

## **Public Attitude to Nuclear Energy from Climate Change and Energy Security Perspectives in Turkey**

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**Abstract.** Most of the energy-environmental policy studies have argued nuclear energy since the second half of the 20th century as it includes a number of risk factors such as high cost of plant building, radiation, diseases, power plant accidents, nuclear waste, nuclear weapon proliferation and terrorism. The length and severity of the nuclear energy debates vary from country to country based on the several factors, in particular, the economic and social development level of the countries. Due to increasing global environmental concerns such as climate change, loss of biodiversity, natural resource depletion, deforestation, ozone layer depletion and recent problems that countries experienced in terms of energy security, especially for such developing countries as Turkey, the governments have relaunched nuclear energy program again and follow their energy policy agenda in spite of occasional anti-nuclear protests in the society. In this regard, the main purpose of this study is to evaluate the public attitude in Turkey to nuclear energy in terms of environmental values like climate change and energy security and at the same time to examine reconciliation of environmental values and energy security with public attitude to nuclear energy. In the literature, many studies concerning environmental values, energy security, and attitudes towards nuclear energy have been conducted for only industrialized countries such as the USA, England, and Japan. However, developing countries with a high energy demand, technical and financial difficulties for low-carbon and renewable energy technology have been neglected, which is the source of inspiration and motivation for this study. The main finding of the study is that environmental values, especially, climate change plays a more important role in public attitude to nuclear energy in the community than energy security, which might be evaluated as an essential input for relevant stakeholders on energy policy in Turkey.

**Keywords.** Nuclear energy, Public attitude, Climate change, Energy security.

**JEL.** O13, Q42, Q54.

### **1. Introduction**

**S**cientific and technological progress throughout the history after the industrial revolution has brought humankind social and economic development. Environmental pollution has increased so much that it poses a threat for social life, which is gaining importance in the international arena. The main reasons of the environmental pollution are the usage of fossil fuel as an energy source and anthropocentric government policies implemented in energy

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sectors. It is an inevitable result because population growth, rising-living standards and the extensive technology usage particularly in industrialized communities have increased demand for energy, which has especially resulted in usage of carbon-intensified energy sources with uncontrolled and short-term planning. Thus, the notion that alternative and renewable energy sources are referred to less damaging to nature, and to moderate global environmental problems such as climate change, loss of biodiversity, deforestation, depletion of ozone layer and so forth is one of the thesis widely accepted in energy-environmental policy literature and it is a rational choice for decision makers and practitioners in international, national, regional and local institutions in the energy sector.

Current technological conditions for utilization of renewable energy sources remain insufficient to meet increasing demands in the short term. So, nuclear energy has been regarded as a potential solution for major environmental and energy troubles, and leading option for the constant economic growth and development. Therefore, especially for the last 20 years, the need for low carbon technologies including nuclear energy has become a matter to be dealt with energy and environmental problems mainly caused by human activities in industrialized countries. Therefore, the national governments have relaunched nuclear energy program and put on their energy agenda to find alternative and reasonable solutions for global and national environmental and energy problems despite the anti-nuclear movement in their communities. In particular, low carbon technologies including nuclear energy are regarded as a requirement for social and economic development especially in developing countries such as Turkey which has a high potential to become a locomotive position of self-reliance on technology in the regions at issue, dependent on foreign energy resources, and high national capital flow.

Anti-nuclear energy debates in most of the energy-environmental studies arguably base on premises that nuclear energy includes a number of risk factors such as radiation, diseases, power plant accidents, nuclear waste, nuclear weapon proliferation and terrorism and high installation cost (IEA, 2014). The size and severity of the nuclear energy disputes vary from country to country based on several factors such as the economic and social development level of the states. This argument is also the main inspiration for the anti-nuclear social movements in the communities. Thus, it is necessary to analyze reasons for anti-nuclear movements in the community to succeed in energy and environmental policies for developing nations which are mainly dependent on foreign energy source and developed nations which seek to minimize environmental problems on their border. *In this regard, the main purpose of this study is to demonstrate Turkey's public attitude towards nuclear energy in terms of climate change and energy security and to examine reconciliation of environmental values including climate change and energy security on nuclear power attitude.*

The study is started with the literature review. The first part provides general background information exploring nuclear energy profile from global to local including primary and secondary energy production and consumption rates and shares of renewable and alternative energy sources to highlight the importance of the issue. In the second part, the theoretical framework of public attitude to nuclear power in the context of climate change and energy security is presented, and the essential gap in the literature on this issue is highlighted. Then, the research design, data sources, collection techniques and main limitations are provided in the method part. Afterwards, findings and discussion part explores the main argument about how energy security and environmental values could be embodied in public attitudes to nuclear power and it includes inferences and recommendations for related stakeholders and decision-makers in energy sectors in Turkey.

## 2. Literature review

### 2.1. Nuclear power in the world today

The share of nuclear energy in the total world energy production has decreased particularly for the last 2-3 years after the Fukushima-Daichi nuclear disaster in 2011. Based on 2015 data, 438 operable commercial nuclear reactors still exist in 31 countries, with 66 nuclear reactors under construction (WNA, 2015a). The total capacity of these reactors is 392,000 MW providing about 10.6 % of total world electricity production in the reliable, continuous and low carbon emission manner (IEA, 2015). Furthermore, a large share of nuclear energy production to meet increasing energy demands takes place in only a few countries. For instance, about 50 percent of all nuclear energy production occurs in the USA, France, Russia, South Korea and China (NEI, 2015). The capacities of existing nuclear reactors in 12 countries except China are accounted for approximately 88% rate of the total world production capacity (see Table 1). The United States is a front-running country in nuclear power with 99 of those nuclear reactors accounted for about one-fifth of current total energy generation with the rate of 19.5 % (WNA, 2015b). France meets 77% of its total energy needs through nuclear energy, which is the highest rate in the world. Based on projections, it is planned to meet future energy demand with 43 and 31 new reactors in the current energy portfolio in China and Russia, respectively (see Table 1).

It is possible to claim that Turkey's position will still rank low even with new planned reactors compared to the other OECD member countries in terms of percentage of the number of nuclear power plants, in the total electricity production. For instance, European OECD member countries with 133 nuclear power plants (833.1 TWh) are accounted for 23.7 percent of total electricity generation while all OECD member countries with 325 power plants (1883.1 TWh) amount to 18.6% of electricity generation (OECD, 2015). On the other hand, by 2015, 4 new reactors with an electricity generation capacity of 4800 MW was planned to be constructed in Turkey, which had the potential for low carbon technology transformation, economic growth and development in the region (WNA, 2015b). However, this new nuclear plant's electricity generation capacity was accounted for only 8 percent of total electricity generation (57000 MW).

