Contract N°: IEE/11/845/SI2.616378

Bringing Europe and Third countries closer together through renewable Energies

BETTER

D5.1: Report on power system inventory and status of RES(-E) deployment in Turkey

Project Coordinator: **CIEMAT**

Work Package 5 Leader Organization: **TUWIEN**

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PREFACE

BETTER intends to address RES cooperation between the EU and third countries. The RES Directive allows Member States to cooperate with third countries to achieve their 2020 RES targets in a more cost efficient way. The core objective of BETTER is to assess, through case studies, stakeholders involvement and integrated analysis, to what extent this cooperation *can help Europe achieve its RES targets in 2020 and beyond, trigger the deployment of RES electricity projects in third countries and create win-win circumstances for all involved parties*.

The case studies focusing on **North Africa, the Western Balkans and Turkey** will investigate the technical, socio-economic and environmental aspects of RES cooperation. Additionally, an integrated assessment will be undertaken from the "EU plus third countries" perspective, including a quantitative cost-benefit evaluation of feasible policy approaches as well as strategic power system analyses. Impacts on the achievement of EU climate targets, energy security, and macro-economic aspects will be also analysed.

The strong involvement of all relevant stakeholders will enable a more thorough understanding of the variables at play, an identification and prioritisation of necessary policy prerequisites. The dissemination strategy lays a special emphasis on reaching European-wide actors and stakeholders, well, beyond the target area region.

PROJECT PARTNERS

N°	Participant name	Short Name	Country code
CO1	Centro de Investigaciones Energéticas, Tecnológicas y Medioambientales	CIEMAT	ES
CB2	German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt e.V.)	DLR	DE
CB3	Energy Research Centre of the Netherlands	ECN	NL
CB4	JOANNEUM RESEARCH Forschungsgesellschaft mbH	JR	AT
CB5	National Technical University of Athens	NTUA	GR
CB6	Observatoire Mediterranéen de l'Energie	OME	FR
CB7	Potsdam Institute for Climate Impact Research	PIK	DE
CB8	Vienna University of Technology	TUWIEN	AT
CB9	United Nations Development Program	UNDP	HR

Contents

1 Introduction

This report is part of the Turkey case study within the BETTER analysis framework. The goal of WP 5 is to assess the potential of the 4th cooperation mechanism in helping Europe to achieve its RES-E targets and to trigger the faster implementation of RES electricity projects in Turkey by 2020 and beyond. This report D5.1 provides a basis for the detailed analysis of prospects and opportunities for the implementation of the cooperation mechanism with Turkey in WP 5.2., 5.3., 5.4 and 5.5 in providing an overview about the current energy policy framework, including support schemes for RES(-E) and the present political RES(-E) discussion and strategies in Turkey. Section 2 gives an overview on the historic development and the current state of the Turkish energy system and the corresponding markets, whereas a special focus is given on the electricity sector, including the description of a detailed power plant database that was developed to serve as input for later tasks. Section 3 comprises the current RES policy framework in Turkey in detail. Finally, Section 4 summarises current drivers and barriers for the RES-E deployment in Turkey. These include non-cost barriers and socio-economic success factors for investment in RES technologies.

2 Energy System characterization and energy market

2.1 Overview on the Turkish energy market

The energy market is one of the most promising branches of the Turkish economy. Because of the high population growth on the one hand and on the other hand due to the efforts to engage private stakeholders within the development of the sector as well as the establishment of strategic partnerships with neighbor countries the branch has experienced a rapid growth. It is expected that this growth will continue in the medium term and consequently massive investments in this sector will be needed. Since 2001 Turkey has started to restructure its energy markets to enable and facilitate competition. As in other countries, the implementation of key requirements of liberalized markets is delayed according to initial plans, but significant progress has been achieved in the previous years. The EU accession negotiations already guided the regulatory reform of the Turkish energy markets in many policy areas, including network industries such as electricity, gas and telecommunications [18]. The legal and regulatory frameworks that have been adopted since the early 2000s are consistent with those in the EU [19]. Figure 1 shows the historic total primary energy supply of Turkey. It can be seen that most of the growth in energy demand has been met by the use of coal and gas. From 1973 up to 2012 we can observe a shift from an oil-dominated supply towards a more balanced supply mainly based on fossil fuels.

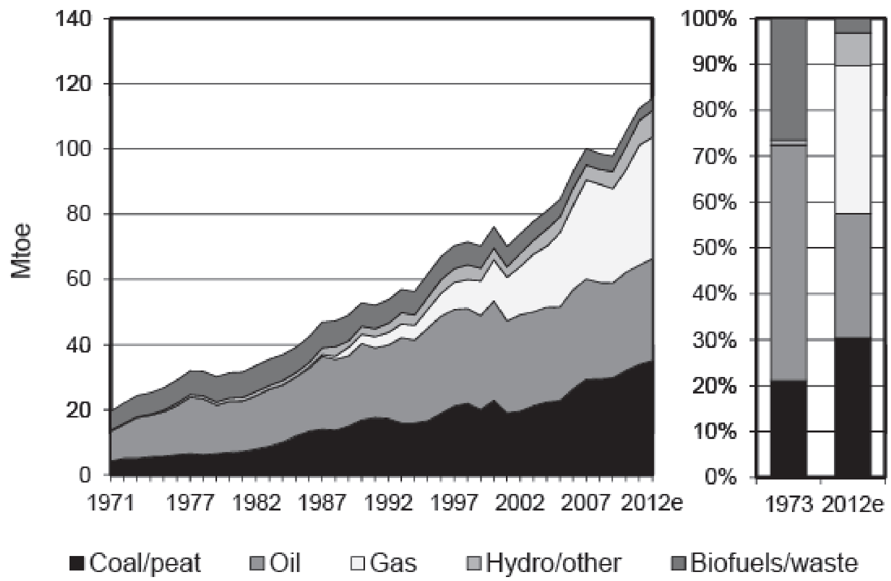

Figure 1: Total primary energy supply of Turkey [1].

Figure 2 provides an overview on the energy production of Turkey within the same time frame. Domestic coal and hydro reserves have been continuously developed and currently account for the main share. However, in absolute terms the own production constitutes only one third of total supply in 2012. Figure 3 illustrates the self-sufficiency calculated as the share of own production on total supply. It can be seen that the share of total production follows a decreasing trend over the whole period and reaches a level of approximately 30% in 2012.

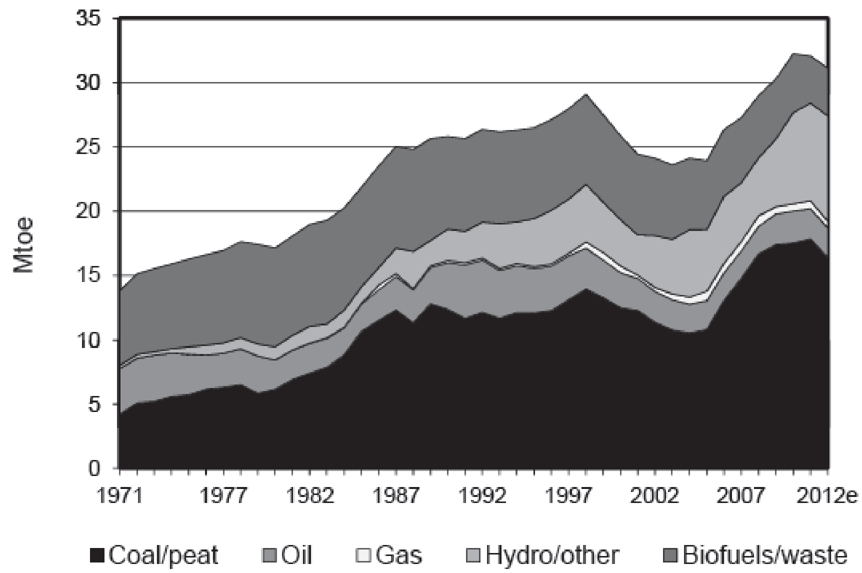

Figure 2: Primary energy production of Turkey [1].

Since the early 2000s this development has been recognized as critical and measures were taken to increase the utilization of domestic resources (see Figure 2 and 3). However, the Turkish energy supply highly depends on imports from gas, oil and coal. In its energy strategy paper the Turkish government emphasizes that their aims until 2023 are *"…the integration of our entire coal and hydraulic potential into our economy, making our wind energy installed capacity reach up to 20,000 MW, and our geothermal energy installed capacity reach up to 600 MW and, additionally, supplying the 5 percent of our electricity energy production through nuclear energy*" [20].

Figure 4 shows the development of a number of selected energy-related indicators. One important observation is that the total primary energy supply (TPES) remains within a constant ratio to the development of the GDP over the whole period. This indicates that so far there has been no decoupling of the economy and the energy demand. Furthermore, it can be seen that both the total energy demand as well as the electricity demand per capita has been increased. Especially, the electricity demand per capita shows significantly higher growth rates as the electricity demand per GDP. This indicates on the one hand that there is a shift of the energy supply towards electricity and on the other hand that people on average consume more electricity. This development is similar to that in other emerging economies and can be observed in the data of the historic development of most OECD countries as well.

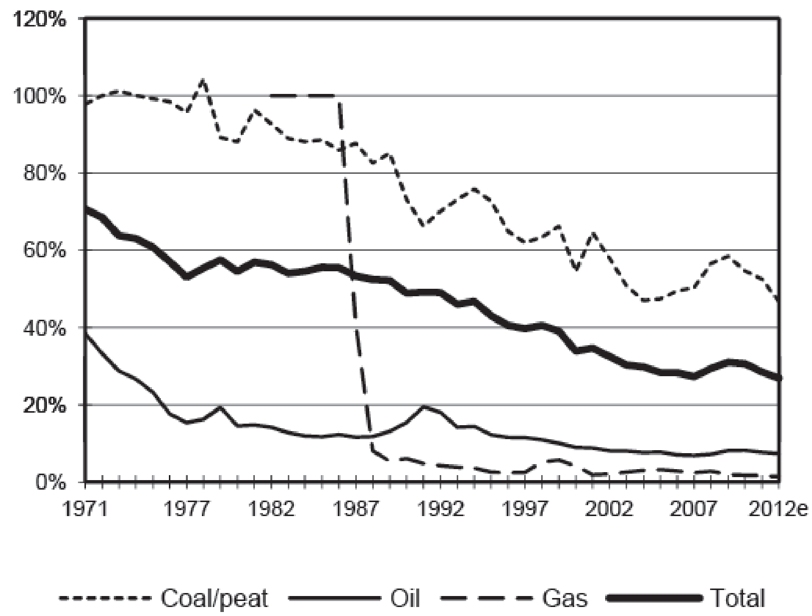

Figure 3: Energy self-sufficiency of Turkey as share on total primary energy supply [1].

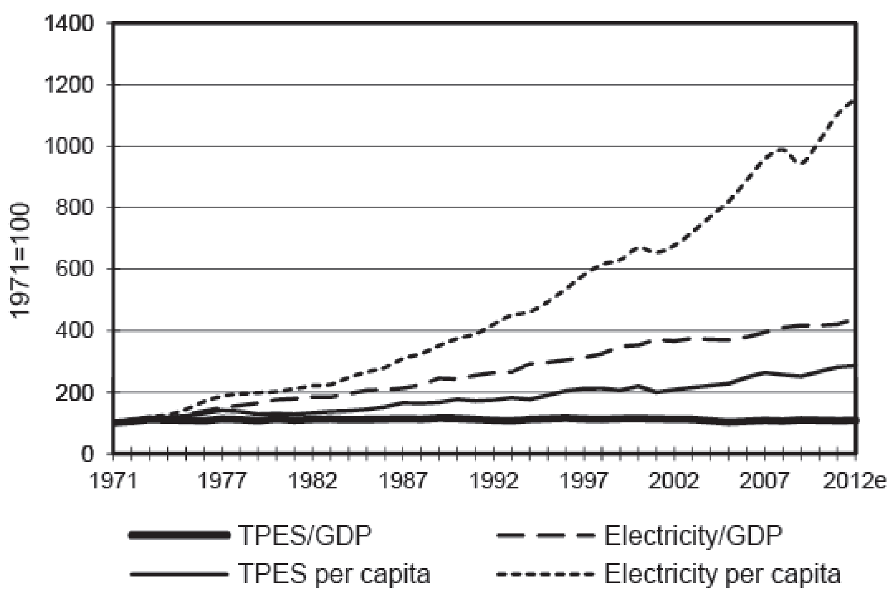

Figure 4: Selected energy indicators of Turkey [1].

2.1.1 Oil

In 2012 Turkey's estimated oil production amounted to 30 Mtoe, or 7% of total oil supply, which is well below the IEA average (45% in 2012). The domestic oil production has been slightly decreased from 1973 to 2000 whereas the demand has been steadily grown. Consequently this led to a decrease in the share of own production during that period. The decline of the oil production has been brought about by the rapid expansion of the use of natural gas. From the 2000s up to now we can see a moderate variation on a steady level. Up to 2020 a further growth of the demand up to 56 Mtoe are expected by the Turkish government [9].

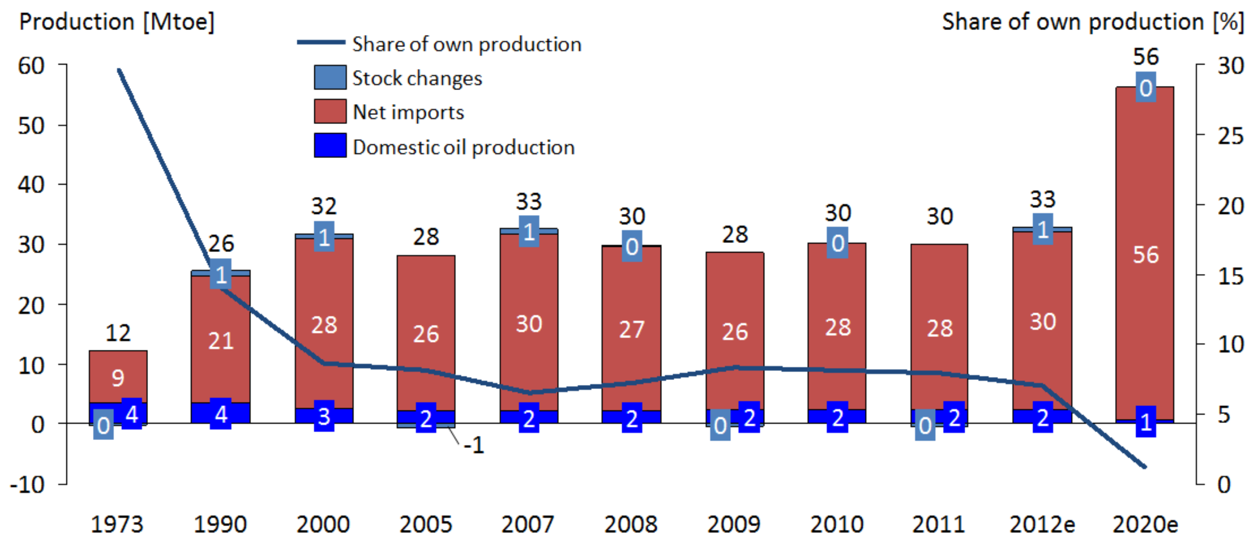

Figure 5: Historic and forecasted total oil supply broken down in balance sheet items (left), Share of domestic oil production on total oil supply (right) [1].

In 2008, the main importsof crude oil were Iran (35%), followed by Russia (32%), Saudi Arabia (16%) and Iraq (9%). Also oil products have been imported from more than 20 countries in the same year [9]. The Turkish Petroleum Corporation (TPAO) accounts for around 76% of domestic production. Recently, TPAO has been active in exploration, especially in the Black Sea region, where it cooperates with different foreign oil companies.

Table 1: Crude oil reserves of Turkey (status 2010) [2][16].

	Reserves	Recoverable reserves	Cumulative production	Remaining recoverable reserves
Million barrels	6886.2	1247.3	955.8	291.5
Million tonnes	1007.7	178.7	135.5	43.14

From Table 1 can be seen that the recoverable crude oil reserves of Turkey are around 43 million tones which is within the range of the yearly oil demand. Oil is mainly produced in the north-west of the country, where tanker terminals are available. Other locations in the middle and the south-east of Turkey are connected to a pipeline system to Iraq and Georgia which is operated by BOTAŞ, the national petroleum pipeline cooperation (see Figure 6).

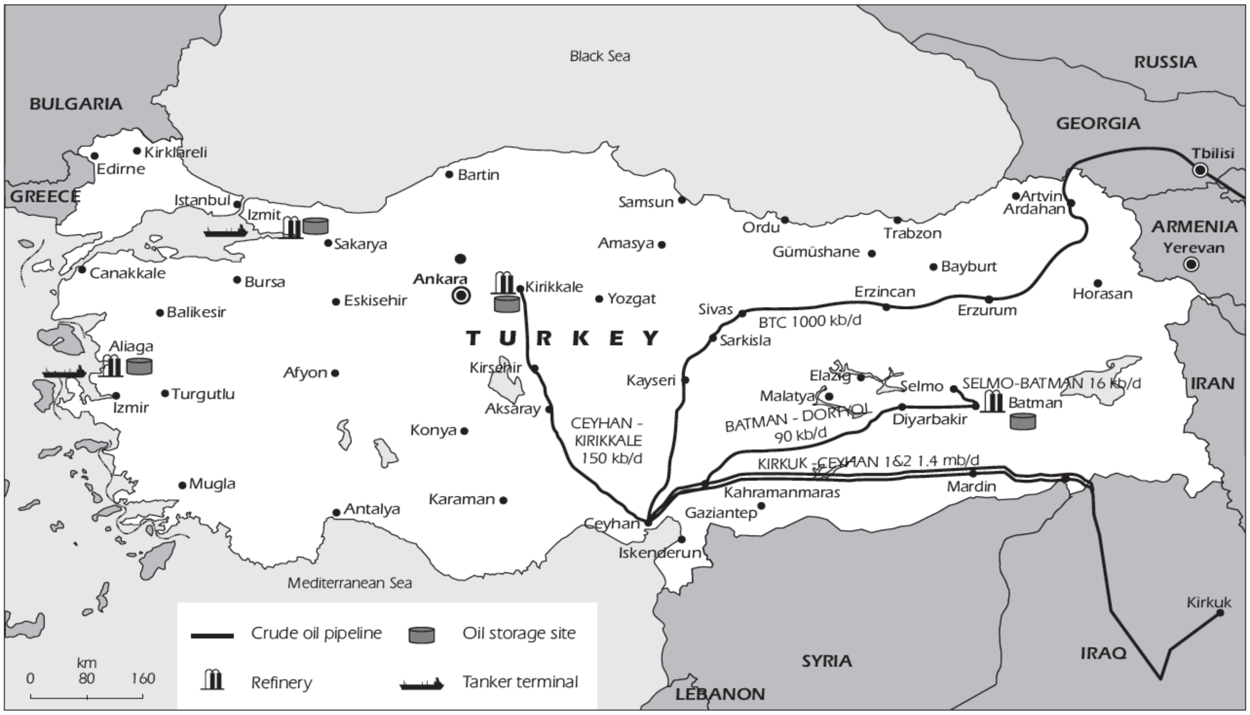

Figure 6: Map of Turkey's Oil Infrastructure (status 2008) [9].

