THE DEVELOPMENT OF TAJIKISTAN'S ENERGY INDUSTRY IN CENTRAL ASIA TODAY

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ABSTRACT

All of Central Asia's river water resources are transborder and used by the upstream countries (Tajikistan and Kyrgyzstan) for generating electricity and by the downstream countries (Kazakhstan, Turkmenistan, and Uzbekistan) for irrigation. However, since the 1980s, the region has been experiencing an acute shortage of water for irrigation farming, while only 5% of the hydropower resources are being tapped.

The future of Tajikistan's economy, a country situated on the upper reaches of the rivers of the Aral Sea Basin, depends entirely on the accelerated development of the energy industry. However, Tajikistan does not have any industrial reserves of oil and gas, while its coal fields are difficult to develop since most of them are located in hard-to-access mountainous regions. This means that the only way to successfully build up Tajikistan's energy industry is to develop the country's hydro resources, of which the country has enormous reserves. Building small hydropower plants is only expedient in terms of supplying energy to small consumers in the remote mountainous regions. Completion of the Rogun Hydropower Plant on the Vakhsh River, the construction of which began in the 1970s, is the most promising hydropower project in Tajikistan today. The hydropower plant building site currently boasts a developed infrastructure. According to expert assessments, the plant is around 30-40% complete. Once in full operation, the Rogun Hydropower Plant will make it possible to double electricity generation and ensure sustainable development of the republic's economy in the near future.

However, we should keep in mind that the Vakhsh River is a transborder river; the Rogun Hydropower Plant can only function efficiently if its construction and exploitation are safe and reliable, and if the national interests of the downstream countries are taken into account. These countries must officially define their interests in the form of specific demands regarding the regulation of water runoff regimes.

KEYWORDS: ***Central Asia, Tajikistan, the hydropower industry, conflict of interests, the Rogun Hydropower Plant, security, interstate cooperation.***

Introduction

Water resources have been the font of life for the people of Central Asia from time immemorial. Water is not only used here for household and industrial needs, but largely for irrigation farming, the produce of which is meant for internal consumption and is also one of the main commodities exported by the region's countries.

In the mountainous countries of Tajikistan and Kyrgyzstan, located on the upper reaches of the rivers of the Aral Sea Basin, water is also the main source of energy. For example, more than 95% of all the electricity produced in Tajikistan is generated at hydropower plants.

All the major rivers of the region are transborder. Using their water to produce electricity (Tajikistan and Kyrgyzstan) and irrigate land (Kazakhstan, Turkmenistan, and Uzbekistan) at the same time often gives rise to a conflict of interests. This contradiction has acquired interstate importance and been steadily gaining momentum since the Soviet Union collapsed and five independent states emerged in Central Asia.[1]

National Interests of the Central Asian Countries in the Use of Water Resources

The national interests of the CA countries regarding water resource use are objective and vitally important for all of them.

Table 1

Tajikistan's Resources of Renewable Sources of Energy, *million toe/year*

Resources	Gross Potential	Technical Potential	Economic Potential
Hydropower, total	**179.2**	**107.4**	**107.4**
including small	**62.7**	**20.3**	**20.3**
Solar energy	**4,790.6**	**3.92**	**1.43**
Biomass energy	**4.25**	**4.25**	**1.12**
Wind energy	**163**	**10.12**	**5.06**
Geothermal energy	**0.045**	**0.045**	**0.045**
Total (without large hydropower plants)	**5,020.595**	**38.635**	**27.955**

Source: G.N. Petrov, Kh.M. Akhmedov, K. Kabutov, Kh.S. Karimov, "General Assessment of Energy in the World and Tajikistan," *Bulletin of the Tajikistan Academy of Sciences*, Dept. of Physical, Mathematical, Chemical, Geological and Technical Sciences, No. 2 (135), 2009.

[1] See: G. Petrov, "Conflict of Interests between Hydropower Engineering and Irrigation in Central Asia: Causes and Solutions," *Central Asia and the Caucasus*, Vol. 11, Issue 3, 2010.

