CENTRAL ASIA

REGIONAL ELECTRICITY EXPORT POTENTIAL STUDY

Appendix Volume

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List of Appendixes

Appendix 3.1

Central Asia
Regional Electricity Export Potential Study
Current Status of Power Sectors in Central Asian Republics

Kazakhstan

Infrastructure: Kazakhstan is endowed with enormous fossil fuel resources. Its oil reserves are estimated in the range of 0.8 to 2.5 billion tons. Its gas reserves exceed 1,950 BCM and its coal reserves exceed 185 billion tons. Its hydroelectric potential is about 20,000 MW of which only 10% had been developed. The installed electricity generation capacity is estimated at 18,240 MW consisting of 4 large thermal power plants (8,630 MW), 12 hydroelectric plants (2000 MW), and 38 combined heat and power (CHP) plants (7,610 MW). Due to their age and lack of maintenance the available capacity is estimated available capacity is around 13,840 MW. The rehabilitation of the two large Ekibastuz thermal power stations would add considerably to the available capacity. Kazakhstan's power system consists of the northern grid (which is well integrated with the Russian grid) and the southern grid (which is an integral part of the CAPS). A single circuit 500 kV line interconnects these two grids, but because of stability problems the line is sometimes kept open. Plans to reinforce the interconnection by another 500 kV line are being actively pursued, and a part of it is already funded with help from an EBRD loan.

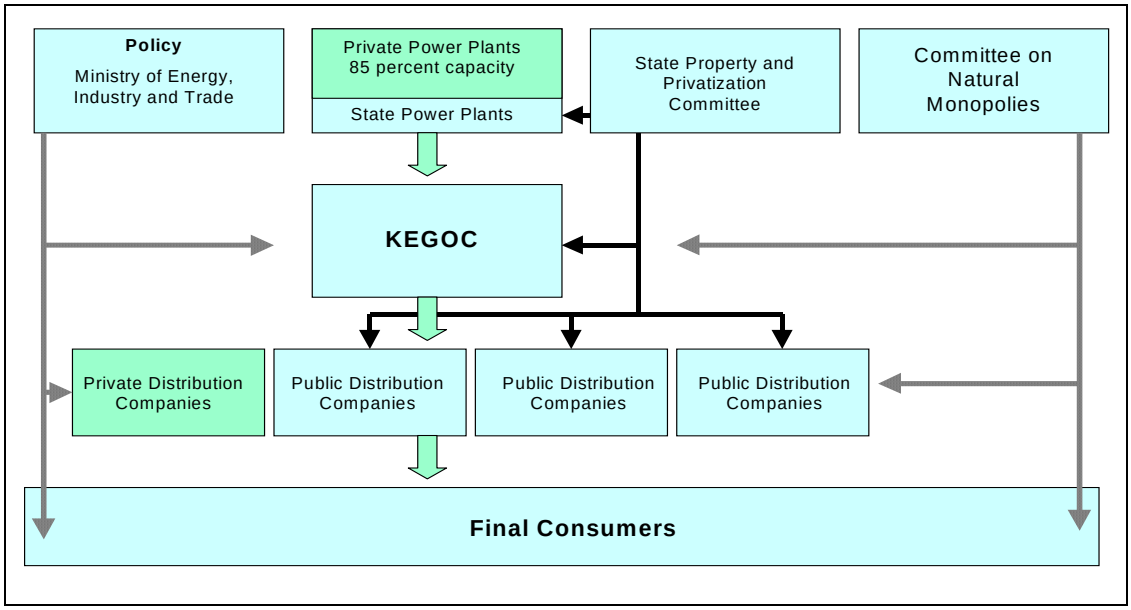
Table A3.1: Kazakhstan: Generation, Trade, and Consumption of Electricity

Indicators	Units	1998	1999	2000	2001 [1]	2002 [1]	2003 [2]
Peak Demand	MW				9,318	9,432	
Domestic Generation							
Hydropower Pants	GWh	6,100 [3]	6,100 [3]	7,500 [3]	8,057	8,861	
Thermal Power Plants	GWh	40,400 [3]	38,900 [3]	41,400 [3]	47,174	49,317	
Total Domestic Generation	GWh	46,600 [3]	45,000 [3]	48,900 [3]	55,231	58,178	63,700
Exports to							
Russia	GWh					595	
Uzbekistan	GWh						
The Kyrgyz Republic	GWh						
Exports total	GWh	130 [3]	90 [3]	90 [3]	-	595	4,119
Imports from							
Russia	GWh				322		
Uzbekistan	GWh						
The Kyrgyz Republic	GWh		970 [4]	1,253[4]	1,095	433	1,389
Tajikistan	GWh		2 [4]			31	360
Turkmenistan	GWh		321 [4]	35 [4]	9		
Imports total	GWh	4,000 [3]	3,070 [3]	3,100 [3]	1,426	464	2,448
Net Supply to Domestic Market	GWh	50,470	47,980	51,910	56,657	58,048	62,029
Domestic Consumption	GWh	33,815	32,626	35,299	39,094	40,053	43,420
System Losses	GWh	16,655	15,354	16,611	17,564	17,995	18,609
Losses as a % of Net Supply [5]	%	33%	32%	32%	31%	31%	30%

[1] Energy sector and Fuel Resources of Kazakhstan, March 2003. [2] Kazakhstan Electricity Association, Energy Industry Bulletin 3-2004. [3] Fossil Energy International, An Energy Overview of the Republic of Kazakhstan, October 2003. [4] UDC "Energiya", Annual Reports. [5] WB's estimate based on *Environmental Performance Review of Kazakhstan*, UN, Economic Commission for Europe, Committee on Environmental Policy, September 2000 and *Regional Review of Social Safety Net Approaches*, USAID, October 2003 (see Appendix 5: Energy Reform and Social Protection in Kazakhstan)

Generation, Trade and Consumption. Table A3.1 shows the historical data for electricity generation, trade and consumption from the year 1998 to 2002 in Kazakhstan. Generation from thermal plants accounted for 85% of overall generation, while hydro plants accounted for the remainder. The northern system was a net exporter of electricity in 2002, where as the southern system is a net importer. Imports in the south are from the Kyrgyz Republic mainly as a result of obligations under the annual IGIAs relating to the operation of the Toktogul reservoir in the Kyrgyz Republic. Domestic consumption, which was declining from 1990 to 1999, resumed growth in the subsequent years reflecting the economic growth experienced by the country and the region. A growth of 23% in domestic consumption of electricity occurred during 1999-2002. The annual peak demand is in the month of January and the summer peak in July is generally around 60% of the winter peak.

System Loss, Billing and Collections: Overall system loss is reported at 30% for the country as a whole. However, there is considerable variation in the loss levels among the distribution entities. In many distribution companies, the loss levels are as high as 35% of the electricity supply received by them. Similar variations in billing and collection efficiencies are reported to exist among these agencies. While overall collection levels are reported to be around 85% of billings, overall cash collection levels appear to be around 55% of billings.



Source: ADB Report on Regional Power Transmission Modernization Project

Figure A3.1: Structure of the Kazakhstan Electricity Supply Industry

Sector Structure**:** Kazakhstan is one of the earliest former Soviet Union countries that pursued structural reforms to enable privatization of sector assets. The sector has been unbundled into generation, transmission and distribution since 1996 (See Figure A3.1). Transmission at 220 kV and above and dispatch are being handled by the state owned joint stock company KEGOC. There are 21 Regional Energy Companies, which own smaller sized generation units[1] (mostly combined heat and power plants), transmission at 110 kV level and

[1] The total capacity of such *regional level units* in Kazakhstan as a whole amounts to 8,860 MW or 48.6% of the total installed capacity in the country.

electricity distribution networks and heat distribution networks. Not all of them have been unbundled and some continue to retain the status of vertically integrated utilities. These RECs are owned by different levels of government. Eleven of them have state ownership, six have communal ownership, and four have trust management ownership. Regulation of the industry is carried out by the State Committee for Regulation of Natural Monopolies and Protection of Competition. The regulatory bodies at the oblast level have also a major role to play in regulation of tariffs.

Private Sector Participation**:** Significant portion of the large sized generation assets (referred to as national level power plants) have been privatized to foreign and local strategic investors. The large hydroelectric generation units have been given on concession basis to private investors. Nine of the electricity distribution networks from the unbundled RECs have been privatized adopting a concessions approach. Regulatory problems have resulted in notable cases of disinvestment by international private investors from distribution business.

Market Operations: Distributors and generators are linked by a system of bilateral contracts. Major industries, connected to the HV transmission grid, as well as RECs and privatized distribution companies are free to contract directly with generators, as third party access to the national grid is legally ensured. A contract trading market has been introduced and determines wholesale prices. Contracts for basic capacity, peak and off peak capacity, standby capacity and reactive capacity are provided. The final consumer pays a tariff which is a sum of the cost of energy, national, regional and distribution network charges, technical losses and maintenance charge.

An experimental market trading organization, KOREM, has been set up, and a trial electricity market trading is already taking place. With assistance form a World Bank/EBRD financed US$190 million loan a Grid Code was prepared during 2001 and has since been approved by the Ministry of Justice; market rules are being finalized; measures for the operation of “a day ahead” and “spot” markets for the real time balancing of supply and demand in a largely bilateral contract driven market are being pursued. Further privatization of distribution is also being pursued.

Electricity Pricing: Since the Kazakhstan power system has multiple generators and multiple distributors, it has a complex tariff system, featuring different generation tariffs, as well as a three-part transmission tariff. Wholesale tariffs presently range from 0.5 US¢/kWh to just below 1 US¢/kWh. Transmission tariffs applied by KEGOC and subject to quarterly review by the regulator are currently at about to 0.7 Tenge/kWh (0.4 US¢/kWh). Retail tariffs are charged by RECs, and tariff levels are generally higher for privatized RECs than for those still remaining in government ownership. Energy Regulators Regional Association (ERRA) reports that the unweighted overall average of all RECs is 2.64 US¢/kWh. In general residential consumers pay more than the industrial consumers, indicating some decline in the cross subsidy.

The Kyrgyz Republic

Infrastructure: Though only 10% of its hydroelectric potential has so far been developed, the Kyrgyz power system is predominantly hydroelectric. It has an installed power generation capacity of 3,713 MW, of which 2,950 MW (79.5) is hydroelectric and 763 MW (20.5%) is thermal. The hydropower units of the Toktogul storage reservoir and those in the downstream

Naryn[2] cascade account for 97% of the hydro capacity and 78% of the total installed power generation capacity in the country. They account for 90% (or 11 to 12 TWh) of the total electricity generation. The thermal capacity consisting of two combined heat and power plants (CHP) fueled by gas, fuel oil or coal generate only about 1.1 to 1.2 TWh though their design outputs were rated at around 4.1 TWh, as a result of lack of fuel and their poor condition. Transmission voltages include 500 kV, 220 kV and 110 kV. Distribution is at 35 kV, 10 kV, 6 kV, and 0.4 kV.

Generation, Sales and Trade: Data relating to generation, exports, imports, domestic consumption and sales in the Kyrgyz Republic are summarized in Table A3.2.

Table A3.2: The Kyrgyz Republic: Generation, Trade, and Consumption of Electricity.

Indicators	Units	1998	1999	2000	2001	2002	5 year Average
Peak Demand	MW	2633	2554	2622	2775	2687	2,661
Domestic Generation							
Hydropower Pants	GWh	9,939	12,137	13,024	12,391	10,778	11,654
Thermal Power Plants	GWh	1,631	982	1,222	1,215	1,115	1,233
Total Domestic Generation	GWh	11,570	13,119	14,246	13,606	11,893	12,887
Exports to							
Uzbekistan	GWh		970	1,926	1,038	523	1,114
Kazakhstan	GWh		970	1,253	1,264	575	1,016
Tajikistan	GWh		149	154	78	118	125
Exports total	GWh	1,043	2,089	3,333	2,380	1,216	2,012
Imports from							
Uzbekistan	GWh		2	195	287	267	188
Kazakhstan	GWh		0	0	0	0	0
Tajikistan	GWh		137	126	35	163	115
Turkmenistan	GWh		49	0	0	0	12
Imports total	GWh	320	188	321	322	430	316
Net Supply to Domestic Market	GWh	10,847	11,218	11,234	11,548	11,107	11,191
Domestic Sales	GWh	6,624	7,251	7,779	6,641	6,836	7,026
Losses	GWh	4,223	3,967	3,455	4,907	4,271	4,165
Losses (as a % of Net supply)	%	39	35	31	42	38	37

On the basis of five-year (1998-2002) averages total generation was about 12.9 TWh of which more than 90% was hydroelectric. About 15.6% of the total generation was exported mainly to Uzbekistan and south Kazakhstan in terms of the annual IGIAs relating to Toktogul reservoir operation; and partly to Tajikistan. Imports are modest and are mainly for technical exchanges needed for system stability and balancing purposes. Net supply to the domestic market amounted to about 11.2 TWh, but domestic sales amounted to only 7.0 TWh implying a system loss level of about 37% of the net supply. Since Toktogul reservoir provides multi year storage facility for irrigation and agriculture in the downstream countries, water releases from it are subject to annual IGIA. This leads to substantial release of water and export of electricity in summer and limited release of water and import of fuels in winter. Thus to a large extent, trade in electricity is a byproduct of water release agreements.

[2] Naryn is the major tributary of Syr Darya River

Power Market: The country is fully electrified and the total number of consumers is about 1.08 million, more than 95% of which are residential consumers. Though the level of electricity consumption by the year 2000 reached the level prevailing in 1990 (before the dissolution of the Soviet Union), the structure of consumption has changed dramatically. Industrial consumption declined sharply and the share of the residential consumers rose from 15% to about 60% of the total consumption.[3] The main reasons for the surge in the residential consumption were the lack of indigenous fossil fuels, the quick rise in the price of imported fossil fuels to internationally traded levels, the scarcity of imported fuels for want of cash to pay for imports, and consequent behavior of residential consumers in switching from fossil fuels to electricity for space heating, cooking and hot water, encouraged by the continued low and highly subsidized price of electricity. Thus seasonal variations in demand became pronounced. The system peak demand occurs in the height of winter and the summer peak demand is only about 55% of the winter peak demand. About 2/3 of the annual electricity consumption takes place in the first and the fourth quarters of the year (winter and fall), as a result of the increased heat demand.

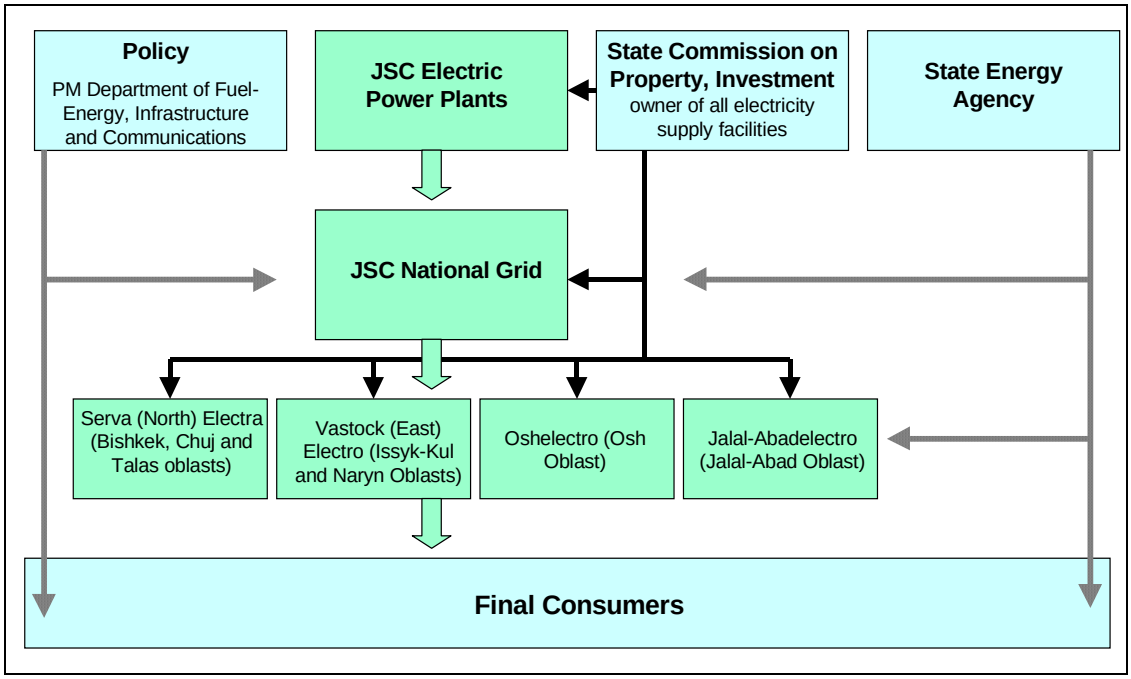
System Loss, Billing and Collection**:** The total system loss level averages to about 37%. The technical losses in the transmission and distribution network have increased on account of the dramatic change in the structure of demand. The network also needs extensive rehabilitation. A substantial portion of the losses (more than 50%) is attributable to unmetered supplies, defective meters and theft of power. Billing and Collection efficiencies are poor at around 80% each, and the sector is still beset with problems of nonpayment and payment in barter.

Sector Structure**:** The Kyrgyz Republic electricity system was unbundled in 2001 creating the Electricity Supply Industry (ESI) comprising: one generation company; one transmission company and four distribution companies (See Figure A3.2). The State Energy Agency is the regulatory body for the whole energy sector, while the policy formulation is in the hands of the Department of Fuel and Energy Complex under the Prime Minister.

Market Operations: According to the Electricity Market Rules adopted by the Government in 2000, the transmission company is a 'common carrier' with no responsibility for buying and selling electricity[4] (other than very small quantities for maintaining system stability and to follow the instructions of the Unified Dispatch Center in Tashkent). The distribution companies trade directly with the generation company for their electricity purchases and pay a transmission service fee to the transmission company. The generation company is responsible for the exports of electricity.

[3] Average annual consumption of the residential consumer in 2003 was about 4,560 kWh

[4] However, the Government later made a decision that, on an exceptional basis and during a transitional period only, the transmission company would be allowed to sell directly to the Kumtor Gold Mining Company.



Source: ADB Report on Regional Power Transmission Modernization Project

Figure A3.2: The Kyrgyz Republic Electricity Supply Industry Structure

Private Sector Participation: The Government has committed itself to seek private sector participation in electricity distribution and in small hydro schemes. Two small hydro schemes, Chakan and Kalinin, have been handed over to private investors. The implementation of the decision to offer Severelectro, one of the four distribution companies, to the private sector on the basis of concessions is still in the preparatory stage.

Electricity Pricing: Though tariffs have been revised several times since 1999 and the overall average tariff in the Kyrgyz Republic power sector in 2003 amounted to 1.42 US cents/kWh[5], it still lagged behind the cost recovery tariff level of about 2.3 US cents. In addition, there is a significant cross subsidization of the residential consumers by industrial consumers. SEA regulates the generation, transmission and distribution tariffs.

Tajikistan

Infrastructure: Tajik power system is also predominantly hydroelectric. The hydroelectric potential of the country is estimated at 40,000 MW with an annual energy content of 527 TWh, and of this only 10% has so far been developed. The total nominal installed power generation capacity is about 4,405 MW consisting of seven large and several small hydroelectric stations (4,059MW) and two fossil fuel fired CHP units (346 MW). The available capacity,

[5] The generation company realizes a tariff of 23 to 26 tyins /kWh from the distribution companies and 71.3 tyins/kWh from the 14 large Industrial consumers to whom it supplies power at 110 kV. Industrial consumers receiving supplies at 35 kV and 10 kV pay to the distribution company a tariff of 80 tyins/kWh. The transmission charge amounted to an average of 8.7 tyins/kWh. Residential consumers pay to the distribution company 43 tyins/kWh for the first 150 kWh per month (lifeline rate) and 80 tyins/kWh for consumption above that limit. The government is examining the possibility of removing the lifeline rate and charging a unified tariff for all residential consumers.

however, is much lower at about 3,428 MW (comprising 3,218 MW of hydro and 220 MW of CHP capacity). The Nurek hydropower cascade, comprising the Nurek reservoir and power houses at Nurek and Baipaza with combined capacity of 3,600 MW and an annual energy capability of 15 TWh is the most important generation asset.

Tajik power system comprises essentially three separate grids. The grid in the northern part (Sogd region) and that in the southern part, (Khatlon region) are not directly interconnected within the country because of the high mountain range that divides them. The grid in the eastern part (Gorno Badakhshan Autonomous Region) is connected to the southern grid by a long 35 kV line with a very limited transfer capacity. Most of the generation is concentrated in the southern grid and major load centers are in the northern grid. The southern and northern grids are however interconnected with the power grid of Uzbekistan at several voltage levels and there is thus a continuous exchange of power between Tajikistan and Uzbekistan. Tajik power system meets its domestic demand mostly by domestic generation and partly by net imports. Its transmission system consists of 226 km of 500 kV lines, 1,203 km of 220 kV lines, 2,839 km of 110 kV lines. Distribution is by 35 kV, 10 kV, 6 kV, and 0.4 kV lines. Electrification of the country is nearly complete and almost every household has access to the electricity grid. Its annual per capita electricity consumption in 2000 amounted to 2473 kWh.

Table A3.3: Tajikistan Electricity Generation, Trade, Consumption and Losses

Indicators	Units	1990	1998	1999	2000	2001	2002	5-year Average
Peak Demand	MW		2,352	2,605	2,723	2,750	2,901	2,666
Domestic Generation								
Hydropower Plants	GWh	17,459	14,147	15,426	14,025	14,206	15,086	14,578
Thermal Power Plants	GWh	633	271	369	222	130	138	226
Total Domestic Generation	GWh	18,092	14,418	15,795	14,247	14,336	15,224	14,804
Exports to								
Uzbekistan	GWh	2,344	3,600	3,691	244	299	72	1,581
The Kyrgyz Republic	GWh	324	124	137	126	35	163	117
Turkmenistan	GWh	-	-	2	-	-	31	7
Exports total	GWh	2,668	3,724	3,830	370	334	266	1,705
Imports from								
Uzbekistan	GWh	3,927	3,619	3,493	729	569	360	1,754
The Kyrgyz Republic	GWh	-	-	149	154	78	118	100
Turkmenistan	GWh	-	350	-	819	1,037	580	557
Imports total	GWh	3,927	3,969	3,642	1,702	1,684	1,058	2,411
Net Supply to Domestic Market	GWh	19,351	14,663	15,607	15,579	15,686	16,016	15,510
Domestic electricity sales	GWh	18,109	12,495	13,310	12,040	12,165	12,988	12,600
System Losses	%	6%	15%	15%	23%	22%	19%	19%

Source: Barki Tajik

Generation, Sales and Trade: Data relating to generation, sales, trade and losses are summarized in Table A3.3. Domestic generation declined from about 18 TWh in 1990 to about 14 TWh during 1995-1998 on account of: (a) the mothballing of the CHP plant at Yavan caused by the shortage of fuels, non-operation for prolonged periods and lack of funds for maintenance; (b) reduction of the Nurek Hydro reservoir capacity caused by silting; and (c) the need to shut down some of the hydro units for lack of spare parts and funds for maintenance. Rehabilitation of some of the hydro units has resulted in some improved hydro output in the later years. Trade

is the result of the annual Inter Governmental Irrigation Agreements (IGIA) made under the Framework Agreement of 1998 among the riparian states of Syr Darya River basin.[6] Tajikistan is obliged under these agreements to store a minimum of 3.4 BCM of water in the Kairakkum reservoir[7] on Syr Darya River during the winter season to enable the flow of adequate water for irrigation in the summer season in Uzbekistan. For this storage service, Uzbekistan is obliged to receive 250 GWh of electricity from Tajikistan in summer and transfer 200 GWh in winter to Tajikistan. Trade above the levels mentioned in the IGIAs has to be paid for in cash. Exports from Tajikistan declined over the decade on account of the energy self sufficiency policy followed by Uzbekistan and imports by Tajikistan declined as a function of its inability to pay in cash for such imports.

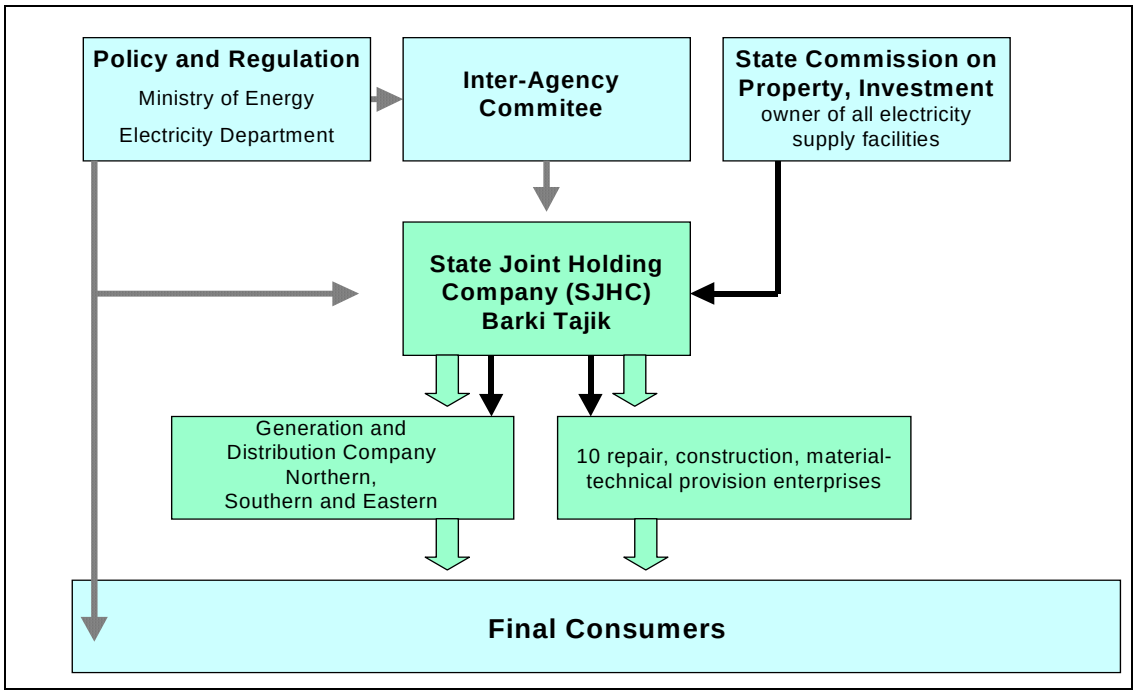
Power Market: The decline in domestic sales by 33% during 1990-2001 was on account of the economic turmoil following the dissolution of Soviet Union and the ensuing internal conflicts within Tajikistan. TADAZ one of the largest Aluminum smelters in the world is located in Tajikistan and it accounts for about 32% of total domestic sales of electricity. Residential consumers account for 34% of the sales, followed by agriculture and irrigation pumping (21%) other industries (7%) and government consumers (6%). During the decade the share of industry (including TADAZ) fell from 68% to 39%, while the share of the residential consumers rose from 8% to 34%. As in the Kyrgyz Republic, and for the same reasons, residential consumers switched from fossil fuels to electricity for heating and cooking during winter. However, the seasonal variations in the demand for electricity in Tajikistan are not as pronounced as in the Kyrgyz Republic due to aluminum production and demand for irrigation water pumping balances. The share of the winter consumption in the total annual consumption is actually only 43% and shortages are acute, mainly owing to lack of supply, as flows in the rivers are reduced significantly, and the storage capacity in the reservoirs is limited. Regional consumption pattern is such that about 40% of the energy is consumed in the northern region followed by southern region (25%), capital region (18%) and others (17%).

