Chapter 1

Present Situation and Future Prospect of Energy Utilization and Climate Change in Turkey

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Additional information is available at the end of the chapter

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1. Introduction

Sustainable development has emerged as the key challenge for the 21st Century. The Johannesburg World Summit on Sustainable Development in 2002 highlighted both the opportunities and the lack of progress since the Earth Summit in Rio de Janeiro, a decade previously. Decision-makers are looking to sustainable development to provide practical approaches that could address traditional issues as well as the newer challenges. Although no universally accepted practical definition of sustainable development exists as yet, the concept has evolved to integrate economic, social and environmental aims [1,2]. Recent increases in energy prices are likely to be the precursor of a longer term trend. While they will encourage much needed energy efficiency and stimulate investment, they pose severe difficulties for expanding access to modern energy services to the one third of people who still do not have it, or whose access is inadequate for economic development. An energy system embodying such inequities is neither sustainable nor acceptable [3].

However, developing the remaining hydropower potential offers many challenges and pressures from some environmental action groups over its impact has tended to increase over time. Hydropower throughout the world provides 17% of our electricity from an installed capacity of some 730 GW is currently under construction, making hydropower by far the most important renewable energy for electrical power production. The contribution of hydropower, especially small hydropower (SHP) to the worldwide electrical capacity is more of a similar scale to the other renewable energy sources (1-2% of total capacity), amounting to about 47 GW (53%) of this capacity is in developing countries [3,4].

Affordable energy services are among the essential ingredients of economic development, including eradication of extreme poverty as called for in the United Nations Millennium Development Goal (MDGs). Modern energy services-mainly provided by liquid and gaseous fuels, as well as electricity-are essential. Convenient, affordable energy is also important for improving health and education, and for reducing the human labour required to cook and meet other basic needs [3-6].

Meanwhile, global climate change poses an unprecedented threat to all human beings. While this problem is important in the long-run, most decision-makers recognise (especially in the developing countries), that there are many other critical sustainable development issues that affect human welfare more immediately. However, even in the short term, climate is an essential resource for development. For example, in many countries (especially the poorest ones), existing levels of climatic variability and extreme events pose significant risks for agriculture, economic infrastructure, and vulnerable households. Climatic hazards continue to take their human and economic toll even in wealthy countries. Such climate threats, which undermine development prospects today, need to be better addressed in the context of the long-run evolution of local and regional climates [1,7].

There is a growing concern that long-run sustainable development may be compromised unless measures are taken to achieve balance between economic, environmental and social 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 [8]. Turkey's new government has continued this policy despite lower energy demand induced by the 2001 economic crisis. On the other hand, CO_2 and other greenhouse gas emissions of the country are increasing rapidly due to energy and electricity utilization [9].

More generally, climate change and sustainable development interact in a circular fashion. Climate change vulnerability, impacts and adaptation will influence prospects for sustainable development, and in turn, alternative development paths will not only determine greenhouse gas (GHG) emission levels that affect future climate change, but also influence future capacity to adapt to and mitigate climate change. Impacts of climate change are exacerbated by development status, adversely affecting especially the poor and vulnerable socio-economic groups. The capacity to adapt to climate change goes beyond wealth, to other key pre-requisites of good development planning, including institutions, governance, economic management and technology [1,10].

The key to an effective climate change response strategy is a better understanding of relevant policy linkages. Development planners, naturally, place development first, and therefore, climate policies need to be integrated within national sustainable development strategies. In particular, they would like to know whether specific climate change impacts and response measures will make existing development efforts less, or more, sustainable in terms of their economic, social and environmental dimensions [1].

2. Climate change, energy and emission profile in Turkey

Turkey’s total carbon dioxide (CO_2) emissions amounted to 239 million tons (Mt) in 2006 (Tables 1-3). Emissions grew by 5% compared to 2001 levels and by just over 50% compared to 1990

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levels. Oil has historically been the most important source of emissions, followed by coal and gas. Oil represented 45% of total emissions in 2004, while coal represented 40% and gas 15%. The contribution of each fuel has however changed significantly owing to the increasingly important role of gas in the country's fuel mix starting from the mid-1980s [3,11,12].

