8

Global Warming and Hydropower in Turkey for a Clean and Sustainable Energy Future

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1. Introduction

More generally, global warming and 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 (Kaygusuz, 2001; Yuksel, 2008a).

Meanwhile, global warming and 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 (PEWCLIMATE, 2002; Yuksel, 2008a).

Delivering sustainability demands that this access and security of supply be provided, while avoiding environmental impacts, which would compromise future social and economic development. Drawing on the wide-ranging discussions of the Congress, the World Energy Council draws some conclusions a few of these as follows (WEC, 2004; Yuksel and Sandalci, 2009):

- Climate change is a serious global concern, calling for changes in consumer behavior, but offering potential win-win opportunities. These include increased transfer of efficient technologies from industrialized to developing countries and incentives to investment through emerging voluntary and regulated emissions trading.
- Technological innovation and development is vital to reconciling expanded energy services for more equitable economic development with protection of the environment.
- Research and development (R&D) must be more strongly and consistently supported than has been the case. It is the pre-condition of the innovation which is needed. A starting point is the reduction of R&D redundancies through international cooperation.

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 (Yuksel, 2007; Yuksel and Sandalci, 2009).

2. Global warming

One major disadvantage of the two-actor matrix presented above is that it gives the false impression that Greens and Developmentalists are evenly matched in their struggle to shape energy politics in Turkey. The actual struggle, however, is far from being between two equals. Developmentalist ideology rules supreme in Turkey and energy politics is no exception to this rule. While energy-related environmental activism, as exemplified by the movements against the Gökova thermic power plant, the Akkuyu Nuclear Power Plant, and the Fırtına valley hydropower dam, is at the heart of environmental politics in Turkey, they either achieve short-lived victories (e.g. the reintroduction of the plans of nuclear power plants) or end-of-pipe solutions that do little to change the overall policy structures (e.g. installation of filters at Gökova). Yet, as several other contributors have argued in this collection, the state in Turkey remains highly sensitive to international forces and dynamics and has frequently improved its environmental policies and practices in response to outside pressures. Therefore, this concluding section discusses the potential impact of global warming and the Kyoto Protocol on the future of Turkish energy policies (Ogutcu, 2002; Kaygusuz, 2003a; Kaygusuz and Sari, 2003; Kaygusuz, 2004a,b; IEA, 2005; MENR, 2005; TEIAS, 2005; Yuksel 2010).

When the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992, all OECD members were included in the list of developed countries in Annex II. Turkey asked for an exception on the grounds that its relative underdevelopment from other OECD members justified special treatment. Such an exception was granted at the Seventh Conference of Parties in Marrakech in 2001, where Turkey was removed from the Annex II. Consequently, the parliament is expected to ratify the Convention. This exception is notable because the flexible implementation mechanisms of the Kyoto Protocol (assuming eventual ratification by Turkey) will open up new avenues for foreign investments for energy efficiency and clean technology projects (IEA, 2005; Yuksel, 2010).

Following the ratification of the Framework Convention and the Kyoto Protocol, Turkey has become eligible for trade in carbon credits under the provisions of the Clean Development

Mechanism. While the necessary institutional capacities and information systems remain to be developed, the government declared its willingness to comply with the general provisions of the UNFCCC. Unlike domestic energy procurement strategies, the global warming dimension of energy politics receives scant attention from civil society and environmental NGOs. Nevertheless, international pressure, especially through the European Union, is likely to lead Turkey to take real steps toward helping prevent global warming (Ogutcu, 2002; MENR, 2005; Yuksel 2010).

Toward this end, the preparation of the 8th Five-Year Development Plan included for the first time an Expert Committee on Climate Change. The committee's recommendations lean heavily toward market-based solutions, support the recent trend toward increased natural gas consumption and make a number of commonsensical suggestions (WECTNC, 2004; Yuksel 2010). A number of promising steps have been taken toward the implementation of these policies. The Electricity Market Act and the Natural Gas Market Law, both of 2001, increased competition and further private involvement. However, given the projected increase in energy demand and consumption, any meaningful reduction of future greenhouse gases in Turkey will necessitate significant investment in renewable energies beyond the current interest in hydropower.

