CHAPTER 3 PRESENT STATUS OF ELECTRIC POWER AND HEAT ENERGY SECTOR IN UZBEKISTAN

3.1 Status of Electric Power Sector

3.1.1 Overview

The Ministry of Power Industry and Electrification (hereinafter referred to as SJSC "Uzbekenergo" collectively) possesses about 97% of the total generation and transmission capacity existing in Uzbekistan, while the remaining power generation of less than 300MW (3% of the national total) are industrial users' auto-production.

SJSC "Uzbekenergo" expects increase in power demand over 15% during the coming ten years. To meet this, SJSC "Uzbekenergo" will make efforts to maintain self-sufficiency, improve power supply reliability and quality, and improve the efficiency in the use of power and fuel. In addition, SJSC "Uzbekenergo" is promoting the development of small, dispersed power plants, and renewable energy resources with a view to preserving the ecology and global environment.

The Uzbekistan's power system consists of nine thermal power plants (three of them are heat & power generation plants) and 28 hydropower plants, totaling 1,126,000 MW (984,000 MW by thermal and 142,000 MW by hydropower). Of these, those having an installed capacity over one million kW are Syrdarya TPP (3,000 MW), Navo-Angren TPP (2,100 MW), Tashkent TPP (1,860 MW) and Navoi TPP (1,250 MW).

The total number of steam turbine sets installed at these TPPs is 64, including 37 units having a capacity over 150 MW. The largest steam turbine generator of 800 MW is under construction at Talimarjan TPP.

Hydroelectric power plants are responsible mainly for making up a portion of demand exceeding the supply capability of TPPs. The largest plant is Charvak HPP with an installed capacity of 620 MW and reservoir of 2 billion tons. 67 hydropower units are installed on these HPPs, with a unit capacity of 1 to 165 MW.

Tables 3.1-1 and 3.1-2 show the outlines of the thermal and hydropower plants respectively.

The thermal power plants serve for district heating in 13 towns. The installed capacity of hot water boilers makes 6,300 Gcal/h.

In the structure of primary energy sources for producing electric heat and power, natural

gas makes 84%, heavy oil makes 12%, and coal makes 4%. Note that environment-friendly natural gas is the main source of primary energy.

Power transmission and distribution is carried out by 15 network enterprises. The total length of all power lines is over 233 thousand km.

Long-term goals regarding the power industry include establishing energetic independence, satisfaction of growing demand, and reduction of fuel consumption, with major directions of further development of power industry:

- Reconstruction and technical re-equipment of existing power plants
- New construction on the basis of modern efficient condensation power units
- Upgrading existing equipment, implementation of modern power generating technologies on the basis of PGU and GTU
- Utilization of hydropower potential of large and medium rivers

In a short-term prospective, it is planned to start up the No.1 power unit with a capacity of 800 MW at Talimarjan TPP. It is also planned, during the same period, to re-equip and reconstruct existing power plants, and to upgrade TPPs by introduction of high-performance steam-gas blocks (PGU) with a unit capacity of 100 to 400 MW.

On the whole, it is planned to put into operation 1,620MW (including a combined cycle of 376MW at Tashkent TPP and 346MW at Navoi TPP) by 2005. These implementation will allow reducing fuel rate for power generation by 30 g/kWh. Moreover, during the next years up to 2010, it is planned to construct a 800MW steam cycle unit at Talimarjan TPP and 404MW unit at Pskem HPP. Table 3.1-3 shows the existing plans for construction of power generating facilities during the years up to 2010. The total installed capacity to be build during the years is 3,276MW.

Table 3.1-1 Existing Thermal Power Generation Plants

No.	Name of Plant	Type of Plant	Location	No. of Units	Total Installed Capacity (MW)	Type of Fuel	Year of Initial Operation	Total Current Effective	Cumulative Operating Hours of All Unit
1	Syrdarya GRES	Steam	Syrdarya reg., Shirin	10	3000	gas, oil fuel	1972	2618	134458
2	Novo-Angren GRES	Steam	Tashkent reg., Nurabad	7	2100	coal, gas	1985	1467	45536
3	Tashkent GRES	Steam	Tashkent reg., Kibray district	12	1860	gas, oil fuel	1963	1787	191340
4	Takhiatash GRES	Steam	Karakalpakstan, Takhiatash	5	730	gas, oil fuel	1974	637	144533
5	Navoi GRES	Steam		12	1250	gas, oil fuel	1963	920	221150
6	Angren GRES	Steam	Tashkent reg., Angren	8	484	coal, PGU gas	1957	331	217714
7	Fergana Cogeneration Plant	Steam	Fergana reg., Fergana	7	330	coal, oil fuel, gas	1956	228	202034
8	Mubarek Cogeneration Plant	Steam	Kashkadarya reg., Mubarek	2	60	gas	1985	57	105000
9	Tashkent Cogeneration Plant(TashTEZ)	Steam	Tashkent	1	30	gas / mazut	1954	22.5	332583

Note Data source : Annual report

1) Types shall be classified into hydro, steam, cogeneration, gas turbine, combined cycle, neuclear and geothermal
2) Installed capacity is the rated capacity of the unit when it is installed.
3) Effective capacity is the maximum continuous capacity that the unit can generate without exceeding the manufactureer's operating parameters at the time when it is questioned.
4) Type of Fuel Natural Gas(NG), Heavy Oil(HO), Diesel Oil(DO), Crude Oil(CO), Coal

Table 3.1-2 Existing Hydro Power Generation Plants

No.	Name of Plant	Type of Plant	Location	No. of Units	Total Installed Capacity (MW)	Type of Fuel	Year of Initial Operation	Total Current Effective	Cumulative Operating Hours of All Unit
1	Charvak HPP	Hydro	Tashkent region	4	620.5	-	1970	653	166,245
2	Khodjikent HPP	Hydro	Tashkent region	3	165	-	1976	165	94,273
3	Gazalkent HPP	Hydro	Tashkent region	3	120	-	1980	120	80,671
4	Coordinated hydroelectric system, Chirchik GES	Hydro	Tashkent region	10	190.7	-	1941	76.5	314,045
5	Coordinated hydroelectric system, Kadyrya GES	Hydro	Tashkent region	8	44.7	-	1933	26.9	463,435
6	Coordinated hydroelectric system, Nizne-Bozsu GES	Hydro	Tashkent region	10	50.9	-	1944	42.1	278,436
7	Coordinated hydroelectric system, Tashkent GES	Hydro	Tashkent	10	29	-	1936	16.1	373,095
8	Farkhad GES	Hydro	Syrdarya reg.	4	126	-	1948	118.7	332,568
9	Coordinated hydroelectric system, Sharikhan GES	Hydro	Andijan reg.	6	27.80	-	1943	1.20	180,007
10	Coordinated hydroelectric system, Samarkand GES	Hydro	Samarkand reg.	9	40.1	-	1945	0	206,100

Note Data source : Annual report

1) Installed capacity is the rated capacity of the unit when it is installed.
2) Effective capacity is the maximum continuous capacity that the unit can generate without exceeding the manufactureer's operating parameters at the time when it is questioned.

Table 3.1-3 Power Generation Plant Development Program

Name of Plant Site	Type of Plant	Fuel	(MW)	Operation
plant	Steam power	Natural gas	800	2004
plant	Steam power	Natural gas	800	2009
Tashkent thermal power plant	sycle	Natural gas	376	2008
Navoi thermal power plant	sycle	Natural gas	346	2009
Mubarek cogeneration plant	sycle	Natural gas	100	2010
Tashkent cogeneration plant	sycle	Natural gas	60	2010
Navoi thermal power plant	sycle	Natural gas	330	2011
Fergana cogeneration plant	sycle	Natural gas	60	2012
Pskem hydro power plant	Hydro power	-	404	2014
Total			3276	

Source : Answer from SJSC "Uzbekenergo"

Power network development projects are also being implemented to ensure reliable and stable power supply for the growing economy and population. The new Sogdiana and Uzbekistanskaya substations of 500kV each will improve the reliability and stability of power supply to the customers in Samarkand, Bukhara and Ferugana, and facilitate the development of productive forces in these regions. The new Keles and Chapan-Ata substations of 220kV each will satisfy the growing power demand in Tashkent and Samarkand.

The present total installed capacity under the jurisdiction of SJSC "Uzbekenergo" of Power Industry is 11,263MW, including thermal generation of 9,844MW and hydropower generation of 1,419MW, producing over 50 billion kWh. Table 3.1-4 shows the growth of total installed capacity during the past ten years. Since 1992, no additional capacity has been put into operation, partly because the power demand temporarily declined due to the economic depressions after independence.

As mentioned before, a gas-fired 800MW Talimardjan TPP under construction is slated for commissioning in this year.

Table 3.1-4 Maximum Power Demand for Last Ten Years

Year	Installed Capacity (MW)			Maximum Power Demand (MW)	Capacity of Largest Unit (MW)
	Hydro	Thermal	Total		
1990	1,399	9,452	10,851	8,374	300
1991	1,399	9,544	10,943	8,608	300
1992	1,419	9,544	10,963	7,873	300
1993	1,419	9,544	10,963	7,900	300
1994	1,419	9,544	11,263	7,556	300
1995	1,419	9,844	11,263	7,379	300
1996	1,419	9,844	11,263	7,478	300
1997	1,419	9,844	11,263	7,476	300
1998	1,419	9,844	11,263	7,579	300
1999	1,419	9,844	11,263	7,494	300

Source : Answer from SJSC "Uzbekenergo"

Before the 1930's, the transmission line voltage was max. 6kV. The first transmission line constructed in the 1930's was a 19km long, 35KV line between the Fergana heat & power generating plant and Kuvasayaskaya SS. In 1939/40, 110kV transmission lines were constructed to connect between Kuvasay TPP and Andijan SS and between Tavaksay TPP and Chekuk SS.

Along with the construction of power generating facilities, construction of trunk transmission lines was started in the beginning of the 1950's in order to increase power supply reliability and interconnect between power units.

In 1959, Tashkent and Fergana power units were joined up via Kairakum hydroelectric power station with. 110kV transmission line.

In 1960, the South-Kazakhstan power system was connected to the Uzbek system via the 200kV Kuiluk-Chimkent line.

