development can work as a link in the mutual complementary system of large-scale power sources.

(4) In this country possessing abundant hydropower resources, to carry out development giving priority to hydro sites close to load areas regardless of the scales of the sites will enable avoiding the same path travelled by advanced countries including Japan which have experienced operating difficulties financially due to capital investments in systems bloated in size, and this will be the most economical method of coping with future demand. In this sense it is desirable for this and other projects of the same conditions to be developed with as much haste as possible.

(5) Therefore, it is concluded that this project should be developed in 2001.

RECOMMENDATION

(1) Köprübaşı project is feasible technically, economically and financially. The project is recommended to be put in service in the beginning of 2001.

(2) Detail design is needed for each structure including access roads because this report shows feasibility design.

(3) The following geological investigations are required for the detail design.

- Drilling investigation at dam site and centerline survey along the roads
- Drilling investigation at the underground powerhouse site
- Drilling investigation at the tailrace tunnel site

(4) It is necessary to fill out the Draft Report of Environmental Impact Study in step by step in accordance with the Report.

Chapter 1 INTRODUCTION

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INTRODUCTION

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Chapter 1 INTRODUCTION

The Republic of Turkey was primarily an agricultural country, but emphasis has been placed on industrialization in recent years. It may be considered that economic exchanges with neighboring countries have increased with the collapse of the former Soviet Union, and the rising demand due to this has spurred acceleration of industrialization.

In step with this, securing of electric energy has become of importance, and the Turkish Government, giving priority to development of domestic energy resources, has been endeavoring to develop lignite thermal and hydroelectric power which are domestic resources. Lignite thermal has met strong opposition because of problems of pollution, and new development has become difficult. Accordingly, the situation in society has become one where installation of pollution prevention facilities cannot be avoided and the increase in construction cost for this has caused priority for development to be lowered, while on the other hand, the superiority of hydroelectric power generation has recently come to be favorably rerecognized.

In general, growth of GNP and growth of electric power become more or less proportionate as industrialization progresses. The growths in GNP and electric power supplied from 1980 to 1992 are shown in Table 1-1.

Table 1-1 GNP Growth and Electric Energy Supply Growth

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
GNP Growth (%)	4.2	4.5	3.3	5.9	5.1	8.1	7.5	3.6	1.9	9.2	0.3	5.9	5.0
Electric Energy Supply Growth (%)	6.8	7.7	4.4	12.5	9.3	11.3	11.0	8.3	8.3	10.6	4.7		

Annual Report (from Central Bank)

1.1 Background of the Project

As the principal energy resources in the Republic of Turkey there are reserves of 5.7×10^6 tons of petroleum and 12.9×10^9 tons of lignite, and besides, 41,000 MW of hydroelectric power resources. Of this hydroelectric potential, only 7,114 MW, or 17% had been developed as of the end of 1991, and in contrast with lignite thermal which is difficult for siting to be done because of environmental pollution, much is expected of its development hereafter as clean energy.

Installed capacities of power generation as of the end of 1991 were 10,093 MW of thermal power stations, and 7,114 MW of hydroelectric power stations, a total output of 17,207 MW.

The Government of Turkey, in a long-range outlook, has forecast the electric power demand in the year 2000 A.D. as approximately 120,000 GWh (annual growth rate 8%), and the electric energy in 2010 A.D. as 258,000 GWh (annual growth rate 8%), and has planned for annual development of an average of 3,000 MW, of which hydroelectric power development is an average of 1,500 MW. The production of petroleum is no more than enough to fill 10 to 20% of domestic demand.

Production of coal is about 20×10^6 tons annually, but there is little hard coal, and lignite which is not of very good quality as coal makes up the greater part, the use of which other than as fuel is difficult. Consequently, hard coal is used for industrial purposes, while lignite is used for heating and thermal power stations. Moreover, use for heating is beginning to be increasingly prohibited in urban areas.

On the other hand, with regard to hydroelectric power, in spite of being in a dry area, the hydroelectric power resources are fairly abundant because of the feature that the entire country of Turkey is in the form of a plateau, and because it is a purely domestic energy, the government is aggressively pushing ahead with development. The Turkish Government, from the point of view

of effective utilization of domestic energy, plans to continue with aggressive development of hydroelectric power with the ratio of hydro and thermal planned to be 50:50 to 45:55. Large-scale power projects commissioned in recent years or scheduled to be commissioned soon are Elbistan Thermal Power Project (4,200 MW), Karakaya Hydroelectric Power Project (1,800 MW), Ataturk Hydroelectric Power Project (2,400 MW), Altınkaya Hydroelectric Power Project (700 MW), Gezende Hydroelectric Power Project (159 MW) and Batman Hydroelectric Power Project (198 MW), while preparation are being made for starting construction in the very near future for Kayraktepe Hydroelectric Power Project (420 MW), Ilısu Hydroelectric Power Project (1,200 MW), Boyabat Hydroelectric Power Project (510 MW), Birecik Hydroelectric Power Project (670 MW), etc., while still further, development targets next to these are also being planned. The hydroelectric power resources of Turkey exist one-sidedly in the eastern part. Since hydroelectric development of sites close to Istanbul and load areas in the western part of Turkey has reached the final stage, development is now in the process of moving to the east.

In these circumstances, hydroelectric projects such as Köprübaşı, which although of small scale but are close to load areas, are naturally being developed with highest priority.

The DSI, which is the agency for carrying out hydroelectric power development, started to prepare a Master Plan for development of the Filyos River Basin, the Filyos being a major river feeding the Black Sea, and concluded a plan for hydroelectric power development of 7 sites (total 184 MW) and irrigation projects considering about 25,000 ha of land.

Particularly, since the Köprübaşı hydroelectric power development site has the best economics of the 7 sites, it has been the object of special geological investigations as the project of first priority.

It was with such a background that the Government of Turkey, in November 1991, requested the Government of Japan to carry out a

feasibility study of the Köprübaşı Hydroelectric Power Development Project.

1.2 Objective of Study

Objective of the study is to decide optimum hydroelectric power development project technically, economically and financially, to prepare feasibility study report and to realize technical transfer through study of the project.

1.3 Field Investigation during the Study

Field investigations carried out by DSI during the study are as shown in Table 1-2.

1.4 The Record of Dispatched Team and List of Engineers

In October 1992, JICA began the work based on the beforementioned "Scope of Works". JICA next dispatched the following survey teams for field investigations concerning the Project.

First survey mission	October 10, 1992 - December 8, 1992
Second survey mission	March 1, 1993 - March 21, 1993
Third survey mission	August 30, 1993 - October 16, 1993
Forth survey mission	January 31, 1994 - February 14, 1994
Fifth survey mission	September 19, 1994 - October 2, 1994

During this period survey team submitted the following reports to DSI. Engineers participated the Study are as shown in the following list.

Inception Report	October 1992
Progress Report	March 1993
Interim Report	February 1994
Draft Final Report	September 1994

LIST OF ENGINEERS

DSI Home Office

Özden BILEN	General Manager
Ahmet ÜNVER	Deputy General Manager

(Investigationand Planning Department)

Suleyman BOZKURT	The former Planning Director
Hüseyin YAVUZ	Planning Director
Sen SÜLÜN	Deputy Planning Director
Dinçer KULGA	Deputy Planning Director
Tuncay SOYSAL	Planning Manager
Kenan BAYTAŞ	Planning Manager
Huseyin ÇELİK	Planning Manager
Necati ÖZCIRPICI	Hydrology Manager
Lale ÇULTU	Hydrology Engineer
Ayham TEKER	Hydrology Engineer
Yunus DOGRAMACI	Hydrology Engineer

(Geology Department)

Cavit BULUT	Geology Director
Ertuğrul ADA	Geophysics Engineer
Çetin HIZLI	Geology Manager
Eray ÖZGÜLER	Geology Engineer

Isıl SALIHOĞLU	Environmental Engineer
Mertkan ERDEMLI	Environmental Engineer
Muharrem POLAT	Environmental Engineer

DSI 5th Region

Müntaz TURFAN	The former 5th Region Director
Gündoğan ÇAVUŞOGULLARI	5th Region Director
İhsan KAYILI	Planning Manager
Necdet KARAASLAN	Geology Engineer
Ali KÖKSAL	Hydrology Engineer
Aysen Ş GÜNGÖR	Agricultural Engineer

JICA TEAM

Mamoru TAKIICHI	(The former Team Leader)
Taisuke HASEGAWA	Team Leader
Kuniaki YOSHIOKA	Design
Masayuki SEINO	Planning
Yoshimasa ISHII	Hydrology
Masahiro SHIBATA	Geology
Ryuichi ABE	Electrical & Mechanic
Masatake HIRAGA	Power System
Toshiyuki OTA	Economy
Ryozo OHNO	Social Environmental
Kiyoshi KIKUCHI	Natural Environmental
Gürol BANGER	Topographcial Survey

Table 1-2 Field Investigations during the Study

Item	Quantity	Remarks
Topographical Map		
Downstream of Dam	0.19 km	
Penstock, Power Station and Tailrace	1.21 km^2	
Installation of Leveling Point		
Dam	2 point	
Power Station	3 point	
Geological Investigation		
Drilling Core	DA-1 ~ DA-6 260 m	See Details Table 7-3
	DDV-1 270 m	
	DD-2 ~ DD-4 130 m	
	DQ-1 ~ DQ-2 80 m	
	Total 470 m	
Test Pit	Core Area 9 Area 3 point per each area Total 27 point	
Hydroelectrical Survey		
New Gaging Station	Between Dam and Power Station 3 point Outlet 1 point	Must be operated after the Feasibility Sutdy
New Meteorological Station	Near Dam Site 1 point	

Chapter 2 GENERAL SITUATION IN THE REPUBLIC OF TURKEY

Chapter 2

GENERAL SITUATION IN THE REPUBLIC OF TURKEY

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Chapter 2 GENERAL SITUATION IN THE REPUBLIC OF TURKEY

2.1 Geography

Turkey is situated in an area from 42°06′ to 35°51′ east longitude and from 44°48′ to 25°40′ north latitude, and is in a straddling position situated on both the European and Asian continents.

The land is in the shape of a rectangle 650 km in width and 1,560 km in length for an area of 779,452 km^2, 97% of which is on the Anatolia Peninsula at the tip of the Asian continent called Asia Minor, while the remaining 3% is the Thrace Region, the southern tip of the Balkan Peninsula at the eastern end of the European continent.

The surroundings of the land consist of the Mediterranean Sea, Syria and Iraq on the south, the Aegean Sea, Bulgaria and Greece on the west, the Black Sea on the north, and the former Sovient Union, Iran, Iraq, and Syria on the east.

Broadly dividing the territory geographically, it consists of the Aegean Sea-Mediterranean Sea Region, Black Sea Coast Region, Eastern-Central Anatolia Region, and Southern Anatolia Region. Of the national territory, 96% comprises a steppe climate zone called the Anatolian Plateau, while the area cultivated is only 30%.

The average elevation of the land is 1,132 m, and only 20% makes up areas with elevations below 500 m.

The average elevation of Ankara, the capital, is 902 m.

The principal rives (length) in the country are the Kızılırmak River (1,355 km), Sakarya River (825 km), Seyhan River (560 km), Yeşilırmak River (520 km), and Çoruh River (410 km), while the

Dicle River (513 km) and the Fırat River (1,263 km) famous as transboundary rivers rise in Turkey.

As natural lakes, Lake Van (3,700 km^2) in Eastern Anatolia and Lake Tuz (1,500 km^2) in Central Anatolia are representative, and both are salt-water lakes. As artificial lakes, Lake Keban (675 km^2) and Lake Atatürk (817 km^2) on the Fırat River, and Lake Hirfanlı (263 km^2) on the Kızılırmak River are well known, and all are playing major roles as reservoirs for hydroelectric power generation, that is, hydroelectric energy sources.

Mountainlands are mostly in Eastern Anatolia which borders the former Soviet Union and Iran, and Mt. Ararat (5,165 m) is the most famous, while others are Mt. Süphan (4,434 m), Mt. Kaçkar (3,932 m), and Mt. Erciyes (3,916 m), constituting the largest hydroelectric potential area of the country.

Vegetation differs according to the climatic and topographic conditions, but broadly divided, consist of the following:

Black Sea Area: A forest belt exists at the slopes of the mountainland facing the coastline with oak, elm, and beech being most abundant.

Aegean Sea-Mediterranean Sea Coastal Area: Olive, citruses, and pine are most abundant along mountains and hills.

Anatolian Plateau Area: Vegetation consists of natural pasturage and scattered forests.

2.2 Climate

The climate of Turkey, because it is surrounded by seas on three sides, the Black Sea on the north, the Aegean Sea on the west, and the Mediterranean Sea on the south, while half of the southern side and the eastern side are connected with the

Eurasian continent, differs considerably according to area. The climate may be broadly divided as follows according to area.

The central area which is a dry region may be divided into Central Anatolia excepting the eastern area and the southern area connecting to the Eurasian continent, the Mediterranean Sea area of Mediterranean climate which is temperate but has little rain and is hot in midsummer, the eastern area of continental climate with sharp differences between hot and cold during the year, and the Black Sea area having much rain and fog.

Annual insolation ranges between 1,800 to 3,200 hours from north to south, with more insolation the more to the south.

2.2.1 Air Temperature

The outline of air temperature according to area is as follows:

The mean temperature of the Black Sea area is from 14 to 15°C, which is temperate, and even in midsummer in July and August, it is 22 to 24°C and comparatively easy to endure, while even in the winter, in January and February, it is 5 to 7°C and not very severe.

