WATER ENERGY NEXUS IN CENTRAL ASIA

IMPROVING REGIONAL COOPERATION IN THE SYR DARYA BASIN

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Appendices

Note:

1. Unless the context otherwise requires the words 'summer' and 'winter' in this report denotes the periods April to September and October to March respectively.
2. In this report dollar ($) and cents denotes US dollar and cents.

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FOREWORD

Upon the dissolution of the Former Soviet Union (FSU), many regional issues in FSU became international issues among the newly independent states. The foremost among them is the need for resolution of the water-energy related issues in river basins, which cut across the boundaries of the new states. The issue is complicated by the energy and water self sufficiency approach, which many of the new states tend to pursue. To resolve these we need analyses, which demonstrate the superiority of the regional cooperation approach to the national self-sufficiency approach.

In this respect, the present report is a notable contribution towards possible solutions for sustainable regional cooperation in the Syr Darya river basin in the water and energy sectors. We believe it proposes a practical and transparent approach involving an equitable distribution of costs and benefits among the cooperating participants and represents a positive sum approach.

The proposals in this Report deal with only one step—although a very important one—among the many that need to be dealt with to improve the performance of these two sectors. These include: in the water/irrigation sector, improved river regulation, reservoir management, irrigation and drainage management, groundwater management; and in the energy sector, demand management, efficiency of use, pricing policies, and promotion of regional markets. The proposals in this report are not intended to preclude any of such steps.

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EXECUTIVE SUMMARY

This report seeks to review the regional cooperation efforts in the water and energy sectors pursued by the Central Asian Republics during the 1990s in the Syr Darya river basin, identify the reasons for the problems encountered, and suggest an approach to make the cooperation more reliable, sustainable and equitably beneficial to all parties. concerned. It also outlines a methodology for valuing costs and benefits involved in different types of arrangements, so that decisions could be made on the basis of a sound cost benefit analysis. Further it identifies the policy options, structural options and institutional improvements to be pursued by these countries to reinforce the cooperation arrangements.

A multi year water storage reservoir was constructed in the mid 1970s in Kyrgyz region on the Naryn river, a major tributary of Syr Darya river, to even out the dry and wet year flows to support effectively irrigation of lands under cotton, fodder, wheat, rice, fruits and vegetables in Uzbekistan and South Kazakhstan. The cascade of this reservoir and four other smaller downstream reservoirs on the same river had collectively an installed hydropower capacity of 2,870 MW. Under Protocol No.413 of 1984 of the Soviet government, in a normal year 75% of the annual discharge from the reservoir was to be made in summer (April-September) and discharges in winter (October-March) at 180 cubic meters/second should not exceed the remaining 25%. Surplus electricity generated in summer was fed into the Central Asian Power System for use by Uzbek and south Kazakh regions. Since Kyrgyz region lacked any significant resources of fossil fuels, they were transferred from Uzbek and Kazakh regions to enable Kyrgyz region to meet its winter demand for electricity and heat.

Once these regions became independent states, the above arrangement came under a great strain. Fossil fuel prices rose quickly to world price levels and payments were often demanded in hard currency. Customers quickly switched from expensive fossil fuel fired heating to electric heating, increasing winter electricity demand. The Kyrgyz Republic could not afford to import fossil fuels and started to increase winter discharges of water to meet its winter power demand and reduce summer releases to store water for the following winter, resulting in the farmers in Uzbekistan and south Kazakhstan facing irrigation water shortages in summer and the frozen waterways and canals being unable to handle the larger volume of water in winter and diverting them wastefully into a series

of depressions which formed the artificial lake called Aydarkul, with adverse environmental consequences. During 1990-2000, the summer releases declined to 45% and winter releases increased to 55% of the annual discharges.

To solve this problem of the competing (and now international) claims on the water, the Central Asian States entered into an agreement in February 1992 to maintain and adhere to the Soviet era arrangements. This, as well as the annual agreements for the release of water and exchange of electricity and fossil fuels proved ineffective and could not arrest the increasing power orientation of the Toktogul operation, resulting in the water storage reaching record low level of 7.2 BCM by April 1998 close to the dead storage level of 5.5 BCM. With the assistance of USAID, the Central Asian States entered into a new Long Term Framework Agreement in March 1998, *which explicitly recognized that annual and multi-year irrigation water storage has a cost and that it needs to be compensated through a barter exchange of electricity and fossil fuels or in cash*. The implementation of the annual Inter Governmental Irrigation Agreements made under the new framework, however, proved unsatisfactory, as the reservoir once again reached the low level of 7.5 BCM in April 2002 eroding the multi-year regulating ability of the reservoir. Further, contrary to the specific provision in the Framework Agreement, the annual agreements did not make any explicit compensation for water storage services and provided only for the import of surplus summer electricity from the Kyrgyz Republic and return in exchange, equivalent amount of fossil fuels in winter from Uzbekistan and Kazakhstan. However, even when agreed summer discharges were made, supply of fossil fuels fell short of agreed quantities, forcing the Kyrgyz Republic to increase winter discharges. In wet years downstream states did not need the agreed volumes of summer discharges and this affected the export of electricity and the compensating quantities of fossil fuel transfers to the Kyrgyz Republic. The latter was thus exposed to a serious risk in terms of timing for meeting its winter demand for heat and power.

The concept of downstream riparian states paying for water or water storage and regulation services to the upstream in a trans boundary basin is well established. Forty-four out of the 145 treaties signed in the twentieth century provide for such payments. Even within this region Kazakhstan has agreed in 2000 to pay the Kyrgyz Republic for the maintenance and supply costs for water in respect of Chu and Talas rivers. Thus in order to make sustainable cooperation, there is a need: (a) to agree to pay explicitly for annual and multi-year water storage and regulation services to be performed by the Kyrgyz Republic at considerable costs to its economy; (b) to have arrangements with a multi-year perspective to take into account normal, dry and wet years; and (c) to divide the compensation for water services into a fixed charge and a variable charge to enable an equitable sharing and mitigation of risks arising from rainfall variations. Among the several factors considered for determining the level of fixed charges, the value of the natural gas needs of the Kyrgyz Republic to meet its winter energy demand appeared to be the most appropriate one. This will ensure a greater consistency in that country's adherence to the agreed levels of summer and winter discharges.

Economic analysis carried out valuing the costs to the Kyrgyz economy, and irrigation and electricity benefits accruing to the economies of Uzbekistan and Kazakhstan under the power regime (low summer discharges and higher winter discharges) and the irrigation regime (high summer discharges and restricted winter discharges) clearly indicate that the latter alternative is distinctly superior with substantially higher net basin benefits as shown below:

Item	Power regime	Irrigation regime	Difference
Costs to the Kyrgyz Republic ($ m)	13.4	48.5	35.1
Benefits to Uzbekistan ($m)	10.5	46.3	35.8
Benefits to Kazakhstan ($m)	8.4	39.9	31.5
Sub Total of Benefits	18.9	86.2	67.3
Net basin benefit ($ m)	5.5	37.7	32.2

The above table also indicates that in order to motivate both parties adequately to adhere to the irrigation regime, compensation payments to the Kyrgyz Republic have to be some where in the middle of the range $35.1 million and $67.3 million. The agreed compensation in 2001 valued at $48 million was in this range but an actual payment at $29 million was substantially lower. In the analysis, fixed payments are sought to be linked to the Kyrgyz Republic's annual consumption of gas valued at $20 million and treat the remaining charge as variable – varying as a function of variable discharges for dry and wet years and the consequent changes in the quantity of power produced for summer export. Following a simple model, 80% of the years are assumed to be normal, 10% dry and 10% wet. In dry years annual discharges and summer discharges are higher and in wet years annual discharges and summer discharges are lower than in the normal year. On this basis, an illustrative scheme of fixed and variable payments for water services and variable payment for electricity exports is presented below:

Year	Fixed Water Services charge ($ m)	Variable Water Services charge ($ m)	Variable electricity charge ($ m)	Total charge ($ m)
Normal	20	6	22	48
Dry	20	7	30	57
Wet	20	4	10	34

Non-performance of the agreed obligations is a serious problem under the present arrangements. To overcome this, Uzbekistan and Kazakhstan could open a letter of credit for the water services charge, and the fixed charges could be drawn down in 6 equal monthly installments based on certification by the BVO (a monitoring agency) that agreed volume of water had been released in summer. The variable charge could be drawn down in one installment at the end of the winter based on BVO certification that winter discharges did not exceed the agreed levels. This arrangement could be backed by guarantees provided by a Guarantee Fund contributed by bilateral and multilateral donors.

In order to reinforce and strengthen the cooperative arrangements and ensure more willing compliance with obligations, certain near term, medium term and long term options have to be pursued. These near term measures would include reform of the water and energy sectors of these three countries enabling improvements to the efficiency of supply and end-use, to moderate demand and reduce the high energy intensity, commercialization of the energy sector to enable prices to recover costs, and separating the transmission systems and making them common carriers to enable freer trade. Volumetric pricing of irrigation water and liberalization of agricultural input and produce prices need to be pursued. Another near term measures would be for Kazakhstan and Uzbekistan to secure carbon trading revenues through deals brokered by Prototype Carbon Fund to encourage them to import hydro power from the Kyrgyz system and reduce their own coal fired power generation.

Medium term measures would include groundwater level management, rehabilitation of irrigation and power systems to reduces losses and provide greater capability in the downstream area to handle, store and regulate winter discharges for sanitary and environmental flows in the river to Aral Sea, promotion of winter wheat cultivation and wetting of the cotton areas in the late winter, and the like.

Long-term structural options like the construction of new storage hydroelectric projects Kambarata I (1900 MW) and Kambarata II (360 MW) at an estimated cost of $1.5 billion upstream of the Toktogul HPP in the Kyrgyz Republic could increase winter power generation without increasing winter discharges. These projects, however, would also substantially increase summer power output and markets for the surplus power have to be found. The projects have to be shown to be the least cost solution to the Kyrgyz power needs and may have to be jointly owned by all relevant riparian countries as well as by other potential buyers of power to enable water sharing and power purchase agreements and to raise funds by spreading the external debt burden among the many owners.

As evidenced by the Bank's experience in the Nile Basin Initiative**,** trans-boundary basin agreements prosper in the context of the participation and presence of neutral International Financial Institutions (IFIs) and bilateral donors to monitor and encourage compliance with agreed obligations and to assist in undertaking complementary capital investments. The Guarantee Fund mechanism referred to earlier is one such way of donor involvement. There could clearly be many other ways of the donor community encouraging and participating in such regional cooperation efforts to optimize benefits for the parties involved.

1. THE PROBLEM

Background

1. The Aral Sea basin in Central Asia has an area of 2.2 million square kilometers and a population of 35 million in the Kyrgyz Republic, Tajikistan, Uzbekistan, Turkmenistan and South Kazakhstan. Syr Darya is one of the two major rivers serving this basin and is formed by the confluence of two major tributaries, Naryn and Karadarya, both originating in the Kyrgyz Republic. With a length of 2200 km and a mean annual discharge of 37 BCM (range 21 BCM to 54 BCM) it originates in the Tien Shan mountain of the Kyrgyz Republic, passes through Tajikistan, Uzbekistan and South Kazakhstan and falls into the Aral Sea.[1] The tributary Naryn has multipurpose reservoirs with hydroelectric generation in the upstream country of the Kyrgyz Republic, while Karadarya and Syr Darya have extensive irrigation infrastructure in the downstream countries of Uzbekistan, and South Kazakhstan diverting water for irrigation, and allowing only an insignificant percentage of the river flows to reach the Aral Sea (See Figure 1).

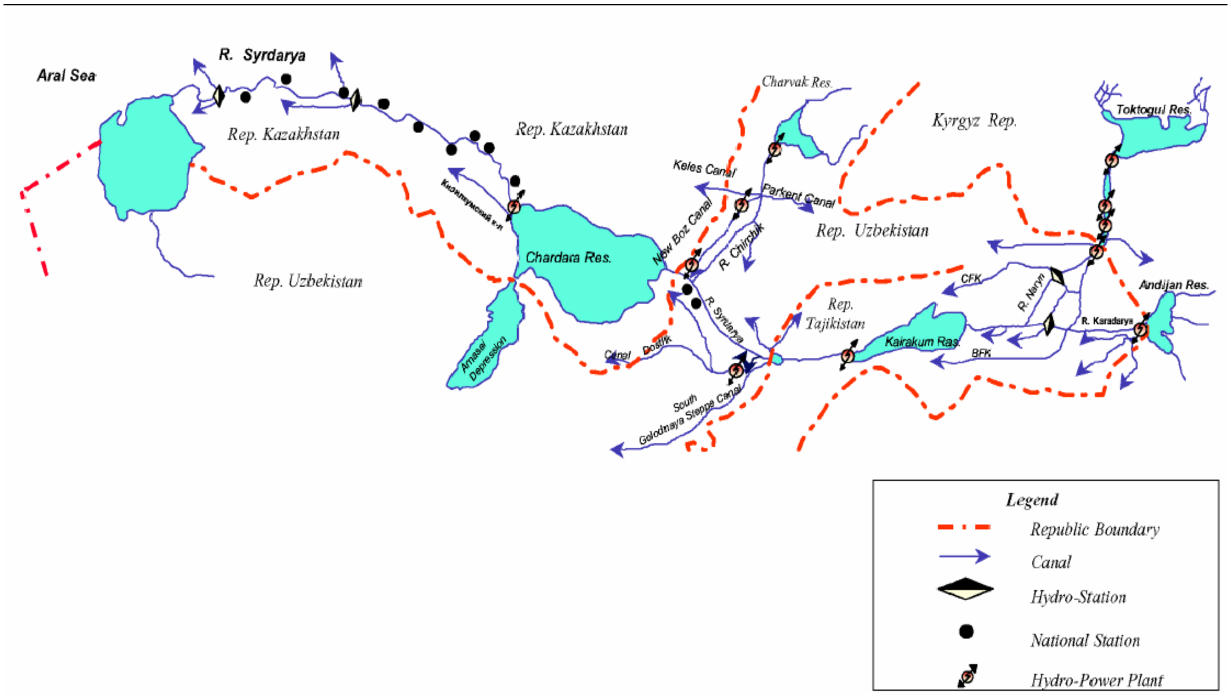
2. While irrigation was practiced for over 2000 years in the river basin, it was only in the period of Soviet rule, water was diverted from the river on a large scale through an extensive irrigation infrastructure such as diversion dams, storage dams, canals, distributaries and pumping stations to enable the irrigated cultivation of cotton, fodder, wheat, fruits and vegetables. In these arid areas of the Central Asia, cultivation of such crops is possible only with irrigation. Most of the crops are grown during the warmer period April to September, often referred to as the vegetation season. The only exception is winter wheat, which is usually sown in October or November and harvested, in the second quarter of the year. The period from October to March is cold and is referred to as the non-vegetation season. For purposes of convenience, these two seasons are referred to in this report as summer and winter seasons.

3. By the 1960s the diversion of water for irrigation from the Syr Darya river was so extensive (around 30 BCM) that in the dry years with lower flows, the irrigation needs were greater than the total flow in the river. This necessitated the construction of the multi-year storage reservoir in the Kyrgyz Republic on the Naryn river, the main tributary of Syr Darya, for the purpose of storing water in wet years and releasing such stored

[1]The other river Amu Darya is formed by the joining of the two main tributaries, Vaksh river originating on the Kyrgyz side of the Pamir Mountain and flowing through Tajikistan and Pandidj river originating in Afghanistan. This river with a length of 2450 km and a mean annual discharge of 78.5 billion cubic meters (BCM) (range 47 BCM to 108 BCM) passes through Afghanistan, Tajikistan, Uzbekistan, and Turkmenistan before reaching Aral Sea. This report does not deal with matters relating to Amu Darya.

water during the dry years for facilitating down stream irrigated cultivation both during normal and dry years. This reservoir was also provided with hydroelectric generating sets for producing electricity when water was being released. Four more reservoirs with limited pondage were constructed down stream in the same Naryn river to produce electricity using the waters released from Toktogul. These five reservoirs are collectively referred to as the Naryn Cascade and have a total installed generating capacity of 2870 MW. The unit of the Toktogul HPP was commissioned in 1975, but the water level reached the full reservoir storage capacity (19.5 BCM) only by 1988.[2]

Figure 1: Main Reservoirs and Hydropower Facilities of the Syr Darya Basin



4. As the main objective of the Soviet government was to maximize the area under the irrigated crops (cotton, fodder, wheat, fruits and vegetables) and ensure adequacy of water for such areas in the normal and dry years, water releases from the Toktogul reservoir followed an irrigation regime (See Box 1: Irrigation in Central Asian Republics). This involved the release of nearly 75% of the annual releases in summer[3] and restricting the winter releases to the remaining 25%. This was generally in line with the natural regime

[2] Perhaps on account of the staged construction of the concrete dam and the completion of the final stage in the mid 1980s.