The weak economies of Tajikistan and Kyrgyzstan can only expect to develop in the near future if the energy industry undergoes a twofold increase[2]; and this can only be achieved by building large hydropower plants. In light of the global warming trend, it is often said today that it would be more expedient to use renewable sources of energy; however, this proposal is not sufficiently substantiated.

The industrial potential of the CA countries is indeed quite low. For example, in Tajikistan it is equal to only 27.955 million toe/year, of which small hydropower plants account for 75% (see Table 1).

In recent years, the small hydropower industry has been developing quite successfully in Tajikistan. Today, 181 small hydropower plants have been built in the republic with a total electricity generation volume of 21.1 million kWh per year (see Table 2). If this figure is compared with the total amount of electricity generated in the country of 16,000 million kWh per year, we can see that 98% of this amount is produced at large hydropower plants.

Table 2

Tajikistan's Small Hydropower Plants as of 1 January, 2013

Total	Operating		Non-Operating
Amount/ Capacity, *kW*	Amount/ Capacity, *kW*	Electricity Generation, *kWh*	Amount/ Capacity, *kW*
181 (15,179.5)	118 (10,691.0)	21,124,303	63 (4,488.5)

Source: Data of the Industrial Energy Ministry of the Republic of Tajikistan.

In order to solve the country's vital task of doubling current electricity generation with such small hydropower parameters, around 140,000 small hydropower plants would have to be built, which means one plant for every 50 residents of Tajikistan. It does not take much imagination to see the technical problems and environmental consequences this could lead to, not to mention the approximately 700,000 workers needed to service them (even with a minimum staff of five people per plant), not including technical personnel for the power transmission lines. By way of comparison, we will note that today, there are only 10,000 people working at all levels of Tajikistan's energy system.

What is more, small hydropower plants do not have reservoirs, cannot regulate river runoff, and operate in a regime that depends on water influx. Since in winter the rivers in Tajikistan are covered with ice, the river stage abruptly drops. This gives rise to a paradoxical situation: in winter, when the demand for electricity in the country reaches its peak, small hydropower plants generate a minimum amount of electricity.

Since Tajikistan essentially has no industrial reserves of oil and gas, the only alternative resource is coal, of which the country has ample supplies. However, the problem is that almost all of the coal reserves are found in a multitude of small fields concentrated in hard-to-access mountainous regions.

Moreover, the coal-fired power industry lags far behind the hydropower industry in terms of economic efficiency. This can be confirmed by a comparative analysis of the net cost of electricity

[2] See: G. Petrov, *Report Review of the Current Status and Prospects of Improving Economic Instruments for Pricing of Fuel and Energy Resources in the Context of Sustainable Development in North and Central Asia*, United Nations, Economic and Social Commission for Asia and the Pacific, 2013.

generated by hydropower plants and thermal power plants in Tajikistan carried out using 1980s data. This timeframe has not been chosen by accident; the thing is that a current financial and economic analysis of Tajikistan's energy company is not suitable for defining the net cost of electricity generation.

The high level of accounts receivable and payable, the lack of expenditure regulation, and financial planning mean that the energy system is currently operating in a survival mode (that is, the net cost is always equal to the actual expenditures). This means that the only reliable way to assess the net cost is to analyze the results produced when the energy system is functioning in a smooth operation mode. The period between 1985 and 1990 proves to be the most suitable timeframe for this (at that time, the energy system's capacity had reached its current level, and the financial system was stable).

The results of the financial and economic activity of the Tajik energy system between 1985 and 1990 are presented in Table 3.