This line, constructed together with Kuylukskaya 220kV SS in Tashkent, was the Uzbekistan's first 220kV transmission line.

Construction of a power line (220kV and 110kV) started with power generation equipment of a Surkhandarya in the mid-60s, and power was supplied from the Dushanbe-Vakhsh system of Tajikistan.

And unification of the power transmission system of Uzbekistan was completed by the Takhiatash hydroelectric power station having connected with the system in 1970.

500kV transmission lines were first constructed in 1972 for connection between Tashkent thermal power plant and Chimkent substation and in 1974 between Tashkent thermal power

plant and Syrdarya heat and power generation plant/Leninskaya substation.

A core is formed in the power transmission system of present Uzbekistan, and the 220kV ~500kV system has tied up the mutual system.

In 1980, the 500kV transmission line between Syrdarya heat and power generation plant and Guzar was put into commercial operation. At present, the total length of power grid (for all voltage ratings) is over 233,000 km (including 1,650 km for 500kV and 5,700 km for 220kV). Table 3.1-5 shows the development of power grid for each voltage rating during the past ten years.

Table 3.1-5 Evolution Records of Circuit Length of Transmission and Distribution line for Last Ten Years

Year	Length of Transmission Lines			Length of Distribution Lines			Total
	500kV	220kV	110kV	35kV	6.1kV	0.4kV	
1990	1,594.9	5,135.0	1,298.2	12,030.6	88,126.2	97,329.5	207,504.4
1991	1,657.6	5,135.0	1,385.2	12,187.0	89,421.4	98,376.0	210,153.2
1992	1,657.6	5,150.0	1,380.0	12,232.0	89,929.0	98,691.0	211,031.6
1993	1,657.6	5,146.0	14,101.2	12,488.3	91,285.2	99,560.4	226,231.7
1994	1,657.6	5,341.0	14,211.9	12,595.8	91,673.9	100,146.7	227,620.9
1995	1,657.6	5,409.1	14,522.4	12,545.1	92,531.4	101,325.9	229,986.5
1996	1,657.6	5,412.3	16,665.9	12,557.7	93,061.0	101,765.9	233,116.4
1997	1,657.6	5,520.4	14,727.4	14,656.9	93,690.4	102,237.1	234,486.8
1998	1,657.6	5,688.5	14,837.6	12,859.3	93,963.5	102,333.2	233,337.7
1999	1,657.6	5,709.8	14,928.6	12,908.6	94,039.5	103,484.4	234,727.5

Source : Answer from SJSC "Uzbekenergo"

Figure 3.1-1 shows the Uzbekistan's power grid and major power plants (source: OECF Development Assistance Study Report 1998/Vol.5, No.2).

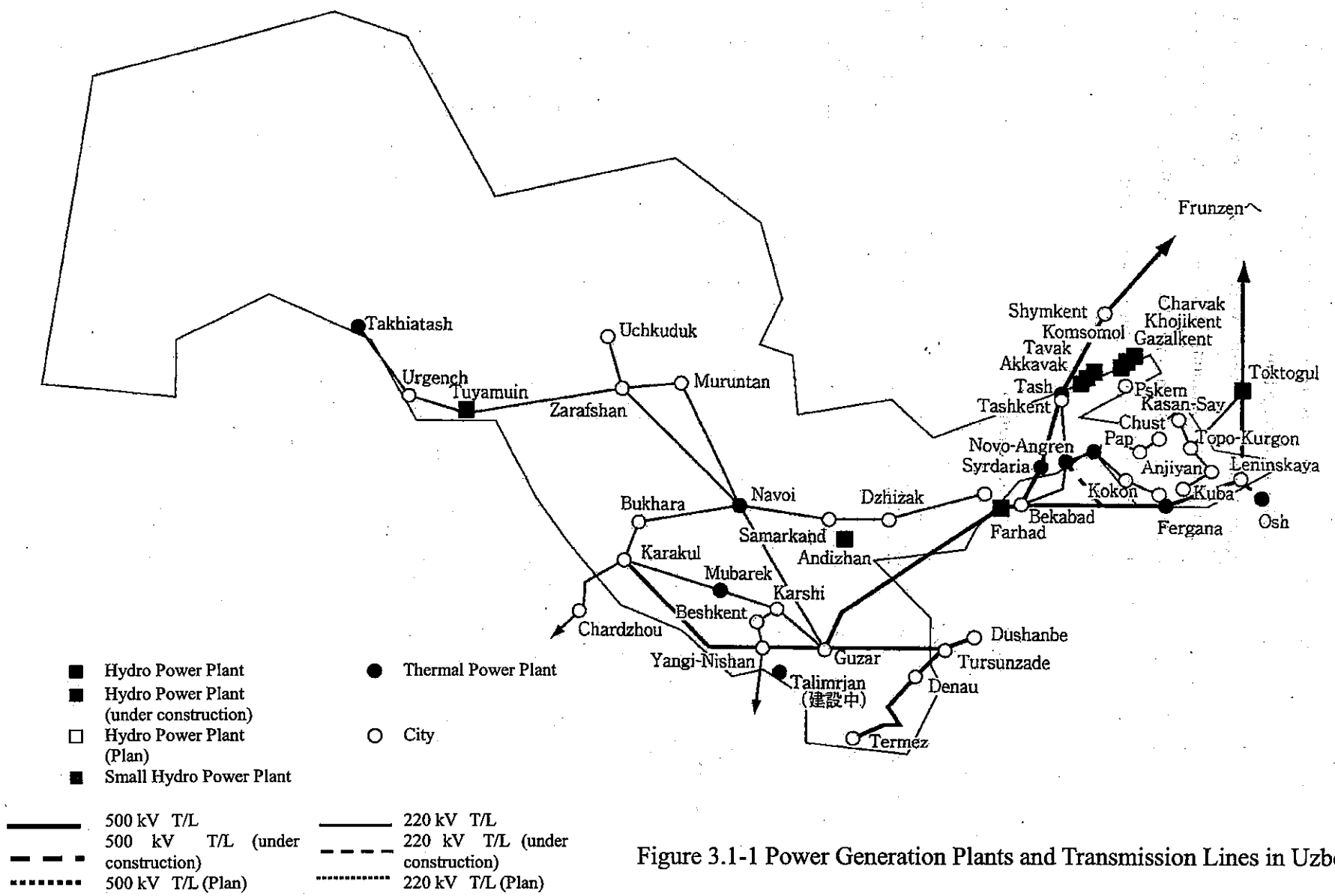

Figure 3.1-1 Power Generation Plants and Transmission Lines in Uzbekistan

3.1.2 Demand and Supply of Power

(1) Overview

Like other former Soviet countries, Uzbekistan's economy and industrial activities have been unstable and stagnant since independence. Power generation since independence in 1991 had been declining (by about 14%) till 1996, and then has remained almost unchanged at the level in 1996. As mentioned before, Uzbekistan and its neighboring countries are trading power within the region. Uzbekistan exports and imports power of 20-30% of its total generation. In every year up to 1997 since independence, Uzbekistan had continued to export power slightly larger than the amount of imports. However, since 1996, the import has been larger than export by about 2% of the total domestic generation. Figure 3.1-2 shows the power generation during the past ten years. Figure 3.1-3 shows the export and import amount of power. In 1999, the power generation by the facilities under the jurisdiction of SJSC "Uzbekenergo" of Power Industry was 5,326GWh by hydropower plus 38,607GWh by thermal generation; and the export and import was 11,090GWh and 12,305GWh respectively.

Annual peak demand in Uzbekistan had grown about 4% every year before independence. However, after independence, it had continued declining to about 86% of the ever largest annual peak demand recorded in 1991. After this smallest peak demand in 1995, it has been growing. Figure 3.1-4 shows the annual peak demand during the last 12 years.

