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Sustainable energy policies in Mediterranean region: a case of Turkey

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Abstract
With the half billion people living in the Mediterranean Basin, the Mediterranean region accounts for 10.2% of the world electricity consumption and 8.2% of the primary energy consumption. Turkey is an energy importing country with more than half of the energy requirement being supplied by imports (70% of the total). In this context, renewable energy sources is very important for Turkey and geographical location has several advantages for extensive use of most of the sources. Turkey's Technical and conomical installed capacity potential in wind is 12.000 MW and estimated wind energy potential is 400 GWh/yr. Turkey's hydro energy potential is 45.000 MW and under project phase is 22.700 MW. Turkey's geothermal energy potential is 2.000 MW_e and 31.500 MW_t. In this regard, renewables appear the most effective solutions for sustainable energy development in Turkey. This paper discusses the energy policies in Mediterranean region, especially in Turkey.

Keywords: Renewables; sustainable energy; climate change; energy policy; Mediterranean; Turkey

1. Introduction

Worldwide, about four billion people live on less than $8 per day. Next to food and housing, energy often is the biggest expense for lowincome households [1]. Most energy expenses are spent for cooking, heating and lightning [2]. Having no or only infrequent access to energy especially affects the poorest segments of society, which often have to diversify their energy sources and buy them in small, expensive units. This has severe consequences for their household spending and they spend up to 30% of their household income on energy [3, 4].

The energy world faces unprecedented uncertainty [5]. The global economic crisis of 2008-2009 threw energy markets around the world into turmoil and the pace at which the global economy recovers holds the key to energy prospects for the next several years. But it will be governments, and how they respond to the twin challenges of climate change and energy security, that will shape the future of energy in the longer term. In the New Policies Scenario, world primary energy demand increases by 36% between 2008 and 2035, from around 12 300 million tonnes of oil equivalent (Mtoe) to over 16 700 Mtoe (see Figure 1). This compares with 2% per year over the previous 27-year period. The projected rate of growth in demand is lower than in the Current Policies Scenario, where demand grows by 1.4% per year over 2008-2035 as shown in Table 1 [4-6].

It is expected that the world population will reach 9.1 billion people by 2050. The largest increase in population is to be experienced in the least-developed countries, whose total population is projected to double from currently 0.84 billion in 2009 to 1.7 billion in 2050. All developing countries taken together will experience population growth from 5.6 billion in 2009 to 7.9 billion in 2050 [7]. On the other hand, it is estimate that, in 2030, 1.3 billion people will still not have access to electricity, compared to 1.5 billion in 2008. The greatest share of people without access to electricity will be found in Sub-Saharan Africa while they are expected to decrease in South Asia and China and East Asia. At the same time developing countries will have to deal with the growing cost of importing fossil fuels [8].

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

	1980	2000	2008	2020	2035
Coal	1 788	2 295	3 315	3 966	3934
Oil	3 107	3 649	4 059	4 346	4 662
Gas	1 235	2 088	2 596	3 132	3 748
Nuclear	186	675	712	968	1 273
Hydropower	148	225	276	376	476
Biomass and waste	748	1 045	1 225	1 501	1 957
Other renewables	12	55	89	268	699
Total	7 223	10 034	12 271	14 556	16 748

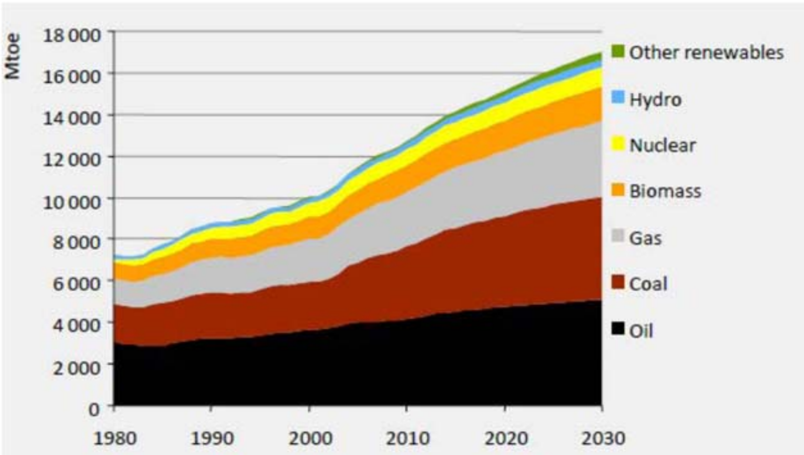

Figure 1.World primary energy demand by fuel (Mtoe: million tons of oil equivalent).

