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Review Article

The Development of Renewable Energy in Turkish Electricity Markets

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Abstract

The development of different Renewable Energy (RE) Sources (RES) technologies in the Turkey Electric Energy Sector have been discussed and future targets from different policy documents are analyzed. Different mechanisms for energy market entry for RES are explained and final comments to support the increase of RES penetration have been proposed. It is pointed out that the RES capacity in the long run should be strongly determined, network capacity should be enhanced, grid integration and market entry mechanisms should be redefined in order to reach a sustainable RES development in Turkey in the presence of volatile global economic circumstances and dependency of the country to external primary fuel resources.

Keywords: Renewable Energy Sources, Turkey Electricity Markets.

Türkiye Elektrik Piyasalarında Yenilenebilir Enerjinin Gelişimi

Öz

Türkiye Enerji Sektöründe farklı Yenilenebilir Enerji (YE) Kaynakları (YEK) teknolojilerinin gelişimi tartışılmış ve farklı politika belgelerinden gelecek hedefleri analiz edilmiştir. YEK'lerin enerji piyasasına girişi için farklı mekanizmalar açıklanmış ve RES kapasite artışınının desteklenmesi için öneriler getirilmiştir. Türkiye'de sürdürülebilir bir RES gelişimi sağlamak için uzun vadede RES kapasitesi güçlü bir şekilde belirlenmeli, şebeke kapasitesi arttırılmalı, şebeke bağlantı süreci ve enerji piyasalarına giriş mekanizmaları yeniden tanımlanmalıdır.

Anahtar Kelimeler: Türkiye, Yenilenebilir Enerji, Elektrik Piyasaları.

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1. Introduction

Energy sector is undergoing a transition aiming to reach a sustainable and carbon-free form in which the Renewable Energy (RE) Sources are at the center. Share of RE in the global electricity sector is expected to perform the fastest growth in the energy sector reaching 33% by 2025 (IEA Electricity, 2020) while the ratio was 24.54% in 2017 (IEA Data and Statistics, 2020). The global electricity production was realized as 25 747 TWh by the end of the year 2017, the highest RE contribution belongs to hydro with a ratio of 16.25% (IEA Data and Statistics, 2020). RE technologies are also widely utilized for supplying the heat demand as well as electricity reaching an annual total of 10% excluding the conventional biomass by the end of 2018 (IEA Renewables, 2019). The countries leading the RE sector in EU, namely Germany, Spain, and United Kingdom, realizing their RE targets via strong policies and supporting action plans. Particularly, Germany and Spain applied ambitious policies including high incentives aiming to develop their domestic energy equipment manufacturing industry. These resulted with increase of the installed capacity to high values in relatively short period. The decrease in the equipment costs with the technological advances and the burden of the high incentives to public finance lead to re-evaluation of these policies (MENR Strategic Plan, 2017).

Turkey, as a developing country took major steps in order to increase the penetration of RE in coherence with the global efforts. The total installed generation capacity of Turkish Electricity Network was increased to 95 709 MW by the end of December 2020. The share of RE capacity is 51.6 % when hydroelectric power plants with dam capacity is considered, and 27.7% when only the run-off hydroelectric river plants are considered among others, while the share of RE in the annual generation of 305 TWh is 42.3 % by the end of 2020, being ahead of world ratio (YTBS, 2021). The types of RE could be counted as hydroelectric, solar PV, wind, geothermal and biomass based power plants. Ministry of Energy and Natural Resources (MENR) and Ministry of Environment and Urbanization established action plans and different targets in different strategy and policy documents to address energy efficiency, RE and climate change in order to increase the utilization of RE beginning from 2010. These are; National Climate Change Strategy issued in 2010, National Climate Change Action Plan of Turkey issued in 2012, National Renewable Energy Action Plan issued in 2014, Intended Nationally Determined Contribution to UN Framework Convention on Climate Change issued in 2015, and National Energy Strategic Plan issued 2015 and revised in 2017. A total RES share of 30% in the total generation capacity, a decrease of 20% in energy intensity in order to reach back 2010 levels and commissioning of new nuclear power plants were targeted for the year 2023 in these documents. RES share target was already achieved with the support of access to various diverse RE sources resulting from the countries' geographical position. The total installed RES capacity nearly doubled in the last decade with the support of the Renewable Energy Support Mechanism (YEKDEM) which enables the RES generators to register to either feed-in-tariff with local content support or day-ahead market. However, several strategy documents namely given above, include different technology specific targets which create uncertainty concerning future ambitions. The country hosts a substantial RE potential including hydro, wind and solar that shall be supported with further actions (IEA Energy Policies of IEA Countries, Turkey, 2016).

This paper takes a closer look at the renewable energy sector in Turkey, discusses the share of RE in Turkish Electric Energy sector and potential development scenarios. A number of strategy documents, which have different priorities and objectives are issued in the last decade to propose diverse action plans and targets. This study aims to describe the background of the RES sector in connection with the Energy Markets, investigate different strategy documents from government authorities and list different future target proposals from these, and finally suggest a coordinated set of action plans considering coordination of announced targets, better resource utilization, redefinition of network connection criteria especially for solar PV and wind power as distributed generation, and strengthening of network infrastructure in order to accelerate and sustain private sector investments.

