Use of Hydroelectric Power in Sustainable Development of Turkey

Ramazan SEVER
Atatürk University, Turkey
rsever@atauni.edu.tr

Ünal ÖZDEMİR
Atatürk University, Turkey
uozdemir@atauni.edu.tr

Serhat ZAMAN
Atatürk University, Turkey
serhatz@atauni.edu.tr

Mete ALIM
Atatürk University, Turkey
metealim@atauni.edu.tr

Ogün COŞKUN
Atatürk University, Turkey
oguncoskun@atauni.edu.tr

Abstract: Energy is a vital element of development. Clear, reliable, environmental friendly and sustainable energy is a prerequisite for the sustainable development. In recent years, it is known that fossil fuel resources are getting towards to finish and also they cause several environmental problems. Therefore, use of renewable energy sources are becoming a necessity. The hydroelectric power, also called green energy, is among the renewable energy sources although it has some disadvantages. Turkey, which is estimated that has 1% of the world and 16% of Europe total hydroelectric power, has initiated projects in order to benefit from these resources and some of them are completed and started to produce electricity. However, as it is the case for several countries nowadays, Turkey is having problems in producing required electricity. This energy necessity is partly overcome by importing petrol and natural gas. However, being dependent on outside energy resources carries important risks for economic and political development. Therefore, it appears that the best solution to the energy shortage is to maximize the use of renewable energy sources in sustainable ways. Currently, Turkey uses 34% (43 billion kwh) of the economic hydroelectric potential (125 billion kwh). Increasing this to 100% in the near future is quite important in terms of reaching planned development objectives.

Keywords: Sustainable development, economic, energy, hydroelectric power.

Introduction

Increasing demand for energy which simultaneously rises with industrialization, population growth and urbanization gains significance each day. To meet energy demand, fossil fuels are commonly used. As of year 2007, the demand for global energy was obtained from 40,6% coal, 35,6% petroleum and 23,8% natural gas (www.enerji.gov.tr/2007). However, global reserves of the mentioned fossil resources are rather limited. Besides, greenhouse effect that emerges after their burning threatens ecosystems. Contrary to them, renewable energy sources such as sun, geothermal, hydroelectric, biogas, waves and wind are very economical in addition to their sustainable renew ability. Due to these reasons, it is necessary to gain attraction and universalize the use of new and renewable energy sources.

Amongst the mentioned renewable energy sources, hydroelectric power-also known as *green energy*, takes the first place. Although there are 150 hydroelectric power plants in the country, it is noteworthy that this ratio represents merely 40% of global operable potential.

As known, there is a detailed technology and experience field concerning dams and HPP (Hydroelectric Power Plant). Water, which is the raw material used in energy generation, has serious advantages for ecology since it is renewable and it continuously takes role in hydrological cycle rotation. Furthermore, it

has low operation cost and high economical life (Frey and Linke 2002, Yüksek and Kangal 2008:37-38). Therefore despite its minor disadvantages, it would be beneficial to actualize HPP projects in advance for the economical, ecological and strategic benefits of Turkey (Sever 2008:230).

Since sustainable development is defined as meeting the demand for economical development needed by modern societies in a way not to hinder the needs of future groups (UNDP), renewable energy takes a step closer in that aspect because as known, conventional energy sources will not only be extinct in the future but their generation and consumption will seriously harm the environment (Altuntaşoğlu 2003:345).

As is known, energy is a critical starting point in achieving the objectives related to social balance, economic growth and environmental protection which constitute three basic components of sustainable development. Accordingly, we need to reduce economical and ecological damages of energy consumption forced by sustainable development of society (Altuntaşoğlu 2003:346). Sustainable energy approach should cover in itself the strategy, technology and application that will enable continuous procurement of energy in a cheap environmental and social cost which can only be assured by considering renewable energy sources. Regardless of its high cost compared to other renewable energy sources (sun, wind, wave etc.) hydraulic power is an energy type with high applicability considering modern energy technology. Yet, while making use of this energy type the environmentalist approach envisaged in *Renewable Energy Report* presented in Global Sustainable Development Summit (2002) in Johannesburg should be strictly followed.

