EU AND TURKEY'S ENERGY STRATEGIES

Seyfi Noyan OĞULATA
ÇUKUROVA ÜNİVERSİTESİ
Assistant Professor
noyan@cu.edu.tr

Çetin Önder İNCEKARA
BOTAŞ
Manager, Ph D candidate

─Abstract ─

Since the first oil shock, the energy sector has experienced a wide range of influences that have greatly influenced energy analysis and modelling activities. Energy models were however not developed for the same purpose; some were concerned with better energy supply system design given a level of demand forecast, better understanding of the present and future demand–supply interactions, energy and environment interactions, energy-economy interactions and energy system planning.

Well-known modelling tools are LEAP(Long-range Energy Alternative Planning Model)- a popular model, MEDEE (Model for Evaluating Demand for Energy) family of programmes and MAED (Model for Analysis of Energy Demand).

By using the above mentioned modelling tools, countries set their energy policies, scenarios and their strategies. Coal was displaced by natural gas in the UK to a large extent and in Spain and Netherlands to a lesser extent. In Italy, fuel–oil based generation which was the dominant form of power in the mid-1990s was replaced by natural gas. In the British case, the electricity generation mix for 2010 was as follows: 38% came from natural gas, 36% from coal, 22.5% from nuclear and the rest from renewable sources including hydropower. Natural gas consolidated its position as the leader in the Netherlands during this period. In

2011, dependence on fossil fuels in electricity generation remained very high in the Netherlands (88%), Italy (79%) and the UK (above 70%).

In 2011, U.S. energy supply is 83% fossil fuels; demand is broadly distributed among the major sectors. And in 2010, U.S. electricity generation was 70% fossil fuels, 20% nuclear, and 10% renewable.

By the end of 2012, Turkey's gross electricity production has reached 239.100 GWh, i.e. 103.291,20 GWh (43,2%) natural gas, 956,4 GWh (0,4%) of geothermal, 57.862,20 GWh (24,2%) hydro-electric, 5.738,40 GWh (2,4%) wind sources and 65.035,20 GWh (27,2%) coal. End of 2012, Turkey's installed power reached 57.072 MW. Turkey's electricity generation is expected by 2020 to reach 499 TWh with an annual increase of around 8% according to the higher demand scenario, or 406 TWh with an annual increase of 6,1% according to the lower demand scenario.

By 2020 EU-27's electricity generation details is as follows: Wind will reach 477 TWh, Hydro will reach 384 TWh, Photovoltaic will reach 180 TWh, Biomass will reach 250 TWh, Geothermal will reach 31 TWh, Solar thermal electricty will reach 43 TWh, Ocean will reach 5 TWh, i.e. by 2020 a share of over 40% of renewables in electricity production is expected.

By making correct scenarios with using the correct modelling tools, Turkey will reach 2023 energy target easily by correct annual energy investment rate, i.e. "By 2023, Turkey's main target is to increase the total installed energy power to 100.000 MW and the share of renewable resources is to increase at least 30 percent of total production, i.e. 20,000 MW installed capacity for wind, 1.000 MW installed capacity for geothermal and an additional installed capacity of 5,000 MW for small hydro and to have at least 3 operating nuclear power plants."

Key Words: *Energy, Models, Strategies, Scenario, Economic, Policy, Electricity, Natural gas, Coal, Nuclear, Geothermal, Wind, Renewable, Fossil Fuels*
JEL Classification: C60, Q21, Q31, Q41, Q42, Q43, Q50

1. INTRODUCTION

On the first oil shock, the energy sector has experienced a wide range of influences that have greatly influenced energy analysis and modeling activities. Energy models were however not developed for the same purpose; some were concerned with better energy supply system design given a level of demand forecast, better understanding of the present and future demand–supply interactions, energy and environment interactions, energy-economy interactions and energy system planning.

1.1. Analysis of Energy Balance Information

Energy balances provide a great deal of information about the energy situation of a country. They are also a source of consistent information that could be used to analyze the supply and demand situations of a country and with appropriate care, can be used for international comparisons. A number of software packages such as GAMS, WASP-IV of the International Atomic Energy Agency (IAEA) or EGEAS developed by the US Electric Power Research Institute have been widely used around the world. Well-known tools of this category include LEAP(Long-range Energy Alternative Planning Model)- a popular model, MEDEE (Model for Evaluating Demand for Energy) family of programmes and MAED (Model for Analysis of Energy Demand). The Long-range Energy Alternatives Planning (LEAP) is a flexible modeling environment that allows building specific applications suited to particular problems at various geographical levels (cities, state, country, region or global).