Section 2 discusses the RE entrance methods to electric energy markets. Turkey RE sector overview is given in Section 3. Section 4 presents issues concerning development of RE. The concluding remarks, summarizing the content, are given in Section 5.

2. Renewable Energy in Turkey Energy Markets

2.1. Electric Energy Markets in Turkey

Turkish Electricity Authority (TEK), that was established in 1970, was the only institution in a vertically integrated environment until 1984. Build-Operate-Transfer (BOT), Build-Own-Operate (BOO) and Transfer of Operating Rights (TOOR) methods provided inclusion of private sector in 1984. TEK was divided into two governmental companies including Turkish Electricity Generation-Transmission (TEAS) and Turkish Electricity Distribution Company (TEDAS) in 1993. TEAS was subsequently divided into three different companies namely; EUAS, responsible for generation, TEIAS, responsible for transmission, and TETAS, responsible for wholesale trade with enactment of Electricity Market Law issued in 2001. The privatization of ownership followed when the government initiated a privatization plan of other state-owned electricity sector companies, except for TEIAS. The law also enabled the formation of Energy Market Regulation Agency (EMRA), which would oversee the electric power, petroleum, LPG and natural gas markets via performing functions of tariff setting, licenses issuing, and assuring competition.

Electric Energy Markets were initiated with the establishment of Market Financial Settlement Center (PMUM) under TEİAŞ in 2006 initiating Balance and Settlement Market. Day Ahead Planning Mechanism and Hourly Pricing and Settlement started in 2009. The two different Energy Markets; Day Ahead Energy Market and Balance and Settlement Markets was active by then, and this was followed by the initiation of Day Ahead Energy Market and Warrant and Down-Payment mechanisms in 2011. Enactment of the Law on the Use of Renewable Energy Resources for the Purpose of Generating Electric Energy, number 5346, started the Renewable Energy Support Mechanism (YEKDEM), and Intraday Market was initiated as the third Energy Market in the same year. Energy Markets Operation A.Ş. (EPİAŞ) was officially established in 2015, to operate, as a separate company to run the mentioned

three Energy Exchange Markets apart from TEİAŞ (EPİAŞ, 2020). Moreover, synchronous connection of Turkey and European transmission systems was realized through the European Network of Transmission System Operators for Electricity (ENTSO-E) the same year. In this context, Turkey gained access to European Electric Energy Markets and improved the regional energy security with the interconnection.

2.2. Renewables and Energy Markets

Three models are in place for the Turkey RES to participate electric energy markets. These are unlicensed, licensed, and the Renewable Energy Resource Zone (YEKA) models (Presidency of the Republic of Turkey Investment Office, 2018).

Unlicensed Model

A RES with an installed capacity lower than 5 MW does not require a license and functions under specific Renewable Energy Support (RES) tariffs (YEKDEM) according to the law numbered 5346 for the first ten years of the operation. The RES facility has to be constructed in the same place with the consumption facility provided that the RES capacity does not exceed installed contract power. Consequently, unlicensed PV facilities can only be set up as rooftop or facade installation. The local content support for the unlicensed facilities is cancelled due to the recent changes in the legislation.

Licensed Model

A majority of power plants which have over 5 MW installed capacity are subject to licensed model. The wind and solar power investors have to apply EMRA for pre-license, with an attachment of 1-year period on-site metering data belonging to the previous five years, in the initial stage depending on the provincial capacities announced beforehand by TEİAS. Investors interested with the same grid connection points/regions shall enter a reverse auction, which is a process of reduction from the RES support YEKDEM tariffs, and the winning party is subject to the reduced tariff for the first ten years of operation. Licensed generators are subject to local content support for the facilities identified in The Law No. 5346 without any bidding process. Wind and solar power plants are the only types that are subject to capacity allocation mechanism while the other RES types do not enter capacity tenders (Presidency of the Republic of Turkey Investment Office, 2019).

Renewable Energy Resource Zone (YEKA)

Unlicensed model supported the expansion of especially Solar PV projects as will be discussed in the next Section. However, the essence of YEKDEM is to compensate one's own consumption and not very suitable for obtaining large RE zones and establishments. Application of major investments in the areas that Ministry of Energy and Natural Resources (MENR) had determined via expert knowledge and the synchronous development of the electricity network is an appropriate strategy in terms of energy management as well as the approval processes (PwC, 2016). MENR strategic plan mentioned YEKA as a new perspective even before the starting of the program in 2017. The policies and regulations executed by the government under YEKA title aims the following main objectives (Thomson and Derrick, 2019):

• The commissioning of renewable energy resources in larger units would be more efficient and effective through identification of renewable energy zones on the public, private, or treasury owned land.