System Loss, Billing and Collection: The overall loss for 2001 is reported at 22% in Table A3.4. However, nearly 32% of the total sales (3,916 GWh) was to the Aluminum smelter TADAZ at 220 kV. The loss here can not be any higher than 1.0 % thus the losses on the remaining sales of 8,249 GWh amounts to nearly 30%. It is estimated that out of the 30% of losses about one half is attributable to technical losses in the transmission and distribution system and the rest is attributable to non-technical losses arising from theft, defective metering, use of norms based billing for consumers without meters, non-billing or inadequate billing. Billing inefficiencies are so high that only about 70% of the consumption gets billed. Collections are at around 70% of the amounts billed. Only 40% of the collections are in cash, the rest being in barter and offsets.

Sector Structure, Market Operation and Private Sector Participation: Barki Tajik (BT), the state owned vertically integrated utility was responsible for generation, transmission and distribution in the whole of Tajikistan till recently (See Figure A3.3). After the privately owned Pamir Energy Company was given a 25-year concession in the end of 2002 for the operation of all power facilities in the Gorno Badakshan Autonomous Region (GBAO), BT's responsibilities cover the remaining areas of the country. BT is registered as a state owned Joint Holding

[6] Kyrgyz Republic, Uzbekistan, Kazakhstan and Tajikistan
[7] It is a 126 MW storage hydro power station in the northern Grid of Tajikistan.

Company (SJHC) and has 28 subsidiary companies within its holding. There are several generation subsidiaries, one transmission and dispatch subsidiary and 11 distribution subsidiaries, in addition to subsidiary companies for maintenance, design, research etc. Though from a legal point of view the generation, transmission and distribution entities are separate companies, BT functions for all practical purposes as a vertically integrated utility and these units function mostly as divisions of BT, especially in terms of system operations and finance. In addition to these, a new Sangtuda I Joint Stock Company (JSC) has been formed for completing the construction of the large run-of river Sangtuda I hydroelectric project downstream of Nurek-Baipaza cascade and later its operation.



Source: ADB Report on Regional Power Transmission Modernization Project

Figure A3.3: Electricity Industry Structure in Tajikistan (2002)

Tariffs: The weighted average tariff in 2003 was of the order of 0.49 US cent/kWh compared to the cost recovery level of 2.1 US cents/kWh. Seasonal tariffs with higher rates for winter than in summer have been introduced in 2003. Lifeline rates for residential consumers is at 0.41 cents Industries and Residential consumption above the lifeline rate limits are charged at around 0.68 and 0.69 cents /kWh. However the limit for the lifeline rate has recently been raised from 150 kWh to 250 kWh per month.

Uzbekistan

Infrastructure: Uzbekistan has oil reserves of 82 million tons, gas reserves of 1,875 BCM and coal reserves of 4 billion tons and a modest hydroelectric potential of 15,000 GWh/year. Its nominal installed power generation capacity at 11,580 MW is nearly 50% of the total generating capacity in CAPS. It consists of 11 thermal plants totaling 9,870 MW and 31 hydroelectric units totaling 1, 700 MW. The large natural gas fueled power plants include Syrdarya (3,000 MW), Tashkent (1,860 MW), and Navoi (1,250 MW). The large coal fired plants include Angren (600

MW) and Novo-Angren (2,100 MW). The largest hydroelectric plant is Charvak (620 MW). Large 800 MW gas fired units are under construction at Talimardjan. It has an extensive transmission system with 500 kV (1,700km) and 220 kV lines (5,100km) and has also a 220 kV line connecting it to Afghanistan.[8]

Generation, Trade, and Consumption. Data relating to generation, trade, sales, consumption and losses are summarized in Table A3.4.

Table A3.4: Uzbekistan: Generation, Trade, and Consumption of Electricity.

Indicators	Units	1998	1999	2000	2001	2002	5-year Average
Peak Demand	MW	7,603	7,494	7,571	7,674	7925	7653
Domestic Generation							
Hydropower Pants	GWh	7,269	6,585	4,909	5,354	7,278	6,279
Thermal Power Plants	GWh	38,645	38,734	41,932	42,574	42,021	40,781
Total Domestic Generation	GWh	45,914	45,319	46,841	47,928	49,299	47,060
Exports to							
The Kyrgyz Republic	GWh		2	195	287	267	188
Kazakhstan	GWh		0	0	0	0	0
Tajikistan	GWh		361	729	569	360	505
Turkmenistan	GWh		77	33	0	7	29
Outside CA (Afghanistan)	GWh		0	0	0	63	16
Exports total	GWh	482	440	957	856	634	674
Imports from							
The Kyrgyz Republic	GWh		970	1,926	1,038	523	1,114
Kazakhstan	GWh		0	0	0	0	0
Tajikistan	GWh		558	244	299	72	293
Turkmenistan	GWh		126	68	13	14	55
Imports total	GWh	658	1,654	2,238	1,350	609	1,302
Net Supply to Domestic Market	GWh	46,090	46,533	48,122	48,422	49,274	47,688
Domestic Consumption	GWh	38,311	37,927	39,465	37,935	38,112	38,350
System Losses	GWh	7,779	8,606	8,657	10,487	11,162	9,338
System Losses as a % of Net Supply	%	17	18	18	22	23	20

About 77% of the total electricity generated is from gas fired thermal plants, 7% from fuel oil fired thermal plants, 3.5% from coal fired thermal plants, and 12.5% from hydroelectric plants. Its electricity trade with the Kyrgyz Republic and Tajikistan is a result of the obligations under the annual IGIAs relating to the irrigation flows in Syr Darya River regulated by Toktogul and Kairakum reservoirs in those countries. Unlike in the Kyrgyz Republic, the difference between the summer and winter peak demands in Uzbekistan is insignificant. In the year 2000, for example, the summer peak at 6882 MW was about 91% of the winter peak demand of 7,571 MW. Irrigation pumping loads in spring and summer compensate for the heating loads in fall and winter. Despite the large nominal installed capacity of 11.6 GW, Uzbekistan has difficulties in meeting its peak demand ranging from 6.9 GW to 7.7 GW, because of the poor availability of its generation units (which significantly reduces the effective reserve margin) and the relatively low percentage of the peaking plants in the generation mix. The poor plant availability is attributable to the old age of many large plants (most are 30 years old and many are over 40

[8] Presently this line can operate only at 110 kV on account of transformer limitations at the Substation located in Mazar-i-Sharif.

years old), the need for extensive rehabilitation, and poor electricity tariffs inadequate to generate internal cash to carry out rehabilitation. Capacity shortages of the order of 1000 MW are being met by rolling power outages or by imports from neighboring countries.

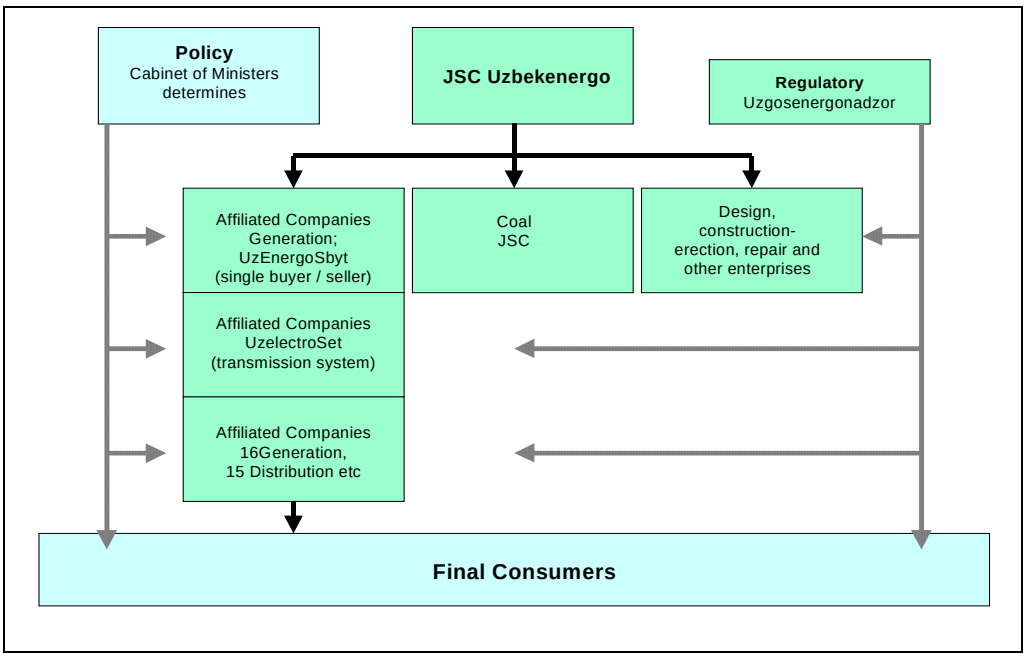
Power Market: Like the Kyrgyz Republic and Tajikistan, Uzbekistan is also fully electrified and all areas and households have access to electricity. The total number of consumers as of 2001 was about 4 million. Based on 2002 data, unlike in the other two countries, the share of the residential consumers in total electricity consumption in Uzbekistan is low at 15.3%. Since most households have natural gas supply, residential households do not depend on electricity for cooking and heating. Industrial consumers have a share of 47.5%, followed by agricultural and irrigation pumping loads (30.6%) and others such as government entities, commercial consumers and transport (6.6%).

System Loss, Billing and Collection: System loss as a difference of gross domestic available supply and billed sales was about 23% in 2002. Approximately half of this is attributable to the transmission and distribution network losses and the rest attributable to defective metering, unmetered supplies and theft of power. No recent data on collection efficiency is available. Based on partial data of 2000, it is estimated that only about 75% of the bills are collected. Payment in barter and offsets is also a major problem as only 40% of the collection is in cash

Sector Structure: Uzbekistan is one of the last former Soviet Union countries to transfer the responsibility for the operational aspects of the electricity system from the government to a legal entity organized on a commercial basis. In 2001, the Uzbekistan Electricity Supply Industry (UESI) was created by abolishing the Ministry of Energy and Electrification and creating a state owned joint stock company UzbekEnergo JSC (See Figure A3.4). UzbekEnergo has three affiliated companies Ugol, in charge of coal mining; UzEnergoSet, for the transmission of energy and one UzEnergoSbyt, as the single buyer and single seller of electricity. In addition, there are subsidiaries for, among others, 7 thermal power plants, 6 hydropower plants, 3 combined heat-and-power plants, and 15 distribution companies. Four of the thermal generation plants (Syrdarya, Fergana, Tashkent, Mubarek) and all the 15 Distribution companies have been registered as independent Joint Stock Companies. UzbekEnergo JSC holds all the shares in them as a holding company. Large industrial consumers receiving supply at 110 kV and above are allowed to buy directly from the generating companies, though at regulated tariffs. A state agency for the technical regulation of the operations of the energy sector, UzGosEnergoNadzor, has also been established. This regulatory agency has authority over electricity, coal and heat energy. It reports to the Cabinet of Ministers, but the economic regulation remains with the Ministry of Finance.

Market Operations: UzEnergoSbyt acts as the single buyer for all generated electricity and a single seller to the distribution companies. In effect it is a clearing house accounting for all electricity flows from generators to the distribution companies and large industrial consumers through the national transmission grid. It is also responsible for electricity trade (both imports and exports). Further, the distribution companies remit to the account of UzEnergoSbyt, the difference between their purchase and sale price of electricity. UzEnergoSbyt then allocates the total revenues among the generating companies and transmission company on the basis of power flows. It is a non profit organization and therefore any surplus left with it is remitted to UzbekEnergo. In the context of low rates of collection and extensive use of barter, the system of

settlement does not always work logically and available cash is distributed among the participants of the market using *ad hoc* formulae.



Source: ADB Report on Regional Power Transmission Modernization Project

Figure 3.4: Structure of the Uzbekistan Electricity Supply Industry

Private Sector Participation: The Government plans to offer up to 49% of the shares in four generation plants and four distribution companies for private investors. However management control by private investor is not envisaged. While there is a possibility for further private sector involvement in generation and distribution, the Government's current plans call for the continued state-ownership of all hydropower plants, transmission network, communications system, UzElectroSet as well as UzEnergoSbyt.

Electricity Pricing: The weighted average tariff in 2001 was 0.5 US¢/kWh at curb market exchange rates. However, since then, the government has been implementing an aggressive tariff adjustment policy for all energy commodities, as a part of which electricity prices have been increased roughly once every two months. As a result, as of August 2004 the posted average tariff was 2.15 US cents /kWh compared to an estimated cost recovery tariff level of 3.5 US cents. The posted tariff structure also appeared to have reduced cross subsidies to some extent. The Ministry of Finance reviews and approves unbundled tariff proposals for generation, transmission and distribution. The retail tariffs for end consumers are uniform all over the country. Each generating unit /company has a separate regulated tariff. Transmission service has a regulated transmission tariff. The retail tariff is the sum of generation and transmission tariffs, and the purchase price of each distribution company from UzEnergoSbyt is derived on the basis of consumer mix, density of load and a desired level of profit.

Appendix 4.1

Central Asia
Regional Electricity Export Potential Study
Electricity Demand Forecasts

I. Background and Methodology

Trending, end-use analysis and macroeconomic modeling are the common approaches to electricity demand forecasting. Given the economic collapse following the dissolution of the Soviet Union and the continued decline in GDP and electricity consumption in the former Soviet Union countries, trending would be inappropriate in CARs. End-use analysis is difficult on account of paucity of data and is distorted by the excessively inefficient use of electricity. Demand projections made during the Soviet rule and even in years immediately thereafter, were more in the nature of targets to be achieved than in the nature of forecasts. Given the central planning background and practices, price as a determinant of demand was largely ignored and concepts of price elasticity and income elasticity were not much in use. Kazakhstan Electricity Association – a national industry association—has recently commenced the practice of making long-term forecasts. There have also been recent forecasts made by consulting firms financed by International Financial Institutions such as ADB and UNDP, and some bilateral aid agencies in the context of their operations, which use macroeconomic modeling and also incorporate considerations of income elasticity and price elasticity. However they do not appear to have considered seasonal variations in demand adequately. Given the high degree of such seasonal variations, it is necessary to incorporate them in the demand projections to determine export surpluses. Also other key assumptions relating to GDP growth rates, electricity prices and possible efficiency improvements need to be updated. The forecast made in this report on the basis of macroeconomic modeling incorporates these elements. The model is based on a simple iso-elastic demand function of the type often used in such aggregate demand analysis.

II. Key Determinants of Demand Growth and Assumptions

Income and price elasticity of electricity demand are the key determinants to demand growth in such aggregated demand analysis. An attempt was made to derive the elasticities from the historical data of the four countries, but this did not prove possible – the statistical series are too short, have too many gaps and reflect a period that is not typical in terms of economic activity. Hence, the above elasticities of demand were adopted after a review of a number of studies in the region and elsewhere.

- *Income Elasticity or GDP elasticity* of electricity demand: The range of available literature indicates that for most developing countries the GDP elasticity of electricity demand ranges between 1.2 and 1.4 (i.e., for every percentage increase in GDP, the electricity demand increases by 1.2 to 1.4 percent). However, most former Soviet Union states (and more so in the case of CARs) do not fit into this category as their electricity consumption is already very high relative to their GDP level. Therefore, it is expected that the relationship between GDP and electricity demand in CARs would be more akin to those prevailing in developed countries, which have exhibited a GDP elasticity of demand of 0.8. This value had been used in relation to CARs in this study.

- *Price Elasticity*: The estimates for price elasticity of demand for electricity in lower income countries generally are in the range of –0.1 to –0.2, implying that for every percentage increase in electricity price, the demand decreases by 0.1 to 0.2 percent. The price elasticity levels for electricity are generally lower than those for other energy forms (e.g., petroleum products), reflecting:
    - consumers' inflexibility to switch from electricity to other forms of energy. This is particularly true of all types of consumers in the short term, and for industries, such as metallurgical and chemical, even in the long term;
    - non-availability of other energy forms (e.g., gas), as is the case in the Kyrgyz Republic and Tajikistan; and
    - the share of industrial consumption in overall consumption - higher the industrial consumption share as is the case with Kazakhstan and Uzbekistan, lower the price elasticity of demand.

  It is also important to note that there is an inverse relationship between price elasticity of demand and a country's income (GDP) level. At higher income levels, electricity demand becomes less and less elastic to electricity price changes as GDP increases. This is the case with Kazakhstan, where its higher level of GDP would tend to lower the price elasticity values. Considering all of the above, a price elasticity values of –0.1 has been assumed in Kazakhstan and Uzbekistan and –0.3 for the Kyrgyz Republic and Tajikistan (where the needed price increases to reach financial viability are 80% and 300% respectively) are used.

Other Assumptions

A. Table A4.1 shows the periods where the GDP data are available and where the values were estimated. Also shown are the GDP growth rates used in the electricity demand projections. GDP growth rates from 2007 to 2025 were estimated by the Team based on previous experience in the four countries and assessments of acceptable growth rates for these 19 years.

Table A4.1: Gross domestic product, 4 CARs, data source and growth rates

Country	Data Source	GDP growth rates			
		2004	2005	2006	2007-2025
KAZ	2004-2006: SIMA, IMF 2007-2025: Estimate	0.072	0.07	0.075	0.04
KYR	2004-2006: SIMA, IMF 2007-2025: Estimate	0.041	0.045	0.051	0.03
TAJ	2004-2006: SIMA, IMF 2007-2025: Estimate	0.153	0.066	0.067	0.03
UZB	2004-2025: Estimate	0.04	0.04	0.04	0.025

B. The electricity tariffs were determined in two stages. The first was to reach the average incremental cost by a certain date and the second was to maintain that tariff in US dollar terms thereafter. In the first stage, the tariffs and dates were taken as in Table A4.2. The tariffs for each year, from 2003 to the date given in Table A4.2, are determined by interpolating linearly between the years.

Table A4.2: Long Run Average Incremental Cost			
Country	Long Run Average Incremental Tariff (US¢/kWh)	Average Tariff in 2003 (US¢/kWh)	Date to Reach Long Run Tariff
Kazakhstan	2.9	2.64	2006
The Kyrgyz Republic	2.45	1.42	2009
Tajikistan	2.1	0.47	2009
Uzbekistan	3.5	1.29	2006

C. It was also recognized that the effective tariffs paid by the consumers were actually lower than the posted tariffs, due to the poor metering, billing and collection efficiencies. Therefore the applied prices to estimate demand were adjusted by the collection rate to arrive at the effective prices. From the posted average tariff, an **effective tariff** was determined based on the amount actually collected. More precisely, the effective or adjusted electricity tariff for a given country and year was taken as:

Adjusted electricity tariff = Electricity tariff x Collection rate

The following assumptions are used to derive the rates for the remaining years:[9]All countries except the Kyrgyz Republic would achieve 98% collection rate by 2010; and the Kyrgyz Republic would reach this level by 2011; and 2011 thru 2025: 98% for all countries. Table A4.3 presents each country's yearly collection rates from 2003 thru 2025.

Table A4.3: Collection rates per year, 4 CARs, 2003 to 2025									
Country	2003	2004	2005	2006	2007	2008	2009	2010	2011-2025
Kazakhstan	50%	57%	64%	71%	77%	84%	91%	98%	98%
The Kyrgyz Republic	40%	48%	56%	64%	71%	79%	87%	95%	98%
Tajikistan	70%	70%	74%	78%	82%	86%	90%	98%	98%
Uzbekistan	50%	57%	64%	71%	77%	84%	91%	98%	98%

D. The monthly electricity demand of the 4 countries for five years (2005, 2010, 2015, 2020 and 2025) were estimated using the average monthly rates of power consumption by the Central Asian Power Systems and Kazakhstan in 1999-2003 (Tables A4.4 and A4.5)[10], which were obtained from the Unified Load Dispatch Center in Tashkent.

Table A4.4: Monthly Power Consumption by Central Asian Power Systems and Kazakhstan, Average in 1999-2003													
Power System	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kazakhstan	6,320	5,877	5,404	3,940	3,602	3,639	3,747	3,561	3,786	4,923	5,285	6,061	56,144
The Kyrgyz Republic	1,636	1,445	1,284	854	623	528	542	535	528	809	1,178	1,610	11,572
Tajikistan	1,417	1,256	1,191	1,171	1,389	1,363	1,434	1,445	1,287	1,185	1,287	1,424	15,850
Uzbekistan	4,462	3,995	4,250	3,791	3,891	3,789	4,084	4,055	3,546	3,762	4,048	4,518	48,192

[9] Note that the collection rate refers to cash collections only.
[10] The assumption of the monthly demand structure remaining constant over 25 years should be treated with caution, as it is unlikely to remain constant for such as long timeframe.

Table A4.5: CAPS Monthly Consumption, Average in 1999-2003 (%)													
Power System	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kazakhstan	11	10	10	7	6	6	7	6	7	9	9	11	100
The Kyrgyz Republic	14	12	11	7	5	5	5	5	5	7	10	14	100
Tajikistan	9	8	8	7	9	9	9	9	8	7	8	9	100
Uzbekistan	9	8	9	8	8	8	8	8	7	8	8	9	100

III. Resulting Estimates of Demand

The resulting forecast electricity demands are given in annual terms (see Table A4.6) for each country separately and for the region as a whole, as well as in monthly values (see Table A4.7 through A4.9). The tables show:

a. A decrease in demand to 2010 everywhere, except Kazakhstan. This is due to the tariff increases that take effect while the economies demonstrate modest growth. During the first five-year period, the electricity demand in Kazakhstan increases by 2.91 percent p.a., while the demand in the Kyrgyz, Tajikistan and Uzbekistan decreases by 3.86 percent, 5.18 percent and 0.63 percent p.a., respectively;

b. From 2005 to 2025, the annual growth rate of demand compared to 2003 at the aggregate level is about 1.90 percent, with Kazakhstan showing the highest growth (3.09%), and Tajikistan showing a decline compared to 2003 (-0.17%);

Table A4.6: Gross Electricity Demand Projections, in GWh, 2005-2025									
Country	Actual	Demand forecast (GWh)				Annual Growth rates			
	2003	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	72,056	84,034	98,367	115,146	2.91%	3.00%	3.06%	3.09%
Kyrgyz Republic	12,145	9,222	10,033	11,296	12,719	-3.86%	-1.58%	-0.43%	0.21%
Tajikistan	16,348	11,267	12,410	13,972	15,731	-5.18%	-2.27%	-0.92%	-0.17%
Uzbekistan	48,691	46,597	51,255	56,589	62,479	-0.63%	0.43%	0.89%	1.14%
All Four Countries	136,128	139,142	157,731	180,225	206,075	0.31%	1.24%	1.66%	1.90%

c. The monthly demands for all countries except Uzbekistan show winter peaking, with Kazakhstan showing the greatest winter peak while the Kyrgyz Republic and Tajikistan showing the least peaking demand. In Uzbekistan there is virtually no seasonal variation in demand. (Tables A4.7 through A4.9)

Table A4.7: Seasonal electricity demand (gross) in Kazakhstan and the Kyrgyz Republic, in GWh, 2005-2025

	Kazakhstan						The Kyrgyz Republic					
	Monthly Cons. (%)*	2005	2010	2015	2020	2025	Monthly Cons. (%)*	2005	2010	2015	2020	2025
Jan	11%	7,033	8,111	9,460	11,073	12,962	14%	1,502	1,251	1,361	1,533	1,726
Feb	10%	6,540	7,543	8,797	10,297	12,053	13%	1,450	1,208	1,314	1,479	1,665
Mar	10%	6,013	6,935	8,088	9,467	11,082	11%	1,236	1,030	1,121	1,262	1,421
Apr	7%	4,384	5,056	5,896	6,902	8,080	6%	675	563	612	689	776
May	6%	4,008	4,623	5,392	6,311	7,388	5%	538	448	488	549	618
Jun	6%	4,049	4,670	5,446	6,375	7,463	5%	511	426	463	521	587
Jul	7%	4,169	4,809	5,608	6,565	7,684	5%	513	428	465	524	590
Aug	6%	3,963	4,571	5,331	6,240	7,304	5%	501	417	454	511	575
Sep	7%	4,213	4,859	5,666	6,633	7,764	4%	486	405	441	496	558
Oct	9%	5,479	6,319	7,369	8,626	10,098	8%	918	765	832	937	1,055
Nov	9%	5,880	6,782	7,910	9,259	10,838	11%	1,217	1,014	1,104	1,242	1,399
Dec	11%	6,744	7,778	9,071	10,619	12,430	14%	1,521	1,268	1,379	1,553	1,748
Total	100%	62,475	72,056	84,034	98,367	115,146	100%	11,069	9,222	10,033	11,296	12,719

Table A4.8: Seasonal electricity demand (gross) in Tajikistan and Uzbekistan, in GWh, 2005-2025

	Tajikistan						Uzbekistan					
	Monthly Cons. (%)*	2005	2010	2015	2020	2025	Monthly Cons. (%)*	2005	2010	2015	2020	2025
Jan	10%	1,351	1,071	1,180	1,328	1,495	9%	4,275	4,350	4,784	5,282	5,832
Feb	9%	1,253	993	1,094	1,232	1,387	9%	3,916	3,985	4,383	4,839	5,343
Mar	7%	1,000	792	873	982	1,106	9%	4,132	4,204	4,625	5,106	5,638
Apr	7%	987	783	862	970	1,093	8%	3,585	3,648	4,013	4,431	4,892
May	9%	1,283	1,017	1,120	1,261	1,420	8%	3,773	3,839	4,223	4,662	5,148
Jun	9%	1,247	988	1,088	1,226	1,380	8%	3,621	3,685	4,053	4,475	4,941
Jul	9%	1,267	1,004	1,106	1,245	1,402	8%	3,814	3,881	4,269	4,713	5,203
Aug	9%	1,274	1,009	1,112	1,252	1,409	8%	3,742	3,808	4,188	4,624	5,106
Sep	8%	1,071	849	935	1,053	1,185	7%	3,326	3,384	3,722	4,110	4,537
Oct	7%	1,048	830	914	1,030	1,159	8%	3,626	3,690	4,059	4,481	4,948
Nov	8%	1,135	900	991	1,115	1,256	8%	3,849	3,916	4,308	4,756	5,251
Dec	9%	1,300	1,030	1,135	1,278	1,438	9%	4,135	4,208	4,628	5,110	5,642
Total	100%	14,216	11,267	12,410	13,972	15,731	100%	45,794	46,597	51,255	56,589	62,479

Table A4.9: Seasonal electricity demand (gross) in Central Asian Republics, in GWh, 2005-2025					
	2005	2010	2015	2020	2025
Jan	14,161	14,783	16,785	19,216	22,015
Feb	13,158	13,728	15,587	17,847	20,448
Mar	12,381	12,962	14,706	16,818	19,247
Apr	9,632	10,050	11,384	12,993	14,840
May	9,603	9,928	11,222	12,784	14,574
Jun	9,428	9,768	11,051	12,597	14,370
Jul	9,764	10,121	11,448	13,047	14,880
Aug	9,480	9,805	11,085	12,627	14,395
Sep	9,095	9,496	10,764	12,291	14,045
Oct	11,071	11,604	13,175	15,074	17,260
Nov	12,082	12,612	14,312	16,373	18,744
Dec	13,700	14,284	16,213	18,559	21,258
Total	133,554	139,142	157,731	180,225	206,075

IV. Results by Country

Kazakhstan

Demand increases from about 60,100 GWh in 2005 to 104,255 GWh in 2025, representing an annual growth rate over the period of 3.09% (compared to 2003). This is the highest rate of all the four countries and is the result of: (a) the highest sustained growth in GDP over the period, (b) the fact that there are no large tariff increases expected with respect to the 2004 levels, to cause a reduction in demand.

