Contract N°: IEE/11/845/SI2.616378

Bringing Europe and Third countries closer together through Renewable Energies

BETTER

D5.2.2: Existing and expected framework conditions for RES development in Turkey

Authors: ***André Ortner, Gustav Resch***

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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

Figures and Tables

Figures

Tables

1. Introduction

Turkey occupies an important and special place in the world due to its geographic, dimensional, economic, cultural and historic characteristics. With its strategically positioned, large land mass and a population of approximately 75 million, producing around 800 billion USD gross domestic wealth (just over 10,000 USD per capita), the country is the 17th largest economy in the world.

Recording fluctuating but high economic growth rates, Turkey has population and urbanization growth rates more akin to the emerging economies rather than Europe which it sees itself associated historically. This has made the country record the highest second demand for energy inputs into the economy after China and its concurrent dependence on fossil resources for energy supply has also made it the country with 2nd highest rate of GHG emissions increases. The high economic growth through imported fossil energy supply is endangering both its balance of trade accounts as well as its claims to sustainable development. Turkey needs to power its development increasingly with local renewable energy resources and the country is in fact in an excellent position regarding resource endowments to do so.

1.1 Energy supply of Turkey - The state of play

The Turkish energy sector has been transformed in the last 20-25 years, in line with the waves of change overtaking the global economy towards deregulation, privatization of public assets and open competitive markets. The chart below shows the chronology of milestones regarding this transformation which is continuing today with the privatization of public generation capacity [1].

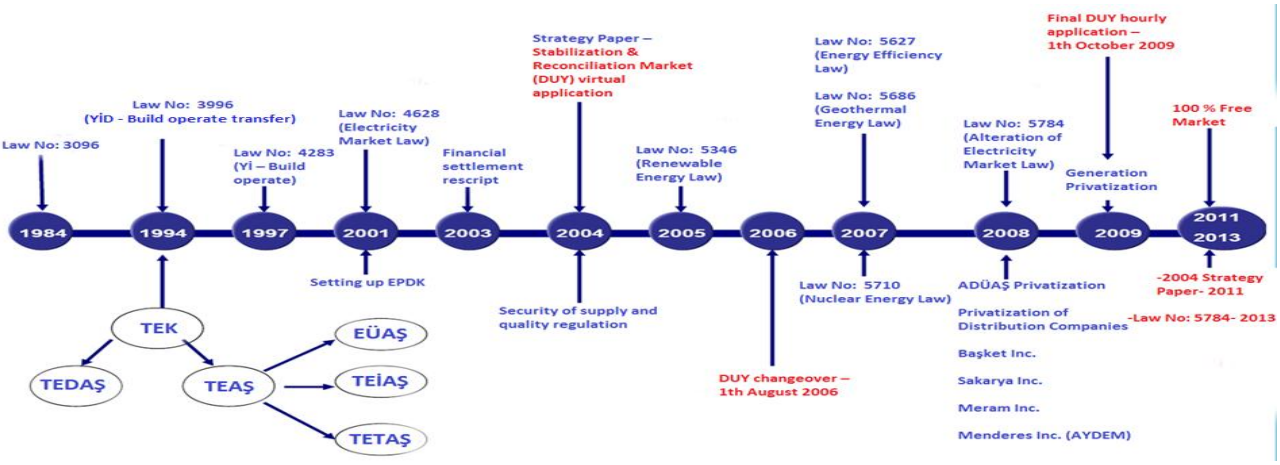
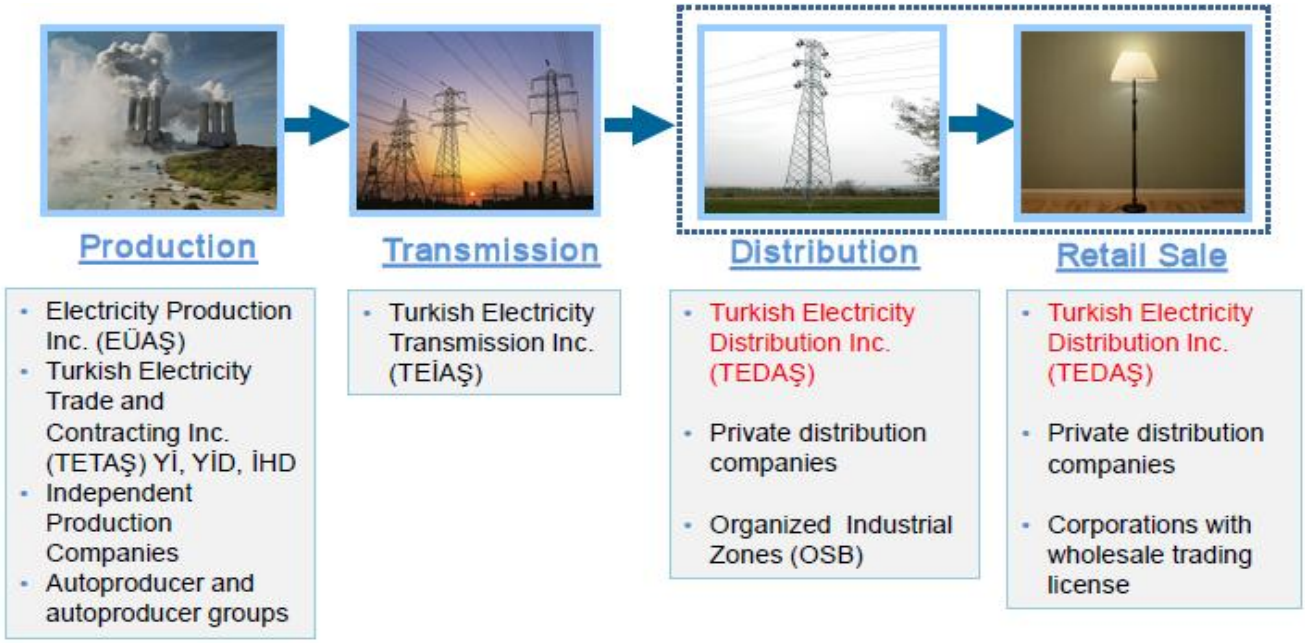


Figure 1: Chronology of Turkish energy sector transformation

The chart also shows the introduction of critical renewable energy and energy efficiency laws 5346 and 5627 in the years 2005 and 2007 consequently. It should be stated that the main motivation for the new legislation were the 'Acquis Communautaire', the agreement that initiated Turkish candidacy for the European Union, the EEC at that time. The privatization of distribution companies is today complete with the final sale of Toros Elektrik recently. 50% of the generation

assets however are still state owned. The schema below demonstrates the present state of play in the administration of the energy sector in Turkey.



Yİ: Build operate, YİD: Build operate transfer, İHD: Transfer of operational rights

Turkish economy is dependent on supplies of imported fossil resources for its growth. The foreign dependence of the energy sector is around 72% and it is growing. Due to the very high demand growth despite periodic downturns, the last 25 years has seen the quadrupling of Turkish installed capacity. Turkish energy consumption is around 110.000 Mtpe (Mega tons of petroleum equivalent) (2011) and power demand approximately 230 billion kWh in 2011 with an 8% increase compared to 2010. Total installed capacity in power production is ~ 53.000 MW. Turkish per capita power consumption is low compared to industrialized countries as can be seen in the table below [2].

Table 1: Power consumption per capita

Countries	**Consumption per capita (kWh)**
World Average	2.500
Developed Countries' Average	8.900
USA	12.322
Turkey	**3.099**

High economic growth rates thus, are predicted to result in demand scenarios of 6.7% per annum for low and 7.5% for high scenario cases. The Energy Ministry predicts investment needs in the power sector for the next 15 years of 100 billion USD while the EMRA (Electricity Market Regulation Authority) forecasts investments needs until 2030 in the range of 225-280 billion USD.

Figure 2 shows the current demand growth for natural gas and power, clear indicators of an accelerating urbanizing economy.

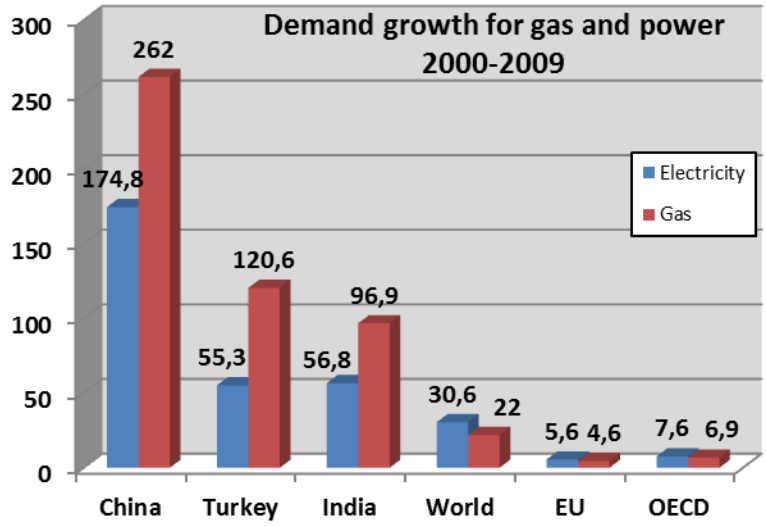


Figure 2: Total demand growth rates for gas and power

The present primary energy resources distribution in Turkey can be seen in Figure 3.

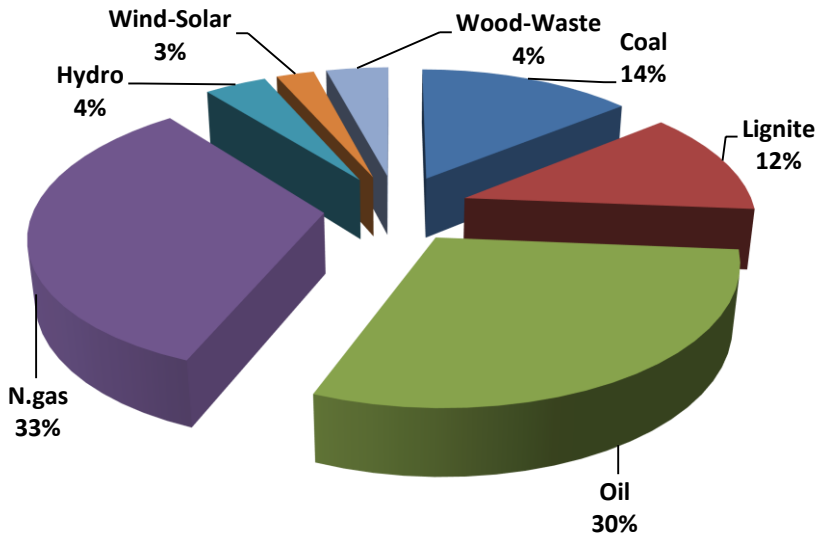


Figure 3: Primary energy resources distribution, 2011

As can be seen in the figure, approximately 90% of consumed energy is from fossil fuel resources. The dominance of fossil fuel resources in power generation is also evident in the figure below, which shows the fuel distribution in the power generation capacity of the country in GWh's.

