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Clean energy in Turkey for climate change mitigation

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Abstract
Energy is an essential factor to achieve sustainable development. Global energy production is growing fastly. As would be expected, the rapid expansion of energy production and consumption has brought with it a wide range of environmental issues at the local, regional and global levels. Clean energy technologies such as wind, biomass, hydropower, geothermal and solar are finally showing maturity. With respect to global environmental issues, Turkey's carbon dioxide emissions have grown along with its energy consumption. States have played a leading role in protecting the environment by reducing emissions of greenhouse gases. In this regard, clean energy resources appear to be the one of the most efficient and effective solutions for sustainable energy development in Turkey. Turkey's geographical location has several advantages for extensive use of most of these clean energy sources. This study shows that there is enough clean energy potential in Turkey for fuels and electricity. Especially hydropower, biomass, solar and wind are very well.

Keywords: Energy issues; renewable energy; sustainable development; Turkey

1. Introduction

Energy is essential to economic and social development and improved quality of life in all countries [1]. Much of the world's energy, however, is currently produced and consumed in ways that could not be sustained if technology were to remain constant and if overall quantities were to increase substantially [2]. The need to control atmospheric emissions of greenhouse and other gases and substances will increasingly need to be based on efficiency in energy production, transmission, distribution and consumption in the country [3]. Electricity supply infrastructures in many developing countries are being rapidly expanded as policymakers and investors around the world increasingly recognize electricity's pivotal role in improving living standards and sustaining economic growth [4].

There is a growing concern that sustainable development may be compromised unless measures are taken to achieve balance between economic and environmental outcomes. Since the early 1980s, Turkish energy policy has concentrated on market liberalization in an effort to stimulate investment in response to increasing internal energy demand. The governments has continued this policy despite lower energy demand induced by the 2001 economic crisis. This paper provides an overview of the clean energy utilization for climate change mitigation and energy sustainability in Turkey.

2. Global energy consumption

Global energy consumption in the last half century has rapidly increased and is expected to continue to grow over the next five decades [5]. The past increase was stimulated by relatively "cheap" fossil fuels and increased rates of industrialization in North America, Europe and Japan; yet while energy consumption in these countries continues to increase, additional factors make the picture for the future more complex [6]. These additional complicating factors include China and India's rapid increase in energy use as they represent about a third of the world's population; the expected depletion of oil resources in the near future; and, the effect of human activities on global climate change [3, 7]. On the

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positive side, the renewable energy technologies of wind, biofuels, solar thermal and photovoltaics are finally showing maturity and the ultimate promise of cost competitiveness [8-10].

The total global primary energy demand was 13 579 million tons of oil equivalent (Mtoe) (Table 1) [5]. The rate of growth is rising mainly due to the very rapid growth in Pacific Asia which recorded an average increase from 2000 to 2013 of 8.6% [5, 6]. Coal is presently the largest source of electricity in the world [5, 6]. All renewables combined accounted for only 18% share of electricity production in the world, with hydroelectric power providing almost 90% of it [5, 10]. However, as the renewables mature and become even more cost competitive in the future they will be in a position to replace a major fraction of fossil fuels for electricity generation [4].

Therefore, substituting fossil fuels with renewables for electricity generation must be an important part of any strategy of reducing CO2 emissions into the atmosphere and combating global climate change [5]. Figure 1 shows the greenhouse gas emissions.

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

	2013	2020	2030
Coal	3 973	3 963	4 908
Oil	4 235	4 415	5 109
Gas	2 880	3 152	3 670
Nuclear	646	841	901
Hydropower	320	386	414
Bioenergy	1 366	1 375	1 662
Other renewables	159	320	350
Total	13 579	14 623	17 014

Mtoe: Million tons of oil equivalent

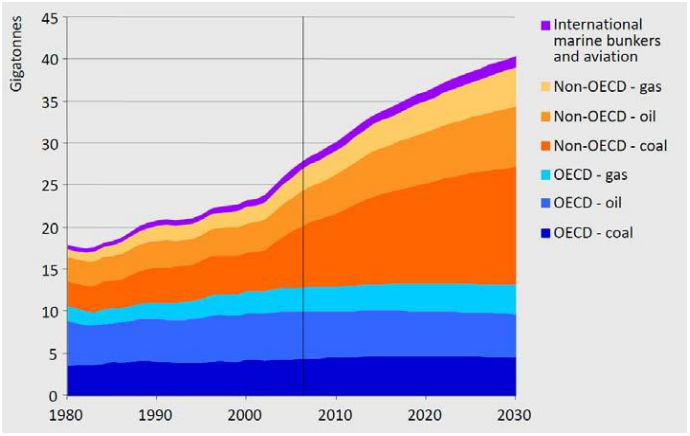

Figure 1. World-wide greenhouse gas emissions (in Gton CO2-equivalent) resulting from the use of fossil energy.

