Journal of Engineering Research and Applied Science
Available at www.journaleras.com
Volume 4(1), June 2015, pp 265-277
ISSN 2147-3471 © 2015

Energy security in a developing world: a case of Turkey

K.Kaygusuz[1,a], E.Toklu[2], A.Coskun Avci[2]

[1]Karadeniz Technical University, Chemistry, Trabzon, Turkey.
[2]Duzce University, Mechanical Engineering, Duzce, Turkey.

Accepted 10 Feb 2015

Abstract
Energy security is a fuzzy concept that has traditionally been used to justify state control over energy and a reluctance to deal with energy issues at global level. However, over time, the concept is acquiring different meanings that are applicable at different levels of governance. Many of the elements of the new definitions also imply a number of inherent contradictions. It argues that within developing countries, energy security implies both access to modern energy services by the poorest aswell as access by the rapidly developing industrial, services, and urban sectors. Lack of adequate resources has implied trade-offs in terms ofwhogets access and in terms of taking into account the social and ecological consequences of specific energy sources. Furthermore, the growing developing country's need for energy is impacted by industrialized country perceptions of the various dimensions of energy security. The development of reliable, continuous, affordable, and environmentally sound provision of energy services combined with a focus on energy efficiency and conservation is the only way of alleviating the various multi-level dimensions of energy security. Turkey is an energy importing country with more than half of the energy requirement being supplied by imports (76% of the total). Turkey should change its energy policy to simply optimize energy consumption by supporting energy efficiency, give up on supporting environmentally hazardous energy generation such as nuclear, coal, or shale gas, and aim for 100% renewable energy. This will help relieve the economy by reducing energy importation, protect the environment by reducing carbon emissions, and provide energy independence which is a national security matter. Residential and commercial buildings consume a considerable amount of the energy produced in Turkey. A reduction to 25% to 50% of energy consumption is possible with only proper insulation of these buildings. In this context, buildings that are efficiently designed and configured will provide energy savings. This paper discusses the energy security in developing countries such as Turkey.

Keywords: Energy security; renewable energy; energy efficiency; developing countries

1. Introduction

Energy security is an evolving concept [1]. Following the significance of reliable access to energy during the two world wars, energy security was used to justify a nationalistic approach to energy and attempts to internationalize the scope of energy security were preempted [2]. Energy security was seen as an integral element of national security, with oil as its primary focus [3]. Energy security became a hot topic after the oil crises of the 1970s. In response, the industrialized countries created an energy security system based on cooperation, coordination, monitoring, and strategic stockpiling [4]. Today, energy security is evolving rapidly to imply a more complex, multi-faceted concept [5].

The multi-faceted nature can be seen from a 2012 energy report of the Turkish administration tried to give the issue in its title 'Reliable, Affordable and Environmentally Sound' [6]. Despite the fact that the issue seems intuitively clear, an accepted analytical and unambiguous definition of energy security seems to be lacking [7]. Other refer to the four R's of energy security as: review (availability and situation), reduce (conserve), replace (shift to other sources), and restrict (new demands) [8]. One analyst called energy security as 'one of the most overused and misunderstood concepts in the energy debate' [9]. Another analyst noted that most definitions are primarily self-serving and ideologically laden, from those who promote free trade, free market, and small government to those who promote the opposite [10]. Energy security has been used as an argument to

[a] Corresponding author;
Phone: +90-539-738-8154, Email: kamilk@ktu.edu.tr

justify a range of often inconsistent decisions [11]. A possible explanation of the 'fuzziness' of the concept may be related to the fact that different dimensions of the concept may (sometimes) be contradictory. Some of these contradictions are further explored in this article, but with a specific focus on energy security issues in relation to the developing World and Turkey [7-12].

The transition to the multi-faceted nature has certain features [12]. First, the focus has shifted from oil alone to more energy sources, initially to natural gas, but eventually also to the supply of electricity [13]. Second, energy security is no longer only related to national security concerns but is also related to human security issues which focus on the affordability and availability of energy to the poorest people—a key issue for the developing world that is also perceived as a global concern as evident from their inclusion in the Millennium Development Goals [14]. Third, energy security has become linked to environmental security issues and sustainable energy sources have become the focus of policy [15]. Fourth, energy and environmental security concerns have merged in the call for demandside management and energy efficiency [16]. The threats to energy security have therefore also diversified, with respect to geography, technology, agents, institutions, and possibly solutions [1-3; 7-8].

Most papers on energy security focus on the perspectives and positions of the industrialized countries (IC) [14-16]. In contrast, this article examines what energy security implies to developing countries (DCs) and what it implies to these countries in the context of their relationship with the industrialized World [17]. The concept of energy security changes as the context of the discussion changes. Within the context of DCs, energy security has two key faces; first, the provision of energy access to the poorest in rural and peri-urban areas and second, the continued access to energy by the industrial, service, and urban sectors [18]. However, there are a number of challenges that DCs face in the domestic context. At the same time, the DCs' use and exploitation of energy resources has complex implications for global security, global energy security, and global environmental security [19]. Global governance on energy issues is struggling to cope with these. These are the different dimensions that are explored further in this article [20-22].

2. Global energy consumption

World primary energy demand is projected in the Reference Scenario to expand by almost 40% from 2013 to 2030, an average annual increase of 1.4% per year. In 2030, demand will reach 15.4 billion tons of oil equivalent (toe) compared to 10.3 billion toe in 2000 (Table 1). The projected rate of growth is, nevertheless, slower than over the past three decades, when demand grew by 2% per year. On the other hand, fossil fuels will continue to dominate global energy use. They will account for around 85% of the increase in world primary demand over 2002-2030. And their share in total demand will increase slightly, from 80% in 2000 to 82% in 2030. The share of renewable energy sources will remain flat, at around 14%, while that of nuclear power will drop from 7% to 5% [23-26].

