[73] T.C. Enerji ve Tabi Kaynaklar Bakanlığı. 2014. National Renewable Energy Action Plan for Turkey. December 2014. Ankara

Figure 2.2: Overview of Renewable Energy installed capacity Targets at 2023.

	Base year		2013		2014		2015		2016		2017	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Hydropower:	19,620	57,837	22,289	59,420	23,908	64,359	25,526	68,767	27,145	73,175	28,763	77,584
Geothermal energy:	162	849	310	1.364	338	1,724	412	2,099	485	2,474	559	2,849
Solar energy:	-	-	-	-	40	64	300	480	800	1,280	1,800	2,880
photovoltaics	-	-	-	-	40	64	300	480	800	1,280	1,800	2,880
concentrated solar energy	-	-	-	-	-	-	-	-	-	-	-	-
Tides, waves, other ocean energy:	-	-	-	-	-	-	-	-	-	-	-	-
Wind energy:	2,261	5,970	2,759	7,494	3,759	9,398	5,660	14,151	7,604	19,010	9,549	23,873
land-based	2,261	5,970	2,759	7,494	3,759	9,398	5,660	14,151	7,604	19,010	9,549	23,873
offshore	-	-	-	-	-	-	-	-	-	-	-	-
Biomass:	159	721	224	1,171	300	1,367	377	1,719	453	2,071	530	2,422
Overall:	22,202	65,377	25,582	69,449	28,345	76,911	32,275	87,215	36,487	98,010	41,201	109,608

	2018		2019		2020		2021		2022		2023	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Hydropower:	30,382	81,992	32,000	86,400	32,500	87,750	33,000	89,100	33,500	90,450	34,000	91,800
Geothermal energy:	632	3,224	706	3,599	779	3,975	853	4,350	926	4,725	1,000	5,100
Solar energy:	2,400	3,840	3,000	4,800	3,600	5,760	4,000	6,400	4,400	7,040	5,000	8,000
photovoltaics	2,400	3,840	3,000	4,800	3,600	5,760	4,000	6,400	4,400	7,040	5,000	8,000
concentrated solar energy	-	-	-	-	-	-	-	-	-	-	-	-
Tides, waves, other ocean energy:	-	-	-	-	-	-	-	-	-	-	-	-
Wind energy:	11,458	28,644	13,308	33,270	15,090	37,725	16,800	41,999	18,436	46,089	20,000	50,000
land-based	11,458	28,644	13,308	33,270	15,090	37,725	16,800	41,999	18,436	46,089	20,000	50,000
offshore	-	-	-	-	-	-	-	-	-	-	-	-
Biomass:	606	2,774	683	3,126	759	3,477	836	3,829	912	4,181	1,000	4,533
Overall:	45,478	120,474	49,697	131,196	52,729	138,687	55,488	145,678	58,174	152,485	61,000	159,433

Source: T.C. Enerji ve Tabi Kaynaklar Bakanlığı. 2014. National Renewable Energy Action Plan for Turkey. December 2014. Ankara

Figure 2.3: Overview of all policies and measures to promote the use of energy from renewable resources

Name and reference of the measure	Type of measure[12]	Expected result[13]	Target group and/or activity[14]	Exists/Is planned	Date of the beginning and end of the measure
Feed-in tariff scheme. ***The Law on the Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (Law No: 5346) and its amendment (Law No: 6094) (8).*** *The end date of the feed-in tariff scheme was extended to December 31, 2020 according to the Board Decision published in the Official Gazette on December 5, 2013 (No: 28842, Decision No: 2013/5625)*	Financial	Investments in renewable energy. New power capacity.	Investors, Private households	Exists	2005 - 2020
Incentive to promote the use of local equipment. ***Local incentives for renewable energy technologies stated in Renewable Energy Law (No:5346)***	Financial	Investments in renewable energy. New power capacity and energy generation for heating.	Industrial players, Investors Energy Investors, Industrial players	Exists	2010 - 2030
Investment Incentives Program. ***The New Investment Incentives Program in Turkey has been in effect since the January 1, 2012 (12).***	Financial	New power capacity and energy generation for heating	Energy Investors, Industrial players	Exists	2012 - on-going
Support from major international financial institutions. ***Promoting support from major institutions, such as TurSEFF and MidSEFF provided by EBRD, the World Bank, the Industrial Development Bank of Turkey (TSKB), the International Finance Corporation (IFC) and the Technology Development Foundation of Turkey (TTGV).***	Financial	Investments in renewable energy. New power capacity and energy generation for heating.	Industrial players, Investors	Exists	2012-2023
Subsidized long-term loans for renewable energy projects. ***In the short term, the Turkish Government, in collaboration with the Turkish financial sector and international financial institutions focused on economic development, will analyze the possibility of enabling mechanisms to provide long-term loans for renewable energy project construction and implementation.***	Financial	Investments in renewable energy. New power capacity and energy generation for heating.	Energy promoters, Investors.	Under consideration	Under consideration
Advisory services, provided by government agency under the General Directorate of Mineral Research and Exploration (MTA), on engineering and best practices in resource development	Technical	Use of geothermal potential more targeted development effort	Geothermal promoters/ investors	Under consideration	Under consideration