Turkey's Hydroelectric Potential and Utilization Status

Turkey which is situated in the closest meeting point of continents Asia, Europe and Africa is amongst developing countries (Figure 1). Similar to most developed and developing countries, Turkey meets significant portion of its energy from expensive fossil fuels imported. In year 2006 in Turkey electrical energy need was procured from 43% natural gas, 28% coal, 25% hydraulic sources. These ratios will remain the same unless new and renewable potential sources are benefited. In that case our dependency to foreign energy sources will continue and besides the budget we desperately need to make use in other investments (industry, service, education) will be shrunk enormously.

Benefiting from most of Turkey's hydroelectric energy potential in advance would allow great economic profits because it is envisaged that merely 30% of the energy need of Turkey in 2030 will be met by hydroelectric. It would be very appropriate to benefit from hydroelectric prior to year 2030. Above all else, cheap electricity that will be attained by this green energy will have a driving role in development. Since the money used for import fuels will lessen, currency loss will also be decreased. Contribution of cheap energy to industrial development will give way to an increase in national income thus the effect of import energy on country economy will decrease. Moreover as pressure of political tensions on energy will be removed, the probability of actualizing investment projects will be greater.

Figure 1: Geographical position of Turkey.

Electrical energy, more than others, has been one of the leading problems of Turkey for a long time. It is obvious that energy trouble we suffer now will be present in future as well. It is urgent that Turkey which probably will have a double energy consumption about 20 years later (2030) should immediately operate all of its water power potential.

Turkey (Table 1) which is estimated to possess approximately 1% of global hydroelectric potential and 16% of Europe has planned major energy projects to benefit from this potential and even started some of these projects' operation.

Table 1: World and Turkey's hydroelectric power potential (www.dsi.gov.tr/hizmet/enerji.htm, 2005).

	Gross HPP Potential (GWh/year)	Technical HPP Potential (GWh/year)	Economic HPP Potential (GWh/year)
World	41 390 000	11 754 000	7 305 000
Europe	3 125 000	760 326	758 705
Asia	19 902 000	4 225 000	2 626 000
Turkey	**433 000**	**216 000**	**123 400**

According to approximate number presented by State Water Works (SWW), annual hydroelectric potential of Turkey which currently has rich water resources is about 128 billion kwh (Figure 2). However some studies envisage that this number can be increased by especially making use of river-type plants. Although there are various development and consumption scenarios about estimating long-term energy need from different parties and organizations, it is not hard to assume that in future Turkey's energy consumption will rise and unless some measurements are taken presently, a bunch of political and economic problems will emerge in future. Finally, under the light of new projects prepared according to planning objectives of State Planning Organization (SPO), it is estimated that Turkey's electrical energy need in 2030 will approximately be around 450-500 billion kwh It is envisaged that in 2020 about 25-30% of Turkey's electrical energy need will be procured from hydroelectric power plants that will have been operated till then. Accordingly in year 2020 about 85% of Turkey's total hydraulic energy potential will have been used.

