RENEWABLE ENERGY POLICIES IN TURKEY

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ABSTRACT

Achieving solutions to environmental problems that we face today requires long-term potential actions for sustainable development. In this regard, renewable energy resources appear to be the one of most efficient and effective solutions. Although, Turkey has substantial reserves of renewable energy resources, actual utilization of these resources is quite low.

The aim of this study is to investigate the renewable energy policies and the political organizations that shape these policies. In these concepts, the renewable energy potential of Turkey, the effective utilization of this potential, the energy politics, the political organizations, incentives, pricing and buying mechanisms, research and development studies, and barriers for development of renewable energy are investigated. In conclusion, proposals and recommendations are given to overcome the problems.

Keywords: Renewable energy sources; energy policy; solar energy; wind energy; geothermal energy; biomass; hydropower

INTRODUCTION

The population of Turkey is about 65 million. The population growth rate is 1.7%, the highest among IEA countries. The country has a very dynamic economy. As a net effect of these factors, Turkey's energy demand is growing rapidly and is expected to continue to grow in near future.

Although Turkey has a wide range of energy resources, these resources are limited. Turkey is an energy importing country. More than about 60% of energy consumption in the country is met by imports, and the share of imports continues to grow each year. Therefore, it is critical to supply its energy demand by using domestic non-renewable resources (such as lignite, hard coal, oil and natural gas) and renewable resources [1].

Renewable energy resources (solar, hydroelectric, biomass, wind, ocean and geothermal energy) are inexhaustible and offer many environmental benefits over conventional energy sources. Each type of renewable energy also has its own special advantages that make it uniquely suited to certain applications. Almost none of them release gaseous or liquid pollutants during operation. In their technological development, the renewables range from technologies that are well established and mature to those that need further research and development [2]. The other important factor of renewable resources is to create new employment opportunities.

Turkey's geographic location has several advantages for extensive use of its renewable energy sources. Turkey is located on the humid and warm climatic belt, which includes most of Europe, the near east and western Asia. A typical Mediterranean climate is predominant at most of its coastal areas, whereas the climate at the interior part (between the mountains that are a part of the Alpine Himalayan mountain belt) is dry with typical steppe vegetation [3].

The subventions given to the renewable energy sources are compulsory until the sector becomes a competitive point with other energy sectors [4]. Every country has its subvention mechanism for renewable energy sources. These subventions can be grouped under three titles; financial, tax and production subvention. For example, in Germany it's compulsory to buy the wind energy with a cost of 9 ¤c/kWh, whereas the photo-voltaic energy is bought at a cost of 40 ¤c/kWh. Besides, the government gives subvention up to 25% of the investment value. ¤343.2 million Euro was spent between 1996-1997 for research and development (R&D) studies on the renewable energy sources [4]. Only indirect subvention mechanisms exist in Turkey today.

Numerous studies have been done by Turkish energy researchers on renewable energy technologies [5-21]. The basic difference of this study compared to other studies can be summarized as follows: In previous studies, renewable energy potential, utilization rates of this energy,

energy conversion technologies and future developments were investigated. In this study, in addition to the some of these previous studies topics, energy policies, organizations that enforce these policies, pricing and buying mechanisms and R&D studies, and barriers for development of renewable energy are investigated.

ENERGY RESOURCES OF TURKEY

Turkey does not possess huge fossil fuel reserves. Excluding lignite; coal, oil and natural gas reserves in the country are few and far from being able to meet the projected domestic demand. In a longer perspective, lignite deposits do not seem to be sufficient either. Turkey has substantial reserves of renewable energy sources.

Fossil Energy Sources

Coal is a major fuel source for Turkey. Domestically produced coal accounted for about 24% of the country's total energy consumption, used primarily for power generation, steel manufacturing and cement production [18]. Turkey is a large producer of lignite; proven reserves of lignite are on the order of 8075, of which 7339 million tons is economically feasible, which comes predominantly from deposits in the southwest and the southeastern Afsin-Elbistan basin. The biggest lignite deposits, 40 % of the total, are in Elbistan [18]. The government expects coal supply to rise from 20.1 Mtoe* in 1999 to 118.4 Mtoe in 2020, more than five times current figures. It believes that domestic lignite production will almost triple.

The amount of fossil energy sources in Turkey is shown in Table 1.