The annual mean temperature of the Aegean Sea-Mediterranean Sea area is 18 to 20°C. However, the temperature becomes 27°C or higher in the summertime and considerably hot, but in the winter it is 8 to 12°C and temperate. It is the so-called Mediterranean climate.

On the other hand, the annual mean temperature of the central area inland is 11 to 20°C. However, in midsummer, it becomes dry and torridly hot.

The eastern area inland has annual mean temperatures between 4 and 18°C according to differences in elevation, and is featured

by a continental climate of extreme difference between hot and cold, with many districts where it becomes lower than 20°C below zero in the midst of winter.

2.2.2 Precipitation

The outline of precipitation according to area is as follows:

The annual precipitation in the Black Sea area is the heaviest in Turkey, with rainfall throughout the year, but with slightly more in the wintertime. Therefore, the vegetation in this area shows very good growth. There is a fair amount of rain throughout the year in the Mediterranean Sea area, but the rainfall in the summertime is exceedingly little. The annual precipitation in the central area is less than 400 mm, and there are parts which are dry and semi-desert. The annual precipitation of the eastern area is around 400 mm, and being mountainland, there is snow cover in the wintertime. The climates in the main cities are given in Table 2-1.

Table 2-1 Climate in the Main Cities

Selected Cities	Regions	Altitude Above Sea (m)	Temperature (°C)			Average Humidity (%)	Average Precipitation (mm)
			Average	Lowest	Highest		
İstanbul	Mar.	39	14.0	-16.1	40.5	75	677.4
Ankara	Cent. A	885	11.7	-24.9	40.0	60	371.6
İzmir	Aegean	25	17.6	-8.2	42.7	65	698.0
Adana	Medet.	20	18.8	-8.4	45.6	66	641.6
Edirne	Thrace	48	13.5	-22.2	41.5	70	597.2
Bursa	Mar.	100	14.4	-25.7	42.6	69	705.8
Antalya	Madit	42	18.6	-4.6	44.6	69	1,064.8
Urfa	A. East A.	547	18.1	-12.4	46.5	48	467.5
Zonguldak	W. Black S.	136	13.5	-8.0	40.5	73	1,223.8
Rize	E. Black S.	4	14.1	-7.0	38.2	77	2,323.2
Van	East A.	1,725	6.6	-28.7	37.5	60	377.0
Ağrı	N. East A.	1,632	6.1	-43.2	38.0	67	528.5
Muğla	Aegean	646	14.9	-12.6	41.2	61	1,206.4
Erzurum	East A.	1,869	7.2	-35.0	35.0	63	452.8

Source: General Directorate of Meteorology
STATISTICAL YEAR Book of Turkey 1989

2.3 Population

The population estimated for the middle of 1992 was 58,584,000, the population growth rate from 1987 to 1992 being an average of 2.2%.

2.4 Economy

The feature of the Turkish economy is an unique mixed economy system (formed in early 1930's). The public corporations established by the national capital have played the central role while private enterprises successfully co-exist with the public

sector, thereby promoting the industrialization of the nation. In recent years, however, the industrialization efforts under the sponsorship of the national government have created large fiscal deficit due to the inefficient management systems and governmental subsidies to corporations running on losses. To meet this situation, the Government has pursued the privatization policy since late 1980's with the objective of developing an economic regime in which the private enterprises take leadership.

The Economic Development 5-Year Plan was formulated after the State Planning Organization was established in 1969. At present, the 6th 5-Year Plan (for 1990 to 1994) is being implemented. In the 5th 5-Year Plan, 14 trillion liras (41 billion dollars) were invested to achieve an economic growth rate of 6.3% per annum, and the actual performance of this plan was an economic growth of rate 5.2% per annum, almost achieving the planned value.

Table 2-2 Growth Rate during Planned Development Period by Sectors

% increase at 1968 Factor Prices

	1st Plan Average (1963-1967)	2nd Plan Average (1968-1972)	3rd Plan Average (1973-1977)	4th Plan Average (1979-1983)	5th Plan Average (1985-1989)	6th Plan Average (1990-1994)
1. Agriculture						
a. Target	4.2	4.1	4.6	5.3	3.6	4.2
b. Realisation	3.1	3.5	3.5	2.2	2.2	
2. Industry						
a. Target	12.9	12.0	11.2	9.9	7.9	4.2
b. Realisation	10.9	7.8	9.8	1.7	5.5	
3. Service						
b. Realisation	7.3	7.9	7.9	2.6	5.0	6.9
4. Gross Domestic Project						
b. Realisation	6.4	6.8	7.3	2.3	3.0	
5. Gross National Product						
a. Target	7.0	7.0	7.9	9.0	6.3	7.0
b. Realisation	6.6	7.1	6.5	2.1	5.2	

Source: Economic Report Turkey 1964 Publication No. 1984/13

In the 6th 5-Year Plan, it is being planned to invest a total of 155 trillion liras (74 billion dollars) with a growth rate of 8.8% per annum. On this growth rate, the growth of investment to the private sector will be 11.3% while that to the public

sector will be 5.0%, thereby increasing the proportion of private sector investment to 62.8% of the total, to achieve an average economic growth rate per annum of 7%.

As to the economic trend in Turkey, the economic activities were temporarily depressed by the Gulf War of 1991, but the business cycle turned upward from '92 to '93. The net growth rate of GDP in 1992 was 5.9%, which was over the government's target of 5.5%. On the other hand, an inflation is in progress, reflecting a robust economic activities. The commodity price escalation has been pretty high, being 59.8% in January, 1993 (over the same month of the previous year), and 58% in March (over the same month of the previous year). For this reason, the suppression of this inflation is currently the most important issue.

Major economic indices in 1987-1992 are presented in Table 2-3.

Table 2-3 Economic Activity

	1987	1988	1989	1990	1991	1992
Economic Growth Rate (%)	7.4	3.7	1.9	9.2	0.5	5.9
Inflation Rate (%)	48.9	69.7	68.0	49.2	66.0	70.1
Export (in $ million)	10,190	11,662	11,627	12,959	13,598	14,715
Import (in $ million)	14,159	14,335	15,791	22,302	21,032	22,872
Balance of International Trade (in $ million)	▲3,969	▲2,673	▲4,164	▲9,343	▲7,434	▲8,157
Current Balance (in $ million)	▲987	1,503	961	2,625	258	▲943
Total Balance (in $ million)	993	888	2,762	1,368	▲1,029	▲1,484
GDP						
At Present Price (in billion liras)	76,316	134,109	232,260	390,083	626,471	-
At '87 price (in billion liras)	76,316	77,998	77,620	85,194	85,827	-
Wholesale Price Index	100	170.5	279.5	425.7	805.0	-
Consumer Price Index	100	173.7	283.6	454.6	957.0	-

Source: Briefing, March 15, 1993
Central Bank Annual Report 1991

The recent status of the international trade of Turkey is as presented in Table 2-4.

Table 2-4 Foreign Trade

Unit: US$ Million (%)

	1987	1988	1989	1990	1991
Exports: Total (FOB)	10,190	11,662	11,627	12,959	13,598
Agricultural Products	1,853 (18)	2,341 (20)	2,125 (18)	2,388 (18)	2,732 (17)
Industrial Products	8,065 (79)	8,943 (77)	9,086 (78)	10,240 (79)	10,579 (78)
Mining and Quarrying Products	272 (3)	378 (3)	416 (4)	331 (3)	287 (5)
Import: Total (CIF)	14,159	14,335	15,791	22,302	21,032
Agriculture and Live-Stock	791 (6)	507 (4)	1,047 (7)	1,323 (6)	813 (4)
Mining and Quarrying	3,035 (21)	2,862 (20)	2,901 (18)	3,989 (18)	2,989 (14)
Industrial Products	10,333 (73)	10,966 (76)	11,843 (75)	16,990 (76)	17,230 (82)

Source: The Turkish Economy '92 (TUBIAD)

The major export items in 1991 were the textiles ($4.2 billion), agricultural products ($2.7 billion), processed agricultural products ($1.1 billion), leather products ($0.6 billion), chemical products ($0.5 billion), etc. The major import items were machinery ($3.8 billion), crude oil ($2.8 billion), chemical products ($2.5 billion), steel ($1.8 billion), etc. The proportion of the crude oil in the total import payment was 13.2%. The major trade partners in 1991 were the following countries.

Export Germany, Italy, U.S.A., France, Britain
Import Germany, U.S.A., Italy, Britain, France

In both exports and imports, the trades with OECD countries are predominant, which proportions were 63.5% in exports, and 67.4% in imports.

The trades with Islam countries were 18.9% in exports and 14.9% in imports.

The international balance of trade is chronically deficit. The export in 1991 was $13,598 million while import was $21,032 million, with $7,434 million deficit.

2.5 Energy Resources

In Turkey, hydroelectric power resources to be developed economically are estimated to be 35,000 MW, of which twenty two (22) percent had already been developed by 1990

Indigenous energy resources in Turkey are petroleum (estimated to be 57 million tons), coal (12,900 million tons), and uranium as well as hydroelectric power resources above mentioned.

As for petroleum, it covers only 10 to 20 percent of domestic demand.

The lignite, the major portion of coal produced in Turkey and with low calorific value is not suitable for industrial use and is mainly used for residential and fuel for coal fired thermal power stations.

The production of primary energy and the situation of its use in Turkey are given in Table 2-5. According to this, the principal energy sources of lignite, water power, wood fuel, and energy from animals and plant life are made up of what are produced indigenously, but for hard coal, natural gas, and petroleum, imports are almost entirely relied on, while although a slight amount, electric power is also being imported. The increase in

importation of natural gas has been especially prominent, this being imported for fuel and heating for urban populations, and for gas-fired thermal power generation. And as described in Chapter 5, since gas-fired thermal power stations will increase rapidly in Turkey, it is thought that importation of natural gas will increase. The sources of these imports will probably be Russia and Iran in view of their reserve situations.

The amount of imported coal will increase for use as raw materials and fuel. However, it is thought there will be almost no petroleum imported for the purpose of electric power.

Table 2-5 Primary Energy Supply and Consumption

(Unit: Million tons of Oil Equivalent)

	1985	1986	1987	1988	1989	1990	1991
Total Consumption	40.8	43.8	49.3	50.6	52.4	55.8	56.8
Petroleum	18.1	19.6	22.5	22.0	22.5	23.9	22.1
Lignite	7.9	8.9	9.2	8.0	10.2	9.2	11.3
Coal	3.8	4.0	4.6	4.9	4.7	6.4	6.4
Electric Power	2.7	2.7	4.1	6.4	4.0	5.2	5.0
Natural Gas	0.1	0.4	0.7	1.1	2.9	3.1	3.9
Wood	5.2	5.3	5.3	5.3	5.3	5.4	5.4
Total Supply	40.8	43.8	49.3	50.6	52.4	55.8	56.8
Domestic Production	23.4	24.8	27.3	28.0	27.9	28.3	30.9
Petroleum	2.2	2.5	2.8	2.7	3.0	3.9	4.3
Lignite	8.2	8.9	9.8	8.6	10.6	8.9	11.1
Coal	2.2	2.2	2.1	1.9	2.0	2.1	2.2
Electric Power	2.7	2.7	4.2	6.5	4.0	5.2	5.0
Wood	5.2	5.3	5.6	5.3	5.3	5.4	5.4
Natural Gas	0.1	0.4	0.3	0.1	0.2	0.2	0.2
Import	18.4	21.0	25.4	28.5	26.9	31.0	29.2
Petroleum	17.6	19.1	22.6	24.4	21.7	23.4	21.2
Coal	1.7	1.8	2.4	3.1	2.5	4.6	4.2
Export (Petroleum)	2.1	2.3	2.3	4.1	2.3	2.0	3.3

Source: The Central Bank: Annual Report 1991

The first unit of a nuclear power station seems not to be realized in this century.

Taking all these into consideration, we can easily understand that the electric power industry supported by two major resources of hydroelectric power and lignite coal plays a significant role in promoting the industrialization of Turkey.

The tendency of each resource used for power generation is shown in Table 2-6.

The outstanding figure in this table is that of other fuels, that is that the use of natural gas and geothermal power have increased sharply in recent years and overcame oil fired thermal power after 1989.

Table 2-6 Distribution of Electrical Energy Generation of Turkey over Primary Power Resources

Years	Hard Coal (%)	Lignite (%)	Oil Products (%)	Other (1) Fuels (%)	Hydraulic (%)	Total GWh
1980	3.9	21.7	25.0	0.6	48.8	23,275
1981	3.6	21.3	23.6	0.4	51.1	24,673
1982	3.4	20.8	22.4	-	53.4	26,552
1983	2.9	28.5	27.1	-	41.5	27,347
1984	2.3	30.7	23.0	0.1	43.9	30,613
1985	2.1	41.8	20.7	0.2	35.2	34,219
1986	1.9	47.0	17.6	3.5	29.9	39,695
1987	1.4	38.4	12.4	5.8	42.0	44,353
1988	0.7	25.3	6.9	6.8	60.3	48,049
1989	0.6	38.3	8.2	18.4	34.5	52,043
1990	1.1	34.0	6.8	17.9	40.2	57,543
1991	1.7	34.1	5.5	21.0	37.7	60,246

1) Generation provided until 1981 through the utilization of fuels such as wood, husk, furnace gas, coke gas etc.
Generation in 1984 was provided only from geothermal resources whereas, from 1985 onwards, it was provided from geothermal and natural gas resources.