• It will be possible to increase the share of domestic, locally manufactured equipment in renewable electricity generation more rapidly by YEKA projects. Moreover, new manufacturing facilities would be constructed. A fast increase in the energy produced from domestic solar and wind power plants would be achieved. The government would enhance support for all types of domestic energy sources. The wind and solar power plant components to be produced by the domestic facilities would be purchased by the YEKA facilities for two years. A YEKA and its electrical connection capacity utilization rights can be offered under "Allocation on the Condition of Local Manufacturing" mechanism in which the investor is encouraged to construct its own facilities and manufacture components for its own generating plant and local market, or "Allocation on the Condition of Using Locally-Manufactured Equipment" mechanism in which the investor purchases components from already existing domestic suppliers. Both methods would encourage domestic and locally manufactured RES plant components sector.

• A potential energy crisis would be avoided with domestic production and external dependency would be mitigated. National current account deficit includes a large share resulting from imported primary fuel resources. Domestic and national energy sector would be an instrument to reduce current account deficit.

YEKA pricing mechanism is different from the licensed model in the sense that a reduction bidding process starting from a certain upper limit considering both the feed-in-tariff and local content support. Consequently, the winning party is not entitled to additional local content support. Moreover, the time period which is determined as 15 years for the first two YEKA tenders extends beyond feed-in-tariff period which is currently ten years.

3. Renewable Energy Sector Overview

The previous section aimed to explain the RE entrance methods to national electric energy markets. This section discusses the contribution of different RE technologies to installed electricity generation capacity, and annual electric energy generation of Turkey.

3.1. Wind Energy

The installed capacity of Wind Power Plants (WPP) reached 7 615 MW as of July 2019 with a number of 3 155 installed turbines across the 183 WPPs in the country (YTBS, 2021). Annual WPP generation was realized as 20 016 GWh which was the 6.6% of total annual national generation by the end of year 2018 (TWEA, 2018). The cumulative installations for WPPs in Turkey are given in Figure 1 (YTBS, 2021).

Nearly all of the WPPs (99.86% of the total capacity) are operating with a license. The remaining capacity, which is negligible, does not have a license, operates under Energy Markets Law no 6446, clause 14, and associated with YEKDEM (law numbered 5346).

In addition to licensed and unlicensed WPP generation, a YEKA tender was performed in August 2017. 1000 MW of WPP capacity, located at 5 different regions existing in 12 different cities, was tendered and a price of US$3.48 ct/KWh, which is

lower than the global average, was achieved. A second WPP YEKA was performed in May 2019 tendering 4 different regions each with 250 MW capacities across the country resulted with prices ranging between US$3.53-4.56 ct/KWh

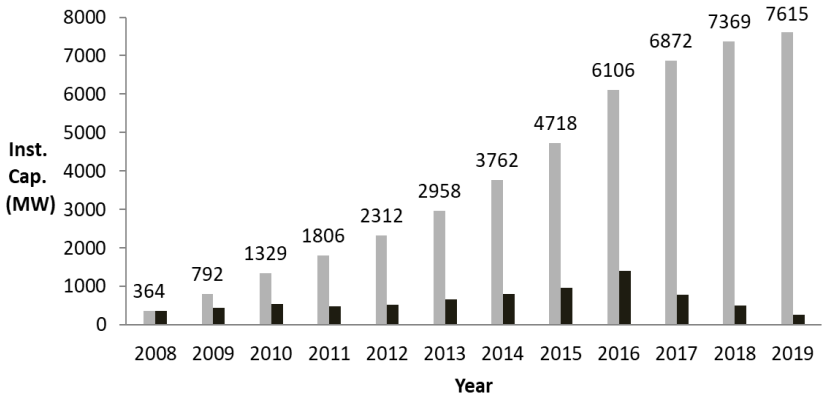

Figure 1. Cumulative Installations for Wind Power Plants in Turkey (Gray: Total Installed Capacity, Black: Annual Installation)

3.2. Solar PV Energy

A total capacity of 5 576 MW exists in 6 434 individual Solar PV Power Plants across the country as of November 2019. Annual Solar PV generation was realized as 7 485 GWh which was the 2.47% of total annual national generation by the end of year 2018. The cumulative installations for WPPs in Turkey are given in Figure 2 (YTBS, 2021).

The 97.5% of Solar PV Power Plants operate without a license under Energy Markets Law no 6446, clause 14, and associated with YEKDEM (law numbered 5346). This is the opposite situation compared to WPPs since installation and commissioning of small sized Solar PV Power Plants is feasible under existing YEKDEM, which is not the case for the former. YEKDEM is not favorable when the energy market prices are high and the USD currency is relatively low which was the case in years 2010-2015. It can be observed from Figure 2 that the installed PV capacity exhibited a rise starting from 2016 due to increased USD currency as shown in Figure 3, relatively low wholesale electricity market prices and feasibility of Solar PV investments with lower capacities suitable for YEKDEM (PwC, 2015).

In addition to YEKDEM, a YEKA tender was performed in March 2017. 1 000 MW of solar PV capacity at Konya/Karapınar region was tendered and a price of US$ 6.99 ct/KWh, which was lower compared to similar global tenders was achieved. A second solar PV YEKA auction was announced in October 2018 and the bidding period was planned to continue until the end of January 2019, but the auction was then canceled. The announcement of Mini YEKA tenders each having a capacity of 40-50 MW is underway (MENR, 2019)..