Table 2.Global renewable energy capacities in 2010

Renewable energy	Capacity
Power generation (GW)	
Wind power	198
Biomass power	62
Solar PV	40
Geothermal power	11
Concentrating solar power (CSP)	1.1
Hydropower	1,010
Ocean power	0.3
Hot water/heating (GW_{th})	
Modern biomass heating	280
Solar colectors for hot water/space heating	185
Geothermal heating	52
Transport fuels (billion liters/year)	
Ethanol production	86
Biodiesel production	19

The majority of people without access to electricity live in rural areas and informal urban settlements in developing and emerging countries [8]. In many countries the existing grid is not adequate to meet the demand and requires technical upgrades and rapid expansion. Especially poor households and small business owners who are highly dependent on reliable and cost-effective electricity access are affected by fluctuating electricity supply and frequent blackouts [3].

According to the IPCC's report that renewables are an affordable and economically viable option to react to the electricity needs of people through the world [9, 10]. Already now, tens of millions of households are being supplied by renewable energy from different sources. The 'Renewables 2010 Global Status Report' [11] estimates that there is an important potential for renewable power generation (Table 2 and Figure 2). For more than three decades, different types of decentralized electricity from renewable sources have been implemented by governments, development agencies, and private-sector initiatives. Besides a few success stories and best practice examples, there have also been many failures in introducing these technologies under difficult context conditions [3].

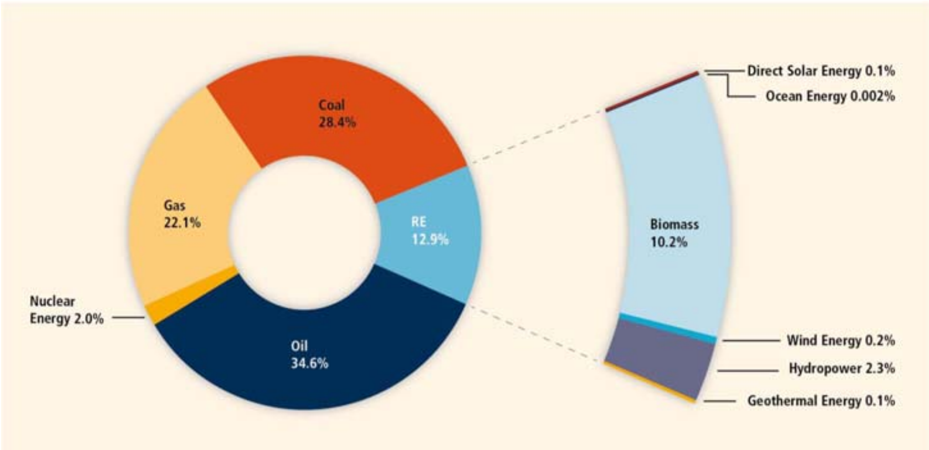

Figure 2. Shares of energy sources in total global primary energy supply in 2008

Turkey, bordering on the Middle East, Russia, and the Caspian states is adjacent to regions which possess over seventy percent of the world's proven oil and natural gas reserves. Turkey also sits on major international waterways. Both factors predispose Turkey to become an important transit state for world energy resources– a role that Ankara has enthusiastically embraced [13]. As part of its drive to serve as a significant energy transit state, Ankara has signed a number of importation agreements in the last decade with neighboring natural gas producers, inaugurated the Baku-Tbilisi-Ceyhan oil pipeline project, launched the Baku-Tbilisi-Erzurum natural gas pipeline, and is exploring additional major energy transport and production projects. Furthermore, in April 2006, after forty years of deliberations on the issue, Turkey announced its decision to build a number of nuclear energy plants. Despite this extensive activity in the energy sphere, it seems, however, that Ankara's energy policy has been undertaken without a strategic plan and with little integration of energy issues into Turkey's overall foreign and security policies [12, 13].

This article will analyze Turkey's energy policies including mediterranean region for energy sustainability and climate change mitigation. The article discusses the following topics: Mediterranean region and Turkey's energy profile, renewable energy sources, environmental impact due to energy consumption, current trends in the world energy market and their implications for Turkey; the risks and opportunities inherent in Turkey's role as an energy transit hub, and policy recommendations.

2. Energy consumption in Mediterranean region

With the half billion people living in the Mediterranean Basin and the region accounts for 10.2% of the world electricity consumption and 8.2% of the primary energy consumption. This primary energy consumption (80% fosil fuels and only 6% renewables) accounted for around 8% of the global CO_2 emissions in 2006 (see Figs. 3-6) [14]. On the other hand, based on a data obtained since 1971 of energy issues, overall socio-economic indicators and trends prevailing to date, several major distinctions can be made, not only on the level of distribution of hydrocarbon resources and the level of energy consumption and supply, but also on the level of the efforts invested in matter of energy efficiency and renewable energies. This retrospective review reveals tensions in matter of energy which are likely to become significantly more acute if no measures are taken in the future. Table 3 and 4 shows the energy intensity and supply per capita, respectively [14].