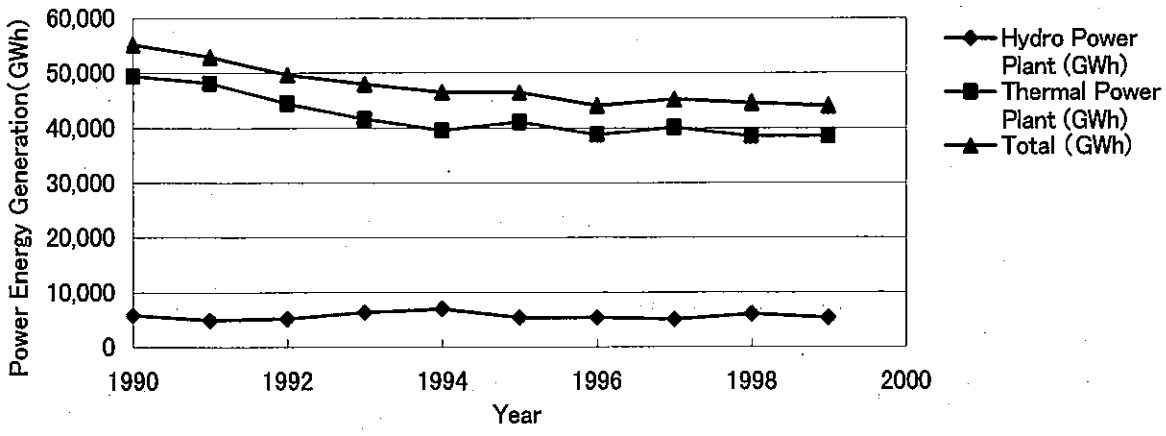

Figure 3.1-2 Power Energy Generation for Last Ten Years

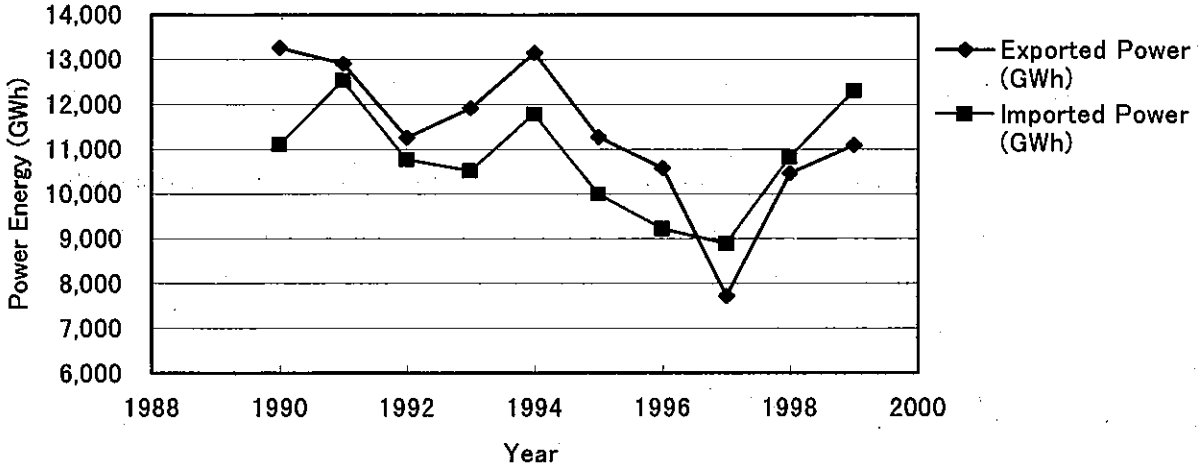

Figure 3.1-3 Export and Import Power Energy for Last Ten Years

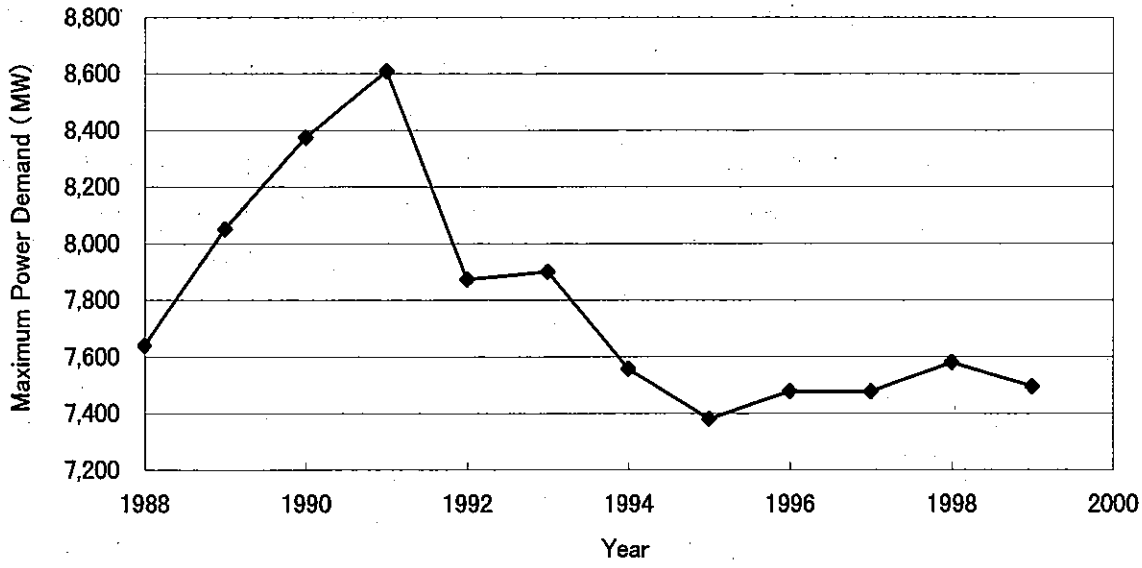

Figure 3.1-4 Maximum Power Demand for Last Twelve Years

(2) Present Status of Power Demand

Annual total demand (GWh) in Uzbekistan had been gradually increasing before independence. However, since independence in 1991, it had been declining to 14% down in 1995 due to the sluggish industrial activities. Since 1996, it has remained almost unchanged. Figure 3.1-5 shows the annual total demand during the last 12 years.

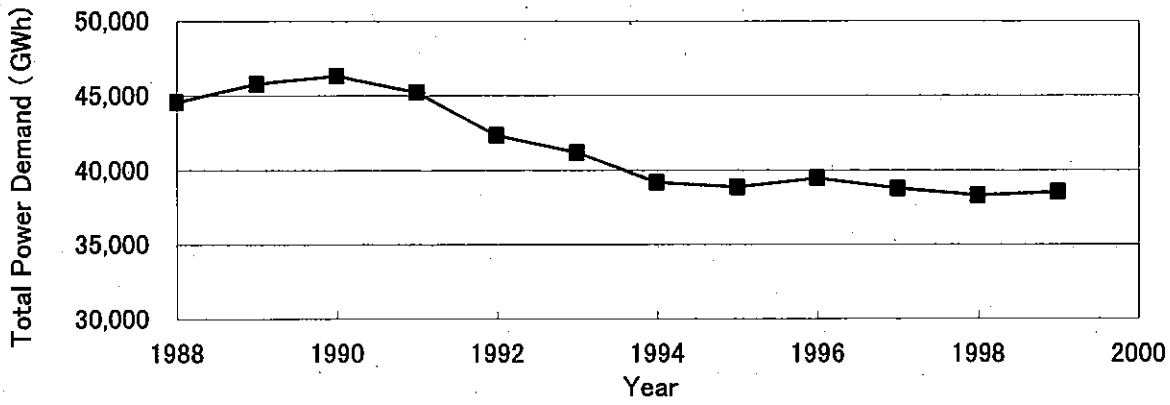

Figure 3.1-5 Total Power Demand for Last Twelve Years (GWh)

A major power consuming sector, manufacturing, reduced its power consumption in 1995 by 16% compared to the level before independence, and then has kept the consumption level in 1995. Agriculture shows the similar trend. Power consumption of family and public users had continued to decline since independence till 1998 , and then has remained unchanged from the 1999 level.

Table 3.1-6 shows power consumption by user type during the past 10 years.

Table 3.1-6 Annual Power Energy Sales (GWh) Every Field of Consumer for Last Ten Years

Year	Household	Commercial	Industries		Public Street Lighting	Other Public Authorities	Others	Total
			Small	Large				
1990	7,781.3	208.4	1,018.9	21,120.6	185.3	2,130.6	13,872.0	46,317.1
1991	7,592.7	203.4	994.3	20,608.8	180.8	2,079.0	13,536.0	45,195.0
1992	7,111.1	190.5	931.2	19,301.5	169.3	1,947.1	12,677.2	42,327.9
1993	6,919.4	185.3	906.1	18,781.3	164.8	1,894.6	12,335.5	41,187.0
1994	6,579.8	176.2	861.6	17,859.4	156.7	1,801.6	11,730.1	39,165.4
1995	6,529.8	174.9	855.1	17,723.7	155.5	1,787.9	11,640.8	38,867.7
1996	6,630.3	177.6	868.3	17,996.5	157.8	1,815.4	11,820.1	39,466.0
1997	6,715.8	179.7	878.5	1,828.7	159.7	1,836.2	11,959.4	23,558.0
1998	6,437.7	172.4	843.1	17,473.8	153.3	1,762.7	11,476.8	38,319.8
1999	6,472.0	172.0	849.7	17,584.2	150.2	1,763.1	11,532.4	38,523.6

Source : Answer from SJSC "Uzbekenergo" Industries Small : Less than 750 kW Large : 750 kW and more

Table 3.1-7 shows statistics on the number of power consumers during the last 10 years. The number of consumers in the manufacturing sector had been increasing to the sector's largest number of 21,947 in 1996, and then has remained almost unchanged. Family consumers have been increasing by about 2% per year. Agricultural consumers have been

decreasing since 1995 by about 8% per year, though the total consumption by the sector has remained unchanged during the period probably due to a larger consumption per consumer.

Table 3.1-7 Power Consumption Person Contract Number of Cases

Year	Household	Industries	Other Public Authorities	Agriculture	Total
1990	3,115,322	16,490	154,258	78,748	3,364,818
1991	3,200,322	16,910	157,878	80,898	3,456,008
1992	3,295,792	17,387	161,647	82,870	3,557,696
1993	3,368,340	19,106	169,592	80,074	3,637,112
1994	3,524,325	18,991	168,908	80,526	3,792,750
1995	3,533,465	19,888	175,075	82,302	3,810,730
1996	3,529,447	21,947	152,265	72,725	3,776,384
1997	3,593,055	20,852	142,774	67,738	3,824,419
1998	3,635,627	20,225	137,806	64,032	3,857,690
1999	3,923,242	21,246	159,594	55,045	4,159,127

Source : Answer from SJSC "Uzbekenergo"

Table 3.1-8 shows the growth in the percentage of electrification in Uzbekistan. As shown in the table, the percentage has been already 100% since 1990, being the highest among underdeveloped countries.

Table 3.1-8 Electrification Rate for Last Ten Years

Year	Electrification Rate (%)
1990	100
1991	100
1992	100
1993	100
1994	100
1995	100
1996	100
1997	100
1998	100
1999	100

Source : Answer from SJSC "Uzbekenergo"

Monthly power demand in Uzbekistan is characterized by a demand curve without distinctive peaks throughout the year with a very small peak in winter. The percentage of the smallest demand to the largest demand in a month ranges between 67% and 72% depending on the month. Figure 3.1-6 shows the maximum and minimum demand by month in 1999.

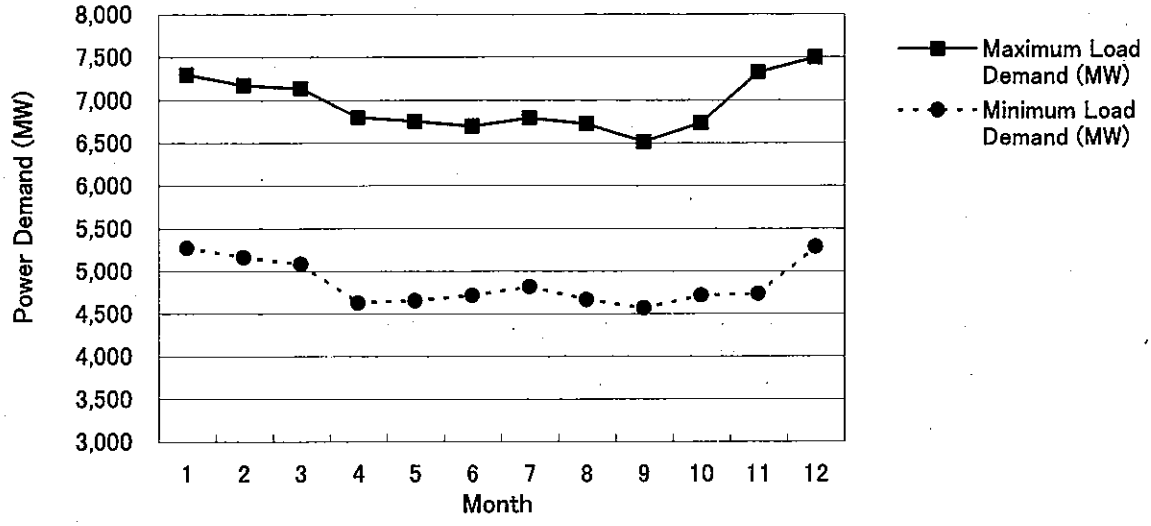

Figure 3.1-6 Monthly Power Demand Variation

Figure 3.1-7 shows a typical hourly swing in demand in a week (working) day in winter and summer in 1999. Peak demand hours are 7 to 9 p.m. both in winter and in summer. No peak appearing in the daytime in summer indicates that the power demand for air conditioning is not large.