Oil will remain the single largest fuel in the global primary energy mix, even though its share will fall marginally, from 32% in 2013 to 35% in 2030 [24]. Oil use will become increasingly concentrated in the transport sector, which will account for two-thirds of the increase in total oil use. Transport will use 54% of the world's oil in 2030 compared to 36% now and 28% in 1980 [25]. In OECD countries, the use of oil in the residential and services sector will decline sharply. In many developing countries, oil products will remain the leading source of modern commercial energy for cooking and heating, especially in rural areas [26].

Primary demand for natural gas will grow at a steady rate of 2.4% per year over the projection period. By 2030, gas consumption will be about 90% higher than now, and gas will have overtaken coal as the world's second-largest energy source. The share of gas in total primary energy use will increase from 23% in 2013 to 25% in 2030. The power sector will account for 60% of the increase in gas demand, with its share of the world gas market rising from 38% in 2013 to 47% in 2030. The power sector will be the main driver of demand in all regions. Natural gas will remain the most competitive fuel in new power stations in most parts of the world, as it is the preferred fuel for high-efficiency combined-cycle gas turbines. A small but growing share of natural gas demand will come from gas-to-liquids plants and from the production of hydrogen for fuel cells [24, 25]. Coal use worldwide is projected to increase by 1.3% per year between 2013 and 2030. By the end of the 2013, coal demand, at just over 4 billion tons, will be just about 50% higher than at present. The share of coal in total primary energy demand will, nonetheless, fall slightly, from 23% to 22% [24].

Coal consumption will increase slowly in end-use sectors. Industry, households and services in non-OECD regions will use more coal, more than offsetting a continuing decline in OECD final consumption.

The role of nuclear power will decline progressively by the end of 2013. The rate of construction of new reactors is expected to keep pace with the rate at which old reactors are retired. This is both because nuclear power will have trouble competing with other technologies and because many countries have restrictions on new construction or policies to phase out nuclear power. As a result, nuclear production will peak soon after 2010 and then decline gradually. Its share of world primary demand will drop from 7% at present to 6% in 2010 and to 5% by 2030. Nuclear output will increase in only a few countries, mostly in Asia.

Table 1. World primary energy demand by fuel (Mtoe) [24]

	1980	2000	2013	2020	2030
Coal	1 788	2 295	3 973	3 966	3 448
Oil	3 107	3 649	4 235	4 346	4 313
Gas	1 235	2 088	2 880	3 132	3 547
Nuclear	186	675	646	968	1 044
Hydropower	148	225	320	376	482
Bioenergy	748	1 045	1 366	1 501	1 827
Other renewables	12	55	159	268	708
Total	7 223	10 034	13 579	14 556	15 370

Renewable energy continued to grow in 2013 against the backdrop of increasing global energy consumption and a dramatic decline in oil prices during the second half of the year. Despite rising energy use, fort he first time in four decades, global carbon emissions associated with energy consumption remained stable in 2013 while the global economy grew. On the other hand, renewable energy sources represented approximately 60% of net additions to global power capacity in 2013, with significant growth in all regions. Wind, solar PV, and hydropower dominated the market. By year's end, renewables comprised an estimated 28% of the world's power generating capacity, enough to supply an estimated about 23% of global electricity. Table 2 shows the global renewable energy capacities in 2013 [26].

Table 2. Global renewable energy capacities in 2013 [26]

Renewable energy	Capacity
Power generation (GW)	
Wind power	319
Biomass power	88
Solar PV	138
Geothermal power	12
Concentrating solar power (CSP)	3.4
Hydropower	1 018
Ocean power	0.5
Hot water/heating (GW_{th})	
Modern biomass heating	320
Solar colectors for hot water/space heating	373
Geothermal heating	66
Transport fuels (billion liters/year)	
Ethanol production	87.8
Biodiesel production	26.3

3. Energy security in developing countries

In many parts of the world, access to modern energy services is poor, irregular, or unreliable [1]. The poverty, development, and energy security discussion has two dimensions to it. First, at national level, DC governments see a direct link between increased Access to energy services and economic development [2]. This is not only evident in the scientific literature but also in the policy and negotiating positions taken by these countries in the

international climate negotiations [3]. This often translates into increased access for the industrial, services, and urban sectors. For example, the Indian industry and services sector has faced a major shortage in energy supply to meet the needs of its industrial sector and this has been amajor incentive for increasing energy supply [7-9; 24-26].

The other dimension is the access of the poor and marginalized to modern energy services [2]. Currently, 2.6 billion people worldwide rely on traditional biomass such as dung, charcoal, or fuelwood as their primary source of energy, and it is estimated that 1.6 billion people lack Access to electricity, the large majority of them in DCs [24]. The provision of improved energy services has been deemed essential for increasing food security, health, education, living standards, as well as to foster economic development [25]. The United Nations Development Program recognizes that 'none of the Millennium Development Goals (MDGs) can be met without major improvement in the quality and quantity of energy services in DCs' [17]. The development of productive activities, health and educational facilities, gender equity, and environmental sustainability all depend on having clean and efficient modern energy services as given in Table 3 [17].

Table 3. Energy and the Millennium Development Goals (MDGs) [14-17]

MDG	Role of Energy
Eradicate extreme poverty hunger	▪ Development of agriculture, industry, commerce, and services. Lighting for work after daylight. ▪ Food cooking, processing and conservation
Achieve universal primary education	▪ Heating, electricity and information and communication technologies in schools. ▪ Energy Access to attract teachers to poorer, particularly rural areas. ▪ Lighting for evening classes and home study. ▪ Freeing children, especially girls, from the need to collect
Promote gender equality and empower women	▪ Freeing women from the need to collect biomass, from the hazards of indoor air pollution due to traditional fuel use and providing more efficient stoves and other household equipment, allowing women to save their time and effort for education, social and economic opportunities.
Reduce child mortality	▪ Reduction of child disease and mortality from exposure to indoor air pollution or from drinking non-boiled water.
Improve maternal health	▪ Power for health clinics and lighting during nighttime deliveries.
Combat HIV/AIDS, malaria and other diseases	▪ Lighting, refrigeration, and sterilization fort he provision of health services.
Ensure environmental sustainability	▪ Sustainability depends on clean energy systems which mitigate climate change and pollution and avoid damage on land, forests, or water resources.
Develop a global partnership for development	▪ Energy has been part of the World Summit on Sustainable Development's call for partnerships among governments, non-state actors, and international organizations