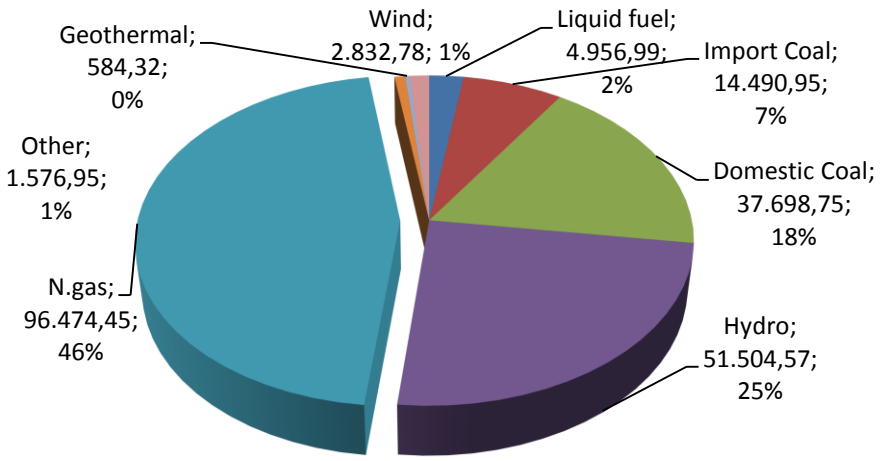


Figure 4: Energy resources for power generation, GWh

The extraordinary place natural gas has taken, in just a decade is not surprising. As the technology that demonstrated the best cost/benefit ratio in the years following the deregulation of the energy sector, natural gas conversion power plants dominated private investments in electricity generation. With the apparent trends in the licensing of new power plants, this dominance of natural gas conversion technology will probably increase. Besides wind energy, non-hydro renewables are presently close to absent in the mix.

The distribution according to primary energy source of supply and consumption can be seen in the Figure 5.

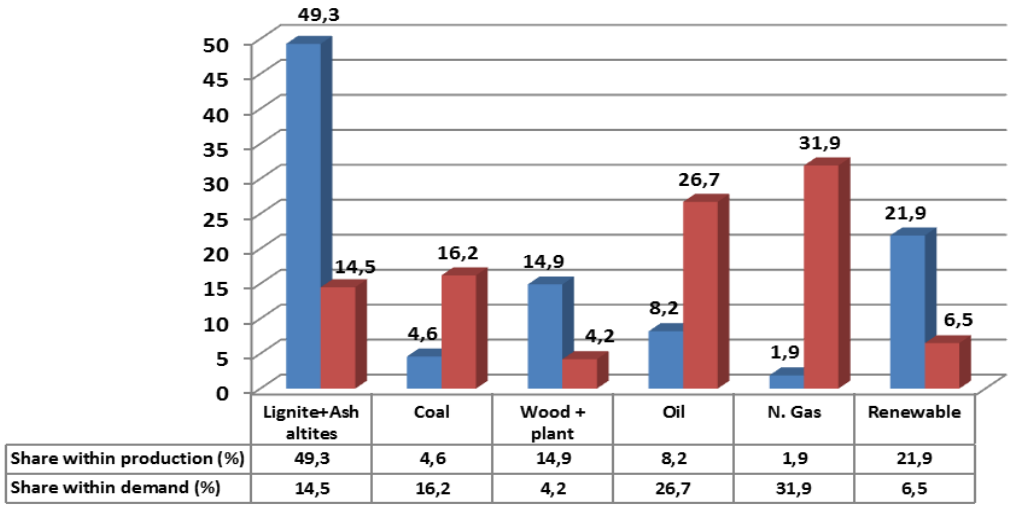


Figure 5: Primary energy resources of supply and consumption [2]

The last 20 years development can be seen in the following table summarizing the energy balance in terms of the trends in demand and supply, import and local contribution.

Table 2: General Energy Balance of Turkey in tons of petroleum equivalent (tpe) from 1990 to 2010

	1990	2010	Change (%)
Total Energy Demand (million tpe)	52,9	109,2	106%
Total Domestic Production (million tpe)	25,6	32,4	26%
Total Energy Import (million tpe)	30,9	87,4	182%
Dom. Production to meet demand (%)	48	29,7	-40%

Source: Ministry of Energy and Natural Resources

According to data provided by the Ministry, Turkish energy demand has grown 106% while national production has not been able to keep up, increasing foreign dependence on imports and lowering local meeting of demand to around 30% in 2010. Fossil resources imports made up almost 23% of the total import bill in 2011 and in 2012 the amount paid for energy imports is roughly 70 billion USD [3].

2. Present Renewables Framework and Development Expectations

2.1 Government energy sector strategy in the medium and long term

The main tenets of the medium-term-program of the government can be summarized by the following statements:

- Complete energy sector deregulation by selling all production and distribution assets
- Build nuclear energy power stations
- Decrease foreign dependence on natural gas by increasing the use of local fossil and renewable resources
- Position Turkey as a transit hub for the flow of petroleum and natural supplies to Europe and elsewhere

The strategy (as documented by the Ministry's Supply Security Strategy for the Electricity Market) the above mentioned aims are to be supported by the following;

- Utilize all local coal resources for power production by 2023
- Utilize all hydro capacity for electricity generation by 2023
- Increase installed wind power capacity to 20 GW by 2023
- Increase the generation of electricity by solar resources.

There are many political, financial and technical barriers to the announced aims and targets of the announced roadmap which will be elaborated in following sections. It is important to mention that the already licensed generation capacity that will be operated with imported coal and natural gas power as of 2011 is approximately 35% of total national capacity. Non-hydro renewable resource

penetration is presently very low and hydro investments are up against environmental barriers and resistance. Major international agreements such as Nabucco, key to Turkey's ambitions to being a transit terminal in international energy flows have been abandoned. However, the government continues to pursue the policy of being a transit terminal in the transportation of fossil fuels to the world.

The Turkish government has set strategic goals related to renewable energy. These goals are detailed in a number of strategy papers, forming the basis of the future trends elaborated in the "2010 – 2014 Strategic Plan" by the Ministry of Energy and Natural Resources, and later the "Electrical Energy Market and Supply Security Strategy Paper" in May 2009 again by the Ministry. 2015 goals specified in these official strategy documents by the government of Turkey indicate up to 30% of renewables supply by 2023 [4]. Total investment amounts range between 150 and 280 billion USD until this date. The EMRA has undertaken to build two scenarios one based on business as usual and another high-renewables scenario as indicated in the tables and figures below.

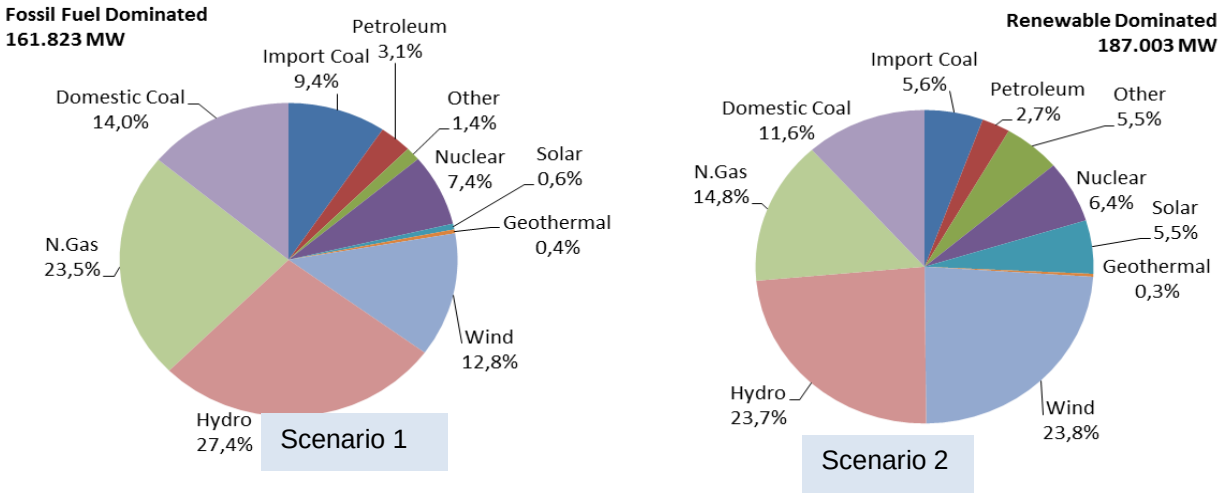


Figure 6: Fossil fuel dominated and renewable dominated scenarios of energy mix of Turkey

This hi-renewables scenario produced by the EMRA above would seem to be a 'thought exercise' as achieving the more eager goals laid out in the Strategy Paper, around 80 billion USD of investment just in the renewable energy sector is needed by 2023, corresponding to an annual investment of 6 billion USD. Keeping in mind the approximate annual investment volumes around 3-4 billion dollars, it is clear that additional forms of financing are required in order to achieve the goals specified in the documents. When all of the projects already in the licensing process, the grid infrastructure investment requirements, the environmental issues and the technical concerns faced by investors are considered, it can be said that there are serious barriers that might challenge these goals.

Since 2005, more than 3.5 billion dollars of loans and credits have been provided for renewable energy investments by international financial institutions particularly through World Bank (IFC) via local banks.

In 2012 the public transmission grid operator TEİAŞ has also published projections pertaining to the power sector. An overview of power plant licenses can be seen in Figure 7 [5].

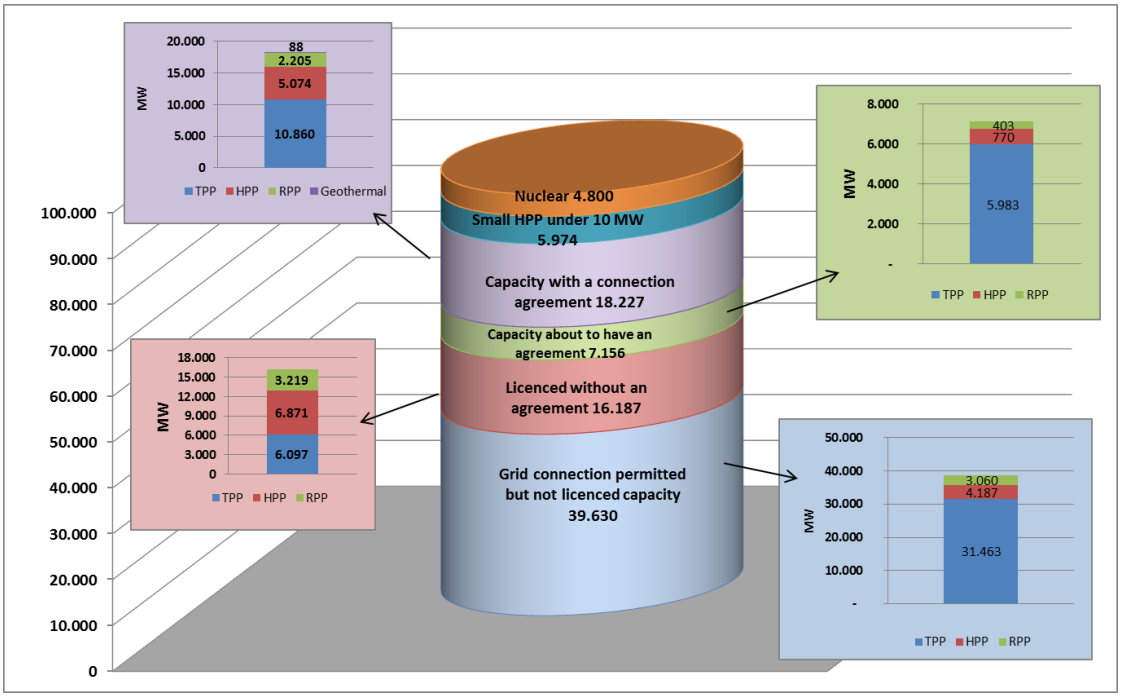


Figure 7: Licensing status of power plants in Turkey as of 2012.