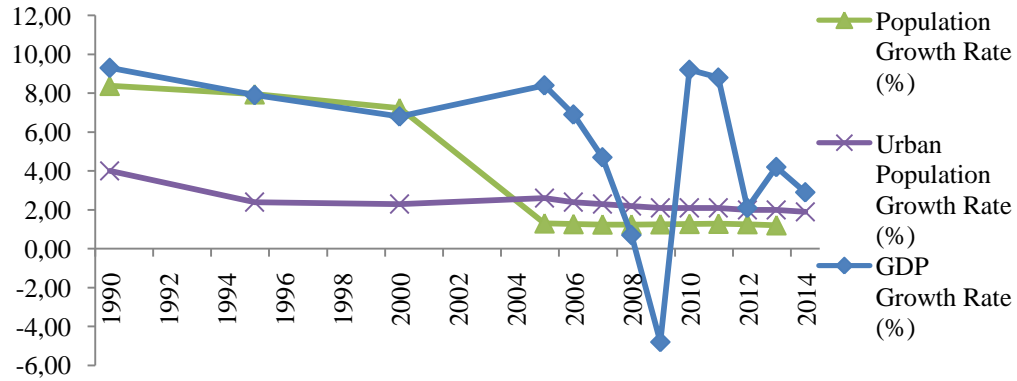
**Table 1.** *Top 12 nuclear generating countries including Turkey*

Country	Nuclear share (%)						Nuclear Electricity Production (TWh)	Number of Nuclear Units	Nuclear Capacity (MWe)	No.	Under Construction (MWe)	No	Reactors planned (MWe).
	2005	2010	2011	2012	2013	2014	2014	2015	2015	2015	2015	2015	2015
United States*	19,30	19,60	19,20	19,00	19,40	19,50	798.6	99*	98,792	5	6018	5	6063
France	78,50	74,10	77.7	74.8	73.3	76.9	418,00	58	63,130	1	1720	1	1720
Russia	15,80	17,10	17,60	17,80	17,50	18,60	169.1	34	25,264	9	7968	31	33264
South Korea	38,60	32,20	34,60	30,40	27,60	30,40	149.2	24	21,657	4	5600	8	11600
China	2,00	1,80	1,80	2,00	2,10	2,40	123.8	23	23,144	24	26313	44	51050
Canada	14,60	15,10	15,30	15,30	16,00	16,80	98.6	19	13,553	0	0	2	1500
Germany	31,00	28,40	17,80	16,10	15,50	15,80	91.80	9	12,003	0	0	0	0
Ukraine	48,50	48.1	47.2	46.2	43.6	49.4	83.1	15	13,107	0	0	2	1900
Sweden	46,70	38.1	39.6	38.1	42.7	41.5	62.3	10	9,487	0	0	0	0
United Kingdom	19,90	19,60	19,20	19,00	19,40	19,50	57.9	16	9,373	0	0	4	6680
India	2,8	2,9	3,7	3,6	3,5	3,5	33.2	21	5,308	6	4300	22	21300
Japan	29,3	29.2	18.1	2.1	1.7	0	14	43	40,480	3	3036	9	12947
Turkey**	0	0	0	0	0	0	0	0	0	0	0	4	4800
World						11.5	2411	438	379,261	66	68,997	168	189,504

2.2. Basic facts of Turkey`s energy profile

Based on 2015 data in World Bank report, Population growth rate (annual 1.2% in the period of 2010-2014), urbanization rate (annual rate of change 1.97 % for 2010-15), increasing Gross National Product Rate (annual average 3-4 % for last 10 years), and high social living standard over time have made more energy use essential for the existing sectors in Turkey. Similarly, the latest data indicate that energy demand in Turkey for last 12 years has increased about 5.7%. An increase by 6% is also expected by 2020 with this trend while the increase in energy demand in the developing countries all over the world is presumed as 4.1 (DOGAKA, 2014). Even worse, current hydrocarbon resources in Turkey have been seemed insufficient to meet the growing energy demand in the future based on these energy inventory data.

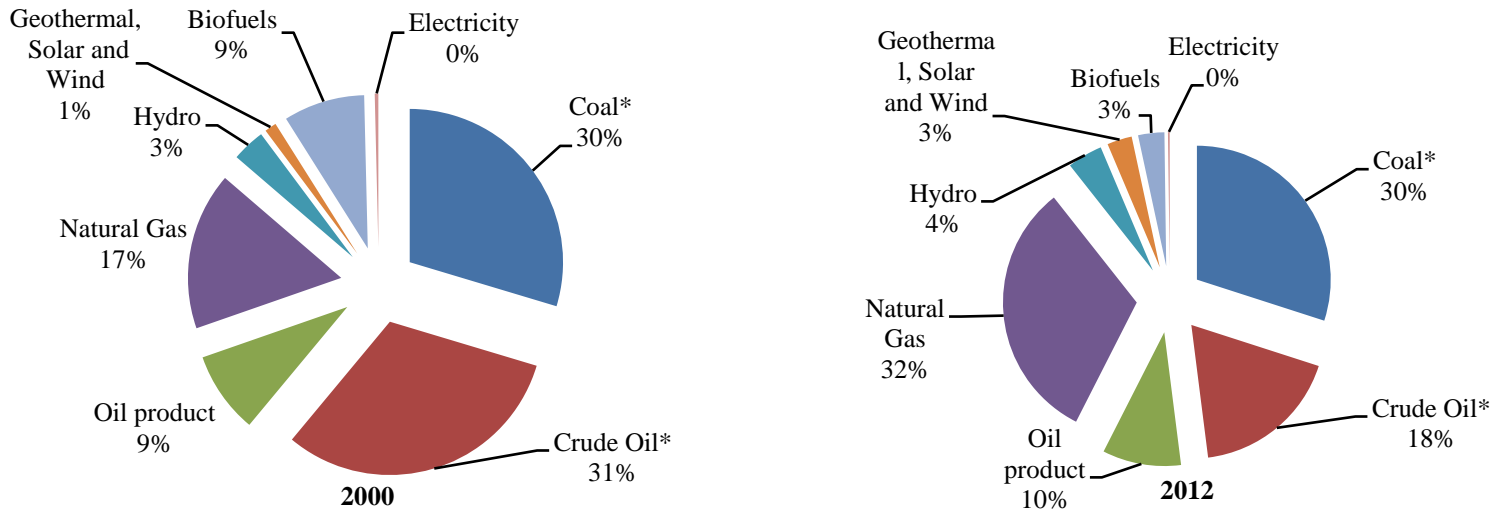
In this case, the Turkish government has decided to implement much more liberal policy, especially in the energy sector since the 2000s to deal with such negatives conditions in the economy. Liberal government policies in Turkey, in particular for last decades have undoubtedly led to an increase in investments in energy sectors. That is, Turkey has a significant effort to alleviate the burden of the energy sector in the country` economy and to have reliable, environmentally friendly and low-carbon energy sources besides dealing with environmental problems. However, while Turkey, which has the 17<sup>th</sup> largest economy in the world and the 6<sup>th</sup> largest economy in Europe, experienced an economic boom in 2010 and 2011 with 9, 3% 8.8% growth rate, it has decreased to a rate of 2.9% for last 3 years. It is clear that energy costs have a significant impact on these fluctuations in the growth rate compared to the population growth (see Graph 1).