2. EU's ENERGY SCENARIO

2.1. World's Energy Scenario

The energy system today is highly dependent on fossil fuels, with coal, oil and gas accounting for about 80% of world primary energy demand. A number of physical and economic activities are involved to capture the energy.

Table-1: Change in the Demand on World Primary Energy Resource (WEO, 2011)

(mtoe)	1980	2000	2007	2015	2030	2007-2030
Coal	1.792	2.292	3.184	3.828	4.887	1,9%
Petreum	3.107	3.655	4.093	4.234	5.009	0,9%
Natural Gas	1.234	2.085	2.512	2.801	3.561	1,5%
Nuclear	186	676	709	810	956	1,3%
Hydro	148	225	265	317	402	1,8%
Biomass and Waste	749	1.031	1.176	1.338	1.604	1,4%
Other Renewables	12	55	74	160	370	7,3%
Total	7.228	10.019	12.013	13.488	16.789	1,5%

2.2. EU's Energy Scenario

By using the above mentioned modeling tools, countries set their energy policies, scenarios and their strategies. By 2020 EU-27's electricity generation details is as follows: Wind will reach 477 TWh, Hydro will reach 384 TWh, Photovoltaic will reach 180 TWh, Biomass will reach 250 TWh, Geothermal will reach 31 TWh, Solar thermal electricty will reach 43 TWh, Ocean will reach 5 TWh, i.e. by 2020 a share of over 40% of renewables in electricity production is expected. Nuclear energy is a decarburization option providing today most of the low-carbon electricity consumed in the EU. Some Member States of EU consider the risks related to nuclear energy as unacceptable. Since the accident in Fukushima, public policy on nuclear energy has changed in some EU Member States. By 2050 wind power provides more electricity than any other technology in the High Renewable

scenario. In the medium term, the contribution of ocean energy can provide an important contribution to electricity supply.

Coal was displaced by natural gas in the UK to a large extent and in Spain and Netherlands to a lesser extent. In Italy, fuel–oil based generation which was the dominant form of power in the mid-1990s was replaced by natural gas. Natural gas consolidated its position as the leader in the Netherlands during this period. Dependence on fossil fuels in electricity generation remained very high in the Netherlands (88%), Italy (79%) and the UK (above 70%). Spain was moderately dependent on fossil fuels in the mid-1990s but its exposure has increased to around 60%.

3. TURKEY'S ENERGY STATUS AND ITS' FUTURE

Due to its geopolitical position, Turkey is near countries that own three fourth of world's proven petroleum and natural gas reserves, and takes part numerous important projects acting as an "Energy Corridor".

3.1. Turkey's Energy Status and Potential

As of 2010, total electricity supply is from natural gas which is the number one approx. 50%, the second one is domestic coal, approx 22%, the third one is hydro, approx. 19%.

Table-2: Electricity Production of Turkey by Sources in 2009 (ETKB, 2010)

Resources	**2008 (GWh)**	**2009 (GWh)**	**Year 2009, distribution %**
Natural Gas	95.530,74	94.173,8	48,52
Domestic Coal	44.917,07	41.839,8	21,55
Hydro	33.264,46	35.904,8	18,50
Imported Coal	12.551,47	12.801,8	6,60
Liquid Fuel	9.772,30	6558,1	3,38
Wind	797,30	1.506,6	0,78

Geothermal	161,67	456,4	0,23
Others	1.334,47	870,80	0,44
Total	198.329,48	194.112,1	100,00

By the end of 2012, Turkey's gross electricity production has reached 239.100 GWh, i.e. 103.291,20 GWh (43,2%) natural gas, 956,4 GWh (0,4%) of geothermal, 57.862,20 GWh (24,2%) hydro-electric, 5.738,40 GWh (2,4%) wind sources and 65.035,20 GWh (27,2%) coal. End of 2012, Turkey's installed power reached 57.072 MW.

3.2. Turkey's non-renewable energy sources

3.2.1. Turkey's Lignite Potential

Turkey's total lignite reserve is at 12,4 billion tons that has about 1,6% of the world's total lignite reserves. Turkey's lignite reserves have a low heating value and around 46% is in Afsin-Elbistan basin. The total hard coal reserve in Zonguldak Basin is 1.322 billion tons. Most of them is used at thermal power plants to produce electricity. By using Turkey's lignite fields, it seems possible to increase Turkey's installed electricity power by 10.000 MW.