Table3. Energy intensity in Mediterranean region (koe/$2000 ppp)

Countries	1990	1995	2000	2005	2007
Spain	138	144	142	141	133
France	178	178	165	163	152
Italy	118	120	117	120	113
Greece	135	134	135	123	120
Cyprus	151	155	158	140	141
Albania	268	152	155	156	132
Turkey	128	128	130	115	122
Syria	352	296	328	268	268
Israel	130	128	119	119	115
Egypt	204	192	190	216	208
Algeria	162	173	167	157	170
Morocco	78	93	92	92	91
Total	153	153	148	145	139
EU-27	191	179	159	153	142
World	263	244	220	207	196

Table 4. Total primary energy supply per capita in Mediterranean region (koe/inhab)

Countries	1990	1995	2000	2005	2007
Spain	2 309	2 560	3 029	3 268	3 208
France	3 859	3 995	4 168	4 320	4 148
Italy	2 586	2 801	2 997	3 120	3 003
Greece	2 074	2 133	2 480	2 725	2 876
Cyprus	2 347	2 682	3 079	2 929	3 097
Albania	809	420	575	733	683
Turkey	939	998	1 132	1 171	1 353
Syria	895	961	1 055	926	987
Israel	2 486	2 822	2 933	2 956	3 062
Egypt	577	582	679	835	891
Algeria	878	853	886	984	1 089
Morocco	287	325	360	435	465
Total	1 784	1 817	1 956	2 055	2 059
EU-27	3 462	3 421	3 491	3 616	3 546
World	1 666	1 626	1 650	1 769	1 820

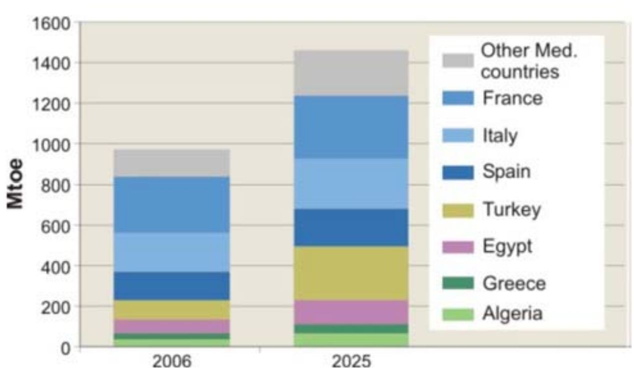

Figure 3. Primary energy demand : baseline scenario up to 2025 in Mediterranean region

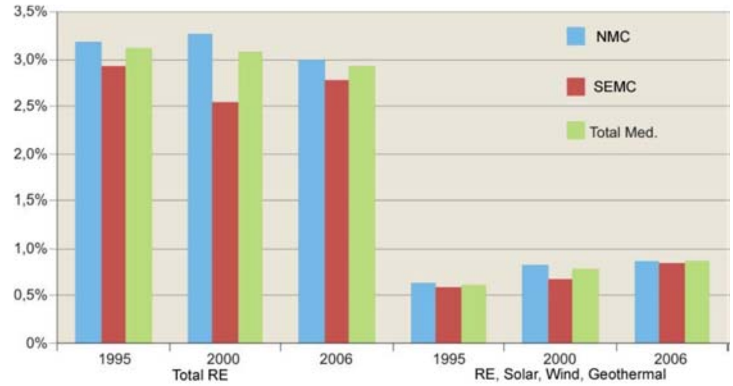

Figure 4. The seven main energy consumer in the Mediterranean

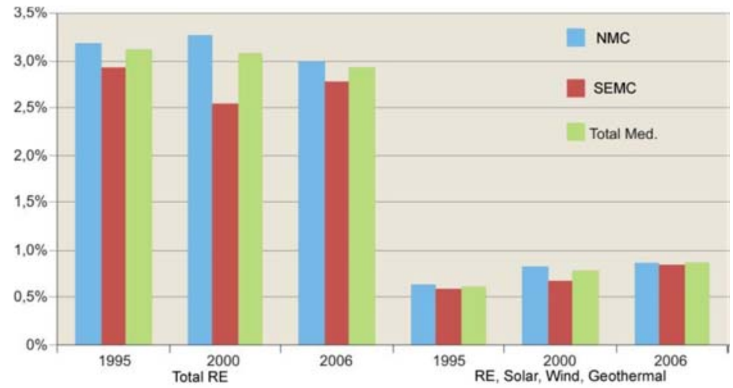

Figure 5. Share of RE in the primary energy consumption (%) in Mediterranean

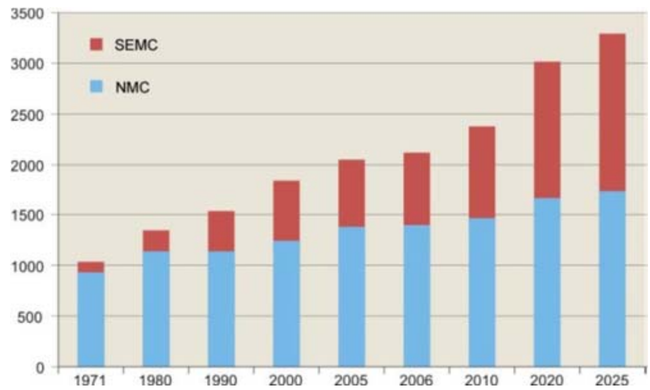

Figure 6.CO_2 emission from energy use in Mediterranean region (Million tons).