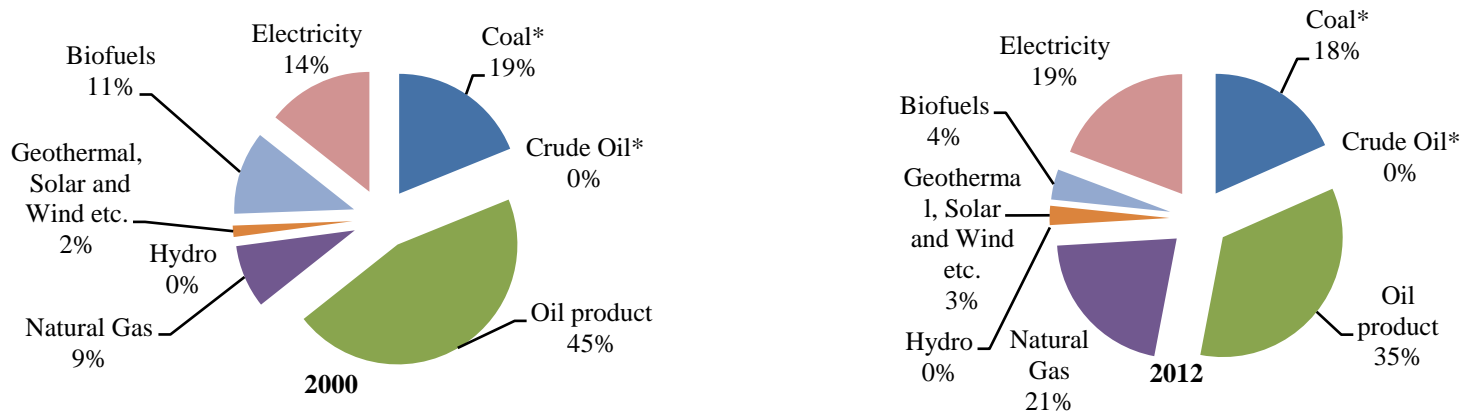
Graph 1. GDP change, population growth and urbanization in turkey since 1990, which was created based on World Bank 2015 data

Despite a stable domestic energy production and a slight change in the energy mix share for each energy source, the total energy demand in Turkey significantly increased in the period of 2000 to 2012, which made essential for the Turkish cabinet to find alternatives and the rational option to meet changes in the energy demand. The primary energy supply in Turkey was 117 million toe (tons of oil equivalents) in 2012 based on IEA`2015 and MENR` 2013 reports. It has been estimated to be 157 mtoe by 2020 and 236 mtoe by 2035. As seen in the figures 2-3 below, the amount and share of the total energy production by source types in Turkey in 2000 and 2012 could be summarized as the followings<sup>2</sup>: Natural Gas with 12,6 (17%) and 37,2 million (32%); Coal with

22,5 (30%) and 35 million (30%); Oil with 30.4 million (40%) and 32,2 (28%); Hydropower with 2,6 (3%) and 5 (4%); Wood, animal and plant debris with 6,5(9%) and 3,7 (3%) million; Geothermal, solar and wind with 0,9 (1%) and 3,5 (3%) million Toe (WEC,2012 and IEA,2015). Similarly, the share and amount of the total energy consumption by source types in Turkey in 2000 and 2012 are as follows: Natural gas with 4,9 (9%) and 18,1 million (21%); Coal with 10,8 (19%) and 15,8 million (18%); Oil with 26,1 million (45%) and 29,8 (35%); Wood, animal and plant debris with 6,4 (11%) and 3,5 (4%); Geothermal, solar and wind with 0,9 (1%) and 3,5 (3%) million; Electricity 8,2 (14%) and 16,6 (19%) Million Toe.

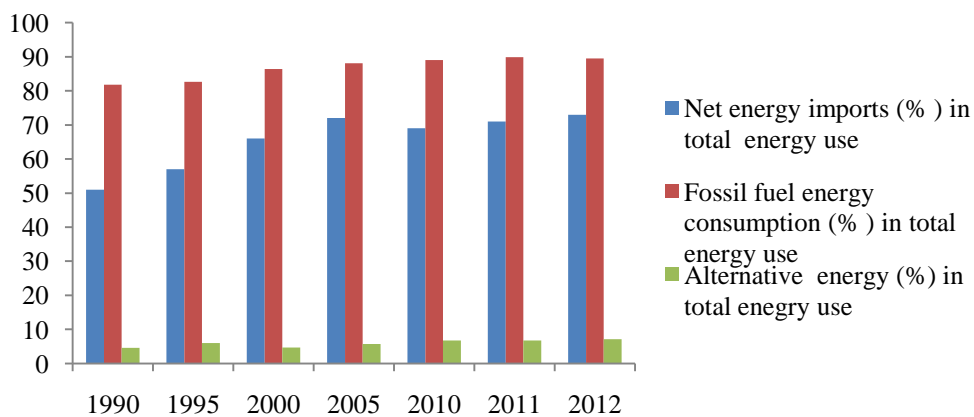


**Graph 2:** The total primary energy production share (%) by resource types for Turkey in 2000 and 2012



**Graph 3:** The total primary energy consumption share (%) with resource type for Turkey in 2000 and 2012. sources: energy balance tables by 2013 in MENR and IEA (2015)