However, the twin challenges in DCs are subject to three types of trade-offs [2]. First, the lack of adequate resources in these countries leads to trade-offs in making priorities with regard to where and for whom energy services should be provided [3]. Progress so far has been highly uneven both in terms of geography and of urban–rural parity. While China, Latin America, and much of the Asia-Pacific region have succeeded in increasing the percentage of their population served with modern energy, in Sub-Saharan Africa and South Asia population growth has largely outpaced those advances [17]. This is a trend which has persisted since at least the early 1970s [18]. At the same time, most of those who

gained access to modern energy through the last decades live in urban areas; four of the five persons without such access today are rural dwellers [19]. Rural areas are much harder to reach with usually centralized power grids, and high start-up costs coupled with fewer economic returns due to low population densities and the consumptive rather than productive nature of the use which lead these areas to be frequently excluded from large-scale energy infrastructure programs. Even when energy becomes

available, it often remains expensive and demands a large share of the rural poor's income, so affordability too becomes an issue [18-21].

Second, the lack of adequate resources leads to trade-offs regarding environmental sustainability [1]. Most developing countries find renewable energy sources relatively expensive and focus on fossil fuels instead [3]. Access to modern Technologies has not always been easy and older and less environmentally friendly technologies are cheaper and more affordable.

Third, liberalization of the energy markets and lean national governance frameworks tend to favor high return energy investments over energy for consumptive uses of the poorest. On the one hand, the liberalization process itself focuses on profit maximization [2]. While in the 1950s oil ownership was concentrated in the hands of a few companies, in both developed and developing countries, power companies and infrastructure tended to be state-owned and centrally organized [2]. A trend to liberalize the power sector was evident in the latter half of the 20th century and since the early 1990s DCs were put under pressure to liberalize their markets [22]. In many DCs, there was also increasing dissatisfaction with the low service quality, non-collection rates, high network losses, poor service coverage, and the increasing drain on public finances [1]. Kuik et al., [2] point out that in the early 1990s, the average electricity tariff in DCs was about 4 cents per kWh, whereas generation costs was about 10 cents per kWh. Such subsidies, they argue, left many utilities economically crippled, unable to finance any quality improvements of their services or extensions to rural areas [7]. The combination of domestic dissatisfaction and pressure from the development banks and aid agencies led to electricity sector reform and liberalization [8]. One of the major opportunities lies in the attraction of private capital to finance badly needed investments in energy infrastructure. For India alone, it has been estimated that it would need $665 billion over 30 years to finance the necessary expansion and modernization of its electricity sector [11]. Various climate change mechanisms and also other international funding mechanisms could possibly fund a part of these capital requirements [12].

4. Management of the global energy security

Global energy governance is highly diffuse: there are a range of activities by governmental actors, hybrid bodies, and treaties that are of relevance. There is no common forum focusing on resolving conflicts between countries and in dealing with the multiple dimensions of the energy security issue [1-3].
There is only one dedicated agency for the International Atomic Energy Agency (IAEA) established in 1957. However, there are several UN agencies that work on various dimensions of energy [12]. As and when problems emerged, ad hoc solutions were envisaged. For example, the problem of large dams led to the establishment of the World Commission on Dams[22]. The UN Commission on Sustainable Development has occasionally dealt with energy issues. In 2003, a decision was taken by the UN to set up a collaborative body and in 2004, UN Energy was created to help unite UN agencies working on energy issues. They focus on four areas—contribution to energy discussion, policy coherence and operational cooperation, information and knowledge management, and cooperation with non-UN partners, but the level of work conducted is quite limited [10]. UN Energy has at present 20 members including FAO, IAEA, the World Bank, and others [19]. The bottom line is that at UN level there is no clear policy framework for managing energy issues [17]. Even the European Union has been unable to come up with a coherent energy security strategy [10-20].

Aid agencies and development banks have made policy on investing in energy infrastructure and this has been influential [1]. Their own policies backed by financial assistance have had a critical influence on the nature of developments in the energy infrastructure and governance sector in key DCs [2]. Many of these agencies have promoted liberalization of the energy sector in the developing world. They also have mechanisms in place pushing for promoting energy access for the poorest through channeling official development assistance funds in this direction [12]. Export credit agencies are also providing assistance in the area of energy but have often promoted fossil fuel technology exports.

There is a dearth of global declarations on energy and policy statements [2]. The Millennium Development Goals aimed to prioritize energy access of the poorest. Multilateral energy agreements are limited to the Energy Charter and the agreements of the International Energy Agency [23]. Some 1400 bilateral and plurilateral agreements on energy have been made between countries. However, the proliferation of these agreements does not provide any clear governing framework on how local to global energy security dimensions can be taken into account [12]. In the meanwhile agreements made in

specific areas have impact on global energy decisions. For example, the discussions within the Climate Change negotiations focus considerably on the nature of energy resources and its Clean Development Mechanism also aims to promote modern energy technologies in the developing world [11-13].

Essentially, the market runs energy governance. Ongoing market reforms in electricity markets have changed the role and position of governments in these markets [1]. The role has changed from a monopoly supplier to a network player alongside private parties and stakeholders. More competition, improved technologies, and the traditional problems with centralized power grids have created opportunities for decentralized energy systems based on renewable energies to address issues of local energy scarcity and security [3]. Governments have to weigh-off the costs and benefits of this alternative approach to the traditional approach of power grid extension on a case-by-case basis [4]. They should also probably consider ways to alleviate financial constraints with regard to up-front investment costs of such decentralized options, and to examine and test new management and business models at the local level [5].