TEİAŞ also provide forecasts for the energy mix in 2021. The graphic below demonstrates TEİAŞ projections.

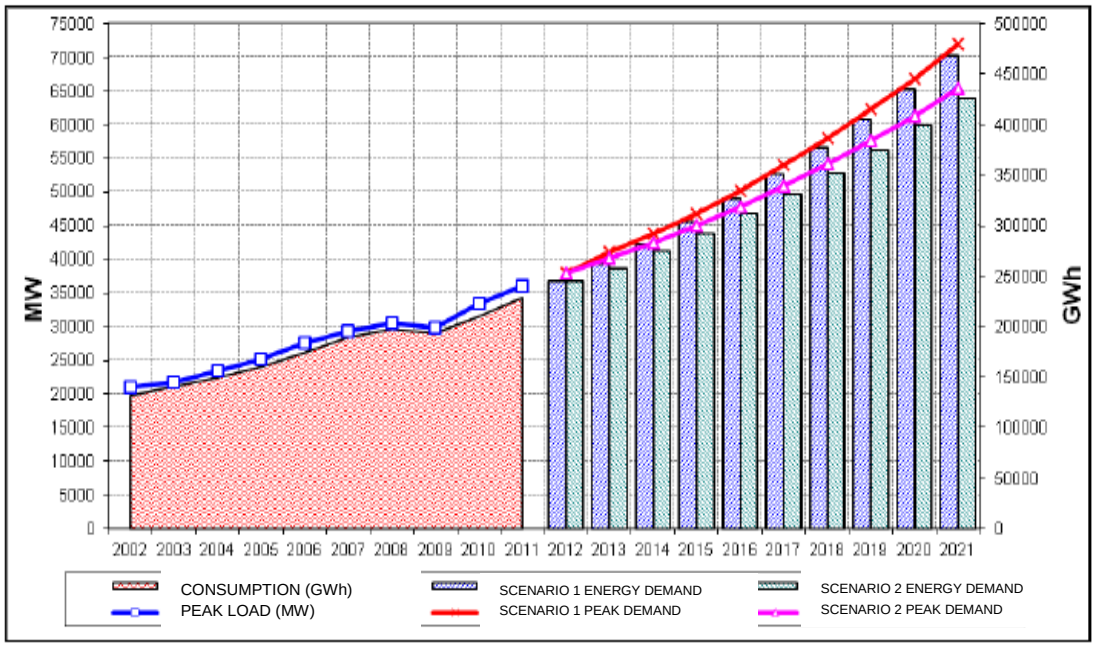


Figure 8: TEİAŞ projections of peak load and capacity projections by technology

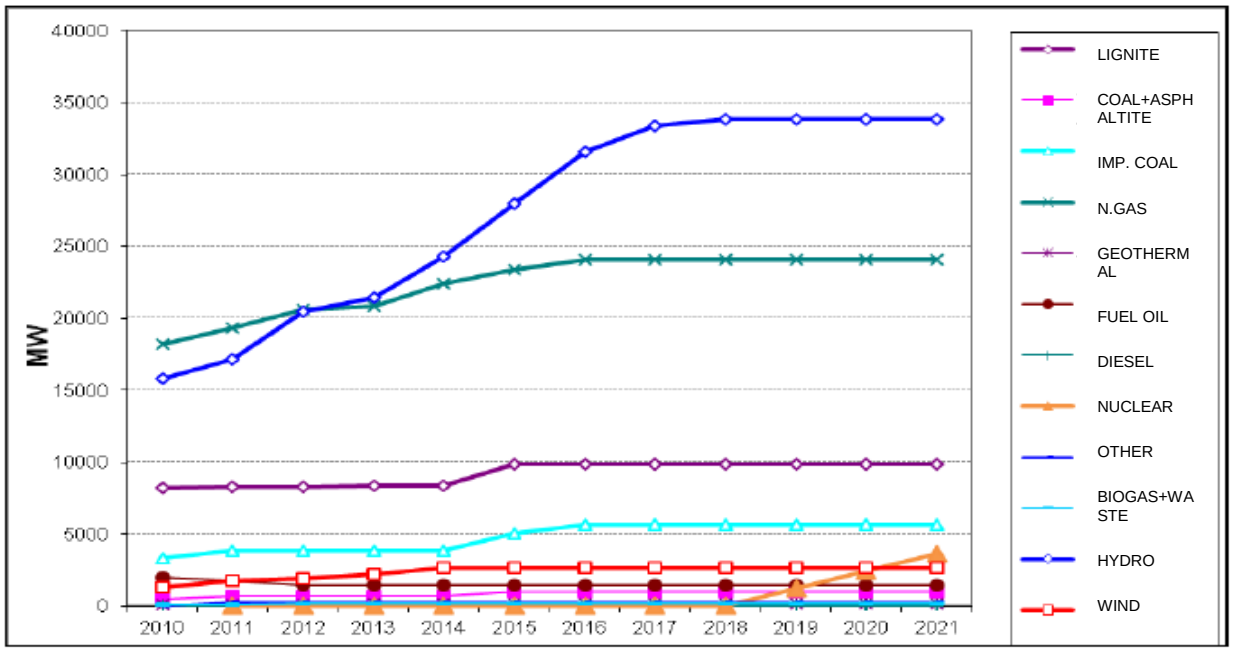


Figure 9: Official forecasts of the energy mix till 2021

This official forecast is notable for its contradictions with earlier produced strategy papers in several aspects:

1. Wind generation is nowhere near the 20 GW target
2. Solar is non-existent
3. Nuclear power plants come on-line as announced in 2018-19
4. Turkish power sector development is essentially based on huge growth of hydro capacity as well as increasing investments in coal. Climate change adaptation studies forecast severe water depletion problems in Anatolia not only in agriculture and rivers but fresh water resources for cities. Turkey has been pointed out to be the third worst effected country in the Mediterranean basin from outcomes of climate change. It is highly unlikely that hydro power predictions are taking into account long term influence of desertification and water depletion.
5. Even with the rate of license cancellations subtracted, total investments of all types result in power production in the range of 900.000 kWh's which is almost twice the TEİAŞ projection of demand for 2021. This is a well-known problem with official Turkish energy demand growth forecasts assuming consistently high economic growth rates which are almost always cyclical due to strong foreign capital input dependencies of the Turkish economy. This recurring high-growth appetite has been repeatedly criticized by Chamber of Engineers communiques and reports.

TEİAŞ has also indicated that according to its analyses, the extent of grid connection for renewable energy resources is limited. Despite the projections for increased installed capacity renewables penetration rates remain nearly flat as seen in the figure below. These limitations or better, 'perceptions' of limitations to grid connection by RES largely result from technically unfounded fears as documented by various reports analyzing the grid and other country experience [6].

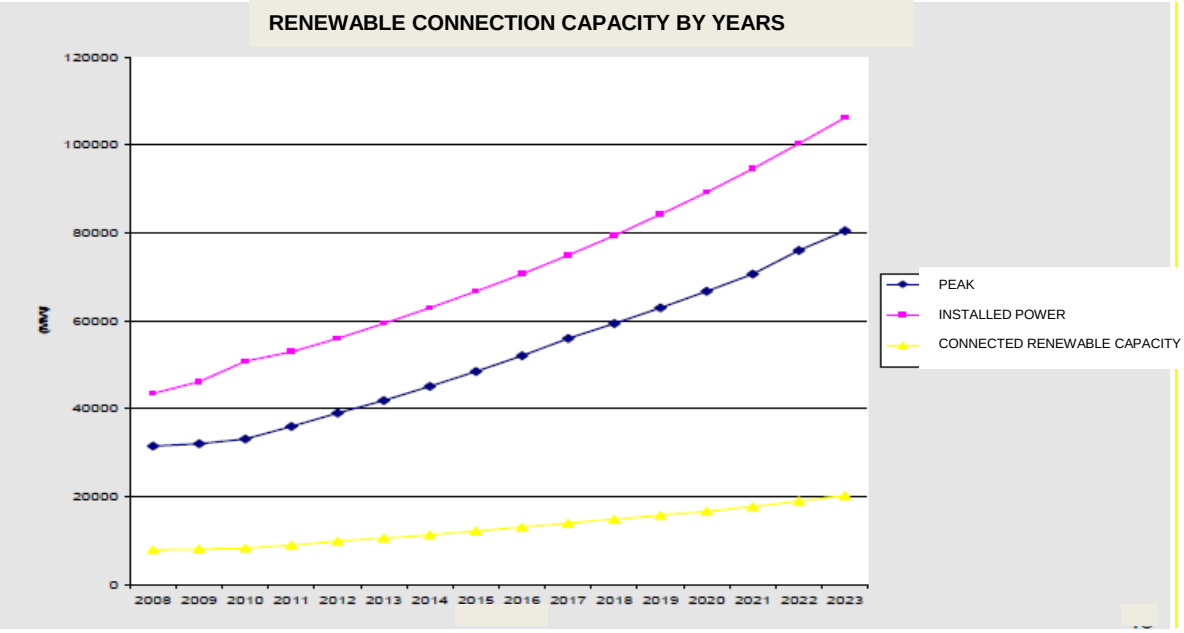


Figure 10: Renewable Connection Capacity by years

As pointed out before, the possibility of much higher RES penetration is contingent on increased intelligence in the grid. Smart grid applications have been mentioned in the various documents from the Ministry and significantly are one of the strategic actions listed in the Energy Efficiency Strategy White Paper 2012 – 2023, under Strategic Actions codes SA-04/SH-02/E-01 [7].

The concrete actions realized seem to be limited to a differentiated price structure and smart meters for households. These actions are to start 24 months after publication of the document, which is 2014. The EMRA has also stated that automated monitoring is needed for the maintenance of the quality of data exchange in the electricity market, presumably through IT applications. Rather than being a part of a general master plan for smart grid implementations, these would seem to be scattered projects.