Further, according to the long-range plans for electric power generation prepared by TEK in September 1993, the installed capacities and composition by type of resource used as of the end of 1996 will be as shown in Table 2-7. As shown in this table, the ratio between thermal and hydro in composition of installed capacity in 1996 will be 51:49. However, this composition ratio will be 57:43 in 2001 and 58:42 in 2006, the proportion of thermal becoming higher as the years go by.

According to the abovementioned long-range electric power plan, lignite-burning thermal will continue to be developed in the thermal power generation program, but there are large increases planned for power generation by natural gas and imported coal. Hydroelectric power generation is also planned to be aggressively developed.

Table 2-7 Composition of Generating Facility in 1996

	Capacity (MW)	Percentage (%)	Composition of Thermal and Hydro (%)		Percentage of Imported Fuel (%)	
Hydraulic	10,950.0	48.6	Hydro	48.6	Domestic	78.9
Coal	6,300.0	27.9	Thermal	51.4		
Geothermal	2.0	0.1				
Natural Gas	3,350.0	14.8			Import	21.1
Oil & Others	1,950.0	8.6				
Total	22,550.0	100	100		100	

2.6 Transportation and Telecommunication

Transportation of goods by road, railroad, ship and air are available in Turkey.

The total length of roads including national and provincial roads amounted for approximately 58,915 km in 1987, ninety-two(92) percent of which is paved.

The most useful measure among various transportation facilities is road, which conveyed 88 percent of passengers and 72 percent of goods transported in Turkey in 1987.

The number of vehicles registered in 1987 amounted for 1,973,670 units, of which 60 percent were passengers cars.

The total length of railroad amounts for 10,186 km, of which 8,439 km are trunk lines (of which 479 km are electrified) and 1,747 km are local lines (of which 72 km are electrified).

Turkey is a peninsula, three directions of which are surrounded by the Black Sea, the Aegean Sea and the Mediterranean Sea, and navigation by the sea made remarkable progress in the old days.

There are 10 international trade ports and another 65 major ports, among which Istanbul port is the most important owing to it's blessed location.

Air liners connecting 10 major cities as well as 3 international air ports of İstanbul, Ankara and İzmir are operated frequently.

Telecommunication systems available in Turkey are mail, telegram and telephone.

The number of telephone exchange offices are, the centrals of 986, the local offices of 2,670 and agencies of 24,427.

TV and radio broadcasting is popularized, a broadcasting network covers all areas in Turkey.

Chapter 3 GENERAL SITUATION IN PROJECT AREA AND SURROUNDINGS

Chapter 3

GENERAL SITUATION IN PROJECT AREA AND SURROUNDINGS

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Chapter 3 GENERAL SITUATION IN PROJECT AREA AND SURROUNDINGS

3.1 General Situation in Project Area

3.1.1 General Situation

The Filyos River has a catchment area of 13,330 km^2 draining into the western part of the Black Sea, and its lengths is 120 km in a south-to-north direction.

The river basin has the plains of Bolu, Gerede, and Çerkes in the upstream area and Çaycuma Plain in the downstream area.

There is no hydroelectric power station already developed in the project area. With regard to irrigation, there is a facility constructed and being operated at Bolu Plain in the upstream area.

- Conditions of Topography

  More than one half of the land in the project area consists of mountains and plains, and the elevation becomes higher going from north to south. The North Anatolia Mountain Range extending parallel to the sea coast is within the catchment area.

  Traffic between north and south is made difficult because of these mountains. The northern part of the basin is suited to agriculture and the population is dense. The southern part has much mountainland and the population density is less than the nationwide average.

- River Basin

  The Filyos River rises at Aladağ in Bolu Province.

The name of the river in the vicinity of the fountainhead is Gerede, and on merging with the Uluçay River, it becomes the Soğanli River to flow north, merges further with another tributary, the Araç River, to become the Yenice River, further merges with the Devrek River, the largest tributary, at the center of the town of Devrek to become the Filyos River, and flows north to feed the Black Sea.

The Project is planned on the Devrek River, the largest tributary of the Filyos River. To describe the Devrek River, it rises from Lake Abant*, becomes the Büyüksu River, flows down the Bolu Plain and merges with the Mengen River which flows in from the east, and becomes the Devrek River. The Devrek merges in the end with the Yenice River to become the Filyos River.

The Filyos River has abundant water in the winter and spring, while the flow decreases sharply at other times.

The annual average runoff of the Filyos River is 104.6 m^3/s, with 230 m^3/s in April and 28 m^3/s in August.

The annual average runoff of the Devrek River is 18.5 m^3/s.

* Lake Abant: Located 32 km southwest of Bolu, it is at an elevation of 1,325 m and has an area of 125 ha.

3.1.2 Water Resources Development Plan and its Present State

The Filyos River is in an area with the greatest amount of rainfall in Turkey and is favored with abundant runoff, but there is presently no electric power development on it at all.

In 1987, the DSI prepared a master plan study report on the river basin centered on electric power development, and in this report, a plan for hydroelectric power development at 7 sites for a total

of 184 MW, and irrigation schemes at the Gerede district on the upstream part of the mainstream and at the downstream part of the tributary Aksu River was proposed.

The power development schemes are the Mandıra Project (52 MW), Suçatı Project (15 MW), Tefen Project (10 MW) on the mainstream, and the Konarı site (18 MW) on the tributary Araç River. On the tributary Devrek River, there is the present project (Köprübaşı Project, 60 MW) and besides it the Kayabükü Project (12 MW) upstream and the Çay Project (25 MW) downstream. These 7 project sites are all at midstream to downstream stretches both on the mainstream and tributaries, and are all schemes for power generation only.

According to the Master Plan Report, the priorities of the abovementioned 7 projects are as follows:

1. Köprübaşı Project
2. Konarı Project
3. Çay Project
4. Kayabükü Project
5. Tefen Project
6. Suçatı Project
7. Mandıra Project

Outline of the seven project are shown in Table 3-1.

Table 3-1 Outline of Filyos River Hydroelectric Power Development

Description	Unit	Kayabükü Project	Köprübaşı Project	Çay Project	Mandıra Project	Suçatı Project	Tefen Project	Konarı Project
River Basin		Filyos	Filyos	Filyos	Filyos	Filyos	Filyos	Filyos
River		Devrek	Devrek	Devrek	Gerede	Soğanlı	Soğanlı	Araç
Catchment Area	km^2	1,870	2,043	2,422	2,880	8,145	9,095	340
Annual Inflow	10^6 m^3	450	482	607	594	1,747	1,941	79
Reservoir								
High Water Level	m	495.00	437.00	219.00	850.00	195.00	85.00	695.00
Effective Storage Capacity	10^6 m^3	-	200	144	-	-	-	-
Dam								
Type		-	Rockfill	Rockfill	-	-	-	-
Height	m	-	95	79	-	-	-	-
Headrace Tunnel								
Inner Diameter × Length	m	4.0 × 3,250	4.0 × 3,00	4.0 × 1,800	3.75 × 11,800	5.0 × 4,700	5.25 × 1,825	3.0 × 4.625
Development Plan								
Maximum Discharge	m^3/s	28.6	42.0	46.0	20.5	55.0	62.7	7.25
Total Head	m	58.0	217.0	94.0	310.0	45.0	25.0	345.0
Installed Capacity	MW	12	60	25	52	15	10	18
Annual Energy Production	GWh	43	210	108	143	81	52	52

3.2 General Situation in Project Area

3.2.1 Landform and General Natural State

(1) Landform

The territory of Turkey, geographically, is partly at the eastern tip of the Balkan Peninsula in eastern Europe (Trakya), but mostly occupies the Anatolia Peninsula (Asia Minor Peninsula) at the western tip of the Asian continent surrounded by the Black Sea and the Mediterranean Sea, the shape as a whole being a rectangle fitting in a range approximately 1,600 km east-west and approximately 550 km north-south.

The topography of Turkey, reflecting its geological structure, is featured by a roughly east-west tectonic form, and may be broadly divided into three belts: the Pontos folded mountain range belt extending east-west along the Black Sea coast while winding broadly to north and south, the Anatolian plateau belt to the south comprising the backbone of the Anatolia Peninsula, and the Taurus folded mountain range belt to the south of the Anatolia Peninsula and extending east-west along the Mediterranean Sea while showing local bends.

The Devrek River, which is the object of development in this Project, is a tributary of the Filyos River which is located at roughly the middle of the western half area of all of Turkey and empties into the Black Sea. The Devrek is one of the rivers in the before-mentioned Pontos folded mountain range.

The Büyüksu River (length approximately 50 km) rising from the southwest outskirts of the city of Bolu, a major relay point on the trunk route connecting Istanbul and Ankara, which flows down in the northeast direction, and the Mengen River (length approximately 50 km), passing through the

town of Mengen, merge in the vicinity of the small hamlet of Gökçesu to change in name to Devrek. The Devrek River bends in the northeast direction downstream of the confluence, and although bending sharply to the northwest direction at times, flows northeast as a whole for approximately 75 km to merge with the Yenice River (length approximately 280 km) to become the abovementioned Filyos River (length 30 km) at the downstreammost stretch.

The project site is located approximately 20 km downstream on the Devrek River from the beforementioned confluence of the Büyüksu River and the Mengen River.

(2) Geology

The territory of Turkey, from a general geological structure viewpoint, makes up a part of the Alpine-Himalayan-Indonesian Orogenic Belt. Turkey is shown to have a roughly eastwest geological structure from a tectogenetic viewpoint, which generally can be divided into the Pontids along the Black Sea coast, the Anatorides to the south making up the central part of the Anatolia Peninsula, and further, along the Mediterranean Sea, the Taurides at the western part and the Border Folds at the eastern part. The project area is located at the northwest part of the Pontides among the abovementioned geological structure belts.

The western part of the Pontides, according to recent related material, is subdivided into the İstanbul Zone and the Sakarya Zone from the standpoint of geological characteristics. The İstanbul Zone comprises a continental borderland (continental terrace) containing a metamorphic rock basement of the Precambrian Period, and is featured by Paleozoic sedimentary rocks (Cambrian Period-Permian Period) in a comparatively quiet environment. In contrast, the Sakaya Zone does not include Paleozoic strata as primary strata. The İstanbul Zone which takes up the

northwest part of the Pontides tectogenetically overlies the Sakarya Zone to the south.

The project area belongs to the İstanbul Zone according to the above classification.

(3) Earthquakes

There are two transform faults named the North Anatolia Fault and the East Anatolia Fault in Turkey which comprise plate boundaries.

The North Anatolia Fault is an active lateral fault to the right having a total length of more than 1,000 km east-west and presenting a gentle are curved north toward the northern part of Turkey. As for the East Anatolia Fault, it is an active lateral fault to the left (thrust fault at the southwest part) which extends a total length of approximately 560 km from the northeast in the eastern part of Turkey.

Earthquakes in Turkey most frequently occur along these two active faults, and this is clearly indicated in the "Seismicity Map" (by the Ministry of Reconstruction and Settlements, 1972).

The North Anatolia Fault stretches out running 25 to 30 km south of the dam site of this Project in the north-northeast-south-southwest direction and passing the vicinities of the cities of Gerede and Bolu. As a result, the projected dam site is located in the "second degree of seismicity zone (near the 'first degree of seismicity zone' boundary)" on the Seismicity Map.

(4) Meteorology

The northern part of the project area is the generally temperate Black Sea climate zone. The northern pat of the

river basin does not show much temperature difference between night and day and between seasons.

Annual mean temperature, precipitation, and number of days of snowfall are as given below.

Station	Annual Average Temperature	Annual Precipitation	Annual Average Rainy days
Devrek	13.5°C	765 mm	8 days
Karabük	13.3°C	495 mm	11 days
Safranbolu	12.5°C	491 mm	11 days
Mengen	10.2°C	662 mm	26 days
Bolu	10.2°C	566 mm	26 days
Gerede	7.6°C	684 mm	46 days
Çerkeş	8.2°C	392 mm	24 days

3.2.2 Natural and Social Environment

(1) Natural Environment

The sea coast area of the Filyos River where the Project is located is governed by the high-rainfall and temperate Black Sea climate. Precipitation decreases from north to south, temperature difference between summer and winter increases, and the southern part of the basin is governed by a continental climate.

With regard to topography, a half of the river basin is mountainland and the rest plain areas, with elevation becoming higher going from north to south.

The North Anatolia Mountain Range is situated parallel to the sea coast, and this constitutes an obstacle to traffic between north and south.

The northern part is suitable for agriculture and is populous, while the southern part is mountainous, does not have much plain area, and population density is low.

The coastal area is favored with natural beaches that can be utilized for tourism. However, the summer season suitable for sea bathing is short.

The surroundings of Bolu have rich forests and also have lakes and snow-covered mountains.

An excellent highway is under construction between Ankara and İstanbul and a part is already opened to traffic. Being sandwiched by these large cities, there is a great possibility of becoming a recreation center in the future.

(2) Social Environment

The population in this river basin is generally concentrated at plain areas and the neighborhoods of rivers. The population gradually increases going towards the sea coast. That is, the population density of the northern part on average is double the average for Turkey. The coal mine of Zonguldak, the steel mill of Karabük, and the development of forestry and paper manufacture utilizing the abundant forest resources are the causes of population increase. In contrast, the population int he southern part is less than the average for entire Turkey. The growth rate has been lower even at a time of nationwide increase in population.

The populations of the principal communities in the project area are as given below.