In the governance vacuum that has emerged in the field, the G-8 stepped in and developed a plan of action on Global Energy Security through increasing transparency, predictability, and stability of global energy markets; improving the investment climate in the energy sector; enhancing energy efficiency and energy saving; diversifying the energy mix; ensuring physical security of critical energy infrastructure; reducing energy poverty; and addressing climate change and sustainable development. The G-8 is thus actively promoting energy governance at least at rhetorical level, and there are now increasing calls for global governance on energy [11,13,15].

The bottom line is that energy governance is an area where national security interests are more explicitly prioritized over global issues, and the natüre of the explicit recognition of these interests has implied that countries are unwilling to promote and support a comprehensive global governance framework on energy. The diffuse and competing results of the different governance frameworks provide countries with the space to promote some common interests, while still maintaining the sovereign rights to do as they please in the energy arena in the domestic context [12].The main challenge at the global level is threefold [1]. First, will countries that see energy security most dominantly within the national security framework. Second, given the significant role of energy in national income, will countries be able to rise above the short-term economic interests embedded in energy politics and trade [2]. Third, given the vast differences in contextual policies at local, provincial, and national levels. To some extent, global governance on energy is already taking place [3]. What remains to be seen is whether these different forms of international cooperation are able to focus more on sustainable energy issues than on the transfer of older and unsustainable technologies.

5. Energy security in Turkey

5.1. Energy situation in Turkey

As a developing country an in conjunction with its fast growing economy and population Turkey's energy consumption has increased rapidly as shown in Figs. 1-3 [27]. For example, while total primary energy consumption in 1996 was 71 Million tons of oil equivalent (Mtoe) in 2013 it raised 120 Mtoe and total energy production in 1996 was 28 and 32 Mtoe in 2013 [28]. Turkey is an energy importing country and dependent on the imported energy sources as given in Table 4 [28].

Table 4. Turkey's energy production and consumption in 2013 (Mtoe) [28]

Energy source	Production	Consumption
Hard coal	990	17 692
Lignite	13 973	13 182
Asphaltite	488	416
Oil	2 485	33 896
Natural gas	443	37 628
Hydropower	5 110	5 110
Geothermal (electric)	1 173	1 173
Geothermal (heat)	1 463	1 463
Animal & plant wastes	1 666	1 666
Wood	2 707	2 707
Wind	650	650

Solar	795	795
Total	31 944	120 290

Furthermore this trend seems to be continuing in the future. Although it has a wide variety of energy sources, the quality and quantity of most of the sources are not sufficient to produce energy. Some of the energy sources in Turkey are hard coal, lignite, asphalt, oil, natural gas, hydropower, geothermal, wood, animal and plant wastes (bio mass), solar and wind energy [29]. The proven reserves of lignite, the most abundant domestic energy source, is 7300 million ton and found in almost all of the country's regions. Lignite has the largest percentage in total energy production with its 43% share. After lignite, wood has the greatest share in total energy production with its 20% and oil accounts for 13%, 12.4% hydro and the final 15% includes animal wastes, solar, hard coal, natural gas, geothermal electricity and geothermal heat [27-29].

Turkey's various renewable energy sources represent its second largest energy source after coal [27]. Biomass and animal waste account 64 %, hydropower 30.2 %, geothermal 3.2 % and wind and solar account for 2.6 % each of total renewable energy production [28]. There are many rivers in Turkey, thus water sources are one of the most important energy sources. In Turkey, 24 % of electricity generation was provided by hydropower in 2013, and will be increased to 36 % in 2020 [28]. The largest hydro power project in Turkey is the Southeastern Anatolia Project (GAP). Upon competition, GAP will have an installed capacity of 7476 MW 22% of Turkey's total estimated economic potential [27-29].

5.2. The role of renewables for energy security in Turkey

Renewable energy supply in Turkey is dominated by hydropower and biomass, but environmental and scarcity-of-supply concerns have led to a decline in biomass use, mainly for residential heating [30]. Total renewable energy supply declined from 1990 to 2007, due to a decrease in biomass supply [29].

As a result, the composition of renewable energy supply has changed and wind power is beginning to claim market share. As a contributor of air pollution and deforestation, the share of biomass in the renewable energy share is expected to decrease with the expansion of other renewable energy sources as shown in Tables 5-7 [27]. These tables shows that there is an important renewable energy potential in Turkey [27-36].

Table 5. Turkey's total installed power in 2013 (MW) [28]

Energy source	Amount	Percent (%)
Natural gas	20 854	% 31.7
Coal	12 828	% 19.5
Other thermal	5 711	% 9.1
Hydropower	22 898	% 34.8
Wind	2 930	% 4.4
Geothermal	317	% 0.5

Table 6. Renewable energy potential in Turkey (2013) [28]

Energy source	Potential (MW)	Power plants With licence (MW)
Hydropower	45 000	20 218
Wind	48 000	9 244
Geothermal	600	636
Solar	33	-
Biomass	9.0	54
Biogas	2.0	190

Table 7. Potentials for investment for renewable energies in Turkey [28, 29]

Sectors	Million €	Remarks
Hydroelectric	114	Economical development potential of 28,600 MW, Corresponding 100,000 GWh/a
Wind power	57	Economical development potential of 48,000 MW With wind speed > 7 m/s
Solar thermal	165	Economical development potential of 131,000 GWh/a, Corresponding to approx. 300 million m^2 collector area
Biogas	4	Agricultural residual material and dung, when used for electricity generation, 1,000 MW_e and 7,000 GWh/yr
Total	340	

5.2.1. Hydropower

Hydropower is a renewable form of energy since it uses the power of flowing water, without vested or depleting it in the generation of energy. Because they are clean energy generation plants hydropower can contribute to reducing air pollution and slowing down global warming. Any other air pollutants or toxic wastes are not produced and it promotes energy safety independence and price stability. Hydropower is an electricity sources with long viability and low operation and maintenance cost [31-33].