The oil storage facilities are widely distributed over the country. According to the energy market regulation authority's (EMRA) Oil Sector Report 2009, the companies with storage obligations had a total storage capacity of 60.9 million barrels (8.3 million cubic meters), as of the end of 2009. One pipeline project of strategic interest for Turkey is currently in its construction phase and will be routed from Samsun to Ceyhan and thus connects the Black Sea to the Mediterranean.

2.1.2 Coal

In 2012 the estimated total coal supply was 35 Mtoe. The own production accounts for 46% of total coal supply and it is expected that this share will stay constant up to the year 2020 [9]. Total supply increased until 2008 and experienced only little growth in the last ten years, which is mainly due to large imports of natural gas. Turkey produces both hard coal and lignite, but 90% of its hard coal has been imported, whereas Russia is the largest supplier (55% of imports in 2008). As can be seen from Figure 9 the hard coal resources are concentrated in the Zonguldak region in the north of Turkey. All the lignite resources are spread all over Turkey and consist of different calorific values ranging from 1200 to 2200 kcal/kg, whereas the hard coal calorific values are in the range between 6000 to 7000 kcal/kg. Besides that also a considerable amount of bituminous shale and peat reserves are spread across the country.

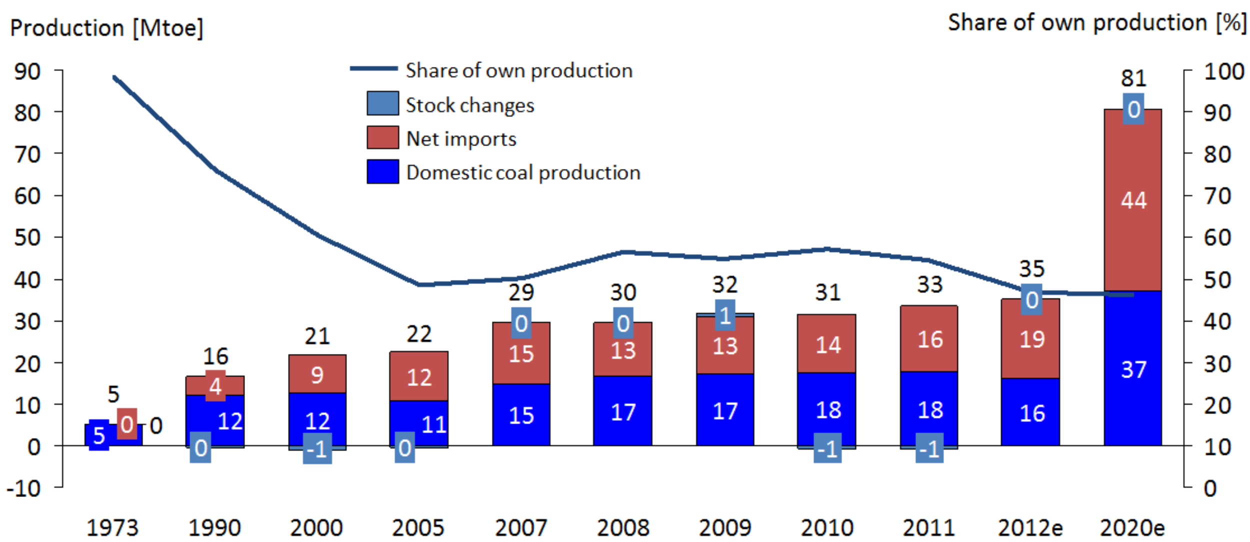

Figure 7: Historic and forecasted total coal supply broken down in energy balance items (left), Share of domestic coal production on own production (right) [1].

Nearly all of the coal-fired power plants are concentrated in the west of Turkey and are closely located to the load centers (see Figure 8). The reserves can be divided in several categories according to the level of confidence to which those resources can be developed. Table 2 provides an summary of the known amounts of coal reserves 2009. The total reserves of coal, lignite and related products correspond to approximately 3700 Mtoe and could cover current demand for about 100 years. In 2012 about one third of total coal supply was used for power generation.

Table 2: Lignite and Hard coal reserves in Turkey [2][11][12][13].

	Possible (mio. tons)	Probable (mio. tons)	Proven (mio. tons)	TOTAL (mio. tons)
Hard coal	368	432	535	1,335
Lignite*	262	1,345	9,900	11,507

* including asphaltite and sub-bituminous coal

Figure 8: Location of coal fields and coal-fired power plants (status 2009) [9].

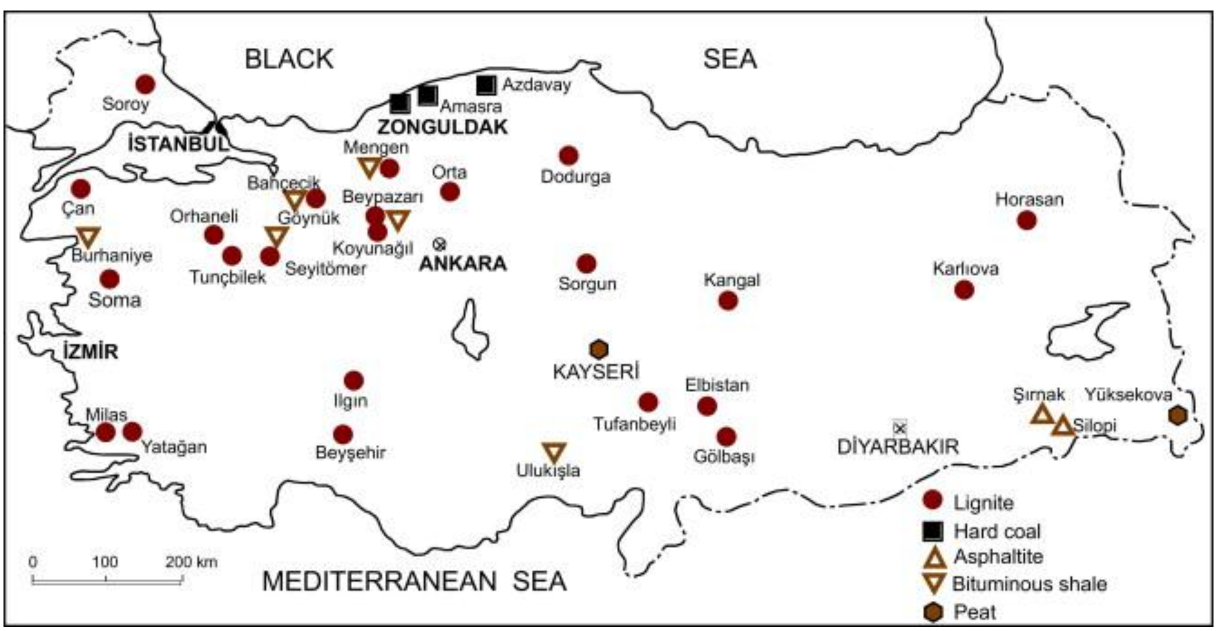

Figure 9: Distribution of lignite, hard coal, asphaltite, bituminous shale and peat deposits [2].

2.1.3 Gas

Natural gas has met a major part of Turkey's rapidly growing energy needs, rising from hardly 7% of TPES in 1990 to 32% of TPES in 2012. Thus, it has overtaken oil as major fuel and has become the most important fuel in volume terms. From 2000 to 2009, natural gas supply increased by 127%, making Turkey one of the fastest growing markets in Europe. However, the financial crisis caused a temporary decline in 2009. Since that, it experienced again significant growth especially in the last years. Nevertheless, nearly the whole amount of gas is being imported and the share of own production is currently around 1.2%. In 2009, 52% of gas imports came from Russia, followed by Azerbaijan (15%), Algeria (14%), Iran (16%) and Nigeria (3%). According to expectations of the Turkish government the demand for gas will rise to 52 Mtoe in 2020 [9]. In 2012 more than half of the total gas supply was used for power generation.

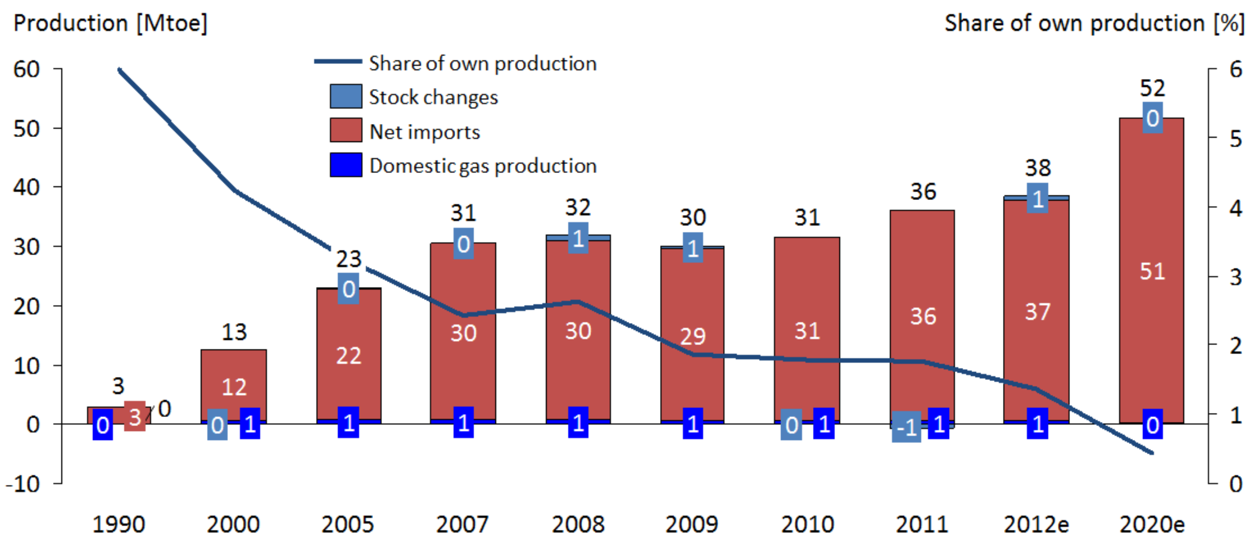

Figure 10: Historic and forecasted total gas supply broken down in energy balance items (left), Share of domestic gas production on own production (right) [1].

The domestic gas resources of Turkey are quite limited. Table 3 provides an overview on several indicators relevant to the gas reserves. The remaining recoverable gas reserves correspond to an energy content of about 3.5 Mtoe, which means that even with current levels of own production the gas reserves do have a static range of about 3-4 years.

Table 3: Natural gas reserves of Turkey (status 2009) [2][15].

	Total reserves (x 10^6 m3)	Recoverable gas (x 10^6 m3)	Cumulative production (x 10^6 m3)	Remaining recoverable gas (x 10^6 m3)
Natural gas	23,140	17,524	11,303	6,221

The Turkish gas pipeline infrastructure is owned and operated by BOTAŞ, the Turkish transmission system operator. The transmission system is well developed across Turkey and consists of a high-pressure grid with a total length of 11,294 km (see Figure 11).

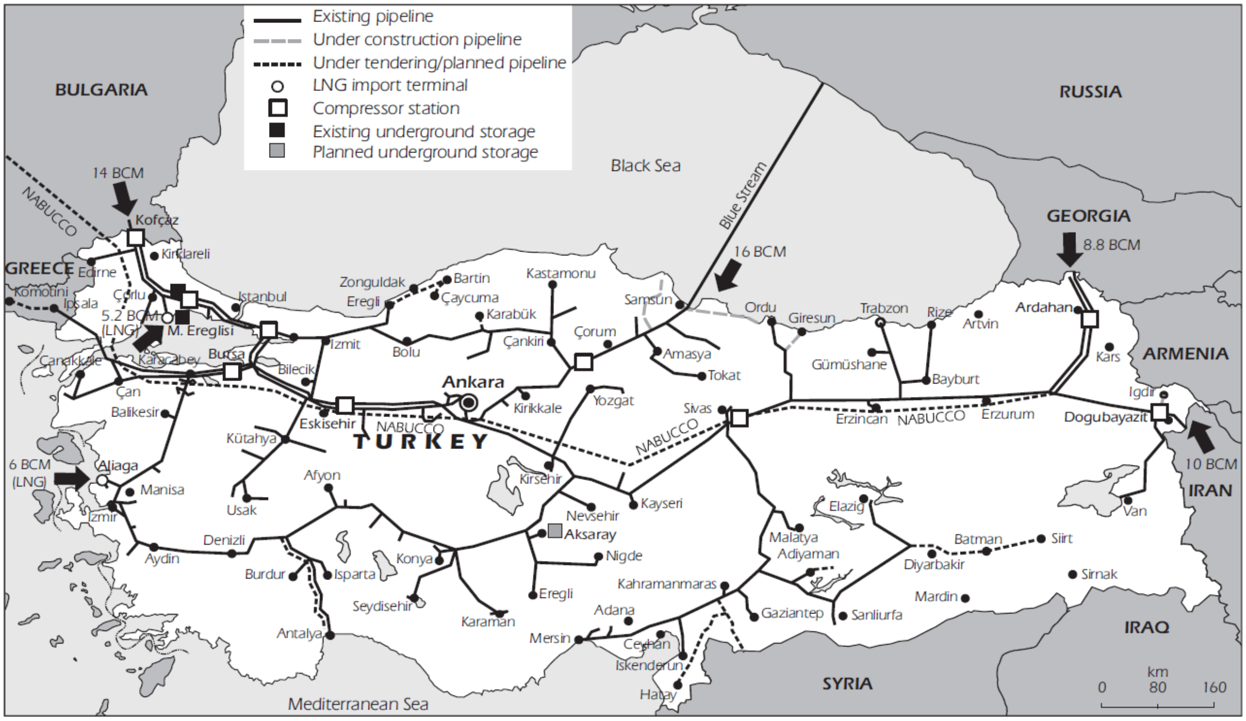

Figure 11: Map of the Turkish natural gas pipelines including storages (status 2009) [9].

Gas from Russia are transported to Turkey via the Russia-Turkey West-Gas pipeline through Bulgaria and via the Russia-Turkey Blue Stream across the Black Sea. Imports from Azerbaijan come through Georgia via the Baku-Tbilisi-Erzurum pipeline that was launched in 2007. There are also a direct connection to Iran and for export reasons a pipeline to Greece, namely TAP (Trans-Adriadic Pipeline), that will be extended to Italy by 2014 and will have a capacity of 11.6 bcm per year. This pipeline serves as an important prerequisite for the integration of the Turkish and the EU internal gas market. It is important to mention that Turkey posses a strategic position as energy transision hub, especially for energy supply from the middle east to Europe. The government is well aware about this fact and studies several options for future pipeline projects. One important project in that respect is the plan to design a concept for a pipeline connecting Iraq to Turkey. A joint working group with the task of finding ways and means for constructing this pipeline has already set up. The Turkish ministry of energy and natural resources expects significant increases in supply, demand and transit volumes by 2020. The assume a potential supply ranging from 116 to 156 bcm (with 30-40 bcm coming from the caspian region and Iran). Assuming a domestic demand of 61 bcm, this would mean a export potential of about 55 to 95 bcm by 2020. The current underground gas storages in Turkey do have an capacity of 2.1 bcm with a injectino capacity of 14 mcm/day and a withdrawal capacity of 17 mcm/day. Those storages possess an upgrade potential of 3 bcm storage capacity and 50 mcm/day withdrawal capacity. Additionally, in the south-east of Ankara new cavern gas storages are planned with a potential storage capacity up to 5 bcm [9]. Besides the cavern storages Turkey maintains two LNG terminal stations (see Table 4).

Table 4: LNG terminals in Turkey (status 2009) [9].

	Maximum capacity (bcm per year)	Maximum send-out capacity (mcm per day)	Storage capacity (m3)	Owner
Marmara Ereglisi	8.2	22.05	255,000	BOTAŞ
Aliaga, Izmir	6.0	16.4	280,000	Egegaz

2.1.4 Electricity

The electricity demand of Turkey has steadily increased from 1973 to 2008 and has experienced a temporary decline during 2009 as a consequence of the financial crisis (see Figure 12). It can be seen that the growth has been mainly fulfilled by the development of coal, gas and hydro power. In Figure 13 the shares of several fuels on electricity generation are depicted. Electricity from gas has been steadily increased and accounted for half of the power generation, however, decreased in relative terms due to the strong expansion of hydro power during the last years. Up to now renewable energy sources besides hydro power do play a minor role in overall electricity generation. Up to 2020 Turkey's government plans to increase the amount of RES generation mainly through hydro power [9].