[3] This is the average value for the 15-year period 1976-1990. The average of summer releases was 8.09 BCM (range 3.6 BCM to 11.2 BCM) and that for the winter releases was 2.68 BCM (range 1.2 BCM to 4.4 BCM).

Box 1: Irrigation in the Central Asian Republics

Syr Darya and Amu Darya are the two major rivers in the Aral Sea basin in Central Asia. In the Soviet era, extensive irrigation infrastructure by way of reservoirs, irrigation canals, pumping stations and field canals had been constructed during 1970-1989 resulting in most of the water flowing in the rivers being diverted for irrigation leaving very little to reach the Aral Sea, which has shrunk in area by 50% with serious adverse environmental consequences. The irrigation infrastructure supported the cultivation of cotton, wheat, fodder, fruits, vegetables and rice in the arid steppe areas. It enabled the expansion of irrigated areas during this period by 150% in Amu Darya basin and 130% in Syr Darya basin (See Appendix 1 for a chart of the reservoirs and facilities in the Syr Darya basin). Large populations moved to the area to work in agricultural farms. Thus by 1999, agriculture contributed 11% of GDP in Kazakhstan, 19% in Tajikistan, 27% in Turkmenistan, 33% in Uzbekistan, and 38% in the Kyrgyz Republic. Cotton accounts for nearly 20-40% of the exports. Central Asia is the third largest producer of cotton in the world.

The total agricultural area in the Syr Darya basin amounted to 3.4 million hectares, 56% of which was in Uzbekistan, and 24% in south Kazakhstan. In 2000, about 35% of the irrigated areas was under cotton cultivation, 30% under wheat, 12% under fruits and vegetables, 9% under fodder, 5% under rice and 9% under other minor crops. Cotton, fodder fruits and vegetables are the economically viable crops. Wheat areas are increasing on account of the food self-sufficiency concerns of the republics.

Irrigation is highly inefficient. Water use is as high as 12,900 cubic meters / hectare and only 21% of this is effectively used. The remaining 79% is lost, most of it on the unlined on-farm and inter farm canals. This compares with the loss level of about 60% in developing countries.

In Uzbekistan, agriculture accounts for 33% of GDP, 60% of foreign exchange receipts and 45% of the employment. The government follows the objectives of stabilizing cotton export revenues, achieving wheat self-sufficiency, and keeping food prices low. In pursuit of these the government controls production, planting, procurement and pricing of the produce. Farmers get low prices. Government monopolies handle input supply and marketing. It bans exports of products like cereals and livestock and imports through state monopolies products like sugar and vegetable oils. About 20% of the farm areas have been privatized, but are still subject control of production and pricing and procurement. Prices of livestock, fruits and vegetables have been liberalized. While agricultural production has been stabilized, incentives for efficiency improvement remain low.

In Kazakhstan, agriculture accounts for 11% of the GDP and 14% of the employment. About 90% of the farmlands are now in private hands. Subsidies on agricultural inputs, procurement monopolies, and price controls have been removed. The drying up of Aral Sea and the consequent environmental damages are a significant set of problems for Kazakhstan. More than normal winter discharges from the Toktogul reservoir cause flooding on account of frozen waterways and diversion of water to Arnasay depressions. The government is pursuing options to improve waterways and ensure flows in the river to the delta area to mitigate the Aral Sea problem. It is also active in discussions with upstream riparian states to improve the water sharing agreements.

of water flow in the river caused by rains and snow melt. The electricity generated during summer in excess of the Kyrgyz requirements was fed into the integrated Central Asian Power System for use by Uzbekistan and South Kazakhstan. During winter hydroelectric generation was restricted by the much smaller volume of water allowed to be discharged.

The quantum of hydroelectric power generation was inadequate to meet the power and heat demand of the Kyrgyz region, and electricity, coal, gas and oil were allocated from the regions of Uzbekistan and Kazakhstan. When all these regions belonged to the same country and were under the Soviet rule, this was merely a matter of national priorities and allocation, and was therefore handled with relative ease.

The Genesis of the Problem

5. With the collapse of the Soviet Union and the creation of the Kyrgyz Republic, Tajikistan, Uzbekistan and Kazakhstan as independent nations, the operating regime of the Toktogul reservoir became an international problem, as the priorities and national interests of the new nations were not always congruent and were often difficult to reconcile. The distribution of water and energy resources among these countries was very uneven as can be seen from Table 1 below. While the upstream states of the Kyrgyz Republic and Tajikistan had plenty of hydroelectric potential[4], they had little by way of fossil fuel resources. In the case of down stream countries the opposite was the case. Further, with the collapse of the Soviet Union, the prices of traded commodities like coal, oil and natural gas quickly rose to international levels, while the price of electricity produced by state owned monopolies remained artificially low. Also the fossil fuels were traded in hard currencies only. Under these circumstances the continuation of the irrigation regime of the operation of the Toktogul reservoir, involved the Kyrgyz Republic generating electricity far in excess of its needs in summer and facing serious shortages for power and heat in winter when its electricity needs were substantially higher than in summer. Winter electricity demand grew much faster than in the Soviet days since the consumers (being unable to afford the high cost of fossil fuel based heating) switched to electric heating. The country was seriously disadvantaged since it simply could not afford to pay the higher prices (and, especially, in hard currency) and import enough of fossil fuels for its winter needs (See Box 2:Electricity in Central Asian Republics).

Table 1: Primary Energy Resources in Central Asia

Fossil Fuel Reserves	Unit	Kazakhstan	The Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan	Total
Crude Oil	MTOE	1,100	5.5	1.7	75	82	1,264
Gas	MTOE	1,500	5	5	2,252	1,476	5,237
Coal	MTOE	24,300	580	500	Insignificant	2,851	28,231
Total	MTOE	26,900	591	507	2,327	4,409	34,732
% of Total		77.4	1.7	1.5	6.7	12.7	100
Hydro Potential	GWh/year	27,000	163,000	317,000	2,000	15,000	524,000
	MTOE/year	2.3	14	27.3	0.2	1.3	45.1
% of Total	%	5.2	31.1	60.5	0.4	2.9	100

Source: BP Global Energy Statistics, World Bank Reports

6. Since 1990 the Kyrgyz Republic was thus forced by the circumstances to release less and less water in summer and increase the volumes of its winter releases to produce

[4] However only about 10% of the potential had so far been developed.

more hydroelectric power to meet its increasing winter demand. Thus during the 10 year period 1991-2000 the average release during summer fell to 45.6% of the annual releases (from 75% during the preceding 15 years) and the releases during winter increased from

Box 2: Electricity in Central Asian Republics

The electricity grids of the Kyrgyz Republic, Tajikistan, Uzbekistan, South Kazakhstan and Turkmenistan belong to the Central Asian Power System (CAPS) of the former Soviet Union. They are adequately interconnected by a 500 kV transmission system enabling power exchange among the grids. They have also interconnections at 220 kV and lower voltage levels. Even after the dissolution of the Soviet Union, the synchronous operation of the grids continue, and the countries have established a Central Asian Power Council, which is responsible for preparing schedules for power exchange at three month intervals. Central dispatch is handled from Tashkent by the Unified Dispatch Center (UDC), called Energia, based on these schedules and the need to balance the systems in real time and regulate voltage and system frequency. Uzbekistan generates 52 percent of the total power in the CAPS, Tajikistan 16 percent, the Kyrgyz Republic 15 percent, Turkmenistan 11 percent, and southern Kazakhstan 6 percent. By and large, most of the power exchanges are based on the IGIAs concluded among the states for the water discharges from the Toktogul reservoir and Naryn cascade of HPPs in the Kyrgyz Republic. Turkmenistan is not involved in these types of exchanges, arising from IGIAs relating to Syr Darya basin.

The volume of power exchanges among these states declined by 70% during 1990-2000, even though the overall consumption level was about 80% of that in 1990. This decline in exchanges is attributed to the internationalization and monetization of the energy trade, as well as the energy self sufficiency policy followed by each country, upon attaining independence (See also Appendix 2).

South Kazakhstan power system covers five southern regions of the country including Almaty. It has an installed capacity of 3,015 MW, of which 82% is from thermal power plants and 18% is from two large and several small hydropower plants. The availability of the thermal power plants is very low. On the basis of annual averages during 1998-2002, domestic generation was about 6.5 TWh (two thirds of which was from thermal plants and the rest from hydro units). It imported a total of about 3.1 TWh, of which 1.0 TWh came from the Kyrgyz Republic and the rest from North Kazakhstan grid, besides a small amount of 99 GWh from Tajikistan and Turkmenistan. Out of the total supply of about 9.6 TWh, domestic sales amounted to 7.3 TWh, implying a system loss level of about 24%. The peak demand in 2000 was 2,079 MW occurring in the first quarter. The summer peak was only about 61.5% of the winter peak. The sector has been unbundled and 85% to 90% of the generation assets and three out of the 18 of the distribution companies have been privatized. Transmission and dispatch is still state owned and the latter is based on bilateral contracts among generators, distribution companies and large consumers. A power pool is in the process of evolution. Wholesale electricity prices range from 0.5 to 1.0 cents/kWh. Transmission tariffs are about 0.4 cents/kWh. Average retail tariffs/kWh among the 18 distribution companies range from 1.4 cents to 2.6 cents, the unweighted average being 2.2 cents.

The Kyrgyz Republic has an installed capacity of 3,713 MW of which 79.5% (2,950 MW) is hydroelectric and 20.5% (or 763 MW) is thermal power, consisting mainly of the combined heat and power plants (CHP) at Bishkek and Osh. The Naryn cascade of HPPs of the Toktogul HPP and four other downstream HPPs account for 97% of the hydro capacity and 78% of the total installed capacity. On the basis of annual averages during 1998-2002, domestic annual generation was about 12.9 TWh of which 11.7 TWh or 91% was from hydroelectric units and the rest from the CHP units. The country exported about 2.0 TWh to Uzbekistan and south Kazakhstan (in approximately equal quantities) and imported 316 GWh from Uzbekistan(188 GWh) and Tajikistan (115 GWh). Supply to the domestic market was about 11.2 TWh of which domestic sales were about 7 TWh, implying a system loss level of 37%. Share of the residential consumption rose from 15% in 1990 to 60% in 2000 as a result of decline in industrial production and the consumers switching from fossil fuel based heating to electric heating on account of the steep rise in the price of fossil fuels. Peak demand occurs in the first quarter and it was 2,609 MW in 2000. The summer peak was at 1,456 MW was about 55% of the winter peak. The key feature of the power system is that summer discharges from Naryn cascade produce electricity to meet the domestic demand in full and export about 2 TWh, while restrictions on winter discharges from the cascade produces a major shortage of electricity in winter when the demand is highest, necessitating imports of fossil fuels. Power system has been unbundled into one generating company, one transmission company and four distribution companies. State Energy Agency regulates the tariffs. Transmission company functions as a common carrier and the generation company handles exports. Average posted retail tariff in 2002 was 1.2 cents per kWh.

Uzbekistan has an installed generation capacity of 11,580 MW, of which 85% (or 9,870 MW come from 11 thermal power plants (fueled largely by natural gas and coal and partly by fuel oil), and 15% (or 1, 700 MW) come from 31 hydroelectric plants. Many of the thermal plants need extensive rehabilitation and the available capacity at around 7,800 MW is inadequate to meet the growing peak demand and the system faces capacity deficits and resorts to rolling black outs during peak load periods. On the basis of the annual averages during1998-2002, domestic generation amounted to 47 TWh of which 41 TWh (or 87%) was from thermal plants and the rest was from hydroelectric units. Natural gas fired units provided most of the thermal power, followed by fuel oil powered units and coal fired units. Annual exports were modest at 674 GWh including 505 GWh to Tajikistan and 188 GWh to the Kyrgyz Republic, while annual imports amounted to 1.3 TWh of which 1.1 TWh came from the Kyrgyz Republic and the rest came mostly from Tajikistan. Thus gross annual domestic supply was 47.7 TWh, while domestic sales amounted to 38.4 TWh implying a system loss level of 20%. In contrast to the other two countries, the peak demand variation from summer (6,882 MW) to winter (7,551 MW) is much less pronounced, the former being nearly 90% of the latter.[5] This is on account of the extensive pumping load for irrigation in summer. Electricity demand is growing at an annual rate of 2% induced largely by the low level of electricity tariffs. The present average retail tariff of 1.3 cents/kWh is well below the cost of supply. A state owned trading company acts as a single buyer and buys all power from generating units and sells them to the 15 distribution units. It is also responsible for imports and exports.

25% to 55.4% of the annual releases. This pattern of power oriented regime of water releases from the Toktogul reservoir caused serious problems for the down stream riparian states.[6] During summer they faced inadequate supplies of water for irrigation, and during winter the irrigation canals and the river bed were frozen and could not handle the larger volumes of water releases causing flooding and the need to divert them wastefully into a series of depressions further to the west of the river and away from the Aral Sea. The lake formed by such water bodies was called Aydarkul.[7] Worse still, in the

[5] The data relates the year 2000.
[6] The affected riparian states are mainly Uzbekistan and Kazakhstan. Tajikistan has only a small share of the water use from Syr Darya and is therefore not affected to any significant extent.
[7] These wasteful discharges average at about 3 BCM annually and reached 9 BCM in certain years.

years of low flow such high winter discharges tended to deplete the long term storage of the reservoir and adversely affect its multi-year regulating capacity.

2. EFFORTS TO RESOLVE THE PROBLEM

7. To tackle the problem arising from the competing claims of the irrigation needs of the downstream riparian states (Uzbekistan and Kazakhstan) in summer and the power generation needs of the upstream riparian state the Kyrgyz Republic in winter, several regional cooperation efforts were undertaken during the 1990s. During the Soviet rule, the shares of water in the Syr Darya river basin among the riparian regions were covered by Protocol No.413 of February 7, 1984. This document allocated 46% of the total surface flow of 22.7 BCM in the river to Uzbekistan, 44% to Kazakhstan, 8% to Tajikistan and 2% to Kyrgyz region. This was based on the priority given for the cultivation of cotton, fodder, fruits and vegetables. It called for the annual releases from the Toktogul reservoir of the order of 9.43 BCM. About 75% of the annual releases were to be made in summer and the remaining 25% to be released in winter. The average winter releases were not expected to exceed 180 cubic meters per second or 2.85 BCM. After the dissolution of Soviet Union, the aim of most regional cooperation efforts was to emulate as nearly as possible the pre-1991 operating regime of the Toktogul reservoir.

8. On February 18, 1992 all five of the newly independent Central Asian states entered into an agreement to maintain and adhere to the existing pattern and principles of water resources allocation stipulated in Protocol 413. (See Appendix 3). It also created the Interstate Commission for Water Coordination (ICWC) to define seasonal allocations in line with annual agreements. BVO Syr Darya, a river basin organization created during the Soviet rule, would become a part of ICWC and be responsible for monitoring and control of water allocations. However, adherence to the allocations made in the Soviet era proved infeasible under the changed conditions. The Republics, thus resorted to concluding annual *ad hoc* bilateral or trilateral barter agreements regarding the water and energy exchanges. Under these agreements, the release of agreed amounts of water in summer was sought to be compensated by: (a) imports by Uzbekistan and Kazakhstan, in equal quantities, of the electricity generated in summer by the Kyrgyz Republic in excess of its own requirements; and (b) supply by Uzbekistan and Kazakhstan of *equivalent amount* of electricity, natural gas, fuel oil and coal in winter when the Kyrgyz Republic faced a shortage of electricity on account of reduced volumes of water allowed to be released in that season. This was essentially a barter transaction in which respective prices were somewhat artificial and non-transparent. The inflated and arbitrary pricing used tended to distort the economics of the incremental energy trades. However, year to year seasonal distribution of water for power and irrigation without a comprehensive multi year approach proved unsatisfactory and, in fact, led to a reduction of Toktogul storage to 7.2 BCM by April 1998, compared to its dead storage level of 5.5 BCM and its

full reservoir level of 19.5 BCM.[8] In turn, this led to a great deal of strain and tension in the relations among the parties. Further, compliance on the part of Uzbekistan and Kazakhstan for the supply of agreed amounts of fossil fuels to the Kyrgyz Republic was not full, forcing the latter to reduce water releases in summer and increase them in winter.