Turkey's theoretical hydroelectric potential is 1% of that of the World and 16% of Europe. The gross theoretical viable hydroelectric potential in Turkey is 433 billion kWh and the technically viable potential is 216 billion kWh. The economically viable potential, however, is 140 billion kWh. Annual energy consumption per capita in Turkey has reached 2.900 kWh which is above world average of 2.500 kWh [28,29]. Currently, Turkey has 178 hydroelectric power plants in operation with total installed capacity of 16 160 MW generating an average of 48.000 GWh/year, which is 35% of the economically viable hydroelectric potential [28]. In 2013, 150 hydroelectric power plants are under construction 8.600 MW of installed capacity to generate average annual 20.000 GWh representing 14% of the economically viable potential. In the future, 1.418 more hydroelectric power plants will be constructed in order to make use of additional 22.700 MW installed capacity. As a result of these works, a total of 1.738 hydroelectric power plants with 45.000 MW will tame rivers to harness the economically viable hydropower of Turkey [29].

Approximately 50% of the additional potential of 38 TWh (that is, 19 TWh) could be realized as small hydroelectric plants (SHP), with installed capacities of less than 10 MW [32]. The share of SHP potential in the total, which is 3% at present, would be 14%. On the other hand, in accordance with the results

obtained from the pre-evaluation study, about 15% of the increase in 126 TWh/year exploitable energy potential might be achieved by developing additional SHP potential [33]. However, this study gives only rough results about the additional SHP potential of the country and the potential must be evaluated more precisely, with comprehensive master plan studies for each hydrological basin [30-36].

5.2.2. Bioenergy

Half of Turkey´s energy demand is covered by natural gas and oil imports [28]. Turkey´s energy demand is currently covered mainly by fossil fuels, coals, oil and natural gas and less by geothermal and hydro power plants [29]. On the other hand, Turkey has a great potential of biomass and bio-energy production. Biomass energy seems to have a major potential for the usage as a energy source. The total annual recoverable bio-energy potential in Turkey was estimated to be around 30 Mtoe, based on the recoverable energy potential from agricultural residues, livestock farming wastes, forestry and wood processing residues and municipal wastes [31, 34, 36].

The share of renewable energy sources to primary consumption is estimated to be 5 % in 2010. Additionally, the contribution of energy production share of animal wastes and plant residues to primary energy consumption in Turkey ranged from 4 % in 2000 to 2 % in 2013 as well. It seems that, despite Turkey has a great potential of biomass to produce renewable energy and the law on utilization of renewable energy resources for the purpose of generating electrical energy has been brought into action in 2005, the share of renewable energy in

energy production is still low. Biogas production potential in Turkey was estimated to be around 1.5 to 2 Mtoe. However, since the share of renewable energy in energy production is so low, the possible contribution of biogas to this share can also be ignored [27-29].

5.2.3. Geothermal energy

In the recent years, among the renewable energy alternatives, geothermal energy in world and our country has become very attractive [29]. The reason for this interest is features of geothermal energy in direct and indirect use. It is unfortunate that geothermal energy in direct use can only be utilized locally. But, firing fossil fuels at 1500 oC, and using the generated heat at only 50-60 oC is obviously a thermodynamic waste. Therefore, utilization of low grade geothermal energy resources fills an important gap in this area [28]. Although indirect use of geothermal energy with relatively low temperatures seems inefficient with respect to fossil fuel fired energy sources, it has an advantage of base-load power generation with respect to other renewable such as hydropower, biomass, wind and solar energy [27-29].

Turkey is one of the countries with significant potential in geothermal energy and there may exist about 2000 MWe of geothermal energy usable for electrical power generation in high enthalpy zones [28]. Turkey's total geothermal heating capacity is about 31,500 MWth. At present, heating capacity in the country runs at 1220 MWth equivalent to 147,000 households. These numbers can be heightened some seven-fold to 6,980 MWth equal to 600, 000 households through a proven and exhaustible potential in 2012. Turkey must target 1.2 million house holds equivalent 7,700 MWth in 2020 [29].

5.2.4. Solar energy

While energy need of Turkey in 2013 was 260 billion kWh, which has produced by using of 56 700 MW power plants (coal, natural gas, fuel and hydro), the estimation for 2015 is around 350 billion kWh which is equal to 84.000 MW Power Plant. If it is considered 72% of energy demand of Turkey is provided from fossil row material and Turkey has 67% dependency to import feedstock [29]. Because of this import row material, Turkey has paid 36 billion dollars at 2012. Turkey needs to head towards renewable energy investments. Turkey is so lucky about solar energy potentials that it has 4.2 hours insulation time avarage per day and 1514 kWh/year.m2 solar radiation level. Only available rooftop area for PV modules is 611 km2 and energy gain from this area will be 90 billion kWh/year. Apart from this area it is determined that the area which has more than 1650 kWh/m2 irradiation level is about 4600 m2 in Turkey. That means this solar energy potential equals to a natural gas plant with a power of 54,300 MW [34].

Except some special applications PV installation is almost non existing in Turkey. However, solar energy is widely used for heating water [36]. The hot water heating system installations cover about 10 million m2 surface in 2013. Turkey is the second big country at hot water heating systems all over the world. Apart from this, PV installations are not so much up to now because of the govermental issues [28]. While the existing feed in tariff is about 6.5 €cent/kWh, it is foreseen that it will be about 26 €cent/kWh for PV and 22 €cent/kWh for CSP in 2013. Moreover, there will be no licence need for systems up to 500 kW. There are some goals about PV installations in Turkey due to these regulations. It is expected that there will be 3 million installations of private homes which has totally power of 3.000 MW. In addition, the target of installed PV power plant by 2020 is 20.000 MW [27-29].

The photovoltaic sector in Turkey is still fairly small, providing work for only a small number of employees. The main actors consist of several companies and a number of research institutes [29]. There are approximately 30 companies which are operating in Turkey's PV sector. The main business types are importer, wholesale supplier, system integrator and retail sales. The companies serve in the installation, engineering and project development sectors. PV modules, battery charge controllers and inverters are mainly imported. Batteries, solar lighting systems, etc., may be supplied by the domestic market. Some of the domestic products are exported. There is not any cell production factory in Turkey [36].