Table 3

Net Cost of Electricity of Tajikistan's Energy Company between 1985 and 1990

Year	Net Cost, *$m*					Takings, *$m*	Profit, *$m*	Generation, *GWh*	Net Cost, *cent/kWh*		
	Total	Including:							Actual	Without Columns 5 and 6	Without Columns 4, 5 and 6
		Salaries	Depreciation	Fuel Purchase	Electricity Purchase						
1	2	3	4	5	6	7	8	9	10	11	12
1985	109.5	5.53	35.4	19.9	32.7	212.1	102.6	15.65	0.70	0.36	0.14
1986	154.3	12.2	37.2	22.2	71.8	220.5	67.86	13.52	1.14	0.45	0.17
1987	129.2	12.9	39.8	20.0	43.4	225.1	95.85	15.81	0.82	0.42	0.16
1988	131.0	13.0	40.5	19.4	43.4	253.9	126.4	18.79	0.70	0.36	0.15
1989	143.4	17.7	42.5	22.9	47.4	227.0	88.06	15.25	0.94	0.48	0.20
1990	137.4	22.2	46.7	21.2	29.2	224.1	94.52	18.09	0.76	0.48	0.22
Av.	134.1	13.9	40.36	20.93	44.65	227.1	95.88	16.19	0.84	0.42	0.17

Source: Annual reports of Tajikistan's National Energy Company "Barki Tojik."

According to the data in Table 3, the total net cost of electricity in the indicated period was officially equal to 0.84 cents/kWh. However, it should be kept in mind that this included expenditures on fuel for central heating and power plants that have nothing to do with the hydropower industry. Nor can funds spent on the purchase of electricity be included in the net cost of hydropower. As a result, after excluding several items of expenditure (columns 5 and 6), the net cost of electricity is equal to 0.42 cents/kWh (column 11).

In actual fact, the net cost of electricity is even lower, since between 1985 and 1990, most expenditures were charged to depreciation (30% for the total net cost and 59% not counting the fuel purchased for thermal power plants or the electricity purchased). At that time, the energy system accrued these centrally planned depreciation expenses and used them for economic development, including enhancement of the hydropower industry. In other words, they acted as revenue that leveled out the cost of the electricity generated at hydropower plants and thermal power plants.

Today, the share of these renovation depreciation charges in the structure of production net cost in Tajikistan is much lower—5-6.5% (see Table 4).

Table 4

Net Cost of Electricity of Tajikistan's Energy Company in 2007-2009, *$m*

Expenditures	2007	2008	2009
Production services	0.17	0.13	0.13
Auxiliary materials	15.08	14.59	14.59
Fuel for technological purposes	31.46	34.70	21.01
Electricity for economic needs	0.61	0.93	1.02
Salaries	15.85	19.02	23.65
Social security assignations	4.04	4.73	5.92
Depreciation	6.69	7.80	7.37
Repair fund	1.94	2.24	2.01
Other expenditures	15.44	16.64	27.94
Innovation fund	11.39	12.20	11.89
TOTAL expenditures	102.67	112.98	115.53
Electricity purchased	0.00	19.63	27.75
TOTAL expenditures	102.67	132.61	143.28

Source: Annual reports of Tajikistan's National Energy Company "Barki Tojik."

At the current level of depreciation, the net cost of electricity generated in the hydropower system in the 1980s might reach only 0.21 cents/kWh.

The feasibility study of the Fan-Yagnob State District Power Plant in the Sogd Region of Tajikistan carried out during the above-mentioned period (the 1980s) by the Atomteploenergoproekt Institute of the U.S.S.R. Energy Ministry (Moscow) can be used to determine the net cost of the electricity generated at thermal power plants.

The power plant was designed to use the resources of the Fan-Yagnob coal field that had already been well studied and successfully developed by that time; it was to be built using state budget funds.

It had the following parameters:

- Established capacity—2,000 MW
- Annual electricity generation—9.185 TWh
- Annual coal expenditure—4.2 million tonnes

The total cost of the project included:

- Capital investments in the state district power plant—$668.1 million
- Capital investments in the development of the coal field—$367.2 million
- Capital investments in power transmission lines—$59 million
- TOTAL—$1,165.64 million

In so doing, the expenditures on operation and maintenance amounted to:

- State district power plant—$266.96 million
- Coal field—$112.0 million
- Power transmission lines—$3.7 million
- Fuel transportation—$23.11 million
- TOTAL—$410.8 million

The total unit cost of the project amounted to 4.94 cents/kWh at a net cost of electricity generation by the state district power plant equal to 2.03 cents/kWh.