Turkish power sector policy as a subset of overall energy strategy is marked by a distinct short-sightedness in that, it is continuing to take little account of the major transformations taking place in global electricity supply sectors. The large scale deployment of non-hydro renewables technologies, the smartening of the grid and the consequent re-shaping of the power market as witnessed by the recent developments in Europe and the USA regarding the future of the electricity sector, are indicators of the transformation of this crucial economic sector.

Much larger in impact compared to the previous deregulation drive that onset during the early 80's, the move towards the distributed grid, nonetheless painful for many incumbent actors (see for instance the solar FIT versus utility wars in the USA, the pains of EoN and RWE in Germany etc), with large scale utility storage being tested, cost cutting in all technological fronts and the integration of IT into power generation, demand side management and efficiency, promises to significantly transform the power supply landscape in the coming decades.

Turkish power sector policy can be analysed critically in three aspects

1. The premise of present forecasts

Similar to previous policy on natural gas shaped in the 80's involving long term supply agreements with Russia, Iran and Azarbeijan, and on the assumption of economic growth rates in excess of 7%, power supply in the decades to come, predict strong growth of the national economy. As in the natural gas strategy, where vast departures from economic forecasts ended up with huge penalties in payments towards unused gas, the power sector strategy is likely to burden the country with a very large stock of out-of-date fossil generation capacity on top of very socially and economically questionable nuclear capacity in the next couple of decades. As mentioned earlier, forecasts on huge increases of hydro power are also put to doubt given climate change induced water shortages in Turkey. There are reports that this phenomena is already happening in small hydro projects in the Black Sea coast. Instead of basing economic development on a more efficient power delivery, generation and end-use (official estimated range between an overall country potential for 40%), instead of planning to cut local peak loads via local renewables generation via solar and wind, thus easing the pressure on the interconnected grid, and instead of preparing the supply architecture for a several decades long transformation to a more agile, smart structure with much higher penetration of renewables penetration, Turkish power sector policy is indeed short-sighted.

2. Present trends vis-à-vis Turkish climate policy

This issue need not be discussed in detail as even Turkey's officially declared climate strategy rests on an energy sector forecast based on coal and natural gas. As the country with second fastest growing GHG emissions, emphasis on Turkey's official climate negotiations position has recently shifted distinctly from mitigation to adaptation. This position is very problematic not only in the face of the future climate regime (up until now Turkey has remained indifferent to calls of any and all mitigation actions) which will take shape in the next 3-5 years but also from an economical point of view vis-á-vis foreign account balances.

3. The desirability of policy with regard to economic, social and ecological outcomes

Apart from the long-term untenability of an 'energy imports' economy in which a large portion of Turkey's foreign deficit remains composed of primary energy imports, such historical 'breaking points' in a major embedded technological system, such as the power supply system, presents newcomers with various first mover advantages. The value added and employment gains of renewable generation and distributed supply have been demonstrated in various studies and need not be repeated here. The discussions that are currently going on regarding 'green modernization' are very relevant for Turkey that is fast destroying its man-made urban as well as natural heritage via 'dirty development'. The fast–track urban development based on urban sprawl (witness the plans for 'urban transformation' by the Ministry of Environment and Urban Development, to tear down a third of the urban building stock – 6 to 7 million buildings – under the pretext of unsafe habitats), automobility and high-consumption life styles is no doubt the fundamental reason for the

appetite for endless sources of energy as can be witnessed in a multitude of government documents. This development paradigm is neither socially nor ecologically desirable and even now face a multitude of social struggles and resistance let alone its production of glaring inequalities and social exclusion.

2.2 Turkish Power Grid - Present state and development

The Turkish distribution system has now been completely privatized with the recent sale of assets of Toros Elektrik responsible for the southern east of Turkey. The public distribution company TEDAŞ, has now been given the mandate to:

- Issue the temporary and permanent permits for non-licensed applications by solar, wind, hydro and other renewable generation systems. The upper limit for installed capacity regarding non-licensed applications has been raised to 1 MWs.
- Issue the permits for the new investments by the private distribution companies
- Issue the permits for the general lighting project investments by private distribution companies
- Issue temporary permits for licensed transmission assets of private companies
- Carry out permitting procedures for large scale generating assets for industrial zones (OSB'S)
- Carry out general audits of private distribution companies

The figure below shows the present state of the Turkish power transmission grid [5].

Figure 11: Turkish power transmission grid

The grid is composed of the following sub-stations:

- 81, 400 kV sub-station
- 2, 220 kV sub-station
- 551, 154 kV sub-station
- 14, 66 kW sub-station
- 648, sub-stations (108.378 MWA)
-

The length of transmission lines are shown in the table below

- 16.324 km 400 kV overhead
- 33.203 km 154 kV overhead
- 85 km 220 kV overhead (Georgia, Armenia)
- 508 km 66 kV overhead
- 220 km 154 and 380 kV cable line
- 50.340 km (total transmission line)

The Turkish grid control center is in Gölbaşı, Ankara at the National Load Distribution Center. Other major control centers are in Istanbul, İzmir, Adapazarı, Samsun, Keban, Erzurum, Adana, Antalya regional centers. The public transmission authority TEİAŞ carries out the following duties;

- Supporting frequency control operations
- Load/reactive power control
- Provide hot reserves
- Support stabilization of power outages

Present international connections are shown in figure below [5].

Figure 12: International grid connections, present situation

The planned international connections can be seen in Figure 13 as of 2013. ENTSO-E trials were started in September and first phase approvals have been given in February 2011. In the second phase of harmonization with the European grid, ENTSO-E has also approved non-commercial power trade. Third phase harmonization has included trials of commercial power trade starting in June 2011 and it was decided in September 2012 to extend this for another year. Trade is presently being limited to 400 MW from Greece and Bulgaria to Turkey and 300 MW from Turkey to Europe.

Figure 13: International grid connections planned for 2013

2.2.1 The future of the Turkish Grid

The most comprehensive analysis of the future of the Turkish power grid has been undertaken by TÜBİTAK, the Turkish Scientific and Technological Research Organization, similar to CNRS in France that carries out both fundamental science studies and technology projects and is responsible also with science and technology policy. In a study commissioned by TEİAŞ and completed in June 2013, Tübitak Energy Institute, Power Systems and Planning Research Group in Ankara, has carried out a detailed analysis of the long term development of the national grid from 2013 to 2022. The report aims to make a critical contribution to long term investment plans by TEİAŞ, and projects power production and demand scenarios into 10 year forecasts. Probably one of the most valuable aspects of the analysis is its analysis of regional supply and demand as well as seasonal variations of them. Demand projections were done on sub-station basis and seasonal variations were based on summer peak loads, winter peak loads and spring minimum loads in MW's. Demand forecasts were based on 7 year trends analysis as well as inputs from economic

and social growth predictions. Figure 14 below shows the Turkey wide demand scenarios of the report [7].

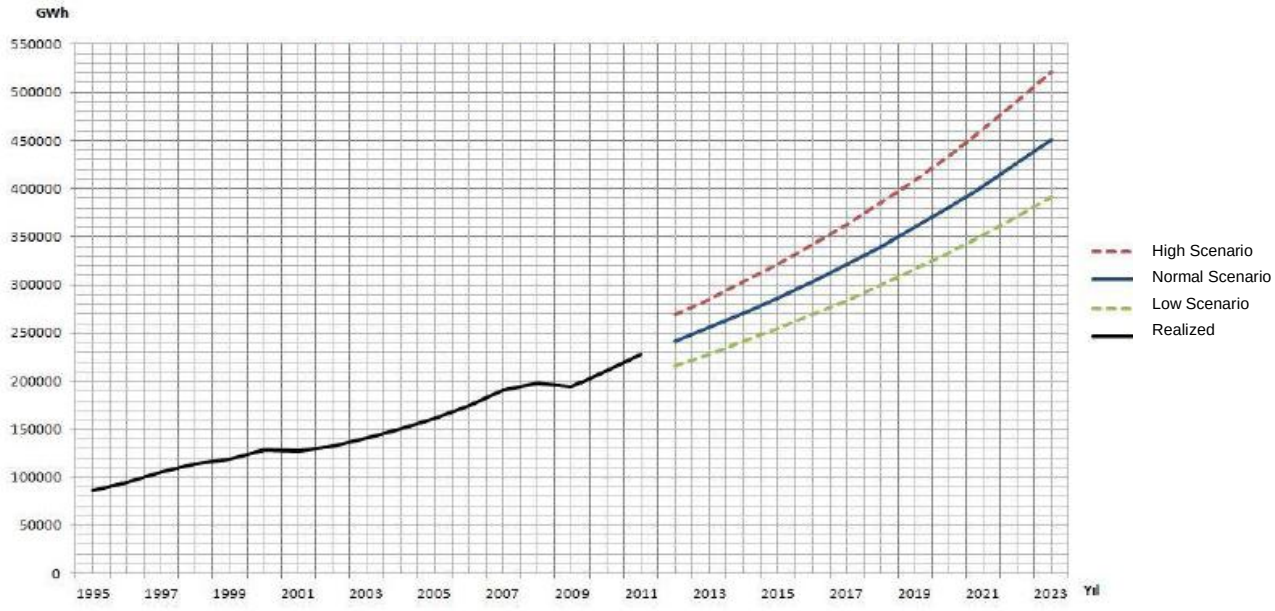


Figure 14: Turkey's Gross Electricity Consumption Scenarios

For the analysis of transmission capacity, EMRA Grid Directive dated 10.11.2010 and other secondary legislation governing grid quality have been used by the study. The first five years (2013-2017) have been taken as the 'short term' where 'firefighting' investments by TEİAŞ for the 154 kV regional grids are necessary). Demand growth for this period was taken as 7.5%. On the other hand, the 2018-2023 period is when good medium to long term predictions need to be at hand where demand growth was taken as 6.4%.

The study projects the capacity of fossil and nuclear power generation in 2022 as 80,000 MW's, as shown in Figure 15. Whereas total renewable generation is projected to be 48,000 MW's bringing total installed capacity in the country to 128 GW's. National demand side predictions can be seen in the Table 3 below.