Renewable energy continued its strong growth in 2010 as well. In 2009, renewable energy supplied an estimated 16% of global final energy consumption including traditional biomass, hydropower, wind, solar, geothermal, modern biomass, and biofuels.

Traditional biomass used primarily for cooking and heating in rural areas of developing countries, accounted for approximately 10% of the total renewable energy share [8-10]. Hydropower represented 3.4% and is growing modestly but from a large base. All other renewables accounted for approximately 2.8% in 2013 and are growing very rapidly in many developed countries as well as in some developing countries [10]. On the other hand, hydropower, biomass power and heat, and geothermal heat and power are growing at more ordinary rates of 3–9% per year, making them more comparable with global growth rates for fossil fuels. In several countries, however, the growth in these renewable technologies far exceeds the global average. Table 2 shows the global renewable energy capacities in 2014.

Table 2. Global renewable energy capacities in 2014

Renewable energy	Capacity
Power generation (GW)	
Wind power	298
Biomass power	72
Solar PV	40
Geothermal power	11
Concentrating solar power (CSP)	1.1
Hydropower	1,210
Ocean power	0.3
Hot water/heating (GW_{th})	
Modern biomass heating	320
Solar colectors for hot water/space heating	185
Geothermal heating	52
Transport fuels (billion liters/year)	
Ethanol production	96
Biodiesel production	29

New wind power capacity added during 2014 reached 54 GW, more than any other renewable technology and over three times the 11.5 GW of wind added worldwide just five years earlier [9]. As a result, existing capacity increased more than 24% relative to 2009, with total global capacity nearing 218 GW by year's end [9, 10]. On the other hand, Biomass is commonly used to produce power and/or heat, and some is transformed into liquid biofuel for transportation. Technologies for generating electricity from biomass include direct firing of solid biomass, municipal organic waste, biogas, and liquid biofuels [1, 4]. Significant increases in biomass use for power production were seen during 2014 in a number of EU countries, the USA, and in China, India, and several other developing countries. Globally, an estimated 82 GW of biomass power capacity was in place by the end of 2014 [10-12].

Solar photovoltaic (PV) capacity was added in more than 110 countries during 2014, ensuring that PV remained the world's fastest growing power-generation technology [9]. An estimated 27 GW of PV capacity was added worldwide in 2014, bringing the global total to about 60 GW. Total existing capacity of all PV grew 72% relative to 2014, with the average annual growth rate over the 2000 to 2014 period exceeding 124% [5, 9, 10].

By the end of 2014, total global geothermal installations came to just over 16 GW and geothermal plants generated about 76.2 TWh of electricity during the year [9]. The lack of available drilling rigs has hindered geothermal developers worldwide, while the lack of a qualified workforce has presented challenges in Kenya and elsewhere; it has been projected that by 2014, the need for drilling rigs in the USA alone will rise almost 150% [9, 10].
Global hydropower production increased more than 7% in 2014, due greatly to new capacity and wet weather in China, and represented about 22% of global electricity production [9].

An estimated 40 GW of capacity was added during 2014, with existing global capacity reaching an estimated 1,210 GW. The top countries for hydro capacity are China, Brazil, the United States, Canada, and Russia, which account for 56% of total installed capacity. China added 16 GW during 2014 to reach an estimated 213 GW of total hydro capacity [1]. Brazil brought about 5 GW into operation, bringing its existing capacity to 80.7 GW, with a further 8.9 GW under construction. Canada generated about 378 TWh of electricity with hydropower in 2014. Development in the USA has slowed recently due to the economic recession, but just over 0.02 GW of new hydro began operating in 2014 for a total of 88 GW. Russia has an estimated 55 GW, which represents about onefifth of the country's total electric capacity [1, 3, 5, 9, 10].