We should not forget that all the estimates of the net cost of electricity presented relate to the end of the 20th century; today, of course, it is higher. However, we are confident in saying that even if a well-surveyed and already developed (which excludes the need for expenditures on social development) field is used to generate electricity, the net cost of electricity generated from coal will be at least tenfold higher than that of electricity produced by a hydropower plant.

So it stands to reason that Tajikistan's energy industry is based on hydropower generated by large hydropower plants, while coal and renewable energy sources (including small hydropower plants) can only serve as additional resources.

Today, the Rogun Hydropower Plant on the Vakhsh River with a capacity of 3,600 MW is recognized by the state as the main energy project determining Tajikistan's development in the near future. Construction of the Rogun Hydropower Plant began in 1972, and as of today, approximately 30-40% of all the work has been completed. When it is put into full operation, the volume of electricity generation will be almost doubled (within the framework of the current energy system).

However, the countries on the lower reaches of the rivers of the Aral Sea Basin are adamantly against completion of the Rogun Hydropower Plant. Uzbekistan is demonstrating the greatest opposition, the irrigation farming of which requires the largest amount of all the region's water resources (60%) formed in the upstream countries (51.5% in Tajikistan and 25.5% in Kyrgyzstan).

The striving of Uzbekistan and the other downstream countries to at least preserve the water use system that has developed in the region (primarily water limits allotted to countries for irrigation farming) is very justified and fully meets their national interests. The increase in population, 70% of which is engaged in farming, makes this issue very urgent.

In the 1980s, all the downstream countries (Kazakhstan, Turkmenistan, and Uzbekistan) began suffering from a chronic shortage of water for irrigation. In Soviet times, a project was even conceived to redirect some of the runoff of Siberian rivers to Central Asia. Later it was recognized as environmentally detrimental, and when the Soviet Union collapsed, this idea was put to bed for good.

Tajikistan and Kyrgyzstan (upstream countries) suggest solving the downstream countries' shortage of irrigation water by modernizing the existing irrigation systems. However, implementing advanced irrigation technology is an internal problem and has nothing to do with building the Rogun hydropower plant and other similar plants. We will also note that today the irrigation systems in the upstream and downstream countries are essentially identical (it can even be said that they are a little worse in the upstream countries).

The Rogun Hydropower Plant: Construction Problems and Possible Solution to the Conflict of Interests with Downstream Countries

Although the concerns of Uzbekistan and other downstream countries about the possible negative influence of the Rogun Hydropower Plant on the water runoff regime may be justified to some extent, there is no real threat.

Indeed, the regulated capacity of the Rogun reservoir, which is equal to almost half of the average annual water runoff of the Vakhsh River (and forms 75% of the runoff together with the existing Nurek reservoir), makes it possible to almost completely cease supplying water to the downstream countries during the vegetation period.

On the other hand, joint regulation of the runoff of the Rogun and Nurek, located further downstream, hydropower plants will make it possible not only to retain the existing system of downstream water release, but also significantly improve it.

The estimates made using optimal mathematical models (see Table 5) show that at any dryness of the year (even minimum), joint runoff regulation by the indicated reservoirs would not only meet Tajikistan's interests, which include leveling out electricity generation (that is, water discharge via the hydropower plants throughout the entire year), but also those of the countries further down stream in need of stable supplies of water during the vegetation period (regardless of the dryness of the year).

Cascade regulation of runoff will make it possible to successfully resolve the designated tasks, although in so doing electricity generation itself does not level out over many years since the reservoir live capacities are insufficient. For both hydropower plants (Rogun and Nurek), they amount to a total of 13.8 cubic km, that is, a total of 67% of the average long-term runoff of the Vakhsh River.

In so doing, launching the Rogun Hydropower Plant will technically make it possible both to significantly improve and significantly worsen the runoff regulation system that has developed today in the Amu Darya basin, particularly with respect to meeting the demand of the downstream countries for irrigation water.