2.1. Energy resources

The Mediterranean region holds 5% of the world oil and gas reserves, concentrated at 98% in the South, and has a considerable potential of renewable energies, especially solar and wind energies. These oil and gas reserves are 8200 Million tons (Mt) and 8900 Giga cubic meter (Gm^3), respectively. These reserves are held by four countries of the Southern rim of the Mediterranean: Libya holds the largest oil reserves, with 5400 Mt, followed by Algeria (1545 Mt) and, to a lesser extent, Egypt (524 Mt) and Syria (400 Mt). As for gas, the main reserves are found in Algeria (4580 Gm^3), followed by Egypt (2148 Gm^3), Libya (1500 Gm^3) and Syria (300 Gm^3) [14-17].

Coal reserves, concentrated in Greece and Turkey, amount to around 9 billion tons for the region as a whole. As for renewable energies, the Mediterranean holds a significant potential, particularly solar and wind, which is as yet under-exploited, even though their production has been on the rise over the past few years. Yet, the share of renewable energies in the energy mix remains modest, with only 6% of the primary energy supply [16].

Over the period 1971-2006, the primary energy consumption of the Mediterranean Basin grew from 402 to 968 Mtoe (Figure 2), and the electricity consumption grew from 384 to 1665 TWh. As regards final energy consumption, transport continues to be the main consumer compared with the other sectors in the Mediterranean [14]. Nevertheless, industry accounts for the highest increase in total final consumption, particularly due to the increase in consumption in the countries of the Southern rim of the Mediterranean. The structure of energy demand has changed drastically over the last three decades. From an energy-based industry, the Mediterranean now offers a more balanced consumption, with the transport and residential sectors thus seeing their share on the rise [17].

Energy demand has been characterised by a much more rapid growth in electricity demand than in primary energy demand. Indeed, electricity consumption in the Mediterranean region grew four-fold over the period 1971-2006. The consumption of the countries of the Northern rim represents, with 1235 TWh in 2006, around three times that of the South Eastern Mediterranean Countries (SEMCs). The level of energy consumption being closely connected with economic and demographic growth, the trends reported confirm a more steady increase in the countries of the Southern rim, for which the average annual growth rate has been of 7.7% per year over the past 25 years, due in particular to high consumption levels especially in Turkey, Egypt, Tunisia, Algeria and Morocco [14, 17].

The progress made in terms of power generation capacity is considerable. The installed capacity in the countries of the Northern rim stood, in 2006, at over 300 GW for a population of 192 million inhabitants, as against 102 GW at most in the countries of the Southern rim for a higher population counting 261 million inhabitants [15]. For the sake of illustration, the installed capacity in France alone (116 GW) is higher than that of the countries of the Southern rim altogether. The fourfold rise of total electricity generation (between 1971 and 2006) had required a 224 GW additional capacity in the Mediterranean Basin, of which over 36% (81 GW) in the SEMCs [14-18].

While remaining the dominant fuel in the Mediterranean energy mix, oil has seen its share strongly decrease from 68% to 43% of the total. This being due to a decrease in the share of oil in electricity production in favor of gas, set off by an increase in the share of fuels in transport. As for coal, even though the quantities in absolute values have almost doubled, its share has dropped by 5 points, this being due to its use in the electricity sector together with the use of new clean production technologies. On the other hand, nuclear power has seen its share increase from 1% to 13% over the same period [14].

The four producing countries (Algeria, Egypt, Libya and Syria) supply around a fourth of the oil imports and over a third of the gas imports of the whole Mediterranean Basin. In 2006, the total international exchanges of Mediterranean countries amounted to around 450 Mt of crude and oil products, 207 bcm of gas and around 249 TWh of electricity. On the other hand, the net intra-Mediterranean energy exchanges amounted in 2006 to around 97 Mt of oil and oil products, 72 bcm of gas and 70 TWh of electricity [16].

The average rural electrification rate exceeds 95% in the SEMCs. For very remote and scattered population without access as yet to electricity (8 million people), renewable energies represent an opportunity. This is already the case in a few countries where the rural electrification programme via electricity distribution grids is relayed by an electrification programme based on renewable energies and, particularly, on the equipment of households with individual photovoltaic systems. It is in this way that the Moroccan electrification programme has involved over 3163 villages and 44,719 households in photovoltaic system, which corresponds to the electrification of over 1,766,960 households and a rural electrification rate of 93% in 2007 [14].

2.2. Renewable energies

Renewable energies account for a mere 6% (biomass included) in the energy balance of the whole region, and this, despite a significant increase. Indeed, prompted by incentives, policies and technological progress, renewables in the Mediterranean have reported exceptional growth. Since 2000, there has been considerable progress in terms of installation of renewable energies excluding hydropower with an exceptional average annual growth of over 36%, reaching 26 GW in 2007. This trend is due to a spectacular increase in wind-based electrical capacity, reaching 21 GW in 2007, as against 3 GW in 2000. Nevertheless, it is hydropower which is currently the most exploited source in the Mediterranean, contributing in 2006 to over 76% of the electric production based on renewable energies [14-17].