	1990	1995	2000	2002	2004	2006
CO_2 sectoral approach (Mt of CO_2)	126.91	152.66	200.56	202.13	2007.25	239.74
CO_2 reference approach (Mt of CO_2)	138.20	157.28	203.48	203.45	209.50	242.61
Total Primary Energy Supply, TPES (Mtoe)	52.94	61.81	76.87	78.73	81.83	94.00
GDP (billion 2000 US$ using PPPs)	309.57	362.57	439.99	464.79	506.30	576.82
Population (millions)	56.20	61.64	67.46	70.71	71.79	72.97
CO_2 / TPES (t CO_2 per TJ)	57.30	59.00	62.30	61.30	60.50	60.90
CO_2 /GDP (kg CO_2 per 2000 US$)	0.91	0.93	1.01	0.96	0.90	0.92
CO_2 / GDP (kg CO_2 per 2000 US$ PPP)	0.41	0.42	0.46	0.43	0.41	0.42
CO_2 / population (t CO_2 per capita)	2.26	2.48	2.97	2.86	2.89	3.29

Table 1. Key indicators in Turkey [3,13].

	CO_2 emissions	Level assessment	Cumulative
IPCC source category	**(Mt of CO_2)**	**(%)**	**total (%)**
Production electricity and heat-coal/peat	42.32	12.6	12.6
Manufacturing industries-coal/peat	42.30	12.6	25.1
Road-oil	36.60	10.9	36.0
Production electricity and heat-gas	27.28	8.1	44.1
Residential-gas	14.45	4.3	48.4
Manufacturing industries-oil	12.35	3.7	52.0
Residential-coal/peat	10.10	3.0	55.0
Non-specified other sectors-oil	9.69	2.9	57.9
Manufacturing industries-gas	8.01	2.4	60.3
Non-specified other sectors-gas	6.51	1.9	62.2
Other transport-oil	5.36	1.6	63.8
Total CO_2 from fuel combustion	239.74	71.1	71.1

Table 2. Key sources for CO_2 emissions from fuel combustion for Turkey in 2006 [3,14].

Years	CO_2	CH_4	N_2O	F gases	Total
1990	139.6	29.2	1.3	0.0	170.1
1992	152.9	36.7	4.0	0.0	193.6
1994	159.1	39.2	2.2	0.0	200.5
1996	190.7	45.0	6.1	0.4	242.1
1998	202.7	47.7	5.6	0.7	256.6
2000	223.8	49.3	5.8	1.1	280.0
2002	216.4	46.9	5.4	1.9	270.6
2004	241.9	46.3	5.5	2.9	296.6
2005	256.3	49.4	3.4	3.2	312.4

Table 3. Greenhouse gas emissions by gas in Turkey (million tons CO_2 eq) [3,13,14].

According to recent projections, total primary energy supply (TPES) will almost double between 2006 and 2020, with coal accounting for an increasingly important share, rising from 24% in 2006 to 36% in 2020, principally replacing oil, which is expected to drop from 40% to 27%. Such trends will lead to a significant rise in CO_2 emissions, which are projected to reach nearly 600 Mt in 2020, over three times 2004 levels [3,12,14,15].

In 2006, public electricity and heat production were the largest contributors of CO_2 emissions, accounting for 30% of the country's total. The industry sector was the second largest, representing 28% of total emissions, followed by transport, which represented 20% and direct fossil fuel use in the residential sector with 8%. Other sectors, including other energy industries, account for 14% of total emissions. Since 1990, emissions from public electricity and heat production have grown more rapidly than in other sectors, increasing by 6%. Simultaneously, the shares of emissions from the residential and transport sectors both dropped by 7% and 3% respectively while the share of emissions from the manufacturing industries and construction sector remained stable [3,11,13,16].

Over 40% of all energy is used by the industrial sector and nearly 35% in the residential sector. The rest is split between transportation and commercial services. Industry in Turkey is energy intensive, especially iron and steel manufacturing and cement production sectors, by far the largest energy users. In the residential and commercial building sector, more than 80% of energy is used for space heating. Use of electrical appliances is rapidly increasing and boosting power demand. Table 4 shows the electric power capacity development in Turkey. Increasing use of air-conditioning, especially in the Mediterranean region, has shifted the peak hours of electricity demand to noon in the summer. Electricity consumption for lighting accounts for 30-40% of power consumption in the residential sector.