3. Clean energy for climate change mitigation

All societies require energy services to meet basic human needs and to serve productive processes [1]. The quality of energy is important to the development process [2]. For development to be sustainable, delivery of energy services needs to be secure and have low environmental impacts [2]. Sustainable social and economic development requires assured and affordable access to the energy

resources necessary to provide essential and sustainable energy services. This may mean the application of different strategies at different stages of economic development. To be environmentally benign, energy services must be provided with low environmental impacts, including GHG emissions [1-4].

GHG emissions associated with the provision of energy services are a major cause of climate change. Most of the observed increase in global average temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations." . Concentrations of CO2 have continued to grow since the AR4 to about 390 ppm CO2 or 39% above pre-industrial levels by the end of 2010 [7]. Forest clearing and burning and land use change, and the release of non-CO2 gases from industry, commerce and agriculture also contribute to global warming [7, 10].

Deployment of renewable energy has been increasing rapidly in recent years [8-10]. Under most conditions, increasing the share of RE in the energy mix will require policies to stimulate changes in the energy system. Government policy, the declining cost of many RE technologies, changes in the prices of fosil fuels and other factors have supported the continuing increase in the use of renewables. While renewable energy is still relatively small, its growth has accelerated in recent years, as shown in Figure 2 [7]. In 2014, despite global financial challenges, renewables capacity continued to grow rapidly, including wind power (32%, 38 GW added), hydro (3%, 31 GW added), gridconnected photovoltaics (53%, 7.5 GW added), geothermal power (5%, 0.6 GW), and solar hot water/heating (24%, 34 GWth) [9].

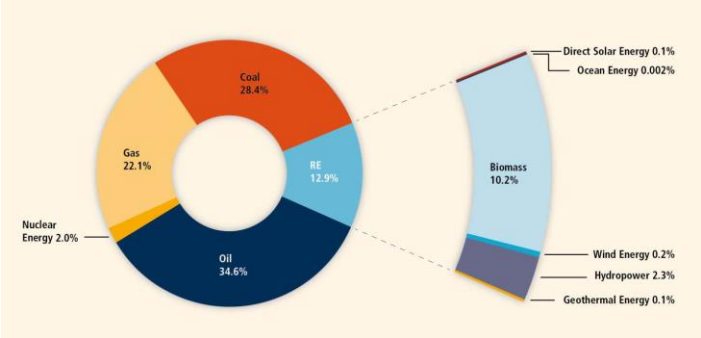

Figure 2. Shares of energy sources in total global primary energy supply in 2012

4. Energy consumption in Turkey

Turkey is an energy importing country; more than half of the energy requirement has been supplied by imports [11, 12]. Oil, coal and gas have the biggest share in total primary energy consumption [13-15]. Turkey, with its young population and growing energy demand per person, its fast growing urbanization, and its economic development, has been one of the fast growing power markets of the world for the last two decades [16]. It is expected that the demand for electric energy in Turkey will be 573 billion kWh by the year 2020 and 760 billion kWh by the year 2030 [13-16]. Turkey's electric energy demand is growing about 4-6% yearly due to fast economic growing [13-17].

Table 3. Total energy production in Turkey (Mtoe)

Energy Sources	2014	2020	2030
Coal and Lignite	26.15	32.36	35.13
Oil	1.13	0.49	0.17
Gas	0.17	0.14	0.10
Nuclear	-	7.30	14.60
Hydropower	5.34	10.00	10.00
Geothermal	0.98	1.71	3.64
Wood and Biomass	5.12	4.96	4.64
Solar/Wind/Other	1.05	2.27	4.28
Total production	39.94	59.23	72.56

In 2014, primary energy production and consumption has reached 40 and 153 Mtoe as shown in Table 3 and 4 [14]. The most significant developments in production are observed in hydropower, geothermal, solar energy and coal production. Turkey's use of hydropower, geothermal and solar thermal energy has increased since 1990 [15]. However, the total share of renewable energy sources in total final energy consumption (TFEC) has declined, owing to the declining use of non-commercial biomass and the growing role of natural gas in the system (see Fig. 3). Turkey has recently announced that it will reopen its nuclear programme in order to respond to the growing electricity demand while avoiding increasing dependence on energy imports [13-20]. Figure 4 shows the power generation in Turkey by energy source.