2.3. Energy efficiency

The measurement of energy efficiency is made based on a total primary energy intensity (EI) indicator corresponding to the ratio between energy consumption and Gross Domestic Product (GDP), the latter being calculated in Purchasing Power Parity (PPP), in order to consider standard of living. This indicator (expressed in TOE per GDP unit) characterises the extent of the "energy sparing" of a given country or mode of development: it measures the quantity of energy consumed for the same comfort or production level. Energy intensity depends, quite obviously, on such factors as climate (the more it is cold, the more energy is consumed for heating, at equal economic level), as well as on the structure of the economy: the more a country has heavy industries, the higher its EI. However, when we compare countries of similar economic structures, the main factor is the efficiency with which energy is produced and consumed: very roughly speaking, the lower the intensity, the greater the efficiency [14].

Awareness of the importance and usefulness of energy efficiency and of the indisputable linkages between environment and development in the Mediterranean is on the increase. In the countries of the Northern region, energy efficiency (EE) policies began to be implemented in the wake of the first oil crisis of 1973. These energy efficiency achievements correspond to energy savings made every year and which can be expressed in "negawatts" or "negajoules". These are calculated on the basis of the improvement of the energy intensity since 1980 for the Northern Mediterranean Countries (NMCs) [14-17].

As regards the SEMCs, one observes a quasistabilisation of the EI level since 1980. However, since 1990, several SEMCs have opted for greater "energy sparing", and a slight decrease in their EI may be observed. The same exercise has been conducted for the SEMCs to estimate the energy efficiency gains which could have been achieved if the SEMCs had, at least, maintained the same EI level of 1980 over the period 1980-2006. These energy savings have ranged from 5% to 14% per year and is an aggregate of 286 Mtoe over the period 1980-2006. Also studies show that there is a significant potential could be tapped via demand side management by improving the energy efficiency in the industry and gaining better control over the demand related to transport, heating and air-conditioning. The benefit was estimated at 208 Mtoe/year for the timeframe 2025 [14].

2.4. Contribution by the energy sector to the greenhouse effect

In 2000, 72% of the Mediterranean greenhouse gas (GHG) emissions were due to CO_2 arising from energy use, with 77% in the NMCs and 64% in the SEMCs. In 2006, the NMCs accounted for around two thirds of the CO_2 emissions due to energy use of the whole Mediterranean region . However, the increase in CO_2 emissions appears to be more rapid in the SEMCs than in the NMCs. The NMCs reported an increase by 23% between 1990 and 2006, while the SEMCs reported an increase by 76% over the same period. This growth pace is twice as fast as the global pace [14-17].

A comparison between the EU-27 as a whole and the Mediterranean region is worthwhile, they being two sets with approximately the same population level. Primary energy and electricity consumption in the Mediterranean amounts to a mere half of that of the EU-27; the per capita consumption of primary energy and electricity in the Mediterranean is around a half of that of the EU-27. The CO_2 emission/toe is 6% superior in the Mediterranean compared to the EU27's. This illustrates that Mediterranean energy mix is emitting more CO_2 than the European mix [14].

3. Energy production and consumption in Turkey

As a developing country an in conjunction with its fast growing economy and population Turkey's energy consumption has increased rapidly (Figure 7). For example, while total primary energy consumption in 1996 was 70.77 Million tons of oil equivalent (Mtoe) in 2009 it raised 106.14 Mtoe and total energy production in 1996 was 28.29 and 30.33 Mtoe in 2009. In Turkey, the industrial sector accounted for 36% of total energy consumption, while residential and commercial sectors represented 35% in 2009. In recent years, the difference between the industrial and residential sectors has increased much more than in former years, according to the Ministry of Energy and Natural Resources (MENR) statistics [13].

As it can be seen, Turkey is an energy importing country and dependent on the imported energy sources (Table 5) [13]. 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 [6]. 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 [6, 13, 18].