Today, both the Tajik government and president are declaring that the interests of all the basin's countries will be kept in mind when building the Rogun Hydropower Plant. Operation of the Nurek Hydropower Plant confirms the truth of these intentions to some extent, which has so far been operating during the vegetation period in the interests of irrigation of the downstream countries. However, unfortunately, neither the statements by the republic's leaders, nor the past experience of Nurek can give any guarantees for the future.

Table 5

Comprehensive Irrigation-Energy Runoff Regulation for the Rogun and Nurek Hydropower Plants

	Regime	May	June	July	August	September	October	November	December	January	February	March	April
Regime of irrigation runoff regulation of the Nurek Hydropower Plant	Existing	842.0	849.5	849.5	849.5	849.5	502.6	502.6	502.6	502.6	502.6	502.6	502.6
	For a maximum year	843.79	818.40	818.40	818.40	818.40	818.40	818.40	818.40	818.40	818.40	818.40	818.40
	For a mean year	842.1	863.7	863.7	863.7	863.7	507.4	507.4	507.4	507.4	507.4	507.4	507.4
	For a minimum year	845.41	863.23	863.23	863.23	863.23	511.46	511.46	511.46	511.46	511.46	511.46	511.46
Average expenditures for the cascade of two hydropower plants	For a maximum year	818.40	794.51	794.51	794.51	794.51	793.06	793.06	793.06	793.06	793.06	793.06	793.06
	For a mean year	643.9	651.0	651.0	651.0	651.0	646.3	646.3	646.3	646.3	646.3	646.3	646.3
	For a minimum year	459.96	465.11	465.11	465.11	465.11	462.69	462.69	462.69	462.69	462.69	462.69	462.69

Source: The author's own estimates.

It stands to reason that the situation could be improved by signing bilateral or regional interstate agreements between Tajikistan and Uzbekistan. However, keeping in mind the low level of trust among the region's countries, such agreements can only be reliably executed with the guarantees of international financial structures or large countries that have corresponding levers of influence in Central Asia.

Such interstate agreements should set forth not simply intentions, but ways to achieve Uzbekistan's specific interests in water supply rates and runoff regulation regimes, as well as corresponding algorithms for Tajikistan to carry them out.

Another very important focus of Uzbekistan's attention is safety of the facilities at the Rogun Hydropower Plant and, primarily, of its embankment dam. Critics have pointed out that if the dam breaks (its full projected height is equal to 335 m), a surge of water 300 m high will initially form that will spread throughout the territory of Tajikistan and Uzbekistan, leaving disaster in its wake.

Such a probability theoretically exists. On the other hand, no engineering facility can guarantee a level of safety that totally excludes destructive accidents. However, the probability of an engineering facility being destroyed should be no higher than the permissible limits accepted in world practice.

In particular, according to the construction standards and regulations adopted in the Soviet Union, water discharge in a river that occurs once in 10,000 years is taken as the norm; it is also one of the main reasons for possible dam destruction. A similar probability coefficient is also taken for seismic estimates. International practice adopts tighter demands, where the probability of exceeding the estimates of the most hazardous exposure is evaluated at once in every 100,000 years.

The level of reliability accepted for high dams can well be compared with the probability of car accidents (see Table 6). According to the data presented in the table, the probability of a person in Russia dying in a car accident is once every 4,960 years, while the probability of sustaining injuries in a car accident is once every 820 years. The overall probability of having a car accident is once every 700 years.

Table 6

Main Accident Indices in the Russian Federation for 1996-2000

Years	Road Accidents		Killed		Injured	
	Number	± % of the Corresponding Period Last Year	Number of People	± % of the Corresponding Period Last Year	Number of People	± % of the Corresponding Period Last Year
1996	160,523	–4	29,468	–10,1	178,378	–3
1997	156,515	–2,5	27,665	–6,1	177,924	–0,3
1998	160,300	+2,4	29,021	+4,9	183,846	+3,3
1999	159,823	–0,3	29,718	+2,4	182,123	–0,9
2000	157,596	–1,4	29,594	–0,4	179,401	–1,5

Source: Data from the State Report on Road Safety, website of the State Road Traffic Safety Inspectorate, Public Safety Service, Russian Ministry of Internal Affairs, available at [http://www.gibdd.ru/index2.php?id=178].