Renewable Energy Resources

Turkey has substantial reserves of renewable energy resources. Renewable energy production represented about 14.4% of total primary energy supply (TPES), i.e. 10.10 million tons of oil equivalent (Mtoe) in 1999, and renewables are the second-largest domestic energy source after coal. Main renewable energy resources in Turkey are: hydro, biomass, wind, and biogas, geothermal and solar.

According to recent studies, the economically usable hydropower

*Mtoe—million tons of oil equivalent

Table 1. Amount of Fossil Energy Sources in Turkey

Sources	*Apparent*	*Probable*	*Possible*	*Total*
Hard coal (million tons)	428	449	249	1,126
Lignite (million tons)	7,339	626	110	8,075
Asphaltite (million tons)	45	29	8	82
Bituminous schist (million tons)	555	1,086	269	1,641
Oil (million tons)	36	—	—	36
Natural gas (billion cubic meter)	8.8	—	—	8

Source: ref. [22-23-24-25].

potential of Turkey is estimated at 125,000 GWh per year (34,729 MW), as given in Table 2. 24,010 GWh of this potential was produced in operating hydro power plants (HPPs) in 2001 [25]. In addition to the dams and run off rivers and canals in operation, several others are in various stages, such as under construction, final design completed and final design in progress (Table 3). The Turkish government hopes that hydroelectric power plant capacity will expand to 35,000 MW by the year 2020.

It is estimated that the usable wind energy potential in Turkey is around 8000 MW [21]. The western coast and southeastern Anatolia are very favorable locations for wind power generation, with annual average wind speeds around 2.5 m/s and annual wind power densities of 2.4 W/m2. These regions are highly suitable for wind power generation, because wind speeds exceed 3 m/s in most of these areas. Old wind mills found in the Marmara and Aegean regions are good indicators of the wind energy potential for these regions [3]. The highest wind speed values are given in the literature as 5.1-5.2 m/s in Bandirma. Progress in wind energy technology in recent years has drawn private-sector attention to this energy resource. As a consequence, numerous companies have submitted their applications to The Ministry of Energy and Natural

Table 2. Hydropower Potential of Turkey

Explanation	*Power (MW)*	*Electricity Generation (GWh/year)*
Gross potential	49,427	433,000
Economically usable potential	34,729	125,000
Exploited potential (total in operation)	9,865	36,000
Dams and hydroelectric plants	9,349	33,518
Run of river and canal hydroelectric power plants	516	2,482

Source: Ref, [3].

Table 3. Potential of Hydro Power Plants under Construction at Various Stages

Explanation	*Power (MW) Electricity Generation*	*(GWh/year)*
Dams (under construction)	3,092	9,809
Dams (final design completed)	4,284	12,898
Dams (final design in progress)	926	3,279
Run off river and canal (under construction)	111	406
Run off river and canal (final design completed)	284	1,101
Run off river and canal (final design in progress)	123	476
Total	8,820	27,696

Source: Ref [3].

Resources (MENR) for the construction of new wind power plants, and three plants have been commissioned. Turkey now has a clear target for wind generation, and numerous wind projects were submitted under the build-own-transfer (BOT) program in recent years. One of them is an

auto-producer plant and the other two were built on the BOT model. Wind power production is not very large, but total installed capacity has reached 18.9 MW and 72 new projects totaling about 2,000 MW are under evaluation by the MENR [22]. The total production for the year 2001 is 152 GWh [25].

Solar energy has interesting potential in Turkey. Preliminary studies indicate that the country has an average 2,640 sunshine hours annually, with an average solar intensity of 3.6 kWh/m2 per day, with higher peaks at some locations. The total solar energy potential of Turkey is calculated as 35 Mtoe per year [25]. In the year 2001 in Turkey, an estimated 287,000 tons of oil equivalent (toe) for solar heating are produced, especially in the southern and western regions and in the residential and commercial sectors [25].

The overall geothermal energy potential of Turkey is estimated at 35000 MW. But, geothermal energy production for the year 2001 is only 1.759 Mtoe [23]. Its use is expected to increase to 6.3 Mtoe by 2020, especially for direct heating. The proposed Geothermal Law, currently being drafted by the MENR, should provide the necessary regulatory framework for this purpose.

Biomass energy includes agricultural residues, municipal wastes, fuelwood, animal wastes and other fuel derived from biological sources. The total recoverable bioenergy potential is estimated to be about 16.92 Mtoe. The estimate is based on the recoverable energy potential from main agricultural residues, livestock farming wastes, forestry and wood processing residues and municipal wastes as given in the literature. The biomass energy production for the year 2001 is 6.98 Mtoe [25].