9. In general, during the 1990s, the upstream countries like the Kyrgyz Republic attempted to become self sufficient in energy by increasing winter flows to generate their own hydroelectric power and to be free of dependence on the imports of fossil fuels, while the down stream countries such as Uzbekistan and Kazakhstan attempted to become self sufficient in water, by contemplating the construction of new reservoirs[9] down stream to store the increasing winter water discharges from Toktogul and using them in summer. However, these proved to be costly solutions and could not be pursued. Several bilateral and multilateral donors have provided assistance to these countries, to study these issues and address the problems. *Inter alia*, they cover Aral Sea Basin environmental mitigation efforts, water resource planning, rational and effective use of water and energy, a comparative review of the riparian right issues in a wide range of countries and, notably, the USAID funded water management issues study relating to the Toktogul reservoir. The last mentioned effort of USAID was largely instrumental in the Kyrgyz Republic, Kazakhstan and Uzbekistan[10] concluding a new Long Term Framework Agreement on 17 March 1998 to achieve coordinated joint solutions over the near term (See Appendix 4). This agreement is widely recognized as a major improvement over the previous ad hoc arrangements and is believed to have reduced the tensions in the region prevailing earlier. The notable elements of this agreement include: (a) a desire to adhere to international law and precedents; (b) a recognition of the need for joint operation of the reservoirs of the Naryn Cascade through multi-year flow regulation and flood control measures to enable the use of water for power generation and irrigation; (c) a clear recognition for the need to compensate for the energy losses involved in the annual and multi-year storage of water in the reservoirs; (d) proposal to make this compensation in the form of equivalent energy sources such as electricity, gas, coal and fuel oil or other products (barter) *or in monetary terms* and a desire to replace barter settlements by financial relations; (e) possibility of using guarantee mechanisms such as lines of credit, security deposits or other forms; (f) provision for arbitration of disputes through arbitration courts; and (g) consideration of structural options to reinforce the mutual cooperation. The agreement had a five year validity and would be considered to have been renewed automatically for another five years unless anyone of the parties objected. None having objected it is deemed to have been renewed for five years from March 17, 2003.

10. The Republics also concluded another agreement on June 17, 1999 for enabling the continued synchronous operation of the power systems of these countries to facilitate imports and exports of power through the 500 kV, 220 kV and other lower voltage

[8] It is worth noting that once again such a low reservoir level of 7.5 BCM was reached in April 2002.
[9] Such as the proposed reservoir at Koksaray
[10] Tajikistan joined this Agreement in May 1999.

networks. Agreements for cooperation in the areas of environment, rational use of natural resources were also concluded at about the same time. These agreements were expected to complement each other and open up opportunities for closer cooperation.

11. While the 1998 Long Term Framework Agreement was a significant improvement over the earlier ad hoc annual agreements, it still provided for annual agreements for actual volumes of water releases and compensations. The implementation of these annual agreements proved unsatisfactory. Though it provided for compensation by barter or cash and expressed a desire to move towards cash, barter continued unabated so that the Framework agreement is often referred to as the Barter Agreement of 1998 in the related literature. The performance of the parties under the annual agreements fell short of the agreed levels and water level in the Toktogul reservoir again reached the dangerously low level of 7.5 BCM by April 2002. Table 2 below summarizes the variations between the agreed and actual performance under the annual Inter Governmental Irrigation Agreements (IGIA) during 1999-2002.

Table 2: Performance Under IGIAs for the Years 1999-2002

Indicators		Units	1999		2000		2001		2002	
Date of signature			May 29, 1999		July 3, 2000		May 20, 2001		Trilat. 3/14/02 Bilat. Kyr-Uz 5/6/02 Bilat. Kyr-Kaz 7/9/02	
Toktogul Reservoir volume	as of Jan 1	BCM	13.5		14.5		11.9		10.4	
	as of Apr 1		10.4		11		8.7		7.5	
	as of Oct 1		16.3		13.7		12.1		17.4	
			Agreed	Actual	Agreed	Actual	Agreed	Actual	Agreed	Actual
Water release during vegetation period from Toktogul Reservoir		BCM	6.5	5.06	6.5	6.5	5.9	5.9	6	3.6
The Kyrgyz Republic's Export										
Power to Kazakhstan	Quantity	GWh	1100	585.3	580	673.6	1100	912.4	1100	422.7
	Price	US¢/kWh	2		1		1		1	
Power to Uzbekistan	Quantity	GWh	1100	970	1905	1925.6	1100	1038.1	1100	523.3
	Price	US¢/kWh	3.34		3.34		3.34		3.34	
The Kyrgyz Republic's Import										
Natural gas from Uzbekistan	Quantity	MCM	500	331	422	430.6	700	593.9	490	360
	Price	US$/KCM	54.174		54.174		54.174		54.174	
Coal from Kazakhstan	Quantity	000' tons	566.7	572	362.5	331.1	618	466.5	500	165.3
	Price	US$/ton	30		16		16		21	

It may be seen from the table that:

- Annual Agreements still do not seem to take care of unusually dry or unusually wet years. During the unusually wet years of 1999 and 2002, the downstream countries did not need and did not take the agreed amounts of water in summer resulting in the reduction of the summer exports of electricity to Uzbekistan and

Kazakhstan. This further led to reduced supply of gas from Uzbekistan and coal from Kazakhstan to the Kyrgyz Republic in the following winter, thus forcing the latter to increase winter discharges;

- Overall the downstream countries supplied less than the agreed quantities of compensatory fossil fuels, resulting in the Kyrgyz Republic being forced to increase winter releases;
- The payment for water services is not explicit. The prices charged for electricity by the Kyrgyz Republic and those charged for fossil fuels by Uzbekistan and Kazakhstan are somewhat arbitrary and high[11] and are explicable only on the basis that the price paid for electricity to the Kyrgyz Republic includes a significant element for water storage services. The downstream countries, however, believe that they are being forced to buy during summer, unneeded power from the upstream country at a cost substantially higher than the cost of their own generation;
- In 2001, though the Kyrgyz Republic released the agreed amount water in summer and Uzbekistan and Kazakhstan absorbed nearly all of the agreed volume of electricity exports by the former, Uzbekistan supplied less gas and Kazakhstan supplied less coal on account of transmission problems and privatization problems;
- Annual agreements take a very long time to conclude resulting in uncertainties. Technical discussions extend beyond the start of the vegetation season and agreements are finalized only by the middle of the season. This leads to uncertainties to the downstream farmers and to increased tension on both sides;
- Once the Kyrgyz Republic releases the agreed volume of water in summer and exports electricity, it has to wait till the ensuing winter for the compensatory supply of fossil fuels with uncertainties relating to the quantity, quality[12] and price. The Kyrgyz Republic believes that it faces a major risk in this regard;
- Finally the *ad hoc* nature of the earlier annual agreements still permeates the present set of IGIAs and there appears to be no focus on the sustainable firm water releases maintaining the multi-year storage character of the Toktogul reservoir as evidenced by the low water storage level of 7.5 BCM reached in April 2002.

[11] For example, the Kyrgyz Republic charges 3.34 cents /kWh for electricity to Uzbekistan, while it charges only 1.0 cents/kWh for electricity supplied to Kazakhstan. The prices of coal varied from $30/ton in 1999 to $16/ton in 2000 and 2001 and to $21/ton in 2002. Quality of coal was also unreliable.

[12] The quality risk often turned out to significant. The coal contained a large admixture of rocks and mud making it difficult to use in the boilers.

3. SUGGESTED IMPROVED APPROACH

11. The present annual IGIAs under the Long Term Framework Agreement of 1998 have turned out to be no better than the *ad hoc* annual agreements of the earlier years, in the sense that they clearly lack the multi-year perspective needed to handle the multi-year storage reservoir related issues. Clearly such a multi-year perspective in the agreement is needed to handle variations in flows in normal, wet and dry years and the timing difference in the resource needs of the upstream parties (power or fossil fuel needs in winter) and downstream parties (water needs in summer).

12. Even more important, despite the specific mention in the Long Term Framework Agreement of 1998 that annual and multi-year water storage is to be compensated, the IGIAs still do not provide explicitly for payment for water services, perhaps based on the belief that downstream riparian states are entitled to the irrigation water without payments for water or water services. This belief is not valid in terms of an international perspective. Of the 145 treaties signed in the twentieth century, forty four (or 30%) treaties incorporate payments for water or water services in monetary transfers or future payments.[13] Examples include:

- Britain moved toward equitable use of the rivers in its colonies as early as 1925. Sudan agreed to pay a portion of the income generated by new irrigation projects to Eritrea, since the Gash River flowed through that state as well;
- Treaties also recognize the need to compensate for hydropower losses and irrigation losses due to reservoir storage. Both the 1951 Finland–Norway treaty and the 1952 Egypt–Uganda treaty include such compensation;
- Republic of South Africa (RSA) pays a royalty to the Kingdom of Lesotho for the water released from the Highlands Water Project on the Orange River, even though RSA is a riparian of the Orange River (See Box 3 below).

In addition, in the region itself, there are some very encouraging signs. In 2001, the Parliaments of Kazakhstan and the Kyrgyz Republic have ratified an agreement for water supply from the rivers Chu and Talas, in terms of which, the former will pay for the costs of maintaining and providing water on these two rivers (See Annex 5). There are thus ample precedents both internationally and regionally to the concept of downstream riparian state paying the upstream country for water or water services. Thus the Long

[13] Patterns In International Water Resource Treaties: The Trans Boundary Water Resource Dispute Database, by Jesse H. Hamner and Aaron T. Wolf, Published in *Colorado Journal of International Environmental Law and Policy*. 1997 Yearbook, 1998

Box 3: Lesotho Highlands Water Project (LHWP)

This is a multi-purpose project in located in Lesotho but essentially serving South Africa (RSA). It is to be implemented in 5 phases that would ultimately transfer 70 cu. m/sec of water to RSA. Phase 1A was completed in 1988 and transfers 17 cusecs and 72MW of power at a capital cost of US$2.5 billion. Phase 1B will transfer 12 cusecs and is expected to cost US$1.1billion through 2005.

A 30-year international water treaty between the 2 states was signed in 1986, under which benefits and costs are apportioned asymmetrically. RSA bears the project costs, most of the environmental and social mitigation costs, and pays royalties to Lesotho for the water transfer, but gets all the consumer and bulk water sale benefits and related economic spin-offs. Lesotho bears the social and environmental losses, gets none of the water use benefits but receives royalties, hydropower benefits, and benefits from economic activity related to construction and from the infrastructure.

The alternative to Phase 1B would be to restrict demand through better water management and higher pricing, but this was found to be much less economically beneficial to the Gauteng region of RSA (Johannesburg-Pretoria) where the main users are located.

Initially the project was selected as the cheapest among alternative water transfer schemes from other sources (particularly the Orange Vaal Transfer Scheme (OVTS), which lies entirely within RSA but which is considerably more expensive due to high electricity needs for pumping water).

Under the 1986 treaty, royalties are not determined on the basis of absolute benefits of the project. Instead, they are based on the cost difference between the LHWP and the OVTS, which was twice as expensive. Lesotho is entitled to 56% of the estimated cost savings.

The royalty has two parts, savings in investment costs and savings in pumping and O&M costs. The former is calculated on the basis of a 50-year annuity discounted at 6%. The latter is calculated per cubic meter of delivered water by discounting the savings and deliveries at 6%. The royalties are indexed for inflation and the variable portion relating to pumping costs is adjusted for increases in electricity tariffs.

Royalties are payable in perpetuity, as long as water is delivered to RSA. Lesotho receives US$8.2 million/year in 1995 prices of incremental royalties from Phase 1B. The total royalty from Phase 1Aand 1B would be US$37 million or about 4% of GDP in 1995. Plus Lesotho gets hydropower benefits of $ 3.7 million/year.

Term Framework Agreement of 1998 needs to be modified to incorporate: (a) a multi-year (minimum of 10 years) perspective; and (b) explicit recognition of the obligation of the downstream riparian states to pay for the annual and multi-year water storage services, which the upstream country is obliged to provide at significant costs to its economy. This is needed to ensure equitable distribution of benefits arising from water use[14]. The modification should also provide for a more effective mechanism for resolving

[14] For a discussion of the concept of equitable *distribution of benefits from water use* as opposed to the concept of equitable *distribution of water*, see "The World's International Freshwater Agreements: Historical Developments and Future Opportunities" in Atlas of International Freshwater Agreements", by Aaron T. Wolf, Oregon State University

disputes and disagreements adopting perhaps international arbitration procedures such as ICC, UNCITRAL etc.

13. Based on the experience under the previous agreements it is clear that a revised approach needs to be adopted to make the regional cooperation more sustainable, make non-compliance with agreed obligations less attractive and, even more importantly, maximize / optimize the net benefits to both upstream and downstream states in an equitable manner. The key elements of the revised approach would be:

- To eliminate the present barter arrangement of fossil fuel supply for electricity imports, and artificial tinkering of prices to include an implicit and indirect payment for annual and multi-year water storage services;
- To recognize explicitly the principle that the upstream country needs to be compensated in cash for the water storage service, which it is obliged to provide at considerable cost to its economy;
- To explicitly provide in the agreements the amounts to be paid in cash for such water storage services;
- To de-link the energy trade (summer exports of electricity from and compensatory fossil fuel supplies in winter to the Kyrgyz Republic) from the water services trade, and allow it to be carried on in the normal way using normally negotiated market prices with out any distortion;
- To ensure a true multi-year approach to the management of the multi-year storage reservoir and to maximize the net benefits to the basin as a whole.

14. The economic analysis carried out in Appendix 7 clearly shows that the net benefit for the basin is higher when the reservoir follows an irrigation regime than when it follows a power regime. While using the irrigation regime, there must be a commonly agreed safe minimum annual discharge from the Toktagul reservoir in a seasonally normal year and it should further be divided into a minimum summer discharge and a maximum winter discharge. All three discharges need to be suitably adjusted for unusually dry or unusually wet years. Based on a review of the hydrological data for 90 years from 1911 to 2000 (See Appendix 6), the safe minimum annual discharge could appropriately be 9 BCM.[15] The minimum summer discharge could be about 6 BCM and the maximum winter discharge could be 3 BCM a figure close to the design winter discharge of 180 cubic meters/second. While the probability of the occurrence of unusually dry or wet years is yet to be determined, it appears reasonable to assume from the hydrological data that about 10% of the years would be unusually dry, another 10% would be unusually wet and that the remaining 80% of the years would be seasonally normal. The seasonal discharges could be adjusted for normal, dry and wet years as shown below:

[15] 9 BCM is the 20 year moving average based on the data relating to 90 years. It is also the annual discharge used in the IGIAs under the Framework Agreement of 1998. Only in 12 out of 90 years the flow had been lower than 9 BCM. Given the secular trend of increasing flows, 9 BCM is a safe and conservative estimate and is close to the firm annual yield of 8.7 BCM assumed while designing the reservoir**. In any** case 9 BCM is used here merely to illustrate the methodology. The correct numbers have to be determined by agreement among experts of these countries.

Season	Normal Year	Dry Year	Wet Year
Summer Discharge in BCM	6	7	4
Winter Discharge in BCM	3	3	3
Annual Discharge in BCM	9	10	7

15. In the present arrangements, the Kyrgyz Republic faces the risk of non-performance of obligations by the downstream countries in terms of power purchase and supply of fossil fuels. The downstream countries face the risk of inadequate summer releases and excessive winter releases. These risks are exacerbated in unusually wet or dry years. To mitigate and manage these risks by sharing them equitably among the parties, especially in the context of multi-year arrangement, the compensation for water services needs to be divided into two parts. The first part would be a fixed sum applicable in all years and the second part would be a sum varying as a function of the rainfall changes. Among the various factors considered for determining the level of the fixed charges, the value of the natural gas needs of the Kyrgyz Republic to meet its winter energy needs appeared to be the most appropriate. The fixed charge thus, could be the equivalent of the cost incurred by the Kyrgyz Republic for its annual gas imports. The variable charge would be the difference between the total charges payable minus the fixed charge. The payment of the fixed charges in six equal monthly installments through a letter of credit mechanism during summer based on monthly releases of water and certification by the monitoring agency like BVO would enable the Kyrgyz Republic to secure gas supplies needed for the ensuing winter and thus minimize the timing risk faced by it in this deal and reduce its temptation to increase winter discharges. Further, the release of the remaining variable charge in one installment through a letter of credit mechanism at the end of the winter, based on a certification by BVO on the actual discharge not being in excess of the agreed volume would provide security to the down stream countries that excess discharges are not made in winter.