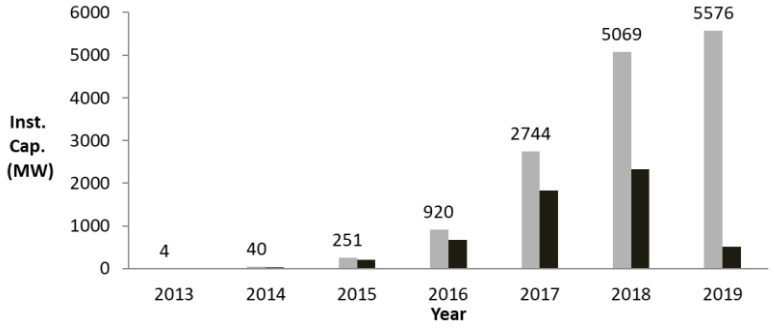

Figure 2. Cumulative Installations for Solar PV Power Plants in Turkey (Gray: Total Installed Capacity, Black: Annual Installation)

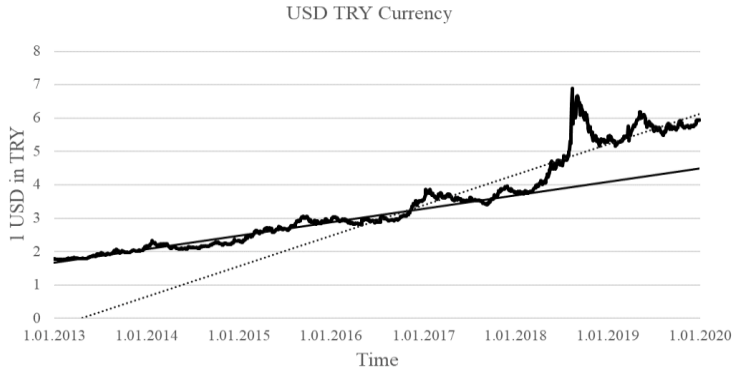

Figure 3. USD- TRY Currency (Solid Trendline: 2013-2016, Dotted Trendline: 2016-2019)

3.3. Hydroelectric Energy

A total of 28 457 MW capacity exists in 669 individual Hydroelectric Power Plants across the country as of November 2019. Annual generation was realized as 59 937 GWh which was the 19.76% of total annual national generation when the total Hydroelectric capacity was considered, and 18 940 GWh which was the 6.24% of total annual national generation when only the Run-off River capacity was considered by the end of year 2018. The cumulative installations for total Hydroelectric and Run-Off River Hydroelectric Power Plants in Turkey are given in Figure 4 and Figure 5 respectively (YTBS, 2021)

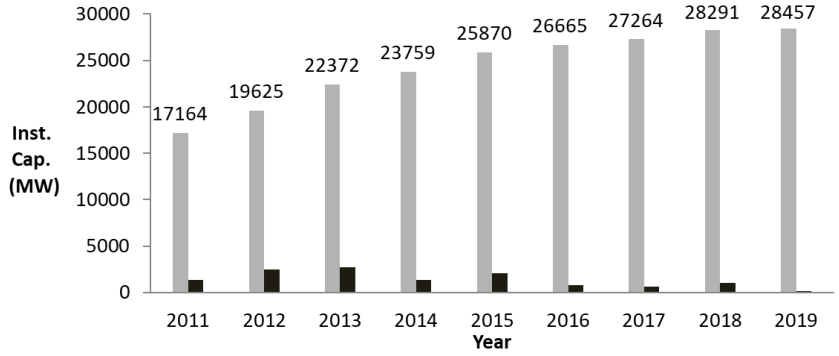

Figure 4. Cumulative Installations for Hydroelectric Power Plants in Turkey (Gray: Total Installed Capacity, Black: Annual Installation)

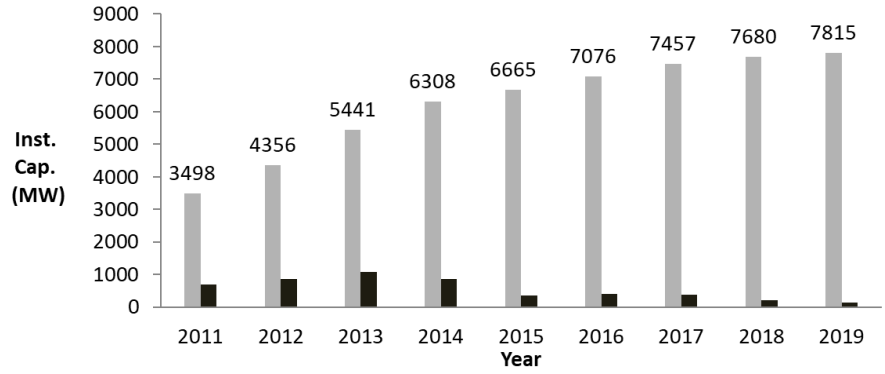

Figure 5. Cumulative Installations for Run-off River Hydroelectric Power Plants in Turkey (Gray: Total Installed Capacity, Black: Annual Installation

3.4. Biomass Energy

A total capacity of 707 MW exists in 158 individual Biomass Power Plants across the country as of November 2019. Annual generation of Biomass Power Plants was realized as 2 586 GWh which was the 0.85% of total annual national generation by the end of year 2018. The cumulative installations for Biomass Power Plants in Turkey are given in Figure 6 (YTBS, 2021).