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Fuel type	2005		2010		2020	
	Installed capacity (MW_e)	Generation (GWh)	Installed capacity (MW_e)	Generation (GWh)	Installed capacity (MW_e)	Generation (GWh)
Coal	14465	48386	16106	104040	26906	174235
Natural gas	10756	66417	18923	125549	34256	225648
Fuel oil	2124	10531	3246	18213	8025	49842
Renewables	14112	50900	25102	86120	30040	104110
Nuclear	0.0	0.0	2000	14000	10000	70000
Total	41457	176234	65377	347922	109227	623835

Table 4. Electric power capacity development in Turkey [11].

On the other hand, the transport sector is dominated by road transport. Vehicle ownership is only seven vehicles per hundred inhabitants compared to the OECD average of fifty. Capacity utilization of available rail lines for passenger transport is low for inter-city traffic and higher for suburban lines [3,17-20].

3. Climate change and greenhouse gas emissions policies in Turkey

Turkey was a member of the OECD when the United Nation Framework Convention on Climate Changes (UNFCCC) was adopted in 1992, and was therefore included among the so-called Annex I and Annex II countries. Under the convention, Annex I countries have to take steps to reduce emissions and Annex II countries have to take steps to provide financial and technical assistance to developing countries. However, in comparison to other countries included in these annexes, Turkey was at a relatively early stage of industrialization and had a lower level of economic development as well as a lower means to assist developing countries. Turkey was not given a quantified emissions reduction or limitation objective in the Kyoto Protocol. Following a number of negotiations, in 2001 Turkey was finally removed from the list of Annex II countries but remained on the list of Annex I countries with an accompanying footnote specifying that Turkey should enjoy favorable conditions considering differentiated responsibilities. This led to an official acceptance of the UNFCCC by the Turkish Grand National Assembly in October 2003, followed by its enactment in May 2004. Turkey has not yet signed the Kyoto Protocol [3,11,14,21].

Throughout this process, the government carried out a number of studies on the implications of climate change and its mitigation. The first efforts were undertaken by the National Climate Coordination Group in preparation for the 1992 Rio Earth Summit. Following this, a National Climate Program was developed in the scope of the UNFCCC. In 1999, a specialized Commission on Climate Change was established by State Planning Organization (DPT) in preparation of the Eighth Five-Year Development Plan (2001-2005). The Five-Year Development Plan was the first planning document to contain proposals for national policies and measures to reduce GHG emissions, and funding for climate-friendly technologies [3,22].

Following the ratification of the UNFCCC, a number of working groups were set up with the objective to define a climate change mitigation strategy and compile the country's first national communication to the UNFCCC. These included a working group on mitigation in the energy sector and a working group on mitigation in the transport sector. However, it remains unclear as to when the strategy and national communication will be completed. The strategy aims to reduce GHG emissions through the implementation of appropriate measures and the development of climate-friendly technologies. Energy efficiency and the development of renewable energy sources are two important components of the strategy. However, the strategy will not include any policies that directly target GHG emissions, such as carbon taxation or emissions trading. It also does not include a specific target for emissions reductions [3,14].

4. Global warming and environmental policy in Turkey

Developing countries, while varying in size and population, political system, economic structure, bear many similarities. They are facing less favourable economic circumstances, worsening environmental degradation and challenges in curbing climate changes. The present paper [1] only focuses on the issues of contradictory objectives, unrealistic standards and limited public participation.

Policy makers in developing countries are well aware of the importance of environmental protection. However, more often than not, they are placed in a dilemma when left to balance between economic growth and environment. Conflicts often rise between social, environmental and economic objectives [1,23]. The headlong pursuit of economic growth is the cornerstone of developing countries. A top Turkish environmental official accepted that economic growth must take precedence over environmental protection for years to come because the former is not only of great importance to maintaining political stability but also to funding the environmental clean-up. This very contradictory objective in developing countries is well materialized in the implementation of "Polluter Pays Principles" (the PPP), the value of which is dramatically belabored. A good example can be found in the way the governments deal with state-owned enterprises (SOEs) in emissions abatement.