The energy policy objectives of Turkey essentially require diversifying the energy sources, to use domestic energy resources, to increase efficiency in electricity generation and consumption and to create an environment-friendly power system. It is clear that all of these objectives include increasing the share of renewable energy sources in total electricity generation [36]. Although the Turkish government and citizens have been familiar with wind energy and accepted it as renewable energy technologies in recent years, most of them don't have enough knowledge about solar electricity potentials as alternative energy sources. Most of the Turkish

people believe that solar energy that can only be used for water heating. To improve a level of understanding and acceptance of PV systems, first, the production of PV panels and the usage of the PV power systems should be promoted for low cost systems. R&D studies at the universities and institutes in the PV area should be significantly supported.

5.2.5. Wind Power

Surrounded by the Black Sea to the north, the Marmara and the Aegean Sea to the west and the Mediterranean Sea to the south, Turkey has huge potential for wind power generation. A study carried out in 2002 concluded that Turkey has a theoretical wind energy potential of nearly 90,000 MW [28]. So far only about 1,000 MW capacity wind farms are in operation in Turkey, generating less than 0.5% of total electricity consumed [29]. There are a number of cities in Turkey with relatively high wind speeds. These have been classified into six wind regions, with a low of about 3.5 m/s and a high of 5 m/s at 10 m altitude, corresponding to a theoretical power production between 1000-3000 kWh/(m2.yr) . The most attractive sites are the Marmara Sea region, Mediterranean Coast, Agean Sea Coast, and the Anatolia inland [34]. Turkey's first wind farm was commissioned in 1998, and has a capacity of 1.5 MW. Capacity is likely to grow rapidly, as plans have been submitted for just under a further 600 MW of independent facilities. At start 2010, total installed wind energy capacity of Turkey is only 900 MW [36].

Turkey, in contrast, relies heavily on imported energy. Only around 30% of the total energy demand is met by domestic sources [28]. The European Wind Energy Association has estimated that Turkey could meet 20% of its electricity demand from wind power with a target capacity of 20,000 megawatts, even assuming an average 8% annual growth in power consumption. On the other hand, Turkey has plenty of great natural resources. Geographical location of Turkey is also a great advantage, especially its distance to industry demanding countries, European Union, Arabic states. In addition to that, climate is a varying factor depending on the landscape [29]. Three sides of Turkey is surrounded by Mediterranean, Black and Aegean sea with the warm and nice weather and good amount of stable wind speeds. However, to use all these advantages, Turkey needs energy. Any country that cannot produce its own energy cannot improve and will always be dependent on other countries; will lack freedom [27-39; 34; 36].

It is shown that Turkey has plenty of renewable energy resources which are still not utilized [28]. This paper proves that wind energy is one of those alternative renewable energy resources which help Turkish economy and development in the following years. Since wind energy is not a stable electricity source, it requires other sources of electricity production investments to different energy resources. In addition to that, the demand of Turkish Republic is much more than the amount that can be produced by wind energy [29].

It is a free energy resource once all the investments are completed. Price of wind does not fluctuate and by the technological advancements in wind power engineering, repair costs, and efficiency levels and it is a great way of producing energy. As a result, it was possible to produce annual energy of 22,807 GW/year from a total wind power plant area of 630 km2 which corresponds to a 35.26 GW/year per 1.0 km2. Considering the fact that it is possible to produce such energy for at least 30-40 years with today's technological achievements, it is certain that wind power plants pay back every penny that is spent to build them [28, 29].

6. Conclusions

Energy security is commonly understood as a supply of energy that is reliable, affordable, and environmentally sound. However, reliable and environmentally sound supplies may not always be affordable and this has led to many trade-offs in decisions focusing on energy supply. In a historical perspective, the Notion of energy security has broadened in a number of dimensions: from concern about oil to a broad array of energy resources, from concern within a national perspective to local and global perspectives, and from a narrow economic perspective to a sustainability perspective [2].

Energy security in relation to the developing world can be examined in terms of domestic issues and extra-territorial issues. Within the domestic context energy security has two faces mostly consumptive uses; and the priority of meeting the needs of the industrial, services and urban sectors. However, lack of resources has led to policies that make tradeoffs between these two priorities and ignore the environmental consequences of energy infrastructure. On the other hand, energy security issues have been receiving more and more attention as globally. The challenges of fossil fuel depletion and its implications for development, the dependence on foreign energy and the correlated implications for

depletion of foreign exchange resources, the rise of energy geopolitics in the aftermath of the resurgence of terrorism at the global scale, the growing issue of access to energy of the poorest people, and the issue of meeting energy demands of the fast developing economies and the implications for climate change call for a more comprehensive understanding of global energy security issues.

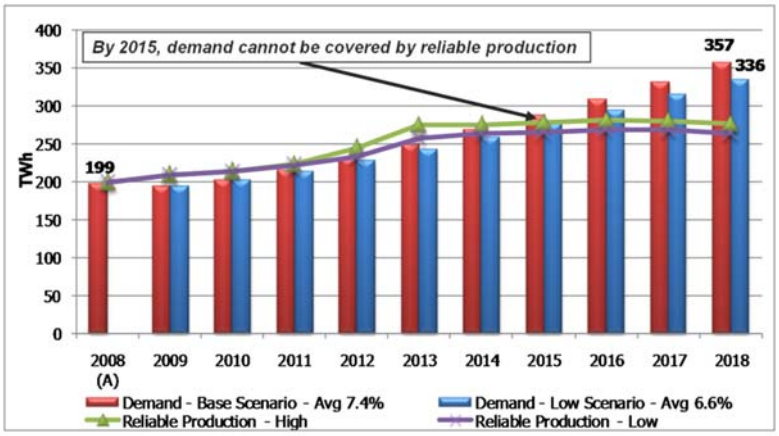

Figure 1. Electricity supply and demand projection for 2009 and 2018 period in Turkey [28].