	Total Population (Person)	Urban Population (Person)	Rural Population (Person)	Population Density (Person/km^2)
Çaycuma	89,670	9,688	79,982	183
Devrek	94,298	12,265	82,033	77
Eflani	21,843	3,183	18,660	35
Karabük	131,349	84,137	47,212	95
Safranbolu	39,464	19,440	20,024	39
Mengen	18,886	2,557	16,329	21
Bolu	87,257	38,283	48,974	57
Gerede	63,137	9,885	53,252	32
Çerkeş	19,123	3,675	15,448	19
Eskipazar	23,063	5,007	18,056	33
Ovacık	9,108	853	8,255	24
Araç	38,626	4,244	34,382	21

Population density of Turkey in 1980 was 58 persons/km^2.

Chapter 4 ELECTRIC POWER IN TURKEY

Chapter 4

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4.1 Present Situation of Electricity

Installed capacity of generating facilities in Turkey has shown a great increase in this ten-year period. The total capacity at the end of 1982 was 6,638.6 MW and the capacity at the end of 1992 became 18,713 MW which is 2.8 times (See Table 4-1). For annual energy production and annual import/export energy, as shown in Table 4-2, they are 2.4 times in this ten-year period.

Table 4-1 Development of Installed Capacity of Turkey and TEK (MW)

Years	Turkey				TEK			
	Thermal	Hydraulic	Total	Increase (%)	Thermal	Hydraulic	Total	Increase (%)
1982	3,556.3	3,082.3	6,638.6	-	2,719.7	2,823.5	5,543.2	-
1983	3,695.3	3,239.3	6,935.1	4.5	2,937.6	2,998.5	5,936.1	7.1
1984	4,584.3	3,874.8	8,459.1	22.0	3,542.9	3,644.2	7,187.1	21.1
1985	5,244.3	3,874.8	9,119.1	7.8	4,147.9	3,644.2	7,792.1	8.4
1986	6,235.2	3,877.5	10,112.7	10.9	5,141.8	3,644.2	8,786.0	12.8
1987	7,489.3	5,003.3	12,492.6	23.5	6,290.9	4,720.1	11,011.0	25.3
1988	8,299.8	6,218.3	14,518.1	16.2	7,046.4	5,935.4	12,981.5	17.9
1989	9,208.4	6,597.3	15,805.7	8.9	7,939.0	6,298.1	14,237.1	9.7
1990	9,550.8	6,764.3	16,315.1	3.2	8,261.7	6,465.1	14,726.8	3.4
1991	10,092.8	7,113.8	17,206.6	5.5	8,793.1	6,521.5	15,314.6	4.0
1992	10,334.9	8,378.7	18,713.6	8.8	9,018.1	7,779.2	16,797.3	9.7

cf: TEK table original

Table 4-2 Turkey's Development of Generation (GWh)

Years	Thermal	Hydraulic	Total	Increase (%)	Import	Export	Gross Supply	Increase (%)
1982	12,385	14,167	26,552	-	1,773		28,325	-
1983	16,004	11,343	27,347	3.0	2,221		29,568	4.4
1984	17,187	13,426	30,613	11.9	2,653		33,267	12.5
1985	22,174	12,045	34,219	11.6	2,142		36,361	9.3
1986	27,822	11,873	39,695	16.0	777		40,471	11.0
1987	25,735	18,618	44,353	11.7	572		44,925	11.0
1988	19,099	28,950	48,049	8.3	381		48,430	7.8
1989	34,103	17,940	52,043	8.3	559		52,602	8.6
1990	34,395	23,148	57,543	10.6	176	907	56,812	8.0
1991	37,563	22,683	60,246	4.7	759	506	60,499	6.5
1992	40,774	26,568	67,342	11.8	189	314	67,217	11.1

cf: TEK table original

Distribution of Electric Energy Generation in 1992 over primary power resources is shown in Table 4-3, the ratio of hydraulic and thermal power generation is 40:60.

Table 4-3 Distribution of Electric Energy Generation in 1992 Turkey Over Primary Power Resources (GWh)

Resources	Turkey's Generation	Ratio Over Total Generation (%)
Hard Coal	1,814.6	2.7
Lignite	22,756.2	33.8
Oil Products	5,273.0	7.8
Hydraulic	26,568.0	39.5
Geothermal	69.6	0.1
Natural Gas	10,813.7	16.1
Total	67,342.2	100.0

4.2 Electric Power Utilities

In Turkey, the following organizations are concerned with electric power, the profiles of which are as shown below;

- Electric Power Development Planning and Survey:

  by Directorate of Electrical Power Resources Survey and Development Administration (EIE)

- Survey, Planning and Construction of Hydropower Stations:

  by General Directorate of State Hydraulic Works (DSI)

- Operation and Maintenance of Hydropower Stations,

- Construction, Operation and Maintenance of Thermal Power Stations, and

- Construction and Maintenance of Transmission Lines:

  by Turkish Electricity Authority (TEK)

DSI and TEK (Türkiye Elektrik Kurumu), two gigantic public authorities, are the principal organizations which generate and distribute electric energy in Turkey.

TEK was established in 1970 as a pubic enterprise for the consolidation of the services of generation, transmission and distribution by bringing together all functions for electric power under one authority. DSI was established in 1953 as a public organization for the development of surface and groundwater resources in Turkey. The tasks and responsibilities of DSI can be summarized as follows:

- Studying master plans of all river basins.

- Preparation of feasibility studies and contract design of each development project.

- To take protective measures against floods and torrents.

- Construction and operation of irrigation and drainage networks.

- Preservation and development of groundwater resources.

- To supply domestic and industrial water to cities with populations over 100,000 provided that the government has authorized.

- To build all types of hydroelectric power plants.

After the construction is completed the operation of a hydroelectric power plant and its switchyard, including headrace structures, is turnover to TEK but where the powerhouse is connected with a large dam, the operation surveillance and maintenance services of the dam and its reservoir are retained by DSI.

The inflow forecast and operation rule curve for each storage reservoir is predicted annually by DSI and the operation of all types of power plants is arranged and done by TEK. However, the power plant of an irrigation oriented multipurpose reservoir should be operated according to the irrigation diversion requirements as set by DSI.

EIE (Electrik Işleri Etüt Idaresi Genel Direktörlügü), Power Resources Surveying Administration, is in charge of exploration and investigation of hydroelectric sites and performing geo-technical investigations and engineering services for planning, feasibility studies and design of hydroelectric projects.

DSI established by Law No.6200 on Dec. 18, 1953 was authorized for the development of surface and groundwater resources of Turkey to achieve the highest benefit from them.

Presently DSI is attached to the Ministry of Public Works and Settlement and its tasks and responsibilities can be outlined as the following:

- To build structures to store and preserve surface and groundwater resources and to utilize them in the most beneficial way.

- To take protective measures against floods and torrents.

- To undertake irrigation and drainage works and to operate such facilities

- To build hydroelectric power plants in connection with the above said activities.

- To supply domestic and industrial water for Ankara, İstanbul and other cities with populations over 100,000 as authorized by Law No.1053 declared on July 3, 1968.

- To train rivers and build control works on streams and make them suitable for navigation, if necessary.

- To operate, maintain and repair all of the above said structures except those which have been turned over to Turkish Electricity Authority.

To collect and evaluate the data for sizing the hydraulic structures: by carrying out measurements, conduct experiments, compile and evaluate statistical data; make research and preliminary investigations or have these activities be conducted by other agencies for DSI; and organize all kinds of financial

and administrative means for the accomplishment of the above said activities.

4.3 Electric Power Facilities

(1) Thermal Power Plant

For the year 1992, the total national electric energy generation amounted to 67.3 billion kWh, and about 61% of them was thermal generation. The installed capacity of thermal power plants over 10 MW in Turkey was 8,993.9 MW at the end of 1992. Outline of thermal power plants in Turkey is as shown in Table 4-4.

Table 4-4 Outline of Thermal Power Plants in Turkey (1992)

Power Plants	Commissioning Date	Installed Capacity (MW) End of 1992	Gross Generation (Million kWh)
			Capacity
Afşin-Elbistan (Lignite)	1984	1,360.0	8,840
Çayırhan (Lignite)	1987	300.0	1,950
Seyitömer (Lignite)	1973	600.0	3,900
Soma A (Lignite)	1957	44.0	290
Soma B I-VI (Lignite)	1981 ~ 92	990.0	6,435
Tunçbilek A+B (Lignite)	1956	429.0	2,790
Yatağan (Lignite)	1982	630.0	4,100
Yeniköy (Lignite)	1986	420.0	2,730
Ambarlı (Fuel-Oil)	1967	630.0	4,100
Hopa (Fuel-Oil)	1973	50.0	200
Aliağa GT+Com. Cycle (Diesel Oil)	1975	180.0	-
Hamitabat + Com. Cycle (Natural Gas)	1985	1,200.0	7,800
Ambarlı (Natural Gas)	1988 ~ 91	1,350.9	8,780
Kangal 1-2 (Lignite)	1989	300.0	1,950
Y. Çatalağzi B-1 (Hard Coal)	1989	300.0	1,950
Orhaneli (Lignite)	1992	210.0	1,365
Total		8,993.9	

cf: TEK table original, others

(2) Hydropower Plants

Installed capacity of hydropower plants over 10 MW in Turkey was 7,762.3 MW at the end of 1992. The outline of hydropower plants in Turkey is as shown in Table 4-5.

Table 4-5 Outline of Hydropower Plants in Turkey (1992)

Power Plants	Commissioning Date	Installed Capacity (MW) End of 1992	Generation Capacity (Million kWh) Average
Almus (Dam)	20.9. 1966	27.0	100
Altınkaya (Dam)	9.12. 1987	700.0	1,632
Aslantaş (Dam)	11.5. 1984	138.0	569
Atatürk I~IV	6~11. 1992	1,200.0	4,450
Demirköprü (Dam)	14.5. 1960	69.0	190
Dervent		56.4	257
Gökçekaya (Dam)	2.11. 1972	278.4	562
Hasan Uğurlu (Dam)	2.12. 1979	500.0	1,217
Hirfanlı (Dam)	8.1. 1959	128.0	400
Karakaya (Dam)	6.3. 1987	1,800.0	7,354
Keban (Dam)	25.2. 1975	1,330.0	6,000
Kemer (Dam)	25.10. 1958	48.0	135
Kesikköprü (Dam)	27.2. 1966	76.0	250
Kılıçkaya		120.0	332
Köklüce (Dam)	10.10. 1988	90.0	588
Menzelet I, II	10, 11. 1992	62.0	256
Oymapınar (Dam)	16.1. 1984	540.0	1,620
H. Polatkan Sariyar (Dam)	24.10. 1956	160.0	400
Suat Uğurlu (Dam)	20.10. 1981	46.0	273
Çıldır (Natural lake)	14.11. 1975	15.4	30
Hazar 1 (Natural lake)	20.10. 1957	20.1	128
Hazar 2 (Natural lake)	20.10. 1957	10.0	64
Kovada 2 (Natural lake)	30.6. 1971	51.2	220
Tortum (Natural lake)	14.5. 1960	26.2	85
Karacaören		32.0	142
Çağ-Çağ (Rivers)	28.6. 1989	14.4	42
Doğankent A+B (Rivers)	24.4. 1971	70.8	314
Tercan		15.0	30
Göksu (Rivers)	1959	10.8	65
İkizder (Rivers)	11.5. 1961	15.1	100
Kapulukaya (Dam)	11.3. 1989	54.0	190
Diğerlari		58.5	214.5
Total		7,762.3	28,209.5

cf: TEK table original

(3) Transmission and Distribution Facilities

Table 4-6 shows the outline of Transmission and distribution facilities in Turkey.

Table 4-6 Outline of Transmission and Distribution System in Turkey (1992)

Voltage (kV)	Transformer Centers		Transmission and Distribution Lines	
	Substation Centers	Trans-formers	Capacity (MVA)	Power Line Length(km)
380 kV	20	62	9,660.0	9,483.9
220 kV	2	2	330.0	87.5
154 kV	284	559	20,481.0	21,661.1
66 kV	42	128	1,044.0	1,030.5
Transmission Line Total	348	751	31,515.0	32,263.0
Distribution line Total (34.5 kV and below)	-	-	-	513,500

Note: Village electrification power line and transformers inclusive.

cf: TEK table original

4.4 Electric Power Supply and Demand

Power demand-supply balance, annual power plant factor and annual load factor in Turkey are as shown in Table 4-7. The annual plant factor in 1992 was only 58.2% and the generating capacity still has a big margin. The annual load factor is 70% which is considered slightly higher than that of other countries.

Table 4-8 shows the energy balance of TEK in 1990 and 1991 as an example. TEK's transmission loss was about 3% in 1991, it improved drastically latest years. The distribution loss is about 10% and still has room for improvement.

The gross electricity consumption reached 67.3 billion kWh in 1992. Consumption per capita was 921 kWh during the same year.

In 1992 the net electricity consumption in Turkey reached 54.0 billion kWh and the industrial consumers had the largest share in this consumption as it had been in the previous years.

As of the end of 1992, the breakdown of the total consumption of electricity in Turkey by the major sectors was 58.4% industrial, 21.3% household, 6.1% commercial, 3.7% government offices and 10.5% others.