RENEWABLE ENERGY POLICIES

Energy development in Turkey has been dominated by public investment and management since independence in 1923, although several waves of liberalization have been launched since 1983, leading to a gradual opening of the Turkish energy market and improving the situation. 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. In the last two years, several encouraging steps have been taken towards greater liberalization. The notion of privatization has been introduced into the Turkish consti-

tution for the first time. Legislation was adopted in February 2001 to allow competition in the electricity market and to adapt Turkey's legislation for European Union (EU) membership. A new Gas Market Law was adopted in May 2001 for the same purposes.

The main objectives of energy policy including renewable are [24]:

- To meet demand using domestic energy resources as the highest priority. In the medium and long term, this is to occur through a mix of public, private and foreign capital.

- To develop existing sources while accelerating the penetration of new and renewable sources.

- To diversify energy sources and to avoid dependence on energy imports from a single source or country.

- To encourage private-sector investment and to accelerate capacity construction and privatization in the power industry. Preparations are to be made for the introduction of nuclear power.

- To improve the reliability of electricity supply through upgrades in the power transmission and distribution grid.

- To improve energy efficiency in end use and transformation, e.g. through reduction of losses in energy production, transmission and consumption.

- To protect the environment and public health.

- To make use of Turkey's geopolitical location to establish the country as a pivotal transit area for international oil and gas trade (" Eurasia energy corridor").

Renewable Energy Policy Institutions

The Ministry of Energy and Natural Resources is the main body for the formation and implementation of energy policy in general and renewable energy in particular [24]. The Electric Power Resources Survey and Development Administration (EIEI) carry out investigations and surveys to identify the energy potential of water, wind and solar energy

resources. If big hydropower generation is regarded in the renewable group, Directorate General of State Hydraulic Works (DSI) is the main implementing organization.

The main state organizations having responsibility for planning the energy policy in Turkey are given in Table 4.

Table 4. The Main State Organizations Having Responsibility for Planning the Energy Policy in Turkey

Organization name	*Under the fold of*
DPT, State Planning Organization	Prime Minister
TUBITAK, Scientific and Technical Research Council of Turkey	Prime Minister
Research, Planning and Co-ordination Board	Ministry of Energy and Natural Resources
Directorate-General for Energy Affairs	Ministry of Energy and Natural Resources
Directorate-General of Mineral Affairs	Ministry of Energy and Natural Resources
Directorate-General of Petroleum Affairs	Ministry of Energy and Natural Res

The main institutions operating under Ministry of Energy and Natural Resources have responsibilities for implementing energy policy are [24]:

- Directorate-General for Energy Affairs
- TEUAS, Turkish Electricity Generation Company
- TEIAS, Turkish Electricity Transmission Company
- TEDAS, Turkish Electricity Distribution Company

- TETTAS, Turkish Electricity Trading and Contractor Company
- DSI, Directorate-General of State Hydrolic Works
- TPAO, Turkish Petroleum Company
- Directorate-General of Petroleum Affairs
- Directorate-General for Mining Affairs
- EIEI, Electric Power Resources Survey and Development Administration
- BOTAS, Turkish Pipeline Corporation
- TKI, Turkish Coal Enterprises
- Turkish Hard Coal Enterprises (TTK)

The above general directorates are operating under the Minister and his Undersecretary. Therefore, the main body responsible from energy policy is the Ministry. All groups get or receive directives from the Ministry and implement the policy accordingly. As it was stated above, there is a separate Department of Energy Directorate General, which reports to Minister and his Undersecretary. The Minister reports to the Prime Minister.

There are also some non-Ministerial agencies responsible for various aspects of energy policy (Table 5).

Renewable Policy Instruments

In Turkey's case, where government expenditure has to be tightly controlled, it is important that the most cost-effective resources be developed. Therefore, the government should attempt to develop competitive renewable energy supplies first, and provide support for renewable energy, if necessary, on cost-effectiveness.

Turkey's renewable energy policies are being improved. Currently, there are a few government-backed incentives to promote renewable energy investments. The MENR is preparing draft legislation, which would allow certain renewable energy projects (mainly geothermal and wind, but also solar, wave, waste and landfill gas only) to be built and operated by the private sector, and provide incentives for such system. This legislation would also set the buy-back rates for renewable electricity. MENR has announced a target for wind energy, namely 2% of the total installed capacity by 2005. There is some municipal support in the area of geothermal heat as well. Private sector involvement in renewable energy promotion exists predominantly in the wind energy and small-scale solar projects [22].