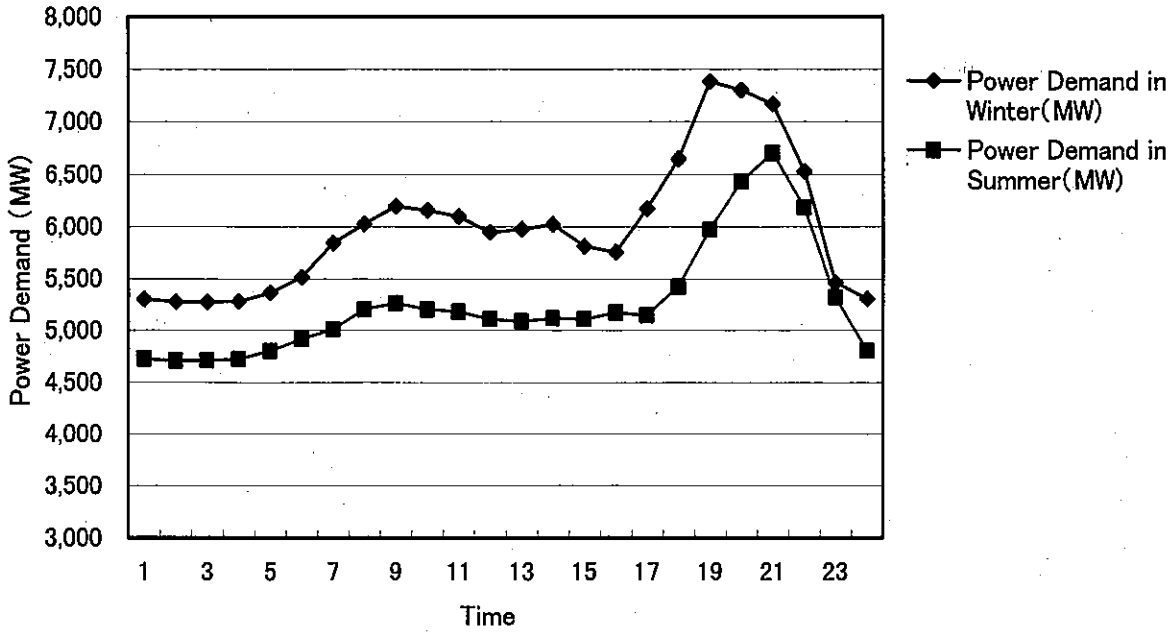

Figure 3.1-7 Power Swing in Typical Weekdays in Winter and Summer

(3) Present Status of Power Supply

As shown in Table 3.1-4 Growth in Installed Capacity of Hydropower and Thermal Power Plants During Last Ten Years, Uzbekistan's power generating capacity grew only 4% during the last 10 years to the present capacity of 11,263MW: 1,419MW (12.6%) of hydropower plus 9,844MW (87.4%) of thermal power. The largest unit is the 300MW unit at Syrdarya TPP. Uzbekistan is abundant in natural gas so that many thermal power plants operating on natural gas have been developed.

As shown in Table 3.1-1 Outline of the Existing Thermal Power and Hydropower Plants, thermal power generator units in operation number 64 including 17 units of 300MW or above, 29 units of 100-160MW and 18 units of 60MW or below. Smaller units have been operating as long as over 40 years. All of the thermal power units are of a steam turbine generator, including six gas-fired and three coal-fired units.

Table 3.1-9 shows the capacity factor and availability factor of power plants in Uzbekistan during the past five years. Some plants are operating at high capacity factor and availability factor. Plants operating at low capacity factor and high availability factor are those operating at low operating load factor due to the aging of facilities and degradation in the effective generating capacity.

Table 3.1-9 Capacity Factor and Availability Factor for Last Five(5) Years

No.	Name of Power Station	Type of Plant	Capacity Factor(%)						Availability Factor(%)					
			1995	1996	1997	1998	1999	Average	1995	1996	1997	1998	1999	Average
1	Syrdarya TPP	Thermal Power	49.8	45.5	47.2	48.0	47.2	47.5	60.6	75.0	73.7	68.4	67.7	69.1
2	Novo-Angren TPP	Thermal Power	30.0	31.5	35.7	37.3	41.6	35.2	45.2	65.0	74.4	83.0	86.8	70.9
3	TashGRES	Thermal Power	66.1/5.55*	59.7/4.8	61.7/6.7	51.7/7.7	48.4/2.6	65.6/5.5	88.6	86.0	82.3	83.3	79.7	84.0
4	Navoi TPP	Thermal Power	65.2/49.2	57.6/44.3	56.7/39.4	54.9/44.1	54.6/42.1	57.8/43.8	80.1	77.4	74.8	72.6	72.8	75.5
5	Takhiatash	Thermal Power	43.0	41.9	41.2	40.6	39.0	41.1	78.0	79.6	78.2	75.2	74.9	77.2
6	Angren TPP	Thermal Power	14.8/27.6	15.4/29.3	16.8/31.6	17.3/24.8	19.7/25.4	16.8/27.7	78.5	82.6	86.2	74.0	73.7	79.0
7	Fergana CP	Thermal Power	36.2/26.9	33.3/25.9	29.6/23.6	27.8/21.4	27.3/19.4	30.1/23.4	75.6	67.5	69.8	98.5	95.6	81.4
8	Mubarek CP	Thermal Power	72.0/55.1	78.0/60.4	83.0/64.4	82.6/62.3	80.0/57.8	79,1/60.0	99.7	99.0	98.9	98.9	98.8	99.1
9	Tashkent CP (TashTEZ)	Thermal Power	63.7/87.1	54.1/68.7	61.4/72.0	45.9/41.9	61.0/67.3	57.2/68.8	97.8	78.9	93.2	73.3	94.6	87.6
10	Urta-Chirchik CHS	Hydro Power	38.4	39.1	35.9	45.6	39.3	39.7	97.7	81.7	97.8	98.2	97.8	94.6
11	Chirchik CHS	Hydro Power	61.0	53.2	57.8	66.7	62.5	60.2	95.4	90.9	94.6	94.9	94.7	94.1
12	Kadirin CHS	Hydro Power	82.5	76.2	83.4	79.1	68.4	77.9	79.8	76.3	83.4	79.2	68.4	77.4
13	Tashkent CHS	Hydro Power	62.2	47.7	50.7	45.1	27.3	46.6	87.2	86.3	83.7	78.5	86.2	84.4
14	N-Bozsu CHS	Hydro Power	51.8	47.7	47.2	49.6	43.5	48.0	74.5	68.3	64.6	68.2	70.1	69.1
15	Farkhad HPP	Hydro Power	43.0	50.0	39.0	50.0	47.0	45.8	86.0	84.0	87.0	77.0	85.0	83.8
16	Samarkand CHS	Hydro Power	60.2	45.6	49.0	47.4	43.6	49.2	76.0	79.2	80.1	79.5	82.3	79.4
17	Shaarikhan CHS	Hydro Power	55.2	66.2	57.6	53.4	42.8	55.0	82.5	87.4	83.0	74.6	70.5	79.6

Note

1) Data Source : Annual reports
2) Capacity Factor = Annual Power Energy Generation (MWh) x 100 / (Installed Capacity (MW) x 8,760)
3) Availability Factor = (8,760 - Outaged Hours) x 100 / 8,760

*) numerator - installed electric capacity factor
denominator - turbines' installed thermal capacity factor

Table 3.1-10 shows the consumption of fossil fuel for power generation during the past five years. In 1997, 82.6% of fossil fuel is natural gas, 13.1% is heavy oil, and 4.3% is coal. Natural gas is the main fuel of power generation. Thus, in order that a natural gas may produce abundantly in Uzbekistan, it turns out that power generation by the natural gas has taken the lead.

Table 3.1-10 Energy Consumption for Power Generation by Fuel

Fuel	Unit	1993	1994	1995	1996	1997
Coal	Mtons/yr	2.42	2.14	2.09	1.96	2.20
	TJ/yr	25,168	22,256	21,736	20,384	22,880
Natural gas	Gm^3/yr	15.61	13.25	13.39	12.70	13.01
	TJ/yr	525,700	446,500	451,200	428,000	438,400
Heavy oil	Mtons/yr	1.40	1.44	1.72	1.68	1.78
	TJ/yr	54,740	56,304	67,252	65,688	69,598

Source : Answer from MOPI

Conversion quantity of heat to energy : Coal 10.4 MJ/kg; Natural Gas 33.7 MJ/m^3; Heavy Oil 39.1 MJ/kg

As show in Table 3.1-1 Outline of the Existing Hydropower Plants, 55 of the 67 units in operation are aged over 50 including ones aged over 70. All of these aged units are small in capacity as 3 to 30MW. Units constructed in the 1970's include large ones of over 90MW. As shown in Table 3.1-9 Capacity Factor and Availability Factor of Power Plants During Last Ten Years, many of the hydropower plants are also operating at high capacity factor and low availability factor, which indicates that they are aged. However, only Kadirin CHS is operating at high capacity factor and high availability factor (both 80%), which indicates that it is operating at high load factor.