16. A detailed economic analysis had been carried out and presented in Appendix 7. This demonstrates clearly that for the Syr Darya basin, as a whole, operating the Toktogul reservoir under the irrigation regime is more beneficial than operating it under the power regime. It shows that when the regime is changed from power to irrigation, costs increase by 3.6 times while the benefits increase by 4.6 times. The net benefits increase by nearly seven times. However the costs are incurred by the Kyrgyz Republic, while the benefits accrue to Uzbekistan and Kazakhstan thus necessitating the payment of water service charges to the former. The analysis, thus, also provides a methodology to calculate the charges payable to the Kyrgyz Republic for water storage services in normal, dry and wet years and to separate charges into fixed and variable charges. Costs to the Kyrgyz Republic have been calculated by valuing the hydro-electricity deficits it is forced to incur during winter at the short run marginal costs of its thermal generation facility at Bishkek Thermal power plant. Benefits to Uzbekistan and Kazakhstan consist of irrigation benefit and energy benefit. The irrigation benefit has been estimated taking into account the existing and potential areas under cotton cultivation (the main profitable cash crop) irrigated from Syr Darya river irrigation facilities, volume of water required for them from the summer discharges and valuing water at $20/ thousand cubic meters. The

energy benefit is the avoided thermal generation costs in these two countries enabled by the import of hydroelectric power in summer. The avoided costs are calculated by valuing the imported electricity at the short run marginal costs of the highest cost thermal power generating units in these countries.

17. On the basis of a firm annual discharge of 9 BCM in a normal year split into a minimum discharge of 6 BCM in summer and a maximum discharge of 3 BCM in winter costs and benefits for the irrigation regime were calculated. For the power regime the annual discharge was split into 3 BCM in summer and 6 BCM in winter in line with the seasonal changes in power demand in the Kyrgyz Republic. Costs and benefits under the two regimes were estimated as shown in Table 3 below:

Table 3: Costs and Benefits of the two Operating Regimes of the Toktogul Reservoir
(Amount in US$ million)

Item	Power Regime	Irrigation regime	Increases
Costs to the Kyrgyz Republic	13.4	48.5	35.1
Benefits to Uzbekistan and Kazakhstan	18.9	86.2	67.3
Net benefits to the basin	5.5	37.7	32.2

The above results not only demonstrate the superiority of regional cooperation arrangements based on the irrigation regime, but also enables us to determine the annual charges payable to the Kyrgyz Republic for water storage services. These charges need to be somewhere between $35.1 million and $67.3 million. At charges close to or lower than $35.1 million the Kyrgyz Republic would not be motivated to change from the power regime, at charges close to or higher than $67.3 million, Uzbekistan and Kazakhstan would not have any incremental benefit at all. A charge of $51.2 million would keep both parties equally motivated in maintaining the irrigation regime for the reservoir. This compares with the monetized value of $48 million of the compensations agreed in the IGIA for the year 2001[16].Actual paid compensation at the equivalent of $29 million, however, fell far short of the agreed amount highlighting the limitations of the IGIAs made under the Framework Agreement in relying on barter mechanisms. Having released the agreed volume of water in summer, the Kyrgyz Republic believed it had been short changed.

18. The annual gas consumption of the Kyrgyz Republic for power generation and for consumers served by KyrgyzGaz (excluding 14 large customers who buy directly from UzTransGaz) amounts to about 500 million cubic meters and is valued at $40 per thousand cubic meters, the contract price it pays for import. Thus out of the charges payable for water services $20 million could be the fixed charge and the remaining $31.2 million the variable charge. The variable charge would vary as a function of adjustments to the flow regime for wet and dry years and the actual volume of electricity produced for

[16] Agreement to pay $48 million implies that the downstream governments are willing to pay only about 70% of the incremental benefits as compensation. This assumption is used in Table 4.

export in summer. The electricity for exports could then be priced at a more realistic level of 1.0 cent/kWh rather than at the inflated level of 3.34 cents/kWh as at present.

19. The following table summarizes what the fixed and variable payments would look like in normal, dry and wet years, based on the above methodology and the assumptions mentioned above:

Table 4 : Charges for Normal, Dry and Wet Years (US$ million)

Item	Fixed water services charge	Variable charge			Total charges
		For water services	For electricity exports	Total variable charge	
Normal Year	20	6	22	28	48
Dry Year	20	7	30	37	57
Wet Year	20	4	10	14	34

4. THE NEXT STEPS

20. The objective of the economic analysis carried out in this report is not to derive the precise numbers to be incorporated in the proposed revised agreement, but to outline and illustrate a methodology to determine the compensation for water storage services. Obviously, the hydrologists of these countries, with the help of international experts as needed, have to determine (a) the optimal irrigation flow regime of the Toktogul reservoir for a seasonally normal year based on the 90 year flow data, focusing especially on the more recent data relating to the last 30 years or so because of their better inter-temporal comparability and because of the secular trend of increasing flows in the recent years[17]; (b) determine the frequency of the occurrence of wet and dry years and adjustments to the flow regime; (c) on the basis of such flow regimes calculate the range of compensation for water storage services in normal, dry and wet years; and (d) divide the compensation into fixed and variable segments, based on a suitable parameter such as the one used in our analysis. While calculating the irrigation benefits, attempts could be made to capture the benefits not only from cotton but also other major crops such as wheat, fodder, fruits and vegetables. Similarly while calculating the costs to the Kyrgyz Republic, the electricity costs should include not only the incremental fuel costs (or SRMC) as this report does, but also the incremental capacity cost needed to produce the additional electricity.

21. Once this is satisfactorily done, a political forum such as the International Fund for Aral Sea should determine the actual acceptable compensation level for water services some where near the mid point of the indicated range. The resulting agreement needs to be ratified by the legislatures of these countries to provide the transaction with the legal framework. Such an agreement should be valid for about 10 years at the end of which the calculations should be revisited in the light of the new hydrological data and changes in the sectors that have taken place and a revised and updated agreement prepared and concluded.

22. Once such arrangements for explicit payment for water storage services are made, the exchange in electricity and fossil fuels could (and should) take place strictly on the basis of commercial prices, and not on the basis of artificially fixed arbitrary prices to pay indirectly for water storage services. Such prices would be internationally or regionally traded prices for fossil fuels and prices reflecting cost of supply for electricity till electricity prices are liberalized. In the light of mutual market dependence among these countries and the absence of new export outlets in the immediate future, perhaps for some time to come the practice of paying for electricity by the supply of fossil fuels may have to continue. There is nothing inherently wrong in this as long as the commodities are priced strictly on commercial lines and the transaction remains fully enforceable in monetary terms, if the need arises.

[17] The annual discharge of 9 BCM assumed in our analysis for a normal year should thus be subject to a thorough and rigorous scrutiny.

23. Inability to enforce compliance with the agreed obligations had been the persistent problem in the past. While the Kyrgyz Republic believes that it faces a major timing risk and is short changed most of the time, the downstream countries believe that the former does not adhere to the agreed water discharge limits. Opening a letter of credit arrangement for the fixed and variable components of the water storage services charge (as described in the previous chapter) is a good commercial method of reducing the payment and timing risk faced by the Kyrgyz Republic and also the discharge non-compliance risk faced by the down stream countries. The letter of credit mechanism could be backed by a guarantee arrangement. A Guarantee Fund (GF) contributed by all or most of the relevant donors and international financial institutions (IFIs) could be established and this fund could guarantee the payment for water storage services. If a downstream country fails to pay, the guarantee is called and the GF would pay the amount to the Kyrgyz Republic and require the defaulting party to assume the debt to the GF and enforce repayment with the sanctions available to the donors and IFIs under the instruments for setting up the fund. Such an assurance of payment would clearly induce the Kyrgyz Republic to a close adherence to the agreed discharge limits.

24. Similar letter of credit and guarantee mechanisms could cover related electricity and fossil fuel exchanges induced by the water services agreement at least in the initial years. In the longer term, however, the trade in electricity and fossil fuels should become one of trade between private companies of different countries (as a result of sector liberalization) from being a government to government transaction as it is now.

25. Kazakhstan is likely to receive the proposals in this report warmly, as it is already moving in this direction. It has agreed in principle with the concept of compensating the upstream riparian country for the water storage services by its willingness to pay for the water services flowing in the rivers Chu and Talas. One may hope that Uzbekistan would also find them acceptable, since several advantages would accrue to it under the proposed arrangements. Uzbekistan is already facing electricity capacity shortages on account of the dilapidated condition of its thermal power plants and their poor availability[18], and it would clearly benefit from the import of hydropower from the Kyrgyz Republic. Even after rehabilitating the thermal plants fully, Uzbekistan will be fully justified in importing hydropower from the Kyrgyz Republic, especially in the context of such power being priced on the basis of the cost of production (at 1.0 cent/kWh as proposed), rather than on the basis of the artificially inflated prices (of 3.34 cents/kWh as now). By importing hydropower, Uzbekistan would also be able to reduce generation from its most expensive and most inefficient thermal plants, thus reducing carbon dioxide emissions. This would qualify Uzbekistan to get revenues from carbon deals brokered by an agency like the Prototype Carbon Fund. Such revenues could grow from about $1.77 million in 2003 to about $11 million by 2010 (see Appendix 9). Uzbekistan could also consider buying surplus power from the Kyrgyz Republic and Tajikistan and exporting it at a reasonable price to Afghanistan, which could make cash payments for this with donors' help. Such arrangements would reduce the risk for the Kyrgyz Republic and ensure better compliance with agreed water discharge levels in summer. Thus the key gains to Uzbekistan in participating in the proposed arrangements would be:

[18] Only about 7,500 MW of the total installed capacity of 11,580 is reported to be available.

- Less expensive and more reliable electricity supply;
- Earning of transit fees for transmission of electricity to Afghanistan or earning export receipts, by exporting its electricity to Afghanistan;
- Earning of carbon emission trading revenues;
- Stable supply of irrigation water in summer; and
- Postponement of expensive investments in downstream dams such as Koksarai.

26. Apart from the near term measures discussed above, there are certain medium and long term measures, which need to be taken to strengthen and reinforce the regional cooperation effort in the water and energy sectors. These would make it attractive to comply with the agreed obligations and provide flexibility in designing water flow regimes to reduce regional tensions.

27. The medium term measures would include reforms of the water and energy sectors in these countries. In the energy sector, the key focus of reform would be on:

- Separation of transmission systems and making them common carriers to enable freer trade;
- Commercialization involving prices reflecting costs of supply and ensuring the financial viability of the supply entities;
- Improvement in the operational efficiencies in such areas as system loss reduction, theft reduction, metering, billing and collections; and
- Enabling increased private sector investments in the sector.

Even more importantly energy conservation and energy use efficiency need to be greatly improved to reduce the very high rates of energy intensity of growth prevailing in these countries. Energy intensity of Uzbekistan at 6716 kilograms of oil equivalent per dollar of GDP is four times higher than that of Kazakhstan and the Kyrgyz Republic, 3.5 times higher than that of Russia, 20 times higher than that of Canada and 30 times higher than that of USA. Electricity intensity of Uzbekistan at 5895 kWh per dollar of GDP is 20 times higher than that of USA. Electricity use efficiency improvements in the Kyrgyz Republic are urgent to reduce its high winter demand and thus reduce its possible temptation to increase winter discharges.

28. In the water sector, irrigation efficiencies have to be improved substantially. As noted earlier in the report, only 21% of the water is actually used and 79% is lost. Extensive rehabilitation of the irrigation facilities needs to be undertaken to reduce some of the losses. Programs like lining canals, adoption of more efficient forms of irrigation, and introduction of volumetric charge for water use, and construction of tamper proof volumetric measuring structures and facilities deserve priority. Farm privatization and liberalization of prices and removal of production and trade controls would reinforce the above measures through market synergy. Such reforms could proceed at a faster pace in Kazakhstan and at a practical pace in Uzbekistan. Development of groundwater use in Ferghana valley would reduce the demand for irrigated water from the canals. Promoting winter wheat and wetting the cotton lands towards the end of winter are methods, which

could make better use of winter discharges and avoid water being diverted to Arnasay depressions wastefully.

29. Structural options constituting the long term measures include: (a) revised operation of the downstream Chardara Dam to store winter releases from Naryn and use it for sanitary and environmental flows to the Aral Sea; (b) re-regulation of Kairakum Reservoir synchronized with Chardara Dam to regulate winter flows, by rehabilitating and suitably strengthening the related dikes and (c) construction of Kamabarata I and Kambarata II hydroelectric projects upstream of the Toktogul reservoir. The first two by making better use of the winter flow would mitigate environmental damage and provide some flexibility to the Toktogul reservoir operation. The last option would enable the Kyrgyz Republic to generate more electricity in winter without increasing winter discharges. These options have to be carefully evaluated before making investments.

30. Kambarata I will have an installed capacity of 1900 MW and an annual power generation of 4500 GWh and would cost $ 1.2 billion. Kambarata II will have an installed capacity of 360 MW, an annual power generation of 1260 GWh, and would cost $270 million. Prima facie, the second project would make sense only when built along with the first project and the matter needs to be further reviewed. These projects do not fully eliminate the winter power deficit and substantially increase summer power generation. Export markets for incremental generation have to be identified, and the option must be demonstrated to be the least cost solution to the power deficits of the country. Innovative financing mechanisms have to be evolved. All relevant riparian states as well as the likely outside importers may be invited to have equity stakes in the project. Such a broad based ownership would help in water sharing agreements and exports and make it somewhat easier to raise debt finance, by spreading the external debt burdens among a number of countries.

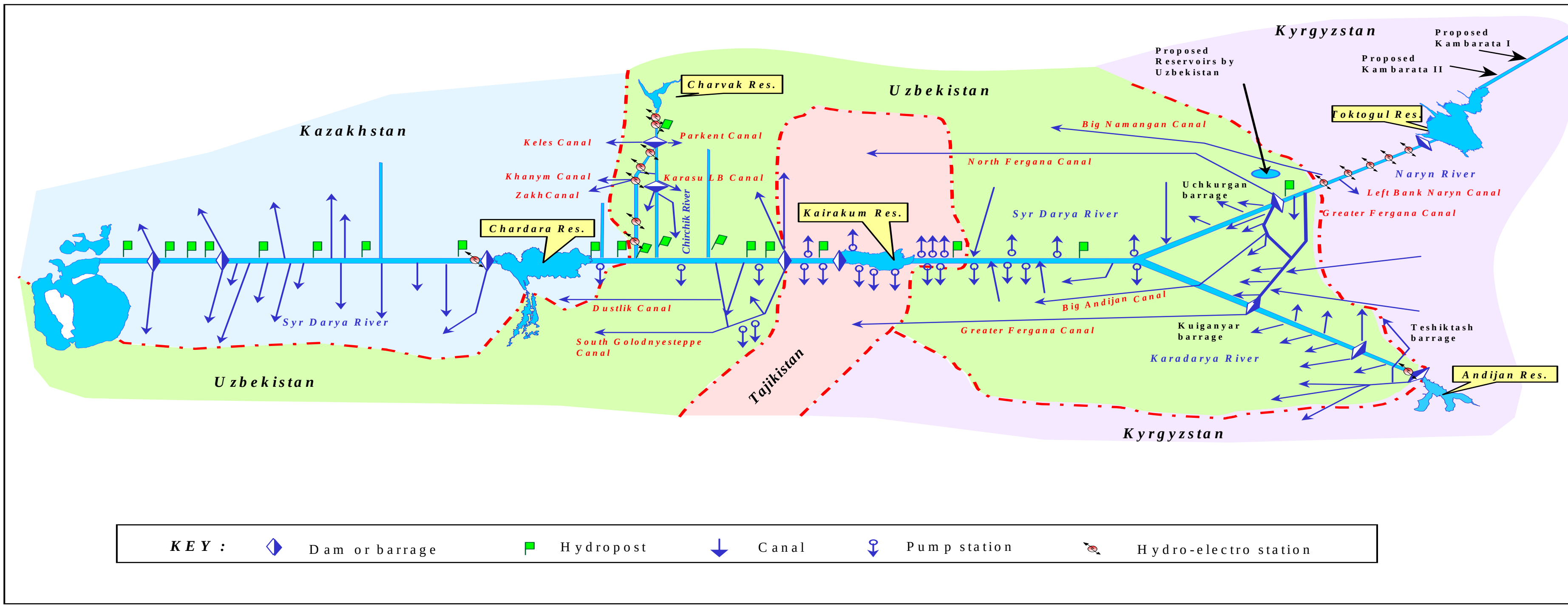
31. Trans-boundary basin agreements prosper in the context of a neutral party participating in the monitoring of the compliance of agreed obligations. The participation of IFIs and donors, as well as representatives of civil society in this, greatly contributes to the success of such agreements. The Bank group experience in the Nile basin cooperation arrangements among the riparian states attests to the efficacy of this approach. In the context of establishing a donor financed Guarantee Fund mentioned earlier, or raising funds for some of the structural options an arrangement similar to the one in Nile basin could be given serious consideration.