Table 5. Non-Ministerial Agencies Responsible for Various Aspects of energy Policy

Organization name and/or regulation	*Functions*
Energy policy and/or regulation	Energy Market Regulatory Council
Nuclear power	Turkish Atomic Energy Authority (state organization)
Energy efficiency	ESÇAE/MAM/TUBITAK Marmara Research Center, (state organization) some universities (presenting reports, organizing meetings and courses)
Energy standards	TSE, Turkish Standardisation Institute JEC, International Electrotechnical Commission
R&D	
	Energy Systems & Environmental Research Institute Marmara Research Center
Renewable	
	Clean Energy Foundation Turkish Wind Energy Association International Solar Energy Society Turkish Section Geothermal Energy Association

Source: Ref [22].

The Ministry of Energy and Natural Resources (MENR), the State Planning Organization (DPT) and the Electric Power Resources Survey and Development Administration (EIEI) are all involved in renewable energy promotion policies. Some promotions and related policies exist with respect to the development and implementation of geothermal heat

and solar thermal energy production. Low-interest loans up to 45% of the capital cost are applicable to appropriate investments.

Until recently, under the Free Market Law of Electricity, the price of energy was decided as a result of negotiations between the energy production company and the state, which is the buyer. This was a kind of incentive. Now, the price of the renewable energy will have to obey the market conditions.

Research and Development on Renewable Energy

Financing of R&D projects is offered via national funds by DPT, TUBITAK-TIDEB and research funds of universities. The budgets are quite small. International co-operation is sought not only in terms of funds but also in terms of know how exchange [22].

The Technology Monitoring and Evaluation Board (TIDEB) of TUBITAK has an R&D assistance program for industrial companies. This includes a financial contribution by the Scientific and Technical Research Council of Turkey and by the Undersecretary of Foreign Trade for up to 60% of the total eligible cost incurred over the duration (up to 36 months) of an individual R&D project.

Low-interest loans are provided by the Technology Development Foundation of Turkey (TTGV) within the scope of the decree.

Two other legal and administrative incentives to promote R&D are: The Decree on Investment Incentives. The first decree covers R&D, environment, quality improvement and small medium-sized enterprises (SMEs). The second covers a tax credit for R&D expenses that makes it possible to postpone payment of annual corporate taxes for three years without interest up to an amount equivalent to 20% of R&D expenses. Another fund for R&D studies is provided by the State Planning Organization to relevant university departments for infrastructure developments. Some support is also provided to industry by Electrical Power Resources Survey & Development (EIEI).

Technology Monitoring and Evaluation Board (TIDEB) of TUBITAK, Electrical Power Resources Survey & Development (EIEI) and DPT act as implementing agencies. The applicable ministries have some actions as well. At present, about 15 types of legal and administrative incentives exist to promote R&D, including the above mentioned: The Decree on Investment Incentives for small and medium sized industries (SMES's) and a tax credit for R&D expenses. The main renewable energy resources being supported are solar, geothermal, and wind. Other R&D

on the demonstration of advanced bio fuels technology, such as electricity generation from biomass and liquid bio-fuel production are also underway.

Turkey has joined the European Community's (EU) 6th Frame project. There are many project opportunities in this program about renewable energy. Turkey's universities and research institutes began to offer project proposal.

Renewable Energy Pricing and Arrangements to Subsidize or to Oblige The Purchase of The Electricity From Renewable Energy

Until recently, the government defined the energy prices. The energy-selling price is much higher than OECD countries. As far as tax is concerned, Turkey seems one of the leading nations to put higher taxes on electricity bills, petroleum and other energy types. With recent constitutional and legislative changes, it is expected that energy prices will be defined naturally in the free market, supervised by the independent regulatory bodies.

Until recently, the price and the amount of the energy produced by the renewable power plant was negotiated and accepted by the Ministry of Energy and Natural Resources. With the new Energy Market Law, the price and amount of energy purchased will be defined under the free electricity market conditions.

The number of solar and geothermal thermal energy applications in Turkey has been increasing in spite of the lack of specific subsidization. The utilization of biomass, except wood, is being promoted as well.