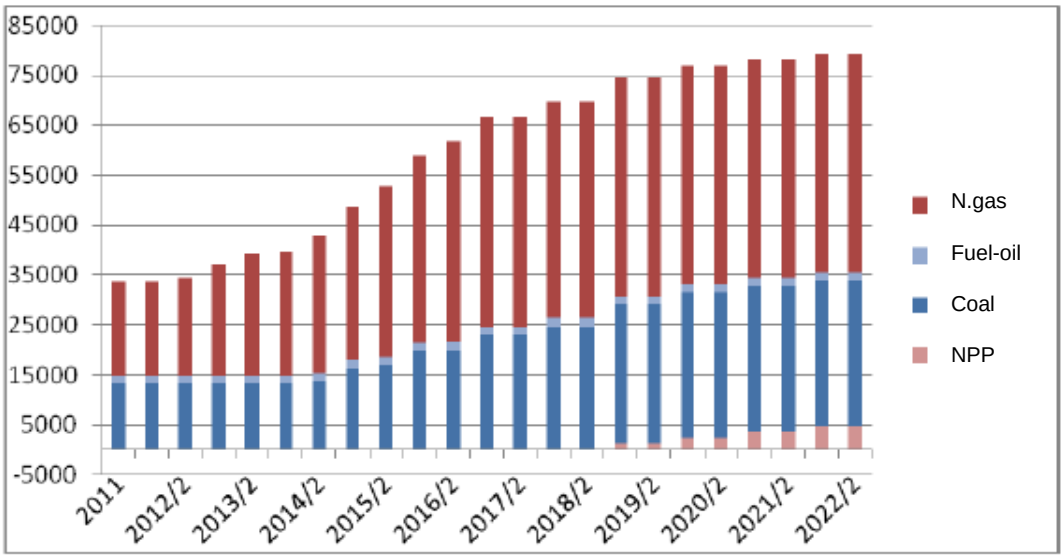


Figure 15: Fossil fuel and nuclear power generation by 2022

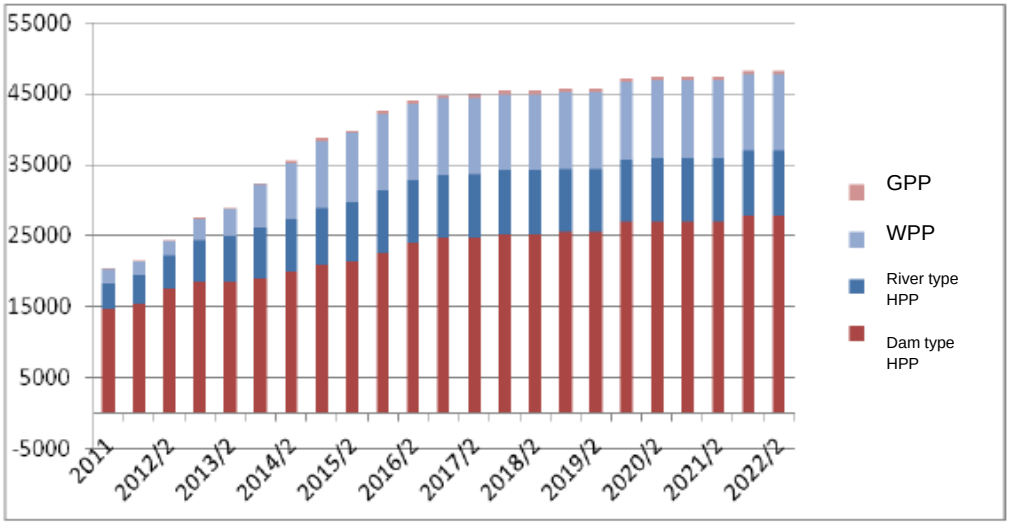


Figure 16: Renewable energy generation by 2022

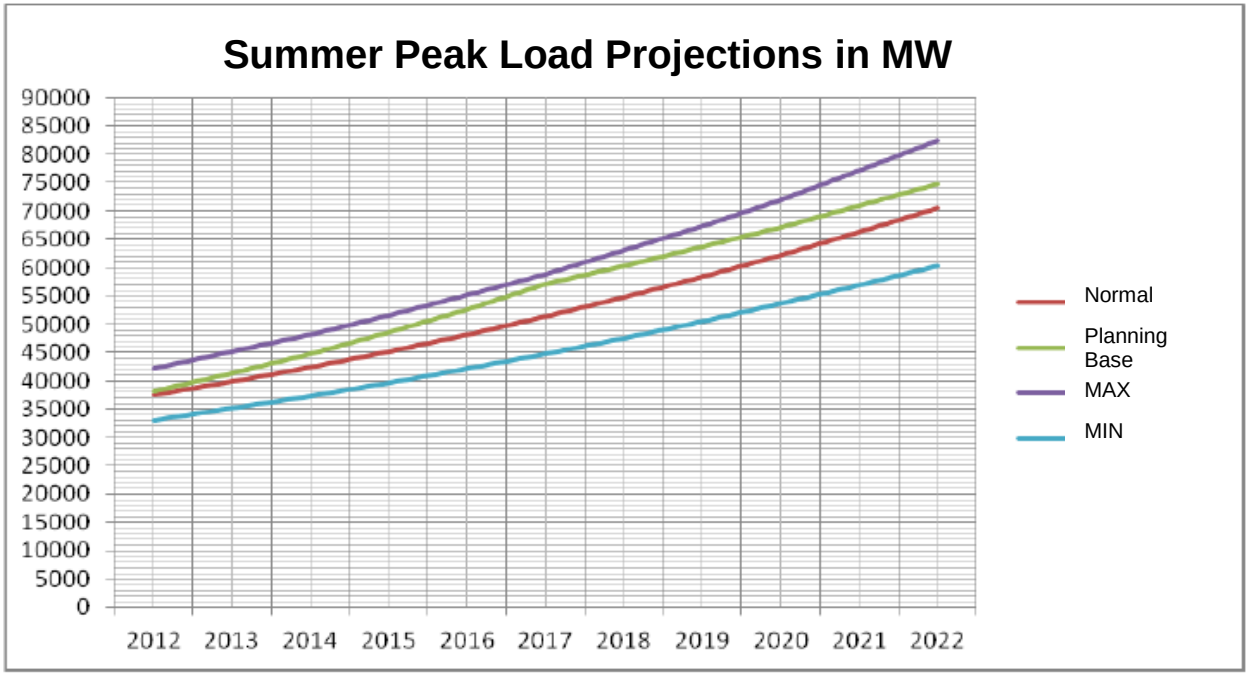
Table 3: Power demand forecast

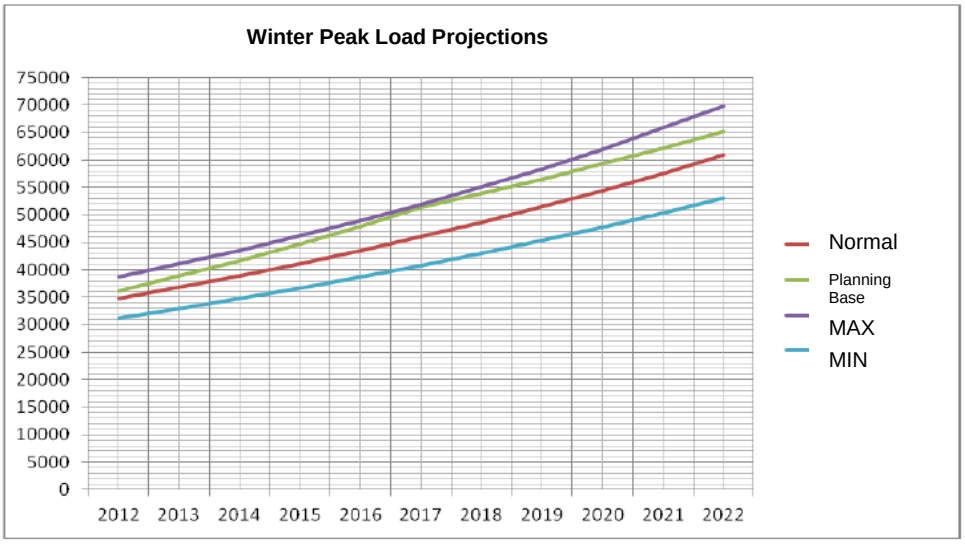
Year	Population	Electricity Consumption (GWh)	Electricity Consumption per capita (kWh)
2011	74.724.269	230.306	3.082
2017	79.337.000	352.490	4.443
2022	83.328.000	449.877	5.400

Table 4: Gross peak demand projections

Year	Summer peak time (gross MW)	Winter peak time (gross MW)	Spring minimum time (gross MW)
2012	38.159	36.812	-
2013	41.503	38.680	16.948
2014	45.263	41.407	19.405
2015	49.511	44.554	20.591
2016	53.734	47.698	21.709
2017	58.039	51.161	23.039
2022	74.429	64.918	28.556

Seasonal projections based on sub-station data of the last 3 years can be seen in the three graphs below for summer peak loads, winter peak loads and spring minimum loads.





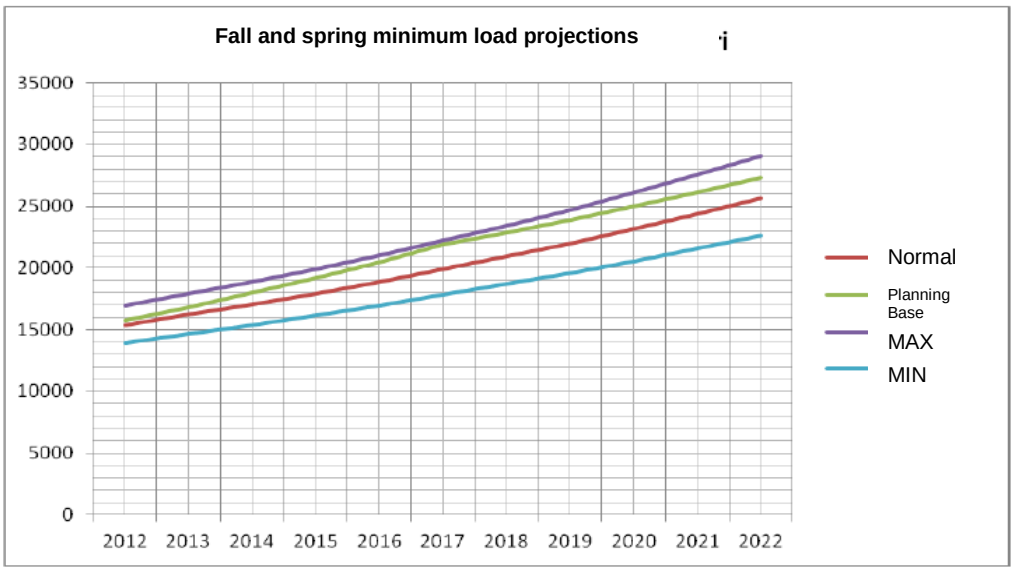


Figure 17: Summer peak load, winter peak load, fall & spring minimum load projections

The figures below show the reports projections for regional supply and demand for 2020.