Table 4-7 Demand/Supply Balance, Plant Factor, Load Factor in Turkey's Power System

Year	Gross Energy Production (GWh)	Installed Capacity (MW)	Hourly Peak Load (MW)	Annual Plant Factor (%)	Annual Load Factor (%)
1982	26,551.5	6,638.6	4,308.2	64.9	70.1
1983	27,346.8	6,935.1	4,419.0	63.7	70.6
1984	30,613.5	8,459.1	5,108.3	60.4	68.2
1985	34,218.9	9,119.1	5,409.9	50.3	72.2
1986	39,694.8	10,112.7	6,340.5	62.7	71.5
1987	44,352.9	12,492.6	7,312.0	58.5	69.2
1988	48,048.8	14,518.1	7,613.0	52.4	72.0
1989	52,043.2	15,805.7	8,499.0	53.8	70.0
1990	57,543.0	16,315.1	9,180.4	58.1	71.6
1991	60,246.3	17,206.6	9,964.9	57.9	69.0
1992	67,342.7	18,713.6	10,895.0	58.2	70.0

cf: TEK table original

The peak power demand of the Turkey's power system, a new peak power (10,895 MW) was recorded in December, 1992. The peak demand is expected to reach 14,610 MW in the year 1996, 20,095 MW in the year 2,000 and 42,485 MW in the year 2010.

Table 4-8 TEK's Energy Balance - Sheet and Sales

Energy Balance - Sheet and Sales	1990 (MWh)	1991 (MWh)	Increase (%)
Gross Generation	52,854,235	55,460,687	4.9
Power Plant Internal Consumption	2,947,814	3,272,784	11.0
Net Generation	49,906,421	52,187,902	4.6
Compensator Consumption	49,235	44,316	-10.0
Purchased Energy	321,830	847,297	263.3
Power Supplied to the Network	50,179,016	52,990,883	5.6
Transmission Network Losses	1,787,241	1,437,823	-19.6
Power Sold by the Generation-Transmission Ent.	48,391,775	51,553,060	6.5
1. Sold Directly to the Customer	8,405,711	10,226,447	21.7
2. Sold to Power Distribution Enterprise	39,986,064	41,326,613	3.4
Power Purchased by Dist. Ent. from Non-TEK Utilities	1,897,566	2,145,530	13.1
Total Power Purchased by Distn. Enterprises	41,883,630	43,472,143	3.8
Distribution Network Losses	4,413,330	5,388,818	22.1
Power Sold by Distribution Enterprises	37,470,300	38,083,325	1.6
Net Consolidated Sales	44,620,603	46,933,550	5.2

* when calculating net consolidated sales, road illumination consumption (1,174,696 MWh) and sales made free of charge were not taken into account.

cf: TEK original table

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Chapter 5

POWER DEMAND FORECAST AND POWER DEVELOPMENT PLAN

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Chapter 5 POWER DEMAND FORECAST AND POWER DEVELOPMENT PLAN

5.1 Power Demand Forecast

5.1.1 Power Demand Analysis

(1) Trend of power demand

Table 5-1 shows the trend of power demand from 1980 to 1992.

It is known from the power demand situation that in 1992 the peak power demand was 10,895 MW and electric energy generation was 67,342 GWh. The annual average increase rate from 1980 onward was 9.7% for the peak power demand and 9.2% for the energy demand. The annual average consumption of energy per capita was 921 kWh.

As for the power interchange with the adjacent countries, it should be noted that in 1991, the energy was first exported to the adjacent foreign countries though until that time it had only been imported inversely. Hence, it was a 731 GWh export surplus in 1991 despite a 253 GWh import surplus 1992. These accounts for about 1.0% or so in terms of the total energy generation in Turkey.

(2) Features of load

a) Demand structure

Table 5-2 shows the trend of power demand structure from 1980 to 1991.

As for the component ratio of customers, it has been more or less the same except 1991 though the household use has so far slightly been on the increase. In 1991, the household use remarkably increased in

particular though the industrial use decreased because of decrease in power demand thus reducing its component ratio. Hence, the main component ratio in 1991 comes to 57.5% for the industrial use, 22.3% for the household use, and 6.2% for the commercial use.

b) Load factor

The annual load factor has been maintaining at a constant level of 70% or so from 1980 onward (see Table 5-1). This trend indicates that the demand structure has almost been remaining constant and unchanged and moreover that any remarkable change has never occurred in the industrial structure.

c) Loss factor

The power loss mainly consists of the consumption in the power station which accounts for 6.0% or so of the generated power and the transmission loss which amounts to 13.0% or so of the sending-end output. Hence, the total loss factor becomes approximately 18% in terms of the generated power.

d) Load curve

The load curves are shown in Figure 5-1 respect of the maximum and minimum load days of 1991. It is known from the curves that the maximum load occurred in December while the minimum load in April, and that the midnight load on the maximum load day accounts for about 54% of the maximum power.

(3) Economic growth rate and power demand

The annual average economic growth rate was 4.96% from 1980 to 1991 while the annual average increase rate of the energy consumption in the same period was 8.34% giving an

elasticity of 1.68 of the power demand to GNP. It should be noted that this elasticity has reached as high as 2.08 in recent years (1986 to 1991) in particular. This is because the increase rate of the power demand has been extremely high as compared to the economic growth rate.

The elasticity of the increase rate of the energy generation to GNP from 1980 to 1991 was 1.82.

Table 5-1 Trend of Energy Consumption

(GWh)

Years	Gross generation	Incr. (%)	Aux. loss	Incr. (%)	Net generation	Import	Supplied energy	Network loss	Incr. (%)	Export	Energy consumption	Incr. (%)	Peak load (MW)	Population (1,000)	Consumption (kWh/capita)	Load Factor (%)
1980	23,275.4	–	1,391.9	6.0	21,881.5	1,341.2	23,222.7	2,824.5	12.2	–	20,398.2	–	3,592	44,438	459	74
1981	24,672.8	6.0	1,327.8	5.4	23,345.0	1,616.1	24,961.1	2,931.7	11.7	–	22,030.0	8.0	3,873	45,540	484	73
1982	26,551.5	7.6	1,420.5	5.3	25,131.0	1,773.4	26,904.4	3,317.6	12.3	–	23,586.8	7.1	4,308	46,688	505	70
1983	27,346.8	3.0	1,680.2	6.1	25,666.6	2,220.8	27,887.4	3,422.3	12.3	–	24,465.1	3.7	4,419	47,864	511	71
1984	30,613.5	11.9	1,890.7	6.2	28,722.8	2,653.0	31,375.8	3,740.6	11.9	–	27,635.2	13.0	5,108	49,070	563	68
1985	34,118.9	11.8	2,306.8	6.7	31,912.1	2,142.4	34,054.5	4,345.9	12.8	–	29,708.6	7.5	5,410	50,306	591	72
1986	39,694.8	16.0	2,815.0	7.1	36,879.8	776.6	37,656.4	5,446.7	14.5	–	32,209.7	8.4	6,341	51,546	625	72
1987	44,352.9	11.7	2,607.7	5.9	41,745.2	572.1	42,317.3	5,620.0	13.3	–	36,697.3	13.6	7,312	52,845	694	69
1988	48,048.8	8.3	2,400.0	5.0	45,648.8	381.2	46,030.0	6,308.5	13.7	–	39,721.5	8.2	7,679	54,176	733	72
1989	52,043.2	8.3	3,234.5	6.2	48,808.7	558.5	49,367.2	6,247.2	12.7	–	43,120.0	8.6	8,556	55,541	776	70
1990	57,543.0	10.6	3,311.4	5.8	54,231.6	175.5	54,407.1	6,680.3	12.3	906.8	46,820.0	8.6	9,180	56,098	835	73
1991	60,246.3	4.7	3,655.2	6.1	56,591.1	759.4	57,350.5	7,561.2	13.2	506.4	49,282.9	5.3	9,965	57,326	860	69
1992	66,630.0	10.6	–	–	–	–	–	–	–	–	54,500※	–	10,895	58,584	930	70

Note : ※ Estimated

Table 5-2 Evolution of Category-Wise Energy Consumption

Years	Household		Commercials		Officials		Industry		Lighting		Others		Total	
	(GWh)	%	(GWh)	%	(GWh)	%	(GWh)	%	(GWh)	%	(GWh)	%	(GWh)	%
1980	3,499.3	17.2	1,146.7	5.6	609.2	3.0	13,007.9	63.8	289.5	1.4	1,845.6	9.0	20,398.2	100.0
1981	3,665.1	16.6	1,256.9	5.7	638.1	2.9	14,206.1	64.5	298.4	1.4	1,965.4	9.0	22,030.0	100.0
1982	3,846.0	16.3	1,375.8	5.8	596.1	2.5	15,197.7	64.4	309.0	1.3	2,262.2	9.3	23,586.8	100.0
1983	4,024.4	16.4	1,399.5	5.7	687.0	2.8	15,575.7	63.7	296.3	1.2	2,482.2	10.2	24,465.1	100.0
1984	4,304.9	15.6	1,569.9	5.7	766.7	2.8	18,027.0	65.2	330.8	1.2	2,635.9	9.5	27,635.2	100.0
1985	4,978.9	16.7	1,620.5	5.4	891.5	3.0	19,607.7	65.9	450.3	1.5	2,202.7	7.5	29,751.6	100.0
1986	5,661.5	17.6	1,680.0	5.2	1,036.3	3.2	20,885.9	64.8	666.0	2.1	2,280.0	7.1	32,209.7	100.0
1987	6,506.3	17.7	1,747.8	4.8	1,168.7	3.2	23,872.9	65.1	786.3	2.1	2,615.3	7.1	36,697.3	100.0
1988	7,612.3	19.2	1,981.4	5.0	1,269.4	3.2	25,257.5	63.6	815.4	2.1	2,785.5	7.0	39,721.5	100.0
1989	8,264.5	19.3	2,300.2	5.4	1,278.3	3.0	27,602.7	64.3	715.7	1.7	2,758.6	6.4	42,920.0	100.0
1990	9,059.8	19.4	2,557.8	5.5	1,463.3	3.1	29,211.8	62.4	1,231.4	2.6	3,295.9	7.0	46,820.0	100.0
1991	10,993.3	22.3	3,054.1	6.2	1,864.3	3.8	28,351.8	57.5	1,417.9	2.9	3,601.5	7.3	49,282.9	100.0

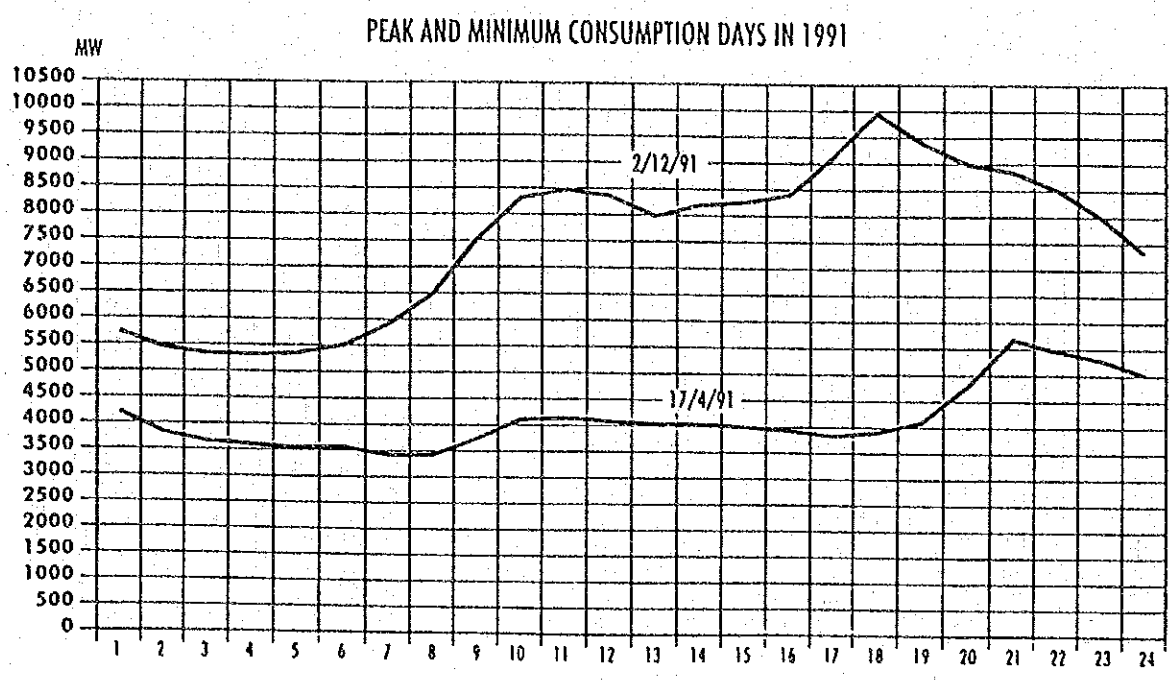


Figure 5-1 Daily Load Curve

5.1.2 Power Demand Forecast

(1) Method of forecast

To estimate the power demand, a macroscopic forecast method is used with regard to the comprehensive nationwide power demand. In this method, a certain fixed rule or tendency is derived from the past actual demand trend and then used to estimate the long-term nationwide power demand.

To this effect, the following three approximate equations are used in order to find out the correlation between the power consumption and economic potential in Turkey.

a) The simple regression equation that is to be used when a linear correlation is found between the power demand and GNP.

b) The multi-regression equation that is to be used when a linear correlation is found among the power demand, population and GNP.

c) The parabolic regression equation that is to be used when a quadratic correlation is found between the power demand and GNP.

Out of the above regression equations, the one most suitable for the power demand pattern in the target country is to be selected.

(2) Conditions for estimation

a) Regression equation and variable

Table 5-3 shows the actual power demand and its descriptive variables, i.e. the GNP and trend of population (1980 to 1991). In the table, the data are given in the form of energy consumption for the power

demand and GNP is given in 1987 price. For population, the results of the national census every five years are used, but as for midterm years having no national census, the population multiplied by the average increase rate in five years is used.