The forecasts can be compared with those derived from other sources (Table A4.10).

Table A4.10: Alternative Forecasts for Kazakhstan (Terawatt hours)				
Source	2005	2010	2015	2020
This Study	62.5	72.1	84.0	98.4
ADB	62.6-66.1	66.0-75.4	72.0-86.7	77.6-98.1
Kazakh Energy Association	62.5-67.0	75.0-82.0	86.0-95.0	n.a.

This study has forecasts that are somewhat lower than KEA's forecasts for 2005-2015; and are towards the higher range of ADB forecast (Study for the Regional Power Transmission Modernization Project) figures. The differences with the national forecasts cannot be analyzed as the basis for them was not available, but the reasons for the differences with the ADB forecasts are as follows:

- There are no further price increases beyond 2.9 c/kWh after 2006 assumed in this study, whereas in the ADB study tariffs go up to 6 c/kWh.
- The ADB study assumed GDP growth falls to 3% p.a. after 2015, in their 'basic scenario' (i.e. the mean of the range given) while this study assumes continuing growth at 4% p.a. to 2025.

The Kyrgyz Republic

Demand decreases from around 12,145 GWh in 2003 to 10,000 GWh in 2015, after which it grows slowly, reaching 11,300 GWh in 2020 and 12,700 in 2025. The reasons for the negative growth to 2010 are: (a) substantial increases in tariffs and collections, which cause the effective tariff rate to rise by 103 percent between 2005 and 2010. Table A4.11 shows a comparison of this study's forecasts with those from other sources.

Table A4.11: Alternative Forecasts for the Kyrgyz Republic (Terawatt hours)

Source	2005	2010	2015	2020
This Study	11.1	9.2	10.0	11.3
ADB	12.3-13.2	13.3-15.6	14.6-18.2	15.7-20.5

The forecasts in this study are lower than the mean of the ADB forecasts by about 13 percent for 2005, 36 percent for 2010, 39 percent for 2015 and 38 percent for 2020. The reasons for the differences with the ADB forecasts are due to higher income elasticity in the ADB Study (1.1 versus 0.8 in this study) and higher GDP growth rates in the ADB Study (4.0% through 2015 compared to 3% in this study); and higher price elasticity in this Study (-0.3), which have a substantial impact on generation 2010.

Tajikistan

Demand would decline from 14,348 GWh in 2003 and even in 2025 will be lower than 2003 level indicating a declining level of demand of 0.17% through the period. The main reason for the decline of demand is the substantial increase in tariffs, which, combined with a large increase in collections, causes the effective tariff rate to rise by almost 4 times more than the 2003 levels.

Table A4.12: Alternative Forecasts for Tajikistan (Terawatt hours)

Source	2005	2010	2015	2020
This Study	14.2	11.3	12.4	14.0
ADB Study	15.7-17.0	16.8-19.8	18.3-22.8	19.7-25.7

Forecasts from this study are compared with those estimated in other sources (see Table A4.12). The forecasts calculated here are lower than the mean of the ADB forecasts in 2005 by 13 percent, thru 2010 by 38 percent, thru 2015 by 40 percent, thru 2020 by 38 percent. The reason for the lower growth rate of demand in this study is the lower assumed growth in GDP after 2006 (3% versus 4% in the ADB study); and higher price elasticity (-0.3).

Uzbekistan

Demand increases from about 44,700 GWh in 2003 to about 62,500 GWh in 2025, representing an annual growth rate over the period of about 1.14 percent. In the first 5 years, the annual growth is a negative 0.63 percent due to increase in collection rate and therefore effective tariff between 2005 and 2010.

Table A4.13: Alternative Forecasts for Uzbekistan (Terawatt hours)				
Source	2005	2010	2015	2020
This Study	45.8	46.6	51.3	56.6
ADB Study	47.8-51.7	52.8-62.6	59.6-75.0	65.2-86.1
JBIC's Forecast	50.7	55.9	61.8	

Table A4.13 presents this study's demand forecasts as well as those from other sources. This study has forecasts that are considerably lower than the mean ADB estimates[11]: 8 percent lower in 2005, 14 percent lower in 2010, 24 percent lower in 2015 and 24 percent lower in 2020. The very substantial differences can be attributed to the higher income elasticity in the ADB study (1.1 versus 0.8 in this Study) and higher GDP growth rates in ADB Study (4% p.a. up to 2015 and 3 % thereafter compared to 2.5% in this study for 2007-2025).

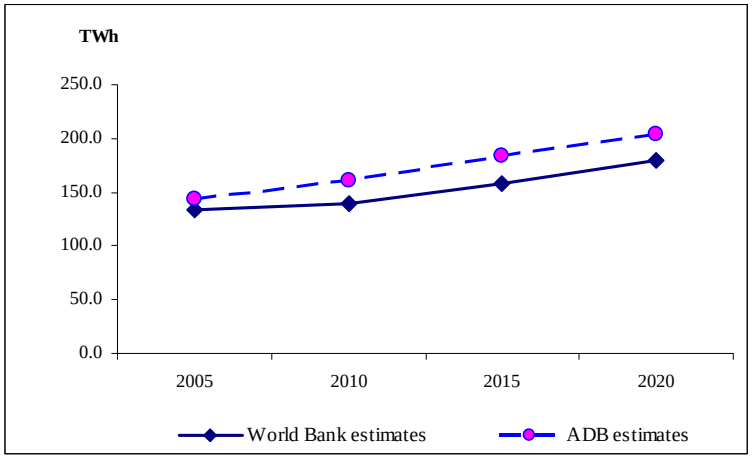


Figure A4.1: Comparison of ADB estimates and WB estimates, Gross Electricity Demand of CARs, 2005-2020

Overall Forecasts Comparison. Overall, therefore, compared with the ADB estimates, this study predicts a lower growth in demand for the region from 2005 to 2020. This can be seen in Figure A4.1.

V. Sensitivity Analysis

In view of the fact that the key determinants of demand, price and income elasticity levels chosen were based on experience elsewhere and not in the CARs, the demand projections were subjected to extensive sensitivity analyses by varying the key determinants of demand – price and income elasticity – in both directions. In addition, the projections were tested for delay or acceleration in reaching cost recovery tariffs. The primary objective of the sensitivity analyses is to ensure that unnecessary investments in new generation would need to be avoided in the CARs, and secondarily to understand the impact of the changes in demand on the exportable surpluses. The following cases were examined and with each case, the demand was matched with supplies from the existing and future supply sources.

[11] as well as the Japan Bank for International Cooperation estimates, and the mean figures of ADB forecasts and those of JBIC are close to each other.

(i) **High case 1:** The proposed tariff adjustments were delayed to 2015 (instead of 2010) for the Kyrgyz Republic and Tajikistan, where the tariff adjustments needed are the highest. The impacts are: the 2003-2025 compounded annual average growth rate (CAGR) of demand is higher by 0.04%; the 2025 demand is higher by about 0.8%; and the exportable surplus is lower by 0.7%. The winter deficits are slightly larger in the 2005-2010 period, confirming the need for new thermal generation sources.

(ii) **High case 2:** Price elasticity values were reduced in the Kyrgyz Republic and Tajikistan, where the poverty levels as well as tariff adjustments needed are the highest. The impacts are: the 2003-2025 CAGR of demand is higher by 8% (2.05% versus 1.9%); the 2025 demand is higher by about 3.25%; and the 2025 exportable surplus is lower by 29%. The winter deficits continue in the 2005-2010 period.

(iii) **High Case 3:** Income elasticity values were increased in all countries. The impacts are: the 2003-2025 CAGR of demand is higher by 20% (2.26% versus 1.9%); the 2025 demand is higher by about 8.23%; and the 2025 exportable surplus is lower by 73%. However, the peak surpluses during the 2010 through 2020 are in the 21.2 TWh to 36.3 TWh range and seasonal surpluses will continue.

(iv) **Low Case 1:** The proposed tariff adjustments were brought forward to 2006 for the Kyrgyz Republic and Tajikistan, where the tariff adjustments needed are the highest. The impacts are: the 2003-2025 compounded annual average growth rate (CAGR) of demand is lower by 2.5% (1.85% versus 1.0); the 2025 demand is lower by about 1.1%; and the exportable surplus is higher by 10%. The winter deficits continue to persist despite reduced demand in the Kyrgyz Republic.

(v) **Low Case 2:** Income elasticity values were reduced in all countries. The impacts are: the 2003-2025 CAGR of demand is lower by 19% (1.54% versus 1.9%); the 2025 demand is lower by about 7%; and the 2025 exportable surplus is higher by 32%. The winter deficits continue to persist in the Kyrgyz Republic and Kazakhstan in the 2005-2010 period, confirming the need for new thermal generation.

(vi) **Low Case 3:** Price elasticity values were increased in all countries. The impacts are: the 2003-2025 CAGR of demand is lower by 34%% (1.25% versus 1.9%); the 2025 demand is lower by about 13%; and the 2025 exportable surplus is higher by 120%. However, despite the significantly lowered demand, winter deficits continue to persist in the Kyrgyz Republic and Kazakhstan in the 2005-2010 period, confirming the need for new thermal generation.

Table 4.14: Results of Sensitivity Analyses on Demand Forecast

Country	Percentage Change in End-of-Period Demand for every	
	1% Change in Income Elasticity	1% Change in Price Elasticity
Kazakhstan	0.74	0.08
The Kyrgyz Republic	0.53	0.52
Tajikistan	0.64	0.74
Uzbekistan	0.45	0.22
All four Countries	0.63	0.20

The result of the sensitivity analyses, summarized in Table A4.14 shows that demand growth in the region overall is more sensitive to income elasticity values compared to price elasticity. Over

the 2005 – 2025 period, every 1% decrease in income elasticity projected demand would decrease by 0.63% compared to 0.2% change in demand for every 1% change in price elasticity. However, projected demand in individual countries behaves differently. Projected demand in Kazakhstan is more sensitive to changes in income elasticity and least sensitive to changes in price elasticity, confirming the international experience that as incomes grow, electricity demand becomes less and less elastic to price changes. Tajikistan, the poorest of the CARs, is more sensitive to price changes. The changes in the timing of projected tariff increases had only a minor impact on projected demand. The analyses also confirmed that even if demand were to be lower than projected, the new thermal capacity, especially Bishkek II, will still be needed. What would change is the timing of the requirement for the various increments of new generation capacity.

Demand Forecasts: Sensitivity Analysis

Key Parameters: **Base Case**

Country	Price Elasticity	Income Elasticity	Cost Recovery Tariff		GDP Growth in 2007-2025 p.a.
			Level USc/kWh	Year Tariffs reach Cost Recovery Level	
Kazakhstan	-0.1	0.8	2.90	2006	1.040
The Kyrgyz Republic	-0.3	0.8	2.45	2010	1.030
Tajikistan	-0.3	0.8	2.10	2010	1.030
Uzbekistan	-0.1	0.8	3.50	2006	1.025

Table A4.15: Gross Electricity Demand Projections, Base Case

Country	Actual	Demand forecast (GWh)					Annual Growth rates			
	2003	2005	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	62,475	72,056	84,034	98,367	115,146	2.91%	3.00%	3.06%	3.09%
The Kyrgyz Republic	12,145	11,069	9,222	10,033	11,296	12,719	-3.86%	-1.58%	-0.43%	0.21%
Tajikistan	16,348	14,216	11,267	12,410	13,972	15,731	-5.18%	-2.27%	-0.92%	-0.17%
Uzbekistan	48,691	45,794	46,597	51,255	56,589	62,479	-0.63%	0.43%	0.89%	1.14%
All Four Countries	136,128	133,554	139,142	157,731	180,225	206,075	0.31%	1.24%	1.66%	1.90%

Table A4.16: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	24786	28588	33340	39026	45683
	Surplus (+) / Deficit (-)	3198	3623	6876	3745	-234
Winter	Supply	35185	40500	50564	53778	57145
	Demand	37689	43468	50694	59341	69463
	Surplus (+) / Deficit (-)	-2504	-2969	-130	-5563	-12318
Annual	Supply	63169	72710	90780	96550	102594
	Demand	62475	72056	84034	98367	115146
	Surplus (+) / Deficit (-)	694	654	6746	-1818	-12552

Table A4.17: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3224	2686	2922	3290	3705
	Surplus (+) / Deficit (-)	4737	6283	6863	6406	5991
Winter	Supply	5754	8120	8628	13767	13767
	Demand	7845	6536	7111	8006	9014
	Surplus (+) / Deficit (-)	-2092	1584	1517	5761	4753
Annual	Supply	13714	17089	18414	23463	23463
	Demand	11069	9222	10033	11296	12719
	Surplus (+) / Deficit (-)	2645	7866	8381	12167	10744

Table A4.18: Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	7648	6233	6814	7597	8479
	Surplus (+) / Deficit (-)	1511	4587	6767	12579	11697
Winter	Supply	6665	7875	9883	14683	14683
	Demand	6569	5033	5596	6375	7252
	Surplus (+) / Deficit (-)	96	2841	4287	8308	7431
Annual	Supply	15823	18695	23464	34859	34859
	Demand	14216	11267	12410	13972	15731
	Surplus (+) / Deficit (-)	1607	7429	11055	20887	19128

Table A4.19: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	21862	22245	24469	27016	29827
	Surplus (+) / Deficit (-)	1620	3904	7635	5088	2091
Winter	Supply	26794	29837	36632	36632	36419
	Demand	23932	24352	26786	29574	32652
	Surplus (+) / Deficit (-)	2862	5485	9846	7058	3767
Annual	Supply	50277	55986	68736	68736	68337
	Demand	45794	46597	51255	56589	62479
	Surplus (+) / Deficit (-)	4483	9389	17481	12147	5858

Table A4.20: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	57520	59753	67544	76929	87694
	Surplus (+) / Deficit (-)	11066	18396	28142	27819	19545
Winter	Supply	74398	86331	105708	118860	122014
	Demand	76035	79390	90187	103296	118381
	Surplus (+) / Deficit (-)	-1637	6942	15521	15564	3633
Annual	Supply	142984	164480	201394	223608	229253
	Demand	133554	139142	157731	180225	206075
	Surplus (+) / Deficit (-)	9430	25338	43663	43383	23178

Demand Forecast: Sensitivity Analysis

Key Parameters: **High Case 1**

Country	Price Elasticity	Income Elasticity	Cost Recovery Tariff		GDP Growth in 2007-2025 p.a.
			Level USc/kWh	Year Tariffs reach Cost Recovery Level	
Kazakhstan	-0.1	0.8	2.90	2006	1.040
The Kyrgyz Republic	-0.3	0.8	2.45	2015	1.030
Tajikistan	-0.3	0.8	2.10	2015	1.030
Uzbekistan	-0.1	0.8	3.50	2006	1.025

Table A4.21: Gross Electricity Demand Projections, High Case 1

Country	Actual	Demand forecast (GWh)					Annual Growth rates			
	2003	2005	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	62,475	72,056	84,034	98,367	115,146	2.91%	3.00%	3.06%	3.09%
The Kyrgyz Republic	12,145	11,409	10,067	10,305	11,528	12,980	-2.65%	-1.36%	-0.31%	0.30%
Tajikistan	16,348	17,532	15,238	13,771	15,199	17,113	-1.00%	-1.42%	-0.43%	0.21%
Uzbekistan	48,691	45,794	46,597	51,255	56,589	62,479	-0.63%	0.43%	0.89%	1.14%
All Four Countries	136,128	137,209	143,958	159,364	181,684	207,718	0.80%	1.32%	1.71%	1.94%

Table A4.22: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	24786	28588	33340	39026	45683
	Surplus (+) / Deficit (-)	3198	3623	6876	3745	-234
Winter	Supply	35185	40500	50564	53778	57145
	Demand	37689	43468	50694	59341	69463
	Surplus (+) / Deficit (-)	-2504	-2969	-130	-5563	-12318
Annual	Supply	63169	72710	90780	96550	102594
	Demand	62475	72056	84034	98367	115146
	Surplus (+) / Deficit (-)	694	654	6746	-1818	-12552

Table A4.23: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3323	2932	3001	3358	3781
	Surplus (+) / Deficit (-)	4638	6037	6784	6338	5915
Winter	Supply	5754	8120	8628	13767	13767
	Demand	8086	7135	7303	8171	9199
	Surplus (+) / Deficit (-)	-2332	985	1325	5596	4568
Annual	Supply	13714	17089	18414	23463	23463
	Demand	11409	10067	10305	11528	12980
	Surplus (+) / Deficit (-)	2305	7022	8109	11935	10483

Table A4.24: Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	9431	8431	7561	8264	9224
	Surplus (+) / Deficit (-)	-273	2390	6020	11912	10952
Winter	Supply	6665	7875	9883	14683	14683
	Demand	8101	6807	6210	6935	7889
	Surplus (+) / Deficit (-)	-1436	1067	3674	7748	6794
Annual	Supply	15823	18695	23464	34859	34859
	Demand	17532	15238	13771	15199	17113
	Surplus (+) / Deficit (-)	-1709	3457	9694	19660	17747

Table A4.25: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	21862	22245	24469	27016	29827
	Surplus (+) / Deficit (-)	1620	3904	7635	5088	2091
Winter	Supply	26794	29837	36632	36632	36419
	Demand	23932	24352	26786	29574	32652
	Surplus (+) / Deficit (-)	2862	5485	9846	7058	3767
Annual	Supply	50277	55986	68736	68736	68337
	Demand	45794	46597	51255	56589	62479
	Surplus (+) / Deficit (-)	4483	9389	17481	12147	5858

Table A4.26: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	59402	62196	68371	77664	88515
	Surplus (+) / Deficit (-)	9183	15953	27315	27084	18725
Winter	Supply	74398	86331	105708	118860	122014
	Demand	77807	81762	90993	104020	119203
	Surplus (+) / Deficit (-)	-3409	4569	14715	14840	2811
Annual	Supply	142983	164480	201394	223608	229253
	Demand	137209	143958	159364	181684	207718
	Surplus (+) / Deficit (-)	5774	20522	42030	41924	21536

Demand Forecast: Sensitivity Analysis

Key Parameters: **High Case 2**

Country	Price Elasticity	Income Elasticity	Cost Recovery Tariff		GDP Growth in 2007-2025 p.a.
			Level USc/kWh	Year Tariffs reach Cost Recovery Level	
Kazakhstan	-0.1	0.8	2.90	2006	1.040
The Kyrgyz Republic	-0.2	0.8	2.45	2010	1.030
Tajikistan	-0.2	0.8	2.10	2010	1.030
Uzbekistan	-0.1	0.8	3.50	2006	1.025

Table A4.27: Gross Electricity Demand Projections, High Case 2

Country	Actual	Demand forecast (GWh)					Annual Growth rates			
	2003	2005	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	62,475	72,056	84,034	98,367	115,146	2.91%	3.00%	3.06%	3.09%
The Kyrgyz Republic	12,145	11,625	10,815	11,904	13,403	15,090	-1.64%	-0.17%	0.58%	0.99%
Tajikistan	16,348	15,699	14,254	15,818	17,809	20,051	-1.94%	-0.27%	0.50%	0.93%
Uzbekistan	48,691	45,794	46,597	51,255	56,589	62,479	-0.63%	0.43%	0.89%	1.14%
All Four Countries	136,128	135,593	143,722	163,010	186,169	212,767	0.78%	1.51%	1.86%	2.05%

Table A4.28: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	24786	28588	33340	39026	45683
	Surplus (+) / Deficit (-)	3198	3623	6876	3745	-234
Winter	Supply	35185	40500	50564	53778	57145
	Demand	37689	43468	50694	59341	69463
	Surplus (+) / Deficit (-)	-2504	-2969	-130	-5563	-12318
Annual	Supply	63169	72710	90780	96550	102594
	Demand	62475	72056	84034	98367	115146
	Surplus (+) / Deficit (-)	694	654	6746	-1818	-12552

Table A4.29: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3386	3150	3467	3904	4396
	Surplus (+) / Deficit (-)	4575	5819	6319	5792	5300
Winter	Supply	5754	8120	8628	13767	13767
	Demand	8239	7665	8437	9499	10695
	Surplus (+) / Deficit (-)	-2485	455	191	4268	3072
Annual	Supply	13714	17089	18414	23463	23463
	Demand	11625	10815	11904	13403	15090
	Surplus (+) / Deficit (-)	2090	6273	6510	10060	8373

Table A4.30: Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	8446	7886	8685	9683	10808
	Surplus (+) / Deficit (-)	713	2934	4896	10493	9368
Winter	Supply	6665	7875	9883	14683	14683
	Demand	7254	6368	7133	8126	9244
	Surplus (+) / Deficit (-)	-589	1507	2751	6557	5439
Annual	Supply	15823	18695	23464	34859	34859
	Demand	15699	14254	15818	17809	20051
	Surplus (+) / Deficit (-)	124	4441	7647	17050	14808

Table A4.31: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	21862	22245	24469	27016	29827
	Surplus (+) / Deficit (-)	1620	3904	7635	5088	2091
Winter	Supply	26794	29837	36632	36632	36419
	Demand	23932	24352	26786	29574	32652
	Surplus (+) / Deficit (-)	2862	5485	9846	7058	3767
Annual	Supply	50277	55986	68736	68736	68337
	Demand	45794	46597	51255	56589	62479
	Surplus (+) / Deficit (-)	4483	9389	17481	12147	5858

Table A4.32: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	58479	61869	69960	79629	90714
	Surplus (+) / Deficit (-)	10106	16279	25726	25119	16526
Winter	Supply	74398	86331	105708	118860	122014
	Demand	77113	81853	93050	106540	122053
	Surplus (+) / Deficit (-)	-2716	4478	12658	12320	-40
Annual	Supply	142983	164480	201394	223608	229253
	Demand	135593	143722	163010	186169	212767
	Surplus (+) / Deficit (-)	7390	20758	38384	37439	16486

Demand Forecast: Sensitivity Analysis

Key Parameters: **High Case 3**

Country	Price Elasticity	Income Elasticity	Cost Recovery Tariff		GDP Growth in 2007-2025 p.a.
			Level USc/kWh	Year Tariffs reach Cost Recovery Level	
Kazakhstan	-0.1	0.9	2.90	2006	1.040
The Kyrgyz Republic	-0.3	0.9	2.45	2010	1.030
Tajikistan	-0.3	0.9	2.10	2010	1.030
Uzbekistan	-0.1	0.9	3.50	2006	1.025

Table A4.33: Gross Electricity Demand Projections, High Case 3

Country	Actual	Demand forecast (GWh)					Annual Growth rates			
	2003	2005	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	63,113	74,549	88,639	105,785	126,248	3.41%	3.46%	3.50%	3.52%
The Kyrgyz Republic	12,145	11,137	9,441	10,422	11,908	13,604	-3.53%	-1.27%	-0.12%	0.52%
Tajikistan	16,348	14,453	11,684	13,059	14,920	17,046	-4.69%	-1.85%	-0.54%	0.19%
Uzbekistan	48,691	46,059	47,547	52,944	59,174	66,138	-0.34%	0.70%	1.15%	1.40%
All Four Countries	136,128	134,762	143,220	165,064	191,787	223,035	0.73%	1.62%	2.04%	2.27%

Table A4.34: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	25039	29577	35167	41969	50087
	Surplus (+) / Deficit (-)	2945	2634	5049	802	-4638
Winter	Supply	35185	40500	50564	53778	57145
	Demand	38074	44972	53472	63816	76160
	Surplus (+) / Deficit (-)	-2888	-4472	-2908	-10038	-19015
Annual	Supply	63169	72710	90780	96550	102594
	Demand	63113	74549	88639	105785	126248
	Surplus (+) / Deficit (-)	57	-1839	2140	-9235	-23653

Table A4.35: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3244	2750	3036	3468	3963
	Surplus (+) / Deficit (-)	4717	6219	6750	6228	5733
Winter	Supply	5754	8120	8628	13767	13767
	Demand	7893	6691	7387	8439	9642
	Surplus (+) / Deficit (-)	-2139	1429	1241	5327	4125
Annual	Supply	13714	17089	18414	23463	23463
	Demand	11137	9441	10422	11908	13604
	Surplus (+) / Deficit (-)	2577	7648	7991	11555	9859

Table A4.36: Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	7775	6464	7170	8112	9188
	Surplus (+) / Deficit (-)	1383	4356	6411	12064	10989
Winter	Supply	6665	7875	9883	14683	14683
	Demand	6678	5219	5889	6807	7858
	Surplus (+) / Deficit (-)	-13	2655	3995	7876	6825
Annual	Supply	15823	18695	23464	34859	34859
	Demand	14453	11684	13059	14920	17046
	Surplus (+) / Deficit (-)	1370	7011	10405	19939	17814

Table A4.37: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	21988	22699	25275	28250	31574
	Surplus (+) / Deficit (-)	1494	3450	6829	3854	344
Winter	Supply	26794	29837	36632	36632	36419
	Demand	24071	24848	27669	30925	34564
	Surplus (+) / Deficit (-)	2723	4989	8963	5707	1855
Annual	Supply	50277	55986	68736	68736	68337
	Demand	46059	47547	52944	59174	66138
	Surplus (+) / Deficit (-)	4218	8439	15792	9562	2199

Table A4.38: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	58047	61490	70648	81799	94812
	Surplus (+) / Deficit (-)	10539	16659	25038	22948	12428
Winter	Supply	74398	86331	105708	118860	122014
	Demand	76715	81731	94417	109987	128224
	Surplus (+) / Deficit (-)	-2318	4600	11291	8873	-6210
Annual	Supply	142983	164480	201394	223608	229253
	Demand	134762	143220	165064	191787	223035
	Surplus (+) / Deficit (-)	8221	21260	36329	31821	6218

Demand Forecast: Sensitivity Analysis

Key Parameters: **Low Case 1**

Country	Price Elasticity	Income Elasticity	Cost Recovery Tariff		GDP Growth in 2007-2025 p.a.
			Level USc/kWh	Year Tariffs reach Cost Recovery Level	
Kazakhstan	-0.1	0.8	2.90	2006	1.040
The Kyrgyz Republic	-0.3	0.8	2.45	2006	1.030
Tajikistan	-0.3	0.8	2.10	2006	1.030
Uzbekistan	-0.1	0.8	3.50	2006	1.025

Table A4.39: Gross Electricity Demand Projections, Low Case 1

Country	Actual	Demand forecast (GWh)					Annual Growth rates			
	2003	2005	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	62,475	72,056	84,034	98,367	115,146	2.91%	3.00%	3.06%	3.09%
The Kyrgyz Republic	12,145	11,069	8,813	9,695	10,915	12,290	-4.48%	-1.86%	-0.63%	0.05%
Tajikistan	16,348	14,216	9,809	10,896	12,268	13,812	-7.04%	-3.32%	-1.67%	-0.76%
Uzbekistan	48,691	45,794	46,597	51,255	56,589	62,479	-0.63%	0.43%	0.89%	1.14%
All Four Countries	136,128	133,554	137,275	155,879	178,140	203,728	0.12%	1.14%	1.59%	1.85%

Table A4.40: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	24786	28588	33340	39026	45683
	Surplus (+) / Deficit (-)	3198	3623	6876	3745	-234
Winter	Supply	35185	40500	50564	53778	57145
	Demand	37689	43468	50694	59341	69463
	Surplus (+) / Deficit (-)	-2504	-2969	-130	-5563	-12318
Annual	Supply	63169	72710	90780	96550	102594
	Demand	62475	72056	84034	98367	115146
	Surplus (+) / Deficit (-)	694	654	6746	-1818	-12552