On the other hand, for developing countries, great importance should be attached to the acceleration of environmentally responsible development rather than following the past, and arguably the present, path of the industrial world in pursuit of "unrestricted economic growth without considerations to its effects on the natural environment".

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Public unawareness of environmental impacts presents a serious impediment in developing countries to effectively implementing environmental policies. Frequently decisions are made in the absence of environmental information in these countries [1,23]. In addition, environmental impacts are normally exposed to the purview of selected environmental departments, and offices in charge, and expert researchers. The public tend to be left in the dark about the seriousness of the worsening environment they are living in, the costs to their health and quality of life, and the opportunity of helping policy-makers to improve the environment. The lack of environmental awareness has resulted in indifference to environmental degradation, an absence of self-regulating motivation and, above all, a lack of enthusiasm to be involved in monitoring polluting operations and enterprises. Public participation could be a cost-effective method of implementing environmental policy, especially for those countries chronically short of funds and trained human resources.

Since possible results of the global warmth gradually started to form the most basic problem on environmental basis, "Framework Convention on Climate Changes" (FCCC) is constituted which was due on March 21, 1994 followed by its approval by 50 countries after being first approved in Rio Environment and Development Conference held in 1992. Aim of the Convention is to keep the concentration of greenhouse gas in the atmosphere at a constant level necessary to prevent its hazardous man caused impact on climate system. On the other hand, international society will come to a common decision in Conference of Parties (COP) held annually where all participating countries are closely involved in decision making process. The countries in Convention's Appendix-1 list decided by Kyoto Protocol to be due between 2008 and 2012 will be forced to reduce total emission level of gases (CO_2, CH_4, N_2O, HFC_s) that have direct greenhouse effect 5% below the level in 1990 [1,24].

5. Electricity generation and CO_2 emission in Turkey

The electricity generation in Turkey is dominated by fossil fuels. As shown in Fig. 1, the share of fossil fuels in total generation has been steadily increasing for last two decades and reached to the peak share of 82,5% in 2008 [25]. The 57,4% of total electricity generation in 2008 was from imported fuels (natural gas, imported coal and liquid fuels). The high level of fossil fuel dependency in the electricity generation is the major cause of increase in the national GHG emissions. Since 1990, the total GHG emission of Turkey has increased more than twofold and reached 366,5 million tons of CO_2e in 2008. Within the same period, the GHG emissions generated upon the electricity generation is increased more than threefold from 30 million tons in 1990 to 101,4 million tons in 2008 [9].

Turkey's GHG emissions were doubled by 2008 and reached to 366,5 million tons CO_2e comparing 1990 level as shown in Fig. 2 [9]. In 2008, around 80% of the total emissions of Turkey were from CO_2 while one third of CO_2 emissions were from electricity generation as shown in Fig. 3 [9]. In other words, more than one quarter of total emissions (27%) are due to electricity generation by fossil fuels. Other important CO_2 sources are industry, road transportation, residential and cement production [9].