As shown in Table 3.1-4 Transmission Length by Voltage Rating During Last Ten Years, the total transmission length is 22,297 km as of the end of 1999, including 500kV trunk lines of 1,658 km and 220kV lines of 5,710 km. The 500kV trunk lines have not been extended after independence, though 220kV lines have been extended by about 600 km. Distribution length is about 210,000 km as of 1999, including a total extension of about 10,000 km after independence. The distribution systems have been gradually expanded. Transmission and distribution losses of the Uzbekistan's power networks have been increasing to 10.1% (1999) after a temporary reduction to a level of 8% after independence

(see Table 3.1-11). This level of the transmission and distribution loss is not so high compared to power systems in other countries. Non-technical losses are zero, which indicates that the transmission and distribution facilities are well maintained.

Table 3.1-11 Change of Yearly Averaged Transmission and Distribution Losses of Last Ten Years

Year	Total Loss (%)	Breakdown of Loss	
		Technical Loss (%)	Non-Technical Loss (%)
1990	10.6	10.6	-
1991	10	10	-
1992	10.2	10.2	-
1993	8.5	8.5	-
1994	8.3	8.3	-
1995	8.4	8.4	-
1996	8.4	8.4	-
1997	8.4	8.4	-
1998	9.8	9.8	-
1999	10.1	10.1	-

Source : Answer from SJSC "Uzbekenergo"

1) Total Loss = (1 - (Total Sales Power Energy))/(Total Generated Power Energy at outgoing terminals) x 100

(4) Future Plans for Power Generation Facilities

Due to the sluggish industrial activities, power consumption in Uzbekistan had declined by as large as 14.3% in 1995 compared to the level before independence (1990). However, since then the power consumption has remained on the same level. Meanwhile, the maximum power demand has been increasing since 1995. To meet this increasing peak value of demand and sustain the development of Uzbekistan's economy, SJSC "Uzbekenergo" of Power Industry is constructing a Central Asia's largest thermal power plant of 800MW operating on natural gas in the south of the country. The No.1 Unit is slated to complete in 2000. SJSC "Uzbekenergo" forecast the growth of maximum power demand in the coming ten years as shown in Figure 3.1-8. According to this figure, the power demand in 2010 will have increased by 2,320MW (=10,000 - 7,680) after an average growth of 3.0% per year.

Table 3.1-12 shows the growth of power consumption during 2000 to 2010 forecast by SJSC "Uzbekenergo".

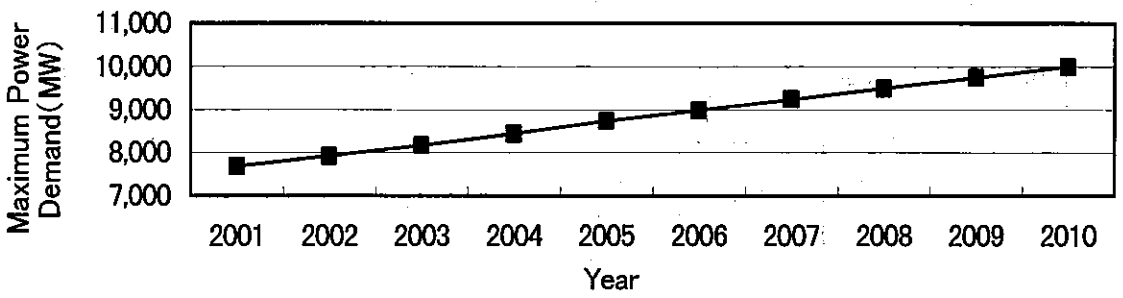

Figure 3.1-8 Maximum Power Demand for Next Ten Years

Table 3.1-12 Forecast of Annual Power Energy Consumption (GWh)

Year	Household	Commercial	Industries		Public Street	Other Public Authorities	Others	Total
			Small	Large				
2001	6,850	180	900	18,600	160	1,870	12,240	40,800
2002	7,070	190	920	19,200	160	1,930	12,630	42,100
2003	7,300	200	930	19,800	170	2,000	13,000	43,400
2004	7,540	200	980	20,500	180	2,100	13,400	44,900
2005	7,840	210	1,020	21,300	180	2,150	14,000	46,700
2006	8,100	210	1,060	22,000	200	2,210	14,420	48,200
2007	8,300	220	1,100	22,800	200	2,280	14,880	49,780
2008	8,600	230	1,120	23,300	210	2,330	15,310	51,100
2009	8,800	230	1,140	24,000	210	2,420	15,800	52,600
2010	9,100	250	1,200	24,600	220	2,500	16,230	54,100

Note 1) Source : Answer from SJSC "Uzbekenergo"

2) Industries Small : Less than 750 kW Large : 750 kW and more

As can be seen in the table, power consumption will annually grow by 3.2% on average with a slight difference in growth level depending on the sectors. This growth rate is slightly larger than that of the maximum power demand. To meet this increasing consumption and maximum demand, SJSC "Uzbekenergo" has plans for constructing new plants shown in Table 3.1-3. During the coming ten years, power generation facilities of 3,276MW will be constructed. The construction plans include two gas turbine heat and power generation plants of small capacity (60MW each), four combined cycle power generation plants (100 to 376MW each), two gas-fired thermal power plants of 800MW each, and a hydropower plant of 404MW.

To forecast power demand, the country's population and/or GDP growth rate is normally used as an index for evaluation. SJSC "Uzbekenergo" used the population growth rate for forecasting the growth of power demand. Figure 3.1-9 shows the Uzbekistan's population and GDP growth rates forecast for the ten years from 2001.

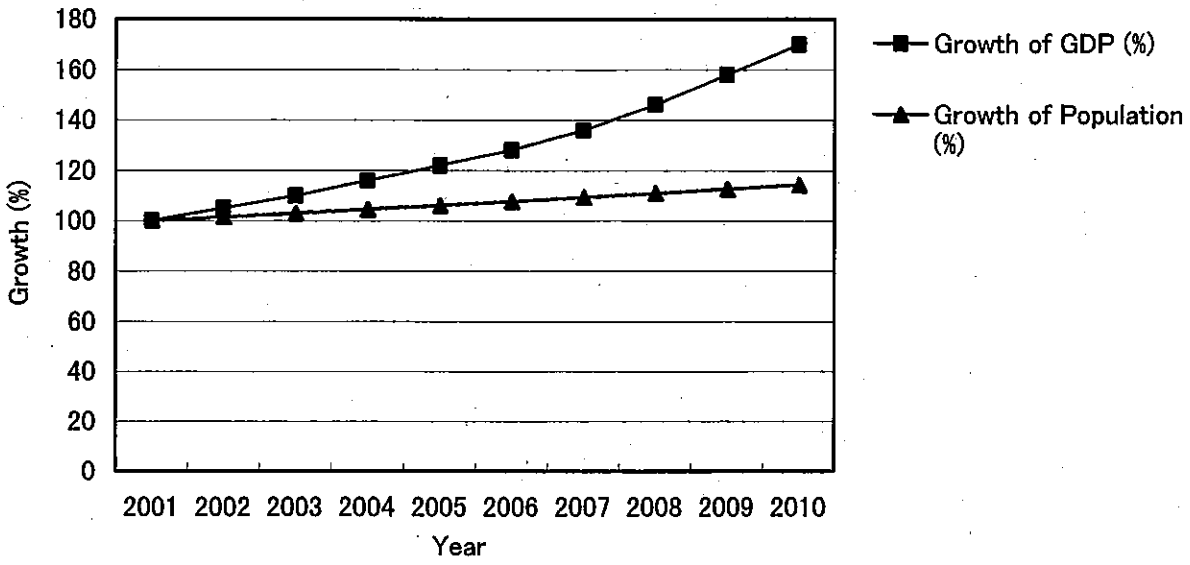

Figure 3.1-9 Evidence Data for Power Demand Forecast

(5) Demand Supply Balance

The newest power plant among those in operation in Uzbekistan is the one constructed 15 years ago. Most of them are aged 30 or more. Compared to hydropower plants, thermal power plants are more easily degraded in performance - generating capacity and energy conversion efficiency - with time elapsed. Degraded generating capacity means a lower supply capability, and degraded energy conversion efficiency means a larger consumption of fuel. Aged facilities suffer from these degradation in performance, and increase in maintenance cost and lower availability factor as well.

Therefore, construction plans for new facilities intended for meeting the increasing demand as forecast according to the economic growth should be determined in consideration of possible decommissioning or degradation in supply capability of existing aged facilities. Moreover, to preserve the global environment and save energy resources, facilities of a higher energy conversion efficiency should be chosen.

SJSC "Uzbekenergo" of Power Industry prepared three tables: new facilities construction plan (Table 3.1-4), generating capacity after executing decommissioning programs for old facilities vs. maximum power demand up to 2010 (Table 3.1-13) and generating capacity vs. power consumption (Table 3.1-14).

Table 3.1-13 Balance between Firm Power Energy and Forecast Maximum Power Demand

Name of Power Station	Type of Plant	Installed Capacity of Existing Units (MW)	Installed Capacity of New Units (MW)	Availability Factor Existing / New (%)	Firm Power Demand (MW) for Next 10 Years									
					2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
MOPI HPPs	Hydro	1419	404	1200/90	1200	1200	1200	1200	1200	1200	1200	1200	1245	1290
HPPS of the Ministry of Agriculture	Hydro	290	1180	20/23	30	30	30	43	53	53	53	53	53	53
Departmentsl TPPs	Steam	29	-	-	25	25	25	25	25	25	25	25	25	25
MOPI TPPs		1844	3112	8065/3112	8140	8190	8780	9151	9187	9116	9496	9606	9656	10456
including:														
Syrdarya TPP	Steam	3000	-	2618/-	2660	2680	2690	2720	2750	2840	2870	2880	2890	2890
Novo-Angren TPP	Steam, steam-gas	2100	330	1463/330	1490	1500	1500	1505	1525	1570	1910	1940	1950	1950
Tashkent TPP	Steam, steam-gas	1860	376	1787/376	1790	1790	1790	2166	1866	1870	1870	1870	1870	1870
Navoi TPP	Steam, steam-gas	1250	346	920/346	920	940	890	900	1246	956	966	976	1006	1006
Taskhiatash TPP	Steam	730	240	637/240	640	640	640	640	640	640	640	640	640	640
Angren TPP	Steam	484	-	330/-	330	330	160	160	160	160	160	160	160	160
Talimardjan TPP	Steam	-	1600	-/1600	-	-	800	800	800	800	800	800	800	1600
Fergana CP	Steam, steam-gas	33	60	228/60	230	230	230	180	120	120	120	180	180	180
Mubarek CP	Steam, steam-gas	60	100	57/100	57	57	57	57	57	100	100	100	100	100
Tashkent CP	Steam, steam-gas	30	60	23/60	23	23	23	23	23	60	60	60	60	60
			Total Firm Capacity (MW)		9395	9445	10035	10419	10465	10394	10774	10884	10979	11824
			Forecast Maximum Power Demand (MW)		7680	7920.0	8170.0	8440.0	8730.0	8980.0	9235.0	9490.0	9745.0	10000.0
			Reserve Ratio (%)		22.4	19.3	22.8	23.4	19.8	15.7	16.6	14.7	12.6	18.2

Note

1) Data Source: Forecast Estimates

2) Firm Capacity is the power generating capacity available with a commitment even under adverse conditions all the time during the period.