Along with the economic growth and population increase, significant increases were observed both in primary energy and electricity consumption during the 10th Plan period [16]. Consumption of primary energy reached 153 Mtoe as of the end of 2014 with an annual average increase of 3.2% while electricity consumption reached 246 billion kWh with an annual average increase of 4.8% during this period. These increases are more evident in the period following 2014 [14, 15]. Figure 5 shows Turkey's installed electricity capacity.

Table 4. Total energy consumption in Turkey (Mtoe)

Energy Sources	2014	2020	2030
Coal and Lignite	39.70	107.57	198.34
Oil	51.17	71.89	102.38
Gas	49.58	74.51	126.25
Nuclear	-	7.30	14.60
Hydropower	5.34	10.00	10.00
Geothermal	0.97	1.71	3.64
Wood and Biomass	5.12	4.96	4.64
Solar/Wind/Other	1.05	2.27	4.28
Total consumption	152.93	280.21	464.13

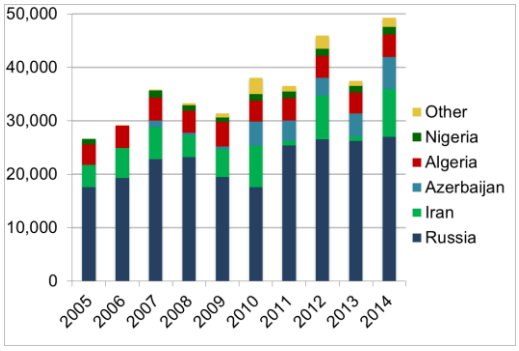

Figure 3. Turkey's annual natural gas imports (Mn Sm3) (Source: Ref. [23]).

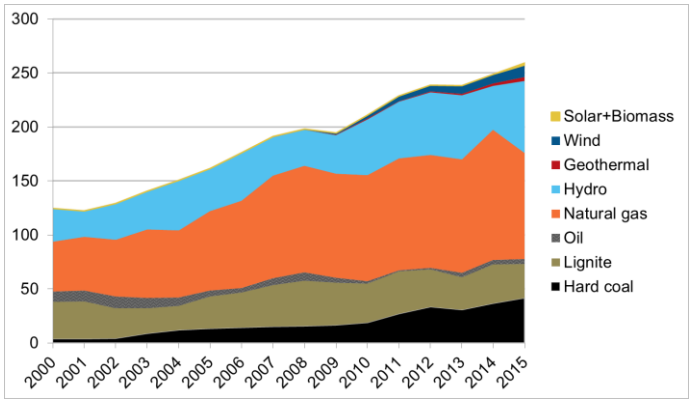

Figure 4. Power generation by energy source in Turkey (TWh) (Source: Ref. [23]).

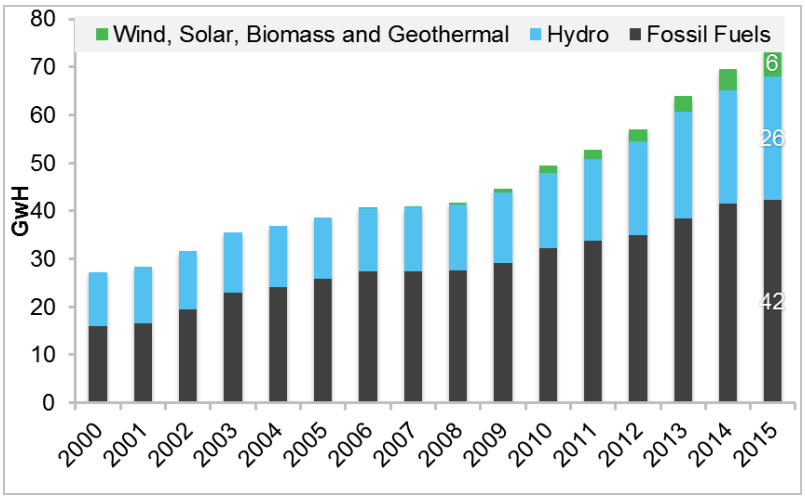

Figure 5. Turkey's Installed capacity (GWH) (Source: Ref. [23])

5. Clean energy in Turkey

Clean energy supply in Turkey is dominated by hydro and biomass, but environmental and scarcity-of-supply concerns have led to a decline in biomass use, mainly for residential heating [20]. Total renewable energy supply declined from 1990 to 2008, due to a decrease in biomass supply [12, 18].