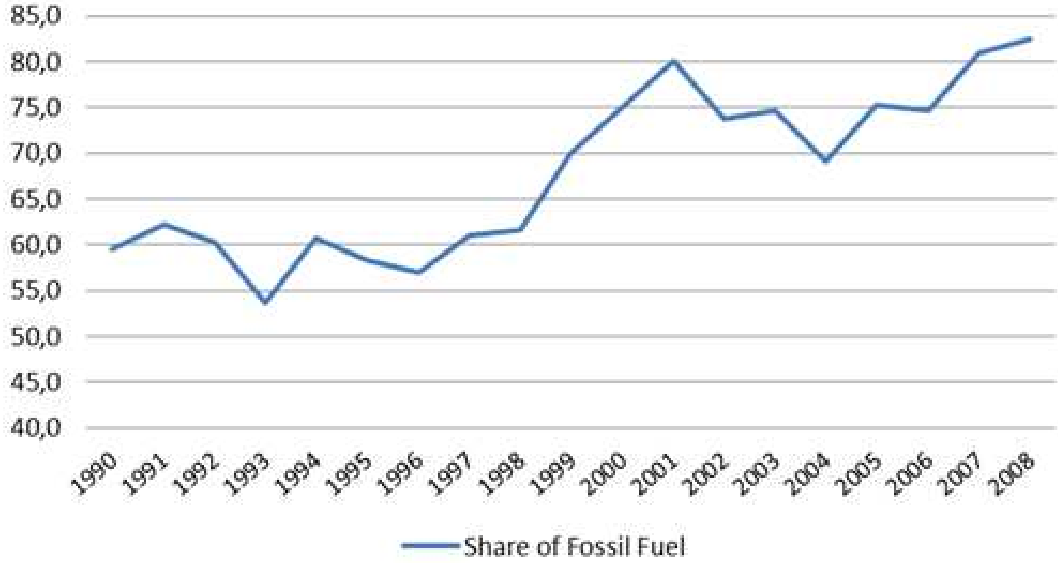

Figure 1. Share of fossil fuels in electricity generation of Turkey by years (%).

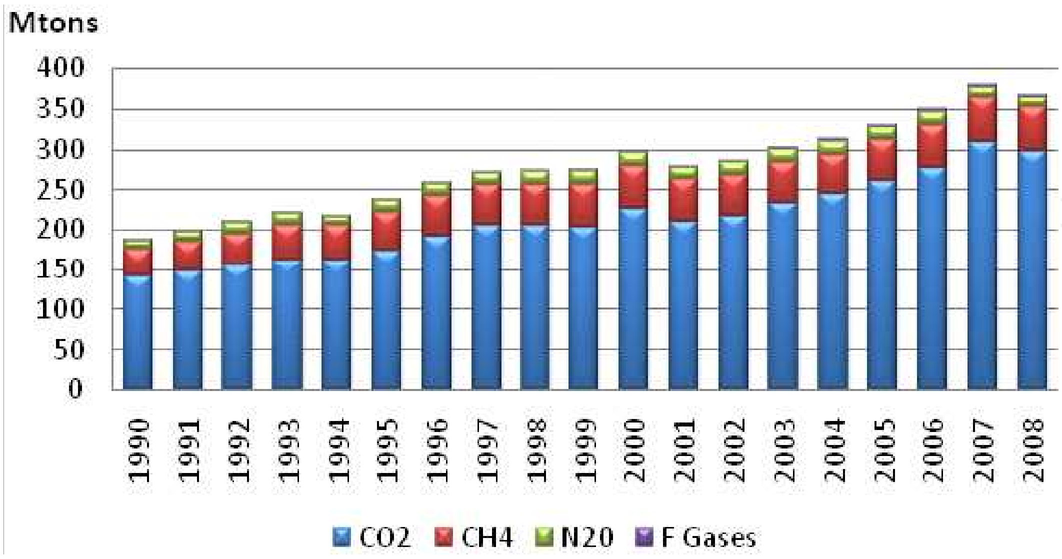

Figure 2. Development of cumulative GHG emissions of Turkey by years.