32. Last, but not least, are the institutional improvements needed to make the cooperation effort successful. These would include:

- Expansion of the remit of ICWC to include energy and environment concerns of the states and perhaps renamed Interstate Council for Water, Energy and Environmental Coordination and its membership may comprise of Prime Ministers;
- Making BVO Syr Darya the regulator of interstate water operations. Payments for water services could be made on the basis of certification by BVO;

- Enabling both BVO Syr Darya and UDC Energia to have staff from all riparian states and be seen as truly international organizations;
- Making UDC Energia the operator of the regional pool and suitably corporatizing and internationalizing it.

Appendix 1: Detailed schematic diagram of the main reservoirs and hydropower facilities in the Syr Darya Basin



Appendix 2: Power Balance IN CENTRAL ASIA for the years of 1990, 1995, and 2000 (GWh)

North Kazakhstan

1990	1995	2000
0	1100.8	2224.3

Turkmenistan	1990	1995	2000
Gross consumption	9609.8	8399.2	8957.1
% Increase		-12.6%	6.6%
Generation	14567.4	9834.2	9845.9
Export	6066.0	2216.0	921.2
Import	946.0	781.0	32.5

1990	1995	2000
0	0	34.8

Kazakhstan (SPS)	1990	1995	2000
Gross consumption	18463.3	14774.6	9237.8
% Increase		-20.0%	-37.5%
Generation	15664.9	10467.4	5725.9
Export	587.0	0	0
Trasm.from North Kaz.	0	1100.8	2224.3
Import from CA	88.36.0	6082.4	1287.7

1990	946.0	6066.0
1995	781.0	2216.0
2000	32.5	67.7

310.0	8139.0	1990
7.2	5198.7	1995
0	0	2000

1990	0
1995	0
2000	818.7

Uzbekistan	1990	1995	2000
Gross consumption	54070.8	46138.9	48121.3
% Increase		-14.7%	4.3%
Generation	56227.9	41429.3	46840.1
Export	13012.0	9936.4	955.9
Import	11103.2	8664.0	2237.3

277.0	697.0	1990
2876.0	883.7	1995
0	1252.9	2000

1990	3927.0	2344.2
1995	3724.5	2704.4
2000	728.8	243.9

232.2

Export outside CA

0	2383.0	1990
0	3718.0	1995
194.6	1925.6	2000

Tajikistan	1990	1995	2000
Gross consumption	19333.7	15421.2	15579.0
% Increase		-20.2%	1.0%
Generation	18092.0	14759.5	14246.6
Export	2668.2	3062.8	369.6
Import	3927.0	3724.5	1701.9

1990	1995	2000
324.0	358.4	125.7
0	0	154.4

The Kyrgyz Republic	1990	1995	2000
Gross consumption	9254.0	10915.6	11832.3
% Increase		18.0%	8.4%
Generation	13154.0	12283.3	14844.7
Export	3080.0	4602.1	3332.9
Import	601.0	3234.4	320.3

Appendix 3: Agreement dated February 18, 1992

Between
the Republic of Kazakhstan, the Republic of Kyrgyzstan, the Republic of Uzbekistan, the Republic of Tajikistan and Turkmenistan
On
Cooperation in the Field of Joint Water Resources Management and Conservation of Interstate Sources

The Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Uzbekistan, the Republic of Tajikistan and Turkmenistan, hereinafter called the Parties,

• Guided by the necessity of approved and organized solution of the problems of joint management of water of interstate sources, and in further pursuance of agreed policy of economic development and raising of the peoples' standard of living;

• Based on the historical community of peoples living on the territory of the Republics, their equal rights and responsibility for providing rational use and protection of water resources;

• Recognizing the unbreakable interdependence and relationship of the interests of all the Republics in solving problems of joint use of water resources on the basis of common principles for the whole region and equitable regulation of their consumption;

• Considering that only unification and joint coordination of action will create favorable conditions for solving social and economic problems, will allow mitigation and stabilization of ecological stresses, which originated as a consequence of water resources depletion, and taking into account that in the Republic of Tajikistan there is a disproportionate amount of irrigated land per capita, and recognizing possible increase in water supply for irrigated agriculture;

• Respecting the existing pattern and principles of water allocation, and based on acting regulations of water allocation from interstate sources, the parties agreed as follows:

Article 1

Recognizing the community and unity of the region's water resources, the Parties have equal rights for their use and responsibility for ensuring their rational use and protection.

Article 2

The Parties are obliged to provide for strict observation of agreed order and the establishment of rules of water resources use and protection.

Article 3

Each of the Parties to this Agreement is obliged to prevent actions on its territory which can infringe on the interests of the other Parties and cause damage to them, lead to deviation from agreed values of water discharges and pollution of water sources.

Article 4

The Parties are obliged to carry out joint works for solving ecological problems, related with the Aral Sea desiccation, and establish sanitary water discharge volumes for each year on the basis of water availability of interstate sources.

During extremely dry years a special separate decision shall be taken on the problems of water supply to the regions of acute water deficiency.

Article 5

The Parties shall facilitate wide information exchange on scientific-technical progress in water economy, complex use and protection of water resources, conducting joint research for scientific-technical support of problems and expertise in water related projects.

Article 6

The Parties take decisions on the joint use of production potential of the Republics' water economy.

Article 7

The Parties decided to establish on parity conditions an Interstate Coordinating Water Management Commission on the problems of regulation, rational use and protection of water resources from interstate sources, including in its membership first authorities of water management agencies, having envisaged quarterly meetings, and if required on Parties initiative.

Meetings of the above-said Commission are held in succession under chairmanship of state representatives and in corresponding capital.

Article 8

The Coordinating Water Management Commission will be responsible for:

- Determination of water management policy in the region, elaboration of its trends with regard for the needs of all branches of national economy, complex and rational use of water resources, long-term program of water supply in the region and measures for its implementation;
- Elaboration and approval of water use limits, annually for each Republic and the region on the whole, corresponding operations schedule for water reservoirs, their correction by specified forecasts depending on actual water availability and the water management situation.

Article 9

The executive and interdepartmental organs of the Interstate Coordination Water Management Commission shall specify the basin water management associations "Syrdarya" and "Amudarya" which shall function on conditions that all structures and facilities on the rivers and water services operated by them are the property of the corresponding Republic which owns them and should be deemed transferred for temporary use with out the right of transfer and redemption as stated by 1 January 1992.

Basin water management associations are maintained at the expense of allocations of water management organs of the Republics on the basis of parity and sharing.

Article 10

The Interstate Coordination Water Management Commission and its executive body shall provide for:

- Strict observance of release regimes and water use limits;
- Implementation of measures on the rational and economic use of water resources, sanitary water discharges along the river channels and through the irrigation systems (where they are planned), delivery of guaranteed water volume to the river deltas and the Aral Sea for the purpose of rehabilitating ecological conditions, preservation of water quality in accordance with achieved agreements.

Article 11

Decisions adopted by the Interstate Coordination Water Management Commission on the observance of limits for water withdrawal, rational use and protection of water resources are binding for all water consumers and water users.

Article 12

The Parties agreed to elaborate within 1992 the mechanism of economic and such other responsibility for violation of the agreed regime and limits of water use.

Article 13

All disputable matters are solved by the heads of water management agencies of the Republics, and, if needed, with participation of a representative of the party concerned.

Article 14

Agreements may be changed or supplemented only by way of joint consideration of all parties to this agreement.

Article 15

This Agreement enters into force the date of signing.

Agreement accepted in Alma-Ata 18 February, 1992.

On behalf of the Republic of Kazakhstan	N. Kipshakbaev
On behalf of the Kyrgyz Republic	M. Zulpuev
On behalf of the Republic of Tajikistan	A. Nurov
On behalf of the Republic of Uzbekistan	R. Giniatulin
On behalf of Turkmenistan	A. Ilamanov

Appendix 4: Agreement Dated March 17, 1998 Between the Governments of the Republic of Kazakhstan, the Kyrgyz Republic, and the Republic of Uzbekistan on the Use of Water and Energy Resources of the Syr Darya Basin

The Governments of the Republic of Kazakhstan, the Kyrgyz Republic, and the Republic of Uzbekistan, hereinafter referred to as the Parties:

GUIDED by sincere spirits of good-neighborliness and cooperation;

RECOGNIZING the fact that the appointed countries followed the agreed procedure of Syr Darya Basin Water and Energy Uses, ensuring social and economic development of their countries and people's welfare;

NOTING that the Syr Darya basin, comprised of the area of four countries, has water and energy resources to promote the economic growth of the countries;

HAVING a common desire to find the most precise and fair solution to use the water and energy resources of the Syr Darya basin in accordance with the precedents of international law;

ACKNOWLEDGING that benefits derived from the joint operation of the reservoirs of the Naryn-Syr Darya Cascade, through a multi-year flow regulation and the flood control measures, include the use of water for irrigation and power generation;

TAKING INTO ACCOUNT that a joint and comprehensive use of the water and energy resources of the Syr Darya basin must be implemented with regards to the environmental safety of the region;

NOTING the common interests of the participating countries and the urgent need for the development of an efficient and coordinated water regime in the Syr Darya basin, taking into account the problems of the Aral Sea; the Parties agree on the following:

ARTICLE I

Definitions

"Naryn Syr Darya Cascade" refers to the aggregate of the multi-year and seasonal regulation reservoirs.
"Growing period" is defined as the period from April 1 to October 1.
"Non-growing season" is defined as the period from October 1 to April 1.
"Water management year" is defined as the period from October 1 to October 1 of the following year.

ARTICLE II

To ensure the agreed-upon operating regimes of the hydrotechnical facilities and the reservoirs of the Naryn-Syr Darya Cascade and irrigation water releases, the Parties deem it necessary annually to coordinate and make decisions on water releases, production and transit of electricity, and compensations for energy losses, on an equivalent basis.

ARTICLE III

The Parties will take no actions which will violate the agreed-upon water use regimes and energy deliveries, or infringe on the rights of the other Parties to obtain water and energy deliveries in the mutually-agreed amounts or to transport resources through their own territories.

ARTICLE IV

The Naryn-Syr Darya excess power emanating from the release mode utilized on the Naryn-Syr Darya during the growing season, and the Toktogul multi-year regulated flows that exceed the needs of the Kyrgyz Republic, will be transferred to the republics of Kazakhstan and Uzbekistan in equal portions.

Compensation shall be made in equivalent amounts of energy resources, such as coal, gas, electricity and fuel oil, and the rendering of other types of products (labor, services), or in monetary terms as agreed upon, for annual and multi-year water irrigation storage in the reservoirs.

A single tariff policy for all types of energy resources and their transportation shall be applied for mutual settlements.

ARTICLE V

The Parties shall undertake essential measures, which will ensure the fulfillment of their Agreement commitments to the other Parties using various forms of guarantees, such as lines of credit, security deposits, or other forms.

ARTICLE VI

The Parties agree that customs fees and duties will not be applied for deliveries of energy or other types of products (labor and services) within the Agreement.

ARTICLE VII

The Parties agree that the operation, maintenance and reconstruction of water and energy facilities shall be covered in accordance with the ownership of the property referred to in the balance sheet and the legal right of ownership.

ARTICLE VIII

Reservoir operation modes, energy amounts and transfers are approved by annual intergovernmental agreements based on the decisions made by water, fuel and energy organizations headed by vice prime ministers of the signatory countries. The BVO Syr Darya and UDC Energia shall be appointed as executive bodies responsible for the release schedules and energy transfers prior to the establishment of the International Water and Energy Consortium and its executive body.

ARTICLE IX

Any disputes or disagreements will be resolved through negotiations and consultations. If the Parties do not reach an accord the issue in dispute shall be considered by an arbitration court that will be established by the Parties for each specific case.

ARTICLE X

To provide further improvement of the management and use of the water and energy resources and the enhancement of economic relations aimed at guaranteed water supply in the basin, the Parties agree to consider jointly the following issues:

- Construction of new hydropower facilities and reservoirs, or alternative sources for hydropower in the region;

- Replacement of barter settlements by financial relations;
- Development of pricing mechanisms based on a single tariff policy;
- Ensuring safe operation of hydrotechnical facilities in the Syr Darya Basin;
- Economic and rational water use with the application of water-conservation technologies and irrigation equipment; and
- Reduction and discontinuation of polluted water discharges in the water sources of the Syr Darya basin.
-

ARTICLE XI

This Agreement shall be in force from the date the Parties forward the notification of depository on the implementation of the internal state procedures to enforce it.

ARTICLE XII

This Agreement is valid for a period of five years and will be automatically renewed for additional five-year periods, if no written notice on the termination of the Agreement is given six months in advance from any Party.

ARTICLE XIII

This Agreement is open for other countries to enter.

ARTICLE XIV

Given the mutual consent of the Parties, amendments and addenda can be introduced and formalized by separate protocols, and will become integral parts of the Agreement.

This Agreement is finalized in Bishkek, March 17, 1998, in one original copy in Russian.

The original copy remains in the office of the ICKKU Executive Committee, which will submit certified copies to each member country having signed the Agreement.

Signatories:

For the Government of the Republic of Kazakhstan	For the Government of the Kyrgyz Republic	For the Government of the Republic of Uzbekistan
N. BALGIMBAEV	A. DJUMAGULOV	U. SULTANOV

Appendix 5: Agreement dated January 21, 2000

Between the Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic on Utilization of the Water Facilities of Interstate Use on the Chu and Talas Rivers

The Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic hereinafter referred to as "the Parties", being guided by the Agreement Regarding Creation of the Single Economic Area of April 30, 1994;

Acknowledging social, economic and environmental value of water resources;

Attaching importance to mutual beneficial cooperation in use of water resources and reliability and safety in operation of the water facilities of interstate use;

Having the common desire to find the most perfect and fair decision in efficient use of water facilities pursuant to the admitted international water law;

Proceeding from the principles of neighborliness, equality, and mutual assistance;

Have agreed as follows:

ARTICLE 1

The Parties agree that use of water resources, operation and maintenance of the water facilities of interstate use shall be targeted at mutual benefits of the Parties on the fair and reasonable basis.

ARTICLE 2

The Parties subsume to the water facilities of interstate use the following water facilities owned by the Kyrgyz Republic:

- Orto-Tokoi Reservoir on the Chu River;
- Chu bypass reinforced concrete canals on the Chu River, from the Bystrovskaya hydroelectric power plant to the town of Tokmok;
- West and East Big Chu Canals with facilities;
- Chumysh water structure on the Chu River;
- Kirovskoye Reservoir on the Talas River.

ARTICLE 3

The Party-owner of the water facility of interstate use is entitled to receive compensation from the Party-user of the facility for the costs needed to provide safe and reliable operation.

ARTICLE 4

The Parties shall take shared part in the recovery of costs associated with operation and maintenance of the facilities of interstate use and other agreed efforts in proportion to the water received.

ARTICLE 5

For reliable and safe operation of the water facilities of interstate use, the Parties shall establish permanent commissions that set up the operation mode and define amounts of costs needed for operation and maintenance.

ARTICLE 6

The Parties shall annually appropriate funds needed to operate and maintain the water facilities of interstate use.

ARTICLE 7

The Parties shall undertake joint measures to protect the water facilities of interstate use and the territories within their areas of influence from adverse effects of floods, mudflows and other natural phenomena.