Energy development in Turkey has been dominated by public investment and management. The current government, however, is keen to complete the process of liberalization, restructuring, and privatization in the energy sector. Turkey has made early and extensive use of financing models such as build-own-operate (BOO) and build-own-transfer (BOT). As yet, however, no decisive breakthrough has been achieved. This does not mean a complete withdrawal of the state from energy development. In fact, state involvement in formulating and implementing favorable policies for renewable energy development remains vital. To ensure timely and effective investment in renewable sources, however, the state needs to mobilize the extensive funds available to the private sector. A number of renewable energy projects, such as certain hydropower and solar thermal applications, are already commercially attractive to private interests.

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, HFCs) that have direct greenhouse effect 5% below the level in 1990 (Say, 2006; Yuksel, 2008a).

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 (World Bank, 1992 and 2000). 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 (Yuksel, 2008a).

3. Climate change

Sustainable development has been recognized as a key cross-cutting theme in the preparation of the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report. Researchers could make pivotal contributions to the IPCC's work on sustainable development, with contributions to this volume highlighting some of the key issues requiring investigation and analysis. On the other hand, technologies and practices to reduce GHG emissions are continuously being developed. Many of these technologies focus on improving the efficiency of fossil fuel energy or electricity use and the development of low carbon energy sources, since the majority of GHG emissions are related to the use of energy. Energy intensity (energy consumed divided by gross domestic product, GDP) and carbon intensity (CO_2 emitted from burning fossil fuels divided by the amount of energy produced) have been declining for more than 100 years in developed countries without explicit government policies for decarbonization, and have the potential to decline further (IPCC, 2001; Yuksel, 2008a).

Perhaps the most contentious issue is the conceptual framework for addressing climate change within a sustainable development mandate. Various stakeholders are bound to have different views and analytical frameworks to support their positions. Given the extent to which the respective debates on climate change and sustainable development have evolved separately in the past, it will be a significant challenge to re-integrate climate change with development policy (Briden and Downing, 2002; Yuksel, 2008a).

A debate on policy requires a framework for evaluating risks and solutions. The choices revolve around the extent to which a framework seeks to explore and visualize alternatives or recommend desirable solutions, the representation of values, and the role of actors. The contributors to this volume do not evaluate their frameworks-often presuming that the structure they use (be it approaches based on cost-benefit analysis, integrated assessment or social analysis), are adequate to the challenge (Munasinghe and Swant, 2004; Yuksel, 2008a).

The more technical issues in analytical methodologies involve persistent challenges to researchers. For example:

- A narrowly focused cost-benefit analysis assumes that researchers can comprehensively estimate the monetary implications of mitigation policy and climate impacts in the economic, social and environmental domains. Few researchers believe that calculations of potential impacts of climate change are well known, and many are sceptical of the hubris involved in bridging the local/global nature and present/century time-scales of climate change. For example, currently available estimates of the social cost of carbon are inadequate in assessing secondary effects, climatic disasters and potential large-consequence risks.
- Integrated Assessment Models (IAMs) do not capture the role of decision-makers (i.e. their worldviews, goals and strategies), rather relying on rational economic criteria or statistical trends in a pressure-state-impacts-responses framework. For example, technological developments are often handled as continuous functions, such as a co-efficient for autonomous improvement in energy efficiency (Downing et al., 2003; Yuksel, 2008a).
- Scenarios are not very reliable frameworks for optimizing present decisions, although they are often used in this manner. Existing scenarios are seldom probabilistic and socio-economic projections tend to be static world-views with little correspondence to the punctuated, dynamic, event-response nature of reality. For example, few vulnerability/adaptation researchers consider scenarios of GHG emissions projections as adequate for understanding potential failures of climate policy.

Given the importance of the conceptual frameworks, there is surprisingly little research into what comprises a 'good' framework. Some research communities have attempted to systematically compare their own frameworks (e.g. the vigorous discussion among IAM teams). Even agreed criteria are missing for comparing such broad scoping frameworks and methodologies (Downing et al., 2003; Yuksel, 2008a).

While it is relatively easy to raise equity and values as key research-policy issues, there is a tendency by researchers to say in effect, "we provide the facts and let policy-makers negotiate on the values and make choices". This is an unduly conservative approach to research. Equally, it removes from climate policy research the rich traditions of some social sciences and the humanities.