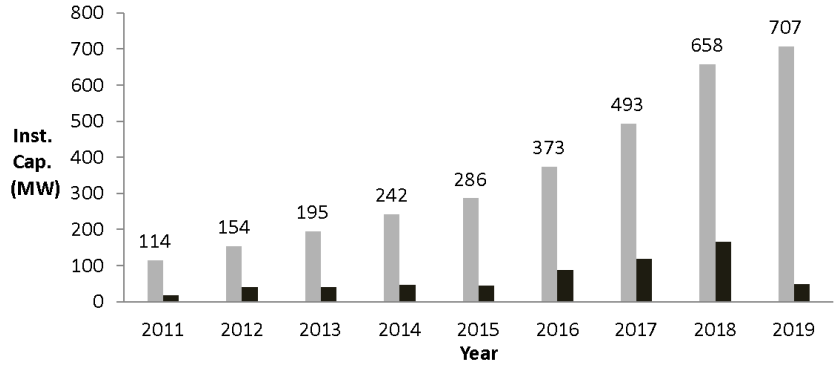

Figure 6. Cumulative Installations for Biomass Power Plants in Turkey (Gray: Total Installed Capacity, Black: Annual Installation

3.5. Geothermal Energy

A total capacity of 1 402 MW exists in 52 individual Geothermal Power Plants across the country as of November 2019. Annual Geothermal generation was realized as 7 611 GWh which was the 2.51% of total annual national generation by the end of year 2018. The cumulative installations for WPPs in Turkey are given in Figure 7 (YTBS, 2021).

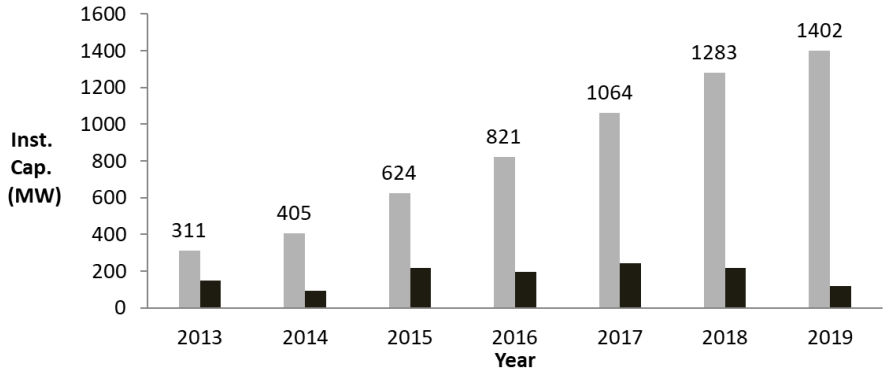

Figure 7. Cumulative Installations for Geothermal Power Plants in Turkey (Gray: Total Installed Capacity, Black: Annual Installation)

3.6. Plans and Strategy Documents Concerning RE Development and Targets

National Climate Change Action Plan of Turkey (NCCAP) (2012):

National Climate Change Strategy (NCCS) (Ministry of Environment and Urbanization, 2010) for Turkey was announced by the Higher Planning Council (obsolete and replaced by Strategic Budget Chair of Presidency of Republic of Turkey as of 2018) and took effect in May 3rd, 2010. NCCS provides a basis for the NCCAP which was published in 2012. The aim of the plan is to coordinate climate-change related concerns within development policies, determine action plans to increase energy efficiency, increasing the use of RES in order to participate in the international efforts that are carried out to prevent and mitigate climate change considering the special circumstances of the country. The plan is organized around nine themes namely; Energy, Building, Industry, Transportation, Waste, Agriculture, Land Use and Forestry, Crosscutting Issues and Adaptation to Climate Change (Ministry of Environment and Urbanization, 2012).

The listed objectives were determined under the Energy theme in order to achieve the objective of increasing the share of clean energy in energy production and:

- Ensuring an increase in the share of RE in electricity generation
- Increase of RES utilization with development of the capacity by 2015
- Ensuring RES related technological development by 2020

The following objectives were determined under the Building theme in order to increase the RES utilization in buildings:

- Generation of financial support mechanisms in order to provide support for energy efficiency, RES and Energy Performance in Buildings until the end of 2013
- A minimum 20% of the yearly energy utilization in new buildings to be supplied from RES by the year 2017

Adaptation theme aims planning of RES concerning their impact on climate change and sustainable ecosystem services having an objective of resiliency for climate change.