ARTICLE 8

In case of emergency at the water facilities of interstate use caused by natural phenomena and technical reasons, the Parties shall notify each other and undertake joint actions to prevent, mitigate and remove consequences of emergencies.

ARTICLE 9

For the purposes of prompt and efficient repairs and reconstruction at the water facilities of interstate use, the Parties shall acknowledge the necessity to use construction, repair, operation and industrial capacities of each other.

ARTICLE 10

The Parties agree to conduct research, design and exploration concerning the efficient use of water resources and water facilities jointly.

ARTICLE 11

The Parties shall implement the order of unimpeded and customs free movement across the boundaries and territories thereof for staff, machines, mechanisms, raw stuff, and materials intended for operation and maintenance of the water facilities of interstate use.

ARTICLE 12

In the event of disputes or controversies related to the interpretation or application of the Agreement, the Parties shall resolve them by negotiations and consultations.

ARTICLE 13

Upon the consent of the Parties, addenda and amendments may be incorporated in the Agreement in the form of separate protocols. The addenda and amendments constitute an integral part of the Agreement.

ARTICLE 14

The Agreement shall come in force from the moment the last notification on the executed internal procedures provided in national legislations has been deposited by the Parties.

The Agreement shall be in effect for five years. It will be automatically prolonged for further five-year periods, unless either Party has delivered a written notice to the other Party of its intention to terminate the Agreement six months before the expiration date.

Done in duplicate, at Astana, this 21st day of January, 2000, in the Kyrgyz, Kazakh and Russian languages, each being equally authentic.

Should a controversy arise, the Parties shall be guided by the Russian text of the Agreement.

For the Government of the Kyrgyz Republic	**For the Government of the Republic of Kazakhstan**

Appendix 6: Historical Flow of Naryn River Through the Current Location of the Toktogul Reservoir During 1911-2000

Year	Annual Flow (BCM)	Year	Annual Flow (BCM)	Year	Annual Flow (BCM)
1911	10.827	1941	11.282	1971	13.008
1912	11.197	1942	12.869	1972	10.817
1913	11.500	1943	10.157	1973	14.226
1914	11.428	1944	9.193	1974	8.479
1915	10.233	1945	10.606	1975	8.839
1916	8.873	1946	10.529	1976	9.207
1917	6.524	1947	8.159	1977	10.700
1918	8.690	1948	10.555	1978	11.717
1919	10.690	1949	11.369	1979	12.597
1920	10.918	1950	11.328	1980	10.634
1921	20.722	1951	10.548	1981	11.952
1922	13.004	1952	16.376	1982	8.442
1923	12.605	1953	14.602	1983	11.043
1924	13.390	1954	14.954	1984	10.838
1925	9.746	1955	12.429	1985	10.303
1926	9.355	1956	12.966	1986	9.425
1927	7.476	1957	9.497	1987	14.979
1928	12.186	1958	13.167	1988	16.487
1929	10.945	1959	15.020	1989	10.081
1930	11.328	1960	14.315	1990	12.465
1931	13.872	1961	9.556	1991	10.737
1932	9.551	1962	9.666	1992	12.019
1933	8.893	1963	12.040	1993	13.612
1934	12.900	1964	14.124	1994	15.302
1935	11.416	1965	9.689	1995	10.805
1936	10.696	1966	15.636	1996	13.111
1937	10.177	1967	10.961	1997	10.701
1938	8.015	1968	12.583	1998	14.505
1939	8.368	1969	18.555	1999	15.173
1940	8.913	1970	14.747	2000	12.660

Appendix 7: Economic Analysis

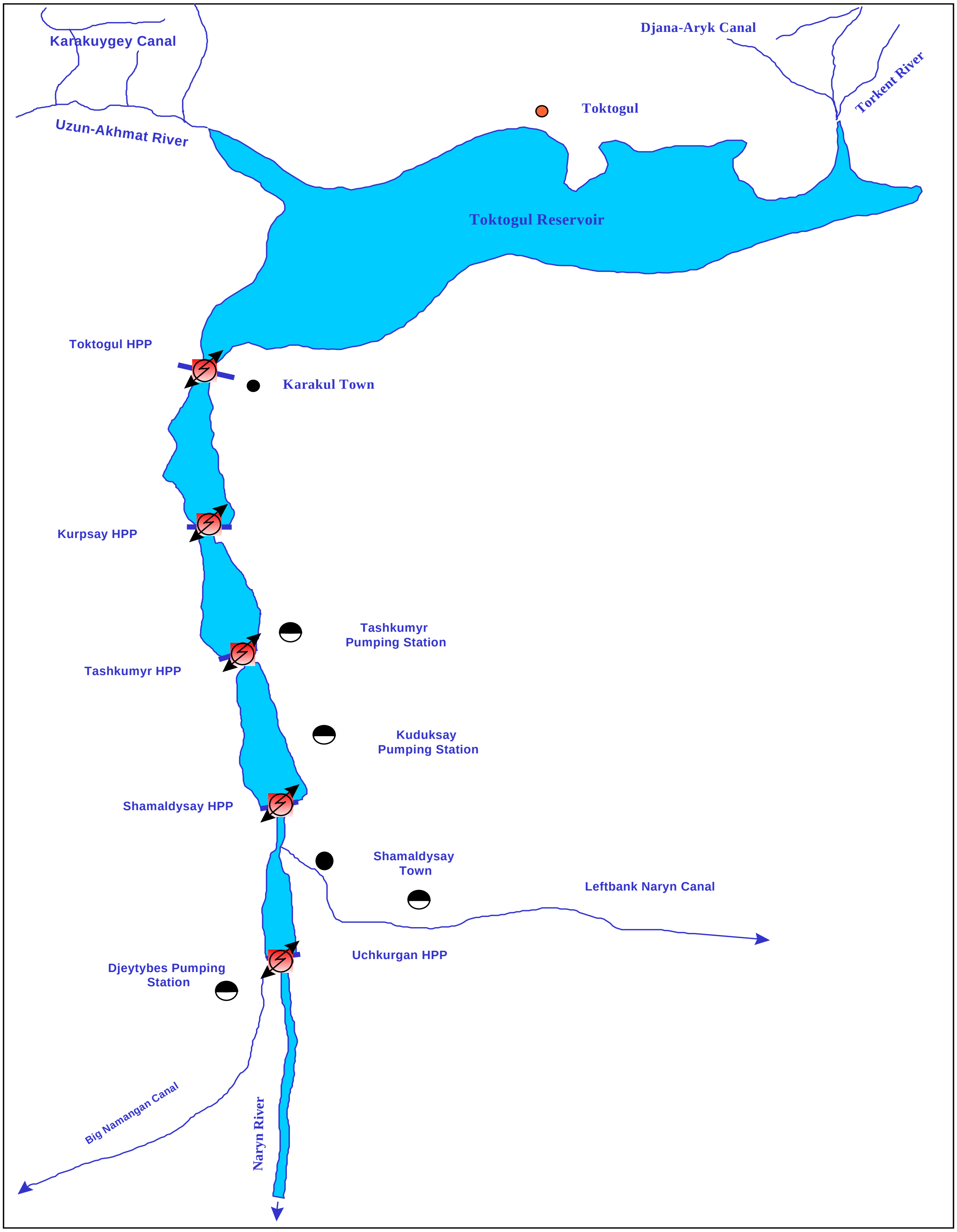


Figure 2: Naryn Cascade

In this Appendix, the economic basis for equitable distribution of benefits is laid out; the performance under the IGIAs is compared with the economically justified equitable distribution of benefits; and finally sensitivity analysis is carried to understand how the benefits can be stabilized under varying hydrological conditions.

Economic Setting

The Naryn River is a major tributary of the Syr Darya on which 5 big hydroelectric power plants (HPPs) are located (Toktogul, Kurpsai, Tashkumyr, Shamaldysai, and Uch-Kurgan), all of them on the territory of the Kyrgyz Republic (See Figure 2). The Toktogul reservoir, the largest of all, has an active storage of 14 BCM and a firm annual yield (i.e., releasable water) of about 9 BCM. Hence it is the main source of water in the Syr Darya River basin on which two downstream riparians, Kazakhstan and Uzbekistan, greatly depend. The Toktogul reservoir was constructed to meet the targets of agricultural production set by the former Soviet Union Government. These targets were achieved – cotton production rose quickly from 4.3 million tons in 1960 to 10-11 million tons in 1990.

Prior to 1991 the Toktogul cascade was operated according to an irrigation regime. The design criterion for release of water from the reservoir during the non-vegetation period (October – March) was to limit it to 180 m^3/sec, which corresponded with the natural flow of the river, but also providing for a minimum electricity generation (See Figure 3).

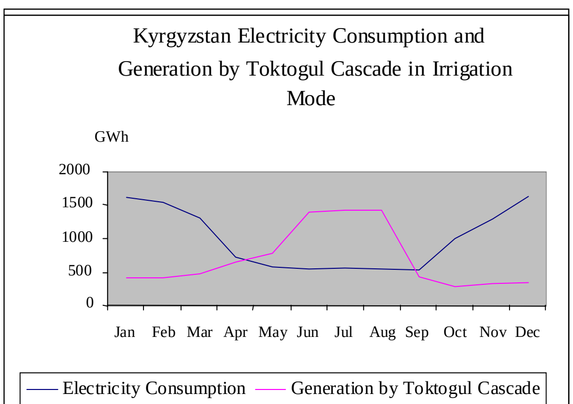


Figure 3

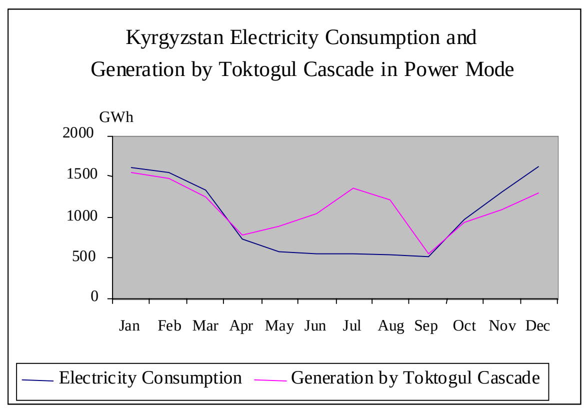


Figure 4

Following the break-up of the Soviet Union however, the Kyrgyz Republic, to minimize import of fossil fuels and to meet as much of its domestic demand for electricity from indigenous sources, tended to operate the Naryn cascade in a hydropower mode, which implies storing water in the summer, and releasing it in the winter (See Figure 4). In contrast, the downstream countries want the Naryn cascade operated in an irrigation mode, which implies release waters in the summer and storing it in the winter.

For the Kyrgyz Republic, meeting the water needs of the downstream countries results in a level of electricity production that is greater than the need to meet its demands in the summer months. Also, because water has not been stored for the winter months; and restrictions placed on water releases during winter, the generation of hydroelectricity is lower in winter than its demand. Therefore, the Kyrgyz Republic is incurring opportunity costs of: (a) storing the water (during winter) when it really needs to release it; and (b) releasing the water (during summer) when it really needs to store it.

At the same time, the downstream countries receive benefits from (a) irrigation water, which has value based on the agricultural (mainly cotton) yields generated; and (b) additional electricity in the summer, which could be valued using the costs of electricity generation in those countries

Assumptions for the Analysis

Availability of Water Resources: On the overall availability of water resources:

- The Haskoning study reports that the average annual inflow from 1975 to 2001 has been 12 BCM);
- On the other hand the TACIS Verbundplan study claims an average annual flow of 11 BCM; and
- An examination of flows rates going back to 1919 suggests a 20-year moving average of only 9 BCM (See Appendix 6).

For the purpose of this analysis therefore, the inflow assumption for the base case is taken as 9 BCM. Second, outflows are assumed to be 9 BCM on an annual basis, as this level of releases would be equal to the firm annual yield, equate the inflows into the reservoir to the outflows and therefore is sustainable over the long term. Also, such releases: (a) are close to the natural flows of the river, thus are deemed sustainable from an ecological and natural resource management points of view,[19] and (b) correspond to the releases in the IGIA levels of the last three years.

Of this 9 BCM annual releases, the normal summer release is assumed to be 6 BCM, with a minimum release of 3 BCM in summer, which roughly corresponds to the Kyrgyz Republic's needs to release to meet its summer electricity needs. Winter releases therefore would be limited to 3 BCM.

Associated Electricity. In the Toktogul cascade, one cubic meter of water flowing through all the 5 HPPs generates 0.86 kWh of electricity at the end of the cascade. In other words, 1.16 m^3 of water are needed to generate 1 kWh of electricity. Accordingly, if 6 BCM of water were released in summer it would generate 5,170 GWh; and if 3 BCM were released during winter, it would generate 2,590 million kWh.

Costs of Energy to Each Party: Critical to the assessment of the costs and benefits of different allocations of water from the Naryn are the costs of electric energy to each party. The relevant costs are: (a) the short run marginal cost (SRMC) of generation to the Kyrgyz Republic if hydropower from Toktogul is reduced in winter and (b) the SRMC of generation saved in south Kazakhstan and Uzbekistan if hydropower is provided to them from Toktogul in summer. The details of SRMC calculations are presented in Appendix 8.

The Kyrgyz Republic: If hydropower production from Toktogul were to change, complementary changes in consumption of fossil fuels would take place in the Kyrgyz Republic system. These can effectively be modeled by looking at the Bishkek CHP, which provides most of the power generated by thermal power stations in the country. T*he SRMC is around*

[19] Daene McKinney et. al., “Optimization of Syr Darya Water and Energy Uses”, April 2001

US¢/1.5/kWh.[20] At present somewhere between 725 and 900 million kWh are being generated, with the plant operating at a capacity of 200-250MW and using about 41 percent gas and 57 percent coal[21].

Uzbekistan: The highest cost plant in Uzbekistan is the Angren coal fired power plant, whose SRMC is about US¢2.3/kWh, followed by Novo-Angren power plant, which is largely coal fired with an SRMC of about US¢2.1/kWh. So when electricity is available from outside the system, it is assumed that these highest cost plants are closed first, followed by the next lower cost plant, if necessary.

South Kazakhstan. Current operations of the south Kazakhstan power system has factored in the availability of hydropower from Toktogul in the summer, to the extent that the privately owned Jambul thermal power plant, a fuel oil fired facility, is shut down due to its higher costs of generation. In case power from Toktogul was not available, it is assumed that Jambul plant would be operated to meet the south Kazakhstan demand. The estimates of costs of generation at Jambul TPP show that the SRMC of generation would be about US¢2.1/kWh[22]

Benefits of Irrigation Operations to Downstream Countries. Irrigation water has value based on the additional value of the agricultural yields generated.

- The irrigation water delivered is used for many crops, including cotton. In view of: (a) the absence of more detailed information on how water is allocated to each crop; (b) the fact that cotton is the one crop with a clear internationally determined value; and (c) the only one whose production is demonstrably profitable when valued in international prices, ***the benefits are calculated only for cotton production;***
- Wheat production, which has expanded as a result of a policy of self-sufficiency, is much less valuable in economic terms and, indeed, if output is valued at international prices it has a negative value-added. Other irrigated crops may have a positive value-added but data to determine these are not available. Consequently, by taking only the value of cotton, the net economic benefits of irrigation water are being underestimated in all probability. However, the data provide a lower bound on benefits from irrigation mode and are useful for comparison purposes;
- Currently about 37 percent of the land irrigated in Syr Darya basin is devoted to cotton in Uzbekistan and 28 percent in Kazakhstan. Depending on the water available, more or less land can be used for cotton, subject to some physical limits. Consultants Haskoning have made an estimate of present land under cotton and how much more can be put

[20] In view of the limited thermal capacity of Kyrgyz Republic, this value is understated. When making calculations for the revised Agreement one should take into account also the incremental capacity cost.
[21] About 2 percent of the fuel used is fuel oil.
[22] It is of relevance to note that Kazakhstan is trying to become self sufficient to meet the electricity demand from its own sources. The options for meeting the demand in South Kazakhstan from domestic sources were: (a) rehabilitation of Jambul TPP, (b) construction of a new fuel oil fired TPP/fuel oil fired combined cycle power plant in the South, and (c) construction of a new North-South 500 kV transmission line together with rehabilitation of existing Ekibastuz TPP/construction of a new coal-fired TPP. The respective Long Run Marginal Costs of these options were estimated to be: (a) 4.79 US¢/kWh, (b) 5.82/4.21 US¢/kWh, and (c) 2.87-2.81/5.15-5.09 US¢/kWh – Source: RWE Solution, KEGOK. Kazakhstan North-South 500 kV Power Transmission Line Investment Pre-Feasibility Study. Final Report

allocated to this crop. Table 1 below summarizes the basic data. These figures limit the amount of cotton benefit that can be derived as water availability is increased;

- The value of water in irrigation in this region is estimated by Haskoning as being in the region of $20-$50 per KCM[23]. Although this is a wide range, it is not inconsistent with other estimates of the value of irrigation water in cotton production. Hence estimates of irrigation water value take these figures, with the base calculations using $20/KCM.