From this it follows that the probability of a car accident is at least an order higher than a dam-related accident. Nor should we forget that when talking about road accidents, we mean those that have actually happened; as for dams, we are only talking about the probability. Nevertheless, Russia not only has no intention of cutting back the country's vehicle-to-population ratio, but, on the con-

trary, intends to raise its current level (129 cars per 1,000 people) to the world level (400-500 cars per 1,000 people) in the near future.

Russia was not chosen as an example by accident. This is because there is no free access to road accident data in Tajikistan and Uzbekistan; however, keeping in mind the recent common history of these three countries, it can be confidently presumed that the situation in them is the similar.

So the current urgency regarding safety of the Rogun Hydropower Plant is related only to the guarantee of ensuring the normative probability of accidents for all facilities of the hydropower plant and, primarily, its dam (during planning, construction, and operation). In so doing, it should be noted that safety of the Rogun Hydropower Plant's facilities is not only important for the downstream countries; it is just as, if not more, important for Tajikistan itself.

The main decisions ensuring the safety of all the hydropower plant's facilities must first be reflected in the Rogun Hydropower Plant project. In this respect, Uzbekistan's concern is understandable. The thing is that Tajikistan does not currently have a Rogun Hydropower Plant project that meets the current demands, while some of the engineering solutions executed in 1978 (that is, 35 years ago) have already become outdated.

An attempt was made in 1993 to correct the situation; at that time, the country's general contracting company, Tashgidroproekt, issued a report titled "The Rogun Hydropower Plant on the Vakhsh River. Additional Elaborations Clarifying the Feasibility Study of the Plant with a Smaller Reservoir Capacity." It noted the numerous points that required changing, not one of which has so far been implemented.

Follow-up revisions of the Rogun Hydropower Plant project were also carried out in 2000, 2005, and 2010, but they bypassed the attention of the Tajikistan government and departments in charge of the energy industry.

In order for Tajikistan to be certain of the safety and reliability of the Rogun Hydropower Plant, as well as to pacify Uzbekistan and other countries of the region, a project that meets the current demands for hydraulic safety must be drawn up, examined by experts, and approved. Its main parameters—installed capacity, dam height, and reservoir capacity—might also be clarified in the process.

An important section of this project should be its financial part, including estimates of the total cost of the power plant, of all of its facilities, and of the different types of work. The fact that these estimates are not available is already having a negative effect. Although Tajikistan has only been carrying out repair work at the Rogun Hydropower Plant in recent years, $950 million in budget funds and $100 million from selling shares have been spent on it between 2007 and 2013. However, the plant is no nearer to its completion than it was in 1992, while its construction expenditures amount to a total of $804 million ($200 million of which were spent on building a town to accommodate the Rogun construction workers).

The magnitude of the funds spent in 2007-2013 is explained by the fact that the general construction company, RogunGESstroi, and Orienbank, which is financing the work, currently belong to the same owners. But the main reason such large sums were "consumed" is the lack of control over the estimate limits, which cannot be determined without an approved project.

Unfortunately, instead of drawing up the above-mentioned project with the help of international organizations, Tajikistan asked the World Bank to carry out a feasibility and environmental study of Rogun Hydropower Plant in 2010. In 2011-2013, the World Bank invited world-level specialists to carry out this study of the power plant's facilities and design documents. Their immense efforts produced an entirely reasonable conclusion that took no one by surprise: the Rogun project could be implemented after carrying out the necessary follow-up revisions, including of the main parameters of the dam and hydropower plant. Essentially, the World Bank was recommending drawing up a new project and continuing construction only after this had been done.

Thus, inviting the World Bank to carry out the feasibility study of Rogun Hydropower Plant delayed its construction for another three years, since the recommended project would have to pass another international expert's examination.