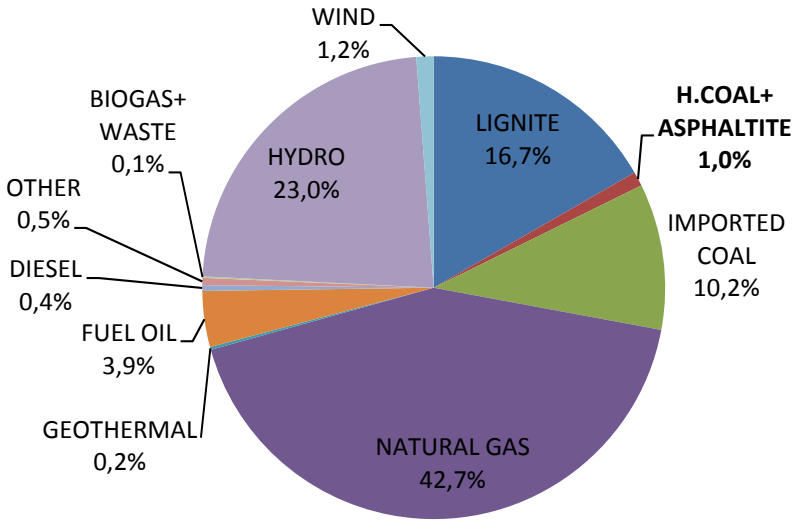

Figure 2. Share of sources in electricity generation in 2020 [29].

Turkey is a fast developing country. The GDP development between 2003-2007 was 6,9 % growth per year. The potential GDP growth is expected to be 5 % in the coming years however, state policies target to increase the GDP in the mid term at least 7%-8% per year in order to reach the half of the EU living standarts. Based on IEA reference scenario, and long term estimations, we accepted to use around 6,3% growth between 2009-2050, a realistic figure which is between the potential GDP growth and the optimistic targets.

Turkey uses the energy sources inefficiently and consumes more energy to produce a product. So, the production costs in this country are higher than the world's average. Energy policies of Turkish government should support the domestic energy sources and use the installed power plants efficiently in Turkey. Coal is the most reliable domestic energy source in Turkey should be consumed more in the industry and electricity production in order to reduce the energy production costs of Turkey and the dependency on other countries. Moreover, Turkish government should improve the coal burning technologies in the thermal power plants, so the energy production will increase and contribute to the developing economy of Turkey.

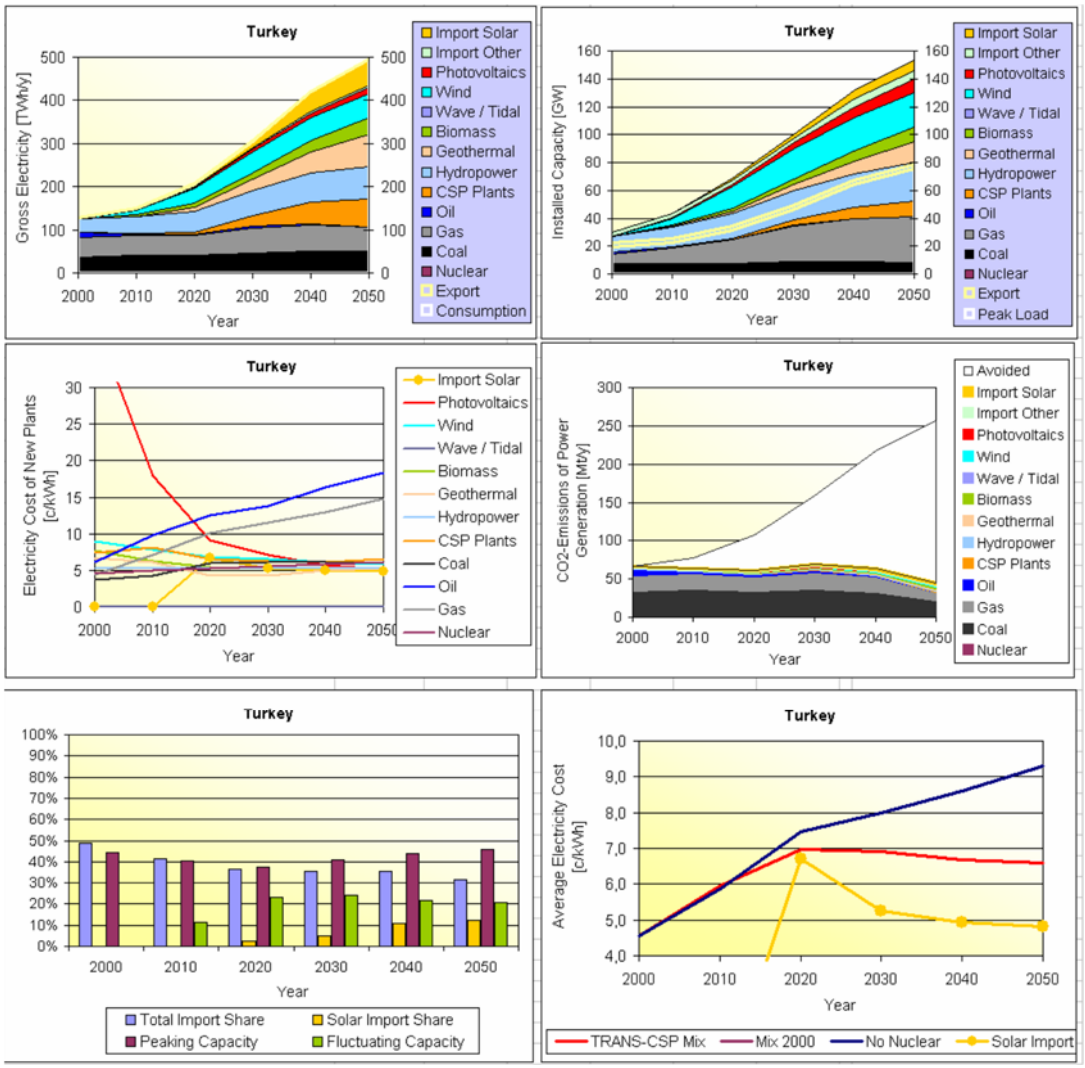

Figure 3. An overview of Turkey's energy, electricity and CO_2 emissions developments [36].