Name and reference of the measure	Type of measure[12]	Expected result[13]	Target group and/or activity[14]	Exists/is planned	Date of the beginning and end of the measure
Financial support to private sector for geothermal exploration activities. ***In the short term, the Turkish Government in collaboration with the Turkish financial sector and international financial institutions focused on economic development will consider analyzing the possibility of enabling mechanisms that mitigate capital risk to support geothermal exploration and drilling activities***	Financial	Use of geothermal potential.	Geothermal promoters / investors	Under consideration	Under consideration
Support for the MTA in expanding its early stage of geothermal exploration activities. ***Turkish Government, in collaboration with the international financial institutions focused on renewable energy development, will consider analyzing the possibility of providing support to the MTA in scaling-up surface and shallow drilling exploration activities across the country***	Technical / Financial	Greater exploration of geothermal potential	MTA	Under consideration	Under consideration
Land Usage Fee Incentives (Law No: 6094) (8). *Discount of 85% for permission, lease, easement rights and servitude right fees for generation facilities based on renewable energy resources. It will be applicable for the first 10 years, including the period of investment and operation.*	Legislative	Investments in renewable energy. New power capacity and energy generation for heating.	Investors	Exists	2005 - 2020
Reduction in electricity bills, in-house waste treatment facilities. **Law on the Environment *(Law No: 2872)* (9)**, *amended in 2006, establishes that industrial plants receive a reduction of up to 59% of their electricity bills if they set up their own waste treatment facilities.*	Legislative	Licensed use of waste.	Investors	Exists	2006 -
Permits unlicensed power generation up to 1 MW and the receipt of feed-in tariff revenue. **Electricity Market *(Law No: 6446)* (6).**	Legislative	Investment in renewable energy and distributed generation.	Private households, Investors	Exists	2013 -
Permits unlicensed power generation up to 5 MW and the receipt of feed-in tariff revenue. **Electricity Market *(Law No: 6446)* (6).**	Legislative	Investment in renewable energy and distributed generation.	Private households, Investors	Planned	Under consideration
Reviewing of procedures for licensing and issuing of permits for unlicensed generation, in order to reduce their costs and establish deadlines for the different administrative tasks. ***In the medium term there will be a revision of administrative requirements to avoid delays and adopting the procedure outlined in Directive 2006/123/EC on services in the internal market.*** ***Among others, the following measures will be taken into consideration: positive administrative silence, time limit for administrative tasks and a one-stop-shop.***	Legislative	Enabling promotions of facilities.	Investors	Planned	Under consideration
Reviewing of licensing and issuing of permit procedures for renewable energy facilities in order to avoid delays. ***In the medium term, there will be a revision of the administrative requirements, avoiding delays and adopting the procedure outlined in Directive 2006/123/EC on services in the internal market.*** ***Among others, the following measures will be taken into consideration: positive administrative silence, time limit for administrative task and a one-stop-shop.***	Legislative	Enabling promotion of facilities.	Investors	Regulation studies for authorization of General Directorate of Renewable Energy in the name of Ministry of Energy and Resources are ongoing	Under consideration

Name and reference of the measure	Type of measure[12]	Expected result[13]	Target group and/or activity[14]	Exists/Is planned	Date of the beginning and end of the measure
Review of Transmission System Operator legal framework. ***In the medium term, a revision might be considered for the system operator revenue model: an incentive based on renewable energy penetration could be established taking into consideration the positive externalities.***	Legislative	Enabling facilities promotion	Investors, TEİAŞ	Under consideration	Under consideration
Grid operation procedures to enable large renewable energy penetration.	Soft	Improvement of the transmission grid and enabling renewable energy capacity connection.	Investors, TEİAŞ	Planned	Under consideration
Implementation of systems to monitor and manage renewable energy penetration in the grid and monitoring in the same center which should be close to National Load Dispatch Center (MYTM). ***TEİAŞ considers Implementing, in the short and medium term, systems for monitoring and managing a large number of renewable energy facilities***	Soft	Enabling renewable energy capacity connection.	Investors, TEİAŞ	Planned	Under consideration
Implement the legal framework to develop distributed generation based on renewables. ***Establish the following: connection to the grid, creating the revenue model, distribution system balancing and signaling.***	Legislative	Increase of distributed renewable energy.	DSO, Investors, Households	Planned	Under consideration
Reinforce International electricity interconnections. **Georgia, Azerbaijan, Armenia, Iran, Iraq, Syria, Bulgaria and Greece.**	Soft	Enable the penetration of RES and improve the reliability of the system.	Energy promoters, TEİAŞ	Exists (being developed)	2012-ongoing
Obligation to purchase the excess electricity generated. ***The Law on the Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (Law No: 5346)*** **(7)** *says that distribution companies holding retail licenses are obligated to purchase the excess electricity generated by the unlicensed renewable energy generators (at feed-in tariff prices).*	Legislative	Enable RES penetration.	Investors	Exists	2005
Establish incentives to promote the installation of capacitor banks in wind farms.	Legislative	Improvement of energy quality and system reliability. Incentive for wind energy penetration.	Wind energy investors, TEİAŞ	Planned	Under consideration
Biofuels obligation ***To obtain a biodiesel content of at least 1% by January 1, 2014, 2% as of January 1, 2015, and 3% as of January 1, 2016 (this regulation was cancelled according to Official Gazette No. 28688 which was published on June 25, 2013).*** ***To obtain a bioethanol content of at least 2% as of January 1, 2013, and 3% as of January 1, 2014.***	Legislative	Increased use of biofuels.	Biofuel Investors, Transportation sector Ministry of Food, Agriculture and Livestock Ministry of Energy and Resources	Exists	2013 -
Biofuels tax exemption **The Energy Market Regulator** ***Authority has established that 2% of biofuels (biodiesel and bioethanol) produced from domestic raw material that is blended with diesel fuel is exempt from the special consumption tax (ÖTV is the Turkish acronym).***	Legislative	Increased use of biofuels.	Biofuel Investors, Transportation sector Ministry of Food, Agriculture and Livestock Ministry of Energy and Resources	Exists	2011 -
Stimulate collaboration plans between biomass energy investors and the agriculture sector.	Soft	Increased biomass usage.	Investors, Farmers	Planned	Under consideration

Name and reference of the measure	Type of measure[12]	Expected result[13]	Target group and/or activity[14]	Exists/Is planned	Date of the beginning and end of the measure
Incentives to develop energy crops.	Legislative	Increased use of biofuels.	Biofuel Promoters, Investors, Transportation sector, Ministry of Food, Agriculture and Livestock	Partially exists	Under consideration
Develop the Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings in order to promote distributed generation based on renewable energy in buildings and zero emission buildings.	Legislative	Promote distributed generation based on renewable energy.	Investors, Households YEGM	Partially exists	Under consideration
Training and education initiatives. Introducing specific programs that enable personnel to deal with new energy technologies: training plans, and academic involvement.	Soft	Establishing qualifications for professionals.	Professionals, Population at large.	Planned	Under consideration
Introduction of green certificates for electricity generated in renewable energy power plants.	Legislative	Increased preference for renewable energy consumption will further that will further encourage its generation	All renewable energy investors	Planned	Under consideration
Within the scope of Renewable Energy Resources Area Regulation (YEKA), the measurement of selected solar fields to be completed under one unit	Legislative	To prevent effort, resource and time loss due to measurement of areas close to each other.	Solar energy investors	Planned	Under consideration
Combination of generation and power	Legislative	Removing the disadvantage of not experiencing scale economy for the small scale investments.	All renewable energy investors	Planned	Under consideration
Actualization of Renewable Energy Cooperatives	Legislative	Easy access to project finance for licensed and unlicensed projects and enabling scale advantage	All renewable energy investors	Planned	Under consideration
Financial support to promote the development of the Hot Dry Rock geothermal technology	Financial	Investment in research activities to develop materials and technology	Investors	Planned	Under consideration
Financial support for the promotion for Tidal/Wave, sea thermal, and marine current energy technologies	Financial	Use of tidal/ wave and current potential.	Investors	Planned	Under consideration
Development of the Turkish National Energy Efficiency Action Plan (NEEAP)	Legislative	Promote energy efficiency actions	Turkish Government, Energy Sector	Planned	Under consideration