As a result, the composition of renewable energy supply has changed and wind power is beginning to claim market share [13]. 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. Table 5 shows clean (renewable) energy resources in Turkey [13-15]. Table 6 also shows the potentials for investment of the clean energies in Turkey. Figure 6 shows expected installed capacity by clean energies in Turkey.

Table 5 Clean energy resources in Turkey (1000 TOE/year)

	2000	2005	2010	2015
Total energy demand	77624	85340	101510	131214
Total energy production	26808	23626	27279	34650
Supply by renewables	10149	10131	9604	10426
Biomass and waste	6546	5332	5023	4864
Wood/wood waste	6541	5325	4994	4322
Biogas	5	7	15	28
Municipal solid waste	-	-	-	6
Biofuels	0	0	14	20
Wind energy	3	5	31	46
Solar energy	262	385	420	964
Hydropower	2655	3402	3083	4864
Geothermal energy	684	1007	1048	1214
Share (%)	13.07	11.87	9.46	10.2
Biomass and waste	8.43	6.25	4.95	5.10
Wood/wood waste	8.43	6.24	4.92	4.96
Biogas	0.01	0.01	0.01	0.02
Municipal solid waste	-	-	-	-
Biofuels	0.00	0.00	0.01	0.01
Wind energy	0.00	0.01	0.03	0.06
Solar energy	0.34	0.45	0.41	0.52
Hydropower	3.42	3.99	3.04	3.46
Geothermal energy	0.00	1.18	1.03	124

Table 6 Potentials for investment for clean energies in Turkey

Sectors	Million $	Remarks
Hydroelectric	118	Economical development potential of 28,400 MW, Corresponding 100,000 GWh/a
Wind power	62	Economical development potential of 48,000 MW With wind speed > 7 m/s
Solar thermal	168	Economical development potential of 131,000 GWh/a, Corresponding to approx. 300 million m^2 collector area
Biogas	5	Agricultural residual material and dung, when used for electricity generation, 1,000 MWe and 7,000 GWh/a
Total	353	

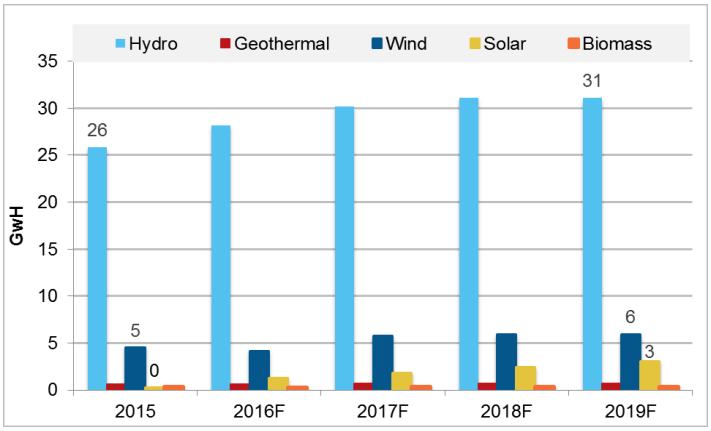

Figure 6. Expected installed capacity by renewables between 2015-2019 (GW) (Source: Ref. [23])

Total gross hydropower potential and total energy production capacity of Turkey are nearly 70 GW and 142 TWh/yr, respectively and about 30% of the total gross potential may be economically exploitable [21-23]. At present, only about 35 % of the total hydroelectric power potential is in operation [21]. The national development plan aims to harvest all of the hydroelectric potential by 2020 [16]. The contribution of small hydroelectric plants to total electricity generation is estimated to be % 5-10 [23-26]. On the other hand, the Southeastern Anatolia Project (GAP) is one of the largest power generating, irrigation, and development projects of its kind in the world, covering 3.0 million ha of agricultural land [27]. This is over 10 % of the cultivable land in Turkey; the land to be irrigated is more than half of the presently irrigated are in Turkey. The GAP project on the Euphrates and Tıgris Rivers encompasses 22 dams and 19 hydroelectric power plants. Once completed, 27 billion kWh of electricity will be generated and irrigating 1.7 million hectares [27].

Among the renewable energy sources, biomass is important because its share of total energy consumption is still high in Turkey [28-31]. Since 1990, the contribution of the biomass resources in the total energy consumption dropped from 15 to 4 % in 2014 [13-15]. Biomass in the forms of fuelwood and animal wastes is the main fuel for heating and cooking in many urban and rural areas [28]. The total recoverable bioenergy potential is estimated to be about 36 mtoe in 2008 [28]. On the other hand, using vegetable oils as fuel alternatives has economic, environmental, and energy benefits for Turkey [30]. Animal wastes are mixed with straw to increase the calorific value, and are then dried for use [29-32].