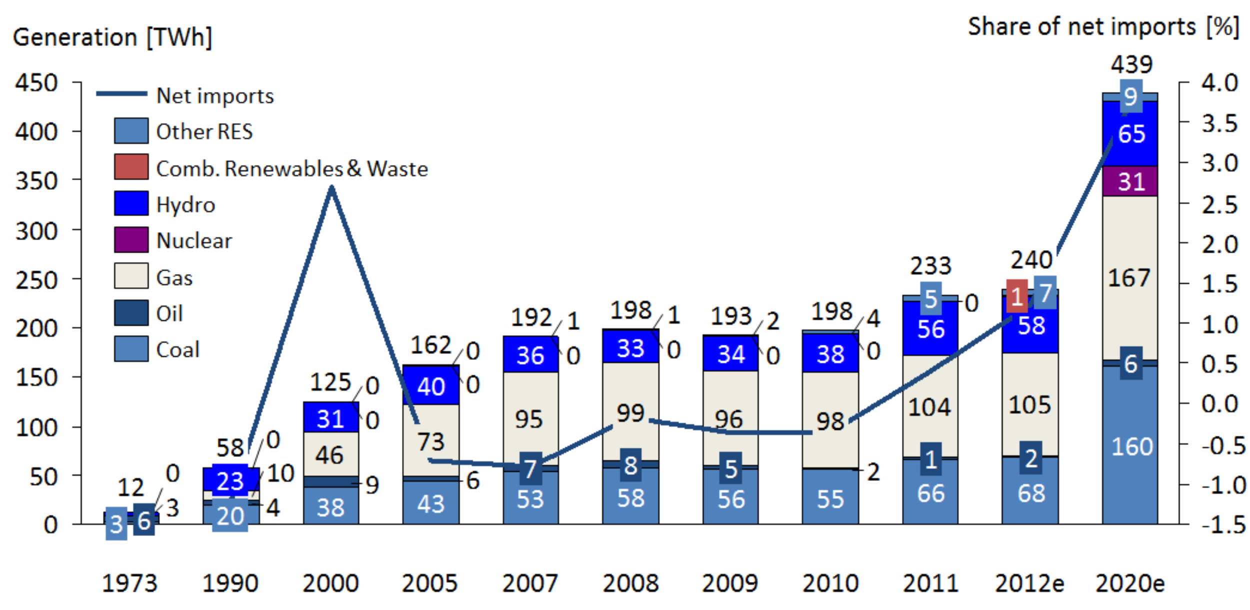

Figure 12: Historic and forecasted gross electricity generation broken down in energy balance items (left), Share of net electricity imports on own generation (right) [1].

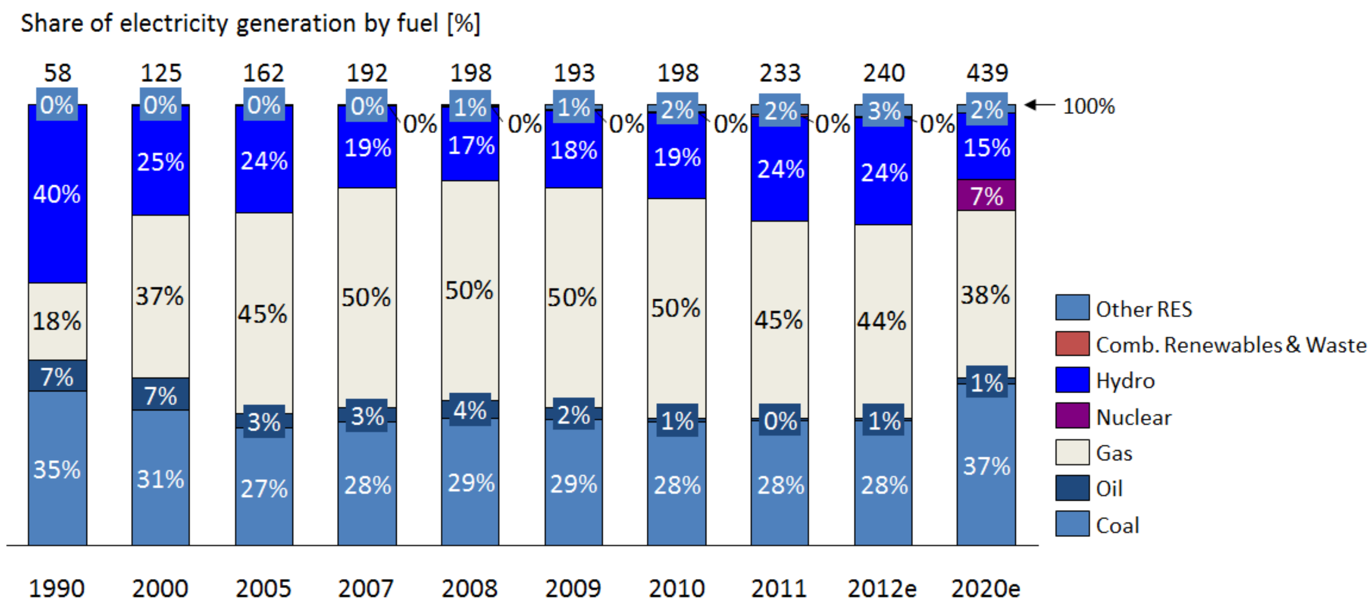

Figure 13: Share of electricity generation by fuel on gross electricity generation [1].

In terms of electricity trade Turkey has alternately been an importer and exporter in the past. However, in absolute terms, the amount of traded electricity ranged within a view percent of total generation and it is expected that Turkey will import about 4% of its electricity by 2020 [9].

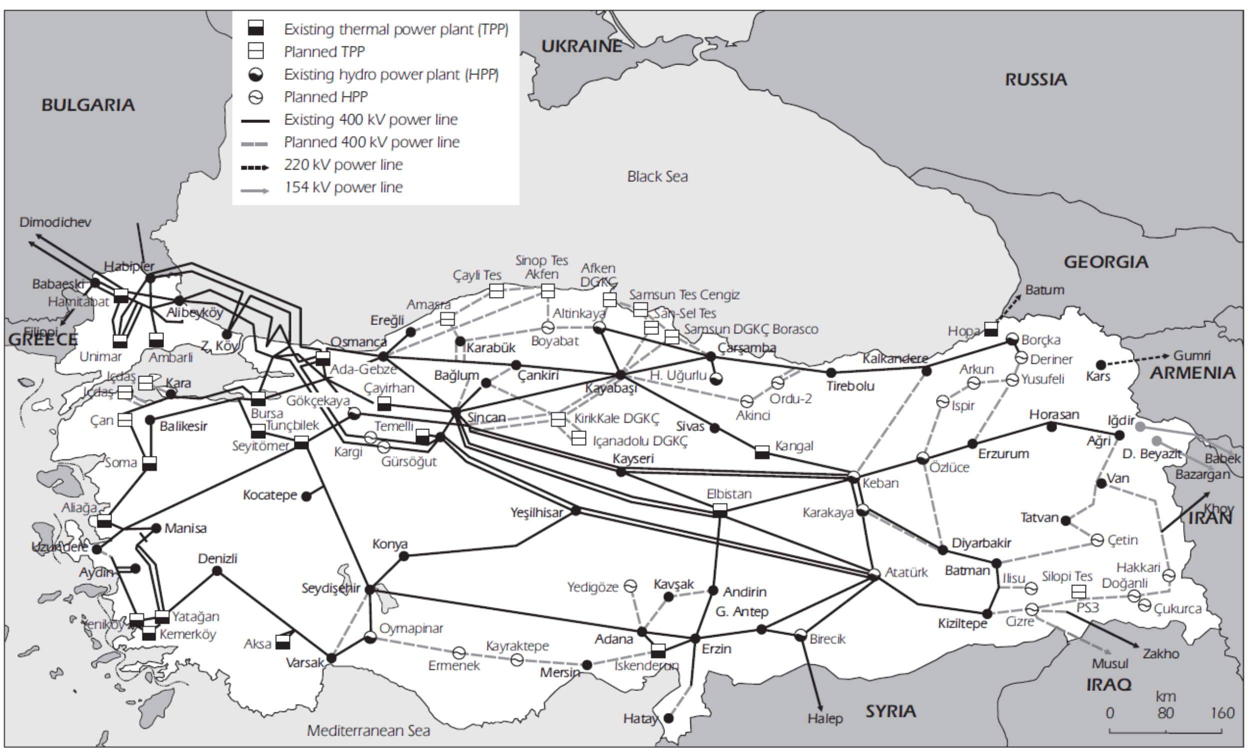

Figure 14: Map of the Turkish electricity transmission grid network and power plants (status of 2009) [9].

An overview on the Turkish high-voltage transmission grid and some expansion plans is given in Figure 14. The load centers in Istanbul and Ankara are well connected to the south-eastern hydro power units with huge water dams like the Atatürk power plant. Most of the thermal power plants are also located close to the areas with high load. It can be seen that the expansion grid plans mainly focus on the area around the Zonguldak region with significant amounts of hard-coal reserves, where a number of new coal-fired power plants will be built.

The Turkish distribution grid is currently operated with a high the share of system losses. Figure 15 shows the yearly amount of system losses in the distribution grid areas of Turkey. View regions located in eastern Turkey stand out because of their huge system losses, whereas there is a steep decline towards the regions in the west of Turkey, which leads to a range of 2 to 72% depending on the region. The overall system losses can be divided in technical losses and illegal use. The national average of total system losses varies according to the data source around 14-19%. The technical losses are estimated to be around 7-8%, whereas the rest are merely a problem of illegal use [18].

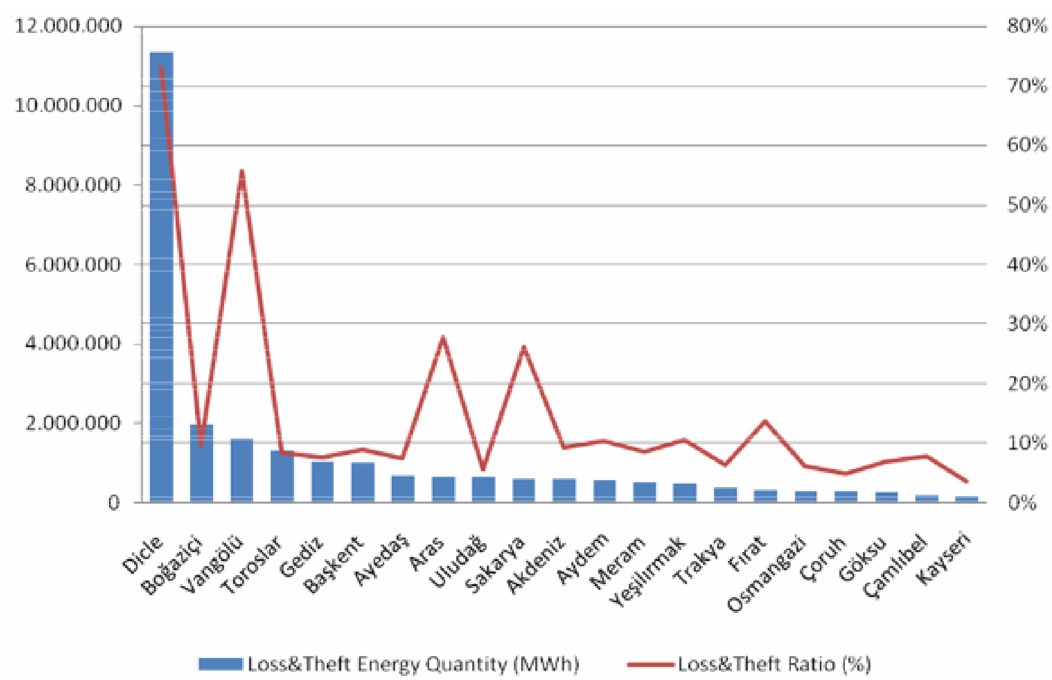

Figure 15: Grid losses of the Turkish distribution grid regions in 2010 [6].

Power outages are common in Turkey, which adversely affect the economic activity. Turkish businessmen report four power outages per month on average [18], whereas interruptions seem to be more common in the eastern part of Turkey. Country statistics indicate that outages occur during 3.06 days per year on average [21]. In January 2012 there was a widespread blackout that lastet for three hours in major industrial cities in the northwest. There was a similar outage of six hours across 13 cities in 2006 in the western part of Turkey. Recently, a law was passed that imposes some common quality criteria to be applied to the operation of the Turkish power grids [22]. It can also be exptected that the grid-connection to ENTSO-E will improve the system stability of the Turkish power grid.

The electricity generation from renewable energies is separately shown for hydro power and all other RES generation in Figure 16 and Figure 17. The share of hydro power on total generation has decreased in comparison to 1990 but this source of energy remains with currently 28% on total generation still an important corner stone of the electricity supply. It is expected that hydro power will significantly contribute to the fulfillment of the future growth in electricity demand.

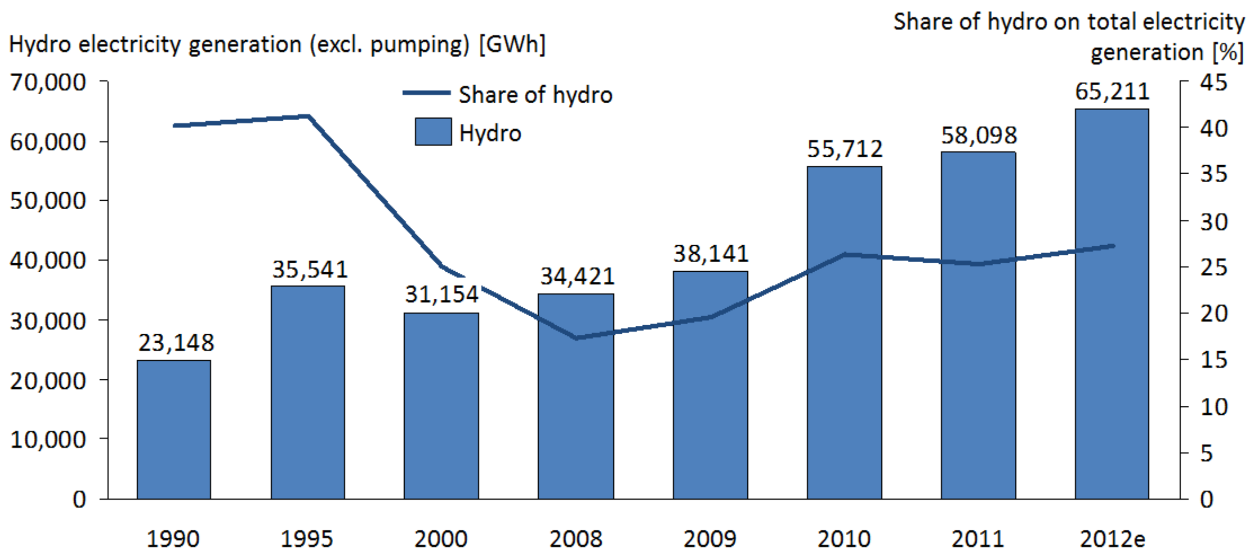

Figure 16: Electricity generation from hydro power plants (left), Share of hydro power generation on gross electricity generation (right) [1].

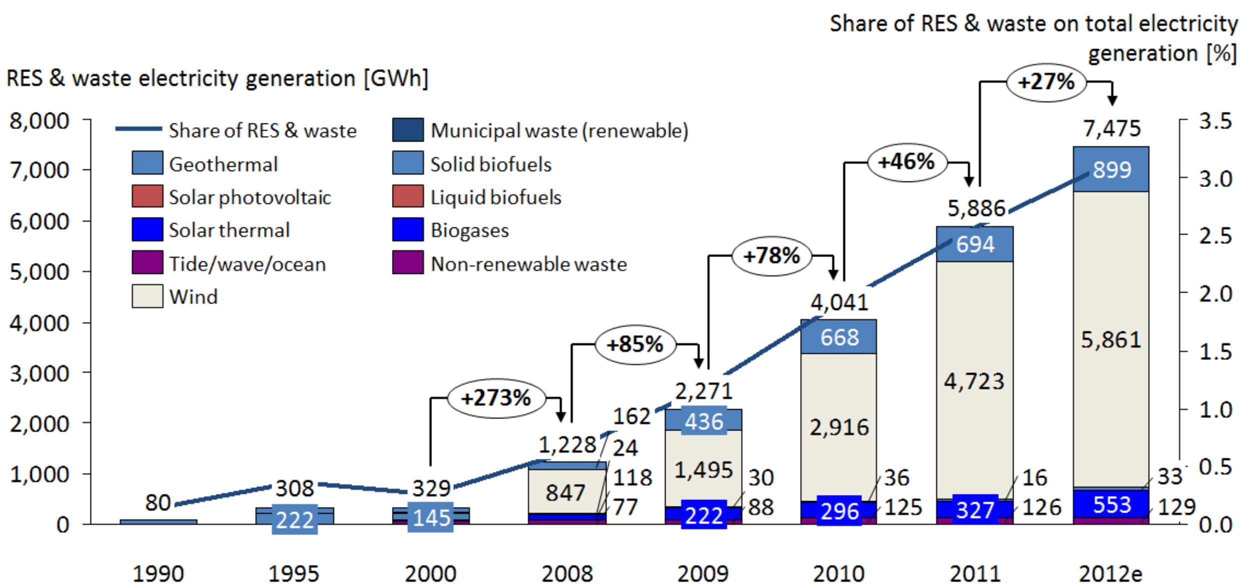

Figure 17: Renewable and waste electricity generation excluding hydro power [1].

Even higher growth rates could be observed from all other RES generation, however, from a very low level. The total amount of RES generation without hydro power increased linearly with growth rates ranging from 273% down to 27% in the last year. Still the absolute level of all RES generation accounts for 3.4% of overall electricity generation in 2012 (see Figure 17).

Figure 18 shows the yearly amount of generated electricity and heat from combined heat and power (CHP) plants in Turkey. It can be seen that CHP plants are primarily fired by gas. Besides that, also coal, oil and a minor share of biofuels or waste, respectively, are used.