Source: T.C. Enerji ve Tabi Kaynaklar Bakanlığı. 2014. National Renewable Energy Action Plan for Turkey. December 2014. Ankara

2.3.5 MENR Strategic Plan – 2015 - 2019

The 2015-2019 Strategic Plan is structured on themes that meet the current needs and expectations of the sector in energy and natural resources, and which are deemed necessary for policy development, primarily for improving the institutional and administrative capacity of the Ministry. In the 2015-2019 Updated Strategic Plan of the Ministry, which consists of 8 themes, 16 objectives and 61 objectives in total:

Table 2.7: 2015-2019 Strategic Plan Themes

General Directive	Energy	Natural Resources
Good governance and stakeholder interaction	Supply security,	Efficient use of raw materials
Regional and international events	Energy efficiency and saving	Raw material supply security
Technology, R & D and innovation		
Improving the investment environment		

Source: T.C. Enerji ve Tabii Kaynaklar Bakanlığı. 2014. ETKB 2015-2019 Stratejik Planı, Ankara

Below mentioned targets has been determined in this strategic plan, respecting the utilization of RES and other energy sources, which is the scope of the study, are given below.

a. *Target A2.1.:* In 2019, the amount of electricity generated from domestic coal will be increased to 60 billion kWh per year.
b. *Target A2.2:* The existing domestic coal resources will be transformed into electricity generation investments and new resources will be explored.
c. *Target A.2.3:* The share of RES in electricity supply is going to be increased and new resources will be explored.
    a. 32.000 MW HPP, 10.000 MW WPP, 1.300 MW GPP, 3.000 MW SPP, 700 MW BPP will be reached by end of 2019.
d. *Target A.2.4:* In 2019, the share of natural gas-based electricity production in total production will be reduced to 34%.[74]

[74] T.C. Enerji ve Tabii Kaynaklar Bakanlığı. 2014. ETKB 2015-2019 Stratejik Planı, Ankara

2.3.6 10th Development Plan

The practices and policies associated to the clean energy and different energy resources included in the 10th Development Plan prepared by the Turkish Ministry of Development in 2014 are as follows.

Target: On the basis of the continuous, high quality, safe provision of energy to the end user with lowest costs and diversification of resources in energy supply. Core reason of this plan is to build competitive energy environment which evaluates domestic and RES at the highest level, uses nuclear technology to generate electricity, facilitates economic energy intensity reduction, eliminates pollution and environmental energy impacts, and enhances the country's strategic position in global energy exchange.[75]

Table 2.8: 10th Development Plan Energy Targets

	2006	2012	2013	2018
Primary Energy Demand (BTEP)	99.642	119.302	123.600	154.000
Electric Power Demand (GWh)	174.637	241.949	255.000	341.000
Primary Energy Consumption Per Capita (TEP / person)	1,44	1,59	1,62	1,92
Electricity Consumption Per Person (kWh / person)	2.517	3.231	3.351	4.241
Share of Natural Gas in Electricity Production (%)	45,8	43,2	43	41
Share of Renewable Resources in Electricity Production (%)	25,3	27	27,7	29
Installed Power (MW)	40.565	57.058	58.500	78.000
Energy Density (TEP / 1000 USD) 2	0,288	0,276	0,272	0,243

Source: T.C. Kalkınma Bakanlığı. 2013. 10. Kalkınma Planı (2014-2018). Ankara

Policies

a. A fair diversification of capital and country of origin will be accomplished on the basis of primary energy reserves, and the proportion of local and RE assets within the production environment will be expanded as much as possible

[75] T.C. Kalkınma Bakanlığı. 2013. 10. Kalkınma Planı (2014-2018). Ankara, http://www.sbb.gov.tr/wp-content/uploads/2018/11/Onuncu-Kalk%C4%B1nma-Plan%C4%B1-2014-2018.pdf [accessed date 8.12.2019]

b. Public investment in power control will be retained so that the electrical system is safeguarded. Necessary expenditure to introduce RE electricity generation into the grid without breaching system security
c. The construction of the first unit of Akkuyu NPP during the Plan period will be largely completed. In addition, the development of a second NGS in Sinop will begin. During the plan period, the site determination, pre-feasibility and investment preparations of a third 5,000 MW NGS will be started
d. It is intended to strengthen the legal and structural infrastructure for nuclear energy. The establishment of an independent, powerful and capable nuclear regulatory and monitoring system to detect and verify the safe and reliable conduct of nuclear programs
e. Storage, management and disposal policies of radioactive wastes; healthy information and transparency. Competence in the field of nuclear technology in our country and increasing domestic contribution, especially in construction, will be supported
f. Domestic coal resources will be converted into electrical energy by the private sector by using highly efficient and environmentally friendly technologies. Afşin-Elbistan basin lignite reserves will be evaluated for electricity generation. It will be ensured that small reserves of coal deposits will be utilized in regional energy production facilities
g. The Energy Efficiency Strategy will be implemented effectively to all sectors. The restoration of the thermal and HEPPs, which are foreseen to remain in the public hands, will be completed and the loss-leakage ratios in electricity will be minimized.[76]

[76] T.C. Kalkınma Bakanlığı. 2013. 10. Kalkınma Planı (2014-2018). Ankara, http://www.sbb.gov.tr/wp-content/uploads/2018/11/Onuncu-Kalk%C4%B1nma-Plan%C4%B1-2014-2018.pdf [accessed date 8.12.2019]

2.3.7 11th Development Plan

The practices and policies related to the RE and other energy resources included in the 11th Development Plan prepared by the Turkish Republic Strategy and Budget Presidency Office in 2019 are as follows.

