Mediterranean and National Strategies for Sustainable Development

Priority Field of Action 2: Energy and Climate Change

Energy Efficiency and Renewable Energy

Turkey - National study's summary

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1. Challenges and energy sustainability:

Turkey is an energy importing country; more than half of the energy requirement has been supplied by imports. Due to the diversification efforts of energy sources, use of natural gas that was newly introduced into Turkish economy, has been growing rapidly. On the other hand, Turkey, with its young population and growing energy demand per person, its fast growing urbanization, and its economic development, has been one of the fast growing power markets of the world for the last two decades. Oil has the biggest share in total primary energy consumption. But it is expected that natural gas consumption will be higher than oil in future. Table 1 depicts the historical and projected relationship between population, economic output and energy demand.

Table 1 Population, economy and energy

Years	Population (000s)	GNP/capita	Total GNP	Total energy demand (Mtoe)	Energy/capita (Kep)	Energy intensity
1973	38,072	1994	75,915,568	24.6	646	81
1990	56,098	2674	150,006,052	53.7	957	50
1995	62,171	2861	177,871,231	64.6	1,039	44
2000	67,618	3303	223,342,254	82.6	1,218	40
2010	78,459	5366	421,010,994	153.9	1,962	35
2020	87,759	9261	812,736,099	282.2	3,216	33

Table 2 The amount of fossil energy resources in Turkey

Sources	Apparent	Probable	Possible	Total
Hard coal (million tons)	428	449	249	1126
Lignite (million tons)	7339	626	110	8075
Asphaltite (million tons)	45	29	8	82
Bituminous schist (million tons)	555	1086	269	1641
Oil (million tons)	36	—	—	36
Natural gas (billion m^3)	8,8	—	—	8

The main energy resources of Turkey are hard coal, lignite, asphaltite, petroleum, natural gas, hydroelectric energy, and geothermal energy. Table 2 shows the amount of fossil energy resources in Turkey.

Turkey's renewable energy sources are plentiful and extensive and represent the second-largest domestic energy source after coal. Primary renewable energy resources in Turkey are: hydro, biomass, wind, biogas, geothermal and solar (Table 3).

Similar to other industrializing countries, with the increases in energy consumption and economical growth, energy related environmental problems are rapidly growing in Turkey. In 2003, it is estimated that 36 % of CO2 emissions occurred due to energy, 34 % due to industry, 15 % due to transportation and 14 % due to other sectors such as housing, agriculture and forestry and in 2020 40 % will occur due to energy, 35 % due to industry, 14 % due to transportation and 11 % due to other sectors. To control these problems for sustainable development, energy related policy should be well determined.

Table 3 Turkey's renewable energy potential

Energy type		Usage purpose	Natural capacity	Technical	Economical
Solar energy		Electric (billion kWh)	977.000	6.105	305
		Thermal (mtoe)	80.000	500	25
Hydro power		Electric (billion kWh)	430	215	124.5
Wind	Direct energy (land)	Electric (billion kWh)	400	110	50
	Direct energy (off shore)	Electric (billion kWh)	—	180	—
	Wave energy	(billion kWh)	150	18	—
Geothermal energy		Electric (10^9 kWh)	—	—	1.4
		Thermal (mtoe)	31.500	7.500	2.843
Biomass energy		Total (mtoe)	120	50	32

In Turkey, electricity is produced by thermal power plants (TPPs), consuming coal, lignite, natural gas, fuel oil and geothermal energy, and hydropower plants (HPPs) (Table 4). The development of nuclear power in Turkey is so new. Present and future total final energy production and consumption in Turkey are shown in Table 5 and Table 6, respectively.

Long term planning studies indicate a heavy burden of investments between 1996 to 2010, amounting to some 68 billion US$. Turkey's funding needs for the energy sector is the highest of the southern and eastern Mediterranean countries. The needs of each energy sector are:

- Electricity: 56 billion US$ (82%),
- Gas: 6 billion US$ (9%),
- Oil: 4 billion US$ (6%),
- Solid fuels: 1 billion US$ (1%).

In 1996, 5.9 billion US$ were invested in the Turkish economy, 24% of which were in the energy sector.