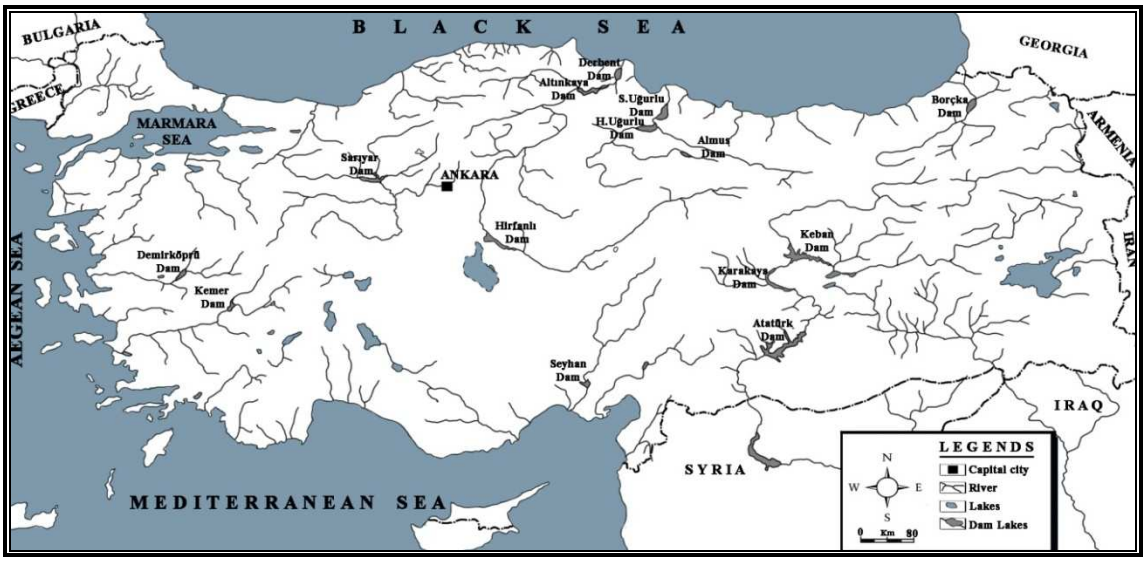

Figure 2: Turkey's Streams and Dams.

In Turkey, following the 1950s, occurring rapid population growth and urbanization accelerated the demand for electrical energy. In the face of this demand particularly in the 1960s and 1970s dam investments followed one another. Finally in the 1980s hydroelectric generation met roughly 50% of our annual energy need. Moreover as indicated in Table 2, in 1988 60% of our energy need was procured from hydroelectric power plants however energy generation ratio from water power has been falling lately (Table 2).

Table 2: Development of electricity generation in Turkey with respect to energy sources, 1980-2007 (TEİAŞ, SHW-2007). ∗ Fueloil, diesel, naphta, renewable waste, geotermal, wind.

Years	Coal (Gwh)	%	Natural gas (Gwh)	%	Hydraulic (Gwh)	%	Others (Gwh)∗	%	Total (Gwh)
1980	5961	26	0	0	11348	49	5967	25	23276
1981	6136	25	0	0	12616	51	5967	24	24719
1982	6441	24	0	0	14167	53	5944	23	26552
1983	8577	31	0	0	11343	41	7427	28	27347
1984	10119	33	0	0	13426	44	7069	23	30614
1985	15028	44	58	0,2	12045	35	7088	21	34161
1986	19438	49	1341	3	11873	30	7045	18	38356
1987	17654	39	2528	6	18618	42	5554	13	44354
1988	12487	26	3240	7	28950	60	3308	7	47985
1989	20270	39	9524	18	17640	34	4311	9	52045
1990	20182	35	10192	18	23148	40	4022	7	57544
1991	21561	36	12589	21	22683	38	3412	5	60245
1992	24571	37	10814	16	26568	39	5390	8	67343
1993	23760	32	10788	15	33951	46	5238	7	73737
1994	28235	36	13822	18	30586	39	5679	7	78322
1995	28047	33	16579	19	35541	41	6080	7	86241
1996	30414	32	17174	18	40475	43	6799	7	94862
1997	33860	33	22086	21	39816	39	7534	7	103296
1998	35688	32	24838	22	42229	38	8269	8	111024
1999	37031	32	36346	31	34678	30	8386	3	116441
2000	38186	31	46217	37	30879	25	9640	7	124922
2001	38417	31	49549	40	24010	20	10749	9	122725
2002	32149	25	52496	41	33864	26	11071	8	129400
2003	32253	23	63536	45	35329	25	9462	7	140580
2004	34447	23	62242	41	46084	31	7925	5	150698
2005	43192	26	73445	45	39561	24	5758	5	161956
2006	47900	28	74368	43	43544	25	7171	4	172983

The low ratio despite the significant developments in the number of HPP is attached to the highness of total energy generation. Indeed total energy generation which was 23 billion kwh in 1980 rose to 172 billion kwh in 2006. Although hydroelectric generation which was 11 billion kwh in 1980 rose to 46 billion kwh in 2004, still its share in total piece decreased. It is true that today, from 142 facilities of which installed capacity is 12 788 MW average annual 45 billion kWh energy is generated. Besides by completing 41 projects in construction, 13 projects in final stage and 13 projects in feasibility and master stages, hydroelectric energy will once again achieve a significant ratio (Table 3, Photo 1).