Target: The key goal is to ensure conservation, efficiency, security, health and bearable energy supply.[77]

Table 2.9: 11th Development Plan Energy Targets

	2018	2023
Primary Energy Demand (BTEP)	147.955	174.279
Electric Power Demand (GWh)	303,3	375,8
Primary Energy Consumption Per Capita (TEP / person)	1,81	2,01
Electricity Consumption Per Person (kWh / person)	3.698	4.324
Share of Natural Gas in Electricity Production (%)	29,85	20,7
Share of Renewable Resources in Electricity Production (%)	32,5	38,8
Electricity Production from Domestic Sources (TWh)	150	219,5
Installed Power (MW)	88.551	109.474

Source: T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı. 2019. On Birinci Kalkınma Planı

Policies

a. A competitive climate for investment and the sustainability of a financially strong, secure, open, reliable, consumer-protected and sustainable energy sector will be required in order to meet the increasing demand for energy.
b. Afşin-B Thermal Power Plant, Keban Hydroelectric Power Plant (HEPP), Karakaya HEPP and Hirfanlı HEPP rehabilitation will be realized,
c. Nuclear energy plants (NGS), initiatives would continue to increase nuclear energy share and operational capability will be improved in the electricity generation portfolio,
d. Construction of the first unit of Akkuyu NGS will be completed in 2023 and electricity production will be started,
e. In addition to Akkuyu NGS, two more NGS will continue to be established.

[77] T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı. 2019. On Birinci Kalkınma Planı (2019-2023). Ankara, http://www.sbb.gov.tr/wp-content/uploads/2019/07/On-Birinci-Kalkinma-Plani.pdf [accessed date 8.12.2019]

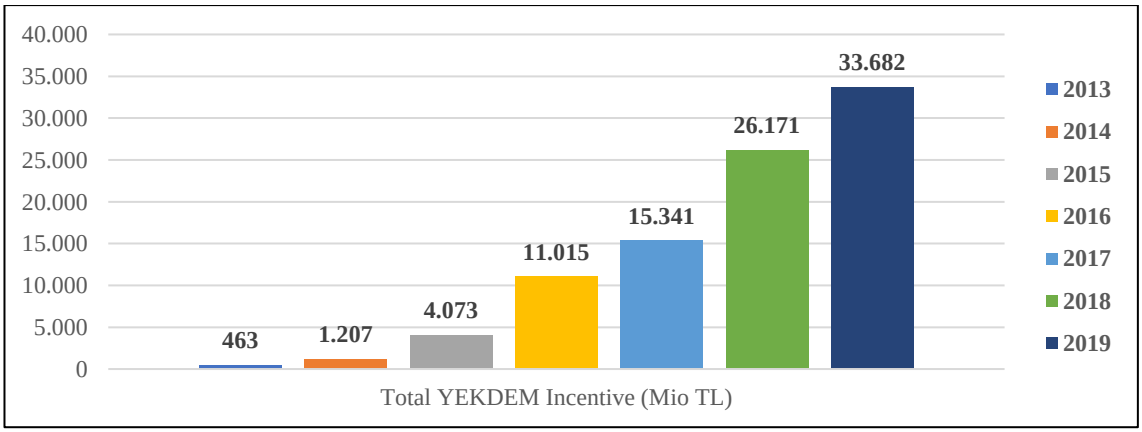
f. Thanks to technology transfer in NPPs, measures will be taken to reduce dependence on foreign technology in nuclear technology,
g. Nuclear Technical Support Joint Stock Company will be commissioned to provide technical support, analysis, consultancy, supervision, training and certification services required by the Nuclear Regulatory Authority,
h. In line with environmental regulations, the use of our lignite resources in electrical energy production is being expanded,
i. The publicly available lignite fields would decrease reliance on imported energy sources and help to create jobs by generating electricity,
j. Measures to reduce carbon emissions will be developed through additional measures such as energy efficiency gains and increasing forest assets.
k. Research and development projects on clean coal technology is going to be backed,
l. The production of electricity from RES will boost and required program and expenditure will be made to ensure the safe integration of RE generation into the power network,
m. Within YEKA-like models, renewable resources will be used more intensively,
n. The integration of RE generation facilities into the grid and related technical assistance projects will be implemented,
o. Energy storage platforms will be built, including pumped storage HEPPs, to minimize the restrictions of increasing RE on the power network.[78]

[78] T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı. 2019. On Birinci Kalkınma Planı (2019-2023). Ankara, http://www.sbb.gov.tr/wp-content/uploads/2019/07/On-Birinci-Kalkinma-Plani.pdf [accessed date 8.12.2019]

3. EFFECT OF RENEWEABLE ENERGY SUPPORT MECHANISM(YEKDEM) IN TURKISH ELECTIRICITY MARKET

Under the Kyoto Protocol signed in 1997 and the Paris Agreements signed in 2015, several studies are underway in the fight against climate change. The focus of these studies is to reduce energy production from fossil fuels and to turn to RES and to reduce CO2 emissions. Turkey parallel to these studies has a lot of work in the internal policies. The Renewable Energy Law in established in 2005 was the first of these studies. For the first time, this law provided a FiT for electricity production from RES. This tariff was the average electricity wholesale price determined by EMRA for the previous year. We can state that this situation adversely affects the development of the resource which requires advanced technology and is costlier than alternatives among the types of RES. Then, in 2010, YEKDEM, which enlarged the scope of the fixed price guarantee and differentiated it according to the sources, was announced by Law No. 6094. YEKDEM create significant acceleration in the growth of RE installed capacity in Turkey. Especially after YEKDEM incentive price remained above the CMP (Clearing Market Price) after 2015, the number of participants within this incentive increased. Refer. Figure 3.1 and Table 3.1.

Figure 3.1: Total YEKDEM Incentive Payments 2013-2019



Source: Energy Exchange Istanbul, EXIST, Transparency Platform. Webpage: https://seffaflik.epias.com.tr/transparency/uretim/yekdem/toplam-gider-yektob.xhtml [accesed date: 05.12.2019]

Table 3.1: YEKDEM Participant Development

Type	2011	2012	2013	2014	2015	2016	2017	2018
Solar	-	-	-	-	-	-	2	3
Hydraulic	4	44	14	40	126	388	418	447
Wind	9	22	3	21	60	106	141	151
Biomass	3	8	15	23	34	42	57	70
Geothermal	4	4	6	9	14	20	29	37
Total	**20**	**78**	**38**	**93**	**234**	**556**	**647**	**708**

Source: T.C. Enerji Piyasası Düzenleme Kurumu. 2019. 2018 Electricity Market Development Report 2018. Ankara, p.75.