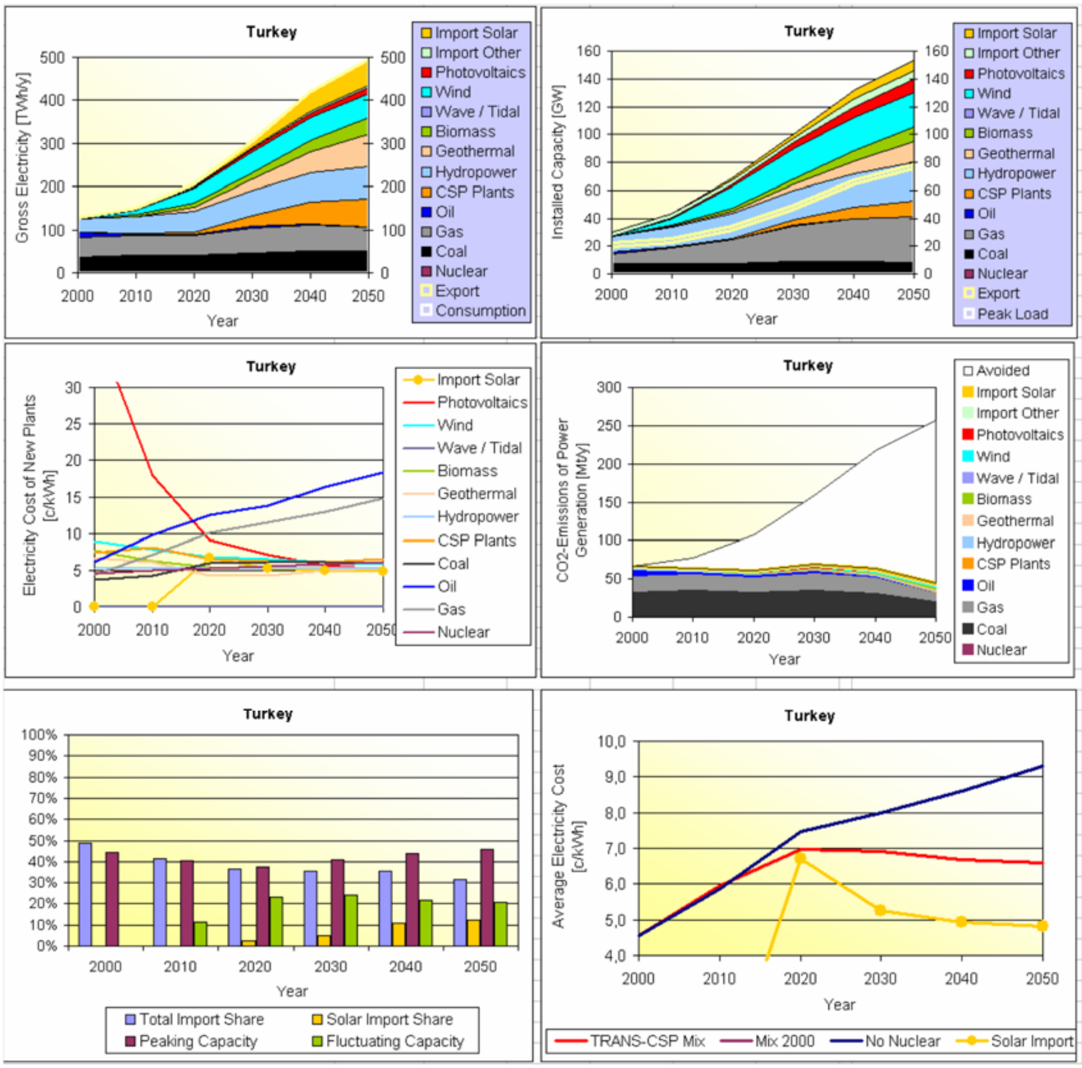

Figure 7.Turkey's energy, electricity and CO_2 emissions developments.

Table 5.Turkey's energy production and consumption in 2009 (Mtoe)

Energy source	Production	Consumption
Hard coal	1 294	14 768
Lignite	15 632	15 672
Asphaltite	476	450
Oil	2 349	30 565
Natural gas	627	32 775
Hydropower	3 092	3 092
Geothermal (electric)	375	375
Geothermal (heat)	1 250	1 250
Animal & plant wastes	1 136	1 136
Wood	3 530	3 530
Wind	130	130
Solar	430	430
Total	30 328	106 138

Turkey's various renewable energy sources represent its second largest energy source after coal [6]. Biomass and animal waste account 67.3 %, hydropower 29.5 %, geothermal 2 % and wind and solar account for 1.2 % each of total renewable energy production [6]. 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 2009, and it increased to 30 % in 2008 [18]. 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 [19].

In spite of its high energy productivity benefits the power plants cause major environmental and social problems such as migration of residences, loss of valuable agriculturally productive alluvial bottomland, alteration of ecosystem. In addition to water sources, Turkey has significant reserves of other renewable energy sources such as wind, solar, biogas and geothermal energy [20, 21].

4. The role of renewables for energy sustainability 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 [22]. Total renewable energy supply declined from 1990 to 2007, due to a decrease in biomass supply [23]. 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.

4.1. 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 [24-27].

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. The average energy consumption for the developed countries is 8.900 kWh, but it varies from 12.322 kWh in the USA to 827 kWh in China. Annual increase in energy consumption is 8-10% in Turkey except for the recession years [6, 18, 25, 27].

Currently, Turkey has 172 hydroelectric power plants in operation with total installed capacity of 13.700 MW generating an average of 48.000 GWh/year, which is 35% of the economically viable hydroelectric potential. 148 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 [25].