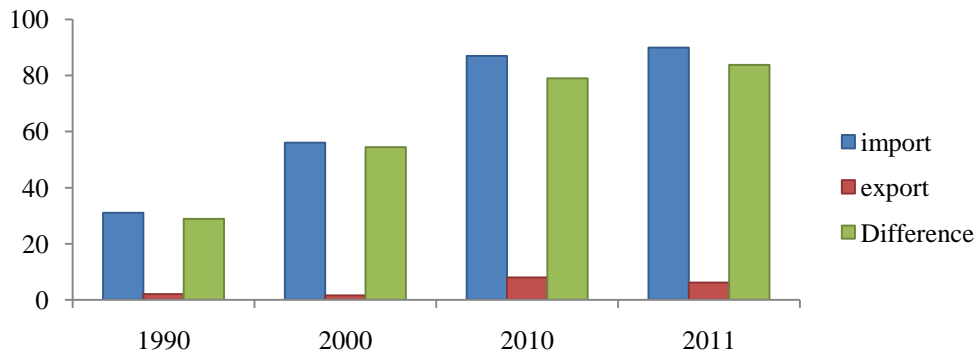
Whereas a small portion of the current demand in Turkey (approximately 27 %) is met through the indigenous production, Turkey is heavily depending on the energy import according to World Bank 2012 energy data (WEC, 2012). During the period of 1990-2012, it is possible to notice that the total energy production increased by %122 while the primary energy use rose by 48, 7 % (kg of oil equivalent per capita) (WEC, 2012). That is, meeting the ratio of the total indigenous energy production to the energy consumption has reduced from % 49 to % 27. As a result, in the same period in Turkey, the energy consumption per capita, the import share in the total energy consumption, the percentage of alternative energy and fossil fuel in the total energy consumption are 49 kWh, 43 %,9% and 54%, respectively (see graph 4). All of those indicate an essential tendency to find alternative and renewable energy options in the country in parallel with global trends.



**Graph 4:** *The energy consumption per capita, the import rate in the total energy consumption, the percentage of alternative energy and fossil fuel in the total energy consumption according to World Bank's 2015 data*

Dependency on foreign energy sources in Turkey burdens the country economy too much and all sectors including energy, transport, industry, building, and so forth have been affected by this undesired situation, which seems a significant obstacle for the country to reach the desired level in terms of economic, social and environmental policy perspectives. In the period of 1990-2011, Turkey experienced a threefold increase from 30 to 90 Million Tonne in the energy import rate (see Graph 5) (WEC, 2012). The ratio of energy exports to imports remained quite low (2.1 in 1990 mtoe and 6.2 mtoe in 2011). Similarly, in the period of 1990-2011, the energy import of natural gas increased 12-fold. Oil imports with 36 mtoe increased the ratio by 57%. It is also observed that the amount of coal import has increased from 4.2 to 15 mtoe (WEC, 2012). So, energy needs in Turkey are mainly met through imports (nearly 72%). Natural gas and oil account for 80% of this 90 mtoe of total energy imports (WEC, 2012). In other words, in terms of energy resource types and net import rates of energy supply in Turkey, it is possible to state that 93% of oil, 98% of natural gas, and 90% of hard coal, in total 72.9%, have been imported from foreign countries according to 2010 data (MENR, 2013). In addition, while it is expected to see an increase in the ratio of the amount of the world's energy supply by approximately 47%, it will be 117% in Turkey, which indicates that the rate of energy dependency by 72% on other countries has affected the energy security of the country in the last 20 years (MENR, 2013).





**Graph 5:** The total energy import and export amounts in Turkey in the period of 1990 to 2011 (btoe), (WEC, 2012).

### 2.3. Electricity profile of the country

There has been a consensus on the relationship between the level of economic development and the share of electricity energy consumption (Güray, 2009). In Turkey, according to 2013 data, the electricity consumption (242, 4 billion kWh) increased by 1, 3 % compared to the previous year (245, 5 billion kWh), and the electricity production (239, 3 billion kWh) decreased by 0, 1 % in comparison with the previous year (239, 5 billion kWh). The electricity generation capacity of current power plants is 64,044 MW (TEİAŞ, 2010). The report carried out by MENR indicates that the electricity demand will be 392 TWh in 2020 based on the high-demand scenario (the predicted average increase by 6,9%) and 357, 4 TWh (an increase by 5, 5%) based on Low Demand Scenario (TEİAŞ, 2010). In addition, it is targeted that the wind power share in the total electricity production will be 20,000 MW and the geothermal power will be 600 MW by 2023 according to Electric Power Market and Supply Security Strategy Paper (GDİ, 2012) published on 18 May 2009. In addition, the share of natural gas in the electricity production by 2023 is also expected to be less than 30%. Similarly, 5% of the total electricity generation from nuclear energy with 4 new reactors is aimed by 2020 (GDİ, 2012). It is also possible to summarize the total electricity generation by resource types like that: 43, 8 % from natural gas, 25, 4 % of domestic coal, 24, 8 % of hydropower, 2 % of liquid fuels, 4% from renewable energy sources based on 2013 data (EUAS, 2010). It is especially possible to notice that the utilization rate of renewable energy has increased annually compared to the previous years.

The Turkish Cabinet has also created mobility and a confidence, encouraging and competitive atmosphere in the electricity sector with new regulations such as the laws of 4628 and 6446. Creating free market conditions, much more liberalization in the energy sector and new sorts of regulation and arrangement in this direction have created fluency and convenience for investors in Turkey's electricity sectors. Hence, the Minister of Energy and Natural Research, Taner Yıldız speech in the Turkish parliaments in 2011 that Turkey maintains its efforts to take steps for the creation of a competitive and transparent market, and to be fully compatible with the European Electricity Market. In addition, especially due to recent legal regulations concerning renewable energy sources and the electricity production, the private sector mainly plays a much more active role in the sector, especially on the construction of the hydroelectric power plants (HPP) (EPDK, 2011). For instance, the majority of the electricity production was provided by the private sector in 2013.<sup>3</sup> EUAŞ (The Electricity Generation Company) on behalf of a public agency accounted for 37, 1 % of the total production in 2013, and remaining 59, 6% was provided by the private sector (TEİAŞ, 2010). In addition,

according to recent legal regulations and plans in the country, by 2023, approximately 5% of the current electricity production from nuclear power and 30% of renewable energy will be aimed (EUAS, 2010).