3.2.2. Turkey's Petroleum Potential

As of the end of 2009, Turkish petroleum reserves are 44,3 million tons, 2008 production is 2,4 million tones, and 2008 consumption is 28,2 million tons. As of the end of 2008, the installed power of Turkey thermal power plants depending on petroleum and petroleum products is 2.300 MW, and such value corresponds to 5,5% of total installed power. In 2008, petroleum based thermal power plants produced 7.519 GWh electricity energy.

3.2.3. Turkey's Natural Gas Potential

Turkey has limited natural gas reserves. The Baku-Tbilisi-Erzurum (BTE) Natural Gas Pipeline (Shah Sea Project), which aims at carrying Caspian gas resources to

Turkey and European markets, has been transmitting since 2006. Also the process of creating trans-Caspian petroleum and natural gas pipelines, in the context of Turkmen and Kazak resources, is being planned. For this reason, Shah Sea Project-2 Natural Gas Pipeline parallel to first project, Nabucco project and the Arabic Natural Gas Pipeline Project are in progress.

3.2.4. Turkey's Nuclear Energy Status

Based on electricity energy supply and demand projections, Turkey's main target is to have at least 3 operating nuclear power plants, 10% share, in 2023. On May 2010, an intergovernmental agreement was signed between Turkey and Russia regarding the construction a nuclear power plant in Mersin-Akkuyu, its capacity is 4x1.200MW (4 units), totally 4.800 MW. And for the second nuclear power plant: Canadia agreement regarding the construction of a second nuclear power plant in Sinop, its capacity is 6x1.400MW (6 units), totally 8.400 MW. The third one will be constructed in Marmara region.

3.3. Turkey's Renewable Energy Potential

3.3.1. Turkey's Hydroelectric Potential

Among various sources of energy, hydroelectric power plants are preferred because they are environment-friendly and have a low potential risk. Turkey's technically feasible hydroelectric potential is 170 GWh/year. Turkey's hydroelectric power plants (HEPP) that are presently in operation correspond to an installed power of 14.417 MW and 38% of the total potential. Turkey's aim is to utilize all hydroelectric potential in electricity production that is technically and economically viable by the year 2023.

3.3.2. Turkey's Geothermal Potential

Since Turkey is located on the Alpine-Himalayan belt, it holds a substantially high geothermal potential. Geothermal potential of Turkey is 31.500 MW which is the 5th at the world. While 1.500 MW of Turkey's geothermal energy potential is assessed to be suitable for electricity generation, finalized data is 600 MW. As

of the end of 2009, Turkey installed power of geothermal energy reached around 94,4 MW. By 2023, Turkey's target about geothermal energy is to increase the total installed energy power to 1.000 MW.