Total energy generation in Turkey in the 1950s was 800 GWh, this figure has increased by about 256 times, reaching 191.555 GWh/year today [18]. As of 2008, the current installed capacity is 42.359 MW, which could generate an average of 246.974 GWh/year. Capacity utilization has been 87% in thermal plants and 70% in hydroelectric power plants. 19% of energy generation depends on hydroelectric power and the remaining 81% on thermal power [13]. A special emphasis has recently been placed on alternative energy sources such as wind and geothermal power. The share of geothermal and wind power in total energy generation has reached 2%. There have been some steps taken towards introducing the use of nuclear power as well [6, 13, 18].

The important river basins with an annual hydropower potential of more than 5 TWh are: Fırat (38,070 GWh), Dicle (16,702 GWh), Dogu Karadeniz (11,271 GWh), Çoruh (10,630 GWh), Seyhan (7,968 GWh), Kızılırmak (6,229 GWh), Yesilırmak (5,308 GWh), Dog˘u Akdeniz (6,212 GWh) and Antalya (5,089 GWh) [25, 27].

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 [25]. 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 [24]. 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 [24-27].

4.2. Biomass and bioenergy

Half of Turkey´s energy demand is covered by natural gas and oil imports [6]. Turkey´s energy demand is currently covered mainly by fossil fuels, coals, oil and natural gas and less by geothermal and hydro power plants [13]. There is no anaerobic digestion plant existent yet, respectively there is no information about operating digestion plants in Turkey available. But Turkey as a developing country in the field of anaerobic digestion has a high potential for the production of biogas, because of their relatively high organic content of their wastes. Also animal manure and some energy crops could be a good basis for an efficient production of biogas [28-30].

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 recoverable bio-energy potential in Turkey was estimated to be around 37 Mtoe, based on the recoverable energy potential from agricultural residues, livestock farming wastes, forestry and wood processing residues and municipal wastes in 2005 [28]. The primary energy consumption of Turkey is forecasted to reach 116.12 Mtoe in 2012 [13].

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 2 % in 2006 to 1 % in 2009 as well. In 2009, the share in electricity production from biogas to the total electricity generation was reported to be less than 0.3 %, while for 2010, this share is forecasted to be 0.45 %. 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 (Law No: 5346), 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 [6, 13].

4.3. Geothermal energy

In the recent years, among the renewable energy alternatives, geothermal energy in world and our country has become very attractive [6]. 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 ^{o}C, and using the generated heat at only 50-60 ^{o}C is obviously a thermodynamic waste. Therefore, utilization of low grade geothermal energy resources fills an important gap in this area [18]. 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 [6, 13, 31].

Turkey is one of the countries with significant potential in geothermal energy (at present seventh in the world) and there may exist about 2000 MW_e of geothermal energy usable for electrical power generation in high enthalpy zones [18]. Turkey's total geothermal heating capacity is about 31,500 MW_{th}. At present, heating capacity in the country runs at 1220 MW_{th} equivalent to 147,000 households. These numbers can be heightened some seven-fold to 6,880 MW_{th} equal to 585, 000 households through a proven and exhaustible potential in 2010. Turkey must target 1.2 million house holds equivalent 7,700 MW_{th} in 2020 [31].

4.4. Solar energy

While energy need of Turkey in 2009 was 200 billion kWh, which has produced by using of 42.400 MW power plants (coal, natural gas, fuel and hydro), he 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. Because of this import row material, Turkey has paid 33 B$ at 2007. 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.m^2 solar radiation level. Only available rooftop area for PV modules is 611 km^2 and energy gain from this area will be 90 BkWh/year. Apart from this area it is determined that the area which has more than 1650 kWh/m^2 irradiation level is about 4600 m^2 in Turkey. That means this solar energy potential equals to a natural gas plant with a power of 54,300 MW [32].

Except some special applications PV installation is almost non existing in Turkey. However, solar energy is widely used for heating water [6]. The hot water heating system installations cover about 10 Million m^2 surface. 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 [18]. While the existing feed in tariff is about 5.5 €cent/kWh, it is foreseen that it will be about 25 €cent/kWh for PV and 20 €cent/kWh for CSP in January of 2009.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 [32, 33].

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. 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 [32].

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 [18]. 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.

4.5. 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 megawatts [13]. So far only about 1,000 megawatts capacity wind farms are in operation in Turkey, generating less than 0.5% of total electricity consumed [18]. 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/(m^2.yr) . The most attractive sites are the Marmara Sea region, Mediterranean Coast, Agean Sea Coast, and the Anatolia inland [6]. 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 [34-46].

Turkey, in contrast, relies heavily on imported energy. Only around 30% of the total energy demand is met by domestic sources [13]. 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 [37]. 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 [13, 32, 38, 39].

It is shown that Turkey has plenty of renewable energy resources which are still not utilized [6]. 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 [18].

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 22,807GW/yearfrom a total wind power plant area of 629km^2 which corresponds to a 35.26 GW/yearper 1 km^2. 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 [38, 39].