Turkey's most recent Five-Year Development Plan, adopted in 2000, affects all policies in all economic sectors and has an indirect impact on greenhouse (GHG) emissions. The first Special Expert Committee on Climate Change was established as one of 98 consultative committees during preparation of this plan. The committee's recommendations were published by the Turkish prime minister as official policy for the current planning period (see Table 1).

• Privatizing energy resource production.
• Increasing the share of natural gas in consumption.
• Transferring electricity production and distribution to the private sector to make utility services more efficient.
• Encourage power savings by matching costs to prices and preventing theft.
• Developing new and renewable energy sources and ensuring their greater role in the market.
• Converting railway management to commercial orientation to ensure efficient, market oriented services.
• Investing in natural gas pipelines and storage facilities.
• A comprehensive strategy is needed for developing renewable energy sources offshore and this should cover assessment of environmental impacts.
• Combining heat and power plants should be regarded primarily as a source of heat.
• Increasing energy efficiency and ensuring energy savings.
• Improving the petroleum product quality for cut sulphur emissions.
• Using proper energy management model for the future of Turkey.

Source: WECTNC (2003)

Table 1. Emission mitigation potential in Turkey

These recommendations serve to guide government actions, but their actual implementation depends on the actions of various agencies and regulators. Under the Electricity Market Act adopted in 2001, the power sector will soon undergo profound reform, leading to the introduction of competition and increasing private involvement. The new Natural Gas Market Law, also adopted in 2001, establishes a competitive gas market and harmonizes Turkish legislation with European law. The Turkish Council of Ministers has adopted several measures to stabilize fuel prices. An automatic pricing formula was abolished and gasoline taxes were made consistent with European countries. For example, taxes comprised over 60% of the price of gasoline by late 2000. To increase energy efficiency in industrial sectors, energy conservation regulations were issued in 1995. These required industrial

establishments with annual consumption above 84 terajoules to establish an internal energy management system, conduct energy audits, and appoint an energy manager in their plants. Some 1,250 plants accounting for 70% of Turkish industrial energy use are covered by this regulation (Kaygusuz, 2004b; Yuksel, 2008a).

Turkey's total carbon dioxide (CO_2) emissions amounted to 239 million tones (Mt) in 2006. Emissions grew by 5% compared to 2001 levels and by just over 50% compared to 1990 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 (MENR, 2005; MENR, 2007; Yuksel and Sandalci, 2009).

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 (MEF, 2007; MENR, 2007; IEA, 2008; Yuksel and Sandalci, 2009).

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 (MENR, 2005; DIE, 2006; DPT, 2006; Yuksel and Sandalci, 2009).

4. Global warming and climate change policy in Turkey

Turkey was a member of the OECD when the 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 (Kaygusuz, 2003b; MENR, 2005; IEA, 2008; Kaygusuz, 2009; Yuksel and Sandalci, 2009).

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 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 greenhouse gas (GHG) emissions, and funding for climate-friendly technologies (ESMAP, 2003; Yuksel and Sandalci, 2009).

Running counter to the technological and economic potential for GHG emissions reduction are rapid economic development and accelerating change in some socio-economic and behavioral trends that are increasing total energy use, especially in developed countries and high-income groups in developing countries. Dwelling units and vehicles in many countries are growing in size, and the intensity of electrical appliance use is increasing. Use of electrical office equipment in commercial buildings is increasing. In developed countries, and especially the USA, sales of larger, heavier, and less efficient vehicles are also increasing. In addition and usually related to technological innovation options, there are important possibilities in the area of social innovation. In all regions, many options are available for lifestyle choices that may improve quality of life, while at the same time decreasing resource consumption and associated GHG emissions (IPCC, 2001; Yuksel, 2008a).

Of course, the target readers for this volume are not only relevant researchers, but also those concerned with and responsible for climate and sustainable development policy at all levels. At an operational level, there is a need to increase awareness of climatic risks in sustainable development, to look for synergies in policy, and to demonstrate effective solutions. International negotiators bear the front-line responsibility for helping to effectively integrate global climate policies with national sustainable development strategies. The pace of achievements seems slow, particularly in the face of certain climate change. The challenges of resolving conflicts among the world-wide community of stakeholders and implementing a broad reaching sustainability paradigm are indeed formidable. Boundary organisations, linking vulnerable groups with civil society, government and private actors, should explore emerging opportunities.