3) The reserve ratio means the ratio of the total firm capacity to the maximum power demand.

Table 3.1-14 Balance between Firm Power Energy and Forecast Maximum Power Energy Demand

Name of Power Station	Type of Plant	Installed Capacity of Existing Units (MW)	Installed Capacity of New Units (MW)	Availability Factor Existing / New (%)	Firm Power Energy (GWh) for Next 10 Years									
					2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
MOPI HPPs	Hydro	1419	404	/	5000	5000	5000	5000	5300	5300	5300	5300	5450	5900
HPPS of the Ministry of Agriculture	Hydro	290	1180	/	1160	1200	1530	1560	2300	2800	3400	4000	4600	5500
Departmentsl TPPs	Steam	29	-	/	130	130	130	140	140	140	150	150	150	150
MOPI TPPs		1844	3112	/	52332	52639	56082	58755	59108	58698	61775	62565	62878	67678
including:														
Syrdarya TPP	Steam	3000	-	67,7/-	15775	15893	15953	16131	16308	16842	17020	17080	17139	17139
Novo-Angren TPP	Steam, steam-gas	2100	330	70,9/85,6	9254	9316	9316	9347	9471	9751	12587	12773	12835	12835
Tashkent TPP	Steam, steam-gas	1860	376	79,7/85,6	12497	12497	12497	15316	13221	13249	13249	13249	13249	13249
Navoi TPP	Steam, steam-gas	1250	346	72,8/87,4	5867	5994	5675	5739	8388	6539	6602	6666	6858	6858
Taskhiatash TPP	Steam	730	240	74,9/85,6	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
Angren TPP	Steam	484	-	73,7/	2130	2130	1032	1032	1032	1032	1032	1032	1032	1032
Talimardjan TPP	Steam	-	1600	-/68,5	-	-	4800	4800	4800	4800	4800	4800	4800	9600
Fergana CP	Steam, steam-gas	33	60	95,6/91,3	1926	1926	1926	1507	1005	1005	1005	1485	1485	1485
Mubarek CP	Steam, steam-gas	60	100	98,8/91,3	493	493	493	493	493	800	800	800	800	800
Tashkent CP	Steam, steam-gas	30	60	94,6/91,3	190	190	190	190	190	480	480	480	480	480
		Total Firm Power Energy (MW)			58622	58969	62742	65455	66848	66938	70625	72015	73078	79228
		Forecast Maximum Power Energy Demand (MW)			48400	49900	51500	53200	55000	56600	58200	59800	61400	6300
		Reserve Ratio (%)			21	18.7	21.9	23	22.4	18.2	21.3	20.4	19	25.7

Note

1) Data Source: Forecast Estimates
2) Availability Factor = (8,760 - Forced and Planned Outage Hours) x 100 / 8,760 = Available Hours x 100 / 8,760
3) Available Hours is the time in hours during which the plant is expected to be available for service.
4) Firm Power Energy =8.76 x Firm capacity(MW) x Availability Factor(%) / 1,000 (GWh)
5) Firm Capacity is the power generating capacity available by a commitment even under adverse conditions all the time during the period.
6) The reserve ratio means the ratio of the total firm power energy to the forecast maximum power energy demand.

According to these tables, the reserve ratio - percentage of generating capacity to maximum power demand - is 15 to 23% in 2001 and later. This level of reserve may not be considered enough to ensure stable power supply, since many of the existing facilities have aged. Another reserve ratio - percentage of generating capacity to consumption - is 18 to 25%. This level of reserve may also not be considered enough for reason of the lower availability factor of aged facilities.

To ensure stable power supply and meet the maximum demand and consumption as forecast by SJSC "Uzbekenergo" of Power Industry, at least the construction projects shown in Table 3.1-3 should be implemented as planned. The table includes a plan for constructing by 2006 a 60MW cogeneration power unit at the Tashkent heat and power generation plant. The construction plan is a byproduct of a study for introducing newest heat supply systems to ensure stable and efficient supply of heat to Tashkent City. The plant is too small to meet the increasing demand.

3.2 Status of Heat Energy Sector

3.2.1 Overview

Heat supply service is placed under the jurisdiction of local governments' Heat Supply Corporations under SJSC "Uzbekenergo" of Utility. SJSC "Uzbekenergo" of Energy responsible for power generation supplies heat produced by power plants to the public Corporations. Of the nine power plants under the jurisdiction of SJSC "Uzbekenergo" of Kokand, Fergana, Mubarek and Tashkent plants supply heat (hot water) to the relevant Heat Supply Corporations.

This report describes the present condition of heat demand supply of Tashkent which investigated this time, and a future situation how.

3.2.2 Overview of Heat Generation Facilities in Tashkent

In Tashkent, there are ten heat generation plants (HP-1 through HP-10) and one heat & power generation plant. The latter covers the central areas of the city, while HP-1 through HP-10 cover other areas in the city. These plants supply both hot water and steam. Hot water, including that for room heating, is supplied to family users, office buildings and other commercial users. Steam is supplied to industrial users near the heat generation plants.

The city's total supply capacity is 4,462 Gcal/h for hot water and 288 Gcal/h for steam. The plants' total installed capacity is 5,650 Gcal/h in the total of hot water and steam. Table 3.2-1 shows the installed capacity of each plant.

Table 3.2-1 Equipment capacity of each heat supply place in Tashkent

	Name	Location	Number of Boiler	Total Heating Capacity (Gcal/h)	Boiler No., Model, Installation Year					
1	Severo-Vostochnaya	TashGRES district	6	500	No. 1 PTVM-100 1968	No. 2 PTVM-100 1969	No. 3 PTVM-100 1970	No. 4 PTVM-100 1975	No. 5 PTVM-100 1978	No. 6 PTVM-100 1999
2	Kara-Su	Kara-Su district	3	300	No. 1 PTVM-100 1978	No. 2 PTVM-100 1980	No. 3 PTVM-100 1999			
3	Zapadnaya	Kukcha district	5	400	No. 1 PTVM-50 1971	No. 2 PTVM-50 1971	No. 3 PTVM-100 1972	No. 4,5 PTVM-100 1978		
4	Severnaya	Yunus-Abad district	10	900	No. 1,2 PTVM-50 1970	No. 3 PTVM-100 1970	No. 4,5 PTVM100 1975-76	No. 6,7 KVGM-100 1981	No. 8,9 KVGM-100 1991,98	Other 100
5	Chilanarskaya	Chilanzar district	7	600	No. 1,2 PTVM-50 1969-70	No. 3 PTVM-100 1971	No. 4 PTVM-100 1975	No. 5 PTVM-100 1977	No. 6,7 PTVM-100 1981	
6	Yugo-Vostochaya	Kuiluk district	3	200	No. 1,2 PTVM-50 1973	No. 3 PTVM-100 1981				
7	Aviastroitelei	Aviastroi-Telei district	5	400	No. 1 PTVM-50 1976	No. 2 PTVM-50 1978	No. 3 PTVM-100 1980	No. 4 KVGM-100 1988	No. 5 KVGM-100 1998	
8	Sergili	Sergili district	4	300	No. 1 PTVM-50 1980	No. 2 PTVM-50 1981	No. 3 KVGM-100 1990	No. 4 KVGM-100 1993		
9	Novo-Chilanzarskaya	Nazarbek settlement	3	540	No. 1 KVGM-180 1986	No. 2 KVGM-180 1987	No. 3 KVGM-180 1988			
#	Severo-Zapadnaya	Near Medical University 2	3	540	No. 1 KVGM-180 1986	No. 2 KVGM-180 1987	No. 3 KVGM-180 1988			
#	TashTETs	Airport area	12	970	No. 1 PTVM-50 1965	No. 2,3 PTVM-100 1968-70	No. 4,5 PTVM-100 1970-74	No. 6,7 PTVM-100 1977-80	Others 5 320	
	Total		61	5,650						

The city's heat demand in 1999 is 10,867 Mcal/y with an hourly peak demand of 5,604 Gcal/h . Table 3.2-2 and Figure 3.2-3 show the annual heat demand during the past ten years. The almost constant demand since independence (1992), as shown in the figure, is an indication of the sound economic activities and larger share of family users. The relatively small variation in demand year by year is attributable probably to the variation in temperature during winter season.