Electricity Market and Supply Security Strategy Paper was enacted by the High Planning Council on 18 May 2009 for involvement of the nuclear power plants to meet energy needs in Turkey. It explicitly indicates that nuclear power generation will be initiated in the electricity production (ES-PS, 2012). Besides, the 9th Development Plan argued for creating a healthy diversification in energy sources for electricity generation including nuclear energy in the energy supply mix (No, 26215). Thus, the agreement between Russia and Turkey was enacted in the Turkish parliament in 2011 for the construction of the first nuclear power plant in Mersin-Akkuyu. The main purpose of the law has been explained as the following:

“to ensure security of the energy supply, to consistently meet the growing electricity demand, to reduce the current account deficit, to maximize the use of local and renewable energy sources, to reduce Turkey’s dependence on imported energy sources, to increase energy efficiency, the intensity of nuclear power in the electricity and to create a reliable energy supply portfolio in the country” (No, 28240).

According to this agreement, the first nuclear power plant (VVER-1200 model with 3,200 MW) will be established in Mersin-Akkuyu. In this regard, the essential institutionalization and coordination will be ensured through MENR (No, 28240). In addition, the Turkish government is planning to establish the second nuclear power plant in Sinop and it continues negotiations with other countries as Japan.

Other crucial points concerning Turkey's energy security are related to political initiatives for becoming energy corridors in the region. It is recommended to use its geopolitical position in a strategic way because it has a central location between Europe and other energy-rich countries as Iran, Iraq, Turkmenistan, Azerbaijan, the Middle East, and the Caucasus nations. In this sense, Turkey has progressing efforts to be an energy hub for the transportation of hydrocarbons in the region with some project such as Nabucco and the Trans-Anatolian pipeline projects. From time to time, it is evaluated that due to the political trouble about natural gas between Russia and European countries, the South alternative gas pipeline in Turkey might greatly benefit European states (Winrow, 2013). Until now, Iraq’s oil with the Kirkuk-Ceyhan pipeline, and Azerbaijan’s oil with the Baku-Tbilisi-Ceyhan pipeline is being transferred to the Iskenderun port of Gulf (Winrow, 2013).

In summary, global effort to deal with environmental problems, limited fossil fuel energy sources, insufficient progress in technology and energy efficiency, desire to have better economic and social life standards, poor legal regulations, and expectation of increases in the future energy demand makes Turkey's energy policy a dilemma issue. In addition, decision-makers on energy policy in the country seek to figure out alternative energy sources. Therefore, nuclear power is only considered among these alternative options in rhetoric, not in practice due to the fact that serious anti- nuclear social movements have taken place in Turkey for last 40 years. The main reasons for such crucial anti-nuclear activities in the country are referred to the Chernobyl nuclear accident in 1986, subsequent health problems and several other problems such as radiation, nuclear waste, nuclear weapon proliferation and terrorism (Caldicott, 2014). All of those make essential to explore main drivers of anti-social nuclear movements in the country, in particular in environmental value and energy security perspectives.

### **3. Public attitude to nuclear energy /climate change/energy security nexus**

One of the controversial topics witnessed by scientists, practitioners, policy decision makers, media, public and other interest groups in the 21st century is a concern about environmental value, energy security, and adoption of low-carbon technologies. Particularly, public attitude towards environmental values such as climate change, energy security and the low-carbon energy technology is considered as the most important factor affecting the acquisition, diffusion, and transformation of a new energy policy in the society (Corner *et al.*, 2011). Many studies in the literature argue that anti-nuclear movement in a community is an important obstacle to the acquisition of new energy technologies such as nuclear energy in spite of the fact that energy security and carbon emissions necessitate the number of individual responsibilities worldwide (Pidgeon *et al.*, 2008). In addition, several studies indicate nuclear energy with the low-carbon electricity production as a compatible energy source for energy security and environmental values, especially for developing countries (Teräväinen *et al.*, 2011; Brook, 2012). Interestingly, the studies including climate change, energy security, and environmental values have been carried out for industrialized countries only such as the USA, UK, and Japan. Hence, there is a huge gap in the literature for developing countries such as Turkey in terms of environment, energy, and nuclear energy.

Trust in society is regarded as the most important factor in acceptance of climate change, environmental and energy policies implemented by the governments. In some societies, it is suggested that NGOs have much more sensibility in the issue of environmental and climate change compared to a government agency (Spence *et al.*, 2010). Several studies emphasize the importance of societal actions rather than individuals so that governments should take a much more active and regulative role in such activities concerning climate change issue (Spence *et al.*, 2010). Consequently, the applicability of the state's energy and environmental policies is significantly and largely composed of confidence and attitude formed in the public sphere.

The study by Truelove & Greenberg (2013) argues that possible concerns about global human-made climate change in the future mitigates American people's anti-nuclear attitude towards nuclear energy. That is, nuclear power is regarded as an important energy source thanks to its low carbon emission compared to other fossil fuel sources for electricity production and dealing with climate change struggle. Besides concerns about climate change, other environmental values, concerns about reliable energy, cultural and demographic factors also have a significant impact on public attitudes towards nuclear power. Particularly, thanks to some characteristics of nuclear energy such as providing reliable, affordable electricity, and energy independence, it is supported by a majority of American people (by 50-70%) (Bisconti, 2009; Bolsen, 2008).

It is difficult to find a consistent result for the European countries in terms of the relationship between concern about climate change and support for nuclear energy. While a number of studies claim that nuclear energy is regarded as an alternative energy source which might provide a possible solution for climate change and energy security (Visschers *et al.*, 2011; Bickerstaff *et al.*, 2008), some studies argue that energy security and climate change could explain only a small part of the support for nuclear energy (Spence *et al.*, 2010; Corner *et al.*, 2011). For instance, Pidgoen *et al.*, (2008) have come up with the same result in their survey that there has been a strong support for nuclear energy due to dealing with climate change compared to renewable energy even if being provisory and justified. The survey conducted in 2007, which was just about climate change, indicated that a large section of European citizens, particularly in the UK, was concerned about

climate change with the rate of 90%. However, considered other social needs and priorities, this rate decreased gradually (as cited in [Spence et al., 2010](#)).

Based on a survey carried out for European countries, it is claimed that the unconditional support for renewable energy sources is high. However, fossil fuels including oil and coal have a low-level support from the public while the rates of supporters and non-supporters of nuclear power are the same. Limited resources such as coal, oil and natural gas are not friendly with environmental values. Additionally, they are expected to run out in near future. Thus, these are described as unreliable resources ([Spence et al., 2010](#)). Possible nuclear waste problems and radiation risk caused by a nuclear accident such as Three Mile Island and Chernobyl are proposed as an effective reason for less support for nuclear energy in the communities (as cited in [Spence et al., 2010](#)). Similarly, [Bickerstaff et al., \(2008\)](#) claim that climate change issue, waste problems and other environmental concerns affect public opinion negatively.