What should researchers seek to achieve? The ultimate aim of the United Nations Framework Convention on Climate Change (UNFCCC) is to stabilize GHG concentrations at a level that prevents dangerous climate change. While there is no agreement on what such a "dangerous" level might be, stabilization of GHG concentrations at any level would require cuts in global GHG emissions substantially below their current levels. The only international agreement in place so far with legally binding emission targets is the Kyoto Protocol, whose targets, if fully implemented, would amount to only a 5% cut in GHG emissions in industrialized countries from 1990 levels by 2008–2012. Although the Protocol does signal an important change in policy and could, particularly through subsequent negotiating rounds, have long-term impacts on technology and economic development, by itself it is far from achieving the aim of the UNFCCC (1999) (Yuksel, 2008a). Annex I countries, need to show far more effective leadership in controlling their own emissions. The gap between where we are today and the policy target of a stable and acceptable climate system is the defining challenge of research into climate policy (Downing et al., 2003; Yuksel, 2008a).

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 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 (World Bank, 1992; Yuksel, 2008a). 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.

Environmental degradation harms human health, spoils amenities and reduces economic productivity, e.g. agriculture production (Arıkan and Kumbaroğlu, 2001; Yuksel, 2008a). However, protecting the environment is a vital part of improving economic productivity as well as improving the well-being of people today and tomorrow. The evidence shows that the gains from protecting the environment outweigh the costs in the long run (World Bank, 1992, 2000; Yuksel, 2008a). While there is still uncertainty as to the extent and the physical effects of climate change, the costs of not taking actions may well be greater than the costs of preventive actions taken now, especially when the absence of action today may lead to irreversibly undesirable environmental consequences. 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".

On May 24, 2004 Turkey became the 189th party by signing Framework Convention on Climate Changes. In the first six months after Turkey became a party of FCCC, the country is obligated to first national declaration to United Nations General Secretariat until November 24, 2004. After this stage is completed Turkey will both have to fulfill new liabilities such as to present national greenhouse gas inventories and national declaration reports to Convention Secretariat regularly, and will also actively participate in efforts carried on global wide so that convention will achieve its ultimate goal. When we compare sectoral distribution of greenhouse effect emissions occurring due to fuel consumption to obtain consumption and projectional values, it is observed that some sectors increased their shares, and some had a significant decrease in their shares. In 2003, it is estimated that 36% of CO_2 emissions occurred due to energy, 34% due to industry, 15% due to transportation and 14% due to other (housing, agriculture and forestry) sectors and in 2020 40% will occur due to energy, 35% due to industry, 14% due to transportation and 11% due to other sectors (Yuksel, 2008a).

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5. Renewable and sustainable energy in Turkey

The government considers alternative transport fuels to be an important option in the longer term to mitigate energy security concerns and reduce GHG emissions. However, it deems current technologies to be expensive and a risky investment, while not offering significant life cycle GHG reduction benefits, especially if the fuel is derived from fossil fuels. On the other hand, liquefied petroleum gas (LPG) demand in transport increased between 1998 and 2000 owing to a government subsidy and a zero-taxation policy. The trend was subsequently reversed in 2001 with an increase in taxation and the removal of the subsidy. Nevertheless, LPG remains an important transport fuel as its share was 8.9% of the total oil product demand in the transport sector in 2002. LPG is used, for example, in taxis in the major cities (MEF, 2007; Yuksel and Sandalci, 2009).

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 31 000 MW in 2020. Some 500 projects (with a total installed capacity over 20 400 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 (DSI, 2005; Yuksel and Sandalci, 2009).

6. The Role of hydropower for renewable and sustainable energy

The hydropower industry is closely linked to both water management and renewable energy production, and so has a unique role to play in contributing to sustainable development in a world where billions of people lack access to safe drinking water and adequate energy supplies. On the other hand, approximately 1.6 billion people have no

access to electricity and about 1.1 billion are without adequate water supply. However, resources for hydropower development are widely spread around the world. Potential exists in about 150 countries and about 70% of the economically feasible potential remains to be developed-mostly in developing countries where the needs are most urgent (IEA, 2002; IHA, 2003; WEC, 2001; Yuksel, 2008b,c).