Table 4 Electricity production from thermal and hydropower sources according to years in Turkey

Year	Thermal (GWh)	Hydropower (GWh)	Total (GWh)	% of hydropower
1950	759	30	789	3.80
1960	1814	1001	2815	35.55
1970	5590	3033	8623	35.17
1980	11,927	11,348	23,275	48.75
1990	34,395	23,148	57,543	40.22
1995	50,621	35,541	86,153	41.25
1999	81,661	34,678	116,339	29.81
2000	93,934	30,879	124,813	24.74
2001	98,563	24,010	122,573	19.60
2002	71,966	44,034	116,000	38.00
2003[a]	104,898	35,324	140,283	25.18

Table 5 Present and future total final energy production in Turkey (mtoe)

Energy sources	1990	2000	2005	2010	2020	2030
Coal and lignite	12.41	13.29	20.69	26.15	32.36	35.13
Oil	3.61	2.73	1.66	1.13	0.49	0.17
Gas	0.18	0.53	0.16	0.17	0.14	0.10
Com. renewables and wastes[a]	7.21	6.56	5.33	4.42	3.93	3.75
Nuclear	—	—	—	—	7.30	14.60
Hydropower	1.99	2.66	4.16	5.34	10.00	10.00
Geothermal	0.43	0.68	0.70	0.98	1.71	3.64
Solar/wind/other	0.03	0.27	0.22	1.05	2.27	4.28
Total production	25.86	26.71	34.12	39.22	58.20	71.68

[a]Comprises solid biomass, biogas, industrial waste and municipal waste.

Table 6 Present and future total final energy consumption in Turkey (mtoe)

Energy sources	1990	2000	2005	2010	2020	2030
Coal and lignite	16.94	23.32	35.46	39.70	107.57	198.34
Oil	23.61	31.08	40.01	51.17	71.89	102.38
Gas	2.86	12.63	42.21	49.58	74.51	126.25
Com. renewables and wastes[a]	7.21	6.56	5.33	4.42	3.93	3.75
Nuclear	—	—	—	—	7.30	14.60
Hydropower	1.99	2.66	4.16	5.34	10.00	10.00
Geothermal	0.43	0.68	1.89	0.97	1.71	3.64
Solar/wind/other	0.03	0.27	0.22	1.05	2.27	4.28
Total primary energy consumption	53.01	77.49	129.63	152.22	279.18	463.24

[a]Comprises solid biomass, biogas, industrial waste and municipal waste.

The total investment required for power plants and distribution lines up to 2010 is expected to be around 45 billion US$, 19 billion of which will be under the build-operate-transfer (BOT) and build-own-operate (BOO) models. The huge size of this investment makes it impossible to lay the burden entirely on public finances. Private capital has to be introduced into Turkey's electricity sector to meet these requirements.

Cogeneration, or autoproduction, is known as Combined Heat and Power (CHP), which has been developed by governmental support to support the continuing need for additional electricity generation.

Turkey spent a total of US$ 120 million (2005 prices and exchange rates) on government energy R&D between 1980 and 2005. In this period, 15.6% of its total energy research and development (R&D) budget (US$ 17.4 million) was allocated to renewable energy.

Among the renewable technologies, geothermal received the most sustained funding over the past two decades and the highest level of funding, equivalent to US$6.1 million or 37% of the renewables R&D expenditures between 1980 and 2005. In addition, Turkey participates in international collaborative R&D in Photovoltaic Power Systems through the IEA Implementing Agreements.

2. The currently established policies in terms of RE and RUE:

Renewable energy:

The real beginning for renewable energy policy was the definition of renewable energy sources in the decree of the Modification of the License Regulation in the Electricity Market in 2003. Before then, there was no national renewable energy policy and few government incentives existed to promote market deployment of renewable energy. However, the Electricity Market Licensing

Regulation, in itself, is not expected to be sufficient to overcome the high invesment cost, risk and lack of security associated with the entrance of renewable power plants into the electricity market.

The industrial sector accounted for 40% of total final energy consumption and for 54% of electricity consumption in 2000, while the agriculture, household and services sectors together accounted for 40% of final energy consumption and 46% of electricity consumption. Although all four sectors have important potential for energy conservation, industry has been targeted as a priority area for energy conservation programmes owing to the projected rapid expansion of industrial energy demand. On the other hand, the structure of industry in Turkey is energy intensive.