Another source of motivation for the steps taken within the scope of RE is the current account deficit. It cannot produce a large portion of the energy needed to make production in Turkey and are forced to import from foreign countries. This increases the current account deficit. In addition, the demand for energy required for production increases day by day. In this case, Turkey's growing energy dependence on foreign demand is increase each day. The increased demand for energy raises the import of energy, which leads to a deepening of the current account deficit (Yurdakul and Cevher 2015). The following Table 3.2 shows the numbers of Turkey's current account deficit and current account balance without energy sector between the years 2007 to 2019.

Table 3.2: Current Account Balance and Current Account Balance Without Energy Sector 2007-2019

Year	Current Account Balance (Million USD Dollar)	Current Account Balance Without Energy Sector (Million USD Dollar)
2007	-30.755,0	-5.978,6
2008	-39.425,0	1.324,4
2009	-11.358,0	14.626,0
2010	-44.616,0	-10.588,2
2011	-74.402,0	-26.823,4
2012	-47.963,0	4.446,3
2013	-63.642,0	-14.449,5
2014	-43.610,0	5.167,6
2015	-32.145,0	1.179,9
2016	-33.139,0	-9.181,4
2017	-47.347,0	-14.469,3
2018	-27.032,0	11.561,6
2019	3.687,0	29.430,1

Source: Türkiye Cumhuriyet Merkez Bankası (TCMB), Electronic Data Delivery System (EVDS), https://evds2.tcmb.gov.tr/index.php?/evds/serieMarket [accessed date 3.12.2019]

As shown in Table 3.2, the current account balance between 2019 and 2007, results deficit except for 2019. However, when energy, which is one of the factors affecting the current account balance, is not included in the calculations, it is seen that if there were no energy imports in many years with a current account deficit, current account surplus could be given. These results suggest that increases in electricity generation from RE will positively effect the energy current account balance.

In this part of the study, in parallel climate change studies experienced in the world of the steps taken in Turkey, the results on the installed capacity of RE will be examined. Especially, the break point in the installed capacity of RE after YEKDEM incentive will be tested with Augmented Dickey-Fuller root test. Then the relationship between the generation of electricity from RES, Turkey CMP and energy sector focused current account balance will be investigated.

3.1 MODEL 1 - RENEWABLE ENERGY INSTALLED CAPACITY

In Model-1, the RE installed capacity data between 1984-2019 were collected as time series in order to find the breaking year regarding installed capacity of RE. Break in the data set was tested by means of expanded Dickey-Fuller (ADF) tests (Dickey and Fuller, 1981). Critical values are automatically generated by EViews 10 based on McKinnon values. The lag length (maximum lag) value is automatically set by the program to 11 according to the Schwarz Info Criteria. As a result of the ADF tests applied to the level values of the variables, breakage was observed in 2008. The results can be observed in Figure 3.2, Figure 3.3 and Figure 3.4.

Data:

i. X10: Renewable Energy Installed Capacity (MW)[79]

[79]Data has been collected from TEİAŞ publications. Webpage: https://www.teias.gov.tr/tr/sektor-raporlari

Figure 3.2: Unit Root Break Test Results

Null Hypothesis: X10 RENEWABLE ENERGY INSTALLED CAPACITY has a unit root
Trend Specification: Intercept only
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 2008
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 6 (Automatic - based on Schwarz information criterion, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.535985	> 0.99
Test critical values:	1% level	-4.949133	
	5% level	-4.443649	
	10% level	-4.193627	

*Vogelsang (1993) asymptotic one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: X10 RENEWABLE ENERGY INSTALLED CAPACITY
Method: Least Squares
Date: 12/11/19 Time: 20:52
Sample (adjusted): 1991 2019
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X10 RENEWABLE ENERGY INSTALL	0.978927	0.039316	24.89911	0.0000
D(X10__RENEWABLE_ENERGY_INSTA	0.387399	0.201419	1.923351	0.0696
D(X10 RENEWABLE ENERGY INSTA	0.093254	0.205503	0.453785	0.6551
D(X10 RENEWABLE ENERGY INSTA	0.235620	0.210283	1.120491	0.2765
D(X10 RENEWABLE ENERGY INSTA	-0.301952	0.224335	-1.345988	0.1941
D(X10 RENEWABLE ENERGY INSTA	0.912436	0.225825	4.040460	0.0007
D(X10__RENEWABLE_ENERGY_INSTA	-0.675332	0.225793	-2.990931	0.0075
C	346.1849	302.5711	1.144144	0.2668
INCPTBREAK	1296.104	424.7498	3.051453	0.0066
BREAKDUM	-825.8262	593.4606	-1.391544	0.1801

R-squared	0.998733	Mean dependent var	17944.09
Adjusted R-squared	0.998132	S.D. dependent var	10814.25
S.E. of regression	467.3392	Akaike info criterion	15.39879
Sum squared resid	4149712.	Schwarz criterion	15.87027
Log likelihood	-213.2824	Hannan-Quinn criter.	15.54645
F-statistic	1663.769	Durbin-Watson stat	1.824149
Prob(F-statistic)	0.000000		