Table 1: Actual and Potential Land Under Cotton

Country	Kazakhstan	Uzbekistan
Land under cotton (000 ha.)	281.4	688.2
Additional land that can be planted with cotton (Med. Term) (000 ha.)	2.2	103
Additional land that can be planted with cotton (Long Term) (000 ha.)	6.6	347

Source: Haskoning (2001)

- The application of water to cotton production is limited, however, by the land available. The amount of water required by each hectare depend on the level of the water table, and Haskoning have estimated these needs and the areas with different levels, as detailed in Table 2 below. Following from these and the land available for irrigation, we can estimate the amount of additional water that can be allocated to cotton production. In the calculations of the irrigation benefits it is assumed that the application of water is constrained by the amount of land available[24].

Table 2: Water Needs for Cotton Irrigation

Water Table Level	Units	1 Meter	2 Meters	> 4 Meters
Water Needed for Full Cotton Yield	m^3/ha.	2700	5430	7340
Land under cotton that is in each category				
Kazakhstan	000 ha.	41.2	41.2	136.1
Uzbekistan	000 ha.	76.4	76.4	535.4
Additional land in each category for cotton (in the medium term)				
Kazakhstan	000 ha.	11.4	11.4	80.1
Uzbekistan	000 ha.	0.4	0.4	1.4

Source: Haskoning (2001)

Base Case Analysis

Costs to the Kyrgyz Republic. The opportunity cost can be measured by the difference between the costs that the Kyrgyz Republic incurs in the irrigation mode versus those incurred in the power mode.

[23] In their Main Report they estimate that an additional 5.1 BCM of water could be generated by reducing drainage flows in the basin. If all of this was applied to cotton, it would yield an increase of $100 million in incomes. This implies a value of $19.6 per 1000 m^3. (Haskoning, 2001, page 11).

[24] The increase in available land is taken as stipulated in the medium term estimate in Haskoning. Production of cotton on this land is assumed to be sustainable – i.e. land is rotated as needed. Any environmental costs associated with cotton production (e.g. intensive pesticide application) are ignored.

Table 3: Costs to the Kyrgyz Republic of Operating Toktogul in Irrigation Mode			
	Vegetation Period (April-September)	Non-Vegetation Period (October-March)	Total
Water Releases (BCM)	6.0	3.0	9.0
Water needed to generate one kWh (m^3)	1.16		
Electricity Generated (GWh)	5,170	2,590	7,760
Domestic Demand (GWh)	2,550	4,950	7,500
Losses[25]	10	15	
Gross Generation (GWh)	2,830	5,820	8,660
Surplus (deficit) (GWh)	2,340	(3,230)	(890)
SRMC of Generation (US¢/kWh)	1.5		
Costs (US$ Million)	**--**	**48.5**	

As shown in Table 3, each cubic meter of water released generates 0.86 kWh of electricity (i.e., to generate 1 kWh, 1.16 m^3 need to be released), which implies that to meet its own demand of 2,550 million kWh plus to account for technical losses during summer, the Kyrgyz Republic needs to release only 3.2 BCM of water approximately. During winter, the releases are only about 3 BCM, which would generate about 2,590 million kWh, where as the needed generation (demand plus losses) is about 5,830 million kWh. Therefore there is a deficit of about 3,240 million kWh, and this deficit needs to be made up from the thermal sources, which at the SRMC of 1.5 US¢/kWh, would cost the Kyrgyz Republic about US$48.6 million.

Table 4: Costs to the Kyrgyz Republic of Operating Toktogul in Power Mode			
	Vegetation Period (April-September)	Non-Vegetation Period (October-March)	Total
Water Releases (BCM)	3.0	6.0	9.0
Water Needed to generate one kWh (m^3)	1.16		
Electricity Generated (GWh)	2,590	5,170	7,760
Domestic Demand (GWh)	2,550	4,950	7,500
Losses (%)	10	15	
Gross Generation (GWh)	2,830	5,820	8,660
Surplus (deficit) (GWh)	(240)	(650)	(890)
SRMC of Generation (US¢/kWh)	1.5		
Costs (US$ Million)	**3.6**	**9.8**	**13.4**

In the power mode of operation, the releases would just reverse relative to the irrigation mode, with 3 BCM in vegetation period and 6 BCM in non-Vegetation period. As can be

[25] Only technical losses are considered, because the rest of the losses are commercial losses, which are very much within the control of the Kyrgyz Republic to minimize them. Moreover, the technical loss levels will be higher during non-vegetation period due to the heavier loading of the networks.

seen in Table 4, there would be minor deficits in meeting the gross generation needs (demand plus losses) and this deficit would be met from the thermal power sources. This is in concert with the requirement that Bishkek CHP should be operated at some minimum level throughout the year, to provide system stability as well as heat supply during winter.

Therefore, the incremental costs incurred by the Kyrgyz Republic of operating Toktogul in an irrigation mode are about the US$35 million, which is the difference between the costs incurred in the two modes of operation. In other words, for every BCM of water released during summer above than the 3 BCM needed by the Kyrgyz Republic to meet its own electricity demand, the Kyrgyz Republic is incurring opportunity costs of about US$11.67 million. Looked at yet another way, the Kyrgyz Republic is incurring costs of US$17.5 million each on behalf of Kazakhstan and Uzbekistan, when Toktogul is operated in an irrigation mode.

Benefits to the Downstream Countries. At the same time, the downstream countries are receiving water for irrigation purposes as well as electricity associated with water releases. Table.5 provides the computations of the benefits accrued to both Uzbekistan and Kazakhstan in the irrigation mode.

Table 5: Benefits to Downstream Countries of Operating Toktogul in Irrigation Mode

Irrigation Benefits	Uzbekistan	Kazakhstan	Total
Value of Water ($/KCM)	20		
Volume of Water Released (BCM)	3	3	6
Benefits from Water (US$ million/BCM)	7	5.6	
Total Irrigation Benefits (US$ million)	**21**	**16.8**	**37.8**
Electricity Benefits			
Electricity Received (GWh)	1,100	1,100	2,200
SRMC of generation (US¢/kWh)	2.3	2.1	
Total Electricity Benefits (US$ million)	**25.3**	**23.1**	**48.4**
Total Benefits to Downstream Countries	**46.3**	**39.9**	**86.2**

For Uzbekistan, with irrigation benefits of US$20/KCM, and only 35% going to production of cotton, the benefits for the value of water is US$7 million/BCM. Uzbekistan allocation is roughly half of the water released from Toktogul, i.e., 3 BCM. Accordingly, the total irrigation benefits amount to US$21 million for the water that Uzbekistan receives. Associated electricity is also split evenly between the two downstream countries, resulting in Uzbekistan receiving 1,100 million kWh at the Uzbekistan border, after accounting for 6% losses in the Kyrgyz Republic transmission system (i.e., 2,200 million kWh of the 2,340 million kWh of surplus is actually delivered)[26]. When this electricity is valued using Uzbekistan's SRMC of US¢2.3 /kWh,

[26] This is the level that the 1998 Framework Agreement and the annual IGIAs include.

electricity benefits to Uzbekistan amount to about US$25.3 million. The benefits from irrigation and electricity together to Uzbekistan amount to US$46.3 million.

Although half the irrigation water is given to Kazakhstan, the value of the irrigation benefits are the somewhat lower, at US$16.8 million, in view of the fact that the area under cotton cultivation is only 28% of the irrigated areas. Further, due to the slightly lower SRMC of electricity generation in south Kazakhstan, the value of associated electricity that is delivered to Kazakhstan amounts to US$23.1 million. As a result, the total benefits of operating Toktogul in an irrigation mode is about US$39.9 million. Taken together, the total benefits to downstream countries from operating Toktogul in an irrigation mode is about US$86 million.

To arrive at the **incremental** benefits enjoyed by the downstream countries in the irrigation mode, it would be necessary to compare such total benefits with any benefits these countries would get from operating Toktogul in a power mode. Such computations are given in Table 6.

Table 6: Incremental Benefits to Downstream Countries of Operating Toktogul in Power Mode

Irrigation Benefits	Uzbekistan	Kazakhstan	Total
Value of Water ($/KCM)	20		
Volume of Water Released (BCM)	1.5	1.5	3.0
Value of Water (US$ million/BCM)	7	5.6	
Total Irrigation Benefits (US$ million)	**10.5**	**8.4**	**18.9**

Due to the fact that only 3 BCM of water is released under the power mode, and that all associated electricity is consumed by the Kyrgyz Republic itself, the only benefits accruing to the downstream countries are those due to irrigation, and these amount to US$10.5 million for Uzbekistan and US$8.4 million in Kazakhstan, for a total value of about US$19 million. Accordingly, by operating Toktogul in an irrigation mode, the annual incremental benefits accruing to Uzbekistan amount to US$35.8 million; and those accruing to Kazakhstan amount to US$31.5 million for a total of US$67.3 million. These figures stand out in stark contrast to the annual incremental costs incurred by the Kyrgyz Republic of US$35 million, when operating Toktogul in the irrigation mode.

Implications of the Analysis

The implications of the base case analysis, summarized in Table 7, are quite clear. When operating in irrigation mode, the Kyrgyz Republic is incurring opportunity costs that are nearly three-and-one-half times the costs that it would incur in a power mode, which means that the Kyrgyz Republic would prefer to operate Toktogul in a power mode.

Table 7: Summary of Incremental Costs and Benefits of Toktogul Operations

	Operation of Toktogul in		**Incremental Values**
	Irrigation Mode	**Power Mode**	
Costs to the Kyrgyz Republic	48.6	13.5	35.1
Benefits to Uzbekistan and Kazakhstan	86.2	18.9	67.3

On the other hand, even with conservative estimates on the value of irrigation benefits (at US$20/KCM) and applied only to cotton cultivation, the downstream countries are reaping benefits from such operations that are nearly twice the costs incurred by the Kyrgyz Republic. Therefore, if the downstream countries want the assurance that Toktogul is operated in an irrigation mode, then the downstream countries must recognize the costs incurred by the Kyrgyz Republic and compensate the Kyrgyz Republic for such costs.

The analysis carried out provides the floor and ceiling of such compensation. If the payment offered by Uzbekistan and Kazakhstan to the Kyrgyz Republic is anything less than or just equal to US$35 million (the incremental costs incurred by the Kyrgyz Republic) then there is no incentive for the Kyrgyz Republic to operate Toktogul in an irrigation mode. Likewise, if the Kyrgyz Republic receives compensation equal to all the US$67 million (the incremental benefits of Uzbekistan and Kazakhstan combined) then there is no gain by Uzbekistan and Kazakhstan from getting that amount of water in summer. ***Therefore, the compensation needs to be somewhere between US$35 million and US$67 million. A political agreement is necessary to decide on the actual compensation level between the downstream countries and the Kyrgyz Republic.***

Comparison of Benefits/Costs with Actual Payments. Comparison of agreed exchanges of commodities with actual exchanges in the year 2001 is provided in Table 8, together with the monetary value of the bartered commodities. The main commodities exchanged in 2001 were coal, gas, and fuel oil.

Table 8: Comparison Between Agreed Annual IGIA and Performance in 2001

Supplies from the Kyrgyz Republic	Unit	Kazakhstan		Uzbekistan		Total	
		Agreed	Actual	Agreed	Actual	Agreed	Actual
Water releases	BCM	2.95	2.95	2.95	2.95	5.9	5.9
Export of Associated Electricity							
Quantity	GWh	1,100	912	1,100	1,038	2200	1950
Price	US$/kWh	0.01	0.0088*	0.0334	0.0201*	0.0217+	0.0148*+
Value	US$ Million	11.00	8.00	36.74	20.87	47.74	28.87
Supplies to the Kyrgyz Republic							
Natural gas							
Quantity	MCM			658.2	368.8	658.2	368.8
Price	US$/KCM			54.174	54.174	54.174	54.174
Value	US$ Million			35.66	19.98	35.66	19.98
Coal							
Quantity	Th. metric tons	618	466.5			618	466.5
Price	US$/ton	16	16			16	16
Value	US$ Million	9.89	7.46			9.89	7.46
Fuel oil							
Quantity	Th. metric tons	20	9.8	20	16.5	40	26.3
Price	US$/ton	55	55	54	54		
Value	US$ Million	1.10	0.54	1.08	0.89	2.18	1.43
Total	**US$ Million**	**10.99**	**8.00**	**36.74**	**20.87**	**47.73**	**28.87**

*** Computed; + Weighted Average**

As regards the agreement itself:

- Kazakhstan and Uzbekistan together agreed to pay the equivalent of about US$48 million in commodities to the Kyrgyz Republic, and this agreed payment level ***lies within the range defined by a minimum of $35 million and a maximum of $67 million.*** In other words, the agreements appear to comprise what can be considered as a fair distribution of benefits between the upstream country and the two downstream countries taken together;
- ***Between the two downstream countries, Kazakhstan is getting the better end of the bargain***. As per agreement, the amount of water as well as electricity received is the same as Uzbekistan, but the commitment is to pay the equivalent of US$11 million versus Uzbekistan's commitment to pay the equivalent of US$37 million;
- The payments, according to the agreements, are being made exclusively for electricity supplied. However, because such electricity is priced at inflated levels (relative to cost of hydro production in the Kyrgyz Republic), especially for Uzbekistan, ***the payments do include implicit payments for water services.***

As regards the performance under the 2001 agreement:

- While the amount of water transferred is as per agreement, the amount of electricity consumed was lower than contracted for. More important, all the main commodities (gas, coal and fuel oil) were a quite a bit lower than contracted. ***As a consequence, the actual value received by the Kyrgyz Republic for electricity was US¢0.88/kWh from Kazakhstan, and US¢2.01/kWh from Uzbekistan, for a weighted average of US¢1.48/kWh;***
- ***The total resource transfer to the Kyrgyz Republic is equivalent to about US$29 million, i.e., less than the incremental costs incurred by the Kyrgyz Republic*** (estimated at US$35 million) to operate Toktogul reservoir in an irrigation mode;
- ***In view of the timing difference in resource exchanges (water/electricity in summer, coal/gas etc. in winter), the Kyrgyz Republic loses the leverage to enforce the agreement*** when the gas/coal supplies are less than agreed, and resorts to drawing down the Toktogul waters in larger quantities (than agreed) to meet its winter power demand.

In summary, the annual agreements under the 1998 Framework Agreement appear to be a fair distribution of benefits by implicitly including a payment for water services. However, the actual performance under the annual agreements short change the Kyrgyz Republic, who, having lost the leverage to enforce the agreement in winter after releasing the water in summer, is therefore compelled to release more water from Toktogul in winter than agreed levels.

To resolve this problem, the water and energy nexus needs to be broken (or unbundled) and put on a commercial basis. Four commodities are involved principally – water services, electricity, gas and coal. Once the trade in water services is put on a commercial basis (with the compensation mechanism in place), then gas can be traded to meet gas needs, electricity to meet electricity needs etc.

Sensitivity Analysis

Wet, Dry, and Normal Hydrological Conditions. The hydrological regimes in the region are complicated, with two factors of relevance playing a critical part. The first is rainfall, particularly in the summer months in the downstream countries, which determines the demand for irrigation water from Naryn. Second there is the snow/glacial melt that determines the availability of water in the Naryn River. Figure 5 describes the four combinations and their implications for the water energy nexus. In regime C_1F_1, the Kyrgyz Republic would suffer because the downstream countries would not need as much water from the Naryn River. In regime C_1F_2, the downstream countries need more water and Toktogul would have sufficient water to meet the increased demand. This would be to the Kyrgyz Republic's benefit. In regimes C_2F_1 and C_2F_2, Tokotgul's ability to supply water is diminished, and there is no issue, as far as the water energy nexus is concerned. The regimes of concern are C_1F_1 and C_1F_2.