[Teräväinen et al., \(2011\)](#) have made a clear explanation with semi-interviews and the text analysis exploring anti-nuclear debates in France, Finland, and the UK in terms of the public institution, civil society, and market. They have come up with the idea that liberal market mechanisms in the UK, a state-centered institution in France, civil society in Finland should be taken into account to analyze the attitudes to the nuclear energy policy. Similarly, [Corner et al. \(2011\)](#), in their study including the three-point Likert scale releasing the conditional, unconditional and reluctant support for nuclear power, have indicated that nearly 30% of the British community support nuclear energy and the main inspiration comes from climate change and energy security. It seems to be a rational expectation that nuclear energy could be an alternative solution for climate change with 50% carbon reduction targeted by 2050 in the UK.

Several studies in literature argue that nuclear accidents occurred in the world might affect public attitude towards nuclear energy ([Bickerstaff et al., 2008](#); [Pidgeon et al., 2008](#)). For instance, after the Fukushima Daiichi nuclear reactor accident in Japan in 2010, it was observed a tendency to use much more renewable energy sources compared to other energy sources in the short period, especially in Europe countries. ([Cyranski, 2012](#); [Hayashi & Hughes, 2013](#)). On the other hand, some studies have claimed that such a nuclear accident will not lead to a significant change in public attitude towards nuclear energy especially for British people, in contrast with Japan ([Poortinga et al., 2013](#); [Demski et al., 2013](#)). Similarly, [Poortinga et al. \(2013\)](#) have found that the British public's confidence in the sources used in electricity production has not changed significantly before and after the accident in Japan.

[Brook \(2012\)](#) has claimed that the principal issue is the social and political acceptability of new low carbon technology, rather than the technical and economic obstacles to electricity generation from nuclear energy. He has also proposed that making a significant progress gradually in the transformation of the current fossil fuel plants into the alternatives, as renewable energy power and CCS<sup>4</sup>, will be a possible solution for climate change.

When focused on Turkey in terms of public attitudes towards nuclear energy, it can be seen that climate change having global and devastating effects is becoming a more controversial issue in parallel with the global trend. First initiatives for nuclear energy were launched in Turkey in 1960-70`s, but it could not be implemented due to the constant anti-environmental and nuclear movement, concerns about loss of votes by political parties, and other economic and political reasons at that time. More interestingly, there has been a limited study in Turkey concerning climate change, energy security and nuclear energy separately or in combination with each other.

The survey conducted by Özdemir (2008) to explore the attitudes towards nuclear energy of the students in the department of education has revealed that knowledge and epistemological stance have important effects on the students' attitudes. Palabıyık *et al*, (2010) have found a quite interesting result in the social acceptance of nuclear energy. He has called it as NIMBY<sup>5</sup> syndrome exploring local people's acceptance of the energy investment in their backyard. Besides, he has found that a conscious and stable political commitment might be an important milestone in overcoming the negativity in this sense. Similarly, the Regional Environmental Center (REC, 2014) has carried out a study with 25 CEO of the companies in Turkey to measure their perception of climate change. The most important results of the study are that almost all of them have awareness for climate change, but the lack of clearness in the available national goals and policies about climate change has a negative effect on emission reduction targets, policies and principles for the adoption on the private sector.

### 4. Methods

This spiritual study comprises face to face and online surveys ( $N=483$ ) in order to explore public attitude towards nuclear power quantitatively in Turkey which has not had any nuclear power plants so far, but surprisingly there has been a high anti-nuclear movement in the community. Only 450 participants completely filled out the survey given. A pilot study was carried out with 47 participants with face to face interview to raise engagement and awareness, and eliminate potential misunderstanding of survey questions.

For the survey, a questionnaire consisting of three main parts with 20 questions was conducted<sup>6</sup>. The first part included 3 questions to identify the respondent profile such as age, gender, and city. In the second part, 7 questions were asked to the respondents in order to determine direct attitude toward nuclear energy in perspectives of environmental values and energy security. In the last part, it was aimed to measure the attitude towards nuclear energy conditionally (indirectly) with 5 questions in terms of environmental values and energy security with multinomial regression analysis. Mainly, it was considered to use multinomial regression analysis with IBM SPSS statistics software to determine the extent of which environmental values and energy security concern explanation or whether there is an effect on attitudes on nuclear energy in the Turkish community. Before the regression analysis, Likelihood Ratio Test in 95 % confidential interval was conducted to determine whether independent variables including environmental values and energy security concerns explain variation on the dependent variable (public attitudes towards nuclear energy). The main finding of the analyses was illustrated with several bar graphs including the percentage rate of the participants' conditional and unconditional support to nuclear energy in Turkish community. Finally, the number of the attendants is the main limitation of this survey. It would be extended; however, it still provides a clear and significant result. This survey could have been conducted using face to face interview techniques to reach a concise result rather than online interviews, but there were timing and financial problems. A recommendation for further studies is that the community could also be categorized into sub-levels as sectoral perspectives, and a survey could be applied to each one separately.

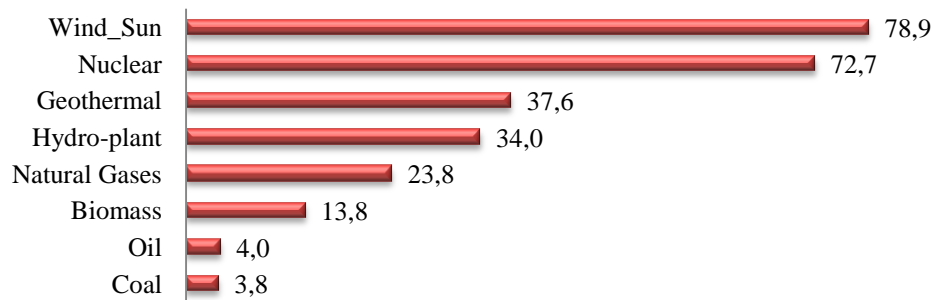
### 5. Findings and discussion

The main finding of the study is that 71.56 % of the participants stated that their attitudes towards nuclear energy are neutral or positive. Also, 54.67 % of the people believed that nuclear energy benefits outweigh risks. As for gender



perspectives on attitudes towards nuclear energy, it is possible to claim that there is a little more positive tendency in male participants (248) compared to females (202). 89 % of participants expressed that they have serious concerns relating to climate change. Similarly, 68.2% explained their concern on environmental values. It is also determined that the percentage of those who have concerns about energy security as fossil fuels reserves, price in the future and dependency on foreign energy sources, is lower than environmental concerns. Consequently, it is claimed that the nuclear energy debate in Turkey arouse from energy security perspective, but our results indicate that environmental concerns have a greater impact on nuclear energy attitudes in public rather than energy security arguments.