Energy efficiency:

In Turkey, the per capita energy consumption (measured as TPES/population) in 1998 was equal to 1.11 ton of oil equivalent (toe), much less than the average of 5.10 toe for all IEA countries, but its growth is much faster than the IEA average and is projected to remain fast in the coming two decades as the economy develops. Energy intensity (measured as toe/$1000 GDP at 1990 prices and exchange rates) in 1998 was 0.35 toe, compared with an IEA average of 0.24 toe, and has increased slowly in recent years. If purchasing power parities are used, Turkey's energy intensity fell well below the IEA average. On the other hand, the government acknowledges the need to reduce the energy intensity of GDP and to improve the energy efficiency of the economy. Figure 1 shows mean heating energy and exergy efficiencies of the industrial sector and its subsectors in 2003 and Figure 2 shows energy and exergy utilization efficiencies in the Turkish residential–commercial sector for 2002.

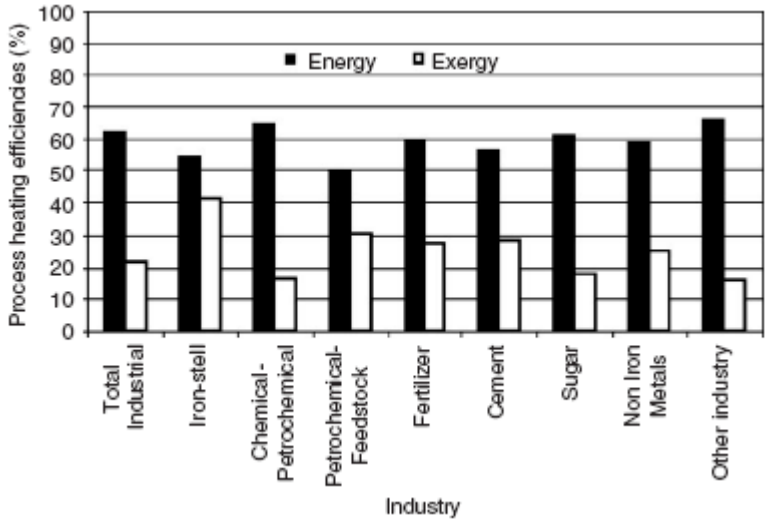

Figure 1 Mean heating energy and exergy efficiencies of the industrial sector and its subsectors in 2003

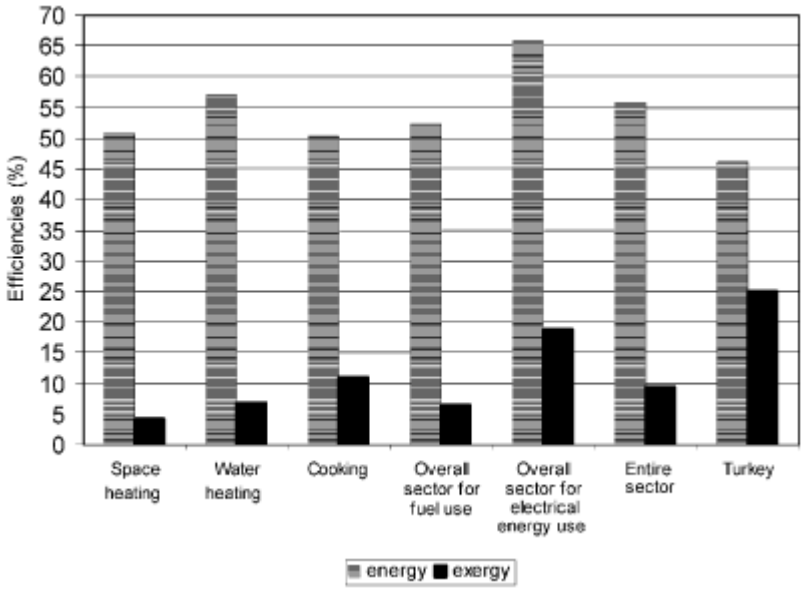

Figure 2 Energy and exergy utilization efficiencies in the Turkish residential–commercial sector for 2002

According to estimates of the MENR, Turkey has an energy conservation potential equal to 12–14 mtoe/year, or nearly 15–20% of total consumption in 1998, and therefore, $3 billion could be saved through conservation measures in three main end-use sectors.

3. Difficulties, possible solutions, needed reforms:

The main barriers for development renewable energy are:

- lack of financial resources and proper lending facilities, particularly for small-scale projects constitute,

- lack of detailed renewable energy resource assessments and data banks pertains to Turkey like to many other countries.

But, lack of awareness and knowledge is not a big barrier in Turkey. Renewable energy is recognized as a major potential for indigenous, clean energy production.