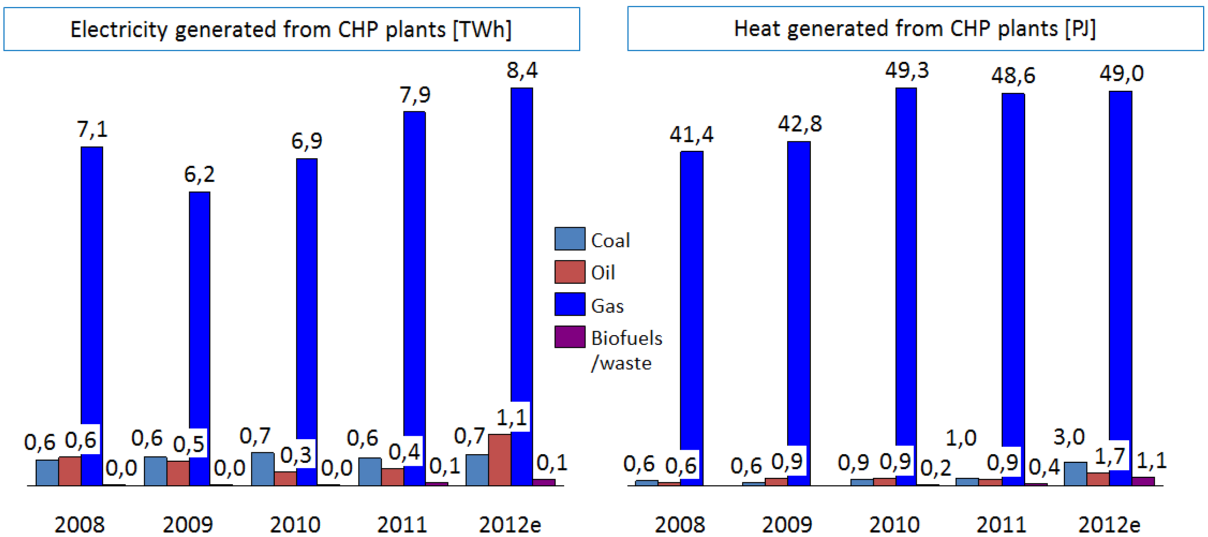

Figure 18: Generated electricity and heat from combined heat and power (CHP) plants by fuel [1]

2.2 Energy taxation

The energy tax rates in Turkey vary across different forms of use. An overview on the tax rates of Turkey, as of 1st April 2012, is given in Figure 19 [8]. On the axis of abscissas the energy content of the corresponding fuel are depicted. The ordinate shows the tax expressed in TRY and EUR per GJ, respectively. Whereas taxes in the transport sector are quite high, in the heating and electricity sector only minor tax rates are applied. One interesting particularity is that in the electricity sector the electricity generation from natural gas (at least in the residential sector), with low carbon content, is exposed to the highest tax rate. Finally, to derive the corresponding values of the taxes in EUR per MWh of electricity, one has to apply the conversion efficiencies of the several technologies considered.

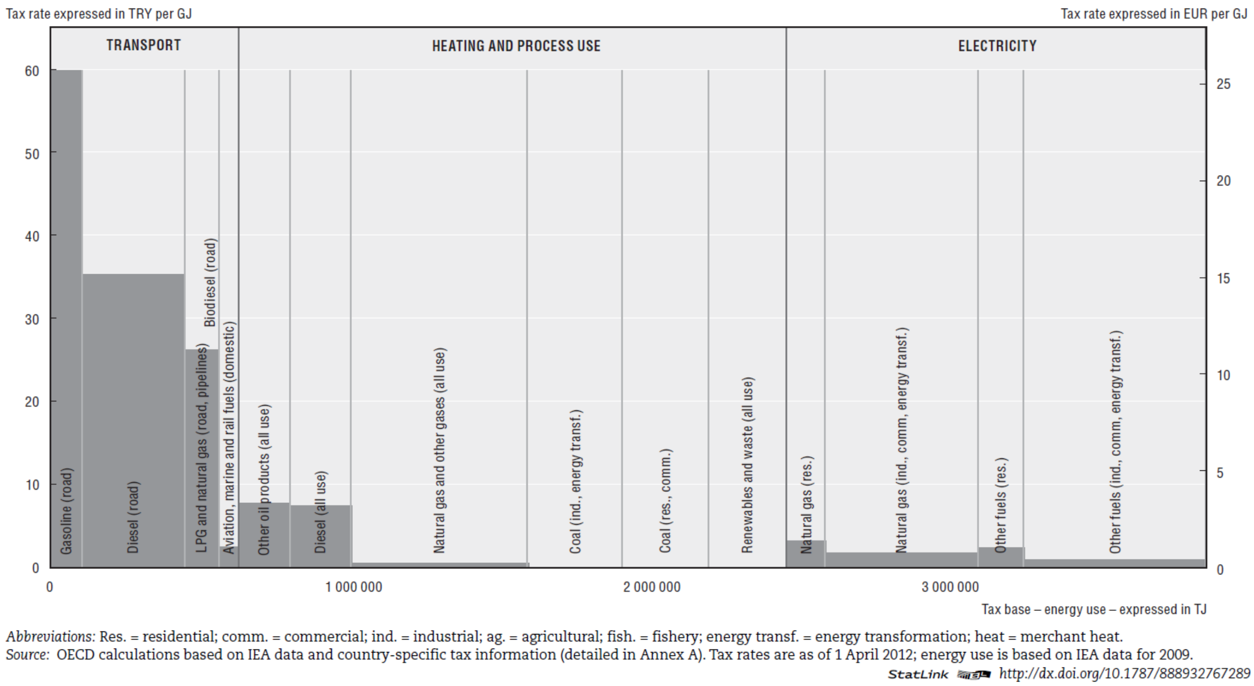

Figure 19: Taxation of energy in Turkey on an energy content basis [8].

2.3 Energy market structure

2.3.1 Oil

By the end of the year 2009 51 distribution companies have been registered within Turkey. However, approximately 90% of the market is being dominated by the five largest distributors, namely Petrol Ofisi, Shell Turcas, BP, Opet and Total. In the past the level of competition has not been satisfactory and as a consequence the Turkish Competition Authority has conducted two inquiries in 2008. They concluded that serious structural barriers to competition exist in the market and that the large companies avoid price competition. As a result, some measures were taken to regulate the market, although in a way that the energy market regulation authority had been imposed a significant workload and at the same time an undesirable business climate for companies were created. However, prices of oil products excluding taxes are still among the highest within all OECD countries [9].

2.3.2 Coal

As candidate for EU membership Turkey is aligning its coal policy to EU legislation. In particular, the national coal policy aims to exploit national resources have been defined by the government as follows [20]:

- developing existing indigenous resources
- utilizing known lignite and hard coal reserves through to 2023 for electricity generation
- increasing the use of domestic coal in power plants
- restructuring the coal mining sector

- privatizing some inefficient and currently inactive coal mines and
- promoting the adoption of clean coal technologies in the utilization of coal in thermal power plants, households and industry

There are no subsidies for the lignite sector in Turkey, whereas the hard coal sector receives significant state support.

Table 5: State Aid to Turkish Hard Coal Enterprises [9].

	2004	2005	2006	2007	2008
Production (thousand tonnes)	1881	1666	1523	1675	1586
Total aid (TRL million)	382	380	571	399	517
Total aid (USD million)	267	282	397	305	398
Aid per tonne (TRL)	203	228	375	238	326
Aid per tonne (USD)	142	169	261	182	251

The key lignite producers are Turkish Coal Enterprises (TKI) and Electricity Generation Co. Inc. (EÜAS), which are state owned. Efforts are being taken to integrate the private sector into the production via mechanisms including leasing, transfer of operating rights and contractor mining. The current share of the private sector amounts for around 10% [9].

2.3.3 Gas

The Turkish gas market currently undergoes a transition phase to privatization. So far the efforts to transfer of long-term supply contracts of the national petroleum pipeline cooperation (BOTAŞ) have not been very successful. One reason is that the counterparts of the contract negotiations (e.g. Gazprom) are hard to get into contracts with private companies. Furthermore, BOTAŞ reportedly selling gas in the domestic market at lower prices than its cost to import gas [18]. These indirect subsidies also form an obstacle for private companies as they cannot compete under those conditions. Table 6 summarizes the current long-term supply contracts of BOTAŞ with several suppliers. To bridge the gap between supply and future gas demand Turkey is currently pursuing additional gas supplies from several countries. Lots of the existing long-term supply agreements will end by 2014 at the latest. From the present state it can be concluded that in the light of current framework conditions in the Middle East region the availability of gas imports pose a risk for Turkey's energy security.

Table 6: Natural gas long-term contracts of BOTAŞ [9].

Contracting party	Amount (billion m3 / yr)	Date of signature	Duration (yrs)	Status
Russia (West)	6	14.2. 1986	25	ongoing
Algeria (LNG)	4	14.4. 1988	20	ongoing
Nigeria (LNG)	1.2	9.11. 1995	22	ongoing

Iran	10	8.8. 1996	25	ongoing
Russia (Blue Stream)	16	15.12. 1997	25	ongoing
Russia (West 2)	8	18.2. 1998	23	ongoing
Turkmenistan	16	21.5. 1999	30	-
Azerbaijan	6.6	12.03. 2001	15	ongoing

However, considerable amounts of spot LPG gas have recently been imported to Turkey where also private companies were involved. Like the observable movement in Europe that is switching from oil-indexed pricing for gas imports towards prices on the spot market, also in Turkey similar developments took place.

2.3.4 Electricity

Inline with the developments of EU member states, the Turkish electricity sector shall be fully unbundled and privatized. Starting in 1984 with the integration of the private sector in the operation of generation, transmission and distribution activities [23], lots of new laws have been passed in order to facilitate the process of privatization, to unbundle generation, transmission and distribution. Furthermore, the establishments of an electricity market, an independent system operator and the energy market regulation authority (EMRA) in 2001 are important cornerstones of the electricity sector. By the end of 2013 it is planned to have a fully liberalized electricity market with market architecture comparable to those implemented in the EU [4]. Finally, with the adoption of the Renewable Energy Law [24] and the Energy Efficiency Law [25] Turkey has defined the legal basis for the support of RES and the attainment of energy efficiency targets.

The current legal basis for the organization of the electricity market is represented by the Electricity Market Law [26] and the Electricity Market Balancing and Settlement Regulation [27]. Of further relevance are also the Geothermal Energy Law [30] and the Nuclear Energy Law [31]. The overall structure of the electricity market architecture can be seen in Figure 20. The market participants can be divided in the categories generators, wholesalers, system operator, distributors or retailers and consumers.

Generators consist of state-owned plants operated by EÜAŞ (Turkish Electricity Generation Company) and affiliates that are comprised of public-private-partnership contracts like “Build-Operate” (BO), “Build-Operate-Transfer” (BOT) and “Transfer-of-Operation-Rights” (TOR). EUAS shall be entitled to build, lease and operate new generation facilities, if deemed necessary, in accordance with the EMRA approved Generation Capacity Projection and with regard to the generation investments by the private sector. Besides that, there is a group of private parties, namely “Independent Power Producers” (IPP) and the group “Autoproducers” which consist of generators that primarily (at least 80% of their production) generate electricity for their own needs.

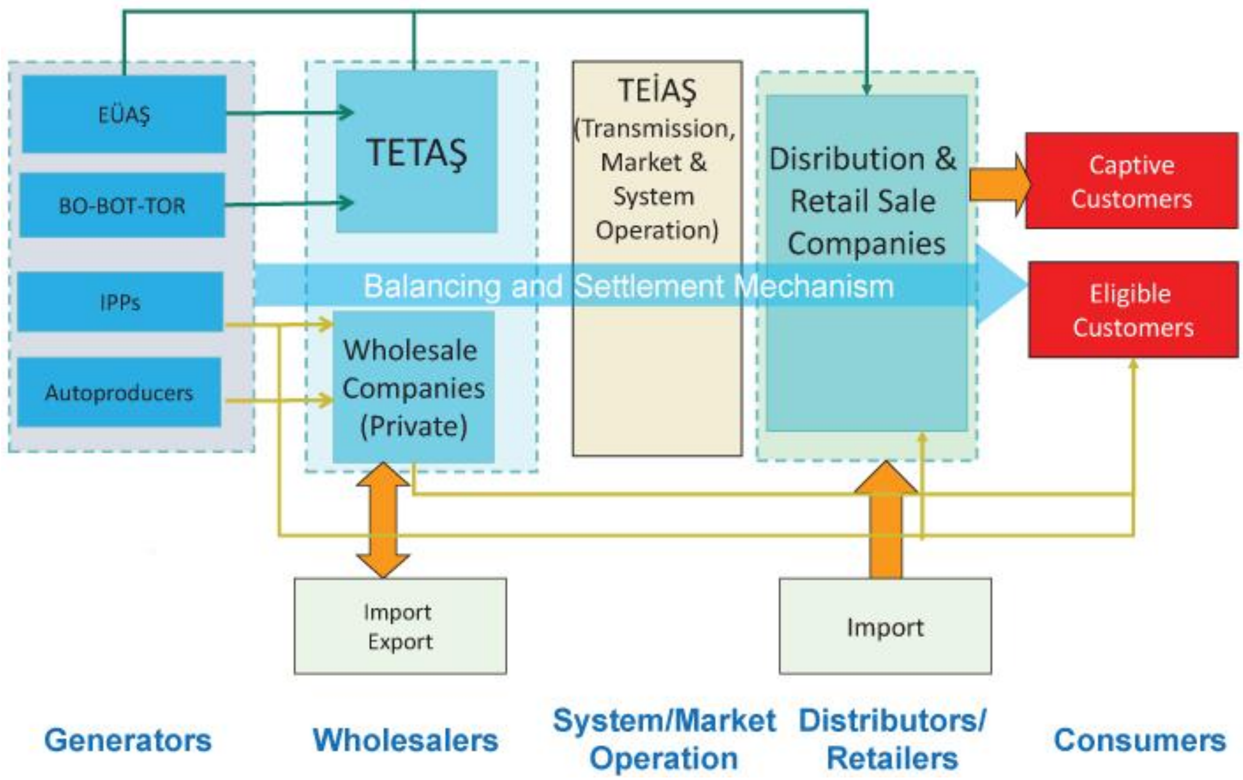

Figure 20: Market architecture of the Turkish electricity market [4].

On part of the wholesalers there are on the one hand the Turkish Electricity Trading and Contracting Company (TETAŞ) and on the other hand private companies that possess a wholesale license and therefore are entitled to participate in the common electricity market (see also next chapter). TETAŞ takes over and executes the existing energy sale and purchase contracts of EÜAŞ and affiliates. Wholesale companies market the electricity of their own power plants or other generators in the electricity market and are also allowed to directly conclude contracts with eligible consumers. They are also entitled to im- and export, respectively, power from abroad under the condition that the respective country meets the international interconnection conditions and the trade has been approved by the Turkish Ministry of Energy and Natural Resources (MENR) and the Market Regulation Authority EMRA.

The Turkish Electricity Transmission Company TEiAŞ is on the one hand the responsible party for network planning and construction and on the other hand the operator of the electricity and balancing market. Besides that they set the tariffs for the use of the transmission grid and are responsible for the allocation of international transmission capacity.

The distribution companies are responsible for the network planning and operation of the distribution grids. The may also engage in retail trades and generation activities. Furthermore, they do prepare their regional demand forecasts.

Retail sale companies are allowed to be involved in retail sale or retail sale services without any limitation on a regional basis. Furthermore, they possess the right to import electricity on the distribution voltage level. The offer regulated tariffs to their consumers that are acknowledged by the Regulation Authority EMRA.

Electricity consumers are grouped into eligible and captive consumers. Eligible consumers either consume electricity above the threshold of currently 25 MWh per year [4], or are directly connected to the transmission grid and are allowed to choose their supplier. Captive consumers are obliged to buy its electricity from their local distributor.

Finally, the market coordination as defined in [27] consists of an hourly day-ahead market, a balancing power market, where both generators and demand side appliances are allowed to participate, and it exist the possibility to trade long-term forwards on a bilateral basis.

2.4 Licensing in the electricity market

In Turkey the authorization requirements to construct and operate electricity plants are organized through a licensing procedure. Also, for every market activity a dedicated license has to be requested by the Regulation Authority EMRA. The overall licensing procedure for generation is depicted in Figure 21.

First, an application to EMRA has to be conducted. During this first check a number of different criteria have to be fulfilled in order to receive a positive feedback. Especially, wind and solar PV generators have to provide an extensive set of historical measurements of their corresponding resource availability to EMRA[1]. Furthermore, depending on the capacity of the power plant a certain amount of pre-payments has to be made. After a positive response of the application phase, a comprehensive project assessment is carried out. This phase comprises technical assessments of the grid operators and the General Directorate of Renewable Energy (YEGM) in case of wind and solar PV. The transmission grid operator TEIAS informs about how much capacity can be added at a certain grid node. If the number of applicants exceeds the maximum capacity at any node, the grid operator auctions the scarce capacity. If this phase are successfully completed an environmental impact assessment (EIA) are conducted and a number of additional points have to be processed (see Figure 21). Finally, if this phase are finished without any objections the power plant receive the generation license.

[1] In particular, applicants of solar PV stations are not allowed to submit already measured data at a certain location. Instead, every potential investor has to install its own measurement equipment to derive the requested data.