Table A4.41: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3224	2567	2824	3179	3580
	Surplus (+) / Deficit (-)	4737	6402	6962	6517	6116
Winter	Supply	5754	8120	8628	13767	13767
	Demand	7845	6246	6871	7736	8710
	Surplus (+) / Deficit (-)	-2092	1874	1757	6031	5057
Annual	Supply	13714	17089	18414	23463	23463
	Demand	11069	8813	9695	10915	12290
	Surplus (+) / Deficit (-)	2645	8276	8719	12547	11173

Table A4.42: Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	7648	5427	5983	6670	7445
	Surplus (+) / Deficit (-)	1511	5394	7598	13506	12731
Winter	Supply	6665	7875	9883	14683	14683
	Demand	6569	4382	4913	5597	6368
	Surplus (+) / Deficit (-)	96	3493	4970	9086	8315
Annual	Supply	15823	18695	23464	34859	34859
	Demand	14216	9809	10896	12268	13812
	Surplus (+) / Deficit (-)	1607	8886	12568	22591	21047

Table A4.43: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	21862	22245	24469	27016	29827
	Surplus (+) / Deficit (-)	1620	3904	7635	5088	2091
Winter	Supply	26794	29837	36632	36632	36419
	Demand	23932	24352	26786	29574	32652
	Surplus (+) / Deficit (-)	2862	5485	9846	7058	3767
Annual	Supply	50277	55986	68736	68736	68337
	Demand	45794	46597	51255	56589	62479
	Surplus (+) / Deficit (-)	4483	9389	17481	12147	5858

Table A4.44: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	57520	58827	66615	75892	86535
	Surplus (+) / Deficit (-)	11066	19322	29071	28856	20704
Winter	Supply	74398	86331	105708	118860	122014
	Demand	76035	78448	89265	102249	117193
	Surplus (+) / Deficit (-)	-1637	7883	16443	16611	4821
Annual	Supply	142983	164480	201394	223608	229253
	Demand	133554	137275	155879	178140	203728
	Surplus (+) / Deficit (-)	9429	27205	45515	45468	25526

Demand Forecast: Sensitivity Analysis

Key Parameters: **Low case 2**

Country	Price Elasticity	Income Elasticity	Cost Recovery Tariff		GDP Growth in 2007-2025 p.a.
			Level USc/kWh	Year Tariffs reach Cost Recovery Level	
Kazakhstan	-0.1	0.7	2.90	2006	1.040
The Kyrgyz Republic	-0.3	0.7	2.45	2010	1.030
Tajikistan	-0.3	0.7	2.10	2010	1.030
Uzbekistan	-0.1	0.7	3.50	2006	1.025

Table A4.45: Gross Electricity Demand Projections, Low Case 2

Country	Actual	Demand forecast (GWh)					Annual Growth rates			
	2003	2005	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	61,840	69,634	79,646	91,439	104,978	2.41%	2.54%	2.62%	2.66%
The Kyrgyz Republic	12,145	11,002	9,008	9,657	10,715	11,888	-4.18%	-1.89%	-0.73%	-0.10%
Tajikistan	16,348	13,981	10,861	11,788	13,079	14,512	-5.67%	-2.69%	-1.30%	-0.54%
Uzbekistan	48,691	45,529	45,663	49,615	54,111	59,014	-0.91%	0.16%	0.62%	0.88%
All Four Countries	136,128	132,352	135,167	150,706	169,343	190,391	-0.10%	0.85%	1.29%	1.54%

Table A4.46: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	24534	27627	31599	36278	41649
	Surplus (+) / Deficit (-)	3450	4584	8616	6494	3800
Winter	Supply	35185	40500	50564	53778	57145
	Demand	37306	42007	48047	55161	63329
	Surplus (+) / Deficit (-)	-2120	-1507	2517	-1383	-6184
Annual	Supply	63169	72710	90780	96550	102594
	Demand	61840	69634	79646	91439	104978
	Surplus (+) / Deficit (-)	1329	3076	11133	5111	-2384

Table A4.47: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3205	2624	2813	3121	3463
	Surplus (+) / Deficit (-)	4756	6345	6973	6575	6233
Winter	Supply	5754	8120	8628	13767	13767
	Demand	7798	6385	6844	7594	8425
	Surplus (+) / Deficit (-)	-2044	1736	1784	6173	5342
Annual	Supply	13714	17089	18414	23463	23463
	Demand	11002	9008	9657	10715	11888
	Surplus (+) / Deficit (-)	2712	8080	8757	12748	11575

Table A4.48 Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	7521	6009	6473	7112	7822
	Surplus (+) / Deficit (-)	1637	4811	7108	13065	12354
Winter	Supply	6665	7875	9883	14683	14683
	Demand	6460	4852	5316	5968	6690
	Surplus (+) / Deficit (-)	205	3023	4568	8715	7993
Annual	Supply	15823	18695	23464	34859	34859
	Demand	13981	10861	11788	13079	14512
	Surplus (+) / Deficit (-)	1843	7834	11676	21780	20348

Table A4.49: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	21735	21799	23686	25832	28173
	Surplus (+) / Deficit (-)	1747	4350	8418	6272	3745
Winter	Supply	26794	29837	36632	36632	36419
	Demand	23793	23864	25929	28278	30841
	Surplus (+) / Deficit (-)	3001	5973	10703	8354	5578
Annual	Supply	50277	55986	68736	68736	68337
	Demand	45529	45663	49615	54111	59014
	Surplus (+) / Deficit (-)	4748	10323	19121	14625	9323

Table A4.50: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	56995	58059	64570	72342	81106
	Surplus (+) / Deficit (-)	11590	20090	31116	32406	26133
Winter	Supply	74398	86331	105708	118860	122014
	Demand	75357	77107	86136	97001	109285
	Surplus (+) / Deficit (-)	-959	9224	19571	21859	12729
Annual	Supply	142983	164480	201394	223608	229253
	Demand	132352	135167	150706	169343	190391
	Surplus (+) / Deficit (-)	10631	29314	50687	54264	38862

Demand Forecast: Sensitivity Analysis

Key Parameters: **Low case 3**

Country	Price Elasticity	Income Elasticity	Cost Recovery Tariff		GDP Growth in 2007-2025 p.a.
			Level USc/kWh	Year Tariffs reach Cost Recovery Level	
Kazakhstan	-0.2	0.8	2.90	2006	1.040
The Kyrgyz Republic	-0.4	0.8	2.45	2010	1.030
Tajikistan	-0.4	0.8	2.10	2010	1.030
Uzbekistan	-0.2	0.8	3.50	2006	1.025

Table A4.51: Gross Electricity Demand Projections, Low Case 3

Country	Actual	Demand forecast (GWh)					Annual Growth rates			
	2003	2005	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,944	60,883	66,563	77,335	90,526	105,968	1.75%	2.29%	2.56%	2.70%
The Kyrgyz Republic	12,145	10,526	7,830	8,418	9,478	10,671	-6.08%	-3.01%	-1.45%	-0.59%
Tajikistan	16,348	12,789	8,799	9,618	10,829	12,192	-8.47%	-4.32%	-2.39%	-1.32%
Uzbekistan	48,691	40,750	37,388	40,969	45,233	49,941	-3.70%	-1.43%	-0.43%	0.12%
All Four Countries	136,128	124,948	120,580	136,340	156,066	178,772	-1.72%	0.01%	0.81%	1.25%

Table A4.52: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	24155	26408	30682	35916	42041
	Surplus (+) / Deficit (-)	3830	5802	9533	6856	3408
Winter	Supply	35185	40500	50564	53778	57145
	Demand	36729	40154	46653	54611	63926
	Surplus (+) / Deficit (-)	-1543	345	3911	-833	-6781
Annual	Supply	63169	72710	90780	96550	102594
	Demand	60883	66563	77335	90526	105968
	Surplus (+) / Deficit (-)	2286	6148	13445	6023	-3374

Table A4.53: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3066	2281	2452	2760	3108
	Surplus (+) / Deficit (-)	4895	6688	7334	6936	6588
Winter	Supply	5754	8120	8628	13767	13767
	Demand	7460	5550	5966	6717	7563
	Surplus (+) / Deficit (-)	-1706	2570	2662	7049	6204
Annual	Supply	13714	17089	18414	23463	23463
	Demand	10526	7830	8418	9478	10671
	Surplus (+) / Deficit (-)	3189	9258	9996	13985	12792

Table A4.54 Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	6880	4868	5281	5888	6572
	Surplus (+) / Deficit (-)	2279	5952	8300	14288	13605
Winter	Supply	6665	7875	9883	14683	14683
	Demand	5909	3931	4337	4941	5620
	Surplus (+) / Deficit (-)	756	3944	5546	9742	9063
Annual	Supply	15823	18695	23464	34859	34859
	Demand	12789	8799	9618	10829	12192
	Surplus (+) / Deficit (-)	3034	9896	13847	24031	22667

Table A4.55: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	19454	17849	19558	21594	23842
	Surplus (+) / Deficit (-)	4028	8300	12546	10510	8076
Winter	Supply	26794	29837	36632	36632	36419
	Demand	21296	19539	21411	23639	26099
	Surplus (+) / Deficit (-)	5498	10298	15221	12993	10320
Annual	Supply	50277	55986	68736	68736	68337
	Demand	40750	37388	40969	45233	49941
	Surplus (+) / Deficit (-)	9527	18598	27767	23503	18396

Table A4.56: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	53554	51406	57973	66158	75563
	Surplus (+) / Deficit (-)	15031	26743	37713	38590	31676
Winter	Supply	74398	86331	105708	118860	122014
	Demand	71394	69174	78367	89908	103209
	Surplus (+) / Deficit (-)	3004	17158	27341	28952	18805
Annual	Supply	142983	164480	201394	223608	229253
	Demand	124948	120580	136340	156066	178772
	Surplus (+) / Deficit (-)	18036	43901	65054	67542	50481

Demand Forecast: Sensitivity Analysis

Key Parameters: **Alternative Demand case**

Country	Changes in Electricity Intensity p.a. in %		
	2005-2009	2010-2014	2015-2025
Kazakhstan	-2.0	-1.5	-1.0
The Kyrgyz Republic	-2.0	-1.5	-1.0
Tajikistan	-2.0	-1.5	-1.0
Uzbekistan	-2.0	-1.5	-1.0

Table A4.57: Gross Electricity Demand Projections, Alternative Scenario

Country	Actual	Demand forecast (GWh)				Annual Growth rates			
	2003	2010	2015	2020	2025	2003-2010	2003-2015	2003-2020	2003-2025
Kazakhstan	58,994	75,706	85,837	99,316	114,911	3.63%	3.17%	3.11%	3.08%
The Kyrgyz Republic	12,145	13,915	15,033	16,573	18,271	1.96%	1.79%	1.85%	1.87%
Tajikistan	16,348	21,485	23,211	25,589	28,211	3.98%	2.96%	2.67%	2.51%
Uzbekistan	48,691	53,828	56,756	61,067	65,705	1.44%	1.29%	1.34%	1.37%
All Four Countries	136,178	164,934	180,837	202,545	227,099	2.77%	2.39%	2.36%	2.35%

Table A4.58: Kazakhstan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	27984	32211	40215	42771	45449
	Demand	23405	30036	34055	39403	45589
	Surplus (+) / Deficit (-)	4579	2175	6160	3369	-140
Winter	Supply	35185	40500	50564	53778	57145
	Demand	42854	45670	51782	59913	69321
	Surplus (+) / Deficit (-)	-7669	-5170	-1218	-6135	-12176
Annual	Supply	63169	72710	90780	96550	102594
	Demand	66259	75706	85837	99316	114911
	Surplus (+) / Deficit (-)	-3090	-2995	4943	-2766	-12317

Table A4.59: The Kyrgyz Republic. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	7961	8969	9786	9696	9696
	Demand	3538	4053	4378	4827	5322
	Surplus (+) / Deficit (-)	4423	4916	5407	4869	4374
Winter	Supply	5754	8120	8628	13767	13767
	Demand	9410	9862	10655	11746	12949
	Surplus (+) / Deficit (-)	-3657	-1742	-2026	2021	818
Annual	Supply	13714	17089	18414	23463	23463
	Demand	12948	13915	15033	16573	18271
	Surplus (+) / Deficit (-)	766	3174	3381	6890	5191

Table A4.60 Tajikistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	9158	10821	13581	20176	20176
	Demand	8794	11887	12744	13914	15206
	Surplus (+) / Deficit (-)	364	-1066	837	6263	4970
Winter	Supply	6665	7875	9883	14683	14683
	Demand	10897	9598	10467	11676	13005
	Surplus (+) / Deficit (-)	-4232	-1723	-583	3007	1678
Annual	Supply	15823	18695	23464	34859	34859
	Demand	19691	21485	23211	25589	28211
	Surplus (+) / Deficit (-)	-3868	-2790	253	9270	6648

Table A4.61: Uzbekistan. Electricity Demand Supply Balance in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	23482	26149	32104	32104	31918
	Demand	23245	25697	27095	29153	31368
	Surplus (+) / Deficit (-)	237	452	5009	2951	550
Winter	Supply	26794	29837	36632	36632	36419
	Demand	28366	28131	29661	31914	34338
	Surplus (+) / Deficit (-)	-1572	1706	6971	4718	2081
Annual	Supply	50276	55986	68736	68736	68337
	Demand	51611	53828	56756	61067	65705
	Surplus (+) / Deficit (-)	-1335	2158	11980	7669	2632

Table A4.62: All Four CA Countries. Electricity Demand Supply Balances in 2005-2025

	Year	2005	2010	2015	2020	2025
Summer	Supply	68585	78149	95686	104748	107239
	Demand	58982	71673	78273	87296	97485
	Surplus (+) / Deficit (-)	9603	6476	17413	17451	9754
Winter	Supply	74398	86331	105708	118860	122014
	Demand	91527	93261	102564	115249	129614
	Surplus (+) / Deficit (-)	-17129	-6930	3144	3611	-7600
Annual	Supply	142983	164480	201394	223608	229253
	Demand	150509	164934	180837	202545	227099
	Surplus (+) / Deficit (-)	-7526	-454	20557	21063	2155

Appendix 4.2

Central Asia
Regional Electricity Export Potential Study
Incremental and Total Supplies from Supply Options

The incremental and total power supplies available from the supply options in each of the countries are presented in this Annex. The supply options to meet the projected demand include (a) projects for rehabilitation of the transmission and distribution system to reduce the high level of T&D losses; (b) projects for rehabilitating the existing generating units; and (c) construction of new generating plants.

Table A4.63: Kazakhstan. Incremental Power Supply and Total Supply (GWh)

	Incremental Supply from Investment Projects in:				
Year	Transmission and Distribution	Ekibastuz GRES-1 Rehabilitation	Other TPPs' Units Rehabilitation	New Generation Units	Total Kazakhstan Supply
Current Generation					61,500
2004	835	-	-	-	62,335
2005	1,669	-	-	-	63,169
2006	2,504	-	-	-	64,004
2007	3,339	-	856	-	65,695
2008	4,174	-	2,225	-	67,899
2009	5,008	-	3,595	-	70,103
2010	5,843	403	4,964		72,710
2011	5,843	3,224	6,334		76,901
2012	5,843	6,447	7,703		81,493
2013	5,843	11,283	9,072		87,698
2014	5,843	11,283	10,613		89,239
2015	5,843	11,283	12,154		90,780
2016	5,843	11,283	13,694		92,320
2017	5,843	11,283	15,406		94,032
2018	5,843	11,283	17,118		95,744
2019	5,843	11,283	17,118		95,744
2020	5,843	11,283	17,118	806	96,550
2021	5,843	11,283	17,118	4,231	99,975
2022	5,843	11,283	17,118	6,850	102,594
2023	5,843	11,283	17,118	6,850	102,594
2024	5,843	11,283	17,118	6,850	102,594
2025	5,843	11,283	17,118	6,850	102,594

Table A4.64: The Kyrgyz Republic. Incremental Power Supply and Total Supply (GWh)

Year	Incremental Supply from Investment Projects in:				Total Kyrgyzstan Gross Supply
	Transmission and Distribution	Bishkek CHP-2	Kambarata 2 HPP	Kambarata 1 HPP	
Current Generation					13,342
2004	184	-	-	-	13,526
2005	372	-	-	-	13,714
2006	566	-	-	-	13,908
2007	764	353	-	-	14,459
2008	968	1,531	-	-	15,841
2009	1,177	2,355	-	-	16,874
2010	1,392	2,355	-	-	17,089
2011	1,612	2,355	-	-	17,309
2012	1,612	2,355	221	-	17,530
2013	1,612	2,355	1,105	-	18,414
2014	1,612	2,355	1,105	-	18,414
2015	1,612	2,355	1,105	-	18,414
2016	1,612	2,355	1,105	-	18,414
2017	1,612	2,355	1,105	252	18,666
2018	1,612	2,355	1,105	1,515	19,929
2019	1,612	2,355	1,105	3,029	21,443
2020	1,612	2,355	1,105	5,049	23,463
2021	1,612	2,355	1,105	5,049	23,463
2022	1,612	2,355	1,105	5,049	23,463
2023	1,612	1,183	1,105	5,049	22,291
2024	1,612	1,183	1,105	5,049	22,291
2025	1,612	2,355	1,105	5,049	23,463

Notes:

The current generation shown (13,342 GWh) is the average generation over the 1999-2003 period, which included a good combination of normal, wet and dry hydrological years. Also it encompasses the modified irrigation mode (recommended for Toktogul operation) since modified mode is a split in seasonal generation and there would not be a change in annual generation.

Table A4.65: Tajikistan. Incremental Power Supply and Total Supply (GWh)

Year	Incremental supply from Investment Projects in:				Total Tajikistan Supply
	Transmission & Distribution	DSM	Sangtuda I HPP	Rogun HPP, Phase I and II	
Current Generation					15,181
2004	266	-	-	-	15,447
2005	537	105	-	-	15,823
2006	815	225	-	-	16,221
2007	1,099	523	-	-	16,803
2008	1,389	572	-	-	17,142
2009	1,685	631	134	-	17,631
2010	1,988	724	802	-	18,695
2011	1,988	751	1,470	-	19,390
2012	1,988	778	2,138	-	20,085
2013	1,988	806	2,673	-	20,648
2014	1,988	833	2,673	515	21,190
2015	1,988	860	2,673	2,762	23,464
2016	1,988	860	2,673	4,643	25,345
2017	1,988	860	2,673	5,282	25,984
2018	1,988	860	2,673	7,712	28,414
2019	1,988	860	2,673	10,712	31,414
2020	1,988	860	2,673	14,157	34,859
2021	1,988	860	2,673	14,157	34,859
2022	1,988	860	2,673	14,157	34,859
2023	1,988	860	2,673	14,157	34,859
2024	1,988	860	2,673	14,157	34,859
2025	1,988	860	2,673	14,157	34,859

Notes:

- The current generation shown (15,181 GWh) is the average generation over the 1999-2003 period, which included a good combination of different hydrological years.
- DSM involves shifting space heating load away from electricity.

Table A4.66: Uzbekistan. Incremental Power Supply and Total Supply (GWh)

Year	Incremental supply from Investment Projects in:			Retirement		Total Uzbekistan Supply
	Transmission and Distribution	Talimarjan TPP Unit #1	Talimarjan TPP Units #2-4	Loss of Capacity MW	Loss of Generation GWh	
2003						48,700
2004	555	-				49,255
2005	1,118	609		250	(151)	50,277
2006	1,690	1,828		110	(435)	51,783
2007	2,270	4,265		100	(849)	54,387
2008	2,860	4,265		160	(1,044)	54,781
2009	3,457	4,265		-	(1,044)	55,379
2010	4,064	4,265		-	(1,044)	55,986
2011	4,064	4,265	609	-	(1,044)	56,595
2012	4,064	4,265	2,437	-	(1,044)	58,423
2013	4,064	4,265	6,703	55	(1,067)	62,665
2014	4,064	4,265	10,359	-	(1,067)	66,322
2015	4,064	4,265	12,796	55	(1,090)	68,736
2016	4,064	4,265	12,796	-	(1,090)	68,736
2017	4,064	4,265	12,796	-	(1,090)	68,736
2018	4,064	4,265	12,796	-	(1,090)	68,736
2019	4,064	4,265	12,796	-	(1,090)	68,736
2020	4,064	4,265	12,796	-	(1,090)	68,736
2021	4,064	4,265	12,796	110	(1,489)	68,337
2022	4,064	4,265	12,796	-	(1,489)	68,337
2023	4,064	4,265	12,796	-	(1,489)	68,337
2024	4,064	4,265	12,796	-	(1,489)	68,337
2025	4,064	4,265	12,796	-	(1,489)	68,337

Table A4.67: All Four CA Republics. Incremental Power Supply and Total Supply (GWh) From Power Investment Program					
Year	Kazakhstan	The Kyrgyz Republic	Tajikistan	Uzbekistan	Total CA Supply
Current Generation	61,500	13,342	15,181	48,700	138,723
2004	62,335	13,526	15,447	49,255	140,563
2005	63,169	13,714	15,823	50,277	142,983
2006	64,004	13,908	16,221	51,783	145,916
2007	65,695	14,459	16,803	54,386	151,343
2008	67,899	15,841	17,142	54,781	155,663
2009	70,103	16,874	17,631	55,378	159,986
2010	72,710	17,089	18,695	55,986	164,480
2011	76,901	17,309	19,390	56,595	170,195
2012	81,493	17,530	20,085	58,423	177,531
2013	87,698	18,414	20,648	62,666	189,426
2014	89,239	18,414	21,190	66,322	195,165
2015	90,780	18,414	23,464	68,736	201,394
2016	92,320	18,414	25,345	68,736	204,815
2017	94,032	18,666	25,984	68,736	207,418
2018	95,744	19,929	28,414	68,736	212,823
2019	95,744	21,443	31,414	68,736	217,337
2020	96,550	23,463	34,859	68,736	223,608
2021	99,975	23,463	34,859	68,337	226,634
2022	102,594	23,463	34,859	68,337	229,253
2023	102,594	22,291	34,859	68,337	228,081
2024	102,594	22,291	34,859	68,337	228,081
2025	102,594	23,463	34,859	68,337	229,253

Appendix 4.3

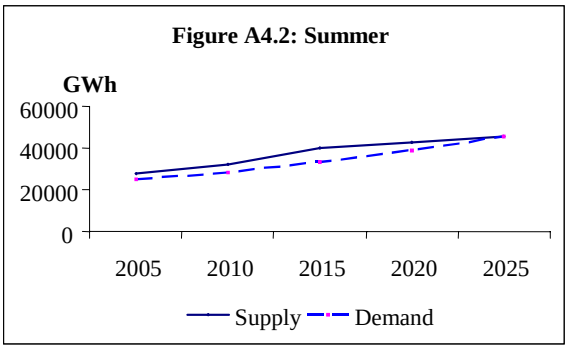
Central Asia
Regional Electricity Export Potential Study
Electricity Demand Supply Balances

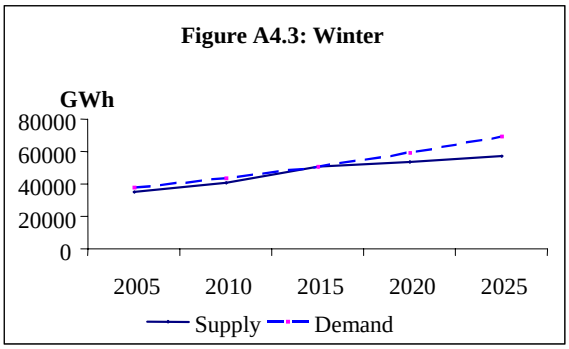
The supplies from the supply options are matched with the projected demand (Base Case) for each of the CARs to arrive at the demand supply balances both on a seasonal (summer and winter) and annual basis in this Annex.