ANALYSIS OF BARRIERS FOR DEVELOPMENT OF RENEWABLE ENERGY AND RECOMMENDATIONS

The role of the government in formulating and implementing favorable policies for renewable energy development is vital. But the private sector, which has the capacity to mobilize funds, needs to be involved in renewable energy development. To facilitate rapid replication of renewable technologies, policies should be put in place to encourage the private sector to consider the technologies and to invest in developing and implementing renewable projects. Lack of coordination and cooperation within and between various ministries, agencies, institutes and other stakeholders is a major obstacle to further promote renewable

energy technology. It should be continued and expanded cooperation with European Member Countries in all major energy policy areas. The energy supply and demand should be closely monitored and forecasts revised to take advantage of the progress of liberalization, energy efficiency improvements, structural changes in industry and other major factors to better inform all players who make the investment decisions.

The main barriers for development of renewable energy are: lack of financial resources and proper lending facilities, particularly for small-scale projects lack of detailed renewable energy resource assessments and data banks pertaining to Turkey. 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. Awareness rising is still a key to involvement, particularly of community based and non-governmental organizations.

The process of liberalization, restructuring and privatization in the energy sector is vital. Any delays to the introduction of competition should be prevented. A favorable environment for investment should be created.

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

No subsidy policies exist within this frame. Introduction of both subsidies and ways to overcome commercialization barriers, as well as the realization of good practices are of utmost importance. Technology developed and/or transferred needs standardization and then replication. There is a need to evaluate applied renewable energy technologies in detail as a precondition for technology transfer. Environmental protection measures need to be considered in technology development.

High initial capital costs and high operation and management costs must be brought down to attract private investors and facilitate technology transfer. Local production of renewable energy technology can reduce the investment costs significantly.

It was recognized that markets for biomass fuels already exist, including in rural areas, where a large number of people generate income through trade of wood and wood residues, primarily for cooking purposes. But policy gaps with regard to the supply side of wood fuels from both forest and non-forest sources need to be reduced.

The energy prices should reflect full costs and eliminate subsidies

and cross subsidies, both direct and indirect. It should take measures to increase the transparency in energy regulation and price setting.

The September 27, 2001 directive of the EC (2001/77/EC) endorses member countries to cover 12% of the energy consumption from the renewable sources after the year 2010. The scarcity of renewable energy sources within the EC will make possible green electricity (electric generated from renewable energy sources) imports from other countries, such as Turkey. Turkey may export green electricity to European countries by improving the renewable energy sources and by developing the electric interconnection.

In Turkey, natural gas and coal combined cycle power plants with a total capacity of 6000 MW will be in operation until the end of 2003. Besides, it can be seen that there will be an energy generation surplus through the end of 2006. The water level in hydroelectric power plants will be increased. As a result, Turkey will have a new electric distribution system with voltage and frequency control similar to European Standards by 2003. At present, Turkey can export total 3400 MW energy; 2400 MW energy through a Bulgaria line and 1000 MW through a Greece line to be built.

In the short term, authority for determining valuable geothermal energy generation areas must be given to Energy and Natural Sources Ministry or a committee that can be organized for this duty. At first, they must coordinate the arrangements to generate electricity from these areas. Secondly, the private sector must be involved. The experience of The Directorate-General of Mineral Affairs must be used to determine the geothermal energy potential of Turkey.

CONCLUSIONS

Because Turkey has limited reserves of oil and natural gas, it is an energy importing country. This situation has caused financial problems. Because of that, the Turkish energy policy is concentrated on assurance of energy supply; reliability, domestic sufficiency, in time, in economic terms, and sustainability. Turkey has inexhaustible renewable energy resources such as solar, hydroelectric, biomass, wind, ocean and geothermal energy. The country has the potential for 125 GWh/yr (34,729 MW) of hydropower, 8000 MW of wind power, 35 Mtoe/yr of solar energy, 35000 MW of geothermal energy, 16.92 Mtoe/yr of bioenergy. The actual

utilization for the year 2001 is 24,010 GWh for hydropower, 152 GWh for wind energy, 287,000 toe for solar energy, 1.759 Mtoe for geothermal energy, and 6.98 Mtoe for bioenergy.

Energy development in Turkey has been dominated by public investment and management. But, the government wants to complete the process of liberalization, restructuring and privatization in the energy sector. The country 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.

The role of the government in formulating and implementing favorable policies for renewable energy development is vital. But the private sector, which has the capacity to mobilize funds, needs to be involved in renewable energy development. The government should investigate which options are viable without financial support. This may be the case for certain hydro projects and for solar thermal applications. The potential of these and other renewable energy sources should be evaluated regularly. For those renewable applications that need support, bidding procedures should be implemented to ensure that the most cost-effective renewable applications are supported.

DISCLAIMER

Although some data has been taken from governmental documents, this article is not necessarily representative of the views of the government.

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