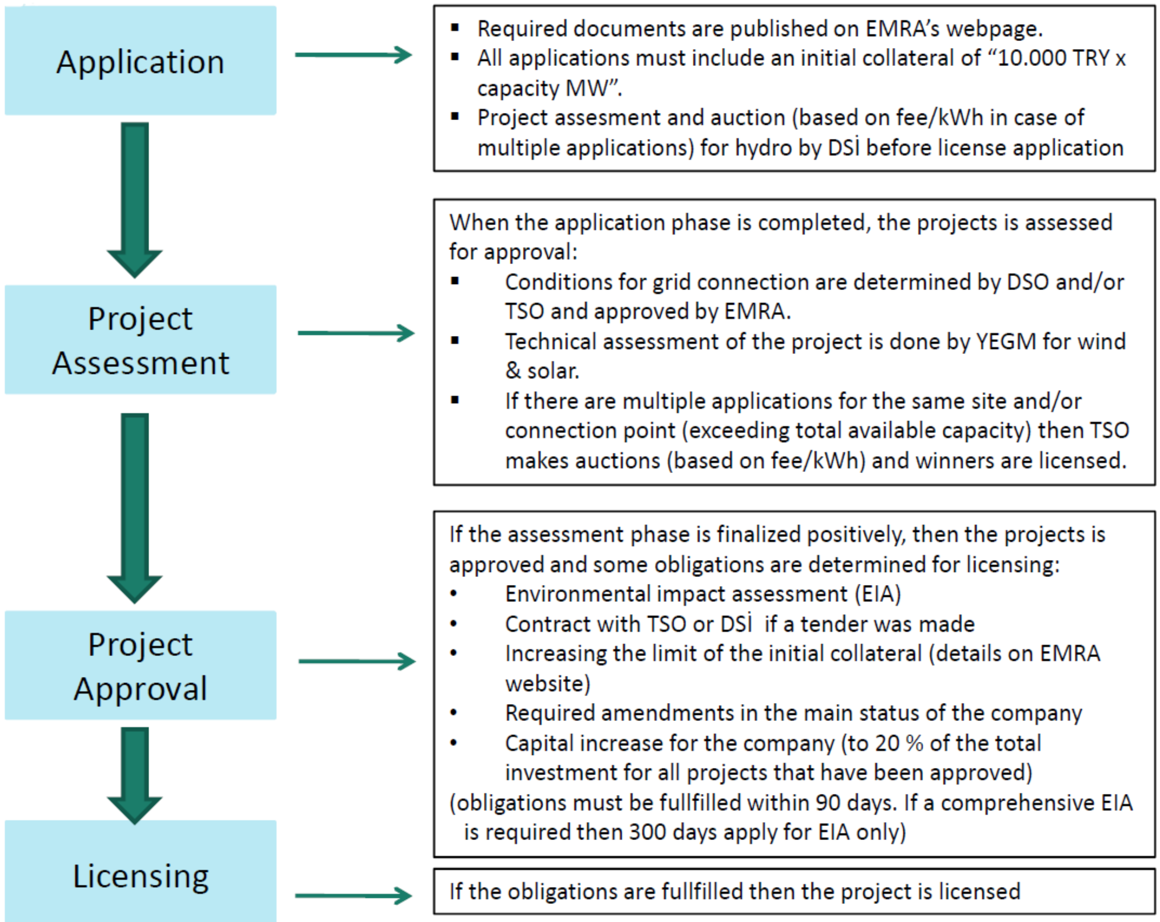

Figure 21: Licensing procedure for the construction of a power plant [7].

2.4.1 Types of licenses

It has already been mentioned that for every market activity the possession of a dedicated license is mandatory. The details of the rights and duties of every license holder are defined in the electricity market law in its current version [26].

Besides the generation license the following licenses are defined:

- Generation license
- Transmission license
- Wholesale license
- Distribution license
- Retail license
- Autoproducer and Autoproducer Group license

The current electricity market law is under revision and potential amendments are already in discussion [31]. The amended version of the law is expected to lead to significant changes. For example, a temporary license shall be introduced that covers the pre-construction period (siting, required permits, etc…). Also, the licensing threshold capacity of currently 500 kW will be increased to 1 MW. The licenses for generation, Autoproducers and wholesale activities shall be combined under a single supply license. Furthermore, currently implemented tariff structures of retail prices are expected to be removed by 2016. In Table 7 the number of active licenses can be seen.

Table 7: Number of issued licenses by year [47].

Type of License	2003	2004	2005	2006	2007	2008	2009	2010	2011	End of 2011
Transmission License	1									**1**
Distribution License				19		1	1	1		**21**
Retail License				19		1	1	1		**21**
Wholesale License	6	10	4	4	3	6	8	48	53	**139**
OIZS License					57	49	13	8	11	**137**
Generation License	137	52	55	86	185	222	168	120	311	**1231**
Auto Producer License	105	14	18	18	10	22	8	16	40	**234**
TOTAL	249	76	77	146	255	301	199	194	415	**1784**

2.4.2 Licensing costs

To get the permission to build a power plant, to connect it to the grid and to market its produced electrcity, an application for a generation and a wholesale license is necessary. To obtain these licenses, a number of several payments have to be settled with EMRA. Furthermure, additional payments have to be made to the grid operator.

The total costs occuring to obtain a *generation and wholesale license* can be divided in an initial payment, which depends in case of the generation license on the size of the capacity to be installed, annual payments and an administrative charge of 1000 TL for each license.

The initial payment for the generation license of a power plant that should be built from scratch is depicted in Table 8. In case that an existing plant should be upgraded the corresponding licensing costs are reduced by 50%[2]. For obtaining a wholesale license an additional payment of 275.000 TL have to be made to EMRA. The annual price for both, a generation and wholesale license is being calculated by

Annual licensing cost [TL] = Generated/sold electricity per year [MWh] * 0,03.

[2] The minimum amount to be paid is 5000 TL.

Table 8: Initial payments for a generation license according to installed capacity [5].

Installed capacity [MW]	Cost [TL]
0 – 10	5,000
10 – 25	10,000
25 – 50	15,000
50 – 100	25,000
100 – 250	50,000
250 – 500	100,000
500 – 1000	150,000
> 1000	250,000

Additionally, several cost components occur due to payments related to transmission fees. On the one hand, there are two regulated tariffs and on the other hand are auction-based connection fees. The tariffs are composed of a *fixed annual payment* of currently 392.86 TL in 2012 [49] and a *usage fee* that varies according to the region in which the plant shall be connected (see Figure 22). It can be seen that tariffs varies enormously between 2010 and 2012.

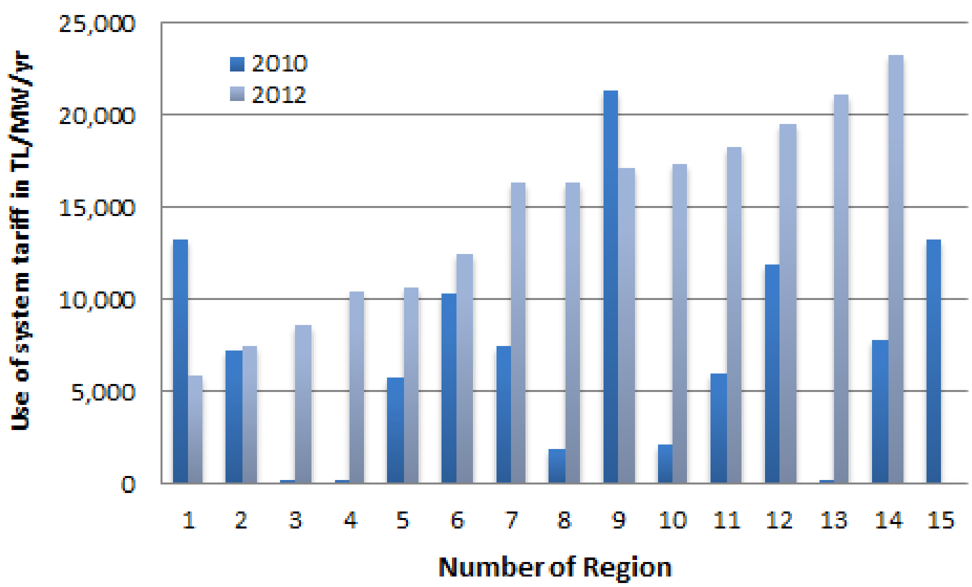

Figure 22: Comparison of Use of System Tariffs for the transmission grid, according to different regions in 2010 and 2012 [48][49].

Due to the fact that the maximum capacity that can be connected to the transmission grid is limited for a certain point in time, the available capacity band is allocated through an auction. In particular, TEIAŞ prepares and published their projections on potential capacity to be added to each grid node. If the number of requests at a certain grid node exceed the available capacity the grid operator are obliged to allocate the capacity in a non-discriminatory way. Therefore, TEIAŞ frequently organizes tenders for wind and solar PV power plants. Historical results of wind power auctions are depicted in Figure 23 and Figure 24. It can be seen that bids varies not only in their offered capacity, but in their price bid as well.

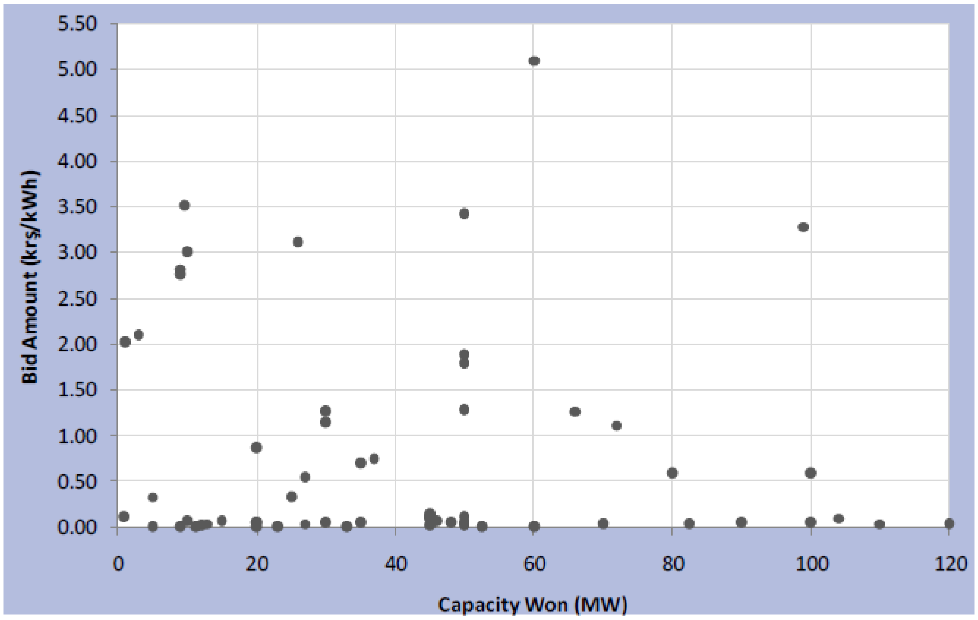

Figure 23: Tendering results of grid connection requests of wind energy power plants by requested capacity [46].

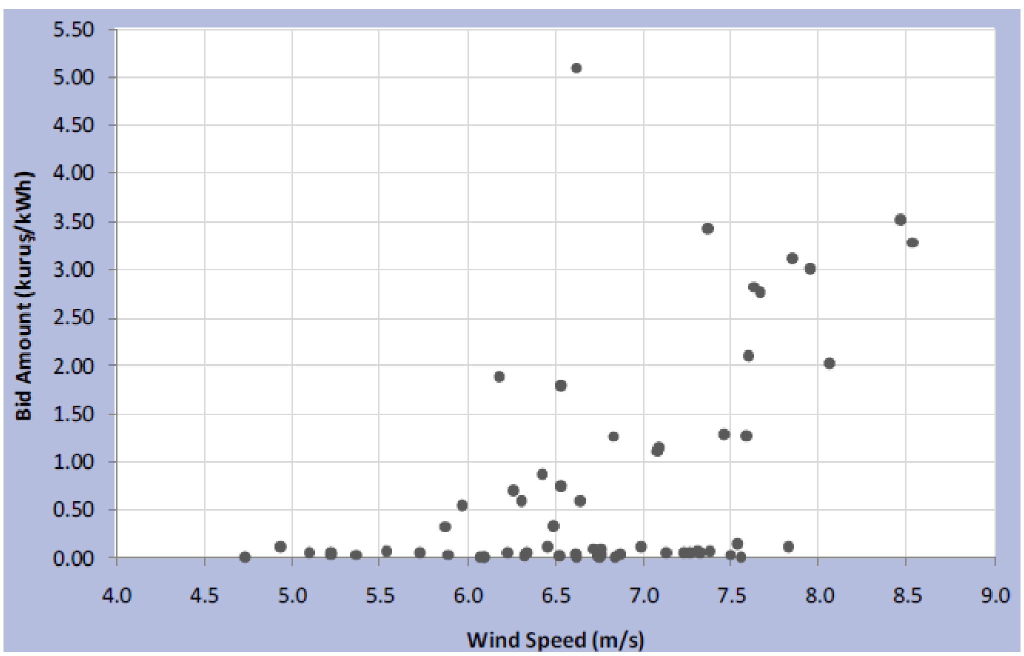

Figure 24: Tendering results of grid connection requests of wind energy power plants by available wind speed [46].

Note, that accepted price bids have to be directly subtracted from market prices and thus reduce the contribution margin of wind power units by exactly this amount. From Figure 24 can be seen that offers with higher wind speeds tend to bid higher prices. However, there have been also some successful bids that got accepted with bids close to zero.

2.4.3 Non-licensed generation

Some generation units are not obliged to go through the licensing process. These generators must be connected to the distribution grid level and have to fulfill one of the following prerequisites:

- The electric capacity of the generators does not exceed 500kW[3] or
- In case of Micro-cogeneration power plants
  - the electric capacity does not exceed 50kW and the overall efficiency must be higher than 80% or
  - the electricity produced is only used for own needs and the overall efficiency is higher than 80%.

All eligible plants can directly approach the corresponding distribution grid operator to check, whether a grid connection is feasible. If they receive a positive feedback, the applicant has to prepare within a period of 210 days at maximum a number of different documents that have to be submitted to the grid operator in order to grid the allowance to start the construction. After the construction period these generators receive a temporary generation license from the ministry. There is a fixed administrative charge of currently 250 TL for such applications, but additional costs that could not be predetermined could arise within the process.

2.4.4 Measures to support RES deployment

The government encourages the development of RES through a number of measures. These measures include [33]:

- Licensing cost reductions
- Purchase guarantees
- Minimum price guarantees (i.e. FiT)
- Priority connection to the grid
- Domestic component incentives
- Certain incentives in land acquisition

A summary of the incentives are presented in Table 9 [7]. A crucial point is that most of the incentives are implemented as temporary measures and do have an expiration date. It is left open if those incentives will be extended, or removed after that period.

[3] It has already been decided that this limit will be increased to 1 MW within the adoption of the Electricity Market Law [32].

Table 9: Incentives for RES-E generators

Incentive	Scope
Licensing fee	• Only 1% of the regular licensing fee has to be paid • Exemption from the annual license fee for first 8 years
Connection to the grid	• Priority grid connection by TEIAS and distribution companies • 85% cost reduction in system usage fees for 5 years (all plants to be commissioned prior to 31/12/2015 – extension possible)
Company establishment and licensing exemption	• For the generators with a max capacity of 500 kW (will be increased to 1 MW within the upcoming period)
Purchase obligation	• The RES support mechanism (RESUM) requires that the total cost of financial RES support are apportioned to all electricity consumer
Feed-in tariff	• For 10 years (all plants to be commissioned prior to 31.12.2015) • Different prices for each resource (add-on for domestically manufactured equipment) • At current levels this tariff serves mainly as lower revenue-cap
Fees on land-use for PPs to be commissioned prior to 31.12.2015 (extension possible)	• If the property in use is in possession of the Treasury for the first 10 years of operation, 85% deduction is applied to fees related to rent, right of access, and permission of usage. • 85% deduction is applied to fees related to transportation and transmission infrastructure investments. • Exemption from special fees (e.g. contribution to the development of the woodland villages). • Free usage of state-owned estates located within the reservoir of HPPs holding a RES certificate.

2.5 Current state of the Turkish power system

The data sources for preparing the database serving the modeling work to be performed in the subsequent tasks in work package 5 stem from various public available resources (see Annex 1). In the following an aggregated overview on the collected data is given. The disaggregated datasets are available in form of separate tables.

2.5.1 Overview on installed capacities and legal ownership

Figure 25 summarizes the data of the developed database and shows the currently installed capacities and those that are in the application procedure by the moment. Figure 26 and Figure 27 show the same power plants according to their legal ownership. It can be seen that currently 58% of total generation consist of indepentend producers. The observed trend of privatization is expected to proceed in the future.

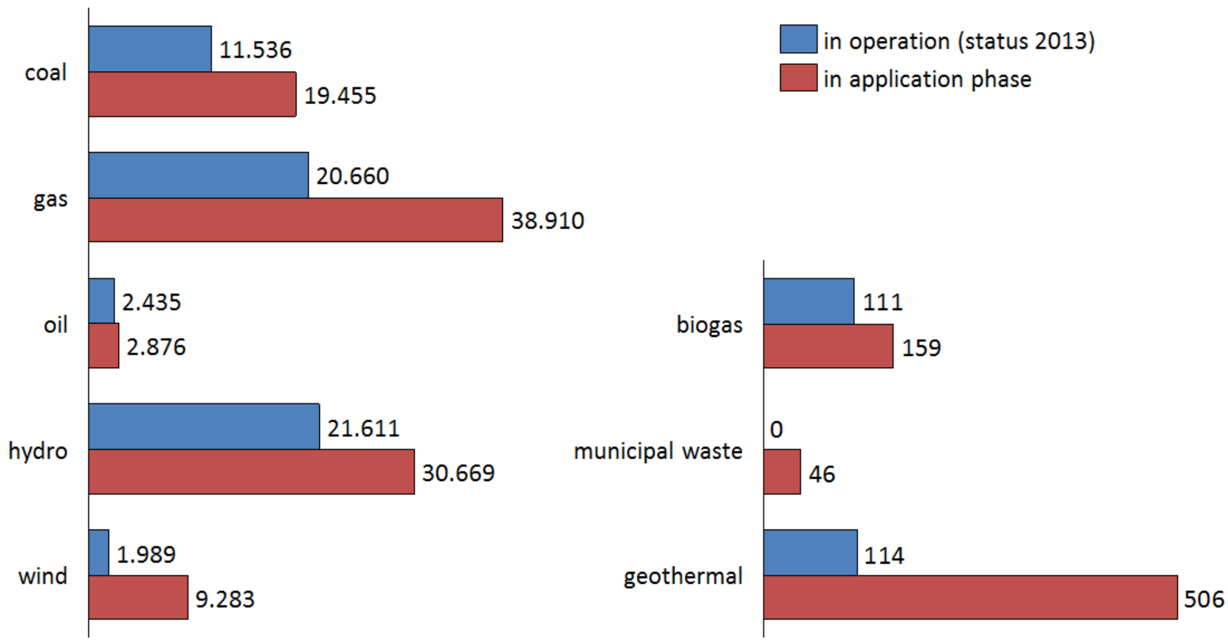

Figure 25: Breakdown of currently installed capacities and capacities in the licensing procedure in MW by development status and type of fuel.