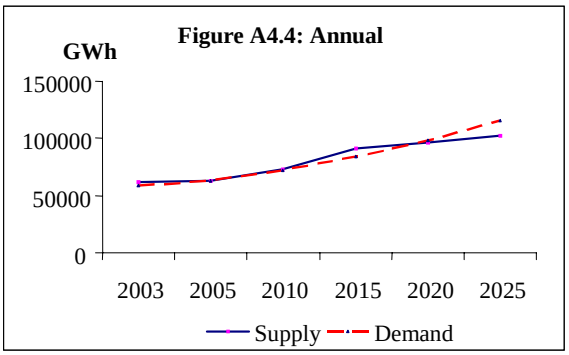
Kazakhstan Supply Demand Balances

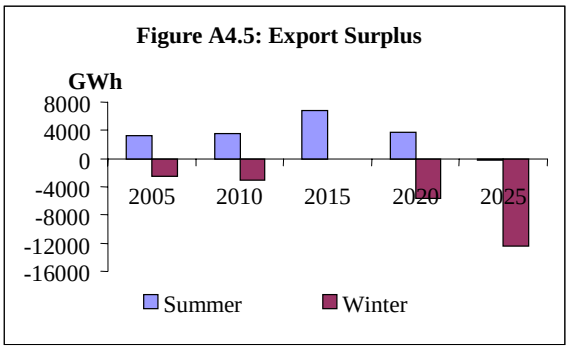
Table A4.68: Kazakhstan. Electricity Demand Supply Balance in 2003-2025

Year		2003	2005	2010	2015	2020	2025
Summer	Supply	27245	27984	32211	40215	42771	45449
	Demand	23385	24786	28588	33340	39026	45683
	Surplus (+) / Deficit (-)	3859	3198	3623	6876	3745	-234
Winter	Supply	34256	35185	40500	50564	53778	57145
	Demand	35559	37689	43468	50694	59341	69463
	Surplus (+) / Deficit (-)	-1303	-2504	-2969	-130	-5563	-12318
Annual	Supply	61500	63169	72710	90780	96550	102594
	Demand	58944	62475	72056	84034	98367	115146
	Surplus (+) / Deficit (-)	2556	694	654	6746	-1818	-12552









The Kyrgyz Republic Supply Demand Balances

Table A4.69: The Kyrgyz Republic Electricity Demand Supply Balance in 2003-2025

Year		2003	2005	2010	2015	2020	2025
Summer	Supply	4430	7961	8969	9786	9696	9696
	Demand	3538	3224	2686	2922	3290	3705
	Surplus (+) / Deficit (-)	892	4737	6282	6863	6406	5991
Winter	Supply	8912	5754	8120	8628	13767	13767
	Demand	8607	7845	6536	7111	8006	9014
	Surplus (+) / Deficit (-)	305	-2092	1584	1517	5761	4753
Annual	Supply	13342	13714	17089	18414	23463	23463
	Demand	12145	11069	9222	10033	11296	12719
	Surplus (+) / Deficit (-)	1197	2645	7866	8381	12167	10744

Figure A4.6: Summer

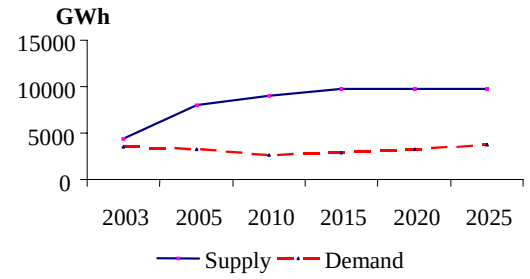


Figure A4.7: Winter

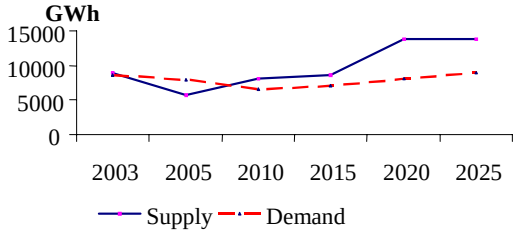


Figure A4.8: Annual

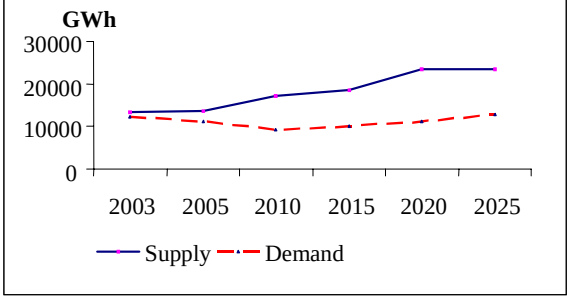
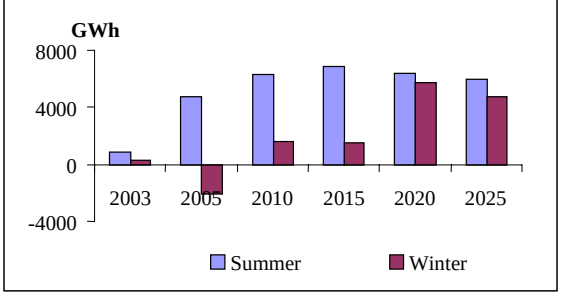


Figure A4.9: Export Surplus



Tajikistan Supply Demand Balances

Table A4.70: Tajikistan Electricity Demand Supply Balance in 2003-2025

Year		2003	2005	2010	2015	2020	2025
Summer	Supply	8835	9158	10821	13581	20176	20176
	Demand	8794	7648	6233	6814	7597	8479
	Surplus (+) / Deficit (-)	41	1511	4587	6767	12579	11697
Winter	Supply	6346	6665	7875	9883	14683	14683
	Demand	7554	6569	5033	5596	6375	7252
	Surplus (+) / Deficit (-)	-1208	96	2841	4287	8308	7431
Annual	Supply	15181	15823	18695	23464	34859	34859
	Demand	16348	14216	11267	12410	13972	15731
	Surplus (+) / Deficit (-)	-1167	1607	7429	11055	20887	19128

Figure A4.10: Summer

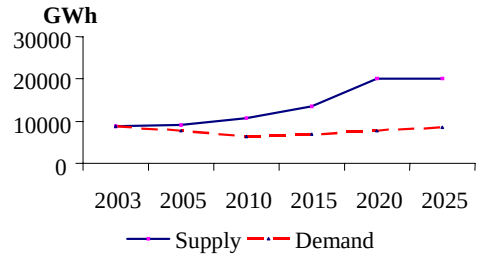


Figure A4.11: Winter

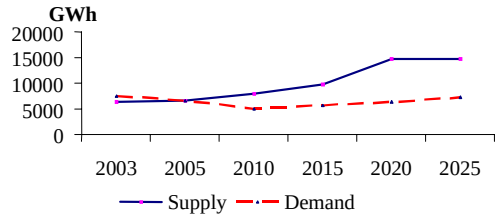


Figure A4.12: Annual

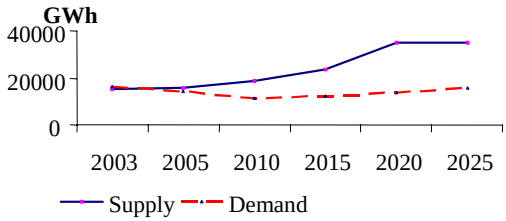
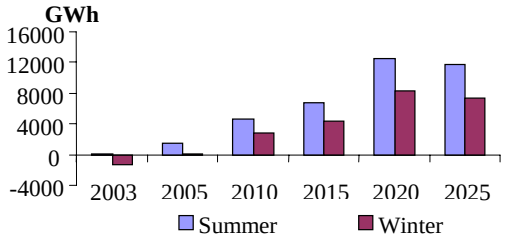


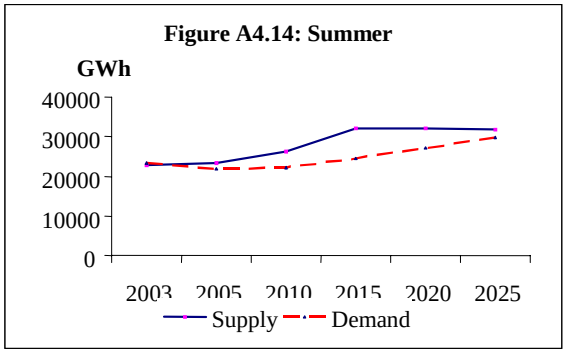
Figure A4.13: Export Surplus

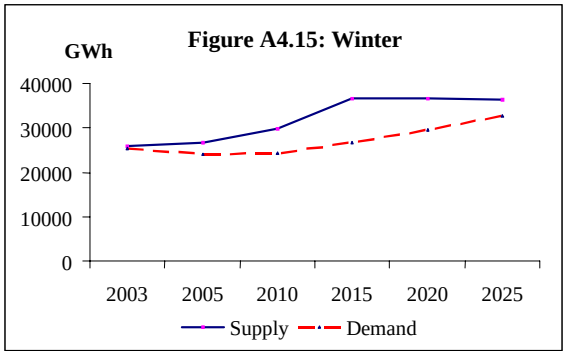


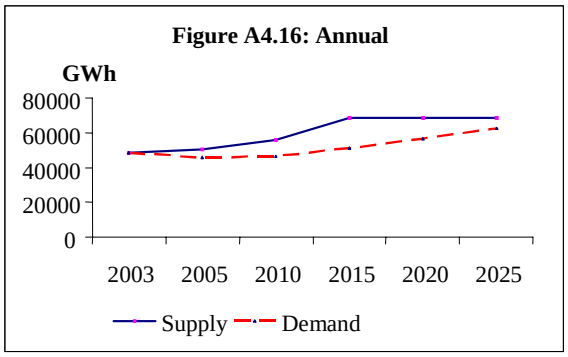
Uzbekistan Supply Demand Balances

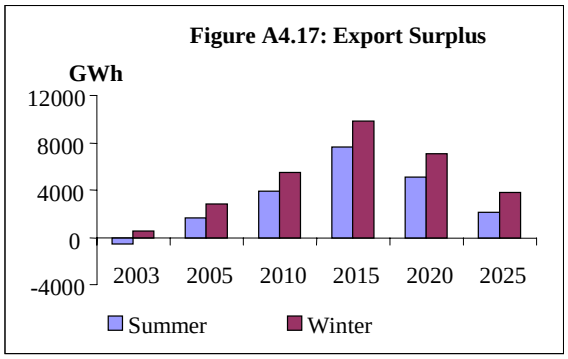
Table A4.71: Uzbekistan Electricity Demand Supply Balance in 2003-2025

Year		2003	2005	2010	2015	2020	2025
Summer	Supply	22746	23482	26149	32104	32104	31918
	Demand	23245	21862	22245	24468	27015	29827
	Surplus (+) / Deficit (-)	-499	1620	3904	7636	5089	2091
Winter	Supply	25,954	26,795	29,837	36,632	36,632	36,419
	Demand	25,446	23,932	24,352	26,786	29,574	32,652
	Surplus (+) / Deficit (-)	508	2863	5484	9846	7058	3767
Annual	Supply	48,700	50,277	55,986	68,736	68,736	68,337
	Demand	48,691	45,794	46,597	51,255	56,589	62,479
	Surplus (+) / Deficit (-)	9	4483	9388	17481	12147	5858



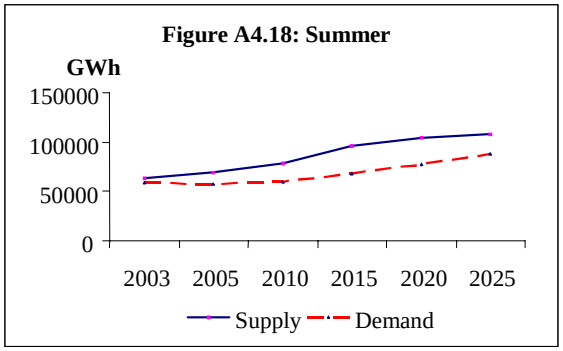


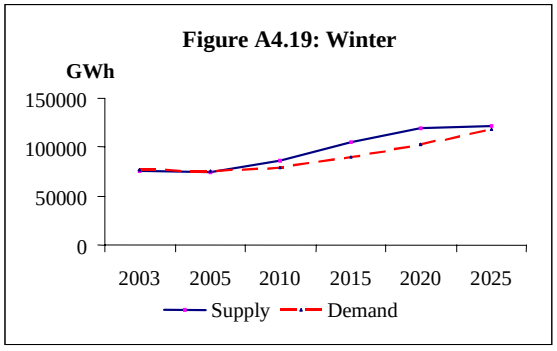


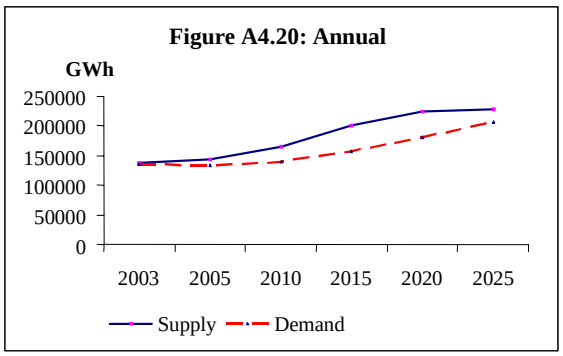


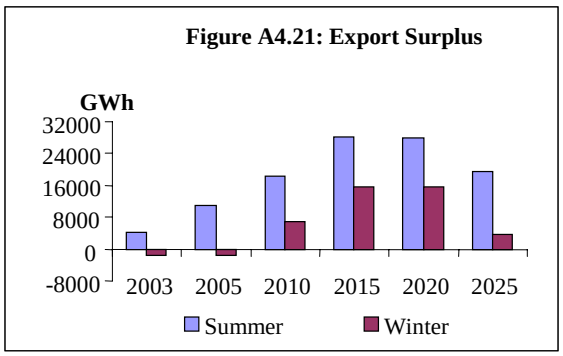
All Four CA Countries Supply Demand Balances

Table A4.72: All Four CA Countries Electricity Demand Supply Balance in 2003-2025							
Year		2003	2005	2010	2015	2020	2025
Summer	Supply	63255	68585	78149	95686	104748	107239
	Demand	58962	57519	59752	67544	76929	87694
	Surplus (+) / Deficit (-)	4293	11066	18396	28142	27819	19546
Winter	Supply	75468	74399	86331	105708	118860	122014
	Demand	77166	76035	79390	90187	103296	118381
	Surplus (+) / Deficit (-)	-1698	-1636	6941	15521	15564	3633
Annual	Supply	138723	142984	164480	201394	223608	229253
	Demand	136128	133554	139142	157731	180225	206075
	Surplus (+) / Deficit (-)	2595	9429	25338	43663	43383	23178









Appendix 5.1

Central Asia
Regional Electricity Export Potential Study
Economic Analysis of Supply Options

Economic costs of output from each of the supply options are derived in this Appendix. The key determinants are annual phasing of capital expenditures, fuel costs (where applicable), operation and maintenance (O&M) costs, as well as incremental sales (as losses are reduced) in the case of transmission and distribution investments and the energy sent out from the generating station (i.e., gross energy generated minus station use or auxiliary consumption) in the case of generation plants.[12] Fuel costs are computed on the basis of gas prices at $35/KCM (the current traded price of Uzbek gas to Kazakhstan)[13]; and coal prices at $20/ton (the current border price for Kazakh coal to Kyrgyz). To arrive at the economic output cost per kWh, the capital, fuel and O&M costs incurred and energy sent out by the plant each year (GWh) are discounted over a 20-year period to the present using a discount rate of 10% (which is considered the opportunity cost of capital in CARs) and discounted costs are divided by the discounted electricity units sent out.

[12] It is important to note that in respect of all the partially completed projects, all costs incurred so far in the past are treated as sunk costs and are ignored for the purposes of this analysis, which essentially compares incremental costs to be incurred with the benefits that will accrue.

[13] These prices indeed are low compared to the international prices of $80-120/KCM (e.g., long-term contract price of Gazprom to Western Europe), and the difference reflects the penalty that Uzbekistan pays for being land-locked, and for being far away from creditworthy markets.

A. Loss Reduction in Transmission and Distribution Systems

1. Kazakhstan

During 2004-2010, Kazakhstan plans to invest $258 million in transmission rehabilitation to reduce losses and to improve the reliability of its electricity supply.[14] Its distribution rehabilitation investment needs are estimated at $1,038 million at the rate of $250 per low

Table A5.1: Kazakhstan. AIC for T&D Rehabilitation

Calendar Year	Capital Investment ($ million)	Incremental O&M Costs ($ million)	Total Incremental Costs ($ million)	Incremental Sales GWh
2003				
2004	129.6	2.6	132.2	835
2005	194.4	6.5	200.9	1669
2006	194.4	10.4	204.8	2504
2007	194.4	14.3	208.7	3339
2008	194.4	16.2	210.6	4174
2009	194.4	18.1	212.6	5008
2010	194.4	20.1	214.5	5843
2011		20.1	20.1	5843
2012		20.1	20.1	5843
2013		20.1	20.1	5843
2014		20.1	20.1	5843
2015		20.1	20.1	5843
2016		20.1	20.1	5843
2017		20.1	20.1	5843
2018		20.1	20.1	5843
2019		20.1	20.1	5843
2020		20.1	20.1	5843
2021		20.1	20.1	5843
2022		20.1	20.1	5843
2023		20.1	20.1	5843
Present Values				
Incremental Costs ($ million) discounted at 10%				1016.7
Incremental Sales (million kWh) discounted at 10%				36016
Average Incremental Costs (¢/kWh)				2.8

voltage consumer connection for 4,152,470 households.[15] Incremental O&M expenditures are assumed at 2% of Capital Expenditure in year 1 through 4, but declining to 1% in year 5 through 7[16]. The system losses are expected to come down from the present levels of 24% to 15% by 2010. The economic cost of additional supply resulting from the loss reduction project is estimated at 2.8 cents/kWh as shown in Table A5.1 by discounting incremental costs and incremental supplies at 10%.

[14] This is the on-going World Bank and EBRD funded project

[15] DFID, IPA Energy Consulting, the Kyrgyz Republic, Azerbaijan, Georgia, Investigations on Electricity Distribution Capital Expenditures Requirements. See also USAID, Regional Review of Social Safety Net Approaches, Annex 5, Energy Reform and Social Protection in Kazakhstan

[16] WB's estimate

2. The Kyrgyz Republic

During 2004-2010, the Kyrgyz Republic would spend $250 million in transmission and distribution rehabilitation to reduce technical losses from the present level of 34% to 13% by 2010. Almost the whole of this investment would be in the distribution system. Incremental O&M expenditures are assumed at 4% of Capital Expenditures in year 1, declining to 3% in year 2, and stabilizing at 2% year 3 onwards. The economic cost of additional supply arising from this project is estimated at 2.3 cents/kWh as shown in Table A5.2.

Table A5.2: The Kyrgyz Republic. AIC for T&D Rehabilitation

Calendar Year	Capital Investment ($ million)	Incremental O&M Costs ($ million)	Total Incremental Costs ($ million)	Incremental Sales GWh
2003				
2004	20.0	0.8	20.8	184
2005	30.0	1.7	31.7	372
2006	50.0	2.7	52.7	566
2007	60.0	3.9	63.9	764
2008	50.0	4.9	54.9	968
2009	30.0	5.5	35.5	1177
2010	10.0	5.7	15.7	1392
2011		5.7	5.7	1612
2012		5.7	5.7	1612
2013		5.7	5.7	1612
2014		5.7	5.7	1612
2015		5.7	5.7	1612
2016		5.7	5.7	1612
2017		5.7	5.7	1612
2018		5.7	5.7	1612
2019		5.7	5.7	1612
2020		5.7	5.7	1612
2021		5.7	5.7	1612
2022		5.7	5.7	1612
2023		5.7	5.7	1612
Present Values				
Incremental Costs (US$ million)				211.3
Incremental Sales (million kWh)				9280
Average Incremental Costs (cents/kWh)				2.3

3. Tajikistan

During 2004-2010, total investment in transmission and distribution rehabilitation in Tajikistan for reducing technical losses from the present level of 28% to 13% by 2010 is estimated at US$310 million. Incremental O&M expenditures are estimated at 4% of capital expenditures in year 1 through 5, declining to 3% in year 6, and to 2% in year 7. On this basis the economic cost of the additional supply is estimated at 2.1 cents/kWh as shown in Table A5.3.

Table A5.3: Tajikistan. AIC for T&D Rehabilitation

Calendar Year	Capital Investment ($ million)	Incremental O&M Costs ($ million)	Total Incremental Costs ($ million)	Incremental Sales GWh
2003				
2004	8.0	0.3	8.3	266
2005	17.0	1.0	18.0	537
2006	38.0	2.5	40.5	815
2007	55.0	4.7	59.7	1099
2008	59.0	7.1	66.1	1389
2009	65.0	9.0	74.0	1685
2010	68.0	10.4	78.4	1988
2011		10.4	10.4	1988
2012		10.4	10.4	1988
2013		10.4	10.4	1988
2014		10.4	10.4	1988
2015		10.4	10.4	1988
2016		10.4	10.4	1988
2017		10.4	10.4	1988
2018		10.4	10.4	1988
2019		10.4	10.4	1988
2020		10.4	10.4	1988
2021		10.4	10.4	1988
2022		10.4	10.4	1988
2023		10.4	10.4	1988
Present Values				
Incremental Costs (US$ million)				254.6
Incremental Sales (million kWh)				12129
Average Incremental Costs (cents/kWh)				2.1

4. Uzbekistan

Transmission rehabilitation investments are estimated at $125 million, based on a loan from ADB for this purpose. The distribution rehabilitation needs are estimated at $ 1,028 on the basis of an investment at the rate of $250 per consumer connection for 4,111,860 households to reduce system losses from the present level of losses of 22% to 15% by 2010. Incremental O&M expenditure is assumed at 4% of the capital expenditures in year 1 through 2, declining to 3% in year 3 through 5, and to 2% in year 6 through 10. The economic cost of additional supplies are estimated at 3.5 cents/kWh.

Table A5.4: Uzbekistan. AIC for T&D Rehabilitation

Calendar Year	Capital Investment ($ million)	Incremental O&M Costs ($ million)	Total Incremental Costs ($ million)	Incremental Sales (GWh)
2003				
2004	57.6	2.3	60.0	555
2005	115.3	6.9	122.2	1118
2006	115.3	10.4	125.7	1690
2007	115.3	13.8	129.1	2270
2008	172.9	19.0	192.0	2860
2009	172.9	22.5	195.4	3457
2010	115.3	24.8	140.1	4064
2011	115.3	27.1	142.4	4064
2012	115.3	29.4	144.7	4064
2013	57.6	30.6	88.2	4064
2014		30.6	30.6	4064
2015		30.6	30.6	4064
2016		30.6	30.6	4064
2017		30.6	30.6	4064
2018		30.6	30.6	4064
2019		30.6	30.6	4064
2020		30.6	30.6	4064
2021		30.6	30.6	4064
2022		30.6	30.6	4064
2023		30.6	30.6	4064
Present Values				
Incremental Costs (US$ million)				873.7
Incremental Sales (million kWh)				24877
Average Incremental Costs (cents/kWh)				3.5

B. Rehabilitation of Generating Units

1. Kazakhstan

(a) Investment in Ekibastuz TPP-1 Rehabilitation

The coal fired Ekibastuz I thermal power plant is located at the mine mouth on the northern side of Kazakhstan, is currently owned by private investor AES, and has eight units of 500 MW each, of which only four are believed to be operational. The remaining four units need rehabilitation. The cost of such rehabilitation to restore the full 4,000 MW capacity of the plant is estimated at $440 million.[17] The rehabilitation project would need three years to prepare (2005-2007), and four years to implement (2008-2011). The first year of generation from the rehabilitated units would be 2010.

Table A5.5: Kazakhstan. AIC for Ekibastuz I Plant Rehabilitation

Calendar Year	Capital Investment	Fuel Cost	Incremental O&M Costs Excluding Fuel	Total Incremental Costs	Incremental Sales
	US$ million	US$ million	US$ million	US$ million	GWh
2007					
2008	44.0			44.0	
2009	132.0			132.0	
2010	132.0	5.3	17.6	154.8	403
2011	132.0	42.0	37.6	211.7	3224
2012		84.1	75.2	159.3	6447
2013		147.2	80.2	227.3	11283
2014		147.2	80.2	227.3	11283
2015		147.2	80.2	227.3	11283
2016		147.2	80.2	227.3	11283
2017		147.2	80.2	227.3	11283
2018		147.2	80.2	227.3	11283
2019		147.2	80.2	227.3	11283
2020		147.2	80.2	227.3	11283
2021		147.2	80.2	227.3	11283
2022		147.2	80.2	227.3	11283
2023		147.2	80.2	227.3	11283
2024		147.2	80.2	227.3	11283
2025		147.2	80.2	227.3	11283
2026		147.2	80.2	227.3	11283
2027		147.2	80.2	227.3	11283
Present Values					
Incremental Costs (US$ million)					1582.6
Incremental Sales (million kWh)					59794
Average Incremental Costs (cents/kWh)					2.65

The net Heat Rate of the units is 9,600 kJ/kWh. The main fuel of the plant would be Ekibastuz coal with a calorific value of 16 GJ/ton with a price of $20/Ton, which is also the export price of coal from Kazakhstan. The fixed and variable O&M costs are based on calculations for similar

[17] WB's estimate and RWE Solution, KEGOK, Kazakhstan North-South 500 kV Power Transmission Line Investment Pre-Feasibility Study

plants in the region.[18] The plant factor for each unit is assumed to be 10% during the first year of operation and 70% in the following years. Plant's self-consumption or auxiliary consumption is estimated at 8% of gross generation. The average incremental cost of supply from rehabilitated units is determined to be 2.65 cents/kWh., as can be seen from the Table A5.5.

(b) Rehabilitation of Other National and Regional Level Generating Units.

Project preparation: 2005 Construction: 2006-2017 The first year of output: 2007

Table A5.6: Kazakhstan. AIC for Rehabilitation of the Other Large and Medium Units at the National and Local Level

Calendar Year	Capital Investment	Fuel Cost	Incremental O&M Costs Excluding Fuel	Total Incremental Costs	Incremental Sales
	$ million	$ million	$ million	US$ million	GWh
2005					
2006	53.5		3.6	57.1	
2007	85.6	11.2	10.4	107.1	856
2008	85.6	29.0	17.6	132.2	2225
2009	85.6	46.9	24.8	157.3	3595
2010	85.6	64.7	32.0	182.4	4964
2011	85.6	82.6	39.3	207.5	6334
2012	85.6	100.5	46.5	232.6	7703
2013	96.3	118.3	54.5	269.1	9072
2014	96.3	138.4	62.6	297.3	10613
2015	96.3	158.5	70.7	325.6	12154
2016	107.0	178.6	79.6	365.2	13694
2017	107.0	200.9	88.6	396.6	15406
2018		223.3	90.4	313.7	17118
2019		223.3	90.4	313.7	17118
2020		223.3	90.4	313.7	17118
2021		223.3	90.4	313.7	17118
2022		223.3	90.4	313.7	17118
2023		223.3	90.4	313.7	17118
2024		223.3	90.4	313.7	17118
2025		223.3	90.4	313.7	17118
Present Values					
Incremental Costs (US$ million)					1861.7
Incremental Sales (million kWh)					67670
Average Incremental Costs (cents/kWh)					2.75

From the total installed capacity of about 18,000 MW in Kazakhstan, about 9,870 MW of thermal plants would be retired by 2015 (including 2,700 MW by 2005, 2,500 MW by 2010, and 4,670 by 2015), reducing substantially the system reserve margin. The Kazakh authorities plan to invest $1,070 million in rehabilitation of these units to prolong their operating lives.[19] The schedule of investment in rehabilitation of the TPPs' large and medium units in general reflects the present retirement schedule. It is assumed that the involved units will consume coal from the Ekibastuz mine. The Heat Rate, coal calorific value, and coal price are thus the same as those

[18] WB estimate and TACIS, Verbundplan-ESBI-Fichtner, Assistance to the Electricity Sector of the Republic of Uzbekistan

[19] Kazakhstan, Plans on implementation of national policy of further power sector development

adopted for Ekibastuz I TPP. Fixed and Variable incremental O&M expenditures[20] adopted are also similar to those adopted in Ekibastuz I plant. It is assumed that the Unit's Capacity Factor would increase by about 20% after rehabilitation[21]; Plants' Own Needs (auxiliary consumption) is assumed at 8% of gross output. The details of AIC calculations are shown in Table A5.6.

2. Uzbekistan

Project Implementation period for the rehabilitation of existing thermal plants is 2004-2023. The installed capacity of the existing thermal power plants is about 10,000 MW.

Table A5.7: Uzbekistan. AIC for Rehabilitation of the existent TPPs.

Calendar Year	Investment in TPPs Rehabilitation	Avoided Decrease of Generation
	US$ million	GWh
2003		
2004	47.5	0
2005	39.5	414
2006	118.6	1338
2007	166.1	4597
2008	94.9	6415
2009	94.9	3750
2010	47.5	2200
2011	23.7	1350
2012	47.5	425
2013	47.5	1350
2014	47.5	1350
2015	80.7	1350
2016	0.0	2375
2017	33.2	0
2018	0.0	1025
2019	0.0	0
2020	47.5	0
2021	94.9	940
2022	71.2	1880
2023	47.5	1365
Present Values		
Incremental Costs (US$ million)		561.0
Incremental Sales (million kWh)		15562
Average Incremental Costs (cents/kWh)		3.60

But according to the most recent consultant's estimate[22] the total available net capacity is about 7,800 MW. Majority of the plants were commissioned during 1960-1970 and some even earlier. They have all suffered for want of spare parts and regular maintenance since 1990.

[20] WB estimate and TACIS, Verbundplan-ESBI-Fichtner, Assistance to the Electricity Sector of the Republic of Uzbekistan

[21] WB's estimate

[22] TACIS, Verbundplan-ESBI-Fichtner, Assistance to the Electricity Sector of the Republic of Uzbekistan, draft Final Report

The objective of the rehabilitation is to increase the lifetime, availability and the efficiency of TPPs and to upgrade the units so that they reach/approach the capacity they were originally designed for. The rehabilitation program will implement those measures, which should have been implemented within the maintenance schedules of the past years but were not. It will concentrate on mitigating the weak points and bottlenecks at the principal power plant components, mainly at the boilers, turbines, condensers, pre-heaters, piping, as well as instrumentation and control. At the damaged sections, the insulation has to be renewed and leakages have to be repaired.[23] It was also assumed that units with installed capacity less than 60 MW would be retired as investments in rehabilitation of such units would not be economic and rational.