Table 3: Distribution of Turkey's hydroelectric energy potential by project levels (Gürbüz, 2007).

Status of projects	Project (Number of facilities)	Installed Capacity (MW)	Annual Average Energy Generation Capacity (GWh)
In-operation	142	12788	45930
In-construction	41	4397	14351
Projects in final stage	13	2356	6019
Projects with feasibility	176	7269	26415
Projects with master plan	93	5260	18280
Projects of which first investigation is complete	301	4474	17559
Total	**772**	**36544**	**129454**

Figure 1: Deriner will become highest (247 m) dam in Turkey, it completed (Çoruh River-Artvin).

Despite the increase in energy consumption per person in our country, it is still lower than general expectations. In Turkey while electricity consumption was *7 kwh* per person during the early years of Republic this number rose to 456 in 1980; in 1990 to 819; in 2000 to 1 449 and in 2004 to 1 687. Some sources indicate that this number reached to even *2 150* kWh as of 2005. Despite this huge increase in electricity generation, still the amount per person is low. Indeed consumption ratio which is behind global average (2 500 kwh), compared to developed countries mostly European with *8 900 kwh* and US average value *12 322 kwh*, it becomes obvious that in energy use we are far behind the general objectives. Therefore while increasing the consumption of energy which is an indication of development, we should at the same time achieve major investments to procure required energy and prevent a possible energy crisis in future.

Today many countries with different social and economic backgrounds have directed themselves to sustainable energy sources and developed major projects to increase the share of these sources in total energy generation. Currently amongst these sources, the most commonly profited one is hydroelectric potential. Actually in countries such as Brazil, Paraguay, Uruguay, Ghana, Zambia, Congo, Tajikistan, Kyrgyzstan, Norway, Albania and Iceland the rate of hydroelectric in total energy generation reached to 90-100%. In addition to them Austria, Sweden, Croatia, Bosnia-Herzegovina, Canada, Peru, Columbia, Georgia and New Zealand can be named as countries where hydroelectric energy generation share is more than half of total energy (Table 3). In Turkey in order to make hydroelectric potential profitable new dam and HPP technologies should be followed, and required arrangements should be accelerated for new investments. These sources should be utilized in coping with energy troubles in Turkey to lessen our foreign-source dependency and currency loss.

Table 3: Hydroelectric shares of various countries in total energy generation, 2000 (U.N., 200: Statistical Yearbook. Geneva, United Nations., Öziş et al., 2008, Atılgan, 2000).

Countries	**The Share of Total (%)**	**Countries**	**The Share of Total (%)**
Paraguay	100	Georgia	79
Zaire/Konngo	100	Venezuela	74
Mozambique	100	Colombia	73
Norway	99	North Korea	65
Albania	99	Australia	63
Zambia	99	New Zealand	63
Tajikistan	98	Canada	61
Uruguay	93	Croatia	55
Kyrgyztan	92	Vietnam	55
Iceland	90	Sweden	50
Ghana	88	Bosnia-Herzegovina	50
Brazil	87	Chile	46
Costa Rica	81	Switzerland	40
Peru	81	Nigeria	37
Ecuador	80	Turkey	32

Conclusion

Currently of approximately 125-130 billion kWh hydroelectric potential of Turkey, merely 35-40 billion kWh which amounts to 30-32%, although subject to change each year, is profited. In order to minimize foreign source dependency in energy and prevent possible energy crisis in future, it is essential that we make use of our renewable energy sources in the most profitable way. If we desire a better world to leave for the next generations, only after making use of sustainable energy sources can we achieve sustainable economical development model. Environment protection measurements and its sanctions go beyond national borders and achieve an international identity. Because of that reason, active participation to international solutions should be provided; renewable and environment friendly sources should be supported and developed.

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