The most important handicap for foreign investors is Turkish bureaucracy. The permission for a foreign investor can be taken through one-year period with applying numerous different associations. New government had promised to make the permission producer easier.

Hydroelectric generation, biomass combustion, solar energy for agricultural grain drying and hot water heating, and geothermal energy have been in use in the country for many years. Domestic water heating is the primary active solar technology. In Turkey, approximately 30,000 solar water heating systems have been installed since the 1980s. This is a minute fraction of the total potential. About 50% of existing dwellings could be fitted effectively with a solar water heater. If this potential were extended to 2025, the deployment of approximately 5 million systems (allowing for a rise in the Turkish housing stock) would be required. This could save an estimated 30 PJ (9.0 TWh) per year of oil, coal and gas and 2.0 TWh per year of electricity, giving a saving of 5.0 million tonnes of CO2 per year, or just under 1% of current Turkey CO2 production.

Agricultural residues have a high potential to take the place of the lignite (40 million tons) and hard coal (1.3 million tons) used in electricity production.

Biogas systems are considered to be strong alternatives to the traditional space heating systems (stoves) in rural Turkey. Geothermal heat pumps are a relatively new application of geothermal energy that has grown rapidly in recent years. On the other hand, the biggest benefit of geothermal heat pumps is that they use 25-50% less electricity than conventional heating or cooling systems. Geothermal heat pumps can also reduce energy consumption, and

corresponding air pollution emissions, up to 44% compared to air source heat pumps and up to 72% compared to electric resistance heating with standard air conditioning equipment.

Success story:

Turkey is among the first five leader countries in its geothermal direct use applications. In Turkey, the district heating system applications were started with large scale, city based geothermal district heating systems. The investigations on geothermal energy in the country gained speed in the 1970s. However, the utilization of geothermal energy could not become widespread sufficiently due to scaling problems up to the early 1980s. Since then, important developments have been recorded in geothermal energy utilization. Recently, geothermal direct use applications have reached up to 52,000 residences equivalence of geothermal heating, and engineering design of nearly 300,000 residences equivalence geothermal district heating has been completed.

Parallel to the development of geothermal energy utilization in Turkey, it is projected that by the years 2010 and 2020, the total installed capacity will increase to 3500 MWt (500,000 residences equivalent, which is about 30% of the total residences in the country) and 8300 MWt (1,250,000 residences equivalent) for space heating and to 500 MWe and 1000 MWe for power production, respectively.

The investment cost for geothermal district heating systems per residence with a floor area of 100 m2 is about 1500–2500 US$ (excluding heater costs in the residence), while the payback period varies between 5 and 8 years. About 30–50% of the investment costs has been paid by consumers as a connection subscription fee, like a capital investment. The heating fees (2001 heating season) were in the range of 14–29 US$.

Needed reforms:

Turkey can not perform a clear strategy concerning the renewable energy sources because of energy costs and investment costs. The State encouraged the private sector for natural gas combined circuit plants and guaranteed to buy the generated electricity with a low cost and with special conditions. State performed the strategy of build, operate and transfer (BOT) system and succeeded it. The share of the natural gas combined circuit plants increased to 20% in total primary energy supply. The state achieved the sustainability in this wise.

Turkey is interested in renewable energy resources and gives effort to provide the sustainability of using these energy resources. The state encouraged the municipalities in respect of the geothermal energy and gave them the permission to behave self-governing.

In Turkey, the efficiency of energy utilization is not as high as Europe yet.

The state leads the private sector to the World Bank's credit in all sources of renewable energy. The State says that it will be the guarantor for the 30-40% of the cost of the private sector's investments which are for their own needs. If the private sector can find buyer, it can sell the electricity produced in these plants.

The cost of 1 kilowatt (kW) power from a renewable energy resource is 13-15 cent. If the State buys for example 10% of the generated energy by private sector for this cost, the State will gain from that too in future.

It is so recently that less energy consuming building projections have taken place. Ground sourced heating and passive heating systems are not common either.

For a sustainable development of renewable energy resources and settling to the Mediterranean strategy, ground sourced and water sourced heat pump systems, wind and solar energy power plants have to be kept unobstructed always. The renewable energy technologies and the energy quantities which are necessary for production per unit have to be kept always in the journal and policy of the country. Legal regulations have to be performed and the State has to give effort to make the public assimilate these regulations highly.