Table 5-3 Data for Regression Equation

No.	Year	Energy Consumption (GWh)	GNP at 1987 price (M.TL)	Population (1000)
1	1980	20,398	50,678,685	*44,737
2	1981	22,030	53,377,284	45,864
3	1982	23,587	55,371,269	47,020
4	1983	24,465	57,900,634	48,204
5	1984	27,635	62,401,389	49,419
6	1985	29,709	65,189,062	*50,664
7	1986	32,210	70,092,365	51,776
8	1987	36,697	76,612,983	52,912
9	1988	39,722	77,799,910	54,073
10	1989	43,120	78,469,365	55,260
11	1990	46,820	86,050,138	*56,473
12	1991	49,283	86,347,877	57,712

Note: *: Census

b) Period of demand forecast

The period of demand forecast is for 18 years from 1993 to 2010.

c) Long-term increase rates of GNP and population

The increase rates of GNP and population from 1993 to 2010 are taken as follows:

- Annual average increase rate of GNP: three cases, i.e. 4%, 5%, and 6%
- Annual average increase rate of population: 2.19%

It is known from the statistics that the annual average increase rate was 4.96% for the past eleven years (1980 to 1991), 4.26% for the past five years

(1986 to 1991), and 3.54% for the past three years (1988 to 1991). In view of these actual results, the economic growth rate is taken in the range of 4 to 6%, while the annual average increase rate of population is taken as 2.19% in compliance with the national estimate of Turkey.

(3) Regression equation

As a result of the above survey, the regression equations are calculated as follows:

a) Simple regression equation

$Y = -18,109 + 0.00078 \times X_1$

$(R = 0.988)$

b) Multi-regression equation

$Y = -56,045 + 0.000363 \times X_2$

$(R = 0.981)$

c) Parabolic regression equation

$Y = 19,554 - 0.000393 \times X_1 + 8.538 \times 10^{-12} \times X_1^2$

$(R = 0.986)$

Where;

Y : Energy consumption (GWh)

X_1: GNP (M.TL)

X_2: Population (1,000 persons)

R : Correlation coefficient

Among these three equations, the equation a) shows the largest correlation, while the equation b) the second largest and the equation c) the third though the differences between them are slight.

(4) Results of demand forecast

The result of the power demand forecast obtained by the regression equations is shown in Table 5-4 comparing with the TEK's forecast (See 5.1.3). The table shows the most closest values to those of the TEK's forecast, which are

chosen from the calculated results using respective regression equations and economic growth rates, in the form of comparison of the demands for energy at an interval of five years from 1995 to 2010.

It is known from the table that among the three regression equations, the parabolic regression equation with 4.0% of economic growth rate gives the most closest values to the TEK's forecast. Other regression equations only give values substantially lower than those of TEK's forecast. The annual average increase rate of the power demand obtained from the parabolic regression equation is 8.38% and thus the elasticity to GNP comes to 2.10.

The elasticity estimated by TEK on the assumption of 8.12% of power demand increase rate and 4.0% of economic growth rate is 2.03 which is comparatively high. Nonetheless, it may be said that these indexes are by no means largely separated from the tendency of the past ten years.

As the result of the above study, it is concluded herewith that the demand forecast by TEK should be regarded as appropriate and that the power development plans should be verified by using the TEK's estimated values hereafter.

Table 5-4 Comparison of Power Demand Forecast

(GWh)

Regression equation	1995	2000	2005	2010	'93-2010 Ann. Av. increase rate (%)	Elas-ticity to GNP
Simple (6%)	83,332	118,519	165,608	228,624	7.09	1.18
Multi (6%)	80,476	107,874	142,064	185,063	5.84	0.97
Parabo.(4%)	83,587	124,222	187,146	283,663	8.38	2.10
TEK	87,205	130,350	189,630	271,450	8.12	-

(Note): ( ) indicates the economic growth rate.
Energy demand (generation) in 1992: 66,630 GWh

Table 5-5 (1) to (3) and Figure 5-2 (1) to (3) show the results of the demand forecast until 2010 obtained from the regression equations, which are presented in the form of energy consumption and energy generation. The energy generation is calculated based on the energy consumption that is obtained from the regression equations presuming that the power station consumption is 6% and transmission loss 13%, both of which are the estimated values derived from the TEK's records from 1980 to 1991. Table 5-6 and Figure 5-3 (1) and (2) show the peak power demand forecast in the cases of simple and parabolic regressions. The peak power demand represents the total output of the power stations and which is calculated based on the energy generation on the assumption that the load factor is 70%.

Table 5-5 Power Demand Forecast

(1) Simple Regression P=f(GNP)

(GWh)

Year	(a) Consumption			(b) Generation			TEK
	4.0%	5.0%	6.0%	4.0%	5.0%	6.0%	Generation)
1993	57,306	58,042	58,789	70,073	70,973	71,887	72,883
1994	60,222	61,756	63,333	73,639	75,515	77,443	79,723
1995	63,254	65,657	68,149	77,346	80,285	83,332	87,205
1996	66,407	69,753	73,253	81,203	85,293	89,574	94,605
1997	69,687	74,053	78,665	85,213	90,552	96,190	102,500
1998	73,098	78,569	84,400	89,384	96,074	103,204	111,050
1999	76,645	83,310	90,480	93,721	101,871	110,639	120,310
2000	80,335	88,289	96,925	98,233	107,959	118,519	130,350
2001	84,171	93,516	103,756	102,924	114,351	126,873	140,850
2002	88,162	99,005	110,998	107,803	121,062	135,727	151,720
2003	92,311	104,768	118,673	112,878	128,110	145,113	163,430
2004	96,627	110,819	126,810	118,155	135,509	155,062	176,040
2005	101,116	117,173	135,434	123,644	143,278	165,608	189,630
2006	105,784	123,845	144,576	129,352	151,436	176,787	203,675
2007	110,639	130,850	154,267	135,288	160,002	188,636	218,835
2008	115,687	138,205	164,539	141,462	168,996	201,197	235,130
2009	120,938	145,928	175,427	147,883	178,440	214,511	252,635
2010	126,399	154,038	186,968	154,560	188,356	228,624	271,450

(2) Multiple Regression P=f(GNP;Popu.)

(GWh)

Year	(a) Consumption			(b) Generation			TEK
	4.0%	5.0%	6.0%	4.0%	5.0%	6.0%	(Generation)
1993	57,427	57,768	58,116	70,221	70,638	71,063	72,883
1994	60,438	61,150	61,883	73,903	74,774	75,670	79,723
1995	63,539	64,656	65,813	77,695	79,060	80,476	87,205
1996	66,734	68,288	69,915	81,602	83,502	85,491	94,605
1997	70,026	72,054	74,196	85,627	88,107	90,727	102,500
1998	73,417	75,958	78,668	89,774	92,881	96,194	111,050
1999	76,911	80,007	83,338	94,046	97,832	101,906	120,310
2000	80,512	84,207	88,219	98,449	102,967	107,874	130,350
2001	84,222	88,563	93,321	102,986	108,294	114,112	140,850
2002	88,046	93,083	98,655	107,662	113,821	120,634	151,720
2003	91,987	97,774	104,234	112,481	119,557	127,457	163,430
2004	96,049	102,642	110,071	117,448	125,510	134,594	176,040
2005	100,237	107,696	116,180	122,569	131,690	142,064	189,630
2006	104,554	112,944	122,576	127,848	138,108	149,885	203,675
2007	109,005	118,394	129,273	133,290	144,772	158,075	218,835
2008	113,594	124,055	136,289	138,902	151,693	166,653	235,130
2009	118,326	129,936	143,640	144,688	158,884	175,642	252,635
2010	123,206	136,046	151,345	150,655	166,356	185,063	271,450

(3) Parabolic Regression P=(f(GNP)

(GWh)

Year	(a) Consumption			(b) Generation			TEK
	4.0%	5.0%	6.0%	4.0%	5.0%	6.0%	Generation)
1993	58,706	59,914	61,183	71,785	73,262	74,814	72,883
1994	63,313	65,973	68,827	77,419	80,671	84,161	79,723
1995	68,358	72,751	77,561	83,587	88,959	94,841	87,205
1996	73,878	80,327	87,529	90,337	98,224	107,030	94,605
1997	79,914	88,788	98,893	97,718	108,570	120,925	102,500
1998	86,512	98,231	111,834	105,786	120,116	136,750	111,050
1999	93,719	108,760	126,559	114,599	132,991	154,756	120,310
2000	101,589	120,494	143,299	124,222	147,340	175,225	130,350
2001	110,178	133,563	162,315	134,725	163,320	198,477	140,850
2002	119,549	148,109	183,899	146,184	181,107	224,871	151,720
2003	129,768	164,292	208,384	158,680	200,895	254,810	163,430
2004	140,908	182,286	236,140	172,302	222,898	288,751	176,040
2005	153,048	202,284	267,589	187,146	247,352	327,206	189,630
2006	166,272	224,500	303,200	203,316	274,517	370,751	203,675
2007	180,673	249,170	343,507	220,926	304,683	420,037	218,835
2008	196,351	276,554	389,105	240,097	338,168	475,795	235,130
2009	213,414	306,939	440,669	260,961	375,323	538,847	252,635
2010	231,980	340,643	498,955	283,663	416,536	610,119	271,450

Note. (b)=(a)/(1-0.06)(1-0.13)
0.06: Aux.loss ratio of power plant
0.13: Transmission loss ratio

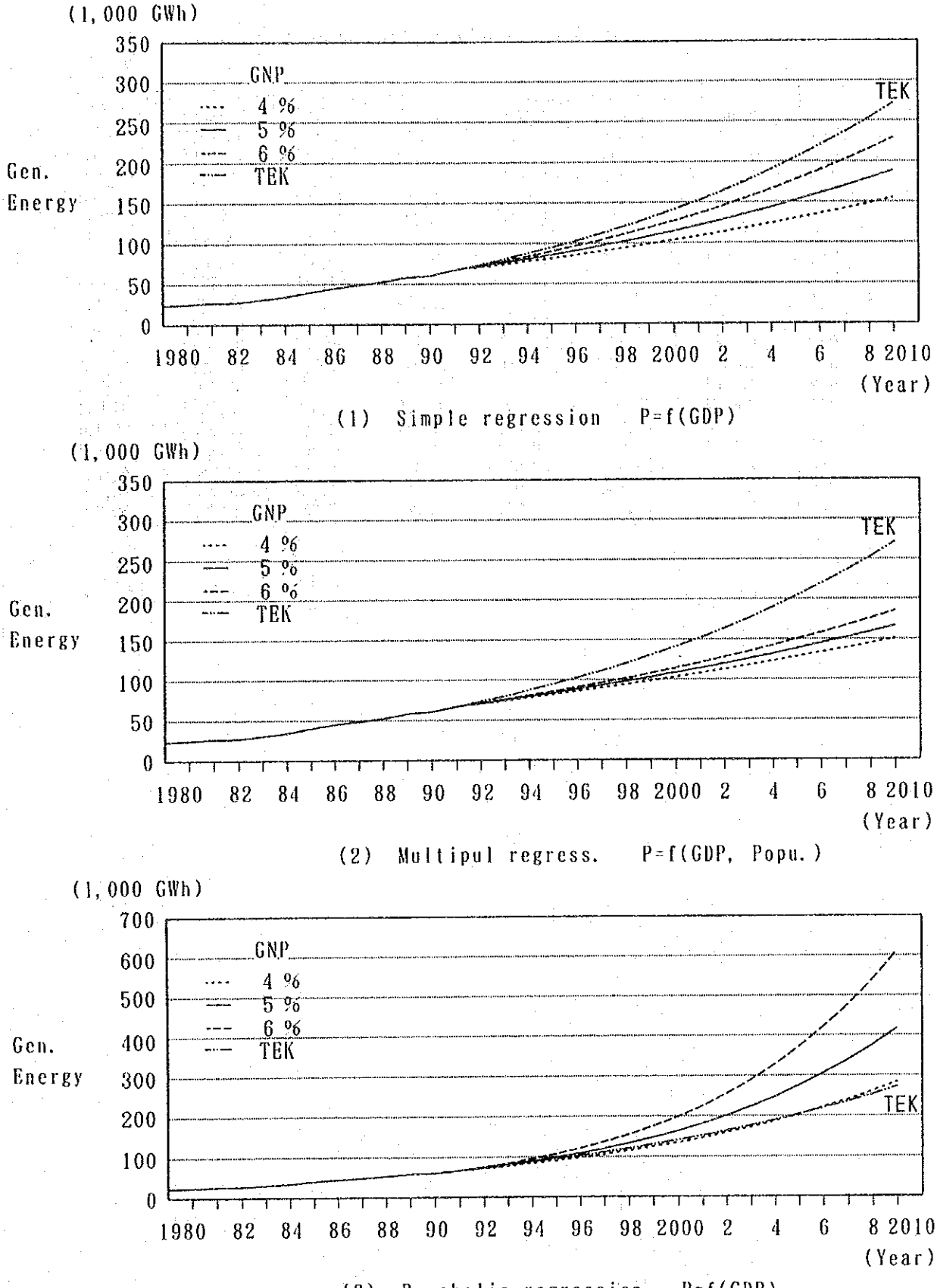
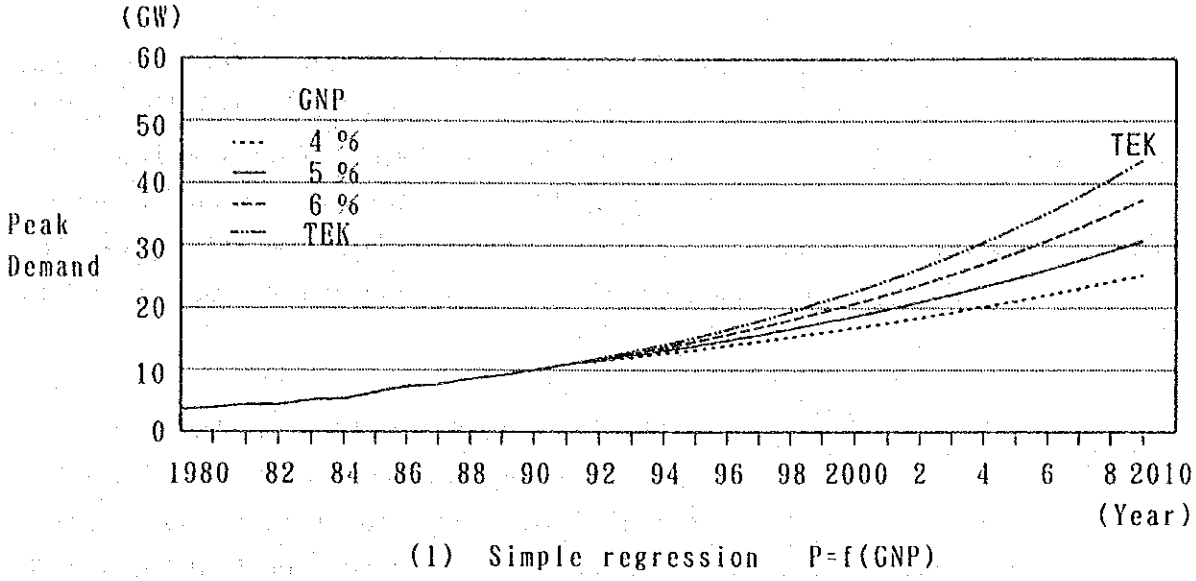