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. Turkey's total geothermal heating capacity is about 31,500 MWth. At present, heating capacity in the country runs at 1240 MWth equivalent to 150,000 households. These numbers can be heightened some seven-fold to 7,180 MWth equal to 800, 000 households through a proven and exhaustible

potential in 2012. Turkey must target 1.2 million house holds equivalent 7,700 MWth in 2020 [33-37].

Turkey receives a high level of solar radiation throughout the year with mean daily sunshine duration of about 7.2 h and solar energy intensity of 12.96 MJ/m2.day. The highest and lowest solar energy potential of Turkey is in the Southeast Anatolian region with an average solar radiation of 14.37 MJ/m2.day and sunshine duration of 8.2 h/day and in the Black Sea region with an average solar radiation of 11.02 MJ/m2.day and sunshine duration of 5.4 hour per day, respectively [23]. The solar potential unconstrained by technical, economic or environmental requirements of Turkey is estimated at 90 Mtoe per year [13, 38, 39].

Total solar energy production of 5 Mtoe in 1986 increased to 465 Mtoe in 2008 and is projected to rise to 5.5 million toe (Mtoe) (5.5% of primary energy production) by 2025 [14]. Flat plate solar collectors are the most widespread solar thermal application in Turkey, which are generally used for the production of commercial and domestic hot water, especially throughout the coastal regions. In 2008, Turkey had 12 million m2 of collector surface area installed with a heat output of 0.4 Mtoe contributing to energy production [23].

In Turkey, electricity is mainly produced by thermal power plants, by consuming coal, lignite, natural gas, fuel-oil and geothermal energy, wind energy (recently) and hydropower plants [13-15]. The electricity requirement was reported as 194 000 GWh in 2008 [15]. The electricity is mainly produced by thermal power plants and accounted for 74,82 % of the total, while hydro power energy was 25,11 % and the wind power energy was 0,07 %. In the thermal electricity production, the lignite part was 18,37 % and natural gas was 44 %. Compared to other energy sources, PV systems don't have sufficient contributions to gross electricity demand. There are no sufficient governmental driving forces to support PV systems in Turkey yet. Turkey's annual solar energy potential is estimated to be 1015 kWh, which is more than 5 700 times of the present electricity consumption [42-48].

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. Capacity is likely to grow rapidly, as plans have been submitted for just under a further 600 MW of independent facilities. At start 2014, total installed wind energy capacity of Turkey is only 1900 MW [40, 41].

6. Climate change mitigation in Turkey

Turkey is a rapidly growing country whose income level is moving towards that of the rest of the OECD area [47, 48]. This catch-up process has been associated with a rapid growth of greenhouse gas emissions. Nonetheless, carbon emissions from any country contribute equally to the pressure on the global climate [12]. Consequently, the major issue facing policy makers is how to contribute to reducing the burden on global resources at a low cost and without jeopardizing the rapid growth of the economy [44-48].

Economy-wide greenhouse gas emissions from fuel combustion jumped 65% in the 1990s, in contrast to the more modest growth in the rest of the OECD area. The Turkish government is now in the process of developing a strategy to reduce the growth of greenhouse gases [12]. Turkey will have the obligation to implement measures and polices to mitigate greenhouse gas emissions but will not be required to meet a specific greenhouse gas emission target [47, 48]. On the other hand, the privatization of the electricity companies will also result in new pricing policies. At present, demand for electricity is boosted by a high level of what is called "non-technical" system losses. In practice, this phrase refers both to electricity that is consumed through illegal connections to the network and non-payment of bills. The new distribution companies will need to invest in new metering systems to ensure that these practices end [12-15]. The problem may be difficult to settle, in that the new distribution companies have different profiles of losses, with illegal consumption rising to 50% in some areas. Enforcing normal contract discipline, though, would further add to the de-coupling of carbon emissions form GDP growth [13, 47, 48].