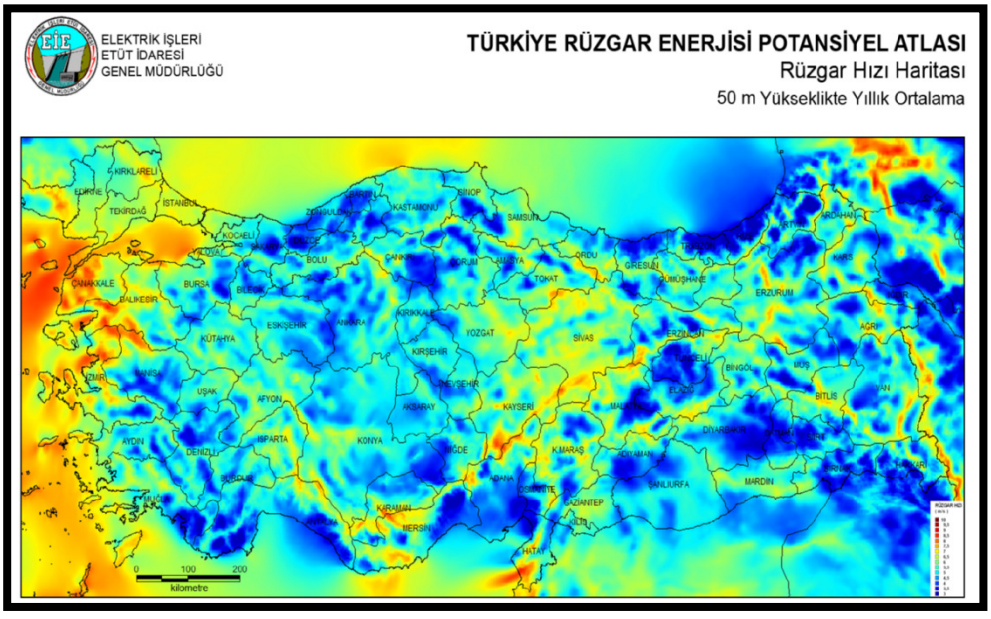
3.3.3. Turkey's Solar Energy Potential

Having a high potential for solar energy due to its geographical position, Turkey's average annual total sunshine duration is calculated as 2.640 hours, and average total radiation pressure as 1.311 kWh/m²-year. Solar energy potential is calculated as 380 billion kWh/year. With the decrease in the cost of using solar cells and increase in their efficiency, solar cell dependent energy generation is expected to increase in Turkey. Furthermore, using Turkey Solar Energy Potential Atlas and the CSP technology, it is calculated that an annual production of 380 billion kWh is possible.

3.3.4. Turkey's Wind Potential

With Turkey Wind Energy Potential Atlas (REPA), which was realized in 2007, it is calculated that Turkey has a minimum wind energy potential of 5.000 MW in regions with annual wind speed of 8,5 m/s and higher, and 48.000 MW with wind speed higher than 7,0 m/s. By 2023, Turkey's target about wind energy is to increase the total installed energy power to 20.000 MW.

Figure-1: Turkey Wind Energy Potential Atlas (REPA) (ETKB, 2009)



3.3.5. Turkey's Biofuels, Biogas and Biomass Potential

The amount of biogas that can be produced in Turkey, considering Turkey's animal waste potential, is reported as 1,5 to 2 MTEP (million tons equivalent of petroleum). Having a total fuel-oil consumption of 22 million tons, 3 million tons of which is benzene, Turkey has an installed bio-ethanol capacity of 160 thousand tons. And Turkey's biomass sources include agriculture, forests, animals, organic urban waste, etc. While Turkey's waste potential is around 8,6 million tons equivalent of petroleum (TEP), 6 million TEP is used for heating. In 2008, the total amount energy obtained from biomass sources was 66 thousand TEP.

4. CONCLUSION

The energy industry is an area of crucial strategic importance in development plans of countries. In 2012, Turkey's electricity generation came from three main sources: natural gas by 43,2%, coal by 27,2%, hydroelectric by 24,2%, liquid fuels by 2,6%, and renewable resources by 2,8%. End of 2012, Turkey's installed power has now reached 57.072 MW.

By making correct scenarios with using the correct modeling tools, Turkey will reach 2023 energy target easily by correct annual energy investment rate, i.e. "By 2023, Turkey's main target is to increase the total installed energy power to 100.000 MW and the share of renewable resources is to increase at least 30 percent of total production, i.e. 20,000 MW installed capacity for wind, 1.000 MW installed capacity for geothermal and an additional installed capacity of 5,000 MW for small hydro and to have at least 3 operating nuclear power plants and aims complete use of Turkey's potential of indigenous coal and hydraulic resources." (ETKB, 2010)

Projections by the International Energy Agency (IEA) show world's primary energy demand will increase by 40% between 2010 and 2030, primary energy demand making it reach 16,8 billion Tons of Equivalent Petroleum (TEP) in 2030.

This corresponds to an annual average increase of %1,5 in energy demand. To ensure that such an increase in energy demand can be met in a timely and secure manner, it is supposed that almost 26 trillion dollars will be invested globally in energy supply infrastructure by 2030.

Table-3: Distribution of Turkey and World's Energy Demand Resource

		According to WEO (Word)	**According to ETKB (Turkey)**
Energy Resources / Years	**2010**	**2020**	**2020**
Petroleum	38,9	29,5	22,6
Natural Gas	21,7	24,6	25,2
Coal	26,1	26,7	42,5
Total	**86,7**	**80,8**	**89,3**

The EU policies and measures to achieve the Energy 2020 goals and the Energy 2020 strategy are ambitious. The share of renewable energy (RES) rises substantially in all EU scenarios, achieving at least 55% in gross final energy consumption in 2050. However, in implementing the Roadmap, the EU will need to consider progress, and concrete action, in other countries. Coal in the EU adds to a diversified energy portfolio and contributes to security of supply. As a large scale low-carbon and lower cost option, nuclear energy will remain in the EU power generation mix.

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