[23] TACIS, Verbundplan-ESBI-Fichtner, Assistance to the Electricity Sector of the Republic of Uzbekistan, draft Final Report

C. Construction of New Generation Units

1. Uzbekistan

(a) Talimardjan Thermal Power Project I: Unit 1

This gas fired 800 MW steam turbine unit had been under construction since the late 1980s and it is now anticipated that it would be commissioned in 2005. Ignoring the sunk costs incurred so far, the cost for completing the project is estimated at $100 million. There are cooling water limitations and other problems based on the experience of similar units operating in Russia, which limit the plant factor to be around 60%- 65%. The unit will have a heat rate of 10,500 kJ/kWh. The calorific value of gas is 34.3 GJ/KCM. The gas price is assumed at $35/KCM which is the cash export price for Uzbek gas. Plant auxiliary consumption is assumed at 6% of the gross output. Fixed and variable O&M costs are based on consultant reports.[24]

Table A5.8: Uzbekistan. AIC of Electricity from Talimardjan Unit 1

Calendar Year	Capital Investment	Fuel Cost	Incremental O&M Costs Excluding Fuel	Total Incremental Costs	Incremental net generation
	$ million	$ million	$ million	$ million	GWh
2004	90.0	0.0	1.6	91.6	0
2005	10.0	6.9	6.7	23.6	609
2006		20.8	7.1	27.9	1828
2007		48.4	7.9	56.3	4265
2008		48.4	7.9	56.3	4265
2009		48.4	7.9	56.3	4265
2010		48.4	7.9	56.3	4265
2011		48.4	7.9	56.3	4265
2012		48.4	7.9	56.3	4265
2013		48.4	7.9	56.3	4265
2014		48.4	7.9	56.3	4265
2015		48.4	7.9	56.3	4265
2016		48.4	7.9	56.3	4265
2017		48.4	7.9	56.3	4265
2018		48.4	7.9	56.3	4265
2019		48.4	7.9	56.3	4265
2020		48.4	7.9	56.3	4265
2021		48.4	7.9	56.3	4265
2022		48.4	7.9	56.3	4265
2023		48.4	7.9	56.3	4265
Present Values					
Incremental Costs (US$ million)					463.1
Incremental Sales (million kWh)					27583
Average Incremental Costs (cents/kWh)					1.68

[24] WB estimate and TACIS, Verbundplan-ESBI-Fichtner, Assistance to the Electricity Sector of the Republic of Uzbekistan

(b) Talimardjan Thermal Plant II: Units 2 to 4

All the site facilities at Talimardjan have been designed and constructed for locating four units of 800 MW each. It is assumed that the preparation for the construction of units 2 to 4 would be during 2005-2008 and that the construction would take place during 2009-2013, while Power will start flowing from 2011.Since all site facilities exist the additional investment needed is estimated at $ 1,200 million[25]. All other assumptions such as heat rate, calorific value of gas, gas price, level of auxiliary consumption, plant factor etc are the same as those for Unit 1.

Table A5.9: Uzbekistan. AIC of Electricity from Talimardjan Units #2-4

Calendar Year	Capital Investment	Fuel Cost	Incremental O&M Costs Excluding Fuel	Total Incremental Costs	Incremental net generation
	$ million	$ million	$ million	$ million	GWh
2008					
2009	120.0			120.0	
2010	360.0			360.0	
2011	400.0	6.9	6.7	413.6	609
2012	280.0	27.7	13.8	321.5	2437
2013	40.0	76.1	21.7	137.8	6703
2014		117.6	22.9	140.5	10359
2015		145.3	23.7	168.9	12796
2016		145.3	23.7	168.9	12796
2017		145.3	23.7	168.9	12796
2018		145.3	23.7	168.9	12796
2019		145.3	23.7	168.9	12796
2020		145.3	23.7	168.9	12796
2021		145.3	23.7	168.9	12796
2022		145.3	23.7	168.9	12796
2023		145.3	23.7	168.9	12796
2024		145.3	23.7	168.9	12796
2025		145.3	23.7	168.9	12796
2026		145.3	23.7	168.9	12796
2027		145.3	23.7	168.9	12796
2028		145.3	23.7	168.9	12796
Present Values					
Incremental Costs (US$ million)					1804.3
Incremental Sales (million kWh)					65343
Average Incremental Costs (cents/kWh)					2.76

2. The Kyrgyz Republic

(a) Bishkek II Thermal Power Plant

The construction of two units of gas fired combined cycle power plant each with a capacity of about 200 MW in the same site as that of Bishkek CHP 2 plant would be an option to meet the chronic winter power deficit of Kyrgyz system. The project would be prepared and funding secured in 2005 and construction would proceed during 2006-2008. Initial output of power

[25] TACIS, Verbundplan-ESBI-Fichtner, Assistance to the Electricity Sector of the Republic of Uzbekistan

would be in 2007. The international cost/ kW of installed capacity of such units is around $700. The Bishkek plant site already has all infrastructure – natural gas connection, 110 kV electric power substation, drinking water and sewerage connections, access road, railway access, erection site, etc. It is assumed that existence of infrastructure would decrease cost per 1 kW of installed capacity by 30%. Total investment needed to complete this project is estimated, thus, at US$196 million. Combined cycle unit's efficiency is assumed as 50%; natural gas price for cash including transportation cost is estimated at $40/KCM; and the natural gas calorific value is 34.3 GJ/KCM[26]. Incremental O&M expenditures (excluding fuel cost) are assumed at 1% of capital expenditures in year 2, 8% of capital expenditures in year 3, and 10% of capital expenditures in year 4 and further. Capacity factor is assumed to be 70%; and annual electricity generation by plant is estimated at 2,450 GWh. Auxiliary consumption is estimated at 4% of the gross output.

Table A5.10: The Kyrgyz Republic. AIC of Electricity from Bishkek II

Calendar Year	Capital Investment	Fuel Cost	Incremental O&M Costs Excluding Fuel	Total Incremental Costs	Incremental net generation
	$ million	$ million	$ million	$ million	GWh
2005					
2006	78.4		0.8	79.2	
2007	58.8	3.1	1.3	63.1	353
2008	58.8	13.4	7.1	79.3	1531
2009		20.6	12.4	33.0	2355
2010		20.6	12.4	33.0	2355
2011		20.6	12.4	33.0	2355
2012		20.6	12.4	33.0	2355
2013		20.6	12.4	33.0	2355
2014		20.6	12.4	33.0	2355
2015		20.6	12.4	33.0	2355
2016		20.6	12.4	33.0	2355
2017		20.6	12.4	33.0	2355
2018		20.6	12.4	33.0	2355
2019		20.6	12.4	33.0	2355
2020		20.6	12.4	33.0	2355
2021		20.6	12.4	33.0	2355
2022		20.6	12.4	33.0	2355
2023		10.4	12.4	22.8	1183
2024		10.4	12.4	22.8	1183
2025		20.6	12.4	33.0	2355
Present Values					
Incremental Costs (US$ million)					388.9
Incremental Sales (million kWh)					15231
Average Incremental Costs (cents/kWh)					2.55

(b) Kambarata I Hydropower Plant.

The site of Kambarata 1 plant is upstream of the Toktogul reservoir. The total installed capacity of this new hydro station would be 1900 MW (four units of 475 MW each). Total investment needed is estimated at $1,940 million, including $265million for 500 kV line that connects Kambarata-1 and substation Kemin in the North of Kyrgyzstan. The annual output from

[26] Information from the Kyrgyz Authorities

Kambarata 1 is estimated at 5,100 GWh and auxiliary consumption is assumed at 1% of gross output. The plant factor of this station is 31%, but the large capacity enables it to meet efficiently the daily system peaks in the Kyrgyz and CAR systems. O&M cost are assumed at 0.1% of capital investment for each power unit after one year of guaranty operation; plus 0.1% of capital investment for dam after completion of the dam construction and one year of guaranty operation. Since agreements among riparian states have to be reached and financing secured, it will take six to seven years (2005-2011) to prepare the project, and it will need seven years of construction time (2012-2019). Initial flow of power could commence from 2017.

Table A5.11: The Kyrgyz Republic. AIC of Electricity from Kambarata 1

Calendar Year	Capital Investment	Incremental O&M Costs	Total Incremental Costs	Incremental net generation
	$ million	$ million	$ million	GWh
2011				
2012	194.0		194.0	
2013	291.0		291.0	
2014	291.0		291.0	
2015	291.0		291.0	
2016	291.0		291.0	
2017	194.0		194.0	252
2018	194.0	0.1	194.1	1515
2019	194.0	0.2	194.2	3029
2020		0.9	0.9	5049
2021		0.9	0.9	5049
2022		0.9	0.9	5049
2023		0.9	0.9	5049
2024		0.9	0.9	5049
2025		0.9	0.9	5049
2026		0.9	0.9	5049
2027		0.9	0.9	5049
2028		0.9	0.9	5049
2029		0.9	0.9	5049
2030		0.9	0.9	5049
2031		0.9	0.9	5049
Present Values				
Incremental Costs (US$ million)				1317.4
Incremental Sales (million kWh)				18382
Average Incremental Costs (cents/kWh)				7.17

The incremental cost of power generation by Kambarata-1 at US¢7.17/kWh (see Table A5.11) is the highest among those from all the generation options available or contemplated in Central Asia.[27]. However, Kambarata 1 is a large storage hydro plant which enables electricity generation in winter, since the water released would be stored in downstream Toktogul reservoir. Thus it will enable Toktogul hydro units and the Naryn cascade hydro units operate following the irrigation regime as per international agreements.

[27] JSC “Electric Power Plants”, Investment Projects, Bishkek, the Kyrgyz Republic

(c) Kamabarata II Hydropower Plant

The site of Kambarata 2 project is also upstream of the Toktogul HPP and is situated between Toktogul and Kambarata-1 HPPs. Construction of Kambarata-2 was started in 1986 and about 30% of civil and erection works have been completed so far. According to estimates of the local experts it is necessary to invest US$280 million to complete this project, including US$18 million for construction of 500 kV connection line[28]. The project will be prepared for lining up funds etc during 2005-2008, and construction would be during 2009-2012. Annual generation of the Kambarata 2 is estimated at 1116 GWh based on the designed Plant Factor of 35%[29].

Table A5.12: The Kyrgyz Republic. AIC of Electricity from Kambarata 2

Calendar Year	Capital Investment	Incremental O&M Costs	Total Incremental Costs	Incremental Sales
	$ million	$ million	$ million	GWh
2008				
2009	56.0		56.0	
2010	84.0	0.1	84.1	
2011	84.0	0.1	84.1	
2012	56.0	0.4	56.4	221
2013		0.6	0.6	1105
2014		0.6	0.6	1105
2015		0.6	0.6	1105
2016		0.6	0.6	1105
2017		0.6	0.6	1105
2018		0.6	0.6	1105
2019		0.6	0.6	1105
2020		0.6	0.6	1105
2021		0.6	0.6	1105
2022		0.6	0.6	1105
2023		0.6	0.6	1105
2024		0.6	0.6	1105
2025		0.6	0.6	1105
2026		0.6	0.6	1105
2027		0.6	0.6	1105
2028		0.6	0.6	1105
Present Values				
Incremental Costs (US$ million)				225.4
Incremental Sales (million kWh)				6055
Average Incremental Costs (cents/kWh)				3.72

Though the marginal cost of generation is ¢3.72/kWh (see Table A5.12), its construction ahead of Kambarata 1 should be weighted carefully, as it does not have seasonal storage and would merely aggravates the problem of the Kyrgyz system with summer surplus and winter deficits.

[28] JSC “Electric Power Plants”, Investment Projects, Bishkek, the Kyrgyz Republic
[29] JSC “Electric Power Plants”, Investment Projects, Bishkek, the Kyrgyz Republic

3. Tajikistan

(a) Sangtuda I Hydropower Plant

The site of the project is downstream of the Nurek Cascade of hydropower plants on the Vaksh River. The installed capacity of this run-of the river project would be 670 MW and the annual electricity generation is estimated at 2,700 GWh at a plant factor 46%. The total cost of the project is estimated at about US$482 million, and, of this, about US$110 million already have been spent[30]. Project preparation would be during 2005-2007 and construction would be during 2007-2012. Power would start flowing from 2009. Incremental investment needed to complete construction would thus be about $368-$370 million. O&M expenses are assumed at 0.1% of capital investment for each power unit after the first year of guaranty operation; plus 0.1% of capital investment for dam after completion of the dam construction and one year of guaranty operation. The average incremental cost of electricity of this project at 1.97 cents/kWh is the lowest of all generation options available to the CARs.

Table A5.13: Tajikistan. AIC of Electricity from Sangtuda I

Calendar Year	Capital Investment	Incremental O&M Costs	Total Incremental Costs	Incremental Sales
	$ million	$ million	$ million	GWh
2006				
2007	37.0		37.0	
2008	55.5		55.5	
2009	111.0	0.0	111.0	134
2010	92.5	0.1	92.6	802
2011	55.5	0.1	55.6	1470
2012	18.5	0.2	18.7	2138
2013		0.4	0.4	2673
2014		0.4	0.4	2673
2015		0.4	0.4	2673
2016		0.4	0.4	2673
2017		0.4	0.4	2673
2018		0.4	0.4	2673
2019		0.4	0.4	2673
2020		0.4	0.4	2673
2021		0.4	0.4	2673
2022		0.4	0.4	2673
2023		0.4	0.4	2673
2024		0.4	0.4	2673
2025		0.4	0.4	2673
2026		0.4	0.4	2673
Present Values				
Incremental Costs (US$ million)				273.0
Incremental Sales (million kWh)				13883
Average Incremental Costs (cents/kWh)				1.97

[30] Information from the Tajik Authorities

(b) Rogun Hydropower Project, Phase I

The site of this project is upstream of the existing Nurek reservoir on Vaksh River. Phase I of the project includes installation of two generation units of 600 MW each, construction of the dam up to a certain height, repairing the previously constructed, but damaged two tunnels; building a third new tunnel; creation of the regulating reservoir. According to Tajik authorities, a sum of $800 million had already been spent during Soviet era, before the construction was stalled for want of funds upon dissolution of the Soviet Union. There has been no progress in construction since 1991 and it is estimated that an additional US$785 million would be needed to complete Phase I. This is a major storage reservoir and it would also facilitate additional generation from the existing downstream hydropower stations. Reaching a fresh agreement among the riparian states would be necessary. Thus project preparation would be during 2005-2010 and construction would be during 2011-2015. Power could flow from 2014.

Table A5.14: Tajikistan. AIC of Electricity from Rogun HPP Phase I

Calendar Year	Capital Investment	Incremental O&M Costs	Total Incremental Costs	Incremental Sales
	$ million	$ million	$ million	GWh
2010				
2011	78.5		78.5	
2012	196.3		196.3	
2013	196.3		196.3	
2014	157.0	0.2	157.2	515
2015	157.0	0.7	157.7	2762
2016		0.9	0.9	4643
2017		0.9	0.9	4643
2018		0.9	0.9	4643
2019		0.9	0.9	4643
2020		0.9	0.9	4643
2021		0.9	0.9	4643
2022		0.9	0.9	4643
2023		0.9	0.9	4643
2024		0.9	0.9	4643
2025		0.9	0.9	4643
2026		0.9	0.9	4643
2027		0.9	0.9	4643
2028		0.9	0.9	4643
2029		0.9	0.9	4643
2030		0.9	0.9	4643
Present Values				
Incremental Costs (US$ million)				590.4
Incremental Sales (million kWh)				23995
Average Incremental Costs (cents/kWh)				2.46

The electricity output of Phase I is about 4,300 GWh; and it would also enable to generate of an additional 400 GWh of electricity at the existing downstream Nurek cascade. O&M cost are assumed at the same level as for Sangtuda I HPP: 0.1% of capital investment for each power unit after one year of guaranty operation; plus 0.1% of capital investment for dam after completion of the dam construction and one year of guaranty operation. The designed Plant Factor of the Phase I Rogun HPP is 41%. The AIC of power generation of this project is ¢2.46/kWh.

(c) Rogun Hydropower Project, Phase I and II

In the second phase, the dam height will be raised to the full level of 335 meters, making it one of the tallest dams in the world, four more generating units (600 MW each) would be installed, raising the total capacity to 3,600 MW. In addition to $800 million believed to have been spent in the Soviet days, the total additional funds needed to complete both Phases I and II would be $2,450 million. The construction of phase II would go on till 2019 and full power output realized in 2020.

Table A5.15: Tajikistan. AIC of Electricity from Rogun HPP Phase I and II

Calendar Year	Capital Investment	Incremental O&M Costs	Total Incremental Costs	Incremental Sales
	$ million	$ million	$ million	GWh
2010				
2011	78.5		78.5	
2012	196.3		196.3	
2013	196.3		196.3	
2014	491.0	0.2	491.2	515
2015	491.0	0.7	491.7	2762
2016	417.5	0.9	418.4	4643
2017	250.5	0.9	251.4	5282
2018	167.0	1.4	168.4	7712
2019	167.0	1.5	168.5	10712
2020		2.6	2.6	14157
2021		2.6	2.6	14157
2022		2.6	2.6	14157
2023		2.6	2.6	14157
2024		2.6	2.6	14157
2025		2.6	2.6	14157
2026		2.6	2.6	14157
2027		2.6	2.6	14157
2028		2.6	2.6	14157
2029		2.6	2.6	14157
2030		2.6	2.6	14157
Present Values				
Incremental Costs (US$ million)				1544.1
Incremental Sales (million kWh)				54535
Average Incremental Costs (cents/kWh)				2.83

The completed project would produce roughly 13,000 GWh of electricity annually. It will totally eliminate spilling of water through the existent Nurek cascade of HPPs and enable them to produce an additional 1300 GWh of power.

O&M cost are assumed at 0.1% of capital investment for each power unit after one year of guaranty operation; plus 0.1% of capital investment for dam after completion of the dam construction and one year of guaranty operation. The designed Plant Factor of the Phase I and II Rogun HPP is 41%. The AIC of power generation of this investment project is US¢2.83/kWh.

4. Kazakhstan

A New Coal Fired Generation Plant

The supply/demand balance for Kazakhstan shows that in 2020s Kazakhstan will experience a notable shortage in power generation, unless action is taken to add at least about1000 MW of

Table A5.16: Kazakhstan. AIC of Electricity from the New TPP

Calendar Year	Capital Investment	Fuel Cost	Incremental O&M Costs	Total Incremental Costs	Incremental Sales
	$ million	$ million	$ million	$ million	GWh
2015					
2016	162.8			162.8	
2017	162.8			162.8	
2018	217.0			217.0	
2019	217.0			217.0	
2020	162.8	11.1	18.0	191.8	806
2021	162.8	58.4	38.6	259.8	4231
2022		94.5	41.3	135.8	6850
2023		94.5	41.3	135.8	6850
2024		94.5	41.3	135.8	6850
2025		94.5	41.3	135.8	6850
2026		94.5	41.3	135.8	6850
2027		94.5	41.3	135.8	6850
2028		94.5	41.3	135.8	6850
2029		94.5	41.3	135.8	6850
2030		94.5	41.3	135.8	6850
2031		94.5	41.3	135.8	6850
2032		94.5	41.3	135.8	6850
2033		94.5	41.3	135.8	6850
2034		94.5	41.3	135.8	6850
2035		94.5	41.3	135.8	6850
Present Values					
Incremental Costs (US$ million)					1424.2
Incremental Sales (million kWh)					31374
Average Incremental Costs (cents/kWh)					4.54

capacity by about 2020. These would be coal fired steam turbine units. One reasonable option would be to locate them in the site of the existing Ekibastuz II thermal plant[31] which already has two units of 500 MW each. It will use Ekibastuz coal. The heat rate, fuel calorific value, fuel prices, and O&M costs and auxiliary consumption would be the same as those used for the rehabilitation of Ekibastuz I plant. The capital costs are estimated at $1,085 million[32]. Construction would be during 2016-2020 and the first year of output would be 2020. The Capacity Factor for each unit assumed at 20% during the first year of operation of each unit and at 85% in the follow up years. On the basis of the above-mentioned assumptions, the AIC of generation by the new units is expected to be ¢4.54/kWh (see Table A5.16).

[31] 50% of the equity in this existing Ekibastuz II power station is believed to have been transferred to RAO UES of Russia.

[32] RWE Solution, KEGOK, Kazakhstan North-South 500 kV Power Transmission Line Investment Pre-Feasibility Study

Appendix 5.2

Central Asia
Regional Export Potential Study
Economic Analysis of Transmission Line Options for Exports

The economic analysis calculates the economic cost of transmission in respect of the proposed six export transmission line options using an 10% discount rate and using constant 2004 dollar price levels.

The Basic Data on the proposed transmission lines are shown in the Table A5.17.

Table A5.17. Basic Data on Transmission Lines

Export Transmission Line	Distance kilometers	Voltage kV	Line type	Annual trans-mission (GWh)	Number of new SS	Number of expanded SS	Investment in US$ million
Almaty (Kazakhstan) - Urumqui (China)	1,050	500	DC	10,000	1	1	390.0
Surhan (Uzbekistan) - Kabul (Afghanistan)	515	500	AC	5,000	2	1	153.0
Kabul (Afghanistan) - Tarbela (Pakistan)	360	500	AC	3,000	1	1	90.5
Kabul (Afghanistan) - Kandaghar (Afghanistan)	490	500	AC	5,000	2	1	138.2
Kandaghar (Afghanistan) - Karachi (Pakistan)	900	500	AC	4,000	3	1	226.6
Surhan (Uzbekistan) - Mashad (Iran)	1,150	500	AC	10,000	4	1	320.0

The following assumptions were assumed during AIC calculations for all Transmission Lines:

- The unit cost of the double circuit 500kV overhead transmission line is US$0.2 million per kilometer;
- Maximum load in the lines is estimated at about 2000 MVA, and average load at about 1000 MVA;
- Construction time is estimated at 24 to 30 months;
- An intermediate 500 kV substation is placed at intervals of 200 to 300 kilometers in the AC lines, inter alia, for reactive compensation purposes;
- Cost of each 500 kV substation is estimated at $20 million;
- Cost of expansion of each existing substation is estimated at $10 million;
- The designed power technical losses is at 1% of electricity transmitted for every 250 km;
- O&M expenses of transmission lines is estimated at 0.1% of the capital cost;
- The amount of power transferred is 10,000 GWh a year in each direction in respect of Almati-Urumqi and Surhan-Mashhad; and 5,000 in respect of Surhan-Kabul.
- Back-to-back DC conversion cost for DC lines is estimated at $150 million but no intermediate substations would be needed.

The details of AIC calculations summarized in Table A5.18.

Table A5.18: Transmission Lines' AIC Calculations

	Almaty - Urumqui		Surhan – Mashad		Surhan – Kabul		Kabul – Tarbela		Kabul – Kandaghar		Kandaghar – Karachi	
Calendar Year	Invest. US$ mil	Sales GWh	Invest. US$ mil	Sales GWh	Invest. US$ mil	Sales GWh	Invest. US$ mil	Sales GWh	Invest. US$ mil	Sales GWh	Invest. US$ mil	Sales GWh
Year 0												
Year 1	97.5		80									
Year 2	156		128									
Year 3	136.5		112									
Year 4		477		2832								
Year 5		2862		6136								
Year 6		5724		9440	45.9							
Year 7		9540		9440	107.1							
Year 8		9540		9440		1460	27.1					
Year 9		9540		9440		3164	63.3					
Year 10		9540		9440		4867		883	41.5			
Year 11		9540		9440		4867		1914	96.7			
Year 12		9540		9440		4867		2945		1462	68	
Year 13		9540		9440		4867		2945		3167	158.6	
Year 14		9540		9440		4867		2945		4872		1147
Year 15		9540		9440		4867		2945		4872		2486
Year 16		9540		9440		4867		2945		4872		3824
Year 17		9540		9440		4867		2945		4872		3824
Year 18		9540		9440		4867		2945		4872		3824
Year 19		9540		9440		4867		2945		4872		3824
Year 20		9540		9440		4867		2945		4872		3824
Year 21		9540		9440		4867		2945		4872		3824
Year 22		9540		9440		4867		2945		4872		3824
Year 23		9540		9440		4867		2945		4872		3824
Year 24						4867		2945		4872		3824
Year 25						4867		2945		4872		3824
Year 26						4867		2945		4872		3824
Year 27						4867		2945		4872		3824
Year 28								2945		4872		3824
Year 29								2945		4872		3824
Year 30										4872		3824
Year 31										4872		3824
Year 32												3824
Year 33												3824
Incremental Costs (US$ mil.)		322.3		264.5		131.2		77.6		118.5		194.3
Incremental Sales (GWh)		48531		53817		30521		18467		30552		23980
Economic Cost of Transmission (cents/kWh)		0.66		0.49		0.43		0.42		0.39		0.81

Appendix 5.3

Central Asia
Regional Export Potential Study
Financial Analysis of Generation and Transmission Options

The financial analysis of the major supply options seeks to estimate the financial cost of supply of electricity to determine the competitiveness of these options, and to help the judge the attractiveness of these investment options in relation to both export and domestic markets. The analysis is limited to major hydroelectric supply options (Kambarata I and II, Sangtuda I, Rogun I and II) major thermal plant options (Talimardjan I and II, Bishkek II, Ekibastuz I rehabilitation and the New Ekibastuz units).

Financing is based on a structure that will roughly result in 25% equity and 75% long term debt ratio after financing cost. The terms of debt are assumed to include a risk adjusted interest at 10%, a repayment period of 15 years including a five year grace period. The equity is expected to earn an internal rate of return (IRR) of 15% over the life of investment, which translates to an annual rate of return on equity in the range of 17% to 24% in respect of these projects. The level of annual Return on Equity varies among the projects, largely, as a function of the construction period. Longer construction periods make the investors wait for longer periods for cash inflows and thus raises the annual equity returns to achieve a 15% IRR on equity over the life of investment. On this basis, the tariff/kWh required to service the debt and provide the return on equity for each year is computed for a 20 year production period. *These annual tariffs are then discounted to 2004 at 10% to arrive at the levelized tariff/kWh for the project.*

The capital costs used for economic analysis which are in constant 2004 dollars, are converted into nominal dollars using a MUV inflation index of 1.52% per year. O&M and Fuel expenses are also similarly inflated at 1.52 % per year for the financial analysis. Preparatory period is the estimate of the time needed for firming up markets and financing sources. The steady state sales in GWh are derived from the steady state generation by reducing from the gross generation, the volume of electricity consumed for the generation station use at the rate 8% for coal fired steam units, 6% for gas fired steam units, 4% for gas fired combined cycle plant and 1% for the hydro plants as per the industry practice.

The levelized tariffs derived for the generation options enable comparison among the among the options and for a given scheme for different financing and output assumptions. Sensitivity analysis has been carried out for decrease in generation, for increases in capital expenditure, fuel cost, interest rate and rates of return on equity. Given their construction schedules and structure of financing they are most sensitive to increases in interest rates and significantly sensitive to increases in rate of return on equity. They are also markedly sensitive to decreases in output and increases in fuel (especially natural gas) prices. Given the high cost per kW, long preparation and construction times and low load factors the hydropower projects are much more sensitive to changes in respect of most parameters, than thermal power projects. Thermal power projects would thus be able to deal with possible reductions in export demand much better than the hydro projects. However thermal projects are also quite sensitive to fuel price increases.