6.1. Emissions

Turkey has achieved decoupling of SOx, NOx and CO emissions from economic growth. In 2008, estimated SO2 emissions are 2.1 million tons, increased by 7% between 1990 and 2008, while GDP and fuel consumption increased by 32 and 28%

respectively. SOx emission intensity (per unit of GDP) fell by 14% between 1990 and 2008. However, SOx emission intensity is still over three times higher than the OECD average. Major contributors to SOx emissions continue to be power plants (64.3%) and industrial combustion (25.6%) [12-15].

NOx emissions, estimated at 1.1 million tons in 2008 [48]. NOx emission intensity (per unit of GDP) decreased between 1998 and 2005 from 2.1 to 1.9 kg/USD 1 000. However, NOx emission intensity still exceeded the OECD average by more than 50%. The major contributor to NOx emissions continued to be mobile sources. Their share in total emissions increased by 5% compared with 1998. Power stations and industrial combustion accounted for 16.9 and 18.8% respectively [13, 47, 48].

Carbon monoxide emissions amounted to 3.2 million tons in 2008, a 30% decrease since 1990 and mostly come from non-industrial (39%) and mobile (38%) sources [47]. Since 1998, the contribution from non-industrial fixed sources has increased while that from mobile sources has decreased by 12%. On the other hand, volatile organic compound (VOC) emissions have increased slightly. Total emissions were estimated at 562 million tons in 2008, with nonindustrial fixed sources contributing 32%, mobile sources 23% and solvents 29% of total VOC emissions [1, 13, 47, 48].

6.2. Reducing pollution from energy production

The government further reformed the regulatory framework to reduce pollution from energy production. In 2006, the new Regulation on Control of Air Pollution from Industrial Plants set standards for emissions of NOx, SO2, CO and PM from combustion plants. PM and CO standards were lowered for both solid and liquid fuel-fired power plants. PM standards were tightened from 150 to 100 mg/m3 for solid fuel-fired power plants and CO standards were lowered from 250 to 200 mg/m3 (for solid fuel-fired plants) and from 175 to 150 mg/m3 (for liquid fuel-fired plants) [1, 12, 13].

Some investments have already been made, especially to address the environmental impacts of the high sulphur content of domestic lignite [12, 13]. New lignitefired power plants have been equipped with flue gas desulphurisation (FGD) technology to comply with regulations. Six of eleven pre-1986 lignite-fired plants have been retrofitted with electrostatic precipitators (ESP) to reduce particulate emissions. However, not all electrostatic precipitators are working at maximum efficiency [15-17]. Construction of one power plant based on circulating fluidised bed technology has recently been completed. This first application of advanced coal technology in Turkey, designed to use low-quality lignite with high sulphur content, was followed by other plants. Studies indicate that an investment of over USD 1.0 billion would be needed to retrofit installed FGD and ESP facilities and to adopt advanced coal technologies [30, 34, 47, 48].

6.3. Promoting renewable energy

In Turkey, there is a much more potential for renewables, but represent about 37% of total energy production and 10% of total energy consumption. This share is not enough for the country and the governments should be increase to this situation. More than half of the renewables used in Turkey are combustible fuels and waste, the rest being mainly hydro, solar and geothermal. Turkey is richly endowed with hydropower, wind and geothermal resources. Sectoral studies have indicated that small-scale hydropower is under developed, and a total potential production of 33 TWh of electricity per year [21]. It is estimated that Turkey has the potential for up to 48 000 MW of wind power capacity, capable of generating about 25 TWh of electricity per year [13-15].

There is also large potential for geothermal and solar thermal applications in Turkey. Solar collectors are already a significant, market-driven business. The government expects the use of geothermal and solar energy to double between 2014 and 2030. The organic component of waste incineration is also considered a renewable option in the future, using appropriate technology to meet high health and environmental standards. On the other hand, commercial use of renewable energy has not developed rapidly. Financial assistance is being provided for the development of renewable energy projects. In 2014, USD 800 million was made available; by 2020, about half had already been committed to finance 66 projects with several other projects under preparation [13-15].

7. Conclusions

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. 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.

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 clean energy sources efficiently and should promote new technologies and use all its renewable energy potential. According to the government policies, new capacity investments, supply diversity and maximizing energy efficiency are critical points for Turkey in conjunction with the increasing primary energy demand. In order to avoid the risks linked to both energy dependence and developing a sustainable energy model, the government is committed to promoting alternative solutions based mainly on local and renewable energy sources. Therefore, Turkey has initiated a forward looking and innovative energy policy in which renewable energy plays a significant role.

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