Hydropower is available in a broad range of project scales and types. Projects can be designed to suit particular needs and specific site conditions. As hydropower does not consume or pollute the water it uses to generate power, it leaves this vital resource available for other uses. At the same time, the revenues generated through electricity sales can finance other infrastructure essential for human welfare. This can include drinking water supply systems, irrigation schemes for food production, infrastructures enhancing navigation, recreational facilities and ecotourism. Hydropower has very few greenhouse gas emissions compared with other large-scale energy options (see Table 2).

Technology	Energy pay back time in months	SO_2 emission In kg/GWh	NO_2 emission In kg/GWh	CO_2 in Ton/GWh
Coal fired	1.0-1.1	630-1370	630-1560	830-920
Gas (CCGT)	0.4	45-140	650-810	370-420
Large-hydro	5-6	18-21	34-40	7-8
Micro hydro	9-11	38-46	71-86	16-20
Small hydro	8-9	24-29	46-56	10-12
Wind turbine				
4.5 m/s	6-20	18-32	26-43	19-34
5.5 m/s	4-13	13-20	18-27	13-22
6.5 m/s	2-8	10-16	14-22	10-17
Photovoltaic				
Mono-crystalline	72-93	230-295	270-340	200-260
Multi-crystalline	58-74	260-330	250-310	190-250
Amorphous	51-66	135-175	160-200	170-220

Source: UNDP, 2000

Table 2. The comparison of energy amortization time and emissions of various energy technologies.

In addition, by storing water during rainy seasons and releasing it during dry ones, dams and reservoirs can help control water during floods and droughts. These essential functions protect human lives and other assets. This will be increasingly important in the context of global warming, which implies an expected rising variability in precipitation frequency and intensity. On the other hand, hydropower projects do not export impacts such as acid rain or atmospheric pollution. Environmental impacts are limited to changes in the watershed in which the dam is located. When well managed, these changes can sometimes result in enhancements, and other impacts can be avoided, mitigated. Hydropower can contribute to mitigating the widespread potential human impacts of climate change (IHA, 2003; WEC, 2001; Yuksel, 2008b,c).

Hydropower energy is a renewable, sustainable and clean energy in the other alternative energy sources. 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 environmental pollution and long-term economic evaluation (Paish, 2002; Yuksel, 2008b; Yuksel, 2008c).

7. Hydropower and dams for renewable and sustainable energy in Turkey

In 2005, primary energy production and consumption has reached 28 and 94.3 million tons of oil equivalents (Mtoe) respectively (see Table 3). The most significant developments in production are observed in coal production, hydropower, geothermal, and solar energy. Turkey's use of hydropower, geothermal and solar thermal energy has increased since 1990. However, the total share of renewable energy sources in total primary energy supply (TPES) has declined, owing to the declining use of non-commercial biomass and the growing role of natural gas in the system. 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 (DPT, 2006; MEF, 2007; MENR, 2007; Yuksel, 2008c).

	2000	2001	2002	2003	2004	2005
Primary energy production (TTOE)	27,621	26,159	24,884	23,779	24,170	28,020
Primary energy consumption (TTOE)	81,193	75,883	78,322	83,936	87,778	94,300
Consumption per capita (KOE)	1204	1111	1131	1196	1234	1249
Electricity installed capacity (MW)	27,264	28,332	31,846	35,587	36,824	39,596
Thermal (MW)	16,070	16,640	19,586	22,990	24,160	26,481
Hydraulic (MW)	11,194	11,692	12,260	12,597	12,664	13,115
Electricity production (GWh)	124,922	122,725	129,400	140,580	150,698	165,346
Thermal (GWh)	94,011	98,653	95,668	105,190	104,556	124,321
Hydraulic (GWh)	30,912	24,072	33,732	35,390	46,142	41,025
Electricity import (GWh)	3786	4579	3588	1158	464	636
Electricity export (GWh)	413	433	435	587	1144	1812
Total Consumption (GWh)	128,295	126,872	132,553	141,151	150,018	
Consumption per capita (kWh)	1903	1857	1914	2011	2109	2240

Source: Ref. [8] (DPT, 2006; MENR, 2007; Yuksel, 2008c).
Table 3. Developments in production and consumption of energy between 2000–2005 in Turkey.