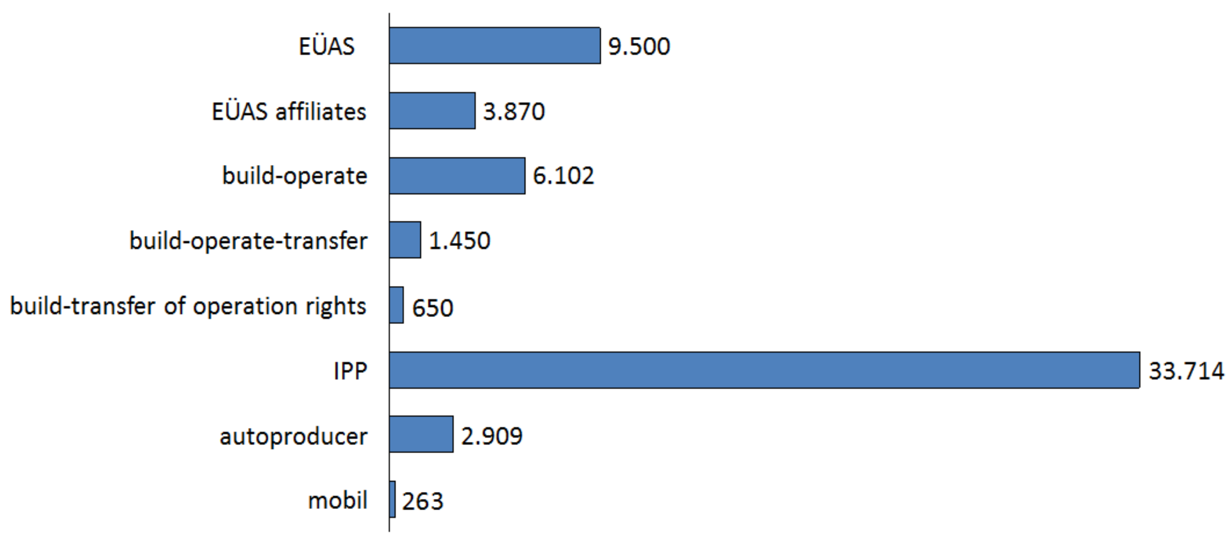

Figure 26: Breakdown of capacities in operation in MW by legal entity (status of 2013)

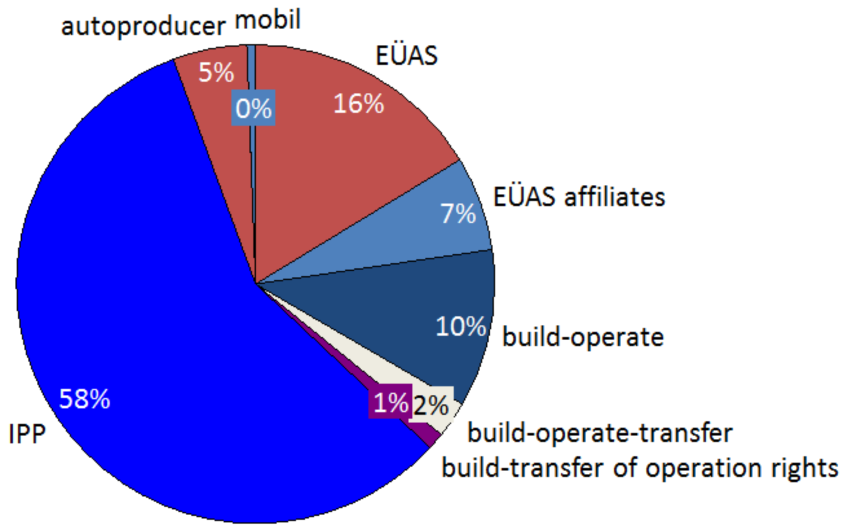

Figure 27: Shares of capacities owned in MW by legal entity (status of 2013)

2.5.2 Hydro power plants

Existing hydro power plants:

The General Directorate of State Hydraulic Works DSI (Devlet Su İşleri Genel Müdürlüğü) reports a presently installed total hydro power capacity of 14.3 GW [50]. For task 5.1 of WP5 detailed data for 75 hydro power plants with a total installed capacity of 13.8 GW was gathered and included in the HiREPS model for Turkey. The cumulative volume of the 75 hydro power reservoirs amounts to 65 billion cubic meters.

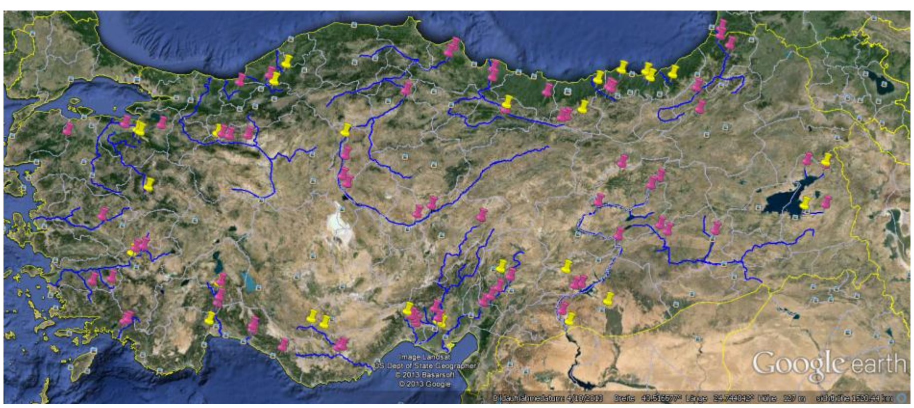

Figure 28: Map of the hydro power plants included in the HiREPS model for WP5 with a total capacity of 13.8 GW. Pink icons indicate the location of storage power plants, the yellow icons represent run of river power plants.

Planned Hydropower Plants:

Further data for hydropower plants under construction and in different stages of planning was gathered. The 59 largest of these planned hydropower plants have a cumulative capacity of 7.5GW and are included in the HiREPS model for future scenarios.

Figure 29 Overview of the largest 59 planned hydro power plants in Turkey.

Planned Pumped Hydro Power Plants:

A report from General Directorate of Electrical Power Resources Survey and Development Administration lists planned locations for pumped hydro power plants. These have been included in in the HiREPS model for future scenarios.

Proje Adı	Yeri	Kurulu Güç (MW)	Proje Debisi (m3/sn)	Düşü (m)
Kargı PHES	Ankara	1000	238	496
Sarıyar PHES	Ankara	1000	270	434
Gökçekaya PHES	Eskişehir	1600	193	962
İznik-I PHES	Bursa	1500	687	255
İznik-II PHES	Bursa	500	221	263
Yalova PHES	Yalova	500	147	400
Demirköprü PHES	Manisa	300	166	213
Adıgüzel PHES	Denizli	1000	484	242
Burdur Gölü PHES	Burdur	1000	316	370
Eğridir Gölü PHES	Isparta	1000	175	672
Karacaören-II	Burdur	1000	190	615
Oymapınar PHES	Antalya	500	156	372
Aslantaş PHES	Osmaniye	500	379	154
Bayramhacılı	Kayseri	1000	720	161
Yamula PHES	Kayseri	500	228	260
Hasan Uğurlu	Samsun	1000	204	570

Table 10 List of planned pumped hydro power plants [52].

1	KARGI	5	İZNİK-2	9	BURDUR GÖLÜ	13	OYMAPINAR	17	HASAN UĞURLU
2	SARIYAR	6	YALOVA	10	EĞİRDİR GÖLÜ	14	ASLANTAŞ		
3	GÖKÇEKAYA	7	DEMİRKÖPRÜ	11	KARACAÖREN-1	15	BAYRAMHACILI		
4	İZNİK-1	8	ADIGÜZEL	12	KARACAÖREN-2	16	YAMULA		

Figure 30: Planned locations of future pumped hydro power plants [52].

2.5.3 Electricity Demand Time Series Data

Data for the hourly historical electricity demand from 2006-2010 was collected from the Turkish Electricity Transmission Company TEIAŞ.

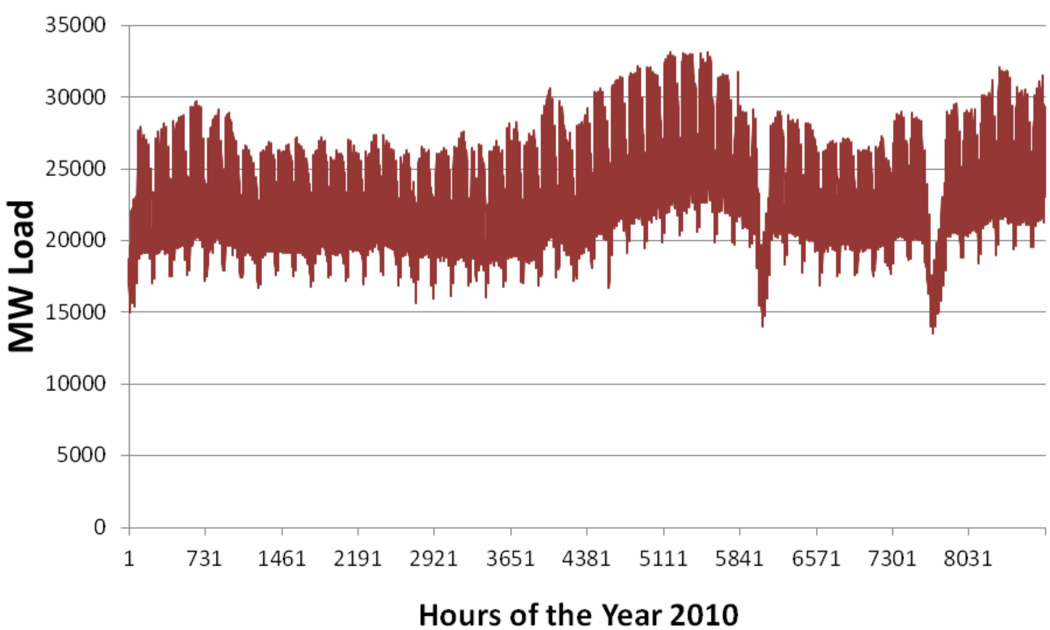

Figure 31 Hourly electricity demand 2010 (Source: TEIAS)

The most prominent features in the electricity demand profile are the braking the fasting festival at end of Ramadan and the Eid al-Adha festival about 2 month later. They cause a strong reduction in the electricity demand. These festivals follow the Islamic calendar and move every year backwards by about 11 days.

2.5.4 Historical Electricity Price Data

Data for the historical electricity market settlement price 2006-2013 was collected from Market Financial Settlement Center PMUM (PİYASA MALİ UZLAŞTIRMA MERKEZİ) for the case study in WP5.

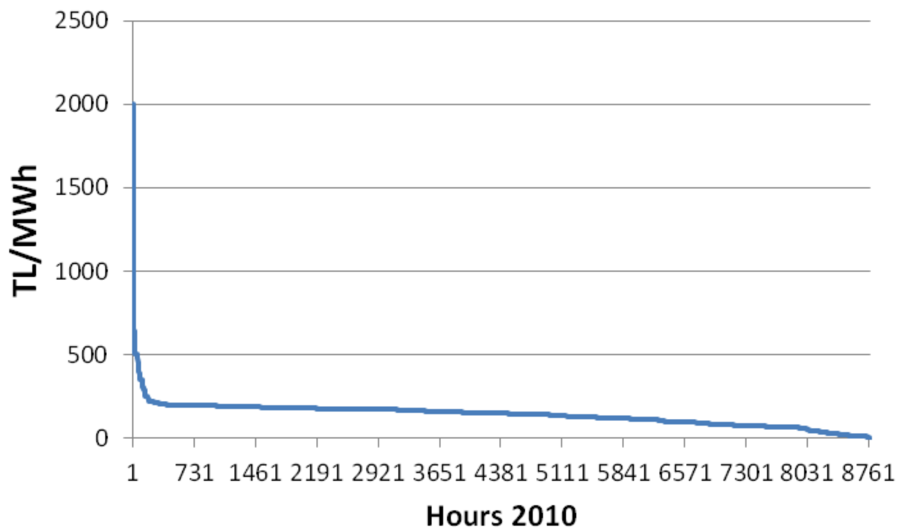

Figure 32 Price duration curve of spot market prices of Turkey in 2010

2.5.5 Grid connection to other countries

The Turkish Transmission Grid is connected to the adjacent countries via several voltage levels (see Figure 33). The largest transmission capacity is available through ENTSO-E and Turkey that amounts for 1510 MVA (Greece) and 2505 MVA (Bulgaria). In the past years a power exchange between Bulgaria and Greece was only possible through direct current converters, as the Turkish grid were in another synchronous area than the ENTSO-E network. The capacity allocation procedure is organized via explicit auction [29]. The historic exchange flows between Turkey and abroad are depicted in Figure 34 and Figure 35. It can be seen that in the past Turkey imported most of its electricity from Turkmenistan and exported to Iraq. However, compared to the overall amount of electricity demand those share are rather neglectable.

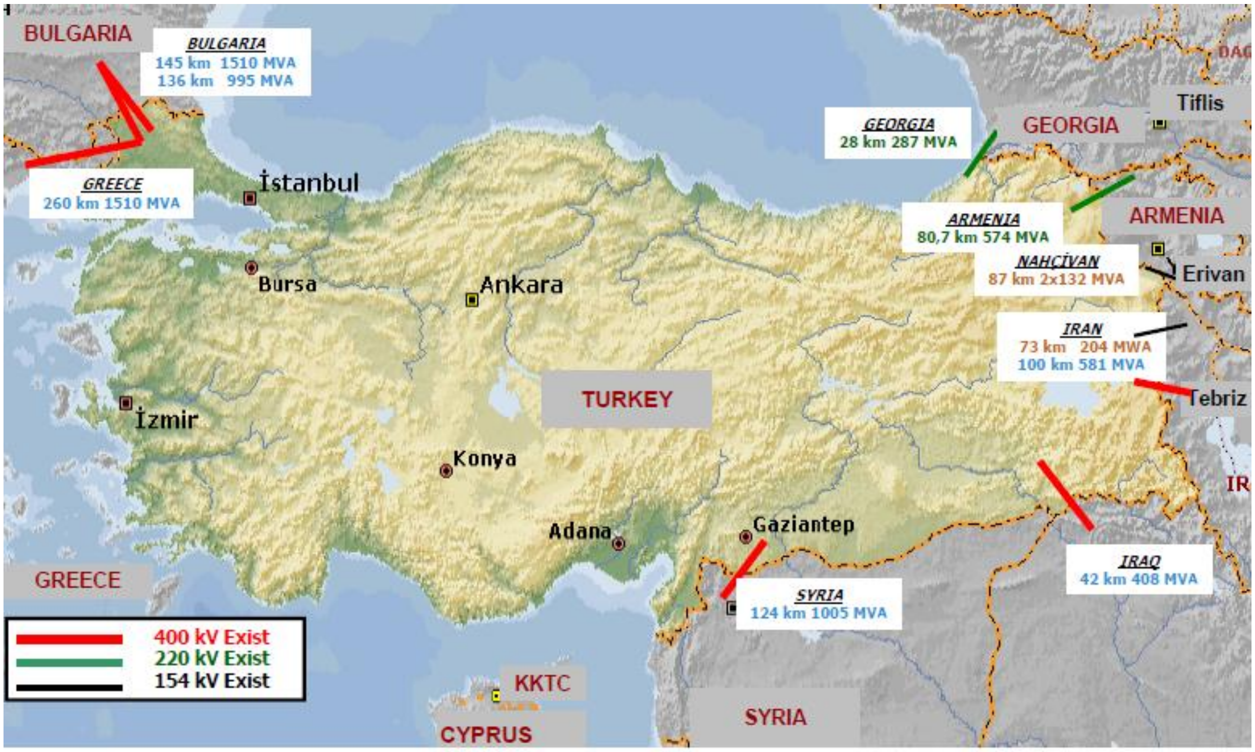

Figure 33: Grid-connection of the Turkish transmission grid to adjacent countries [3].

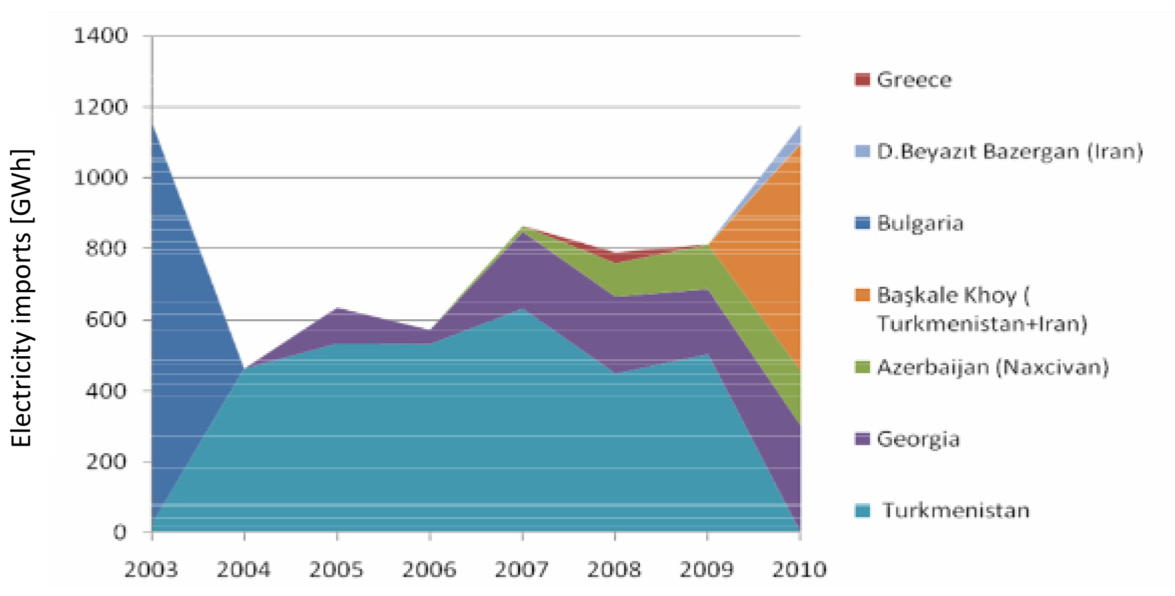

Figure 34: Historic cross-border electricity imports to Turkey [6].