Figure 5-2 Energy Demand Forecast

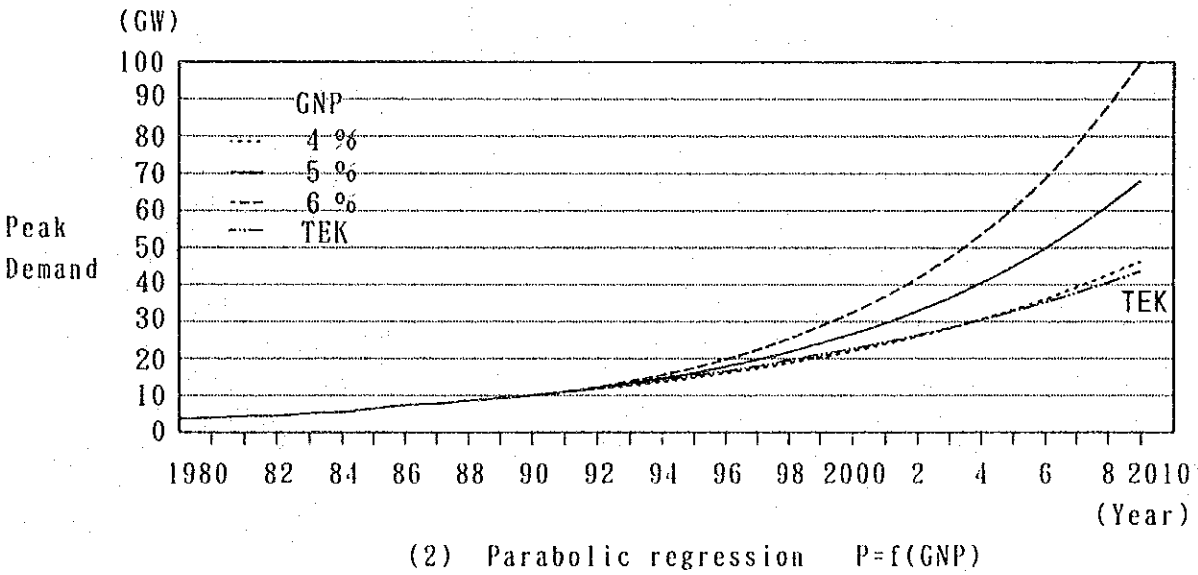
Table 5-6 Peak Power Demand (1980 - 2010)

(MW)

Year	(1) Simple Regression			(2) Parabolic Regression			(3) TEK
	4.0%	5.0%	6.0%	4.0%	5.0%	6.0%	
1982	10,895	10,895	10,895	10,895	10,895	10,895	11,255
1983	11,427	11,574	11,723	11,707	11,948	12,201	12,390
1984	12,009	12,315	12,629	12,626	13,156	13,725	13,635
1985	12,614	13,093	13,590	13,632	14,507	15,467	15,005
1986	13,242	13,910	14,608	14,733	16,018	17,454	16,335
1987	13,896	14,767	15,687	15,936	17,705	19,720	17,600
1988	14,577	15,668	16,830	17,252	19,588	22,301	19,080
1989	15,284	16,613	18,043	18,689	21,688	25,237	20,685
2000	16,020	17,606	19,328	20,259	24,028	28,576	22,435
2001	16,785	18,648	20,690	21,971	26,634	32,367	24,765
2002	17,580	19,743	22,134	23,840	29,535	36,672	26,315
2003	18,408	20,892	23,665	25,878	32,762	41,554	29,030
2004	19,269	22,099	25,287	28,099	36,350	47,089	31,430
2005	20,164	23,366	27,007	30,520	40,338	53,360	34,025
2006	21,095	24,696	28,830	33,157	44,768	60,462	36,340
2007	22,063	26,093	30,763	36,029	49,687	68,499	39,380
2008	23,069	27,560	32,811	39,155	55,148	77,592	43,175
2009	24,117	29,100	34,982	42,558	61,207	87,875	46,745
2010	25,206	30,717	37,284	46,260	67,928	99,497	50,600



(1) Simple regression P=f(GNP)



(2) Parabolic regression P=f(GNP)

Figure 5-3 Peak Power Demand

5.1.3 Power Demand Forecast by TEK

According to the power demand forecast until 2010 prepared by TEK in 1993, it is known that the peak power demand in 2010 is 43,590 MW and the energy generation is 271,450 GWh. These values are about four times the demand of 1992 giving the annual average increase rate of 8.0%. The load factor is estimated to be 71% on the assumption that the power demand structure continues to be the same as it is now.

The elasticity of the energy generation to GNP is 2.0 to 1.6, which is more or less the same as the actual value from 1980 to 1991 (the elasticity of the energy generation in that period was 1.82), presuming that the economic growth rate until 2010 is 4.0 to 5.0%. Power demand forecast prepared by TEK is detailed in Table 5-7 as well as the power demand and supply balance.

5.2 Development Plan for Power Demand and Supply Balance

5.2.1 Power Development Plan

(1) Scale of development

The power development plan corresponding with the power demand forecast (1995 to 2010) prepared by TEK is shown in Table 5-7.

It is known that the scale of development of power is 41,216 MW, of which the thermal power accounts for 26,575 MW (64.5%) and hydroelectric for 14,641 MW (35.5%). Accordingly, it is anticipated that the total installed capacity in 2010 will be as much as 60,056 MW, of which the thermal and nuclear power amounts to 36,970 MW (61.6%) in combination while the hydroelectric power to 23,086 MW (38.4%).

The total installed capacity is 3.4 times for the thermal power and 2.7 times for the hydroelectric power as compared to that by the end of 1992, and moreover, their annual increase rates are 7.3% and 5.7% respectively giving 6.6% of their average.

(2) Types of power resources

Table 5-8 shows by type the trend of power resources planned to be developed during the period from 1995 to 2010. As for the coal firing thermal power, it is known that from 2005 onward, construction of import coal firing power stations are under plan in addition to the development of lignite firing power stations. Likewise, from 2005 onward, the development of nuclear power stations are under plan.

As for the component ratio of power resources, the hydroelectric power will be on the gradual decrease from

now on while the coal firing thermal power on the gradual increase. The ratio of natural gas firing thermal power may reach 20% in 1999 but from that time onward, the ratio will remain almost unchanged. Development plans for heavy oil firing thermal power station are none.

(3) Schedule of development

Power development schedule of each project from 1995 to 2010 is listed in Table 5-9. Köprübaşı Project with 60 MW output, which is the original plan, is scheduled to be commissioned in 2001.

5.2.2 Demand and Supply Balance

Table 5-7 shows the demand and supply balance till 2010 which is prepared based on the previously stated power demand forecast and development plan for power resources. It is known from the table that the demand and supply balance with regard to the peak power demand, the reserve capacity is 36 to 48% while on the other hand, it comes only to 4 to 7% and may be said to be rather tight with regard to the annual energy demand.

The reason why the reserve capacity differs so largely between the peak power demand and energy demand is that in the component ratio of the power resources, the ratio of the hydroelectric power is rather high which amounts to as much as about 40% and that the load factor is also high (to 70%). From these results, it is known that the power plants should be built with higher plant factor.

5.2.3 Necessity of Köprübaşı Power Station and its Commissioning Year

The commissioning year of Köprübaşı power station, the installed capacity of which is 70 MW, is scheduled in 2001. It was recorded that the maximum power demand of TEK network was 9,965

MW in 1991. Share of the output of Köprübaşı power station seems to be minor in the power demand and supply balance of the said TEK network.

However, various advantages inherent in Köprübaşı power station are revealed as follows.

a) Köprübaşı power station is adequate scale power source to supply power for the local power demand (i.e. 540 MW in 2001) of the 154 kV system nearby the said power station.

b) Power source for the local power demand is only Çatalağı thermal power station of 300 MW. Development of an adequate scale of hydropower station will provide possibility of flexible operation of the power system.

c) Share of thermal power source is of increment in the development program of TEK. Some hydropower developments will be required from a viewpoint of diversification of power source, regardless of their scales.

d) From a viewpoint of power system characteristics, the proposed power station will bring to remarkably reduce transmission loss and improve system voltage level (See 10.3.2).

In the context it is recommendable that Köprübaşı power station will be completed in 2001 around in line with the TEK power development program.

Table 5-7 Power Demand Forecast and Demand Supply Balance (1995 to 2010)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Power Balance (MW)																
Installed Capacity																
Thermal	10.309	11.580	12.260	14.070	15.730	16.710	18.070	19.090	20.450	21.620	23.770	26.130	28.640	31.770	34.090	36.970
Hydroelectric	10.297	10.969	11.498	11.498	11.498	12.537	13.841	15.421	16.508	18.111	18.677	19.127	19.579	19.773	21.631	23.086
Total	20.606	22.549	23.758	25.568	27.228	29.247	31.911	34.511	36.958	39.731	42.447	45.257	48.219	51.543	55.721	60.056
Peak Power Demand	14.065	15.235	16.505	17.800	19.375	20.900	22.610	24.360	26.240	28.260	30.445	32.719	35.145	37.760	40.570	43.590
Reserve capacity	6.631	7.314	7.253	7.688	7.853	8.257	9.301	10.151	10.718	11.471	12.002	12.547	13.074	13.783	15.151	16.466
Reserve ratio (%)	47	48	44	43	41	39	41	42	41	41	39	38	37	36	37	38
Energy Balance (GWh)																
Energy Generation																
Thermal	63.348	71.023	75.443	87.208	97.908	104.368	113.208	119.838	128.678	136.283	150.758	166.098	182.413	202.758	217.838	236.558
Hydroelectric (Dependable)	28.958	29.798	30.767	30.767	30.767	33.453	35.619	38.291	40.795	43.745	44.631	45.385	35.994	46.134	49.938	52.219
Total	92.306	100.821	106.210	117.975	128.765	137.821	148.827	158.129	169.473	180.028	195.389	211.483	228.407	248.892	267.776	288.777
Energy Demand	87.205	94.605	102.500	111.050	120.310	130.350	140.850	151.720	163.430	176.040	189.630	203.675	218.835	235.130	252.635	271.450
Reserve capacity	5.101	6.216	3.710	6.925	8.455	7.471	7.977	6.409	6.043	3.988	5.759	7.808	9.572	13.762	15.141	17.327
Reserve ratio (%)	6	7	4	6	7	6	6	4	4	2	3	4	4	6	6	6

Table 5-8 Installed Capacity and Trend of Component Ratio of Power Resources

(MW, %)