Figure 3.3: Dickey-Fuller t-statistics

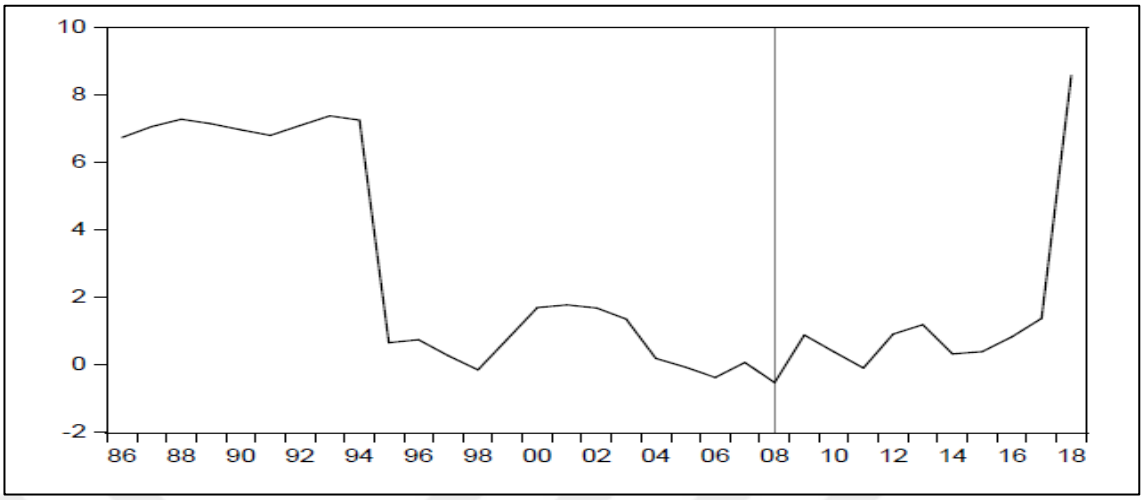


Figure 3.4: Dickey-Fuller autoregressive coefficients

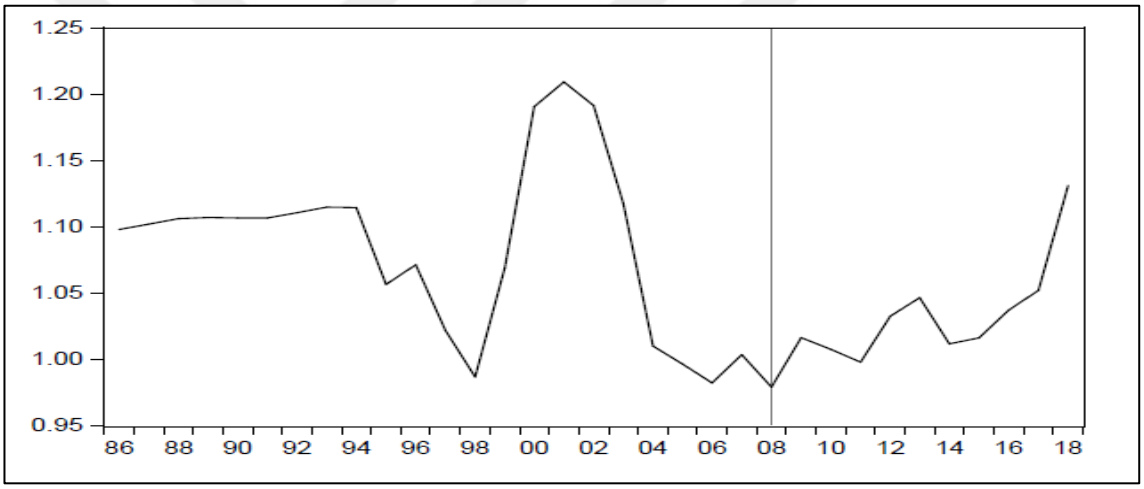
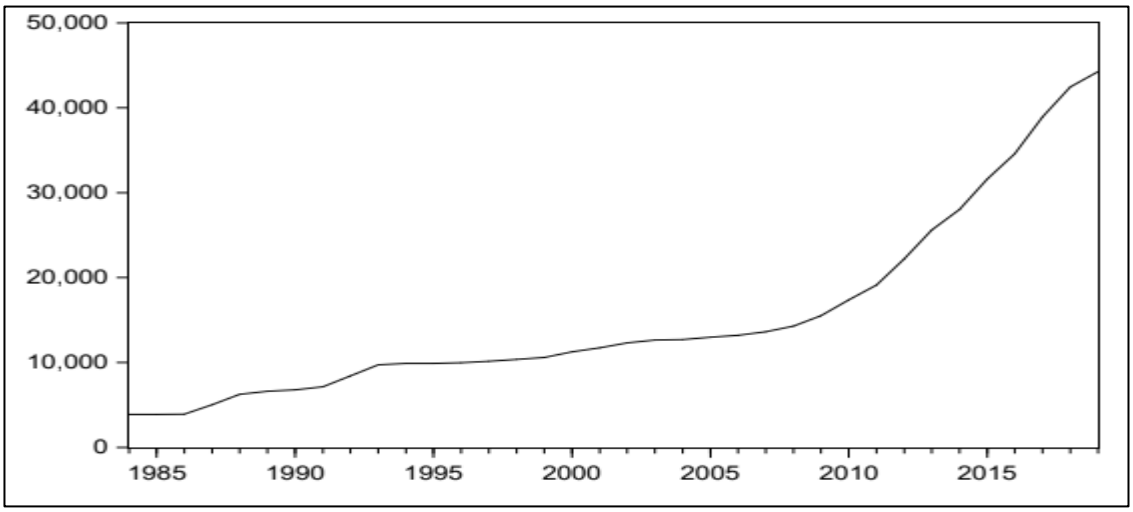


Figure 3.5: Renewable Energy Installed Capacity Development between 1984-2019



3.2 MODEL 2 – EFFECT OF ELECTRICITY PRODUCTION FROM RENEWABLE ENERGY SOURCES ON CURRENT ACCOUNT DEFICIT

The long-term relationship between Johansen Cointegration and Granger Causality was investigated between the data compiled as time series. First, whether the data set is stationary or not is tested by using the unit root test (Augmented Dickey-Fuller (ADF)) (Dickey and Fuller 1981) and the problem of false regression is prevented. After the data were found to be stable, the appropriate lag length was determined in accordance with the VAR lag length selection criteria, followed by the Johansen Cointegration test (Johansen and Juselius 1990), and the long-term relationship between the data and Granger (1969) causality. The most appropriate regression equations were selected by Trace and Eigenvalue tests, and the amount of deterioration in the value and the long-term equilibrium were determined by means of the Vector Error Correction Estimates using the EViews 10 program.

Data:

i. A1: Total Electricity Production (MWh), [80]
ii. A2: Renewable Sources Electricity Production (MWh), [81]
iii. A3: Weighted Average of Market Clearing Price (USD),[82]
iv. A4: Energy Sector Current Account Balance (Million USD), [83]

For each testing figure or for any desired test size, to obtain a P value, some procedures have been applied to interpolate between table values. According to the method developed by MacKinnon (1996), regression is defined as;

[80] Energy Exchange Istanbul, EXIST, Transparency Platform. Webpage: https://seffaflik.epias.com.tr/transparency/uretim/gerceklesen-uretim/gercek-zamanli-uretim.xhtml [accesed date: 05.12.2019]
[81] Energy Exchange Istanbul, EXIST, Transparency Platform. Webpage: https://seffaflik.epias.com.tr/transparency/uretim/gerceklesen-uretim/gercek-zamanli-uretim.xhtml [accesed date: 05.12.2019]
[82] Energy Exchange Istanbul, EXIST, Transparency Platform. Webpage: https://seffaflik.epias.com.tr/transparency/piyasalar/gop/ptf.xhtml [accesed date: 05.12.2019]
[83] Türkiye Cumhuriyet Merkez Bankası (TCMB), Electronic Data Delivery System (EVDS), https://evds2.tcmb.gov.tr/index.php?/evds/serieMarket [accessed date 3.12.2019]

$$\phi^{-1}(\alpha) = \gamma_0 + \gamma_1\hat{q}(\alpha) + \gamma_2\hat{q}^2(\alpha) + \gamma_3\hat{q}^3(\alpha) + \varepsilon_\alpha \qquad (\mathbf{3.1})$$