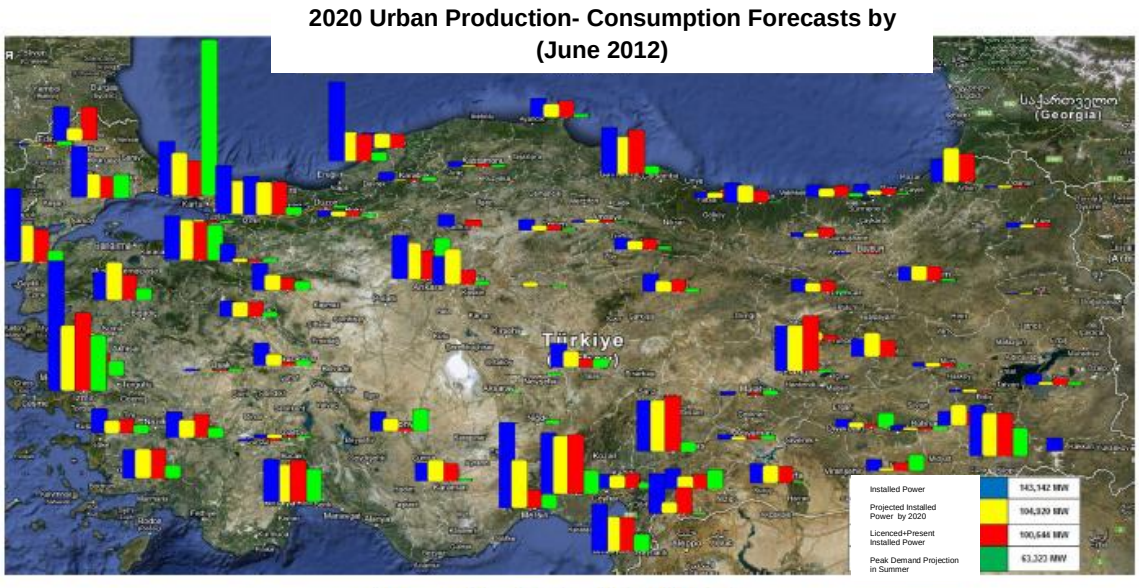


Figure 18: 2020 Urban Production-Consumption Forecasts (June 2012)

The report also gives detailed predictions for grid losses based on various supply scenarios. Furthermore, it forecasts the following generation mix for 2022 in Turkey:

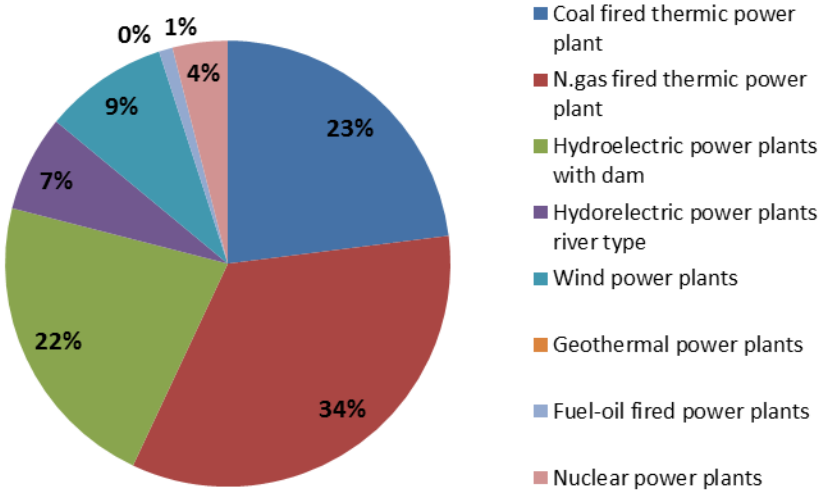


Figure 19: Installed power projection by 2022

Apart from global predictions, seasonal variations for generation are predicted.

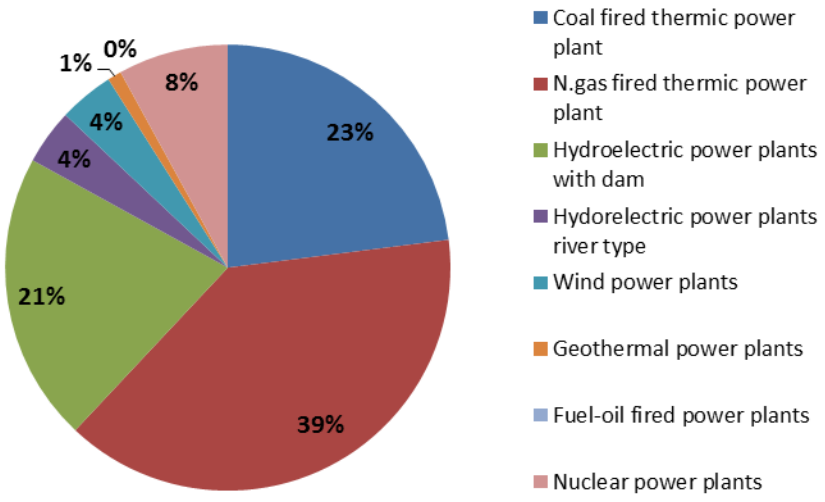


Figure 20: Winter peak loads, generation mix for 2022

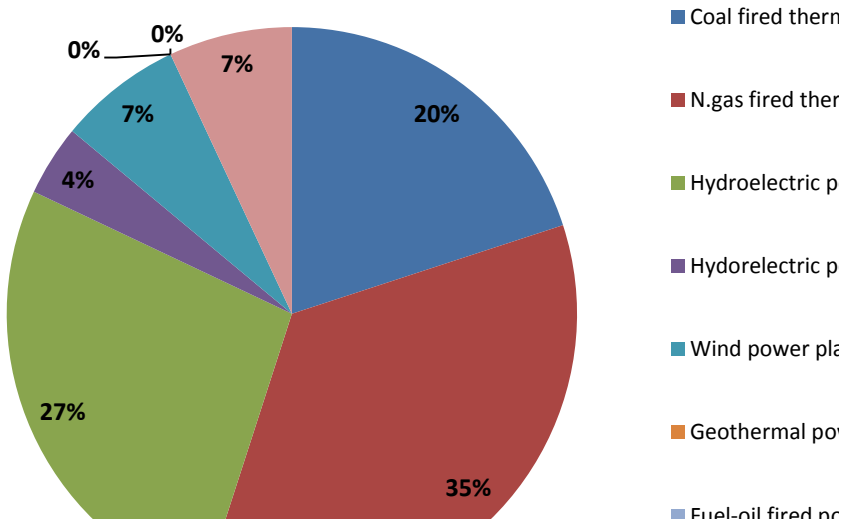


Figure 21:Summer peak loads, generation mix 2022

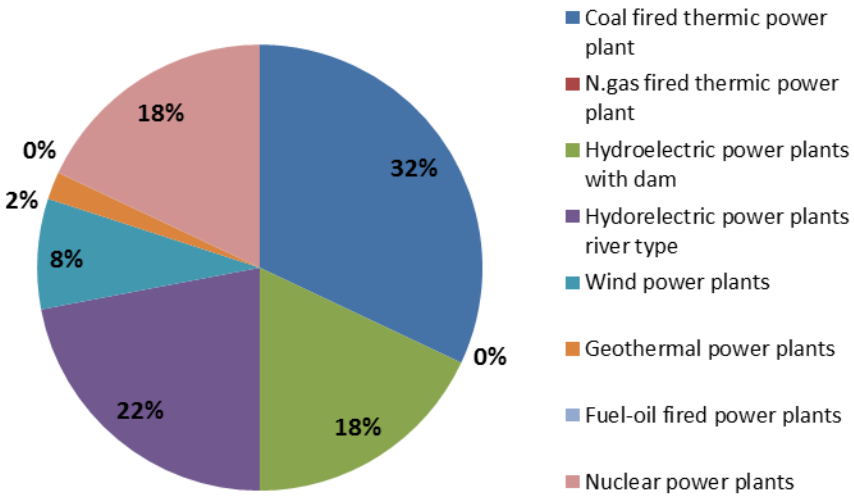


Figure 22: Spring minimum time loads, generation mix for 2022

The report details 18 different generation scenarios, the list of which is given below. The main assumptions for regional generation asset concentration are wind in the west, small hydro in the north, large hydro in the east, scattered nuclear, fossil fired assets around İstanbul and the north-west. Solar energy is prominent with its absence in all TEİAŞ scenarios. The scenarios are as follows [7]:

- Base scenario, three subs as low, base and high
- 4.8 GW Nuclear power online by 2022
- Low wind scenario
- High wind
- Low hydro
- High hydro
- International interconnect I, present 400 MW trade with ENTSO-E is increase to 1000 MW's
- International interconnect II, 600 MW import from Iran and 1000 MW export to ENTSO-E
- Coal I, Coal II and Coal III various capacity factors
- Natural gas I, Natural gas II, Natural gas III, Natural gas IV and V, various capacity factors
- 8 Country International interconnect 8 additional southern neighbors, 1000 MW exports and 700 MW imports of power

Important results can be gathered from the analysis of regional supply and demand forecasts. The map below charts the overloaded parts of the grid, the level and low load regions according to assumptions detailed in the report. The red points denote >80% overloads requiring supplements to grid infrastructure and sub-station deficiencies. The loading on the systems below 80% are

shown by shades of red depending on closeness to 80% loading. The example taken from the report is for summer peak loads.

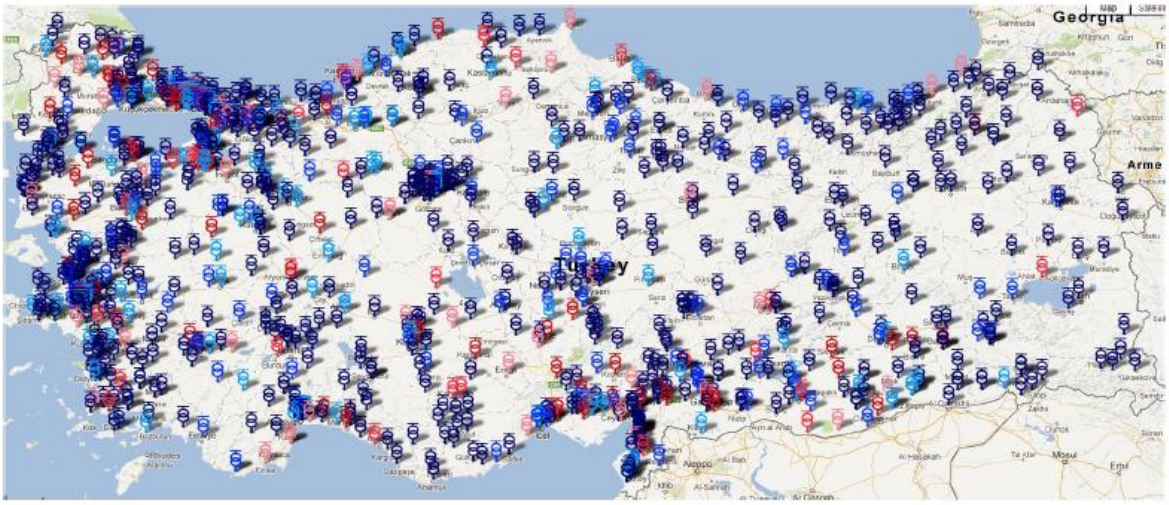


Figure 23: Summer peak loads, grid overload scenario, 2022

It can be seen in Figure 24 that around main population centers of İstanbul, İzmir, Antalya, Adana and Mersin, summertime peak loads will give rise to congestion and overload according to assumed supply and demand values. Most of this overloading is thought to result from summer air-conditioning needs in overcrowded urban areas. Neither TEİAŞ nor Ministry sources give any place to solar generation that may be very efficient in peak-shaving summer peak loads.