Year	Coal			Gas	Oil	Thermal Total	Nuclear	Hydroelectric	Grand Total
	Lignite/coal	Imported coal	Total						
1995	5,803		5,803	2,671	1,925	10,399		10,297	20,696
	(28.0)		(28.0)	(12.9)	(9.3)	(50.2)		(49.8)	(100)
1996	6,304		6,304	3,351	1,925	11,580		10,969	22,549
	(28.0)		(28.0)	(14.9)	(8.5)	(51.4)		(48.6)	(100)
1997	6,304		6,304	4,031	1,925	12,260		11,498	23,758
	(26.5)		(26.5)	(17.0)	(8.1)	(51.6)		(48.4)	(100)
1998	7,434		7,434	4,711	1,925	14,070		11,498	25,568
	(29.1)		(29.1)	(18.4)	(7.5)	(55.0)		(45.0)	(100)
1999	7,734		7,734	6,071	1,925	15,730		11,498	27,228
	(28.4)		(28.4)	(22.3)	(7.1)	(57.8)		(42.2)	(100)
2000	8,714		8,714	6,071	1,925	16,710		12,537	29,247
	(29.8)		(29.8)	(20.7)	(6.6)	(57.1)		(42.9)	(100)
2001	9,394		9,394	6,751	1,925	18,070		13,841	31,911
	(29.4)		(29.4)	(21.2)	(6.0)	(56.6)		(43.4)	(100)
2002	9,734		9,734	7,431	1,925	19,090		15,421	34,511
	(28.2)		(28.2)	(21.5)	(5.6)	(55.3)		(44.7)	(100)
2003	10,414		10,414	8,111	1,925	20,450		16,508	36,958
	(28.2)		(28.2)	(21.3)	(5.2)	(55.3)		(44.7)	(100)
2004	10,904		10,904	8,791	1,925	21,620		18,111	39,731
	(27.4)		(27.4)	(22.1)	(4.9)	(54.4)		(45.6)	(100)
2005	11,054	1,000	12,054	8,791	1,925	22,770	1,000	18,677	42,447
	(26.0)	(2.4)	(28.4)	(20.7)	(4.5)	(53.6)	(2.4)	(44.0)	(100)
2006	11,734	2,000	13,734	9,471	1,925	25,130	1,000	19,127	45,257
	(25.9)	(4.4)	(30.3)	(20.9)	(4.3)	(55.5)	(2.2)	(42.3)	(100)
2007	12,564	3,000	15,564	10,151	1,925	27,640	1,000	19,579	48,219
	(26.1)	(6.2)	(32.3)	(21.0)	(4.0)	(57.3)	(2.1)	(40.6)	(100)
2008	13,014	4,000	17,014	10,831	1,925	29,770	2,000	19,773	51,543
	(25.2)	(7.8)	(33.0)	(21.0)	(3.7)	(57.7)	(3.9)	(38.4)	(100)
2009	13,654	5,000	18,654	11,511	1,925	32,090	2,000	21,631	55,721
	(24.5)	(9.0)	(33.5)	(20.7)	(3.4)	(57.6)	(3.6)	(38.8)	(100)
2010	14,854	6,000	20,854	12,191	1,925	34,970	2,000	23,086	60,056
	(24.7)	(10.0)	(34.7)	(20.3)	(3.2)	(58.2)	(3.3)	(38.5)	(100)

Table 5-9 Power Development Plan (1/7)

Year	Project Name	Type	Unit	Installed Capacity (MW)	Projected Energy (GWh)	Dependable Energy (GWh)
1995		Ligni.	1	5,450	34,484	34,484
		Coal	1	353	2,082	2,082
		N.Gas	1	2,671	17,281	17,281
		Oil	1	1531	8,394	8,394
		Dies.	1	394	1,017	1,017
		GT	1	15	90	90
	Thermal Total			10,414	63,348	63,348
		Hydro	1	5,141	18,765	14,479
		Hydro	1	5,141	18,765	14,479
	Hydro Total			10,282	37,530	28,958
	Ann. Total			20,696	100,878	92,306
1996	TUNÇBİLEK A	Ligni.	1	129	840	840
	KEMERKÖY	Ligni.	3	210	1,365	1,365
	DOĞAL GAZ	N.Gas	1	680	4,420	4,420
	Thermal Total			1,161	7,675	7,675
	KRALKIZI	Hydro	1	94	146	111
	ÇAMLIGÖZE	Hydro	1	32	88	77
	SUAT UĞURLU 3	Hydro	1	30	78	0
	KÜRTÜN	Hydro	1	85	198	95
	BATMAN	Hydro	1	198	483	251
	ÖZLUCE-PERİ	Hydro	1	170	413	290
	SANLIURFA	Hydro	1	50	124	0
	MANSURLAR	Hydro	1	13	48	16
	Hydro Total			672	1,578	840
	Ann. Total			1,853	9,253	8,515

Table 5-9 Power Development Plan (2/7)

Year	Project Name	Type	Unit	Installed Capacity (MW)	Projected Energy (GWh)	Dependable Energy (GWh)
1997	DOĞAL GAZ	N. Gas	1	680	4, 420	4, 420
	Thermal Total			680	4, 420	4, 420
	MERCAN	Hydro	1	19	78	48
	BERKE	Hydro	1	510	1, 668	921
	Hydro Total			529	1, 746	969
	Ann. Total			1, 209	6, 166	5, 389
1998	ELBİSTAN A 5, 6	Ligni.	2	340	2, 210	2, 210
	KANGAL 3	Ligni.	1	150	975	975
	ÇAYIRHAN 3, 4	Ligni.	2	150	975	975
	DOĞAL GAZ	N. Gas	1	680	4, 420	4, 420
	Thermal Total			1, 810	11, 765	11, 765
	Ann. Total			1, 810	11, 765	11, 765
1999	TUFANBEYLİ 1	Ligni.	1	300	1, 950	1, 950
	DOĞAL GAZ	N. Gas	2	680	4, 420	4, 420
	Thermal Total			1, 660	10, 790	10, 790
	Ann. Total			1, 660	10, 790	10, 790
2000	ELBİSTAN B 1, 2	Ligni.	2	340	2, 210	2, 210
	TUFANBEYLİ 2	Ligni.	1	300	1, 950	1, 950
	Thermal Total			980	6, 370	6, 370
	BİRECİK	Hydro	1	672	2, 516	1, 801
	KARKAMIŞ	Hydro	1	180	652	462
	ALPASLAN 1	Hydro	1	160	488	418
	CİNDERE	Hydro	1	27	88	5
	Hydro Total			1, 039	3, 744	2, 686
	Ann. Total			2, 019	10, 114	9, 056

Table 5-9 Power Development Plan (3/7)

Year	Project Name	Type	Unit	Installed Capacity (MW)	Projected Energy (GWh)	Dependable Energy (GWh)
2001	ELBISTAN B 3,4	Ligni.	2	340	2,210	2,210
	DOGAL GAZ	N.Gas	1	680	4,420	4,420
	Thermal Total			1,360	8,840	8,840
	KAYRAKTEPE	Hydro	1	421	991	639
	BOYABAT-KEPEZ	Hydro	1	513	1,468	925
	YEDIGOZE	Hydro	1	300	969	459
	KÖPRÜBAŞI	Hydro	1	70	212	152
	Hydro Total			1,304	3,640	2,175
	Ann. Total			2,674	12,480	11,015
2002	ELBISTAN C 1	Ligni.	1	340	2,210	2,210
	DOGAL GAZ	N.Gas	1	680	4,420	4,420
	Thermal Total			1,020	6,630	6,630
	UZUNGOL-OF-SOLAKLI	Hydro	1	380	1,000	213
	ILISU	Hydro	1	1,200	3,833	2,459
	Hydro Total			1,580	4,833	2,672
	Ann. Total			2,600	11,463	9,302
2003	ELBISTAN C 2,3	Ligni.	2	340	2,210	2,210
	DOGAL GAZ	N.Gas	1	680	4,420	4,420
	Thermal Total			1,360	8,840	8,840
	TORUL	Hydro	1	103	322	131
	UZUNÇAYIR	Hydro	1	74	317	214
	CIZRE	Hydro	1	240	1,208	947
	DERINER	Hydro	1	670	2,118	1,212
	Hydro Total			1,087	3,965	2,504
	Ann. Total			2,447	12,805	11,344

Table 5-9 Power Development Plan (4/7)

Year	Project Name	Type	Unit	Installed Capacity (MW)	Projected Energy (GWh)	Dependable Energy (GWh)
2004	ELBİSTAN C 4	Ligni.	1	340	2,210	2,210
	ÇAN 1	Ligni.	1	150	975	975
	DOĞAL GAZ	N.Gas	1	680	4,420	4,420
	Thermal Total			1,170	7,605	7,605
	ÇAMLICA 1	Hydro	1	140	227	0
	ASLANCIK	Hydro	1	90	349	179
	YUSUFELİ	Hydro	1	540	1,705	1,129
	BEŞKONAK	Hydro	1	201	660	380
	ARTVİN	Hydro	1	332	1,028	662
	BORÇKA	Hydro	1	300	1,039	600
	Hydro Total			1,603	5,006	2,950
	Ann. Total			2,773	12,611	10,555
2005	CAN 2	Ligni.	1	150	975	975
	İTHAL KÖMÜR	Coal	2	500	3,250	3,250
	NÜKLEER	Nucle.	1	1,000	7,000	7,000
	Thermal Total			2,150	14,475	14,475
	ÖZKÖY	Hydro	1	156	182	124
	MURATLI	Hydro	1	115	444	253
	SAMI SOYDAN	Hydro	1	175	515	272
	AKSU	Hydro	1	120	344	237
	Hydro Total			566	1,485	886
	Ann. Total			2,716	15,960	15,361

Table 5-9 Power Development Plan (5/7)

Year	Project Name	Type	Unit	Installed Capacity (MW)	Projected Energy (GWh)	Dependable Energy (GWh)
2006	ELBİSTAN D 1, 2	Ligni.	2	340	2, 210	2, 210
	DOĞAL GAZ	N. Gas	1	680	4, 420	4, 420
	İTHAL MÖMÜR	Coal	2	500	3, 250	3, 250
	Thermal Total			2, 360	15, 340	15, 340
	DİLEK-GÜROLUK	Hydro	1	180	593	168
	GÖKTAŞ	Hydro	1	270	1, 160	586
	Hydro Total			450	1, 753	754
	Ann. Total			2810	17, 093	16, 094
2007	ELBİSTAN C 3, 4	Ligni.	2	340	2, 210	2, 210
	BURSA-KELEŞ	Ligni.	1	150	975	975
	DOĞAL GAZ	N. Gas	1	680	4, 420	4, 220
	İTHAL MÖMÜR	Coal	2	500	3, 250	3, 250
	Thermal Total			2, 510	16, 315	16, 315
	GÜRSÖGÜT	Hydro	1	242	278	159
	KONAKTEPE	Hydro	1	210	730	450
	Hydro Total			452	1, 006	609
	Ann. Total			2, 962	17, 321	16, 924
2008	ÇAYİRHAN 8	Ligni.	1	300	1, 950	1, 950
	SEYİTÖMER 5	Ligni.	1	150	975	975
	DOĞAL GAZ	N. Gas	1	680	4, 420	4, 420
	İTHAL KOMUR	Coal	2	500	3, 250	3, 250
	NÜKLEER	Nucle.	1	1, 000	6, 500	6, 500
	Thermal Total			3, 130	20, 345	20, 345
	KARGI	Hydro	1	194	245	140
	Hydro Total			194	245	140
	Ann. Total			3, 324	20, 590	20, 485

Table 5-9 Power Development Plan (6/7)

Year	Project Name	Type	Unit	Installed Capacity (MW)	Projected Energy (GWh)	Dependable Energy (GWh)
2009	BEYŞEH İR	Ligni.	1	340	2,210	2,210
	AMASRA 1	Coal	1	300	1,950	1,950
	DOĞAL GAZ	N.Gas	1	680	4,420	4,420
	İTHAL KÖMÜR	Coal	2	500	3,250	3,250
	Thermal Total			2,320	15,080	15,080
	OBRUK	Hydro	1	180	473	337
	KLAVUZLU	Hydro	1	54	100	7
	ULUBAT-ÇINARCIK	Hydro	1	120	548	422
	ALPASLAN 2	Hydro	1	140	430	120
	ERMENEK	Hydro	1	320	1,022	925
	HAKKARİ	Hydro	1	322	1,043	582
	ALKUMRU	Hydro	1	222	812	350
	ÇETIN	Hydro	1	350	1,237	730
	PEMBELİK	Hydro	1	100	313	220
	DALAMAN-BEZKESE	Hydro	1	50	205	111
	Hydro Total			1,858	6,183	3,804
	Ann. Total			4,178	21,263	18,884

Table 5-9 Power Development Plan (7/7)

Year	Project Name	Type	Unit	Installed Capacity (MW)	Projected Energy (GWh)	Dependable Energy (GWh)
2010	BEYPAZARI	Ligni.	1	300	1,950	1,950
	AMASRA 2	Coal	1	300	1,950	1,950
	ÇATALAĞZI C	Coal	2	300	1,950	1,950
	DOGAL GAZ	N.Gas	1	680	4,420	4,420
	İTHAL MÖMÜR	Coal	2	500	3,250	3,250
	Thermal Total			2,880	18,720	18,720
	KUPLU	Hydro	1	18	31	25
	ADIGÜZEL 2	Hydro	1	22	36	3
	GÜZELCE	Hydro	1	27	62	0
	İKİSU	Hydro	1	60	127	81
	TIREDOLU	Hydro	1	60	114	59
	LALELİ	Hydro	1	69	245	204
	TOKMAKKAYA	Hydro	1	11	24	0
	ÇAMLICA 2	Hydro	1	30	80	23
	ÇAMLICA 3	Hydro	1	25	79	25
	GÜZELDERE	Hydro	1	73	168	37
	FEKE	Hydro	1	170	426	223
	KIZKAYASI	Hydro	1	114	261	200
	DOĞANLI	Hydro	1	462	1,327	850
	AKKÖPRÜ	Hydro	1	115	343	176
	TOHMA	Hydro	1	14	67	0
	MANYAS	Hydro	1	20	66	52
	DOĞANCAY	Hydro	1	19	148	94
	SÖYLEMEZ	Hydro	1	46	250	142
	DİM	Hydro	1	36	126	72
	ÇİNE	Hydro	1	36	111	18
	Hydro Total			1,455	4,098	2,281
	Ann. Total			4,335	22,818	21,001