Table 3.2-2 Heat Demand for Last Ten Years of Tashkent City

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Heat Demand ($x10^3$Gcal/year)	10,239	10,431	10,857	12,045	11,560	11,758	11,612	10,113	12,186	10,867

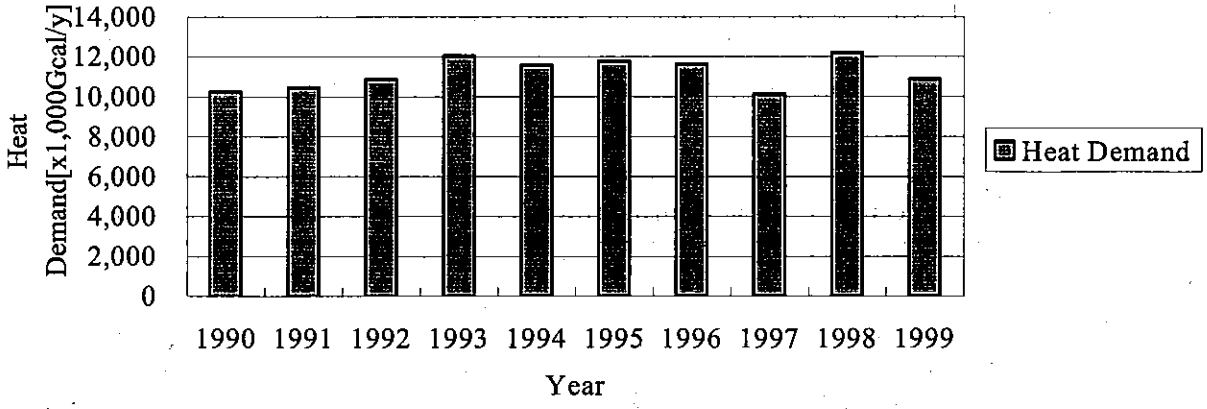

Figure 3.2-1 Heat Demand for Last Ten Years of Tashkent City

Monthly change in heat demand in the city is characterized by a larger demand in winter including hot water for room heating from November to March, e.g. 1,826 Mcal/month in January 1999, and a smaller demand in summer as evidenced by a hot water demand of as small as 351 Mcal/month in September 1999. (See Table 3.2-3 and Figure 3.2-2.)

Table 3.2-3 Monthly Heat Demand of Tashkent City (1999)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Heat Demand ($x10^3$Gcal/month.)	1826	1348	1355	643.8	489.5	419.6	411.2	382.5	351.2	543.3	1342	1730

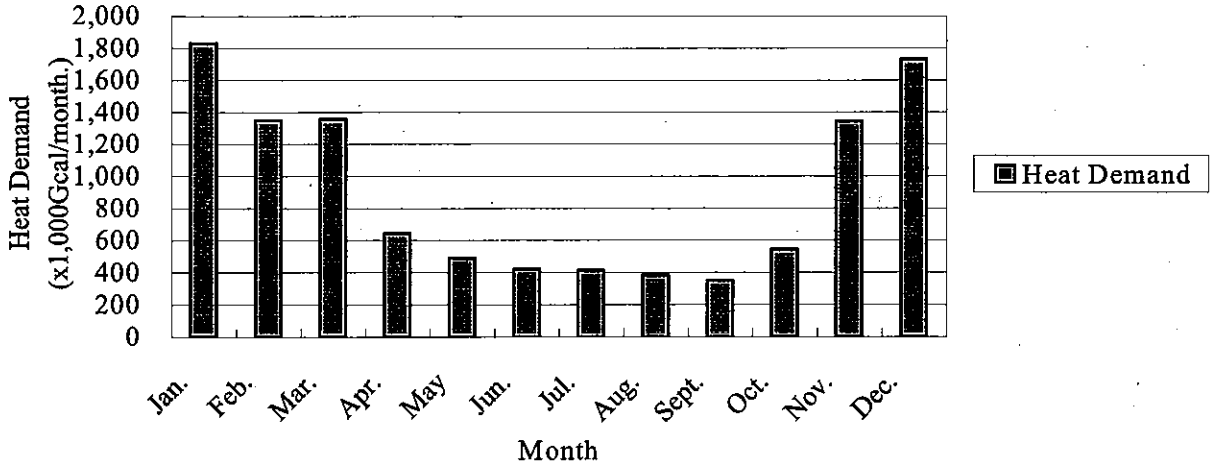

Figure 3.2-2 Heat Demand of Tashkent City

3.2.3 Forecast Heat Demand and Source Development Plans

The city's heat source development plan for the coming ten years describes a positive growth of demand along with increasing population: 18% increase in heat demand in 2005 and 23% increase in 2010 compared to the level in 2000. The forecast heat demand in 2010 is 13,398 Mcal/y as shown in Table 3.2-4 and Figure 3.2-3.

Table 3.2-4 Heat Demand Forecast of Tashkent City

Year	Heat Demand (Mcal/y)	Population
1990	10,239	—
1995	11,758	—
2000	10,867	1,394,500
2005	12,858	1,535,000
2010	13,389	1,667,600

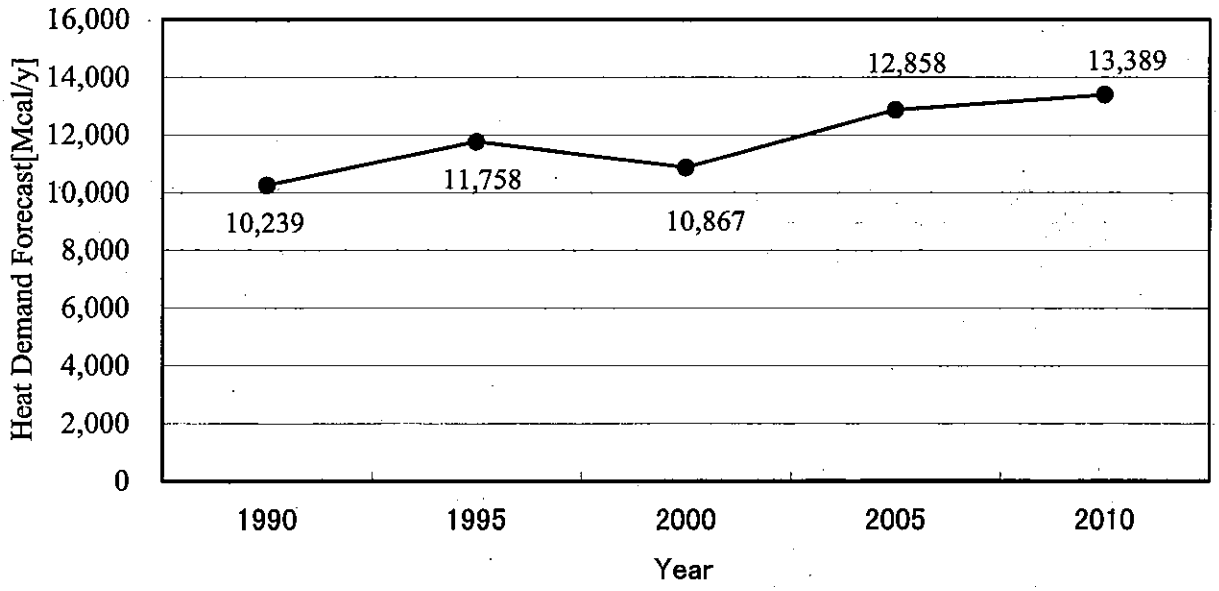

Figure 3.2-3 Heat Demand Forecast of Tashkent City

3.3 Electricity and Heat Energy Tariff

Electricity and heat energy tariff notified as applicable on and after April 1, 2003 is as per Table 3.3-1.

Table 3.3-1 Electricity and Heat Energy Tariff in Uzbekistan applicable on and after April 1, 2003

Group	Electricity Tariff	(Sum/kWh)
I	Industrial user not less than 750kVA	*22,690
		10.65
II	Industrial user less than 750kVA	17.00
III	Agriculture	12.10
IV	Transport and City Transport	17.00
V	Public Organization	13.85
VI	Commercial User	34.00
VII	Residential	12.10
	Residential for Electric Stove	6.05
VIII	Heating and Air conditioning	34.00
IX	Advertisement	110.00
X	Energy System Use	11.75

Group	Heat Energy Tariff	(Sum/Gcal)
I	All Users except II and III	5,555
II	Wholesale Users	4,710
III	Energy System Use	4,080

(Note) Sum 22,690 for industrial user not less than 750kVa is payable per kW contract per year.
All tariffs are inclusive of VAT.

Weighted average electricity tariff including VAT is calculated as Sum 15.83/kWh at the same method applied at Table 5.3-12.

3.4 Current State in Power Transmission System

3.4.1 Current State in Power Transmission System

The electric power system of Central Asia was constructed to compose one electric power system gathered five countries (Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan) without considering the country border of today during the time of former Soviet Union.

The trunk transmission system is mostly composed of the one circuit 500kV and 220kV line, and maintains the reliability level by looping operating both. (Figure -3.4-1) The outline of the transmission lines and the substations in Uzbekistan as of 2002 are as follows.

Overhead transmission line

500kV	1,657.2	km
220kV	5,910.9	km
110kV	15,048.7	km
35kV	12,730.6	km
6kV-10kV	86,607.5	km
400V	100,092.7	km

Underground transmission line

110kV	19.8	km
35kV	281.5	km
6kV-10kV	7,56 .9	km
400V	2,640.6	km

Capacity of transformer

500kV	4,509.0	MVA
220kV	12,209.0	MVA
110kV	13,419.0	MVA
35kV	5,731.2	MVA

3.4.2 Export and import of electric power

Results of the importing and exporting of the electric power with neighboring countries in 2002 are as follows.

Import : From Turkmenistan 13 GWh

	From Kyrgyzstan	523 GWh
	From Tajikistan	72 GWh
Total		608 GWh
Export :	To Turkmenistan	6 GWh
	To Kyrgyzstan	267 GWh
	To Tajikistan	358 GWh
Total		631GWh

The electric power is exported total 23GWh in the balance of importing and exporting.