As a foundation of the NCCAP, the NCCS document published in 2010 targets 30% share of renewable energy in total electricity generation capacity, fully utilization of technical and economic hydroelectric potential which is 48 183 MW in total; 28 233 MW currently under operation, 4 411 MW under construction and 15 539 MW to be constructed as stated in (General Directorate of State Hydraulic Works, 2018), 20 000 MW of wind and 600 MW of geothermal electricity generation capacity, and support for solar energy generation by 2023.

National Renewable Energy Action Plan (NREAP) (2014):

The Directive 2009/28/EC of The European Parliament and of The European Council of 23 April 2009 on the promotion of the use of energy from renewable sources requires determination of strong targets for all Member States, and the development of national action plans targeting high shares of energy from renewable sources consumed in electricity, heating and cooling, and electricity sectors in 2020 (MENR, 2014). General Directorate of Renewable Energy (obsolete and replaced by General Directorate of Energy Affairs as of 2018) has carried out the NREAP for the period 2013-2023, originating from the methodology defined in the EC directive. NCCAP, which was introduced above, was already one of the references of NREAP other than three MENR strategy documents.

The plan includes envisaged contribution of each RES technology to binding 2023 targets and a reference trajectory of RES energy shares for transportation, electricity, and heating and cooling sectors. 34 000 MW of hydropower is targeted considering the emerging trends for this technology. A growing trend based on the evolution of electricity demand is proposed for the other RES and at least 20 000 MW of wind power, 5 000 MW of solar power, 1 000 MW of biomass power, an updated 1 000 MW of geothermal power is targeted.

Intended Nationally Determined Contribution to UN Framework Convention on Climate Change (INDC) (2015):

Renewable energy is referred to under the measures of the NCCAP 2011-2023, the Energy Efficiency Strategy 2012-2023 and the MENR Strategic Plans for the periods 2010-14 and 2015-19. Besides to that, Turkey's INDC includes targets of 16 000 MW of WPP and 10 000 MW for Solar PV by 2030. MENR announced INDC in late 2015 as a preparation of the Paris COP21 Conference.

National Energy Strategic Plan (NESP) (2015-2019):

Ministry of Energy and National Resources of Republic of Turkey (MENR) issued a strategic plan covering 2015-2019 period and this policy document is updated in 2017 due to negative impact of large decrease in global petroleum prices on energy markets and developments in the neighbor countries in the period of 2015-2016. Energy Supply Security, Energy Efficiency and Energy Saving, Good Governance and Stakeholder Interaction, Regional and International Efficiency,

Technology, R&D and Innovation, Improvement of the Investment Environment, Raw Material Supply Security, Efficient and Effective Use of Raw Materials themes were covered in the plan. These eight themes were studied in such a way to achieve a balance between different sectors and to reflect the relation and synergy between energy and natural resources. A ninth theme; economic, social and environmental sustainability was separately designed as a frame topic encapsulating the former eight ones (MENR Strategic Plan, 2017).

It is pointed out under Energy Supply Security theme that Turkey has substantial potential in RE Sources to be utilized for both electric and heat energy production, however improvement of financial capabilities, legislation and transmission infrastructure and investor awareness have to be improved. Different yearly capacity targets for RE sources given in Table 1 were appointed under the Energy Supply Security theme.

The strategies associated with this theme could be listed as below:

- Development of RE monitoring and forecast systems as well as potential atlases both for Wind and Solar PV resources
- The continuation of YEKDEM and enhancement of the infrastructures in order to support the integration of RE sources to the grid
- Determination and leveling of YEKA zones

Energy Efficiency and Energy Saving is another theme which is also addressed by policies of many countries. Commissioning of energy storage systems to ensure on-site consumption of RES was targeted under Energy Efficiency and Energy Saving target. The strategies associated with this theme could be listed as below:

- Support of production facilities based on RES, cogeneration or micro cogeneration systems, central and regional heating and cooling systems, and preparation of a legislative infrastructure for the heat market.
- Revision of the relevant legislative infrastructure for on-site production as a facilitator in terms of permits and other administrative processes, in order to expand the decentralized electrical energy production based on renewable energy sources, cogeneration or micro cogeneration and similar systems,
- Strengthening of the network infrastructure in this direction

Different targets for the same RES technology, contradicting for some specific years were determined in different strategy documents as shown in Table 1. Hydroelectric capacity was determined as 48.1 GW in NCCAP, while the target is decreased to 34 GW in NREAP for the year 2023 and determined as 32 GW for 2019 in MENR NESP. Wind Power target was kept identical as 20 GW in NCCAP and NREAP for 2023 while it was decreased to 16 GW in INDC even for a further year 2030 and determined as 10 GW for 2019 in MENR NESP. Geothermal target was given as 600 MW in NCCAP, raised to 1 GW in NCCAP and NREAP both for the year 2023, and determined as 1,3 GW for 2019 in MENR NESP. Solar PV target was first given as 5 GW in NREAP for the year 2023, raised to 10 GW in INDC for the year 2030, determined as 3 GW in MENR NESP for the year 2019. Biomass target was only given in NREAP as 1 GW for 2023 and updated as 700 MW for 2019 in MENR NESP.