Table A5.19: Financial Analysis of Sangtuda I Hydropower Project

Year	Construction Period					Operating Period					
	Capital Expenditures without IDC	IDC	Capital Expenditures with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2007	$19	$1	$20	$17	$3						
2008	$39	$4	$43	$37	$6						
2009	$79	$9	$88	$76	$12						
2010	$80	$17	$97	$72	$25						
2011	$122	$26	$149	$122	$27						
2012	$62	$35	$97	$55	$42						
2013						$0.41	$38	$22	$61	2,538	2.40
2014						$0.41	$38	$22	$61	2,538	2.40
2015						$0.42	$38	$22	$61	2,538	2.40
2016						$0.42	$38	$22	$61	2,538	2.40
2017						$0.43	$38	$22	$61	2,538	2.40
2018						$0.44	$69	$22	$92	2,538	3.64
2019						$0.44	$66	$22	$89	2,538	3.52
2020						$0.45	$63	$22	$86	2,538	3.39
2021						$0.46	$60	$22	$83	2,538	3.27
2022						$0.46	$57	$22	$80	2,538	3.14
2023						$0.47	$54	$22	$77	2,538	3.02
2024						$0.48	$51	$22	$73	2,538	2.90
2025						$0.49	$47	$22	$70	2,538	2.77
2026						$0.49	$44	$22	$67	2,538	2.65
2027						$0.50	$41	$22	$64	2,538	2.52
2028						$0.51	$13	$22	$36	2,538	1.40
2029						$0.52	$12	$22	$35	2,538	1.38
2030						$0.52	$11	$22	$34	2,538	1.35
2031						$0.53	$11	$22	$34	2,538	1.33
2032						$0.54	$10	$22	$33	2,538	1.31
Total	$402	$91	$493	$379	$114						

Levelized Tariff (c/kWh): 2.44 (in 2004 prices)

Table A5.20: Sangtuda I Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		2.4350		
Sensitivities				
(1) Change in Generation	-20%	3.0438	25.0%	(1.25)
(2) Change in Interest Rates	1%	2.4521	0.7%	0.70
(3) Change in Return on Equity	1%	2.4453	0.4%	0.42
(4) Change in CapEx	1%	2.4587	1.0%	0.97

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.21: Financial Analysis of Rogun Hydropower Project Phase I

Year	Construction Period					Operating Period					
	Capital Expenditures without IDC	IDC	Capital Expenditures with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2011	$88	$4	$92	$75	$16						
2012	$223	$18	$241	$214	$27						
2013	$226	$39	$265	$194	$71						
2014	$184	$59	$243	$165	$78						
2015	$187	$76	$263	$191	$72						
2016						$0.9	$84	$52	$137	4,643	2.94
2017						$0.9	$84	$52	$137	4,643	2.94
2018						$0.9	$84	$52	$137	4,643	2.94
2019						$1.0	$84	$52	$137	4,643	2.94
2020						$1.0	$84	$52	$137	4,643	2.94
2021						$1.0	$154	$52	$207	4,643	4.45
2022						$1.0	$147	$52	$200	4,643	4.30
2023						$1.0	$140	$52	$193	4,643	4.15
2024						$1.0	$133	$52	$186	4,643	4.00
2025						$1.0	$126	$52	$179	4,643	3.85
2026						$1.1	$119	$52	$172	4,643	3.70
2027						$1.1	$112	$52	$165	4,643	3.55
2028						$1.1	$105	$52	$158	4,643	3.40
2029						$1.1	$98	$52	$151	4,643	3.25
2030						$1.1	$91	$52	$144	4,643	3.10
2031						$1.1	$28	$52	$81	4,643	1.74
2032						$1.2	$27	$52	$79	4,643	1.71
2033						$1.2	$25	$52	$78	4,643	1.68
2034						$1.2	$24	$52	$77	4,643	1.65
2035						$1.2	$22	$52	$75	4,643	1.62
2036											
Total	$908	$196	$1,104	$839	$264						
Levelized Tariff (c/kWh): 2.91 (2004 prices)											

Table A5.22: Rogun Phase I Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		2.9104		
Sensitivities				
(1) Change in Generation	-20%	3.6380	25.0%	(1.25)
(2) Change in Interest Rates	1%	2.9310	0.7%	0.71
(3) Change in Return on Equity	1%	2.9235	0.5%	0.45
(4) Change in CapEx	1%	2.9392	1.0%	0.99

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.23: Financial Analysis of Rogun Hydropower Project Phases I&II

Year	Construction Period					Operating Period					
	Capital Expenditures without IDC	IDC	Capital Expenditures with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2011	$88	$4	$92	$75	$16						
2012	$223	$18	$241	$214	$27						
2013	$226	$39	$265	$194	$71						
2014	$575	$76	$651	$506	$145						
2015	$584	$127	$711	$527	$184						
2016	$504	$91	$596	$473	$123	$0.9	$84	$52	$137	4,643	2.94
2017	$307	$129	$436	$273	$163	$0.9	$84	$52	$137	4,643	2.94
2018	$208	$154	$362	$243	$119	$0.9	$84	$52	$137	4,643	2.94
2019	$211	$178	$389	$290	$99	$1.0	$84	$52	$137	4,643	2.94
2020						$2.7	$279	$209	$491	14,157	3.47
2021						$2.7	$349	$209	$561	14,157	3.96
2022						$2.8	$342	$209	$554	14,157	3.91
2023						$2.8	$335	$209	$547	14,157	3.86
2024						$2.8	$328	$209	$540	14,157	3.82
2025						$2.9	$321	$209	$533	14,157	3.77
2026						$2.9	$477	$209	$689	14,157	4.87
2027						$3.0	$454	$209	$666	14,157	4.70
2028						$3.0	$431	$209	$643	14,157	4.54
2029						$3.1	$408	$209	$620	14,157	4.38
2030						$3.1	$384	$209	$596	14,157	4.21
2031						$3.2	$305	$209	$517	14,157	3.65
2032						$3.2	$287	$209	$499	14,157	3.53
2033						$3.3	$270	$209	$482	14,157	3.40
2034						$3.3	$252	$209	$464	14,157	3.28
2035						$3.4	$234	$209	$446	14,157	3.15
Total	$2,927	$816	$3,743	$2,795	$948						
Levelized Tariff (c/kWh): 3.24 (in 2004 prices)											

Table A5.24: Rogun Phases I & II Sensitivity Analysis

	Percentage Change in Parameter(%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff(%)	Sensitivity Index [a]
Base Case		3.2388		
Sensitivities				
(1) Change in Generation	-20%	4.0485	25.0%	(1.25)
(2) Change in Interest Rates	1%	3.2644	0.8%	0.79
(3) Change in Return on Equity	1%	3.2547	0.5%	0.49
(4) Change in CapEx	1%	3.2676	0.9%	0.89

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.25: Financial Analysis of Kambarata I Hydropower Project

Year	Construction Period					Operating Period					
	Capital Expenditures without IDC	IDC	Capital Expenditures with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2012	$221	$10	$230	$193	$38						
2013	$336	$35	$370	$308	$63						
2014	$341	$65	$406	$305	$101						
2015	$346	$97	$443	$333	$111						
2016	$351	$132	$483	$363	$121						
2017	$238	$161	$398	$267	$131						
2018	$241	$174	$415	$307	$108						
2019	$245	$190	$435	$322	$113						
2020						$0.9	$240	$196	$437	5,049	8.65
2021						$0.9	$240	$196	$437	5,049	8.65
2022						$0.9	$240	$196	$437	5,049	8.65
2023						$1.0	$240	$196	$437	5,049	8.65
2024						$1.0	$240	$196	$437	5,049	8.65
2025						$1.0	$440	$196	$637	5,049	12.61
2026						$1.0	$420	$196	$617	5,049	12.22
2027						$1.0	$400	$196	$597	5,049	11.82
2028						$1.0	$380	$196	$577	5,049	11.43
2029						$1.0	$360	$196	$557	5,049	11.03
2030						$1.1	$340	$196	$537	5,049	10.64
2031						$1.1	$320	$196	$517	5,049	10.24
2032						$1.1	$300	$196	$497	5,049	9.84
2033						$1.1	$280	$196	$477	5,049	9.45
2034						$1.1	$260	$196	$457	5,049	9.05
2035						$1.1	$80	$196	$277	5,049	5.49
2036						$1.2	$76	$196	$273	5,049	5.41
2037						$1.2	$72	$196	$269	5,049	5.33
						$1.2	$68	$196	$265	5,049	5.26
						$1.2	$64	$196	$261	5,049	5.18
Total	$2,319	$864	$3,183	$2,398	$785						
Levelized Tariff (c/kWh): 8.54 (in 2004 prices)											

Table A5.26: Kamabarata I Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		8.5445		
Sensitivities				
(1) Change in Generation	-20%	10.6806	25.0%	(1.25)
(2) Change in Interest Rates	1%	8.6143	0.8%	0.82
(3) Change in Return on Equity	1%	8.5894	0.5%	0.52
(4) Change in CapEx	1%	8.6298	1.0%	1.00

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.27: Financial Analysis of Kambarata II Hydropower Project

Year	Construction Period					Operating Period					
	Capital Expenditures without IDC	IDC	Capital Expenditures with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	$ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2009	$61	$3	$63	$52	$11						
2010	$93	$9	$102	$83	$19						
2011	$94	$18	$112	$82	$30						
2012	$64	$24	$88	$55	$33						
2013						$0.6	$27	$17	$45	1,105	4.10
2014						$0.6	$27	$17	$45	1,105	4.10
2015						$0.6	$27	$17	$45	1,105	4.10
2016						$0.7	$27	$17	$45	1,105	4.10
2017						$0.7	$27	$17	$45	1,105	4.10
2018						$0.7	$50	$17	$68	1,105	6.16
2019						$0.7	$48	$17	$66	1,105	5.95
2020						$0.7	$45	$17	$64	1,105	5.75
2021						$0.7	$43	$17	$61	1,105	5.54
2022						$0.7	$41	$17	$59	1,105	5.34
2023						$0.7	$39	$17	$57	1,105	5.14
2024						$0.7	$36	$17	$54	1,105	4.93
2025						$0.7	$34	$17	$52	1,105	4.73
2026						$0.8	$32	$17	$50	1,105	4.52
2027						$0.8	$30	$17	$48	1,105	4.32
2028						$0.8	$9	$17	$27	1,105	2.47
2029						$0.8	$9	$17	$27	1,105	2.43
2030						$0.8	$8	$17	$26	1,105	2.39
2031						$0.8	$8	$17	$26	1,105	2.35
2032						$0.8	$7	$17	$26	1,105	2.31
Total	$311	$54	$365	$272	$93						
Levelized Tariff (c/kWh): 3.95 (in 2004 prices)											

Table A5.28: Kambarata II Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		3.9534		
Sensitivities				
(1) Change in Generation	-20%	4.9418	25.0%	(1.25)
(2) Change in Interest Rates	1%	3.9684	0.4%	0.38
(3) Change in Return on Equity	1%	3.9716	0.5%	0.46
(4) Change in CapEx	1%	3.9926	1.0%	0.99

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.29: Financial Analysis of Bishkek II Thermal Power Project

Year	Construction Period					Operating Period						
	Capital Expend. without IDC	IDC	Capital Expend. with IDC	Debt Funded	Equity Funded	O&M Expenses	Fuel Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2006	$81	$3	$85	$69	$16							
2007	$62	$9	$71	$45	$26							
2008	$63	$14	$77	$55	$22							
2009						$12.6	$21	$17	$12	$62	2,355	2.62
2010						$12.8	$21	$17	$12	$62	2,355	2.64
2011						$13.0	$21	$17	$12	$63	2,355	2.66
2012						$13.2	$22	$17	$12	$63	2,355	2.68
2013						$13.4	$22	$17	$12	$64	2,355	2.71
2014						$13.6	$22	$31	$12	$78	2,355	3.33
2015						$13.8	$23	$30	$12	$77	2,355	3.29
2016						$14.0	$23	$28	$12	$77	2,355	3.25
2017						$14.2	$23	$27	$12	$76	2,355	3.22
2018						$14.4	$24	$25	$12	$75	2,355	3.18
2019						$14.6	$24	$24	$12	$74	2,355	3.15
2020						$14.9	$24	$23	$12	$73	2,355	3.11
2021						$15.1	$25	$21	$12	$72	2,355	3.08
2022						$15.3	$25	$20	$12	$72	2,355	3.04
2023						$15.6	$25	$18	$12	$71	2,355	3.01
2024						$15.8	$26	$6	$12	$59	2,355	2.50
2025						$16.0	$26	$5	$12	$59	2,355	2.51
2026						$16.3	$27	$5	$12	$60	2,355	2.53
2027						$16.5	$27	$5	$12	$60	2,355	2.55
2028						$16.8	$27	$5	$12	$60	2,355	2.56
2029												
2030												
Total	$206	$27	$233	$169	$64							

Levelized Tariff (c/kWh): 2.67 (in 2004 prices)

Table A5.30: Bishkek II Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff(%)	Sensitivity Index [a]
Base Case		2.6743		
Sensitivities				
(1) Change in Generation	-20%	3.1178	16.6%	(0.83)
(2) Change in Interest Rates	1%	2.6822	0.3%	0.30
(3) Change in Return on Equity	1%	2.6800	0.2%	0.21
(4) Change in CapEx	1%	2.6866	0.5%	0.46
(5) Change in Fuel Price	1%	2.6833	0.3%	0.34

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.31: Financial Analysis of Talimarjan - Phase I Power Project

Year	Construction Period					Operating Period						
	Capital Expenditures without IDC	IDC	Capital Expenditures with IDC	Debt Funded	Equity Funded	O&M Expenses	Fuel Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2005	$102	$6	$108	$85	$23							
2006						$8.1	$48	$9	$3	$68	4,266	1.60
2007						$8.2	$49	$9	$3	$69	4,266	1.62
2008						$8.3	$50	$9	$3	$70	4,266	1.64
2009						$8.4	$51	$9	$3	$71	4,266	1.66
2010						$8.6	$51	$9	$3	$72	4,266	1.68
2011						$8.7	$52	$16	$3	$80	4,266	1.88
2012						$8.8	$53	$15	$3	$80	4,266	1.88
2013						$9.0	$54	$15	$3	$80	4,266	1.89
2014						$9.1	$55	$14	$3	$81	4,266	1.89
2015						$9.2	$55	$13	$3	$81	4,266	1.90
2016						$9.4	$56	$12	$3	$81	4,266	1.90
2017						$9.5	$57	$12	$3	$81	4,266	1.91
2018						$9.7	$58	$11	$3	$82	4,266	1.92
2019						$9.8	$59	$10	$3	$82	4,266	1.92
2020						$10.0	$60	$10	$3	$82	4,266	1.93
2021						$10.1	$61	$3	$3	$77	4,266	1.80
2022						$10.3	$62	$3	$3	$78	4,266	1.82
2023						$10.4	$63	$3	$3	$79	4,266	1.84
2024						$10.6	$63	$2	$3	$80	4,266	1.87
2025						$10.7	$64	$2	$3	$81	4,266	1.89
2026						$10.1	$61	$3	$3	$77	4,266	1.80
2027						$10.3	$62	$3	$3	$78	4,266	1.82
2028						$10.4	$63	$3	$3	$79	4,266	1.84
2029						$10.6	$63	$2	$3	$80	4,266	1.87
2030						$10.7	$64	$2	$3	$81	4,266	1.89
Total	$102	$6	$108	$85	$23							
Levelized Tariff (c/kWh) : 1.75 (in 2004 prices)												

Table A5.32: Talimardjan Phase I Sensitivity Analysis

	Percentage Change in Parameter(%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		1.7490		
Sensitivities				
(1) Change in Generation	-20%	1.8770	7.3%	(0.37)
(2) Change in Interest Rates	1%	1.7506	0.1%	0.09
(3) Change in Return on Equity	1%	1.7497	0.0%	0.04
(4) Change in CapEx	1%	1.7520	0.2%	0.17
(5) Change in Fuel Price	1%	1.7614	0.7%	0.71

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.33: Financial Analysis of Talimarjan - Phase II Power Project

Year	Construction Period					Operating Period						
	Capital Expend. without IDC	IDC	Capital Expend. with IDC	Debt Funded	Equity Funded	O&M Expenses	Fuel Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2009	$130	$6	$136	$113	$23							
2010	$397	$31	$428	$390	$38							
2011	$448	$70	$518	$398	$120							
2012	$318	$104	$422	$277	$145							
2013	$46	$124	$170	$124	$46							
2014	$130	$6	$136	$113	$23							
2015						$24.2	$145	$130	$75	$375	12,796	2.93
2016						$24.6	$147	$130	$75	$377	12,796	2.95
2017						$24.9	$150	$130	$75	$380	12,796	2.97
2018						$25.3	$152	$130	$75	$383	12,796	2.99
2019						$25.7	$154	$130	$75	$385	12,796	3.01
2020						$26.1	$156	$239	$75	$497	12,796	3.88
2021						$26.5	$159	$228	$75	$488	12,796	3.82
2022						$26.9	$161	$217	$75	$480	12,796	3.75
2023						$27.3	$164	$206	$75	$472	12,796	3.69
2024						$27.7	$166	$195	$75	$464	12,796	3.63
2025						$28.1	$169	$185	$75	$457	12,796	3.57
2026						$28.6	$171	$174	$75	$449	12,796	3.51
2027						$29.0	$174	$163	$75	$441	12,796	3.45
2028						$29.4	$177	$152	$75	$433	12,796	3.38
2029						$29.9	$179	$141	$75	$425	12,796	3.32
2030						$30.3	$182	$43	$75	$331	12,796	2.59
2031						$30.8	$185	$41	$75	$332	12,796	2.59
2032						$31.3	$188	$39	$75	$333	12,796	2.60
2033						$31.7	$190	$37	$75	$334	12,796	2.61
2034						$32.2	$193	$35	$75	$335	12,796	2.62
2035						$30.3	$182	$43	$75	$331	12,796	2.59
2036						$30.8	$185	$41	$75	$332	12,796	2.59
2037						$31.3	$188	$39	$75	$333	12,796	2.60
2038						$31.7	$190	$37	$75	$334	12,796	2.61
Total	$1,340	$335	$1,675	$1,303	$372							
Levelized Tariff (c/kWh): 2.92 (in 2004 prices)												

Table A5.34: Talimardjan Phase II Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		2.9168		
Sensitivities				
(1) Change in Generation	-20%	3.3893	16.2%	(0.81)
(2) Change in Interest Rates	1%	2.9305	0.5%	0.47
(3) Change in Return on Equity	1%	2.9258	0.3%	0.31
(4) Change in CapEx	1%	2.9340	0.6%	0.59
(5) Change in Fuel Price	1%	2.9217	0.2%	0.17

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.35: Financial Analysis of Ekibastuz I Rehabilitation Project

Year	Construction Period					Operating Period						
	Capital Expend. without IDC	IDC	Capital Expend. with IDC	Debt Funded	Equity Funded	O&M Expenses	Fuel Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2008	$47	$2	$49	$39	$10							
2009	$143	$11	$154	$137	$17							
2010	$146	$23	$169	$115	$54							
2011	$148	$35	$183	$124	$59							
2012						$81.4	$147	$42	$25	$295	11,283	2.62
2013						$82.7	$149	$42	$25	$299	11,283	2.65
2014						$83.9	$151	$42	$25	$302	11,283	2.68
2015						$85.2	$154	$42	$25	$306	11,283	2.71
2016						$86.5	$156	$42	$25	$310	11,283	2.74
2017						$87.8	$158	$76	$25	$348	11,283	3.08
2018						$89.1	$161	$73	$25	$348	11,283	3.09
2019						$90.5	$163	$69	$25	$349	11,283	3.09
2020						$91.9	$166	$66	$25	$349	11,283	3.09
2021						$93.3	$168	$62	$25	$349	11,283	3.10
2022						$94.7	$171	$59	$25	$350	11,283	3.10
2023						$96.1	$173	$55	$25	$350	11,283	3.11
2024						$97.6	$176	$52	$25	$351	11,283	3.11
2025						$99.1	$179	$49	$25	$352	11,283	3.12
2026						$100.6	$181	$45	$25	$353	11,283	3.12
2027						$102.1	$184	$14	$25	$326	11,283	2.89
2028						$103.7	$187	$13	$25	$329	11,283	2.92
2029						$105.2	$190	$12	$25	$333	11,283	2.95
2030						$106.8	$193	$12	$25	$337	11,283	2.99
2031						$108.5	$196	$11	$25	$341	11,283	3.02
2032												
2033												
Total	$484	$71	$555	$416	$140							
Levelized Tariff (c/kWh) : 2.66 (in 2004 prices)												

Table A5.36: Ekibastuz I Rehabilitation Project Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		2.6617		
Sensitivities				
(1) Change in Generation	-20%	2.9956	12.5%	(0.63)
(2) Change in Interest Rates	1%	2.6665	0.2%	0.18
(3) Change in Return on Equity	1%	2.6649	0.1%	0.12
(4) Change in CapEx	1%	2.6677	0.2%	0.23
(5) Change in Fuel Price	1%	2.6750	0.5%	0.50

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.37: Financial Analysis of Kazakhstan New Ekibastuz Project

Year	Construction Period					Operating Period						
	Capital Expend. without IDC	IDC	Capital Expend. with IDC	Debt Funded	Equity Funded	O&M Expenses	Fuel Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Generation	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
2006	$197	$8	$205	$169	$36							
2007	$200	$25	$225	$164	$60							
2008	$270	$46	$316	$250	$66							
2009	$274	$71	$345	$252	$93							
2010	$209	$93	$302	$200	$102							
2011	$212	$112	$324	$235	$89							
2012						$42	$99	$127	$88	$356	6,850	5.20
2013						$42	$101	$127	$88	$358	6,850	5.23
2014						$43	$102	$127	$88	$360	6,850	5.26
2015						$44	$104	$127	$88	$363	6,850	5.29
2016						$44	$105	$127	$88	$365	6,850	5.33
2017						$45	$107	$233	$88	$473	6,850	6.90
2018						$46	$109	$222	$88	$465	6,850	6.78
2019						$46	$110	$212	$88	$456	6,850	6.66
2020						$47	$112	$201	$88	$448	6,850	6.54
2021						$48	$114	$190	$88	$440	6,850	6.42
2022						$48	$115	$180	$88	$432	6,850	6.31
2023						$49	$117	$169	$88	$424	6,850	6.19
2024						$50	$119	$159	$88	$416	6,850	6.07
2025						$51	$121	$148	$88	$408	6,850	5.95
2026						$51	$123	$138	$88	$400	6,850	5.84
2027						$52	$124	$42	$88	$307	6,850	4.48
2028						$53	$126	$40	$88	$308	6,850	4.49
2029						$54	$128	$38	$88	$308	6,850	4.50
2030						$55	$130	$36	$88	$309	6,850	4.51
2031						$55	$132	$34	$88	$310	6,850	4.52
Total	$1,361	$356	$1,717	$1,270	$447							
Levelized Tariff (c/kWh): 5.05 (in 2004 prices)												

Table A5.38: Kazakhstan New Ekibastuz Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		5.0468		
Sensitivities				
(1) Change in Generation	-20%	5.6524	12.0%	(0.60)
(2) Change in Interest Rates	1%	5.0700	0.5%	0.46
(3) Change in Return on Equity	1%	5.0720	0.5%	0.50
(4) Change in CapEx	1%	5.0766	0.6%	0.59
(5) Change in Fuel Price	1%	5.0614	0.3%	0.29

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.39: Financial Analysis of Surhan - Mashad Transmission Line Project

	Construction Period					Operating Period					
	Capital Expend. Without IDC	IDC	Capital Expend. With IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return On Equity	Total Cash Outflow	Transm	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
Year 1	$86	$4	$89	$72	$17						
Year 2	$139	$13	$152	$123	$29						
Year 3	$124	$24	$148	$98	$50						
Year 4						$0.3	$29	$17	$47	9,440	0.49
Year 5						$0.3	$29	$17	$47	9,440	0.49
Year 6						$0.3	$29	$17	$47	9,440	0.49
Year 7						$0.3	$29	$17	$47	9,440	0.49
Year 8						$0.3	$29	$17	$47	9,440	0.49
Year 9						$0.3	$54	$17	$71	9,440	0.75
Year 10						$0.3	$51	$17	$69	9,440	0.73
Year 11						$0.3	$49	$17	$66	9,440	0.70
Year 12						$0.3	$47	$17	$64	9,440	0.68
Year 13						$0.3	$44	$17	$61	9,440	0.65
Year 14						$0.4	$42	$17	$59	9,440	0.62
Year 15						$0.4	$39	$17	$56	9,440	0.60
Year 16						$0.4	$37	$17	$54	9,440	0.57
Year 17						$0.4	$34	$17	$52	9,440	0.55
Year 18						$0.4	$32	$17	$49	9,440	0.52
Year 19						$0.4	$10	$17	$27	9,440	0.29
Year 20						$0.4	$9	$17	$27	9,440	0.28
Year 21						$0.4	$9	$17	$26	9,440	0.28
Year 22						$0.4	$8	$17	$26	9,440	0.27
Year 23						$0.4	$8	$17	$25	9,440	0.27
Total	$225	$41	$266	$170	$96						
Levelized Tariff (c/kWh) 0.54											

Table A5.40: Surhan - Mashad Transmission Line Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		0.5075		
Sensitivities				
(1) Change in Generation	-20%	0.6344	25.0%	(1.25)
(2) Change in Interest Rates	1%	0.5106	0.6%	0.61
(3) Change in Return on Equity	1%	0.5094	0.4%	0.38
(4) Change in CapEx	1%	0.5125	1.0%	0.99

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.41: Financial Analysis of Kandahar - Karachi Transmission Line Project

Year	Construction Period					Operating Period					
	Capital Expend. without IDC	IDC	Capital Expend. with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Transm	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
Year 1	$85	$3	$88	$59	$29						
Year 2	$200	$14	$215	$166	$48						
Year 3						$0.2	$23	$13	$36	3,824	0.94
Year 4						$0.2	$23	$13	$36	3,824	0.94
Year 5						$0.2	$23	$13	$36	3,824	0.94
Year 6						$0.2	$23	$13	$36	3,824	0.94
Year 7						$0.2	$23	$13	$36	3,824	0.94
Year 8						$0.2	$41	$13	$55	3,824	1.43
Year 9						$0.2	$39	$13	$53	3,824	1.38
Year 10						$0.2	$38	$13	$51	3,824	1.33
Year 11						$0.2	$36	$13	$49	3,824	1.28
Year 12						$0.2	$34	$13	$47	3,824	1.23
Year 13						$0.2	$32	$13	$45	3,824	1.18
Year 14						$0.2	$30	$13	$43	3,824	1.13
Year 15						$0.2	$28	$13	$41	3,824	1.08
Year 16						$0.2	$26	$13	$40	3,824	1.04
Year 17						$0.3	$24	$13	$38	3,824	0.99
Year 18						$0.3	$15	$13	$28	3,824	0.74
Year 19						$0.3	$6	$13	$20	3,824	0.52
Year 20						$0.3	$6	$13	$19	3,824	0.51
Year 21						$0.3	$6	$13	$19	3,824	0.50
Year 22						$0.3	$5	$13	$19	3,824	0.49
Total	$285	$17	$302	$225	$77						
Levelized Tariff (c/kWh): 1.03											

Table A5.42: Kandahar - Karachi Transmission Line Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		0.9839		
Sensitivities				
(1) Change in Generation	-20%	1.2299	25.0%	(1.25)
(2) Change in Interest Rates	1%	0.9892	0.5%	0.54
(3) Change in Return on Equity	1%	0.9876	0.4%	0.37
(4) Change in CapEx	1%	0.9937	1.0%	0.99

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.43: Financial Analysis of Kabul - Kandahar Transmission Line Project