High Glacial/ Snow Melt **C_1**	DRY YEAR • Demand for Irrigation high • Available supply of water in summer from Toktogul high. **C_1F_1**	WET YEAR • Demand for irrigation low • Available supply of water in summer from Toktogul high **C_1F_2**
Low Glacial/ Snow Melt **C_2**	DRY YEAR • Demand for irrigation high • Available supply of water in summer from Toktogul low **C_2F_1**	WET YEAR • Demand for irrigation low • Available supply of water in summer from Toktogul low **C_2F_2**
	Low Rainfall **F_1**	High Rainfall **F_2**

Figure 5: Different Hydrological Regimes in Naryn River

The probabilities of the occurrence of each of these regimes should be calculated but, as far as the study team was able to determine, no such estimates have been made. Thus the analysis below is based on rough estimates of the frequency of regimes C_1F_1 and C_1F_2.

- If 20 percent of years are, respectively wet or dry and 80 percent are 'normal', then the average flow will be roughly consistent with the 9 BCM per year long term sustainable flow;
- In dry years summer irrigation water released would be about 7 BCM, i.e., some 17% higher than a normal year, where as in a wet year the release would be about 4 BCM. Net associated electricity delivered in dry year would be 3,000 GWh (36% higher than in a normal year) and in wet years, the associated electricity would amount to just 1,000 GWh – some 55% lower than in a normal year.

Table 9: Impact of Extreme Hydrological Regime Under Current Agreements

	Unit	Dry	Normal	Wet
Frequency of State	%	10%	80%	10%
Water Released	BCM	7	6	4
Electricity Supplied	GWh	3000	2200	1000
Electricity Tariff*	US$/kWh	0.0217	0.0217	0.0217
Payments to the Kyrgyz Republic	US$ Million	65.1	47.74	21.7

*Weighted Average

- Under the present payment system, which is solely based on electricity tariffs at a weighted average of US$0.0217/kWh (from Table 8), net receipts to the Kyrgyz Republic will vary from as low as $22 million to as high as $65 million, resulting in large fluctuations. Moreover, in a wet year, the payment is quite low compared to the costs the Kyrgyz Republic incurs (US$48 million) in an irrigation mode.

One way in to smoothen the large fluctuations and to ensure that the Kyrgyz Republic has sufficient resources to meet its minimum winter needs is to divide the water services payment into a fixed (or capacity), charge and a variable (or flow) charge. In Tables 10 through 12 below, the impact of splitting the payment to the Kyrgyz Republic into fixed and variable portions is provided, for a normal, wet and dry year. In doing so, as per earlier recommendations, the total payments (through inflated electricity prices to Uzbekistan) are unbundled into payment for water services and for electricity. Only the payments for water services are split into fixed and variable portion, and electricity imports are shown to be paid separately and more realistic prices.

From the earlier analysis, it can be seen that of the total irrigation benefits to downstream countries (Table 5), 44% of the benefits accrue to Kazakhstan, and the remaining 56% to Uzbekistan. Also, from a comparison of the agreed payments under the 2001 IGIA (Table 8), which amount to about US$48 million to the maximum payable benefits of US$67 million, (Table 7), the downstream countries agree to pay roughly 70% of the maximum payable. These two ratios are used as guidelines to split the payment for water into a fixed and variable portion and further between Kazakhstan and Uzbekistan.

Table 10: Impact of Splitting Irrigation Water Services Payments Into Fixed and Variable Portions

In a Normal Year

	Unit	Kazakhstan	Uzbekistan	Total
Water Released	BCM	3	3	6
Payment for Water Services				
Fixed Portion	US$ Million	8.6	11.4	20
Variable Portion	US$ Million	2.9	3.1	6
Total Payment for Water Services	US$ Million	10.4	14.5	26
Electricity				
Quantity traded	Million kWh	1100	1100	2200
Price	US¢/kWh	1	1	
Electricity Payment	US$ Million	11	11	22
Total Payment	US$ Million	22.5	25.5	48

The principle used to set the fixed portion of the payment for water services is that such payment should equal the amount the Kyrgyz Republic needs to spend to buy gas for its winter needs. The Kyrgyz Republic's annual gas needs are about 500 MCM[27], and at roughly US$40/KCM, US$20 million would be needed annually to meet the gas needs. The remaining US$ 6 million (of the

[27] This amount includes gas for power generation and for industrial and household use (served by KyrgyzGas). It does not include the 14 customers who buy gas directly from UzTransGas.

payment for water services) would be the variable portion, and these funds could be used to buy coal from Kazakhstan. At a price of about US$15/ton, the Kyrgyz Republic can buy about 400,000 tons of coal, which should be sufficient, together with the gas, to meet its winter power generation needs.

In a normal year, the Kyrgyz Republic would export 2,200 million kWh of associated electricity, split equally between Kazakhstan and Uzbekistan. However, since there is no need to inflate electricity prices to include water services charges, the export price can be US¢1.0/kWh for both the importers, which is more realistic. The Kyrgyz Republic would therefore get another US$22 million from the two electricity importers. This means, for together with the payment for water services, the total payment received by the Kyrgyz Republic would be US$48 million, which equals the implicit payment commitments made by the two downstream countries to the Kyrgyz Republic in the 2001 IGIA.

The above suggested split between fixed and variable portion implies that the price of water released to be about US$0.001(one-tenth of one cent) per cubic meter (US$6 million for a flow of 6 BCM in the summer months). In addition, the net payment by Kazakhstan to the Kyrgyz Republic (after netting out the coal purchases by the Kyrgyz Republic) would be US$16.5 million; and the net payment from Uzbekistan would be US$5.5 million, after netting out the gas purchase.

Table 11: Impact of Splitting Irrigation Water Services Payments Into Fixed and Variable Portions

In a Wet Year				
	Unit	Kazakhstan	Uzbekistan	Total
Water Released	BCM	2	2	4
Payment for Water Services				
Fixed Portion	US$ Million	8.6	11.4	20
Variable Portion	US$ Million	1.8	2.2	4
Total Payment for Water Services	US$ Million	10.4	13.6	24
Electricity				
Quantity traded	Million kWh	500	500	1000
Price	US¢/kWh	1	1	
Electricity Payment	US$ Million	5	5	10
Total Payment	US$ Million	15.4	18.6	34

In a wet year, both the water releases and (generation and) exports of associated electricity will reduce, thus reducing the variable portion of the payment for water services as well as the electricity exports revenues. However, due mainly to the fixed portion of the payment for water services, the Kyrgyz Republic would have enough resources to meet its winter fuel needs. In a dry year, water releases as well as exports of associated electricity will be larger, resulting in a total payment to the Kyrgyz Republic of US$57 million.

The results in Tables 11 and 12 indicate strongly that incomes of the upstream country can be stabilized by using a fixed charge[28], and the downstream countries would be guaranteed that certain minimum flows would be maintained.

Table 12: Impact of Splitting Irrigation Water Services Payments Into Fixed and Variable Portions

In a Dry Year

	Unit	Kazakhstan	Uzbekistan	Total
Water Released	BCM	3.5	3.5	7
Payment for Water Services				
Fixed Portion	US$ Million	8.6	11.4	20
Variable Portion	US$ Million	3.1	3.9	7
Total Payment for Water Services	US$ Million	11.7	15.3	24
Electricity				
Quantity traded	Million kWh	1500	1500	3000
Price	US¢/kWh	1	1	
Electricity Payment	US$ Million	15	15	10
Total Payment	US$ Million	26.7	30.3	57

Separation of the payments to the Kyrgyz Republic into payment for water services and payment for electricity results in the establishment of unit values for irrigation water and energy as can be seen from Table 10. If these form the basis of payments from the downstream countries to the upstream country, the underlying incentives for the system to operate efficiently will be met. Second, by splitting the payment for water services into a fixed and variable payment, volatility of the payments that occurred due to variance in hydrological conditions is reduced significantly, and the Kyrgyz Republic is assured of some reasonable amount irrespective of the hydrological condition. Third, by moving the transaction to cash payment (and away from barter), the Kyrgyz Republic would have the wherewithal to buy fuel (gas, coal or fuel oil) from some other sources in case Uzbekistan in particular is unable to supply gas to the Kyrgyz Republic (which if course needs to be paid for in cash).

Lower level of sustainable water inflow. As noted earlier, the sustainable level of inflow could be, not 12 BCM, as assumed in Table 3, but perhaps only 11 BCM, or even as little as 9 BCM. Whatever level is sustainable, the model suggests that the irrigation mode is the optimal one. The key issue here is not to determine the appropriate policy *a priori* but rather to **agree on what is the correct sustainable level.** If the system is operated allowing too much to be released, there will be a secular decline in the levels and future releases will not be able to be maintained.

Changes in Electricity and Irrigation Values and Other Parameters. The above analysis has been carried out with cotton values at the lower end of the range and with energy costs as given by the detailed analysis of each of the three systems. If higher irrigation benefits are assumed, the conclusion that operating the system in irrigation mode will only be strengthened. The same will apply if some benefits are attached to the irrigation benefits from other crops.

[28] Indeed this proposal has been made by others as well. The Danish/Austrian consultants Verbundplan propose a similar two tier energy/water tariff

On the marginal energy costs, the greater are these costs in the Kyrgyz Republic relative to the downstream countries, the more likely it is that an energy mode for operations will be favored. Presently however, with the present calculations, the Kyrgyz Republic energy costs are lower than those incurred in Uzbekistan and Kazakhstan. Switching value analysis shows that an irrigation mode of operation is justified until the SRMC of generation in the Kyrgyz Republic reaches about US¢4.65/kWh. Below that value an irrigation mode is justified, above it an energy mode would be optimal (with the irrigation values taken in the above calculations).

Appendix 8: Short Run Marginal Cost of Electricity in the Three Countries

This appendix gives the details of the estimates of the short run marginal cost of electricity in the Kyrgyz Republic, Uzbekistan and Kazakhstan.[29] The calculations have been made in respect of the Bishkek CHP in the Kyrgyz Republic, Jambul Thermal Power Plant in south Kazakhstan (which at present can use only fuel oil or natural gas), and Angren and Novo Angren thermal power plants in Uzbekistan using mostly coal and a small amount of coal bed gas (with a low calorific value of 0.81 Gcal/KCM). All plants use some fuel oil for start up purposes. The calorific value and the economic prices of the relevant fuels are given in Table 1 below.

Table 1: Calorific Value and Economic Prices of Fuels

Country	Natural gas		Coal		Fuel oil	
	Price US$/KCM	Calorific value kcal/m^3	Price US$/ton	Calorific value kcal/kg	Price US$/ton	Calorific value kcal/kg
South Kazakhstan	35	8,190	-	-	54	9,450
The Kyrgyz Republic	39.6	8,190	16	3,900	54	9,940
Uzbekistan	35	8,090	24	3,350	54	9,520

Uzbekistan exports natural gas at South Kazakhstan border at $35/KCM. This border price is the economic gas price for both the countries. The Kyrgyz Republic pays an additional charge of $5/KCM for gas transmission up to the Bishkek CHP unit. Thus the economic price of gas for the Kyrgyz Republic is $40/KCM**.**

Coal from Karaganda coal field in Kazakhstan is sold at $16/ton to the Kyrgyz Republic under the IGIA. This is the economic price of coal to Bishkek CHP. The economic cost of coal produced in Angren coal fields is estimated at $24/ton, based on its current coal production technology.

The fuel oil price used in Uzbekistan – the Kyrgyz Republic IGIAs for 2000 and 2001, $54.174 / ton, is considered the economic price for all three countries, as it is also the traded price in the region.

Calorific values are the actual or average 2001 values reported.

[29] South Kazakhstan computations are based on information provided by Central Asia Country Unit and RWE Solution. The Kyrgyz Republic computations are based on information collected during mission in February and August 2002 and provided by the former JSC "KyrgyzEnergo", the JSC "Electric Power Plants", the Bishkek CHP, and the JSC "KyrgyzGas". Uzbekistan computations are based on information collected during mission in January and May 2002 and information provided by the SJSC "UzbekEnergo" through the World Bank Tashkent Resident Mission, the Central Asia Unified Dispatch Center's (CA UDC) Annual Reports, and Verbundplan-ESBI-Fichtner.

The heat rates, composition of the fuel mix, and the fuel cost per kWh of generation in the respective plants are summarized in Table 2.

Table 2: Heat Rates, Fuel Mix and Cost of Fuel/kWh										
Indicators	Year of commissioning	Fuel cost in US$/kWh				Heat Rate	Fuel Mix		
		Gas	Coal	Fuel oil	Total fuel cost	kcal/kWh net	Gas	Coal	Fuel oil
South Kazakhstan									
Jambul TPP	1967-1976	0.0004		0.0155	0.0159	2800	0.03	-	0.97
The Kyrgyz Republic									
Bishkek CHP winter - 200 MW	1961-2000	0.0055	0.0065	0.0003	0.0123	2779	0.41	0.57	0.02
Uzbekistan									
Angren TPP[1)]	1958-1964	0.0015	0.0153	0.0038	0.0207	2940	0.07	0.7	0.23
Novo-Angren TPP, Units #1-5	1981-1988	0.0007	0.0166	0.0018	0.0192	2716	0.06	0.82	0.12

Bishkek CHP has to provide heat and hot water to the district heating system and in that mode its power output is limited to 200 MW only. The heat rates are based on the current modes of operation.

In order to arrive at the short run marginal cost we have to add the variable operation and maintenance cost to the total fuel cost/kWh from Table 2 above. The SRMCs thus calculated are given below in Table 3.

Table 3: Short Run Marginal Costs of Generation (Amounts in US dollars)				
Country	Name of the Generation Plant	Fuel cost/kWh	Variable O&M cost/kWh	Total SRMC
Kazakhstan	Jambul TPP	0.0159	0.0051	0.021
The Kyrgyz Republic	Bishkek CHP	0.0123	0.0027	0.015
Uzbekistan	Angren TPP	0.0207	0.0023	0.023
Uzbekistan	Novo Angren TPP	0.0192	0.0018	0.021

The O &M costs for Bishkek are based on actuals for 2001. For the others they were estimated taking into account the high maintenance needs of these old plants.

Appendix 9: Scope for Carbon Emission Trading Revenues to Uzbekistan

When Uzbekistan imports hydroelectric power from the Kyrgyz Republic and reduces electricity generation from its own old thermal power plants with poor heat rates, it will be reducing substantially the carbon dioxide emissions. Such emission reductions could be traded internationally to generate significant revenues to Uzbekistan. Each GWh of hydroelectric power would help to reduce 535 tons of carbon dioxide from the coal fired units. In the emission trading market the reduction one tone of carbon dioxide can fetch a revenue of $3. Thus if Uzbekistan were to import 1100 GWh of hydroelectricity and reduce a corresponding amount of coal fired generation, it would receive an emission trading revenue of $1.77 million compared to the power purchase cost of $3.67 million at a price of 3.34 cents /kWh (as now) or $1.1 million at a more appropriate price of 1.0 cents/kWh (as proposed elsewhere in this Report). Projections indicate that if Uzbekistan were to continue this strategy over the next few years and reduce its entire coal fired generation, emission trading revenues could reach the level of $11 million per year by 2010 (see Table 1 below). Such carbon dioxide emission trading deals could be brokered by the Prototype Carbon Fund, presently managed by the Bank.

Table 1: GHG Emission Reduction Potential in Uzbekistan

Indicators	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Option I											
Electricity Consumption	GWh	48,421	49,051	49,680	50,309	50,939	51,568	52,198	52,827	53,457	54,086
Electricity Import	GWh			1,752	2,382	3,011	3,641	4,270	4,900	5,529	6,159
Cost of Import (Import tariff US$0.03/kWh)	Mil.US$			5.256	7.146	9.033	10.923	12.81	14.7	16.587	18.477
CO_2 emission with generation of 1 GWh	Tons/GWh			535	542	550	557	565	572	580	588
CO_2 emission reduction due to electricity import	Mil.Tons			0.937	1.292	1.656	2.03	2.412	2.805	3.207	3.618
Emission trade Revenues at $3/ton of CO_2	Mil.US$			2.811	3.876	4.967	6.089	7.237	8.415	9.62	10.855
Cost of power import minus Emission trade revenue	Mil.US$			2.445	3.27	4.066	4.834	5.573	6.285	6.967	7.622