Conventional electricity supply options include thermal (coal, oil, and gas), nuclear and hydropower. These technologies currently dominate global electricity generation (thermal 60%, hydraulic 20%, nuclear 17% and all others 3%, approximately). Use of cogeneration, particularly geothermal and wind generation, both for isolated supply and small- to medium-scale grid-feeding applications, is small but increasing globally (Altinbilek, 2000; Ceylan and Ozturk, 2004; IHA, 2006; Yuksel and Sandalci, 2009).
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 (Yuksel, 2008c; Yuksel and Sandalci, 2009).

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 (UNDP, 2000; Yuksel, 2008c; Yuksel and Sandalci, 2009).

8. Energy policy in Turkey

The preceding discussion already has laid the foundations for an analytical framework necessary to understand the structural dynamics and political forces at work. The discussion of the determinants of energy intensity and energy sources makes it clear that specific policy outcomes can be understood as a function of two conceptual categories concerning policy-making: regulation and technology. While these two conceptual categories account for most aspects of environmental and energy policy outcomes, a third indicator, political outlook, is required to fully capture the domestic and geopolitical forces at work in Turkey.

The first category, regulation, concerns both the means of devising regulatory frameworks on energy and the overarching goal of such policies. The second category also comprises two variables: the relationship between technology and risk and the nature of technology implementation. Finally, the category of political outlook comprises a discursive alignment and outlook on the nature of international relations (MEF, 2007; MENR, 2007; IEA, 2005; Yuksel 2010).

Using these three categories, it is possible to construct a matrix of the competing energy and environment discourses in Turkey. For the sake of simplicity, this chapter uses only two major orientations, though a variety of combinations are possible. These do not necessarily correspond with real world actors as the matrix is merely intended as a heuristic device to chart the profile of the ongoing policy debates in Turkey. Naturally, the real world of energy politics has various shades of gray, and it is not uncommon for actors to borrow from each camp over time. Nevertheless, these two positions, Greens and Developmentalists, capture the tenor of the ongoing debate in Turkey (Kaygusuz and Arsel, 2005; Yuksel 2010).

Greens believe in extensive environmental regulation. In line with their European and North American counterparts, Greens in Turkey articulate their positions with an implicit critique of markets that question both their desirability as social institutions and effectiveness as regulatory tools. Thus, this position is characterized by calls for the direct involvement of the state in protecting the environment through command-and-control mechanisms. Moreover, Greens privilege ecological protection over continued economic growth. This is not to suggest that this position rejects economic growth entirely, since such deep ecology-inspired movements in Turkey remain relatively rare. The practical upshot of this for their energy policy is built around small-scale and alternative technologies, such as wind farms and solar panels. Finally, in their political outlook, the Greens in Turkey parallel

the 'liberal' school of international relations, constructing their discourse around concepts such as multiculturalism and universal human rights, believing on the one hand that non-state actors are increasingly important in energy politics and on the other interpreting the interstate system as one characterized by win–win cooperation (Kaygusuz and Arsel, 2005; Yuksel 2010).

Air quality standards for four pollutants, namely SO_2, nitrogen dioxide (NO_2), particulate matter (PM) and ozone (O_3) are set under the 1986 Air Quality Protection regulation. The monitoring of ambient air pollution has improved over recent years but remains a problem, particularly with regards to NO_2 and O_3. On the other hand, until recently, the 1986 regulation was also responsible for setting air pollution standards for combustion plants. It was amended in October 2004 by the new Industrial Air Pollution Control Regulation (ESMAP, 2003; MEF, 2007; Yuksel and Sandalci, 2009).

The emissions standards for power plants remain significantly less stringent than those currently in force at the European Union (EU) level as defined by the revised Large Combustion Plants (LCP) Directive. For example, for new solid fuel-fired power plants with a thermal input greater than 300 MW, the NOx emissions limit is set at 200 mg/Nm^3 at the EU level, while the NOx emissions limit is 800 mg/Nm^3 in Turkey. On the other hand, first estimates show that achieving the standards defined under the LCP directive would entail investments of over US$ 1 billion. This would include investments in the retrofitting of installed FGD and ESP equipment and the adoption of advanced and environment-friendly coal technologies. The 2004 Industrial Air Pollution Control Regulation is an important step towards aligning air quality standards with EU regulations, but more efforts will be needed (MEF, 2007; Kaygusuz, 2009; Yuksel and Sandalci, 2009).