Year	Construction Period					Operating Period					
	Capital Expend. without IDC	IDC	Capital Expend. with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Transm	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
Year 1	$51	$2	$53	$35	$17						
Year 2	$120	$9	$129	$100	$29						
Year 3						$0.1	$14	$8	$21	4,872	0.44
Year 4						$0.1	$14	$8	$21	4,872	0.44
Year 5						$0.1	$14	$8	$21	4,872	0.44
Year 6						$0.1	$14	$8	$21	4,872	0.44
Year 7						$0.1	$14	$8	$21	4,872	0.44
Year 8						$0.1	$25	$8	$33	4,872	0.67
Year 9						$0.1	$24	$8	$32	4,872	0.65
Year 10						$0.1	$23	$8	$31	4,872	0.63
Year 11						$0.1	$21	$8	$29	4,872	0.60
Year 12						$0.1	$20	$8	$28	4,872	0.58
Year 13						$0.1	$19	$8	$27	4,872	0.56
Year 14						$0.1	$18	$8	$26	4,872	0.53
Year 15						$0.1	$17	$8	$25	4,872	0.51
Year 16						$0.1	$16	$8	$24	4,872	0.49
Year 17						$0.1	$15	$8	$23	4,872	0.46
Year 18						$0.1	$5	$8	$12	4,872	0.26
Year 19						$0.1	$4	$8	$12	4,872	0.25
Year 20						$0.1	$4	$8	$12	4,872	0.25
Year 21						$0.1	$4	$8	$12	4,872	0.24
Year 22						$0.1	$4	$8	$12	4,872	0.24
Total	$171	$10	$182	$135	$46						
Levelized Tariff (c/kWh): 049											

Table A5.44: Kabul - Kandahar Transmission Line Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		0.4636		
Sensitivities				
(1) Change in Generation	-20%	0.5795	25.0%	(1.25)
(2) Change in Interest Rates	1%	0.4661	0.5%	0.54
(3) Change in Return on Equity	1%	0.4653	0.4%	0.37
(4) Change in CapEx	1%	0.4698	1.3%	1.34

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.45: Financial Analysis of Almaty - Urumqui Transmission Line Project

Year	Construction Period					Operating Period					
	Capital Expend. without IDC	IDC	Capital Expend with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Trans	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
Year 1	$104	$4	$108	$86	$22						
Year 2	$169	$16	$185	$148	$37						
Year 3	$150	$29	$179	$116	$63						
Year 4						$0.4	$35	$22	$57	9,540	0.60
Year 5						$0.4	$35	$22	$57	9,540	0.60
Year 6						$0.4	$35	$22	$57	9,540	0.60
Year 7						$0.4	$35	$22	$57	9,540	0.60
Year 8						$0.4	$35	$22	$57	9,540	0.60
Year 9						$0.4	$64	$22	$87	9,540	0.91
Year 10						$0.4	$61	$22	$84	9,540	0.88
Year 11						$0.5	$58	$22	$81	9,540	0.85
Year 12						$0.5	$55	$22	$78	9,540	0.82
Year 13						$0.5	$53	$22	$75	9,540	0.78
Year 14						$0.5	$50	$22	$72	9,540	0.75
Year 15						$0.5	$47	$22	$69	9,540	0.72
Year 16						$0.5	$44	$22	$66	9,540	0.69
Year 17						$0.5	$41	$22	$63	9,540	0.66
Year 18						$0.5	$38	$22	$60	9,540	0.63
Year 19						$0.5	$12	$22	$34	9,540	0.36
Year 20						$0.5	$11	$22	$33	9,540	0.35
Year 21						$0.5	$11	$22	$33	9,540	0.34
Year 22						$0.5	$10	$22	$32	9,540	0.34
Year 23						$0.5	$9	$22	$32	9,540	0.33
Total	$422	$50	$472	$350	$122						

Levelized Tariff (c/kWh): 0.72

Table A5.46: Almaty - Urumqui Transmission Line Sensitivity Analysis

	Percentage Change in Parameter(%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		0.6176		
Sensitivities				
(1) Change in Generation	-20%	0.7720	25.0%	(1.25)
(2) Change in Interest Rates	1%	0.6212	0.6%	0.59
(3) Change in Return on Equity	1%	0.6200	0.4%	0.39
(4) Change in CapEx	1%	0.6237	1.0%	0.99

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.47: Financial Analysis of Kabul - Tarbela Transmission Line Project

Year	Construction Period					Operating Period					
	Capital Expend. without IDC	IDC	Capital Expend. with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Transm	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
Year 1	$32	$1	$33	$22	$11						
Year 2	$76	$5	$82	$64	$18						
Year 3						$0.10	$9	$5	$14	2,946	0.46
Year 4						$0.11	$9	$5	$14	2,946	0.46
Year 5						$0.11	$9	$5	$14	2,946	0.46
Year 6						$0.11	$9	$5	$14	2,946	0.46
Year 7						$0.11	$9	$5	$14	2,946	0.46
Year 8						$0.11	$16	$5	$21	2,946	0.71
Year 9						$0.11	$15	$5	$20	2,946	0.68
Year 10						$0.12	$14	$5	$19	2,946	0.66
Year 11						$0.12	$14	$5	$19	2,946	0.63
Year 12						$0.12	$13	$5	$18	2,946	0.61
Year 13						$0.12	$12	$5	$17	2,946	0.59
Year 14						$0.12	$11	$5	$17	2,946	0.56
Year 15						$0.12	$11	$5	$16	2,946	0.54
Year 16						$0.13	$10	$5	$15	2,946	0.51
Year 17						$0.13	$9	$5	$14	2,946	0.49
Year 18						$0.13	$3	$5	$8	2,946	0.27
Year 19						$0.13	$3	$5	$8	2,946	0.27
Year 20						$0.13	$3	$5	$8	2,946	0.26
Year 21						$0.14	$2	$5	$8	2,946	0.26
Year 22						$0.14	$2	$5	$7	2,946	0.25
Total	$109	$7	$115	$86	$29						
Levelized Tariff (c/kWh) 0.51											

Table A5.48: Kabul - Tarbela Transmission Line Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		0.4878		
Sensitivities				
(1) Change in Generation	-20%	0.6098	25.0%	(1.25)
(2) Change in Interest Rates	1%	0.4905	0.5%	0.54
(3) Change in Return on Equity	1%	0.4896	0.4%	0.37
(4) Change in CapEx	1%	0.4927	1.0%	0.99

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Table A5.49: Financial Analysis of Surhan - Kabul Transmission Line Project

Year	Construction Period					Operating Period					
	Capital Expenditures without IDC	IDC	Capital Expenditures with IDC	Debt Funded	Equity Funded	O&M Expenses	Debt Service Expenses	Return on Equity	Total Cash Outflow	Trans	Annual Tariff
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	c/kWh
Year 1	$46	$2	$48	$30	$18						
Year 2	$125	$9	$134	$104	$30						
Year 3						$0.20	$14	$8	$22	4,865	0.46
Year 4						$0.21	$14	$8	$22	4,865	0.46
Year 5						$0.21	$14	$8	$22	4,865	0.46
Year 6						$0.21	$14	$8	$23	4,865	0.46
Year 7						$0.22	$14	$8	$23	4,865	0.46
Year 8						$0.22	$26	$8	$34	4,865	0.70
Year 9						$0.22	$25	$8	$33	4,865	0.68
Year 10						$0.23	$24	$8	$32	4,865	0.65
Year 11						$0.23	$22	$8	$31	4,865	0.63
Year 12						$0.23	$21	$8	$30	4,865	0.61
Year 13						$0.24	$20	$8	$28	4,865	0.58
Year 14						$0.24	$19	$8	$27	4,865	0.56
Year 15						$0.24	$18	$8	$26	4,865	0.53
Year 16						$0.25	$16	$8	$25	4,865	0.51
Year 17						$0.25	$15	$8	$24	4,865	0.48
Year 18						$0.25	$5	$8	$13	4,865	0.27
Year 19						$0.26	$4	$8	$13	4,865	0.26
Year 20						$0.26	$4	$8	$13	4,865	0.26
Year 21						$0.27	$4	$8	$12	4,865	0.25
Year 22						$0.27	$4	$8	$12	4,865	0.25
Total	$171	$11	$182	$134	$48						
Levelized Tariff (c/kWh) 0.51											

Table A5.50: Surhan - Kabul Transmission Line Sensitivity Analysis

	Percentage Change in Parameter (%)	Levelized Tariff c/kWh	Percentage Change Lev Tariff (%)	Sensitivity Index [a]
Base Case		0.5061		
Sensitivities				
(1) Change in Generation	-20%	0.6320	25.0%	(1.25)
(2) Change in Interest Rates	1%	0.5087	0.5%	0.54
(3) Change in Return on Equity	1%	0.5078	0.4%	0.37
(4) Change in CapEx	1%	0.5111	1.0%	0.99

[a)] Sensitivity index is the % change in parameter divided by % Change in Levelized Tariff.

Appendix 7.1

Central Asia
Regional Electricity Export Potential Study
Establishment of Water Energy Consortium-Conceptual Approaches

Conceptual Approaches of the Experts
of the Republic of Kazakhstan, the Kyrgyz Republic, Tajikistan and Uzbekistan
Towards Creation of Water and Energy Consortium

To implement the instructions of the heads of the Republic of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan as of July 5-6, 2003, on the issues of creation of an International Water and Energy Consortium (hereinafter – the IWEC) the following basic conceptual approaches are proposed:

1. Conditions of Creation

IWEC shall be created based on the intergovernmental agreement where each of the member countries determines the IWEC founders. It is important for the parties' Governments to create necessary conditions of their founders for parity participation in the Consortium of the latter;

IWEC shall be a legal entity with the charter, address, settlement and currency accounts, and other attributes of an interstate organization. Its activity shall be guided by the laws of the country of destination;

It shall be generally managed by the Council (or Board) of the authorized Consortium representatives formed by equal representation of the parties. In the process of decision making each party shall have equal votes. The decisions shall be made on the assumption of full parties' agreement;

Within the framework of International Water and Energy Consortium distribution of water resources will be performed in the economic interests of the CACO member countries;

All countries shall fulfill the common requirement on trans-border rivers;

Legal status, start-up conditions, establishment conditions and the authorized fund size along with the other conditions of Consortium creation shall be defined by the intergovernmental agreement;

The member countries of the Consortium when using trans-border waterways on all territory shall apply all appropriate measures to prevent damage to other countries in compliance with the principles and norms of International Law.

2. Goals and Objectives

(a) Ensuring optimum proportion between the energy and irrigation regimes for operation of cascades of water reservoirs in annual and perennial cycles breakdown with consideration of balances of fuel-energy resources of the IWEC member countries;
(b) Ensuring implementation of international agreement of CACO member countries on the issues of cross-supply of water, energy and power sources;

(c) Attracting investments for reconstruction of the existing and construction of new water and water-energy facilities for development and effective use of water and energy potential of the region;
(d) Creating conditions for production and technological cooperation of water and fuel-energy sectors, expanding their export potential, and introduction of innovation technologies;
(e) The other functions determined by the inter-state and inter-governmental agreements can be committed to the Consortium.

3. Main Activity Directions

Coordination of joint activity of water and fuel-energy entities of the member countries in the area of rational and effective use of water and energy resources within the competence provided by the founders;

Creating conditions for ensuring economical and effective operation of energy systems, taking advantages of parallel operation, established regime of reservoirs operation, and interstate supplies of fuel-energy resources and flows of electric energy in volumes determined by the agreements and treaties;

Preparing proposals on rapprochement of legislations, improvement of legal frameworks enabling the entities to implement their activities based on a single legislative framework in the area of rational use of water and energy resources with consideration of international law;

Pursuing investment policy oriented on construction of new (Rogun hydropower station in Tajikistan, Kambarata hydropower stations in Kyrgyzstan, and other facilities) and rehabilitation, modernization of the existing capacities;

Interacting with interstate and intergovernmental bodies, and state organizations, economic entities of the member-countries of the Consortium;

Ensuring functioning of the coordinated mechanism of cross-payments and payment for interstate electric power flows and fuel-energy resources supplies;

Participating in preparation of interstate and intergovernmental agreements on developing cooperation in the area of electric power and water;
The other functions determined by the inter-state and inter-governmental agreements can be committed to the Consortium.

From Experts' Group
of the Republic of Kazakhstan
From Experts' Group
of the Kyrgyz Republic
From Experts' Group
of the Republic of Tajikistan
From Experts' Group
of the Republic of Uzbekistan

Opinions and Proposals of the Republic of Uzbekistan (in hand writing)

Amu Darya and Naryn – Syr Darya are the trans-border rivers. Any changes in their regimes enabled by previously approved documents on distribution of water resources are the breach of regime of water reservoirs cascade. Coordination with other countries is required.

At time of creation of IWEC the charge for water resources has not been considered, and distribution of water resources cannot be performed for commercial purposes.

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Proposals of the national experts:

- there is a need for establishing a regional working group to elaborate in details the Feasibility Study and the funding mechanisms considering the issues of related sectors' cooperation, study of the legal framework, and determination of the share of each CACO' Parties in this Consortium;
- during the preparation of the Feasibility Study it is also necessary to envisage the principle of financing the authorized fund being established, economic benefits from the activities of the consortium, and the principle of distribution of the benefits gained;
- it is necessary to address international financial institution with the request for practical and technical assistance, and financial assistance, if needed, for the preparation of the Feasibility Study for the establishment of the consortium.

Appendix 7.2

Central Asia
Regional Electricity Export Potential Study

Theun-Hinboun Hydropower Project - Lao

Theun Hinboun hydropower project, is an inter-basin transfer scheme in the Lao People's Republic (Lao PDR) designed to export power to neighboring Thailand. The main objective of this project was to support economic growth in the Lao PDR by enhancing foreign exchange earnings through the export of power to Thailand. It diverts 110m^3/sec of river flow from the Nam Theun basin into the Nam Hinboun basin (this combination gives the project its name) through a 5.2km headrace tunnel into a power station lying some 240m below the level of the reservoir created by the dam on the Nam Theun. The capacity of the plant is 210 MW and the average annual generation potential is 1,645 GWh.

The Project is very good example of public private partnership, as well as of importers of power having equity stake in the generation company. The total estimated project cost of $240 M was funded by 46% equity and 54% debt. 60% of the equity was provided by the Lao PDR Government through its state owned power utility, Electricity du Laos (EdL). The other investors that make up the consortium are: MDX Lao Company Ltd. of Thailand (20%); and Nordic Hydropower AB of Sweden (20%), itself a consortium of the two largest Nordic hydro utilities, Norway's Statkraft and Sweden's Vattenfall each with equal shares in Nordic Hydropower. The debt funds were provided by the Government, Commercial Loans and Export Credit. Further Asian Development Bank partially financed the Lao PDR Government's equity through a $60 M loan from its soft loan window.

The power is sold to Electricity Generating Authority of Thailand (EGAT) through a 25 year Power Purchase Agreement based on a take-or-pay principle by which EGAT undertook to purchase 95% of the Project's available energy output.

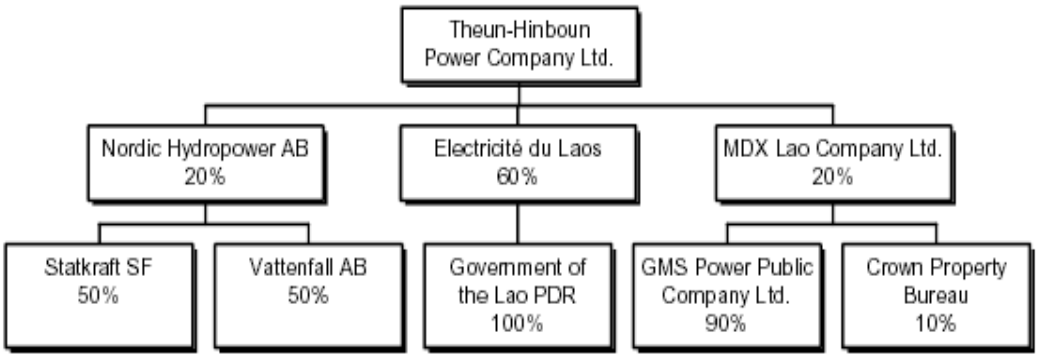

Figure A7.1: Ownership Structure of Theun-Hinboun Power Company

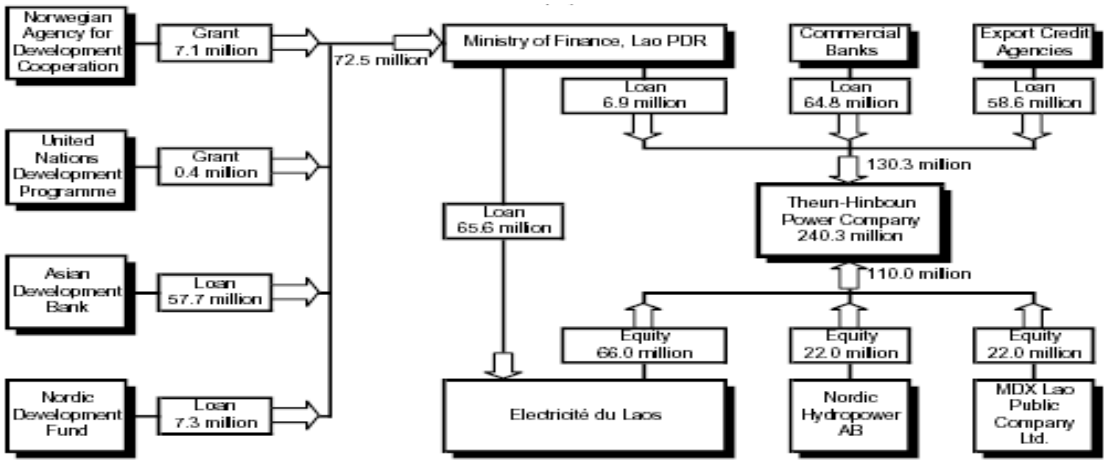

Figure A7.2: Financial Structure of Theun-Hinboun Power Company

Appendix 8.1

Central Asia
Regional Electricity Export Potential Study
Options For De-Congesting the Southern Central Asian Power System

At present Tajikistan supplies power from its southern part to its northern part and further to Kazakhstan through Uzbekistan, the latter often claims transmission capacity limitations. These capacity constraints are likely to be exacerbated once the Talimardjan I plant starts dispatching. Therefore Tajikistan is examining options to transmit its power generated in the south of the country to its north and beyond

The construction of a north-south 500 kV transmission line from SS Regar to northern Tajikistan is one such option. At the same time, the Kyrgyz Republic and Tajikistan have decided to interconnect themselves in the Fergana valley and are building a 54 km 220 kV transmission line between Batken (the Kyrgyz Republic) and Kanibodom (Tajikistan).

In view of the expected growth in demand in the region, new generation sources coming on stream (e.g., Sangtuda I) and new markets (e.g., Russia and Afghanistan) on a seasonal basis, it would make sense to examine the option of linking the Toktogul cascade in the Kyrgyz Republic with the Nurek cascade in Tajikistan. This would have the dual advantage of de-congesting southern CAPS and enhance exports on a seasonal basis.

In order to complete this Naryn Nurek link, the key element is the South North Line in Tajikistan linking Nurek with Khodjand. In addition, some improvements to the associated 220 kV system in Tajikistan and the Kyrgyz Republic need to be done as follows: (see Figure A8.1 showing the locations):

- A 220 kV line (**a**) between SS Aigul-Tash (Batken, Kyrgyzstan) – SS Kanibodom (Tajikistan). SS Kanibodon has developed connections to the Southern Tajikistan power grid by 220 kV and 110 kV lines (**b**);
- A new 500/220 kV SS Dakta in Kyrgyzstan (**c**). As a Phase I, SS Datka could be constructed as a 220 kV switch yard;
- An 80 km length 220 kV line tap (**d**) from SS Datka to 220 kV line Kurpsay-Crystal;
- A 6 km length 220 kV line tap (**e**) from SS Datka to 220 kV line Kurpsay – Oktiabrskaya;
- A new 120 km length 220 kV line(**f**) Osh – Datka; and
- A 30 km length line tap (**g**) from SS Alay to 220 kV line Osh – Lochin (Uzbekistan).

The first of these is already under construction by Kyrgyz and Tajik governments using their own resources. The other elements need to be funded and construction started. Some alternative configurations are also under study for these elements. These aspects will have to be studied further in detail.

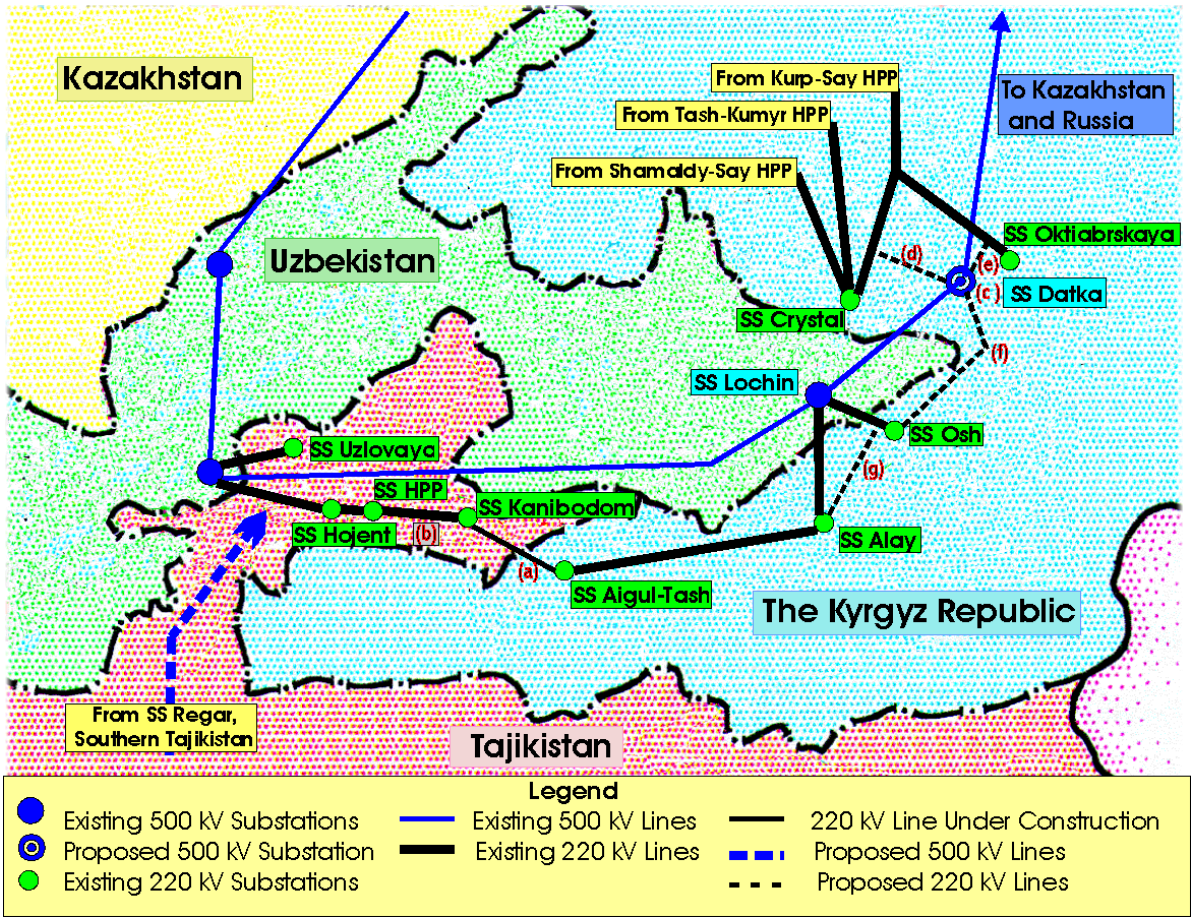

Figure A8.1: Tajikistan North South 500 kV Line and De-conjunction of the Power Transmission in the Southern CAPS

Assessment of the North South Line in Tajikistan

This would be the key (and highest cost) element of the Toktogul-Nurek Link. The capital cost of constructing this 350 km line, a new substation and rehabilitating one existing substation is estimated at $ 145.6 million. The construction can be completed in three years. Conservatively it is assumed that the line will carry 3000 GWh annually even though, according to Fichtner International the maximum annual carrying capacity of the line is actually 8300 GWh. The line losses are assumed at 1.4% and substation losses are assumed at 0.4%. Incremental O&M expenses are assumed at 0.05% of the capital costs. On this basis, the average incremental cost (the economic cost) of transmission is estimated at 0.63 cents/kWh (see Table A8.1). At the initial likely levels of loading at about 3600 GWh/year the AIC will come down to 0.53 cents.

Table A8.1: Tajikistan South North Transmission Line AIC (Economic) of Transmission

Year	Capital Investments (% of total)	Incremental Transmission (GWh)	Capital Investments (US$ Million)	Incremental O&M Exp. (US$ Million)	Cumulative O&M Exp. (US$ Million)	Total Incremental Costs (US$M)	Incremental Sales (GWh)
Year 1						0	
Year 2	30		43.67	0.02	0.02	43.69	0
Year 3	40		58.22	0.03	0.05	58.27	0
Year 4	30	900	43.67	0.02	0.07	43.74	884
Year 5		2100			0.07	0.07	2946
Year 6					0.07	0.07	2946
Year 7					0.07	0.07	2946
Year 8					0.07	0.07	2946
Year 9					0.07	0.07	2946
Year 10					0.07	0.07	2946
Year 11					0.07	0.07	2946
Year 12					0.07	0.07	2946
Year 13					0.07	0.07	2946
Year 14					0.07	0.07	2946
Year 15					0.07	0.07	2946
Year 16					0.07	0.07	2946
Year 17					0.07	0.07	2946
Year 18					0.07	0.07	2946
Year 19					0.07	0.07	2946
Year 20					0.07	0.07	2946
Year 21					0.07	0.07	2946
Year 22					0.07	0.07	2946
Year 23					0.07	0.07	2946
Present Values (23 years)							
Incremental Costs (US$ million)							121.2
Incremental Sales (million kWh)							191790
Average Incremental Costs of Transmission (cents/kWh)							0.63

Data Source: Barki Tajik Report

On the basis of financing assumptions similar to those employed for the financial analysis of all other export transmission lines elsewhere in this report, the levelized transmission tariff needed for the service by this line would be 0.92 cents/kWh (see Table A8.2).

Table A8.2: Tajikistan South North Transmission Line Levelized Tariff Calculations

Year	Construction Period					Operating Period					
	Capital Expend. Without IDC	IDC	Capital Expend. With IDC	Debt	Equity	O&M Expense	Debt Service Expense	Return on Equity	Total Cash Outflow	Net Electricity Transmitted	Annual Tariff c/kWh
	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	($ M)	GWh	
Year 1	50	2	52	35	17						
Year 2	68	6	74	45	29						
Year 3	52	9	61	20	41						
Year 4						0.02	10	15	26	2,946	0.87
Year 5						0.02	10	15	26	2,946	0.87
Year 6						0.02	10	15	26	2,946	0.87
Year 7						0.02	10	15	26	2,946	0.87
Year 8						0.02	18	15	34	2,946	1.15
Year 9						0.02	18	15	33	2,946	1.12
Year 10						0.02	17	15	32	2,946	1.10
Year 11						0.02	16	15	31	2,946	1.07
Year 12						0.02	15	15	31	2,946	1.04
Year 13						0.02	14	15	30	2,946	1.01
Year 14						0.02	13	15	29	2,946	0.98
Year 15						0.02	13	15	28	2,946	0.95
Year 16						0.02	12	15	27	2,946	0.92
Year 17						0.02	11	15	26	2,946	0.90
Year 18						0.03	3	15	19	2,946	0.64
Year 19						0.03	3	15	19	2,946	0.63
Year 20						0.03	3	15	19	2,946	0.63
Year 21						0.03	3	15	18	2,946	0.62
Year 22						0.03	3	15	18	2,946	0.62
Year 23						0.03	3	15	18	2,946	0.62
Total	171	17	187	101	86						
Levelized Tariff (c/kWh): 0.92											

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