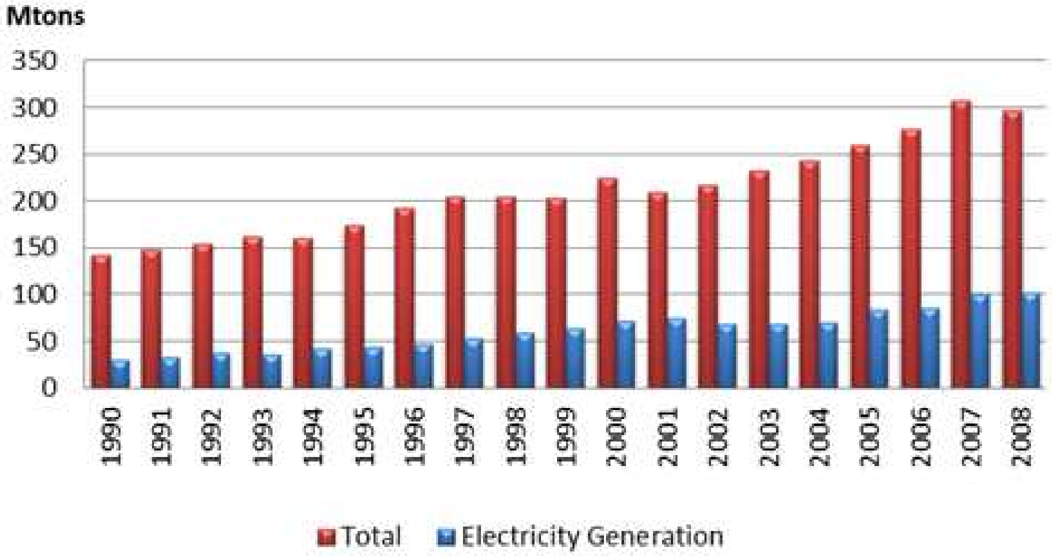

Figure 3. Development of total and electricity generation CO_2 emissions by years in Turkey.

6. Hydropower as a renewable energy in Turkey

Turkey has substantial renewable energy resources. Renewables make the second-largest contribution to domestic energy production after coal. In 2003, energy from renewable sources amounted to 10 Million tons of oil equivalent (Mtoe). More than half of renewables used in Turkey are composed of combustible renewables and waste, the rest being mainly hydro and geothermal as shown in Table 5. Combustible renewables and waste used in Turkey are almost exclusively non-commercial fuels, typically wood and animal products, used in the residential sector for heating. The use of biomass for residential heating, however, has declined owing to replacement of non-commercial fuels by commercial fuels. The contribution of wind and solar is still small but is expected to increase. Electricity generation from renewables totalled 35.5 TWh and contributed 25% to total generation in 2004. In 1990, generation from renewables was 23.2 TWh and their share in power generation was higher, representing 40%. Hydro is the dominant source of renewable electricity, with only 0.15 TWh derived from other sources. Hydro production fluctuates annually depending on the weather [3,12,15,26-28].

Hydropower generation climbed from 2 Mtoe (23.1 TWh) in 1990 to 3.0 Mtoe (35.3 TWh) in 2004, growing on average by 3.8% per year. The economic hydropower potential has been estimated at 128 TWh per year, of which 35% has been exploited. The government has a strategy for developing the hydropower potential and expects a few hundred plants to be constructed over the long term adding more than 19 GW of capacity. Construction costs would be approximately US$ 30 billion. The government expects hydropower capacity to reach about 31000 MW in 2020. Some 500 projects (with a total installed capacity over 20400 MW), which are in different phases of the project cycle, are awaiting realization. On the other hand, Turkey has a lot of potential for small hydropower (< 10 MW), particularly in the eastern part of the country. At present the total installed capacity of small hydropower is 176 MW in 70 locations, with annual generation of 260 GWh. Ten units are under construction with a total installed capacity of 53 MW and estimated annual production of 133 GWh. Furthermore, 210 projects are under planning with a total capacity of 844 MW and annual production of about 3.6 TWh [3,29].

Renewable energy sources	**1990**	**1995**	**2000**	**2002**	**2004**
Primary energy supply					
Hydropower (ktoe)	1991	3057	2656	2897	3038
Geothermal, solar and wind (ktoe)	461	654	978	1142	1215
Biomass and waste (ktoe)	7208	7068	6457	5974	5728
Renewable energy production (ktoe)	9660	10779	10091	10013	10001
Share of total domestic production (%)	38	40	38	40	42
Share of TPES (%)	18	17	12	13	12
Generation					
Hydropower (GWh)	23148	35541	30879	33684	35330
Geothermal, solar and wind (GWh)	80	86	109	153	145
Renewable energy generation (GWh)	23228	35627	30988	33837	35480
Share of total generation (%)	40	41	25	26	25
Total final consumption					
Geothermal, solar and wind (ktoe)	392	580	910	1048	1134
Biomass and waste (ktoe)	7208	7068	6457	5974	5728
Renewable total consumption (ktoe)	7600	7648	7367	7022	6882
Share of total final consumption (%)	18	15	12	12	11

Table 5. Renewable energy supply in Turkey [3,12].

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Hydropower is solar energy in a naturally and ideally concentrated form that can be utilized with the help of a mature and familiar technology with unsurpassed rates of efficiency. Moreover, it does not deprive future generations in terms of raw materials, or burdening them with pollutants or waste. Hydroelectric power plants utilize the basic national and renewable resource of the country. Although the initial investment cost of hydropower seems relatively high, the projects have the lowest production costs and do not depend on foreign capital and support, when considering long-term economic evaluation [3,30,31].