The preference among energy sources was asked to each participant to measure their energy security tendency in the survey. Wind and solar energy has top priority among the alternatives of renewable energy sources and fossil fuels with 78.9% with regard to the perspective of energy security and environmental concerns (see graph 6). The rank of nuclear energy is the second with 72.2%, which is quite high among other choices. Although natural gases preference rate is quite high among fossil fuels, it is still possible to claim that their percentage rates are lower compared to alternatives and renewable energy sources.



Graph 6. Electricity generation sources preference (n=450)

Based on the results of the correlation analysis including pairwise comparisons, a significant relationship among environmental values, energy security and attitude to nuclear energy was found. In addition, it is found that there is a positive correlation between environmental concerns and nuclear energy attitudes (Pearson's  $r=0.21$ ,  $p<0.0001$ ). Another positive and significant correlation was between energy security and the environmental value (Pearson's  $r=0.145$ ,  $p<0.002$ ). Moreover, there is a negative and significant correlation between climate change concerns and nuclear energy attitudes (Pearson's  $r=0.199$ ,  $p<0.0001$ ). On the other side, it was surprisingly not found a significant relation between energy security concerns like fossil fuel reserves, price in the future, dependency on foreign energy sources and attitudes to nuclear energy (respectively  $p=0.864$ ,  $p=0.947$  and  $p=0.921$ ).

Multinomial logistic regression analysis was applied as our variable consists of more than two groups and non-metric in order to determine the extent of which categorical variation among public attitudes towards nuclear energy changes with climate change and energy security concerns variations. The likelihood ratio test bases on the possibility ratio of maximum possibility values in the hypothesized parameters. Firstly, Likelihood Ratio Test was used to test whether all independent variables disclose the dependent variable in the model with 95% confidence intervals. All in all, based on the Multinomial logistic regression analysis, the results are given in the tables below, which indicate a significant relationship between environmental concerns with attitudes towards nuclear energy.

**Table 2.** Likelihood ratio tests (n=450)

	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	889.597	21.694	5	0.001
Climate change concerns	890.754	22.852	5	0.000
Fossil fuels reserves in the future	871.453	3.550	5	0.616
Energy prices in the future	870.973	3.070	5	0.689
Dependency on foreign energy resources	871.189	3.286	5	0.656
Environmental values concerns	881.061	13.158	5	0.022

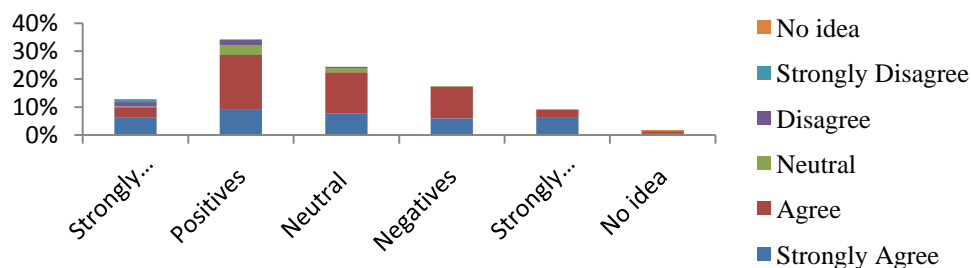
**Table 3.** Parameter estimates (n=450)

Attitudes to nuclear power <sup>a</sup>		B	Std. Error	Wald	Sig.	Exp.(B)
High Positives	Intercept	0.847	1.48	0.327	0.567	
	Climate change concerns	-0.234	0.39	0.358	0.55	0.792
	Environmental values concerns	1.382	1.086	1.618	0.203	3.982
Positives	Intercept	2.098	1.45	2.093	0.148	
	Climate change concerns	-0.312	0.374	0.692	0.405	0.732
	Environmental values concerns	1.298	1.074	1.463	0.226	3.664
Neutral	Intercept	2.165	1.461	2.196	0.138	
	Climate change concerns	-0.578	0.387	2.223	0.136	0.561
	Environmental values concerns	1.365	1.079	1.6	0.206	3.914
Negatives	Intercept	2.647	1.482	3.19	0.074	
	Climate change concerns	-0.722	0.402	3.224	0.073	0.486
	Environmental values concerns	0.938	1.092	0.738	0.39	2.556
High negatives	Intercept	4.724	1.618	8.526	0.004	
	Climate change concerns	-1.574	0.488	10.422	0.001	0.207
	Environmental values concerns	-0.319	1.223	0.068	0.794	0.727

**Notes:** a. the reference category is no idea.

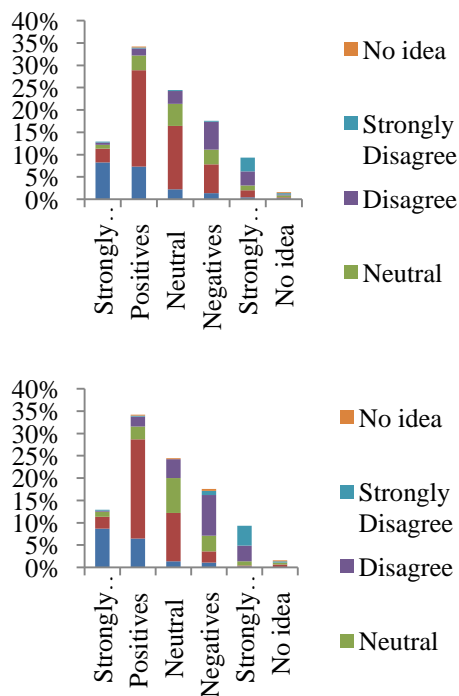
As seen in the regression analysis results in table 3, climate change concerns have a significant impact on negatives' and high negatives' attitude towards nuclear energy with 10% confidential interval. That is to say, those people's (negatives and high negatives) attitudes toward nuclear energy could mainly be affected at least 0.48 and 0.20 much more times higher than the attitudes of no idea, references categories.

If two questions of climate change concerns and public attitudes towards nuclear energy are taken into account simultaneously, 36.44% and 52.44% of the participants explain "strongly agree" and "agree" respectively on the expression of climate change concerns, which means that about 89% of the total participants concerns on the climate change issue. Interestingly, only 26.44% of those participants have "negative" and "very negative" attitude towards nuclear energy (see Graph 7).