Construction of one power plant based on circulating fluidized bed technology has recently been completed. The plant is the first application of advanced coal technology in Turkey and has been designed to use low-quality lignite with high sulfur content. The industry and residential sectors are also responsible for significant air pollution, mainly as a result of lignite consumption. In order to reduce emissions from these sectors, the state-owned Turkish Coal Enterprises (TKI) has developed significant lignite washing capacity. By the end of 2006, total washing capacity was approximately 10.8 Mt, equivalent to current coal demand from both sectors. In addition, the use of high-sulfur coal in residential heating is prohibited. Lastly, the substitution of gas as distribution networks are expanded in urban areas should further contribute to reduce air pollution (TEDAS, 2006; MEF, 2007; MENR, 2007; Yuksel and Sandalci, 2009).

9. Conclusions

The following concluding remarks may be drawn from this study (Yuksel, 2008c):

- There are a number of environmental problems in the country that we face today. These problems span a continuously growing range of pollutants, hazards and ecosystem degradation over the country. So, all government agencies and other non-governmental agencies in the country must work together to utilize their renewable energy and choose the appropriate application in Turkey.
- Take into account the effects of liberalization in the energy forecasts. Continue to revise forecasts regularly to enable the creation of a robust long-term energy policy framework in light of the sharp demand growth and increase focus on the demand side in energy policy planning.

- The technology of hydropower involved has proven itself over a long period of time and is therefore very reliable. So, the government and private sectors should be consider steps to accelerate economic hydropower projects, including refurbishment, consistent with the protection of the environment, to utilize the remaining hydropower potential.
- Fuelwood and modern biomass energy presents a considerable opportunity for Turkey to obtain a significant part of our future energy needs from this sustainable and domestic energy source, since, at present, modern technologies are increasingly being applied to fuelwood development.
- Growing environmental and social concerns, both on the part of decision makers and public opinion, have brought a new perspective to the perception of renewable energy sources as a valid alternative in the long-term, and a useful and practical complement to traditional sources of energy in the short and medium-term. In this respect, geothermal, solar and wind energy sources present a considerable opportunity for our country to obtain a significant part of future energy needs from this sustainable, clean and domestic sources.
- The government should be enact the renewable energy law as envisaged and monitor and evaluate its cost and effectiveness. Share information and experience with other countries introducing quota and certificate-based promotional schemes for renewables.
- Assess the impact on the network reliability and stability resulting from increased penetration of intermittent wind power and explore ways to minimize such an impact. Consider a combination of wind power and pumped storage hydropower for this purpose. Share information and experience with other countries on technical and regulatory approaches to intermittency.

Hydropower represents an alternative to fossil fuel generation, and doesn't contribute to either greenhouse gas emissions or other atmospheric pollutants. 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. Moreover, in the context of the restructuring of the electricity sector, markets may favour more polluting and less costly options. On the other hand, small hydropower's main challenges relate to both economics and ecology. Especially small hydropower can be successfully developed as long as it produces electricity at competitive prices and under conditions that respect the environment. In addition, hydro plants are often superior to other power plants from the standpoint of socio-economic and environmental considerations. The environmental impacts of hydropower plants are at the lowest level compared with the other alternative resources.

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This book is intended to introduce the reader to examples of the range of practical problems posed by "Global Warming". It includes 11 chapters split into 5 sections. Section 1 outlines the recent changes in the Indian Monsoon, the importance of greenhouse gases to life, and the relative importance of changes in solar radiation in causing the changes. Section 2 discusses the changes to natural hazards such as floods, retreating glaciers and potential sea level changes. Section 3 examines planning cities and transportation systems in the light of the changes, while section 4 looks at alternative energy sources. Section 5 estimates the changes to the carbon pool in the alpine meadows of the Qinghai-Tibet Plateau. The 11 authors come from 9 different countries, so the examples are taken from a truly international set of problems.

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