$\phi^{-1}(\alpha)$ in the formula (1) is expressed as the inverse cumulative normal distribution function cumulative standard and indicated by the α sign. MacKinnon (1994), stochastic regressors in the formula and the absence of regression in the case of the predicted quantiles (quantities) are very accurate results and consequently the errors that may occur in the variables are concluded to be insignificantly small. If the distribution of the estimated quantiles shows normal distribution with any mean and variance, if the regression is (1), the distribution in which the estimated quantities are obtained is actually defined as $\gamma_2 = \gamma_3 = 0$. Therefore, this regression is only given here as an assumption. Therefore, estimation was made using only a small number of points called τ, close to the observed test statistics. After the regression (1) is estimated, the estimated P value (2) is associated with the given τ value;

$$\hat{P} = \Phi(\hat{\gamma}_0 + \hat{\gamma}_1\tau + \hat{\gamma}_2\tau^2 + \hat{\gamma}_3\tau^3) \qquad (\mathbf{3.2})$$

By MacKinnon (1996), the regression equation (1) is translated as follows to obtain approximate critical values;

$$\hat{q}(\alpha) = \delta_0 + \delta_1\Phi^{-1}(\alpha) + \delta_2\left(\Phi^{-1}(\alpha)\right)^2 + \delta_3\left(\Phi^{-1}(\alpha)\right)^3 + e_\alpha^* \qquad (\mathbf{3.3})$$

In truth, equation (3) is not the opposite of equation (1). However if there is indeed a normal dispersal with any mean and variance, the distribution from which the estimated quantities are obtained, then equation (3) is defined as (3) $\delta_2 = \delta_3 = 0$. In this case, equation (1) will be $\gamma_2 = \gamma_3 = 0$ and equation (3) will be the inverse of equation (1).

Regressions (1) and (3) are predictable by OLS (Ordinary Least Squares), but this ignores both heteroskedasticity and serial correlation. MacKinnon (1996) has shown how to consider both. Therefore, it uses the GLS (Generalized Least Squares) method to estimate these equations. The above-mentioned equations (1) and (3) should only be brought to a small number of points near the specified test statistic or test size. Experiments show that

the number 11 is the most suitable for use here. Also, in most cases, it is possible to take γ_3 veya δ_3 equal to zero based on a t-test.

By Granger (1969), a feedback mechanism was considered as the sum of two causal mechanisms, and the fact that these causalities could be studied by separating cross or partial cross spectra, and a causality method was proposed to investigate such mechanisms. In the method proposed by Granger (1969), Z_t value according to the power spectrum in the form of X_t is defined as (4);

$$f_{x,z}(\omega) = \frac{\sigma_1^2\sigma_2^2|b_3|^2+\sigma_1^2\sigma_3^2|\beta|^2+\sigma_2^2\sigma_3^2|b_1|^2}{f_z^{'}(\omega)} \qquad (\mathbf{3.4})$$

$(\mathbf{3.4})$

Granger (1969) investigated the causality and feedback relationship between X_t and Y_t with the consistency and phase diagrams obtained from the second and third components of the partial cross spectrum (5) (Bayram and Others 2019);

$$\text{coherence } \left(\underrightarrow{xy,z}\right) = \frac{\left|C_2^{xy,z}\right|^2}{f_{x,y}f_{y,z}} \qquad (\mathbf{3.5})$$

Model-2 Analysis:

First, the analysis of the stationarity of the series was made with Dickey Fuller (Augmented Dickey Fuller-ADF) (Table 2) test level values. The regression equation was not added with an external constant (intercept) value, and the lag length was automatically selected according to the Schwartz Information Criteria. The first difference of the series was taken into a stationary state.

Table 3.3: Model -2 Augmented Dickey Fuller-ADF Test Results.

		Augmented Dickey-Fuller test statistic	Test critical values:		
			1% level	5% level	10% level
A1	t-Statistic	-4.754.369	-2.600.471	-1.945.823	-1.613.589
	Prob.*	0.0000			
A2	t-Statistic	-4.988.443	-2.597.476	-1.945.389	-1.613.838
	Prob.*	0.0000			
A3	t-Statistic	-1.115.639	-2.595.340	-1.945.081	-1.614.017
	Prob.*	0.0000			
A4	t-Statistic	-1.416.234	-2.596.160	-1.945.199	-1.613.948
	Prob.*	0.0000			

When the regression results were analyzed (Table 3.4), no relation was found between A2: Renewable Sources Electricity Production (MWh), A3: Weighted Average of Market Clearing Price (USD), A4: Energy Sector Current Account Balance (Million USD Dollar). A relation was found between A2: Renewable Sources Electricity Production (MWh), A1: Total Electricity Production (MWh),

Table 3.4: Model -2 Regression Results

Dependent Variable: FARKA2
Method: Least Squares
Date: 12/10/19 Time: 00:50
Sample (adjusted): 2013/06 - 2019/09
Included observations: 76 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FARKA1	0.361860	0.076485	4.731.113	0.0000
FARKA3	6.901.249	15902.23	0.433980	0.6656
FARKA4	8.588.288	4.832.158	1.777.319	0.0797
C	6.889.354	139016.7	0.049558	0.9606
R-squared	0.241575	Mean dependent var	102487.0	
Adjusted R-squared	0.209974	S.D. dependent var	1342414.	
S.E. of regression	1193183.	Akaike info criterion	3.087.334	
Sum squared residual	1.03E+14	Schwarz criterion	3.099.601	
Log likelihood	-1.169.187	Hannan-Quinn critter.	3.092.237	
F-statistic	7.644.541	Durbin-Watson stat	1.992.361	
Prob(F-statistic)	0.000166			

Table 3.5: Model -2 Results of Johansen Cointegration Test.