Natural gas is an expensive energy source and the consumption is high in Turkey. Moreover, the share of natural gas in electricity generation is 46% in Turkey. Because of dramatically high dependency on natural gas, Turkey will be one of the most affected countries in a possible natural gas crisis in the world. In other words, consuming natural gas is a disadvantage for Turkey in terms of development. On the other hand, energy production from renewables should be improved in Turkey to reduce the dependency and environmental pollution and increase the development level of the country by increasing the economic level of the country. The author believes that Turkey does not use its renewable energy sources efficiently and should promote new technologies and use all its renewable energy potential. On the other hand, the phenomenon of global climate change is a very serious economic, social and environmental problem. In order to diminish of this problem, the governments should be supported to utilizing renewables most effectly.

References

[1] Yergin D. Ensuring energy security. Foreign Affairs 2006, 85: 69–82.

[2] Kuik, OJ., Lima, MB., Gupta, J. Energy security in a developing World. WIREs Climate Change 2011; 2(4): 627-634.

[3] Kruyt B, van Vuuren DP, de Vries HJM, Groenenberg H. Indicators for energy security. Energy Policy 2009, 37: 2166–2181.

[4] Kaygusuz, K. Energy services and energy poverty for sustainable rural development. Renewable and Sustainable Energy Reviews 2011; 15: 936-947.

[5] Kaygusuz, K. The paradigm of sustainability in Turkey's energy sector. Energy Sources, Part B 2011; 6: 83-95.

[6] MENR, Ministry of Energy and Natural Resources (MENR). Blue Book. available from http://www.enerji.gov.tr (accessed date 16 July

2014).
[7] Hughes L. The four 'R's of energy security. Energy Policy 2009, 37: 2459–2461.
[8] Helm D. Energy policy: security of supply, sustainability and competition.Energy Policy 2002, 30:173–184.
[9] Alhajji AF. What is energy security? Definitions and concepts. Middle East Economic Survey, L (45), 2007.
[10] UNDP, United Nations Development Programme. Energy for sustainable development: a policy agenda (Eds. TB, Johansson & J. Goldmberg), UNDP, 2002.
[11] Gupta J, Ivanova A. Global energy efficiency governance in the context of climate politics. Energy Efficiency 2009, 2: 339–352.
[12] Umbach F. Global energy security and the Implications fort he EU. Energy Policy 2010, 38: 1229–1240.
[13] Lefevre N. Measuring the energy security implications of fossil fuel resource concentration. Energy policy 2010, 38: 1635–1644.
[14] UNDP, United Nations Development Programme (Eds. Modi V, McDade S, Lallement D, Saghir J). Energy services for the millennium Development Goals. NY: Energy Sector Management Assistance Programme, UN Millennium Project, and World Bank; 2005.
[15] Gupta J, van Asselt H, Kuik O, Evans C. Exogenous promotion of sustainable electricity options in India: opportunities and challenges. Energy Environment 2007, 18: 403–420.
[16] Rehfuess E. Fuel for life: household energy and health. Geneva: World Health Organization; 2006.
[17] UN-Energy. The energy challenge for achieving the Millennium Development goals.United Nations 2005. at: http://esa.un.org/un-energy/. (Accessed June 15, 2012).
[18] UNDP, United Nations Development Programme. Human Development Report 2007/2008. New York, 2008.
[19] World Bank. Rural energy and development for two billion people. Washington, DC, World Bank, 1996.
[20] Silva D, Nakata T. Multi-objective assessment of rural electrification in remote areas with poverty considerations. Energy Policy 2009; 37: 3096–3108.
[21] Jamasb T, Mota R, Newberry D, Pollitt M. Electricity sector reform in developing countries: a survey of empirical evidence on determinants and performance. World Bank Policy Research Working Paper, 2005.
[22] WCD, World Commission on Dams. Dams and development: a new framework for decision-making, The Report of the WCD. London: Earthscan Publishing; 2000.
[23] IEA, International Energy Agency. Renewables for heating and cooling. IEA, 2007.
[24] IEA, International Energy Agency. World energy Outlook 2012. IEA, Paris, 2012.
[25] WEC, World Energy Council. World Energy Survey 2012, WEC, 2012.
[26] REN21. Renewables 2013 Global Status Report. Paris, France: REN21 Secretariat; 2013 Available at: http://www.ren21.net/ (accessed 12.06.2014).
[27] IEA, International Energy Agency. Energy Policies of IEA Countries: Turkey 2009 Review, OECD/IEA, Paris, 2010.
[28] MENR, Ministry of Energy and Natural Resources (MENR). Energy Statistics in Turkey. available from http://www.enerji.gov.tr (accessed date 16 January 2014).
[29] WECTNC, World Energy Council Turkish National Committee. Energy report of Turkey for 2012, WECTNC, Ankara, Turkey, 2012.
[30] Ozturk M, Cicek BN, Ozek N. Turkey's energy production, consumption, and policies, until 2020. Energy Source Part B 2009; 4: 315–31.
[31] Kaygusuz, K. Sustainable energy, environmental and agricultural policies in Turkey. Energy Conversion and Management 2010; 51: 1075-84.
[32] Kucukali S, Baris K. Assessment of small hydropower (SHP) development in Turkey:laws, regulations and EU policy perspective. Energy Policy 2009; 37: 3872–79.
[33] DSI, State Water Works. Hydropower potential in Turkey, Ankara, Turkey, 2011.
[34] Kaygusuz, K. Clean energy policies for sustainable development in Turkey. Journal of Engineering research and Applied Science. 2012; 1(2): 1-10.
[35] Yüksel, I. Hydropower for sustainable water and energy development.Renewable and Sustainable Energy Reviews 2010; 14: 462-469.
[36] Kaygusuz, K., Toklu, E. Energy issues and sustainable development in Turkey. Journal of Engineering research and Applied Science. 2012; 1(1): 1-25.