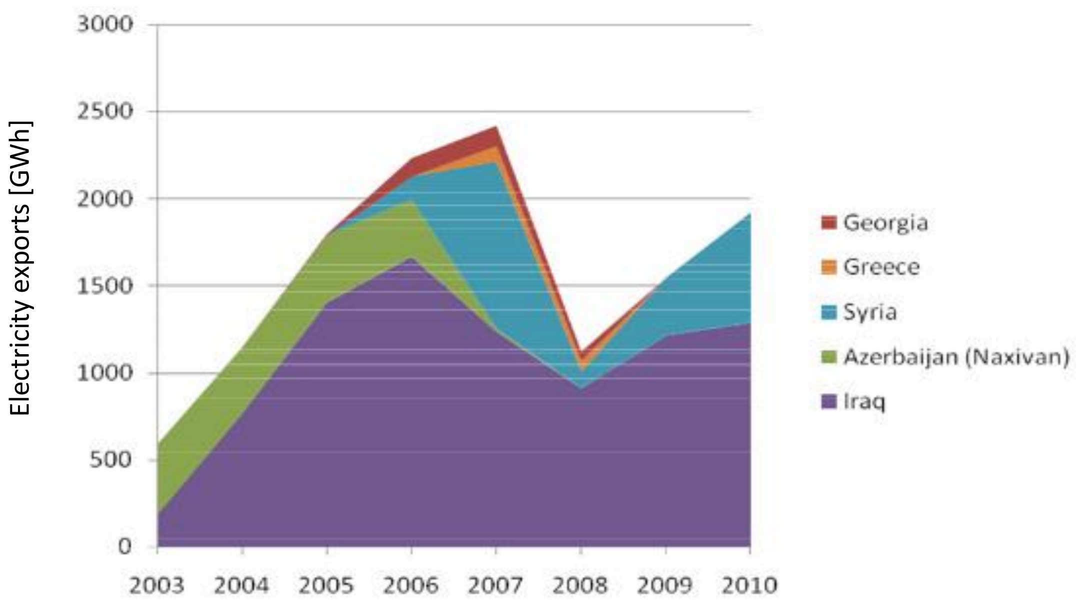

Figure 35: Historic cross-border electricity exports from Turkey [6].

Recently, Turkey got in negotiations with ENTSO-E to get connected to the ENTSO-E synchronous zone. After the completion of a number of technical tests, the process is now in its final phase and commercial trades up to a certain limit are already allowed. At its meeting of 17 April 2013, the ENTSO-E Regional Group Continental Europe decided to increase the capacities for commercial power exchanges between Continental Europe (CE) and Turkey. The capacity for imports from CE to Turkey will increase to 550 MW (currently 400 MW) and the capacity for exports from Turkey to CE will increase to 400 MW (currently 300 MW). As in the past, these capacities will be split by a ratio of 2/3 for the Bulgaria-Turkey border and 1/3 for the Greece-Turkey border. The agreement is subject to technical conditions being put in place, including an addition to the special protection scheme in Turkey. 1 June 2013 is the expected date for the application of the new values [28]. The milestones of the EU-Turkey grid connection process are summarized in Table 11. During the ENTSO-E connection test phase it was necessary to disconnect all neighbor countries. In the future, when the Turkey is integrated in the ENTSO-E synchronous zone, it will be necessary to implement frequency converters at the cross-border lines to the other neighbor countries.

Table 11: Milestones regarding the grid-connection of ENTSO-E and Turkey

Process	Date
Isolated test at Maximum Load Conditions	11-25 January 2010 (completed)
Isolated test for Minimum Load Conditions	22 March – 05 April 2010 (completed)
Trial Parallel Operation	• Stabilization Period (No exchange) 18 September 2010 (completed)

	• Non-commercial exchange (limited) 21 February 2011 (completed) • Commercial exchange (limited) 1 June 2013 (increase of NTC values)

3 RES policy framework

3.1 Overview of RES targets, strategies and policies

Turkey is a country with growing energy needs, especially in the electricity sector. Therefore it has been a key part of the energy strategy to diversify and make use of alternative and more efficient energy technologies, amongst them also renewable energy sources.

Renewable energy policy framework dates back to 2001. The Electricity Market Law and Electricity Market Licensing Regulation set forth a number of pro-renewables provisions. In 2005, Turkey enacted its first law on renewable energy. The Law on the Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy (No. 5346) [52] (YEK Law) introduced the “Renewable Energy Resource Certificate” (RES Certificate) to identify and monitor the renewable electricity purchased and sold in the domestic and international markets. While this Law gave an impetus to renewable electricity generation through hydro plants and wind farms (Saygin & Cetin, 2010 [53]) the uncertainty in the purchase guarantees hindered the interest in renewable energy projects. In respond to that, a series of amendments were introduced in 2007 and 2008 [54][55]. These amendments secured a constant purchase price for all types of renewable sources (Sayging & Cetin, 2010). The incentives offered are as follows ([56][57][58]).

For Renewable Power Plants in operation for not longer than 10 years:

- The average electricity wholesale price of the previous year is to be determined by EMRA and limited to €cent 5-5.5/kWh RES,
- Certificate owners are also granted the right to sell their output at higher rates whenever available in the spot market or via bilateral contracts with eligible customers,
- The share of renewable output within the retail licensees’ portfolio cannot be less than their domestic market share.

A 85% deduction is applied to fees related to permission, rent, and right of access and usage permission over the investment and operation period during the first 10 years. 85% deduction is applied to fees related to investments in the transportation infrastructure and power lines until the connection point to the grid.

In 2010, a new Amendment to the Energy Law differentiated the feed-in tariff structure with regards to the sources (see table 12). The Law also offers add payment for components made in Turkey. EMRA will give priority in evaluating generation licence applications to facilities generating renewable energy. The Amendment Renewable Law offers Incentives through the

Pooling of Payments: It envisages a pool managed by the Market Financial Settlement Centre (MFSC) whereby the electricity suppliers will make the payment of the renewable energy and the renewable energy generators will collect their fees [59].

In 2009, the Higher board of Planning adopted the “Electric Energy Market and supply Security Strategy Paper” (MENR, 2009 [60]). This strategy document defines a roadmap of increasing the share of renewable energy in electricity generation. The energy target is to increase the share of renewable resources by 2023 to at least 30 percent.

To determine near-term targets, Ministry of Energy and Natural Resources prepared a Strategic Plan covering the period between 2010 and 2014 (MENR, 2010 [61]), the renewable energy targets within this Plan is presented in Table 12.

Table 12 Renewable electricity sector targets defined in the Strategic Plan covering the period 2010-2014 (MENR, 2010).

Resource type	Targets defined in Supply Security Strategy Paper (MW)
Wind energy	From 802,8 MW in 2009 will be increased to 10, 000 MW by 2015 , and 20,000 MW in 2023
Hydro power	Construction of 5,000 MW plants will be completed in 2023
Geothermal	Installed capacity of 77,2 MW in 2009 will be increased up to 300 MW by 2015
Solar	600 MW until the 31 December 2013, while the maximum capacity of a single installation is limited to 50 MW
Biomass	2,000 MW in 2023

3.2 Financial support schemes for RES

In Turkey, renewable electricity production is mainly promoted through a guaranteed feed-in tariff. The YEK-Law differentiates the amount of the fixed feed-in-tariffs depending on the technology and whether the plant components were produced in Turkey or not. If the mechanical and electro-mechanical equipment of the power plant is produced locally (at least half of the parts have to be produced within Turkey), a premium shall be added to the feed-in tariffs during the first five years of operation.

The feed-in tariff varies according to the energy source and the origin of the plant components. It has to start to be in operation between 18.05.2005 and 31.12.2015. The feed-in tariff and the local-content bonus for the following energy sources are fixed in YEK, chart 1 and 2 (Table 13 and Table 14). For the time being, all the FITs are guaranteed for a period of 10 years.

Table 13: Support tariffs (FiT and local equipment bonus)

Plant type	Feed-in Tariff (USD cents/kWh)	Local equipment bonus (USD cents/kWh)
Wind energy (on-/offshore)	7.3	0.6 – 3.7
Hydro power	7.3	1.0 – 2.3
Geothermal	10.5	0.7 – 2.7
Solar (PV)	13.3	0.6 – 6.7
Solar (CSP)	13.3	0.6 – 9.2
Biogas	13.3	0.4 – 3.8
Biomass	13.3	0.4 – 1.8

Table 14 Premium for local equipment

Type of power plant facility	Type of equipment	Premium (USD cents/kWh)
Wind	Blade	0.8
	Generator and power electronics	1.0
	Turbine tower	0.6
	Entire mechanical equipment in rotor and nose cone group	1.3
Hydro power	Turbine	1.3
	Generator and power electronics	1.0
Geothermal	Steam or gas turbines	1.3
	Generator and power electronics	0.7
	Steam injector or vacuum compressor	0.7
Solar (PV)	PV panel integration and solar structure mechanics	0.8

	PV modules	1.3
	PV module cells	3.5
	Inverter	0.6
	Focusing materials to collect solar rays onto PV models	0.5
Solar (CSP)	Radiation collection tube	2.4
	Solar tracking system	0.6
	Reflective surface plate	0.6
	Mechanical equipment in thermal energy storage system	1.3
	Mechanical equipment in steam production system via collection of solar rays on roof	2.4
	Stirling engine	1.3
	Panel integration and solar structure mechanics	0.6
Biomass	Steam boiler with fluid bed	0.8
	Liquid-fired and gas-fired steam boiler	0.4
	Gasification and gas removal group	0.6
	Steam or gas turbines	2
	Internal combustion engine or Stirling engine	0.9
	Generator and power electronics	0.5
	Cogeneration system	0.4

The costs of the feed-in tariff are eventually borne by the consumers via their electricity bills (§ 6 art. 1 YEK). The costs of the support scheme are borne by the grid operator. The total amount will be determinate by the PMUM and then invoiced to the supplier (§ 6 art. 6 YEK).

The renewable energy plants with capacities of less than 500 kWe do not require a generation license or start a company. Such producers should apply to the distribution company in their region and sell the excess energy at the prices specified in the YEK for 10 years. Other incentives provided are as follows (Table 15).

Table 15 Incentives other than feed-in tariffs for renewable energy investment [62]

Incentives within the Renewable Energy Law (No. 5346)	Assigning of land belonging to the Treasury and "land at the disposal of the state" to renewable energy projects. 85% discount in easement, usufruct, permit or lease fees for the first 10 years of operation.
	Use of national parks, nature parks, natural protection areas, preservation forests, wildlife cultivation areas and special nature preservation areas with necessary permits.
	Exemption from the compulsory 1% turnover payment for operating business on immovable assets of the Treasury.
Incentives within the Electricity Market Licensing Regulation (No. 24836)	99% exemption from licensing fee and annual license fees for the first 8 years of operation
	Priority in system connection
Tax Incentives within the Cabinet Decree on State Aid Investments (No. 2009/15199)	VAT exemption for domestic equipment for Investment Support Certificate holders
	VAT, Customs Tax, Resource Support Utilisation Fund payment exemptions in imports for Investment Support Certificate holders
Incentives within the Law Regarding the Support of Research and Development Activities (No. 5746)	R&D deduction (deduction of R&D expenditures from corporate tax base at a rate of 100%)
	Income Tax exemption (80% of salary income for eligible R&D and support personnel), Social Security Premium support for 5 years, Stamp Tax exemption

3.3 Grid regulation

In Turkey, the connection to the grid occurs through a bidding procedure. The available connection regions and points are published by the Turkish Transmission System Operator (TEIAS) on every 31 March of the year. A plant operator who wants to be connected to the grid needs to obtain a production license, to clarify the connection details and to arrange an agreement of the connection with the TEIAS. Production facilities based on renewable energy resources will be given priority (§ 6/B art. 3 YEK) by TEIAS and the distribution companies. However, due to technical limitations, wind capacity is fixed on a substation basis (to be updated according to the capacity developments). Same procedure will apply for solar energy [63]. When there are multiple applications (such as for same water source to produce hydro energy, same plant site or connection point for wind and solar), usage rights are granted by tenders (based on fee/kWh) through Turkish Electricity Transmission Co. (TEİAŞ) for wind and solar projects and DSİ for hydro projects.

According to the Electricity Market Licensing Regulation Turkish Electricity Transmission Company (TEIAS) and/or distribution companies shall assign priority for system connection of generation facilities based on domestic natural resources and renewable resources

In addition, Law No. 5784 published in July 2008 allowed legal entities to be exempted from obtaining license to generate electricity from renewable energy up to a capacity of 500 kW. By this law, government also guarantees to buy the excess electricity.

4 Barriers for RES deployment

In the following the main obstacles to the development of renewable energy sources in Turkey are summarized. The presented overview documents the state of the art. However, it has to be mentioned that Turkey's energy market are currently in a dynamic process of restructuring (partly driven by the EU accession process, partly because of efforts being taken to fully liberalize the market) and thus regulations and corresponding obstacles might change accordingly.

4.1 RES electricity support measures

In the past, regulations in the electricity market and in particular regarding RES support schemes have been frequently adopted. In the current support scheme RES generators can either choose to directly market their electricity in the common electricity market, or to receive a Feed-in-Tariff (FiT). On the one hand the FiT for solar PV in the southern regions seems to be sufficiently high, on the other hand, the currently implemented FiT for wind and hydro power are lower than the yearly average spot market price [35]. This means that at current levels the FiT represents for wind and hydro power a guaranteed lower cap on revenues, rather than a support measure[4]. Consequently, in the previous period nearly all of those generators chose to participate in the RESUM scheme and preferred to earn their revenues from the electricity market.

However, the electricity market design in its current version is not in favor of intermittent RES generation like wind and solar PV. By the time being, the intra-day market is not fully liquid and as a reason wind and PV generation is forced to be primarily marketed in the day-ahead market. In this situation generators have to forecast their generation 36 hours ahead of actual delivery and are fully responsible to balance their forecast error. Additionally, the pricing scheme in the balancing market do further adversely affect intermittent generation, as forecast errors irrespective of the direction of its deviation are penalized in the same way. The generation

[4] This is not valid if more than half of the components of the power plants are produced within Turkey. In that case the investors are offered an additional add-on on top of the common FiT in the frame of the so-called *Schedule II* program.

forecasts have to be organized by each generator itself, even though forecasts get worse if fewer plants are in the portfolio. On average the costs for balancing energy reduces the revenue by a range of 10% to 15% [34]. In the past the Turkish reform model was largely inspired by the New Electricity Trading Arrangements of the UK [18]. Recently, the regulation was more aligned to the German approach, although it has to be critically mentioned that at low levels of RES penetration, the applied regulation might not be appropriate.

Regulation in the overall market frequently changes and there are a number of regulated tariffs that vary significantly in time as well (cf. Figure 22 – use of transmission tariffs). Furthermore, a number of incentives for the development of RES are assigned with an expiration date, whereas it is left open if those measures will be extended (stop-and-go policy) [7]. As a result, the current framework imposes unnecessarily high risks for investors and increases risk premiums. A further barrier is also that there are no long-term loans or pure project financing are available on part of the private sector banks within Turkey [36]. Finally, subsidies on fossil fuels lead to a non-cost-based pricing in the electricity market and undermine the competitiveness of RES generators.

4.2 Administrative procedures

A peculiarity of the Turkish energy market regulation is the need for applying for a license for every market activity. Although some efforts were taken to simply licensing procedures there are still a high number of parties involved in the process. In general, public authorities show a lack of service orientation. For example, the main authorities do not have local representatives and request all applicants to travel to their headquarters in Ankara.

Within the licensing procedure RES generators do have to fulfill costly and time-consuming tasks. Especially, wind and solar PV generators are requested to provide an extensive set of historical measurements of their corresponding resource availability to EMRA. In particular, applicants of solar PV stations are not allowed to submit already measured data at a certain location (also not from another applicant). Instead, every potential investor has to install its own measurement equipment to derive the requested data. In the light of the fact that the available capacity that can be connected to the grid are limited and the share of applicants that succeed to receive a license in the past is still small, this practice can be seen as inefficient.

In general, the duration for the application of a license varies significantly from case to case and can last from 6 months up to 7 years. In some cases it happened that already taken pre-payments were no longer recognized by EMRA due to the exceeding of a certain time limitation period. With the introduction of the new electricity market law some of those remedies might be dissolved. It has been proposed that a pre-license should be issued in order to take out the fulfillment of preliminary tasks (e.g. feasibility study, bank guarantee letters) out of the main licensing process. A further simplification of bureaucracy is being expected by the announced increase of the capacity threshold for generation license exemptions from currently 500 kW up to 1 MW.

Finally, it seems like that a significant number of licenses have been issued to investors that actually did not had the intention for a real investment, rather than to resell their license on a secondary market. After the first wind license tender held in November 2007, there were 750 applications for 78 GW of capacity, with around 350 cleared for evaluation. In the subsequent period there were 264 issued wind licenses on EMRA's website, equating to 9.3 GW. Under Turkish regulations, licenses cannot be traded or transferred, but firms that do not use their licenses for wind generation prefer to sell the entire company along with the license at prices that carry a 15-30% premium [39].