7. The role of hydropower and dams for sustainable energy

The generation of hydropower provides an alternative to burning fossil fuels or nuclear power, which allows for the power demand to be met without producing heated water, air emissions, ash, or radioactive waste. Of the two alternatives to hydropower, in the last decade, much attention has been given to thermal power production because of the adverse effect of CO_2 emissions. With the increasing threat of greenhouse gases originating from such anthropogenic activities on the climate, it was decided to take action. Thus the Framework Convention on Climate Change was enacted on 21 March 1994 and has been signed by 174 countries to date [3,31].

Dams that produce electricity by this most productive renewable clean energy source in the world provide an important contribution to the reduction of air pollution. The result of an investigation held in the USA suggests that the productivity of hydroelectric power-plants is higher than 90% of thermal plants and this figure is twice that of thermal plants. In case of Turkey, the public has been wrongly informed. Some people have claimed that hydro plants do not produce as much energy as planned because of irregular hydrological conditions and rapid sedimentation of reservoirs. It is also claimed that the cost of the removal of dams entirely filled by sediment at the end of their physical lives is not considered in the total project cost, and that there are major problems in recovering the cost of investment and environmental issues [3,5,31].

8. Cost of the renewable energy technology

In terms of selection of the capital costs of renewable technologies by 2015; the World Bank Study [32], the market analysis and data tables of the International Energy Agency [33] and report prepared by the Ministry of Environment and Forestry [34] are benefited from. On the other hand, the calculated prices are adjusted for the year 2015 by learning rates for each technology. The learning rates are the decrease in cost of technologies for each doubling of capacity due to technological and operational improvements in these kinds of technologies. The formula used to calculate the future cost of technology is given below as [34]:

$$SCI_F = SCI_{P*}\left(C_F/C_P\right)^{\ln(1\text{-}LR/\ln 2)} \quad (1)$$

where SCI_P is the current specific capital investment cost, C_P is the current global installed capacity, C_F is the installed capacity of the technology in a future time, and LR is the learning rate of the technology.

The learning rates for each technology type and estimated 2020 capacities for each technology are taken from the literature [32]. The calculated decrease by 2020 for capital cost of each technology types are given in Table 6.

Electricity generation technology	Learning rates	Capital cost decrease rate from 2008 to 2020
Pvotovoltaics (PV)	24%	13%
Wind-Onshore (good wind)	8%	14%
Wind-Onshore (Moderate wind)	8%	14%
Wind-Offshore	8%	19%
Solar thermal with storage	10%	13%
Geothermal	10%	8%
Biomass Gasifier	5%	8%
MSW/landfill Gas	12%	6%
Biogas	13%	7%
Mini Hydropower	2%	5%

Table 6. Decrease in capital cost by learning rate for each technology types

9. Carbon reduction prices

There are only a few credible studies on future carbon price forecasts. It is assumed that 2010 prices for each generation types which are also given in Table 7 will be applicable in 2020 for voluntary market prices. As given in Table 7, the price projections of some analysts for Phase III period of EU ETS (2010-2020) are used for the CDM/JI and EU ETS prices in 2020.The single projected price of CDM/JI which is 20 €/tCO_2e (25 USD/ tCO_2e) as given in this table, is taken as it is while the average estimation of three different prices (30, 35 and 40 US$) presented is taken as a reference for EU ETS price forecast which is 35 €/tCO_2e (45 USD/ tCO_2e) [35].

As given in Table 8, wind energy potential of Turkey is 50,000 MW. But according to the TEIAS [25], only 8,000 MW of these potential has high level wind speed (i.e. capacity factor is 40%). The entire 40.000 MW potential have a moderate wind speed (ie. capacity factor is 25%-30%).