The determined targets in the MENR NESP for Geothermal, Biomass and Solar PV installation were achieved, nearly even doubled for Solar PV, while Wind and Hydroelectric installations were lagged behind when the determined targets are compared with actual installations given in Figure 1 to Figure 7. This might be due to higher investments cost of these with respect to other RE sources. Moreover, different strategy documents were prepared in different years in which the national and global situation differs. However, long term and ambitious targets should be determined in order to give clear signals to the sector and guarantee a healthy RES sector development.

Table 1. *Different RE targets and actual 2019 realization*

Strategy Document (Issue Year)	**Target Year**	**Hydroelectric (MW)**	**Wind Power (MW)**	**Geothermal (MW)**	**Solar (PV) (MW)**	**Biomass (MW)**
NCCAP (2012)	2023	48 183	20 000	600	-	-
NREAP (2014)	2023	34 000	20 000	1 000	5 000	1 000
INDC (2015)	2030	-	16 000	-	10 000	-
MENR NESP (2015)	2013	22 289	2 759	311	-	237
	2015	25 000	5 600	360	300	380
	2017	27 700	7 000	700	1 800	540
	2019	32 000	10 000	1 300	3 000	700
Actual Realization (2019)	2019	28 547	7 615	1 402	5 576	707

4. Concerns Related to Development of Renewable Energy

The previous sections discussed the participation of different types of RE into the Energy Markets and existing situation regarding each of these sectors. This part discusses the issues and concerns associated with the future development.

4.1 Resolving Differences of Future Targets

Turkey determined a number of measureable targets however a legally binding target fixed in legislation does not exist. The target defined in NCCS and NCCAP was an ambitious share of 30% of RE generation by 2023 and is already achieved by 2015. NREAP and the INDC targets have differences. These should be resolved and a coherence should be achieved for the future targets that are to be published by different government and private sector entities.

4.2 Determination of RES in the Long Run

A long term target is required to go beyond 2030 other than INDC. Turkey met its 2009 dated MENR and 2010 dated NCCS RES targets of 30% capacity ratio by 2023, already by the year 2015. New long term targets shall be established in order to encourage RES investments in the energy sector. In spite of the fact that the government has already secured 2023 Solar PV and geothermal targets, formal announcements and legislative proposal shall be made. The Turkey economy is set to grow continuously even the global economic slowdown is considered, and determination of ambitious long term targets would promote further investments to ensure the country benefits from good competitiveness of RES

4.3 Grid Integration Rules, Network Infrastructure and Licensing

The grid connection rules and electricity transmission and distribution system connections limit the private sector and utilization of diverse domestic RE potential, notably for wind and solar power. Turkey energy sector includes two different energy markets and regulatory frameworks for licensed and unlicensed operators. Unlicensed market entry is widely applied with all developers to avoid license procedures. The increasing number of unlicensed but relatively large RES capacity brings power system operational and regulatory risks since monitoring of a large number of relatively small sized RES plants is a challenge. Moreover, the extensive distribution of licenses led to the secondary trading of licenses and created delays in the actual deployment of the facilities. Definition of YEKA mitigated the situation, however, a long term and sustainable YEKA strategy shall be announced.

4.4 Redesign of Market Mechanisms for RES

A Generation Company that owns RES has the option to choose either YEKDEM or sell directly into the electricity wholesale day-ahead market in each year. Wholesale market is less attractive in the country since the electricity prices declined in the recent years due to economic developments and slowed demand. It is advantageous to rethink YEKDEM tariff and develop it into a longer-term addition on top of market prices in times of the second phase of a more accelerated RES deployment. YEKDEM tariff support has a short-term ten-year duration and subject to significant currency rate risks, since it is referenced to US dollars.

4.5 Better Utilization of Hydroelectric Potential

To date, the development of renewables has resumed with many of the RES. Solar power exhibited an acceleration due to advantages of YEKDEM with respect to wholesale prices in the recent years. The potential of wind power and hydroelectric are high in Turkey while 15 539 MW of capacity is still untapped from a total of 43 183 MW hydroelectric capacity as discussed above. One of the underlying reasons is the deficiency of available technology to be applied to various conditions while the other is the public acceptance issues. There are a number of studies aiming to increase generated energy from hydroelectric power plants (HEPP) by extending operational regimes and efficiencies and application of these technologies might improve utilization. Hydroflex (HYDROFLEX, 2019) aims to increase flexibility of HEPP by increasing on the operation interval of Francis turbines, the configuration of synchronous generators and frequency converters that allow for variable speed turbine operation. FITHydro (FITHydro, 2019) project aims to develop low-cost environmental solutions and strategies to avoid individual fish damage and enhancing population developments. The objective of the HYPERBOLE (HYPERBOLE, 2019) project is to enhance hydropower plant value by extending the flexibility of its operating range, while also improving its long-term availability. National MİLHES (TÜBİTAK MRC, 2020) project aims to develop hydroelectric power plant components utilizing domestic design and manufacturing capacity of Turkey.