4.3 Infrastructure development and electricity network operations

A major cornerstone in the application process of new RES generators is the technical evaluation of the transmission and distribution grid operators, respectively. In this respect, TEIAŞ prepares and published their projections on potential capacity to be added to each grid node. If the number of requests at a certain grid node exceed the available capacity the grid operator are obliged to allocate the capacity in a non-discriminatory way. The Turkish transmission grid operator TEIAŞ frequently organizes tenders for wind power plants [37]. The resulting prices of the auctions are so-called royalty- or connection fees, which have to be paid by wind applicants in order to get a positive approval by TEIAŞ.

Due to high competition of wind energy projects, particularly in secondary market for generation licenses, in some cases the resulting royalty fee of past auctions where quite high (cf. Figure 23) and even made several projects economically unattractive. What is more, with regard to economic theory the pricing of transmission capacity as a variable cost component seems not to be efficient, as costs incurred by the connection of new generation capacity to a power grid are mainly depend on the size of the capacity connected rather than on the actual amount of energy generated.

The grid access to solar PV power plants is subject to high competition as well. In contrast to the competition regulation of wind power plants, the applied regulation for solar power is conducted by giving a so-called deduction fee instead of payment of a contribution fee to TEIAŞ [38]. The auctioned fee is defined as the amount to be deducted from the FiT of solar PV generators. As in the case of wind energy, there is a risk that many investors will push their bids to high levels.

A crucial barrier to the deployment of RES is also the evaluation of available capacity that can be connected to the power grid. This evaluation is carried out by TEIAŞ and is published in their connection plan up to 2023. In the current regulation no dedicated incentives are put in place to facilitate grid extension efforts by the transmission grid operator TEIAŞ.

4.4 Social acceptance

Recently, a study has been published that assessed the public opinion on nuclear and renewable energy sources within Turkey [40]. In particular, the aim was to understand citizens' preferences regarding renewable and nuclear energy. The authors found out that almost twothirds of their sample endorsed investment in renewable energy sources, and only a small minority expressed opposition to them. However, they point out that this research is carried out in the light of a low current RES penetration in Turkey and therefore the public opinion might change in the future. On the other hand, they found a high level of nuclear opposition. This is very interesting in the view of the fact that Turkey is willing to start generating electricity from nuclear and plan to build 3 new nuclear power plants until 2023 [41]. The authors also found that the awareness of climate change seems to be a common factor in the support of both renewable energy and nuclear power. However, the endorsers differentiate in their concern about the environment, their level of pessimism regarding the future and their skepticism about technology. Supporters of nuclear energy found to be mainly males who were basically knowledgeable about the climate change problem and engaged in environmental issues as well, but were less concerned about the environment in general and optimistic about its future [40]. The relation between knowledge of climate change and nuclear support, led experts and policy makers to come to the conclusion that all people who are aware of climate change would be supporters of this technology as well. Strong popular anti-nuclear sentiments and in some cases local and national protests by activists have so far been completely ignored by the government [40]. The authors see this as a critical factor for the future and conclude that it might be seen whether the current plans for the expansion of nuclear power in Turkey will materialize or not.

An important barrier that has to be considered is the public objection towards the construction of hydro power plants. Turkey faces the problem that it is highly depended on energy imports and at the same time has a huge hydro power potential. Current regulation foresees an Environmental Impact Assessment (IEA) for such projects, however, citizens in Turkey seem to be concerned about the preservation of local ecosystems and believe that especially small hydro power plants would damage the integrity of those ecosystems [43].

Another study has investigated the renewable energy education on university level in Turkey [44]. A questionnaire was developed and applied at different universities. They concluded that the current state of teaching practice seems to be inadequate and should be expanded and strengthened in order to develop experts in this field. Also another study confirmed that there is currently a lack of teaching in the field of renewable technologies throughout the whole education system [45].

However, it has to be mentioned that the public awareness on the need for renewable energies within Turkey exists and that Turkey even have a dedicated department for RES, namely the General Directorate of Renewable Energy [46].

5 Summary and Conclusions

This report gives an overview on the current state and historical development of the Turkish energy system, whereas a special focus is laid on the electricity sector. It can be concluded that the import dependency of Turkey increased over the last years and has already reached a level which is well above the OECD average. The historic RES development was moderate and there are still some severe barriers to overcome in order to reach the 30% RES-E target in 2023. In particular, the currently implemented FiT does not trigger RES investments, rather than providing a lower revenue cap, which is, however, in many cases not sufficient to recover costs. The following table summarizes the findings of the report and categorizes them into the scheme that was developed within D2.4 of this project.

Strengths	Weaknesses
MACRO • Clearly defined energy strategy and legal framework • Current restructuring process in energy markets is comparable to those in EU countries • High growth potential in gas demand • Turkey possess a well-developed gas infrastructure and is closely located to countries with significant gas resources • Favorable location as energy transit hub between Europe and the Middle East MICRO • EMRA as independent Energy Market Regulation Authority • Increasing share of the private sector in the energy markets ACCEPTANCE • Public awareness of climate change and general understanding for the need of CO_2 abatement	MACRO • High energy import dependency (in particular in the case of gas supply) • Coal as only fuel with relevant domestic resources available • Need to store huge amounts of gas because of energy security reasons MICRO • Energy subsidies to fossil fuels • Many upfront requirements for the licensing of wind and solar PV • FiT mainly serves as lower revenue cap for some technologies • National transmission grid operator TEIAŞ have no incentive to facilitate grid expansion ACCEPTANCE • Lack of teaching in the field of RES
Opportunities	**Risks**
MACRO • High growth potential of the Turkish Energy sector in comparison to other European countries • Potential to act as future energy trade center MICRO • Development of competitive energy markets • High interest of foreign investors in the Turkish energy market ACCEPTANCE • Increasing shares of young generation with an interest in RES technologies	MACRO • Turkey is currently seeking for new long-term gas contracts • High political instability in the region • Increasing risk of blackouts due to the high electricity demand growth MICRO • Frequent adoption of regulated tariffs in the power sector • Temporary incentives for RES ACCEPTANCE • Risk of ignorance of public opposition against nuclear and hydro power projects on part of the government

6 References

[1] IEA 2013, *Energy balances of OECD countries,* 2010-2013 edition.

[2] Capik et.al. 2012, *Present situation and potential role of renewable energy in Turkey,* Renewable Energy 46 (2012) 1-13, 12 April 2012.

[3] EPDK 2012, *Turkish Energy Market: An Investor's Guide,* www.epdk.gov.tr, 06/2013.

[4] EPDK 2012, *Recent Regulatory Developments in Turkish Electricity Market*, Fatih Kölmek, Kiev, Ukraine, 5 April 2012.

[5] EPDK 2011, *Electricity Market Report 2011,* www.epdk.gov.tr, 06/2013.

[6] EPDK 2010, *Electricity Market Report 2010,* www.epdk.gov.tr, 06/2013.

[7] EPDK 2010, *Turkish Electricity Market,* Regional Black Sea Regulatory Workshop, Chisinau, Moldova, 5-6 May 2010.

[8] OECD 2013, "*Turkey*", in Taxing Energy Use: A Graphical Analysis, OECD Publishing: http://dx.doi.org/10.1787/9789264183933-36-en, 06/2013.

[9] IEA 2009, "*TURKEY – 2009 review"* in Energy Policies of IEA countries, OECD/IEA, 2010.

[10] Eurostat 2012, *Energy balance sheets 2009-2010,* 2012 edition.

[11] TTK 2009, Turkish hard coal enterprises, *annual report*, Zonguldak; 2004.

[12] TKI 2010, Turkish coal enterprises, *coal (lignite) annual sector report*; 2004, 2009.

[13] Yılmaz AO, et.al. 2003, *The importance of lignite in energy production and Turkish coal enterprise*, Proceedings of the 18th international mining congress and fair of Turkey. Antalya: Mining Engineers Chamber of Turkey, 2003.

[14] WECTNC 2010, World energy council-Turkish national committee, *Turkey energy report,* Ankara, 2010.

[15] DPATR 2010, General directorate of petroleum affairs of Turkey Republic, http://www.pigm.gov.tr/uretim.php , 2010.

[16] PI GM 2010, General directorate of petroleum affairs, www.pigm.gov.tr, 2010.

[17] ENTSO-E 2013, European Network of Transmission System Operators, www.entsoe.eu (07/2013).

[18] Atiyas et.al. 2012, *Reforming Turkish Energy Markets. Political Economy, Regulation and Competition in the Search for Energy Policy*, Springer press, 2012, DOI 10.1007/978-1-4614-0290-9.

[19] Hoekman, Bernard and Subidey Togan 2005, *Turkey: Economic Reform and Accession to the European Union*, Washington DC: Word Bank Publications.

[20] MENR 2009, *The Republic of Turkey Ministry of Energy and Natural Resources Strategic Plan (2010-2014),* http://www.enerji.gov.tr/, 06/2013.

[21] NM 2013, Energy key statistics, http://www.nationmaster.com/country/tu-turkey/ene-energy, called on 18.08.2013.

[22] Law Nr. 28504, *Regulation on service quality in electricity distribution and retail sale*, 21.12.2012.

[23] Law Nr. 3096, *Law On Assignment Of Enterprises Other Than Turkish Electricity Administration To Produce, Transmit, Distribute And Trade Electricity*, 04.12.1984.

[24] Law Nr. 5346, Renewable Energy Law, *Law on Utilization of Renewable Energy Sources for The Purpose of Generating Electrical Energy*, 10.5.2005.
[25] Law Nr. 5627, *Energy Efficiency Law*, published in the official gazette on 18.04.2007.
[26] Law Nr. 5346, *Electricity Market Law*, published in the official gazette on 3.3.2001.
[27] Law Nr. 27200, *Electricity Market Balancing and Settlement Regulation*, published in the official gazette on 15.04.2009.
[28] ENTSO-E 2013, *Progress of ENTSO-E connection*, www.entsoe.eu, 22.04.2013.
[29] TEIAS 2013, Cross-border capacity auctioning platform for explicit cross-border capacity, https://tcat.teias.gov.tr/, called on 18.08.2013.
[30] Law Nr. 5686, *Law on geothermal resources and mineral waters*, 6.3.2007.
[31] Law Nr. 5710, *Law on construction and operation of nuclear power plants and energy sale,* 09/2007.
[32] Cakmak 2013, *The New Electricity Market Law,* Çakmak Avukatlık Bürosu Attorneys at Law, Turkish Law Company, http://www.cakmak.av.tr, 22 March 2013.
[33] Cakmak 2013, *Overview of the Electricity Regulation in Turkey,* Çakmak Avukatlık Bürosu Attorneys at Law, Turkish Law Company, http://www.cakmak.av.tr, 2013.
[34] Erden 2013, *Barriers for the development of wind energy*, IRENEC 2013, 27th-29th June 2013, Istanbul.
[35] EMRA 2013, *Renewable Energy Regulations & Incentives in Turkey,* Turkey Chairman meeting, Abu Dhabi, 2013.
[36] Enerjisa 2013, *Barriers for Renewable Energy Projects in Turkey*, IRENEC 2013, 27th-29th June 2013, Istanbul.
[37] Cakmak 2010, *Regulation regarding the selection process for multiple wind project applications,* Çakmak Avukatlık Bürosu Attorneys at Law, Turkish Law Company, http://www.cakmak.av.tr, 28.09.2010.
[38] Cakmak 2012, *Recent developments in Solar Power in Turkey*, Çakmak Avukatlık Bürosu Attorneys at Law, Turkish Law Company, http://www.cakmak.av.tr, 06.06.2012.
[39] ICIS 2013, http://www.icis.com/heren/articles/2013/05/08/9666277/power/edem/turkeyaposs-emra-to-review-licences-for-struggling-projects.html, called on 16.07.2013.
[40] Akyazi et.al. 2012, *Citizens Preferences on Nuclear and Renewable Energy Sources – evidence from Turkey,* Working paper, Department of Economics, Boğaziçi University, Turkey.
[41] MENR 2013, *Current nuclear power situation in Turkey,* Technical Meeting on CNPP, International Atomic Energy Agency, Vienna, 18 – 21th March.
[42] Kentel 2013, *Hydropower in Turkey: Economical, social and environmental aspects and legal challenges,* Environmental Science & Policy 31 (2013), 34-36, 23th of April 2013.
[43] Karabulut 2011, *An investigation on renewable energy education at the university level in Turkey,* Renewable Energy 36 (2011) 1293-1297, 23th October 2010.
[44] Acikgoz 2010, *Renwable energy education in Turkey,* Renewable Energy 36 (2011), 608-611, 5th August 2010.

[45] MENR 2013, General Directorate of Renewable Energy, http://www.eie.gov.tr/, visited in 07/2013.

[46] TÜREB 2011, *TEIAŞ RÜZGAR YARIŞMALARI RAPORU, TEIAŞ wind energy report*, Turkish Wind Energy Association, 2011.

[47] EMRA 2011, *Energy Market Report 2011*, Electricity Market Regulation Authority, Ankara, Turkey.

[48] EMRA 2012, Energy Market Regulatory Authority, *decision no 3689*, date of decision: 09.02.2012

[49] EMRA 2012, Energy Market Regulatory Authority , *decision no: 421*1, date of decision : 27.12.2012

[50] DSI 2013, General Directorate of State Hydraulic Works (Devlet Su İşleri Genel Müdürlüğü) http://www2.dsi.gov.tr/skatablo/Tablo1.htm, called on 18.08.2013.

[51] DSI 2009, *Turkey water report 2009*, General Directorate of Electrical Power Resources Survey and Development Administration (Elektrik Đsleri Etüt Đdaresi Genel Müdürlüğü Đlk Etüt Raporları, Ankara, Turkey.

[52] Law on Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy, *Official Gazette*, with No. 24335, dated 10.05.2005 (Law No.: 5346)

[53] Saygın, H. and Cetin F. (2010). New energy paradigm and renewable energy:Turkey's vision, *Insight Turkey*, Vol. 12, No. , pp. 107-128.

[54] The Law Amending the Law on Utilization of Renewable Energy Resources in Electricity Generation, *Official Gazette*, with No. 26510, dated 02.05.2007.

[55] The Law Amending the Law on Utilization of Renewable Energy Resources in Electricity Generation Law on Utilization of Renewable Energy Sources for the Purpose of Generation Electricity, *Official Gazette*, No. 270522, dated 03.12.2008.

[56] The Law Amending the Law on Utilization of Renewable Energy Resources in Electricity Generation Law on Utilization of Renewable Energy Sources for the Purpose of Generation Electricity, *Official Gazette*, No. 270522, dated 03.12.2008.

[57] EUMS (Energy, Utilities & Mining Sector), (2009) Renewables Report On the sunny side of the street* Opportunities and challenges in the Turkish renewable energy market Industries, Available from www.boell-meo.org/downloads/Renewable_Energy_Turkey.pdf.

[58] Gümüş, S.,(2011) ,Turkey: Incentives For Renewable Energy, Energy & Natural Resources, on 28 April 2011. Available from http://www.mondaq.com/x/130778/Renewables/Incentives+For+Renewable+Energy.

[59] The Law Amending the Law on Utilization of Renewable Energy Resources in Electricity Generation (Law No: 6094), *Official Gazette dated 8 January 2011 and numbered 27809*

[60] Turkey's Electric Energy Market and Supply Security Strategy Paper with Res. No. 2009/11, dated 18.09.2009, Available from http://www.enerji.gov.tr/yayinlar_raporlar/Arz_Guvenligi_Strateji_Belgesi.pdf.

[61] The Republic of Turkey Ministry of Energy and Natural Resources Strategy Plan 2010-2014, Ankara, Turkey

[62] Law on Amendments on the Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy. Law No. 6094 Date Ratified: 29/12/2010

[63] Kolmek, F. 2011. *Regulationson Renewable Energy in Turkish Electricity Market.* Workshop on Renewable Energy Investment Framework and Development of Regional Regulatory Guidelines.

7 Appendix

7.1 Annex 1

Public sources for data collection on current state of the Turkish power system (visited during April/May 2013):

http://www.biyogaz.web.tr/tr/turkiyedeki-biyogaz-tesisleri
http://www2.epdk.org.tr/lisans/elektrik/lisansdatabase/verilentesistipi.asp
http://www2.epdk.org.tr/lisans/elektrik/lisansdatabase/verilenuretim.asp
http://www.euas.gov.tr/BirimlerDokumanlari/Basin/euasharitafinal.jpg
http://www.euas.gov.tr/Sayfalar/TermikSantralBilgileri.aspx
http://www.entekelektrik.com.tr/#
http://www.age.com.tr/tr/Icerik.ASP?ID=743&M1=610&M2=743
http://www.altek.alarko.com.tr/
http://www.akfen.com.tr/en/yatirimlar/enerji/
http://www.aksaenerji.com.tr/tr/operasyonel.aspx
http://www.bisenerji.com.tr/bis/index2.php?page=teknik
http://www.dilerhld.com/grup.asp?anagrup_no=4
http://www.canenerji.com.tr/uretim.html
http://www.enerjisa.com.tr/tr-TR/ElektrikUretimi/Pages/termal.aspx
http://www.gulsancons.com.tr/enerji.asp
http://www.icdas.com.tr/icdas/enerji_tr.htm
http://www.polatenerji.com/f_burgaz.php
http://www.nuhenerji.com.tr/devredeolanlar.html
http://www.mosbenerji.com.tr/mosb.php
http://www.soyakenerji.com.tr/Content/FaaliyetAlanlarimiz.aspx
http://www.teknoenerji.com.tr/hizmetler/uretim.html
http://www.yildizlar.com/iys/enerjiYatirim.php?DK=TR
http://www.zoren.com.tr/TR/companies/companies1.asp
http://www.zorlu.com/TR/INDEX/
http://www.teias.gov.tr/eng/ApkProjection/CAPACITY%20PROJECTION%202009-2018.pdf
http://www2.dsi.gov.tr/skatablo/teklif.htm