Another example is the 8 country interconnection scenario (scenario 18) where 8 countries to the south of Turkey and in North Africa are connected for power exchange of 1000 MW exports and 700 MW imports. The effect of this scenario on the 400 kV grid infrastructure is shown on Figure 24 [7].

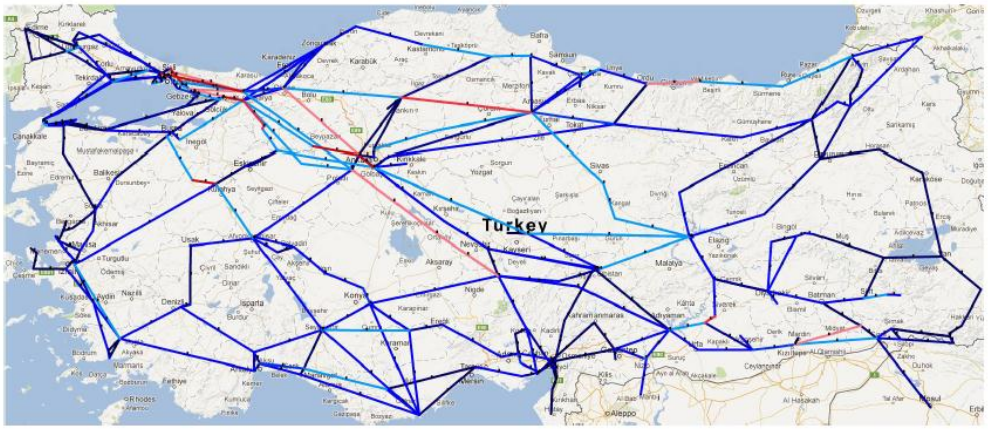


Figure 24: 400kV interconnected system - Scenario 18 where Turkish system is connected to Syria, Lebanon, Iraq, Palestine, Egypt, Tunisia and Libya

This scenario looks at 1000 MW exports through the Birecik sub-station to Syria and 700 MW imports through the Cizre sub-station from Iraq. The red and shades of red lines show the location of the need for parallel corridors.

The investment necessary to overcome grid overloads and congestions is not discussed in any detail in the report. TEİAŞ strategy documents forecast around half a billion €'s investment necessary until 2015.

2.3 Renewables in Turkey - Potential, Markets and Policy

With the onset of global climate change and its confirmation by international organizations such as the IPPC, countries have increased the policy drive as well as financial streams to the renewable energy sector globally. Turkey, very well endowed with solar, wind, geothermal and biofuel resources has been quite late in legislating for the market introduction of various renewables technologies. Official Turkish interest in RES for electricity has been limited to hydro projects for very long time and interest in renewable generation can be said to have started with EU accession processes and harmonization of legislative frameworks. With a very large dependence on foreign primary energy imports that are damaging to current account balances and also creating great volatility in energy prices, Turkey has slowly begun to move towards local renewable resources and achieve energy security in the long term. Higher deployment of renewable energy for electricity would be a very good policy for Turkey given its resources and the potential for savings in both foreign currency and GHG emissions.

The table below gives an overview of current estimations and possible capacities.

Table 5: Summary of approximate RES-E potential in Turkey

Resource name	Resource potential in GW	Present installed capacity in GW	Projections for 2023
Hydro	37 + 5 (small hydro)	21	full potential
Wind	87	2.3	20
Geothermal	2	0.1	0.6
PV	450-500	0.8-1.0	7-10 (no official target)
CSP	not estimated	-	1
Biofuels	1.5 - 5	0.8	-

More extensive information on RES-E potentials, targets, present state of play and their possible role in energy demand scenarios in the Turkish market can be found in [8], as well as in Appendix I ("Renewables in Turkey, Potential, Markets and Technology"), a supplement to this report.

2.4 Present and Expected Policy Framework for Renewables

As mentioned earlier in this report, Turkey has acted quite late to legislate for renewable energy. The initial impetus was given by the EU accession process requiring harmonization of legislation. Government after government has particularly stalled solar initiatives and initial introduction of the FIT for wind energy has not made investors happy for a long time. Subsequent turn of events in

the world after the financial crisis of 2009 has however rewarded this prudence despite unintentional. The inertia of the Turkish political system and the legislation making speed has prevented recourse to measures that have been seen in Spain, Czech Republic and later in Italy.

The milestone for renewable energy policy in Turkey is Law No 5346 titled Renewable Energy Resources for the Generation of Electric Energy (The Renewable Energy Law), dated 10 May 2005. Other laws such as Law No 5627 on Energy Efficiency and Law No 5788 on Amendments to the Electricity Market and of some other Laws that include stipulations for renewables

In the Renewable Energy Law, renewable energy resources are defined and incentives are introduced. The subsequent need to review some of these incentives due to changing market dynamics over time have led to many discussions about the revision to this Law. Renewable Energy Law was revised on 29 December 2010 by Law No 6094 on “Amendments for the Law on Renewable Energy Resources for Generation of Electrical Energy” in which the incentives were differentiated on the basis of resources and a new focus on the introduction of local content requirements.

The Renewable Energy Law defined renewable energy resources as “non-fossil energy resources such as hydraulic, wind, solar, geothermal, biomass, gas obtained from biomass (including landfill gas), wave, energy from currents and tides and has set up EMRA to issue “Renewable Energy Resource Certificates” (RER Certificates) to legal entities that hold generation licenses for facilities that generate energy using any of these resources. By establishing a RER Support Mechanism under the Law, the extent of the obligation to participate in the RER Support Mechanism is defined for supply companies as the proportion of the total electricity energy that they supply, while opportunities to participate in the RER Support Mechanism are provided based on the generation amounts recorded on the RER Generation Certificates. Under the RER Support Mechanism, different levels for the feed in tariff (FIT) are defined for differing renewable energy technologies, and the local equipment bonuses are determined that can be added to the feed in tariff for each relevant equipment regarding specific types of renewable energy technologies.

The following provisions are listed by the Law for participation in the mechanism:

- Any renewable energy plant that wishes to benefit from the mechanism must first apply to the EMRA in order to receive a RER Certificate. On this RER Certificate, there are parameters specific to the plant, such as the type of renewable resource used for electricity generation, its commissioning date and its annual electricity energy generation capacity.
- Participation in the mechanism is on an annual basis. Plants that wish to participate in the mechanism in the following year must re-apply to EMRA before October 31 for a RER Generation Certificate.
- Each year, the plants that will be included in the mechanism for the following year are announced by EMRA on November 30.

Incentives and support framework regarding renewable energy resources are elaborated in Chapter 3 of[9]. A complete and detailed listing of renewable energy supports including local content incentives are also summarized in Appendix II of this report. This supplement contains the following;

- Incentives for electricity production from RES
- Incentives for RES with Law 5346 (FiT legislation)
- Additional incentives for local content
- Other incentives (tax rebates, transaction cost exemptions)
- Incentives accordign to Law 4628 (licence exemptions, non-licensed uses, special terms)
- Supports according to Law 5627 (EE Law stipulating RES use)
- Incentives regarding greenhouse heating and hot water production (Law 5346)
- Incentives for Biofuels (EMRA Communiques regarding gasoline additions)
- Other government subsidies (Treasury Investment Incentives)

Expected Policy Developments

As emphasized earlier in the report, the Turkish government has been late in legislating for support regarding renewables resources and technology. Although government thinking has evolved vis-à-vis global developments and market transformation, it is quite unlikely that direct financial incentives to renewable energy will increase in the medium to long term. Turkish energy policy, as much as can be gathered from present trends and thinking, at least in the foreseeable future will be based on imported fossil based power production, especially natural gas and an element of nuclear energy in the mix. It cannot be expected that energy policy will change significantly in favor of much higher RES penetration.

As pointed out in the section evaluating government energy policy in the long term:

> *Turkish power sector policy as a subset of overall energy strategy is marked by a distinct short-sightedness in that, it is continuing to take little account of the major transformations taking place in global electricity supply sectors. The large-scale deployment of non-hydro renewables technologies, the smartening of the grid and the consequent re-shaping of the power market as witnessed by the recent developments in Europe and the USA regarding the future of the electricity sector, are indicators of the changing dynamics of this crucial economic sector.*

Official policy is largely stuck in the 'deregulation' period and the new market realities involving privatized distributions companies cannot be said to create favorable conditions for the larger penetration of renewable energy. Although policy changes regarding increased financial incentives to RES-E are unlikely, there is one topic of significant importance that has the potential to become an eye-opener for the government and that is the rapid expansion of the non-licensed installations market. Solar PV, small/medium scale wind, biogas and biofuel reactors all serving self-consumption, promise to be 'the' market segment that carries the potential for significant growth. This huge market potential just being tapped as legislation matures, still experiences many hurdles, legislative (too many procedural steps and authorities, thus long process times), financial (unready private lending institutions and practice previously analyzed), quality (uncertified bad quality products and services) and outright resistance from distribution companies (some have even entered the market). Nevertheless, volatile power prices and RES-E technologies cost reductions are in the medium term bound to catch up with small and large power consumers. There are precedents in Turkish service and consumer markets to legislation following popular trends such as in telecoms, mobile telephony and mass media. It may be expected that especially in the household solar markets, legislation will follow reality.

2.5 Renewable Energy Investment Flows

Capital markets and private capital play differing roles in different countries, regarding financing renewable energy investments. Foreign direct investment and energy service companies may all take part in renewable energy investments.

Stock and bond markets

Investor interest in renewable energy investments have allowed energy firms to either offer the main company or some subsidiary to the public via stock markets thus raising money for investment. This is the way Iberdrola of Spain has raised 6 billion USD in such fashion in 2005. Stock and bond transactions by renewable energy firms had reached 24 billion USD by 2007. This type of funding regarding Turkish renewable energy firms is not widespread in Turkey presently. The year 2010 has seen the 200 million TL IPO of Aksa Energy in the Istanbul Stock Exchange and it is expected that some of the raised funds will be used for the renewables investments. Regarding the export of bonds, the only notable example is Akfen's 100 million TL bond export.

Private financial institutions

Sustainable financial markets in renewable energy and energy efficiency can only be created by the creation by formation of stable private lending and credits climate. This also signals to financial markets the 'normalization' of the above mentioned investment fields. In the global energy sector, most renewable generation technologies are at the beginning of the process of normalization with regard to attracting finance. The financial crisis that started in the third quarter of 2008, has deeply affected renewable energy funds negatively. It should also be said that there are wide differences in attractiveness of different technologies, depending on geography.