Series: FARKA1 FARKA2 FARKA3 FARKA4				
Unrestricted Cointegration Rank Test (Trace)				
H0: No Cointegration exist H1: Cointegration exist		Trace	0.05	
	Eigenvalue	Statistic	Critical Value	Prob.**
H0: r=0 *	0.612166	167.2587	40.17493	0.0000
H0: r≤1 *	0.505126	98.11471	24.27596	0.0000
H0: r≤2 *	0.345918	46.76265	12.32090	0.0000
H0: r≤3 *	0.194314	15.77249	4.129906	0.0001
Series: FARKA1 FARKA2 FARKA3 FARKA4				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
H0: No Cointegration exist H1: Cointegration exist		Trace	0.05	
	Eigenvalue	Statistic	Critical Value	Prob.**
H0: r=0 *	0.612166	69.14394	24.15921	0.0000
H0: r≤1 *	0.505126	51.35205	17.79730	0.0000
H0: r≤2 *	0.345918	30.99016	11.22480	0.0000
H0: r≤3 *	0.194314	15.77249	4.129906	0.0001

When the results of the Granger causality test were examined (Table 3.6), in this case, A4: Energy Sector Current Account Balance (Million USD Dollar) was the cause of A2: Renewable Sources Electricity Production, and no long-term causal relationship was found between the other variables.

Table 3.6: Model -2 VAR Pairwise Granger Causality Test Results.

Pairwise Granger Causality Tests				
Date: 12/11/19 Time: 21:18				
Sample: 2013M05 2019M11				
Lags: 2				
Null Hypothesis:	**Observation**	**F-Statistic**	**Prob.**	**Result**
FARKA2 does not Granger Cause FARKA1	76	0.39681	0.6739	Do not have causality
FARKA1 does not Granger Cause FARKA2		1.66072	0.1973	Do not have causality
FARKA3 does not Granger Cause FARKA1	76	0.87410	0.4217	Do not have causality
FARKA1 does not Granger Cause FARKA3		0.68530	0.5072	Do not have causality
FARKA4 does not Granger Cause FARKA1	74	1.07109	0.3483	Do not have causality
FARKA1 does not Granger Cause FARKA4		0.03809	0.9627	Do not have causality
FARKA3 does not Granger Cause FARKA2	76	0.48029	0.6206	Do not have causality
FARKA2 does not Granger Cause FARKA3		0.45288	0.6376	Do not have causality
FARKA4 does not Granger Cause FARKA2	74	3.25691	0.0445	Has causality
FARKA2 does not Granger Cause FARKA4		0.85426	0.4300	Do not have causality
FARKA4 does not Granger Cause FARKA3	74	0.17260	0.8418	Do not have causality
FARKA3 does not Granger Cause FARKA4		0.09024	0.9138	Do not have causality

4. CONCLUSION

Under the Kyoto Protocol signed in 1997 and the Paris Agreements signed in 2015, several studies are underway in the fight against climate change. The focus of these studies is to reduce energy production from fossil fuels and to turn to RES and to reduce CO2 emissions. Turkey parallel to these studies has a lot of work in the internal policies.

With the steps of liberalization in the energy sector which started in the 1990s, the attractiveness of the sector towards private investors has started to be increased. Turkey's progress has slowed due to the economic turmoil that happened in that period, yet within the establishment of the EMRA in 2001, the energy sector has re-entered a restructuring process.

With the Renewable Energy Law, which was enacted in 2005, the first step was taken to produce electricity from renewable energy. For the first time, this law provided a Feed in Tariff for electricity generation from RES. This tariff was the average electricity wholesale price determined by EMRA for the previous year. We can state that this situation adversely affects the development of the resource which requires advanced technology and is costlier than alternatives among the types of RES. Then in energy efficiency and RE sectors along with Turkey's official signing of the Kyoto Protocol in 2009 reformed again. Within Electrical Energy Market and Supply Security Strategy document published in 2009, the targets for electricity market operation and supply security were determined until 2023. The main objective was to ensure that the share of electricity produced from RES in total electricity production is at least 30% in 2023. In this context in 2010, YEKDEM, which enlarged the scope of the fixed price guarantee and differentiated it according to the sources, was announced by Law No. 6094. YEKDEM create significant acceleration in the growth of RE installed capacity in Turkey. According to the Model-1 as a result of RE installed capacity between 1984 to 2019 years in Turkey as, appears to be broken in 2008 and the acceleration of the increase in installed capacity was observed to increase significantly after this break year.

The main purpose of the strategy document published in 2009 is to create supply security in electrical energy. In this respect, it is aimed to promote electricity production from RE and domestic sources. This goal also has an economic output. Table 3.2 shows that energy gas a high role in Turkey's current account balance. As shown in Table 3.2, the current account balance between 2019 and 2007, results deficit except for 2019. However, when energy, which is one of the factors affecting the current account balance, is not included in the calculations, it is seen that if there were no energy imports in many years with a current account deficit, current account surplus could be given. These results suggest that increases in electricity generation from RE will positively affect the energy current account balance. When the results of the Granger causality test were examined in Model-2 (Table 3.6), a long term causal relationship was found between Energy Sector Current Account Balance (Million USD Dollar) and Renewable Sources Electricity Production.

Turkey in 2014, has released their 2023 targets for RE by renewing in the National Renewable Energy Action Plan. According to the plan, it is aimed to reach 61 GW renewable installed capacity by the end of 2023. 61 GW is planned to be composed of 34 GW hydro, 20 GW wind, 5 GW solar, 1 GW geothermal and 1 GW biomass energy power plants (Figure 2.2). As of end of October 2019 Turkey has 28,5 GW hydro, 7,5 GW wind, 5,6 GW solar, 1,5 GW geothermal and 1,1 GW bio mass total 44.2 GW RE installed power capacity. 30 GW of this installed power, approximately 68%, has been realized in the last 10 years with the steps taken after the publication of the strategy document in 2009.

In 2016, EMRA issued YEKA strategy document. With YEKA regulation firstly, it is aimed to benefit from the domestic production of advanced technology components used in RE production facilities and to ensure the transfer of technology. Secondly, RE license allocation is intended to use economies of scale and capacities of 1,000 MW have been allocated to investors. In March 2017, the first solar YEKA tender with 1 GW capacity was held and awarded. In August 2017, the first onshore wind YEKA tender with 1 GW capacity was held and awarded. The second onshore wind YEKA tender with 1 GW(4x250MW) capacity was announced in November 2018 and took place in May 2019.

Totally, 3 GW capacity has been allocated to investors. The completion of these capacity planned to be accomplished in 2022.

In this respect, the YEKA tender system will be limited in achieving the momentum of capacity increase provided by YEKDEM incentive. At the end of 2020 is planned to the end of YEKDEM incentive, Turkey should explain the incentive mechanism which substitute YEKDEM after 2020 and will act as a catalyst to achieve its targets for 2023.

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