5. Climate change mitigation policies in Turkey

The basic principle of Turkish energy policy, as set out in the 9th National Development Plan (2007-2013), was to ensure sufficient energy supply to meet the increasing demand, at the lowest cost possible [37]. The 9th plan also introduced provisions for minimising negative environmental impacts, improving energy efficiency and increasing the share of renewable energy in energy consumption [40-42].

5.1. Reducing pollution from energy production

The government further reformed the regulatory frameworkto reduce pollution from energy production. In 2006, the new Regulation on Control of Air Pollution from Industrial Plants set standards for emissions of NOx, SO_2, CO and PM from combustion plants [6]. The PM and CO standards were lowered for both solid and liquid fuel-fired power plants. PM standards were tightened from 150 to 100 mg/m^3 for solid fuel-fired power plants and CO standards were lowered from 250 to 200 mg/m^3 (for solid fuel-fired plants) and from 175 to 150 mg/m^3 (for liquid fuel-fired plants) [42-46].

Some investmentshave already been made, especially to address the environmental impacts of the high sulphur content of domestic lignite. 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. Construction of one power plant based on circulating fluidised bed technology has recently been completed [40]. 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 on compliance with the EU LCP Directive indicate that an investment of over USD 1 billion would be needed to retrofit installed FGD and ESP facilities and to adopt advanced coal technologies [20, 21, 45, 46].

5.2. Improving energy efficiency

Energy intensitydecreased by 8% between 1990 and 2005 and is below the OECD average. Its improvement through improved sectoral energy efficiencies is an important objective of Turkey, which should bring multiple benefits: economic benefits, environmental benefits and related health benefits. Official studies have demonstrated that Turkey has large energy conservation potential (25-30%). Energy efficiency policies have been implemented in the industrial, residential and services sectors. General investment support programmes also have an indirect positive impact on energy efficiency. There are no direct tax incentives to encourage end-use energy efficiency, nor is there any other kind of direct financial incentives.

5.3. Promoting renewable energy

In Turkey, renewablesrepresent about 12% of TPES. 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(less than 20 MW) is underdeveloped, with 90 plants in operation compared with 350

prospective development sites and a total potential production of 33 TWh of electricity per year (about 25% of current demand). It is estimated that Turkey has the potential for up to 11 000 MW of wind power capacity, capable of generating about 25 TWh of electricity per year [6, 32].

There is also large potential for geothermal and solar thermal applicationsin Turkey. Solar collectors are already a significant, market-driven business. The government expects the use of geothermal and solar energy to double between 2007 and 2020 [18]. The Geothermal Energy Law, enacted in 2007, aims to boost geothermal residential heating. The organic component of waste incinerationis also considered a renewable option in the future, using appropriate technology to meet high health and environmental standards [13]. On the other hand, commercial use of renewable energy has not developed rapidly. Financial assistanceis being provided for the development of renewable energy projects. In 2004, USD 200 million was made available; by 2008, about half had already been committed to finance 19 projects with several other projects under preparation. Table 6 shows the potentials of the investments for renewable energies in Turkey [13, 32].

Table 6. Potentials for investment for renewable energies in Turkey

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 MWe and 7,000 GWh/a
Total	340	

6. Conclusions

The Mediterranean, and more especially the Southern and Eastern regions, is and will be more affected by climate change than most other regions of the world in the course of the 21st century. The impacts of the rise in temperatures, the decrease in rainfall, the multiplication of the number and intensity of extreme events and the possible rise in sea level overlap and amplify the already existing pressures of anthropogenic origin on the natural environment. Through the crucial issue of scarcity of water resources, their impacts are fraught with consequences in the 21st century for human activities, in particular agriculture, fishery, tourism, infrastructures, urbanised coastal areas and hydropower production. In order to minimize as much as possible the economic losses and damages, several adaptation options must be thought out and implemented.

The marked expansion of the region's renewable energy market, as well as the diversity of countries now participating in it, is driven by a number of key factors: energy security enhancement; major energy demand growth due to population increases, urbanisation, and economic progress; and water scarcity. With high fossil fuel prices resulting in both steep bills for net oil-importing countries (NOIC) and opportunity costs for net oil-exporting countries (NOEC), renewables have become an increasingly attractive alternative to domestic oil and gas consumption. Renewable energy is also cited as a potential means of industrial diversification, new value-chain and employment activities, technology transfer, and improved environmental footprints.

From 2008 to 2011, non-hydropower renewable power generation in the region more than doubled to reach almost 3 terawatt-hours (TWh) and grew at a much faster pace than conventional energy sources. Although wind has become the largest renewable energy source after hydro, solar power generation has seen higher growth in recent years, first through photovoltaic (PV), and then with the commissioning of large concentrating solar power (CSP) plants in Algeria, Egypt, Iran, and Morocco as well as, most recently, the world's largest CSP plant in the United Arab Emirates. This trend is expected to continue in the foreseeable future.

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.

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.

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