Turkish private financial institutions are also regarded as critical players in the investment flows towards renewable energy. Especially after the deregulation of the energy sector, private investment has increased greatly in the energy sector, but flowed predominantly to natural gas conversion, hydro and coal power generation plants. The push towards renewable generation has accelerated by the financial intermediary credits by large international development funds and loan organızations such as the World Bank, EBRD, EIB, AFD and KfW. Single or multi-partite international finance organizations have played important roles in harmonization and climate friendly investment activities in developing countries for a long time. Table 6 summarizes the intermediary loans utilized by local private and public banks in Turkey to finance renewable energy and energy efficiency projects.

Table 6: Loans utilized by private & public banks in Turkey for RES and Energy Efficiency

Bank	Investment (mioUSD)	Date	#Projects	MW's	IFI*	Project type**
TSKB	1,500	2009-10	115	2.950	EBRD, EIB, AFD, KfW	87 H, 6 W, 2 G, 3 B, 17 EE
Akbank Denizbank Garantibank Vakıfbank	260	2010-12			EBRD (TURSEFF)	EE
Garanti	3,000	To 2012		3.357	EIB, EBRD	
YKB	1,300			2,500	EIB	H, C
İşBank	1,500	2008-10	70	2.123	WB, Islamic Development	69 H, 1 G
Halkbank	230	To 2010		785	AFD	H
Akbank	2,100	To 2009	31	2.500	EBRD, IFC, EIB	610 MW H
TKB	1,300	To 2012	95	1.398	WB, EIB, Islamic Development	76 H, 5 W, 3 G, 4 Wa, 7 EE
Vakıfbank	324		15			65% renewable projects
Denizbank	400					EE

*International Financial Institutions

*H: hydro, W: wind, G: geothermal, B: biofuel, Wa: waste, C: coal

It should be pointed out that not all intermediary finance from IFI goes towards renewable energy projects. Clean energy finance has not been attractive for large private banks in Turkey for the following reasons:

- Renewable energy is seen as a small market for the banks not worth putting resources to work
- Maturity of renewable funds are short and transaction costs are high, making them unattractive
- The right financing products are non-existent
- The banks do not have the necessary technical capacity for these types of loans
- Risk perceptions of the banks for renewables investments are high resulting in high interest rates for the renewable loans
- Small projects increase transaction costs

The reasons why Turkish banks rely almost completely on IFI credit lines is quite clear. The question is of course how a sustainable finance flow can be created for the increasing Turkish power sector investments.

Venture funds

Venture funds have traditionally supported clean-tech investments at beginning stages and use risk capital as well as private equity for high returns. This financing model has worked well particularly in the USA where venture capital has financed clean-tech start-ups to the tune of over 15 billion USD in 2008-2012. This market is virtually non-existent in Turkey. Out of the many so called ‘risk capital ventures’ very few have actually realized any investment in the renewable energy sector.

Export Credit Funds

Notable export credit sources in Turkey are the US OPIC and some Islamic bank funds. OPIC has announced 250 million USD credit line for private Turkish banks - particularly Akbank in the field of renewable energy investments - but the only notable and sizable project has been the Germencik geothermal plant supported by OPIC for around 5 million USD. Small credits have been given to biogas installations in the agrifood sector, also by the Dutch export programs.

Mergers and Acquisitions

Mergers and acquisitions have been a strong financial input into growing renewable energy investments globally. This activity is very time- and locality-specific, but considering the amount of foreign direct investment into Turkey in the last ten years could be an important source of capital in the sector. There has been some activity in the energy sector, all of which cannot be attributed to renewable energy. Table 7 summarizes the recent activity in the field.

Table 7: Recent mergers and acquisitions in Turkey

Acquirer	Country	Acquired	Amount, mUSD
Verbund	Austria	EnerjiSA	326,6
CEZ	Czech Republic	Ak Enerji	302,6
Italgen	Italy	BARES	50,2
Cogentrix	USA	Taşyapı Enerji	Not known
Statcraft	Norway	Yeşil Enerji	118,9
EnBW	Germany	Borusan	Not known
Manitoba	Canada	Palmet	Not known

Energy Service Companies

Energy service companies or ESCO's are important tools for financing EE and distributed renewables projects and have become important in the USA and Europe. Although legislative moves have encouraged such developments in Turkey also, particularly through EE legislation, ESCO's have not been successful in Turkey. There are many reasons to this failure but it should be pointed out that ESCO markets mature in long periods as has been demonstrated by international experience. High economic risk perceptions in developing country markets make this financial tool difficult to mature.

Carbon finance

Turkey is in the volunteer carbon market and especially at the beginning of wind energy installations this source of finance has been used. The most recent summary can be seen in Table 8. Turkey is in the volunteer carbon market and especially at the beginning of wind energy installations; this source of finance has been used. Over the last few years the number of applications has risen quickly. The most popular international standard is the Gold Standard (GS). This is followed by the Voluntary Carbon Standard (VCS), whereas Voluntary Emission Reductions (VER+) applications are rare according to the Blue Registry. There are currently 125 Hydro, 64 Wind, 19 Biogas, 6 Geothermal and 5 Waste heat Recovery projects that are already certified or going to be certified in Turkey under the voluntary Carbon market. A summary overview of the current status on those projects is given in following table.

Table 8: Current Status of Voluntary Carbon Trade Investments in Turkey

Type of Facility	Projects (#)	Capacity (MW)	Projected GHG Reduction (t CO2e/year)
Hydro	125	2,486	7,297,513
Wind	64	2,680	5,603,468
Biogas	19	100	2,987,882
Geothermal	6	108	405,309
Waste heat	5	43	151,432
Total	**219**	**5,417**	**16,445,604**

International Standard	Projects (#)	Capacity (MW)	Projected GHG Reduction (t CO2e/year)
GS	174	3,748	11,281,241
VCS	43	1,579	4,976,863
VER+	1	60	115,790
GS, VER+	1	30	71,710
Total	**219**	**5,417**	**16,445,604**

Status of Application	Projects (#)	Capacity (MW)	Projected GHG Reduction (t CO2e/year)
Issued	25	1,029	2,693,525
Registered	25	762	1,925,211
Validated	39	657	2,991,954
Listed	87	1,390	3,858,051
Unknown (VCS)	43	1,579	4,976,863
Total	**219**	**5,417**	**16,445,604**

Source: GS Registry, VCS Registry, VER+ Blue Registry

As is well known, Turkey joined the Kyoto Protocol of the UNFCC just before the termination of the first period and has not taken on any commitments for GHG reductions. Turkey has participated in the volunteer market with the capacity shown in the Table above and despite the relatively limited nature of this market, was able to register a significant number of projects with considerable potential for reductions. Although still relatively small, this participation has resulted in:

a) a learning process on the part of investors and project developers

b) a certain building of capacity for easier integration to post-Kyoto climate regimes.

Turkey is still in the process of developing MRV mechanisms but there is a distinct possibility of developing NAMA's in the EE and RES areas as the post-Kyoto climate regime is shaped in the next 5 years.

2.6 Social Perspectives

As explained in previous sections, a combination of technical, financial and global economic developments as well as the prospects of more rigid climate regimes in the medium term, will act together to render present Turkish energy policy untenable. Turkish society, under rapid transformation to urban consumer cultures, but at the same time experiencing the non-egalitarian, ecologically and socially unsustainable urban developments of the last 30 years, is also learning in

the process of modernizing and forming citizen identities. Although environmental struggle has a long history in Turkey, recent events have demonstrated the shaping of 'the citizen right to the city' and concomitant 'ecological rights' constituencies. These political and cultural changes have already, and will continue to have, in the medium to long term, serious repercussions, and influence the present top down decision making cultures embedded in Turkish state structures. The ecological struggles directed at current energy policy in the form of anti- hydro and fossil power plant resistances and the much wider opposition to nuclear power plants all have the potential to transform public opinion. One should not forget the birth of strong renewables movements in the crucible of 'gegen Atomkraft' in Germany but also Europe in general.

The one single argument by politicians and officials in Turkey to condemn resistance against power plant installations is that "development thus economic growth cannot be compromised". Tenets of this thesis collapse under global developments that are proving that not only is it possible to fuel growth via clean energy but that it is actually doubly desirable due to its employment and downstream/upstream economic impacts. As Turkey installs more and more distributed power, providing local power needs and creating local jobs, as banks learn the economics of PV installations, lower risk perceptions and transaction costs, as local production lowers manufacturing and installation costs, the overall perception of society pertaining to distributed power generation will advance. Local governments should have critical roles to play in this transformation both as legitimizers and self-fulfillers of the new transformation. This movement has already started via energy planning roadmaps by local governments. Nevertheless, legislative devolution is required for greater local government control over urban energy flows.

It is probably possible to say that society is ahead of its decision makers and they will in turn catch up. Without doubt, fortunes for the midterm expansion of renewable energy technologies in Turkey will be a complex mixture of economics, policy and learning by doing. Policy advice to the government as well as capacity raise in the energy bureaucracy can be expected to have a large impact on this vector of forces.

2.7 Conclusions

As can be understood from the data given, government policy today and forecasts, renewable energy resources are not expected to make a very large contributions to the Turkish energy mix in the mid to long term. Government energy policy and strategy seems to have been build-on increasing dependence on foreign imports of fossil resources, problematic also from a point of view of balance of trade accounts. Official climate strategy also does not give any hope of a serious de-carbonization of power generation. Turkish urbanization, given its high migration rates, characteristic urban sprawl and automobile based transportation modalities, is one of the most significant drivers of this high carbon future.

Despite the extraordinary resource endowments regarding solar, wind, geothermal and biofuel technologies, as detailed in the report, the country does not have a comprehensive vision and strategy to harness them. Incomplete and outright bad planning and implementation of specific renewables projects have also had unacceptable social consequences.

Foremost among these are the small hydro projects carried out without significant planning and basin wide analysis. These have created a very polarized environment in certain regions giving rise sometimes to violent clashes. The top down planning and decision making culture embedded in the energy bureaucracy has even caused wind projects to be stalled due to resistance from local populations. The NIMBY effect can also said to be an important factor here.

One important exception may come in the non-licensed solar applications as the economics of self-consumption dictates PV installations. As electricity prices rise and solar PV system costs decline, this type of distributed generation is even now attracting much interest. Though financial institutions are only just beginning to understand project economics in solar energy, if not a gold-rush, serious expansion of the market is expected in this sector. As large international third party project developers enter the market, such as Sun Edison from the USA, soft know-how regarding project development and financing is expected to penetrate.

Turkish industry interest in manufacturing is also growing. Presently more than 15 enterprises are either producing or about to commence production in PV modules. One Chinese manufacturer that has already started producing modules has announced plans to manufacture cells also. Glass and mounting structures are already produced locally. It can be said that, a migration to higher value added in downstream manufacturing is inevitable given the potential size of the market. This will also allow local technological capacities to increasingly drive manufacturing costs down. Legally, with the latest tertiary legislation in force as of September, there is no ceiling for capacity on installations for self-consumption. If not in the immediate future, it is thought that non-licensed distributed generation may demonstrate significant market penetration.

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