Power System Diagram of Central Asia

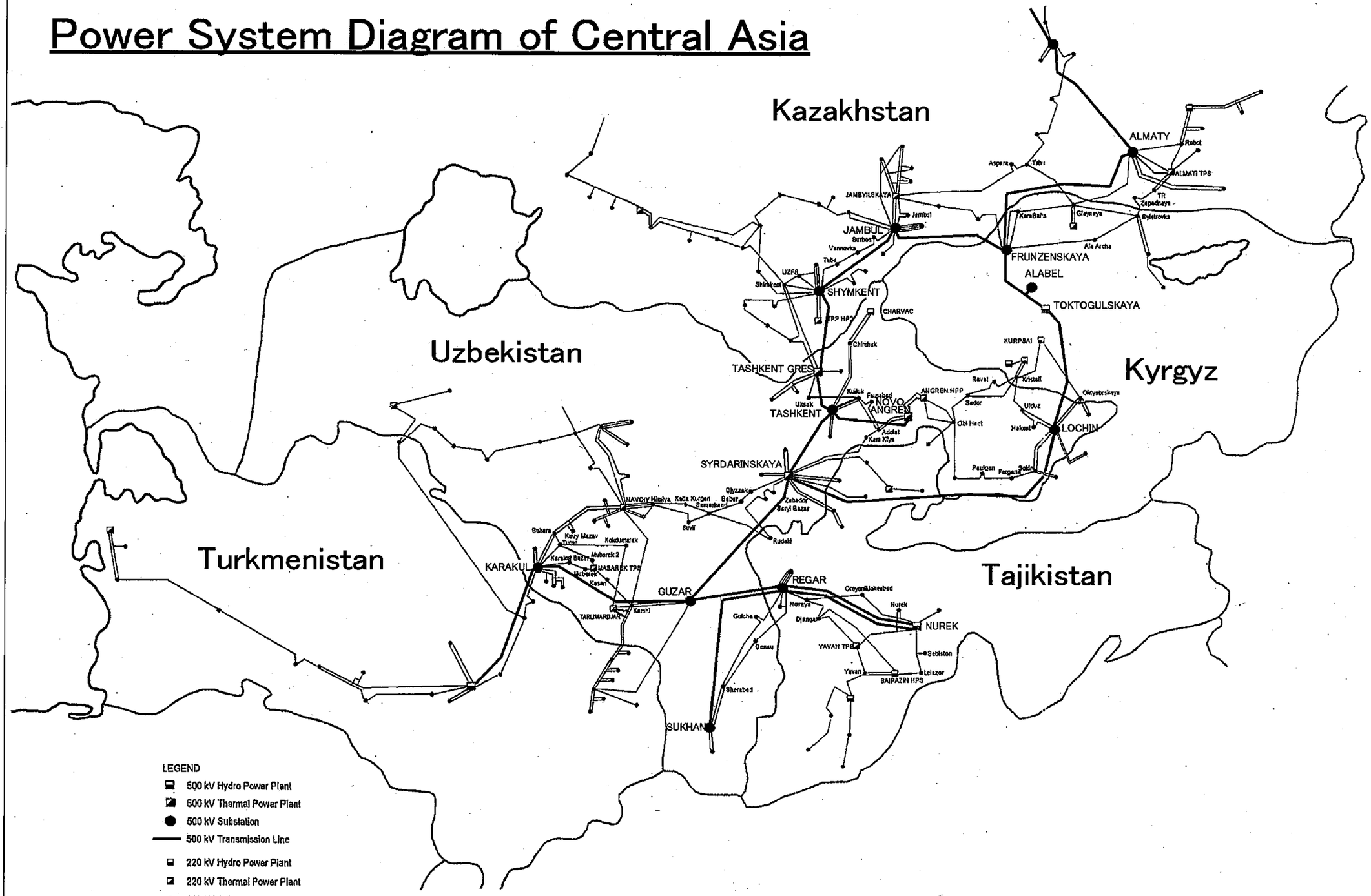

Figure 3.4-1 Power System Diagram of Central Asia

CHAPTER 4 PREPARATION OF TENDER DOCUMENT AND RELATED STUDIES

THE DETAILED DESIGN STUDY FOR

MODERNIZATION OF TASHKENT THERMAL POWER PLANT

IN THE REPUBLIC OF UZBEKISTAN

FINAL REPORT

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CHAPTER 4 PREPARATION OF TENDER DOCUMENTS AND RELATED STUDIES

4.1 Summary of Preparation of Tender Documents

4.1.1 Constitution of Tender Documents

Tender documents for Tashkent Combined Cycle Power Plant Project are comprised the following four (4) books.

- Volume I : Commercial Specification
- Volume II : Technical Specifications
- Volume III : Schedule of Performance and Technical Particular
- Volume IV : Drawings and Appendices

4.1.2 Contents of Tender Documents

- Volume I : Contractual matters which are related to all of the Project are specified.
- Volume II : General technical matters and technical specifications are described.
- Volume III : Formats to be filled in by Bidders are mentioned.
- Volume IV : Drawings and appendices related to the Project are described.

4.1.3 Basic Studies

Various kinds of studies were executed before preparing the Tender Documents.
The following are lists of reports which were made in basic studies.

- The Comparison Study on Type of Shaft Arrangement of 370MW Combined Cycle Power Plant
- Basic Technical Specifications and Data for Preparation of Tender Documents of 370 MW Combined Cycle Power Plant
- The Study Result of Generator Cooling Method of 370 MW Combined Cycle Power Plant
- List of Tie-in Points for Utilities and Communications of 370 MW Combined Cycle Power Plant
- Selection of Optimum Cycle of Bottoming System
- Scope of Services and Works

- Comparison and Evaluation Method between Bids
- Estimation of Liquidated Damage Rate for Performance Guarantee Test Results and Late Completion
- Questionnaire about Design Conditions of New Hot Water Supply System
- Transportation Route Survey

4.2 Site Investigations

4.2.1 Objectives of Site Investigations

The objectives of Site Investigations are to obtain the information necessary to layout the Tashkent C/C power plant. The site investigations cover two kinds of investigations as mentioned bellow. The main items to be confirmed are site boundary lines, base points, general elevation and the soil condition of the proposed project site as well as the existing objects in the area.

- Soil Investigation
- Topographic Survey

In order to observe the technique, method and site management capability, the Investigation works were to be carried out by local subcontractors.

4.2.2 Local Subcontracting

Three bidders participated in the site orientation on Oct 7th. Evaluating the items listed below and negotiating the price, the subcontract of the investigation works was entrusted to TEPROELECTRO PROJEKT (hereinafter TEP) on Oct 17th with the approval of JICA.

- Priced bill of quantities and items of the proposed estimates
- Management condition of and quondam similar works by the company
- Convenience of the acquaintance with the concerned persons of DC "TASHTPP"
- A bank account possible of dollar payment

4.2.3 Schedule

(1) Soil Investigation

- Field Work: Oct.21,2003～Dec.15,2003
- Submittal of draft report: Jan.15,2003
- Submittal of final report: Feb.15,2003

(2) Topographic Survey

- Field Work: Oct.21,2003～Nov.30,2003
- Submittal of draft report: Jan.15,2003
- Submittal of final report: Feb.15,2003

4.2.4 Outline of the Results of the Investigations

(1) Soil Investigation

The local methods of the soil investigation was substituted for Standard Penetration Test (hereinafter SPT) since STP has not been executed in the nations of ex-Soviet Union for decades and the notice of refraining from STP had been announced from ex-Soviet authorities. The local methods of Soil Investigation mainly rely on laboratory tests and analysis of soil samples from the site. The chemical test to analyze the chemical elements of the soil is regarded as important as the physical test from the point of the quality of concrete underground. An adjustment was made to meet the consent about the same amount of the boring work between STP and the local methods.

The result of the soil investigation is shown in the Appendix A in Volume IV of the Tender Documents. The typical outline of the geological situation deduced from the data of the above-mentioned investigation is following,

- 0~1m depth from the existing ground level at the time of November 2002:
  Disturbed top soil/Piled-up loamy soil, lumpy with pebble, gravel and debris
- From the bottom of the top soil down to approximately 494m above Mean Baltic Sea Level (hereinafter M.S.L):
  Mainly Loamy Sand Layer/ Loamy soil, lumpy, macro porous, from semi-solid to soft plastic, clay sand
  Amongst the above layer, single Sandy clay Layer of approximately 1~4m thickness at the diverse depth
- From the bottom of the above layer to approximately 495m M.S.L:
  Sand with various grains, clayey with small gravel inclusions
- Down from the bottom of the above layer: Loam, hard, dense, fractured clay

Determination sequences of the mechanical characters of the soil are explained in the report of the above-mentioned documents. According to the reported data, a referential analysis of soil bearing capacity (=R) is presented by TEP as below.

a. Water saturated loam with consideration of water-weighing as the foundation base of 3m width embedding from the ground level (501.15m M.S.L)
   - -2.0m: R=20.0t/m^2
   - -2.5m: R=22.1t/m^2
   - -3.0m: R=24.1t/m^2

b. Water saturated sandy loam with consideration of water-weighing as the foundation base

embedding –3.0m from the ground level (501.15m M.S.L)

- Foundation base of 3.0m width: R=18.5t/m^2
- Foundation base of 4.5m width: R=19.5t/m^2

Chemical analysis shows specific consideration of sulfur components in the soil is necessary for underground concrete.

The level of the underground water to be considered for the planning of site and new underground structures changes seasonally along with the level of the existing canal adjacent to the site. De-watering work is necessary during the construction work.

(2) Topographic Survey

The result of the topographic survey is shown in the Appendix A in Volume IV of the Tender Documents. According to the survey maps of the site, the accurate information of the location and area is acquired. The information had been reflected in the Drawing of Site Layout Plan /TMP-G-002 etc.

The base point in the whole premises of DC "TASHTPP" is 501m M.S.L on the side of the existing pump house for 7^{th} & 8^{th} power unit. Site elevation ranges from 501m M.S.L to 507m M.S.L. The highest point is in the northeast and the lowest is in the southwest of the proposed project site. There remain several single storied warehouses, fences and other structures as shown on the survey map. The elevation of the existing gas pipeline between the area for the extension of the new power line and the division for the new Power Plant ranges from 506m M.S.L to 515m M.S.L.

According to the result of the survey TEP has suggested the level of preliminary grading shall be 504.3m M.S.L after removal of the above-mentioned structures with the least stripping of topsoil away from the site.

4.2.5 Considerations

The result of the investigations is sufficient and useful as a part of the draft of Tender Documents. Apart from the sufficiency of the result, there are several points to be considered as for the process of the investigations.

Although workers in the site and engineers in the laboratory of soil tests are sincere, well motivated and proud of their skills, instruments for the site work and equipment of the laboratory are old-fashioned. Fortunately there was not any accident or trouble in the site work of the investigation. The consideration for safety control of site work to be checked by the local subcontractor and the records of the process of the investigations to be reported from them were insufficient.

Since CAD technique is not prevalent in Tashkent, survey maps executed by local subcontractor are drawn by hand. The quality and size of papers on the market for drawings and copies are limited. There will be difficulties in communicating with drawing-data in international construction projects.