	Price
Project type	(USD/tCO_2e)
Pvotovoltaics (PV)	21.50
Wind-Onshore (good wind)	12.40
Wind-Onshore (Moderate wind)	12.40
Wind-Offshore	12.40
Solar thermal with storage	21.50
Geothermal	17.00
Biomass Gasifier	16.20
MSW/Landfill Gas	16.20
Biogas	16.20
Mini Hydropower	5.20

Table 7. Voluntary credit price changes by project type in 2010

	Potential	Potential	Utilized	2030 Target
Energy sources	(TWh/yr)	(GW)	(GW)	(GW)
Hydropower	180	50	15	180
Wind energy	150	50	1	40
Geothermal	4.2	0.60	0.1	4.2
Solar energy	380	0.1	0.1	10
Biomass	3.6	0.50	0.1	2.2

Table 8. Renewable source potential, utilization by 2010 and target for 2030

10. Results and discussion

According to the result of financial analysis, none of the listed renewable electricity generation technology will be financially attractive without additional carbon finance in 2020. Onshore wind plants in the areas with high level wind speed, landfill gas and biogas power plants will be attractive if they secure emission reduction certification and sell those certificates in the voluntary markets based on the price assumptions. However, the wind projects having smaller capacity factor and geothermal projects can be financially attractive. It is clear that, other than price for mini hydro, at least till 2020, none of this prices are realistic, hence these technologies shall have higher feed-in-tariffs to be more attractive by private investors. The effect of carbon finance as an additional revenue to the renewable electricity generation is analyzed. The renewable electricity generation technologies analyzed are; PV, wind, solar thermal with storage, geothermal, biomass gasifier, MSW/landfill gas, biogas and mini hydropower.

According to the result of financial analysis based on the current VCM conditions, carbon finance opportunities for Turkish renewable projects under the voluntary market would be limited to wind power projects with high speed wind potential and also limited to landfill and biogas projects with financial viability. PV, solar thermal, wind projects with moderate or lower wind speed potential, geothermal, biomass gasifier and mini hydro projects are not projected to be financially attractive even with additional VER revenues based on the VER prices of 2020. The potential electricity generation through those projects is estimated to be around 40,000 MW. The national target for installed capacity for wind projects by 2023 is 20,000 MW but, if the current feed-in-tariff prices are not to be increased, the highest available carbon prices in voluntary market will not be sufficient to enable investments of the wind projects with low speed potential. Hence, the investments would be limited to the 8,000 MW wind power projects which are financially attractive based on their high speed wind potential. The additional 12,000 MW wind capacity are projected to be utilized if CDM/JI like carbon scheme will be applicable by 2020, will result additional reduction of 19 million tCO_2e emissions considering baseline emissions. In addition to the wind, the entire geothermal energy potential for electricity generation (510 MW) and biomass gasifier as well as most of mini hydro (10 MW) potentials can be utilized with any carbon scheme leading emission reduction prices by 2020.

11. Conclusions

Turkey's high rate of energy-related carbon emissions growth is expected to accelerate, with emissions climbing from 57 million tons in 2000 to almost 210 million tons in 2020. Carbon intensity in Turkey is higher than the western developed nation average. Energy-intensive, inefficient industries remain under government control with soft budged constraints, contributing to undisciplined energy use in Turkey.

But the country has made significant progress in reducing local air pollution, particularly in large cities. Nevertheless, significant efforts still need to be made to ensure existing standards are met and to prepare for further reductions in air pollution. The potential long-term impacts of the liberalization process on air pollution and on GHG emissions should be investigated and monitored in order to optimize policy outcomes. The recent construction of a power plant based on fluidized bed combustion technology is laudable. Further adoption of such cleaner coal plants and more efficient technologies would help Turkey meet more stringent air pollution standards. Similar to other industrializing countries, with the increases in energy consumption and economical growth, energy related environmental problems are rapidly growing in Turkey.

Developing countries are likely the most vulnerably to this change because of their less favourable economic circumstances, weaker institutions and more restricted access to capital, technology and information. Given rapid growth of economies and populations, there are a number of implications for developing countries that indicate a need to curb GHGs and thereby

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to lessen the impact of climate change. Great efforts have been made in reforming energy pricing, promoting energy efficiency and the use of renewable energy sources. With some possible options, the paper concludes that the reduction of emissions can only be achieved when policies are supportive and well targeted, standards and incentives are realistic and flexible, and the public is actively responsive to environmental degradation.

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