**Graph 7.** Climate change concern and nuclear energy attitudes in pair comparison (n=450)

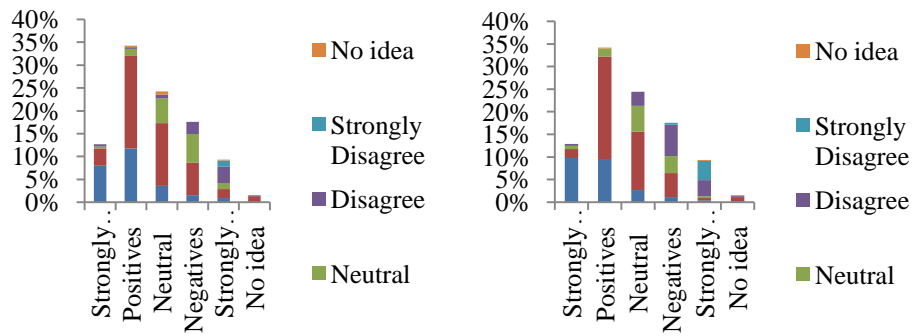
It is possible to determine slightly different values if indirect attitude (conditional) towards nuclear energy is taken into account as climate change, environmental values and energy security concerns compared to unconditional support, 67 % of participants state that they would be positives on nuclear energy if it were the rational solution for climate change problems while only 18.67% still show negative attitudes even if they have climate change concern (see graph 8). Similarly, 56.89 percentage of the respondents claim that nuclear energy would be a possible solution for electricity production because only renewable energy sources will not be sufficient to meet energy increasing demand. It should be noted that neutral respondents have slightly higher percentage rates because renewable energy is seen as alternatives and rational solution for energy needs particularly in the long term.



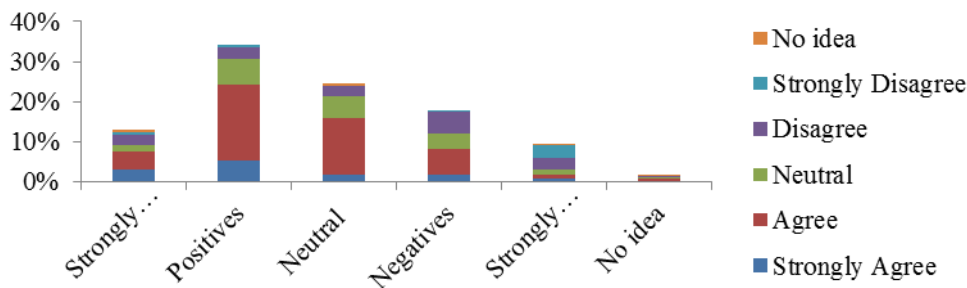
**Graph 8.** Conditional support for nuclear energy including climate change and electricity generation (n=450)

As in the graph 9, the percentage rate of those who support nuclear energy with renewable energy sources because power shortage in electricity is around 74%. It indicates that alternatives and renewable energy sources are supported by the community in Turkey where there is an increasing energy demand and dependency on foreign sources in the short and long run. If we take account of nuclear energy and extract renewable energy preference from the question, it is found that rate of positives' attitudes have increased to 68%, which indicates that there has been significant support in the community for nuclear energy.





Graph 9. Conditional support for nuclear energy electricity power shortage, energy dependency (n=450)



Graph 10. Conditional support on nuclear energy including climate change and energy security (n=450)

If we take account of climate change and energy security concerns simultaneously, it is possible to observe that the rate of the supporters of nuclear energy have decreased to 58%, and change from positive attitudes to the neutral tendency as seen in the graph 10 above. All in all, the main finding in this study is that energy security could explain slightly less change or a variation on public attitudes towards nuclear energy compared to environmental concerns, which has a significant impact on people’s preference on energy mix in Turkey. It is slightly different from the main thesis that nuclear energy would be a rational choice in Turkey because of energy security rather than environmental concerns.

### 6. Conclusion

Consequently, it is a fact that energy demands have increased considerably all over the world in particular for last two decades because the social, economic, technological and cultural changes in social life, and environmental problems have already gone beyond the limits of the nature. Renewable and alternatives energy sources are regarded as a rational solution to deal with energy and environmental problems, especially for developing the countries. At this time, renewable energy sources are not sufficient in the short term because of the increasing energy needs and environmental concerns. Thus, nuclear energy is still only and the main option for developing countries and it awaits in their policy agenda. Many studies indicate that the adoption of nuclear energy technology mainly depends on public attitudes in the communities which should be taken into account by governments and interest groups, and gives inspiration for this study.

Public attitudes toward nuclear energy could change if climate change, environmental values and energy security concerns are dealt, which are the major

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arguments of the study. Therefore, Turkey as a developing country was selected as a case study, and an online survey was conducted for 450 participants chosen with an appropriate and scientific manner. The main finding of the study is that climate change and environmental values have a much more significant impact on change or variation of public attitude about nuclear energy compared to energy security.

In the literature, concerning environment-energy policy domains, the following points could also be recommended as a solution for Turkey's economic development and growth besides nuclear energy option: the concentration in exploration activities in the indigenous resources, much more adoption of renewable and alternative energy resources into energy mix, increasing energy efficiency, and the use of geopolitical position as much as possible. In addition, an emphasis on each one of these options at the same level is required with the new laws and regulations in order to reach the goals. Adoption of alternative and renewable energy technologies into energy mix in Turkey seems to be the most rational option in order to alleviate economic burden caused by energy import and dealing with environmental concerns.

### Notes

<sup>1</sup> This article was presented on the Second Black Sea and the Balkans Economic and Political Studies Symposium held on November 9-13, 2015 in St Petersburg-Russia with a title of "Public Attitude to Nuclear Power in Turkey". This study was also supported by research fund of the Recep Tayyip Erdogan University. Project no: 2015.53007.107.04.03

<sup>2</sup> It is preferred to use international databases such as World Bank (WB) and International Energy Agency (IEA) to resolve the confusion about energy data units. Only data for 2012 are available in the database of these organizations. The rest of the data have been obtained from the Energy Balance Tables in the Ministry of Energy and Natural Resources (MENR) websites.

<sup>3</sup> Until 2013, 90 % additional power generation with 29 474 MW in total 32 198 MW was provided by the private sector (EGC).

<sup>4</sup> One of the methods to deals with climate change is carbon capture and storage (CCs) recently, but if taken current and future energy demand increase, and technological and economics

<sup>5</sup> "Not in My Back Yard" indicates oppositions of residents for new civic project and development policy implementations

<sup>6</sup> For last five questions is asked for exploring economical attitudes on nuclear energy in the Turkish community

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