4.6 Requirement for Supporting Technologies

The integration of more RES into generation fleet brings extra challenges in means of maintaining supply and demand balance. The uncertain nature of RES requires extensive generation reserve when a certain ratio of installed capacity is reached. Aged conventional generation capacity might fail to cope with continuously variable operation regime and might not fulfill the required ramp-up and ramp-down capabilities. This requires new technologies such as demand response, increased flexible generation reserves and electricity/mechanical storage to be integrated into the electricity markets and system due to the volatility and intermittent character of RES. This shall be supported with transmission and distribution systems grid expansion.

5. Conclusions

The development of different RES technologies in the Energy Sector of Turkey has been discussed and future targets from different policy documents are noted. Different mechanisms for energy market entry for RES are explained and final comments to support the increase of RES penetration have been discussed. It is seen that Geothermal, Biomass and PV targets were achieved earlier than anticipated in the strategy documents due to lower investment cost of these technologies compared to Wind and Hydroelectric Power Plants. The issues of determination of long term RES targets, grid integration rules, network infrastructure and licensing, redesign of market mechanisms, better utilization of hydroelectric potential and requirement of support technologies are highlighted.

References

International Energy Agency (2020) Renewable Electricity, https://www.iea.org/reports/renewables-2020/renewable-electricity-2#abstract,

International Energy Agency (2020) Data and Statistics, https://www.iea.org/data-and-statistics?country=WORLD

International Energy Agency (2019) Renewables 2019 -Market analysis and forecast from 2019 to 2024, https://www.iea.org/reports/renewables-2019

Ministry of Energy and Mineral Resources (2017) 2015-2019 Strategic Plan, https://sp.enerji.gov.tr/ETKB_2015_2019_Stratejik_Plani.pdf

https://ytbsbilgi.teias.gov.tr Access Date: 07.03.2021, Topic: *TEİAŞ YTBS (Load Dispatcher Information System) Energy Statistics*

International Energy Agency (2016)"Energy Policies of IEA Countries, Turkey, 2016 Review, www.iea.org

https://www.epias.com.tr/epias-kurumsal/hakkimizda/ Access Date: 07.03.2021, Topic: *EPİAŞ/History,*

Presidency of the Republic of Turkey Investment Office (2018) Turkey's Renewable Energy Market and Investment Opportunities, http://v1.invest.gov.tr/tr-TR/infocenter/publications/Documents/YENILENEBILIR.ENERJI.SEKTORU.pdf

Presidency of the Republic of Turkey Investment Office (2019) Guide to Investing in Turkish Renewable Energy Sector, https://www.invest.gov.tr/en/library/publications/lists/investpublications/guide-to-investing-in-turkish-renewables-energy-sector.pdf

Price Waterhouse Coopers (2016) YEKA Üzerine Bir Değerlendirme, https://www.pwc.com.tr/tr/sektorler/enerji-altyapi-madencilik/enerji-spotlights/yeka-uzerine-bir-degerlendirme.html

Thomson, P., Derrick, J. (2019) *GLI-Energy*, Global Legal Group, London https://www.kilinclaw.com.tr/wp-content/uploads/2018/11/GLI_EN7_Turkey.pdf

Turkish Wind Energy Association (TWEA) (2018) Turkish Wind Energy Statistic Report, https://www.tureb.com.tr/files/bilgi_bankasi/turkiye_res_durumu/istatistik_raporu_temmuz_2019.pdf

Price Waterhouse Coopers (2015) YEKDEM Kapasitesi Üzerine Bir Değerlendirme, https://www.pwc.com.tr/tr/sektorler/enerji-altyapi-madencilik/enerji-spotlights/yekdem-kapasitesi-uzerine.html

Ministry of Energy and Mineral Resources (2019) Türkiye bölgenin en büyük ve yatırım açısından en cazip ülkesidir, https://www.enerji.gov.tr/tr-TR/Bakanlik-Haberleri/Turkiye-bolgenin-en-buyuk-ve-yatirim-acisindan-en-cazip-ulkesidir-

Ministry of Environment and Urbanization (2010) National Climate Change Strategy, https://webdosya.csb.gov.tr/db/iklim/editordosya/iklim_degisikligi_stratejisi_EN.pdf

Ministry of Environment and Urbanization (2012) National Climate Change Action Plan of Turkey, https://webdosya.csb.gov.tr/db/iklim/editordosya/iklim_degisikligi_eylem_plani_EN_2014.pdf

General Directorate of State Hydraulic Works (2018) 2019-2023 Strategic Plan, http://bilgi.dsi.gov.tr/spland/splan4/files/assets/basic-html/index.html#3

Ministry of Energy and Mineral Resources (2014) National Renewable Energy Action Plan for Turkey, http://policy.thinkbluedata.com/node/3908

HYDROFLEX, https://cordis.europa.eu/project/rcn/214058_en.html Access Date: 07.03.2021

FITHYDRO, https://cordis.europa.eu/project/rcn/205921_en.html Access Date: 07.03.2021

HYPERBOLE, https://cordis.europa.eu/result/rcn/208601_en.html Access Date: 07.03.2021

TÜBİTAK MRC (2020) "National Design and Development of Hydroelectric Power Plant Components (MİLHES) Project Final Report"