Precise implementation of the project demands was to guarantee the safety of the Rogun Power Plant's facilities, but Tajikistan has neither the corresponding construction structures nor the qualified personnel to ensure this. This requires inviting international construction companies that have the necessary experience and work on a contractual basis. One of the contract provisions could be establishing quotas on recruiting local workers (which to a certain extent will be advantageous to the contract companies themselves). This is because Tajikistan has a high unemployment level so labor is cheap.

Apart from technical issues relating to the safety and reliability of the facilities, the project's critics are also concerned about how filling the reservoir will affect the runoff. This is the main argument being put forward today by the downstream countries opposed to building the Rogun Hydropower Plant.

At first glance, filling the Rogun reservoir to its full capacity of 13 cubic km (which is 65% of the average annual runoff of the Vakhsh River) could indeed create serious water supply problems for the downstream countries. However, this "anti-regulation" can only come about if an open conflict arises among the region's countries. As noted above, in order to establish joint efficient use of water resources, corresponding agreements must be drawn up and signed. It should be noted that this cooperation would be mutually advantageous for all the participating countries.

Although Uzbekistan, which is the main consumer of irrigation water, is not showing any initiative today, but categorically denying the very possibility of building the Rogun Hydropower Plant, Tajikistan could make a conceding gesture by asking it and the other downstream countries to determine their interests in regulating the runoff of the Vakhsh River after the Rogun Hydropower Plant has been built in order to take them into account during construction and operation of the hydropower plant.

In that case, use of the Rogun reservoir might even improve the water situation in the basin during its construction, if merely from the viewpoint that the reservoir will be filled over the relatively long time needed for building the hydropower plant.

Moreover, any reservoir regulating river runoff (including the Rogun) has two functions relating to its live and dead storage capacity. Dead storage takes the river runoff irrevocably, while live storage, as the same suggests, serves to regulate runoff, that is, ensures the reservoir's periodical filling (during water surplus) and, when necessary, use of this water. In the Rogun reservoir, the dead storage is very small—only 3 cubic km of the total 13 cubic km. The rest, which is equal to 10 cubic km, is live storage.

So throughout the entire construction period only 3 cubic km of water will be removed from water circulation. And since this period will last for around 5 years (based on the capacity of the hydropower plant), it stands to reason that removing 3 cubic km of water will not have any significant effect on the runoff of the Vakhsh River. The reservoir's live storage, on the other hand, both during operation and construction of the plant will perform the function of alleviating the natural fluctuations in river runoff.

The Toktogul Hydropower Plant on the Naryn River in Kyrgyzstan can be used as live proof to confirm how unjustified the fears are about the negative influence of filling the reservoir of the Rogun Hydropower Plant. The average water runoff of the Naryn River amounts to 11 cubic km, while that of the Vakhsh River is 20 cubic km. The contribution of the latter to the total runoff of the Amu Darya is equal to 40%; the rest is provided by the Panj River.

So the influence of the Toktogul reservoir on the water situation in its basin is at least fourfold greater than the Rogun. However, the Toktogul reservoir is always efficiently used up and refilled. For example, in April 2009, its full capacity, equal to 19.5 cubic km, decreased to 6.3 cubic km. At that time a situation similar to Rogun developed in the basin of the Naryn River that required filling a res-

ervoir of 13 cubic km. And we are talking here about a river basin with a lower water supply that is more intensely used, and a reservoir that is not under construction but fully complete.

However, not one of the downstream countries is even paying attention to the operation of the Toktogul Hydropower Plant, never mind complaining about it, while they continue to make a fuss about the Rogun Hydropower Plant.

And another thing. The net cost of electricity of the Rogun Hydropower Plant will be much lower (after return of the investment component of the project) than that generated by thermal plants, on which the energy systems of Uzbekistan and the other downstream countries are based. This could make the Rogun Hydropower Plant a serious rival in the regional electricity market, although no worries about this are being openly expressed.

Today Uzbekistan is actively exporting its electricity to Afghanistan. There are also prospects for delivering it to Pakistan and other Asian countries. After the Rogun Hydropower Plant has been put into operation, Tajikistan could become a serious rival for Uzbekistan in these markets too.

This problem can be resolved by entering corresponding agreements regulating the common electricity market (like the common water market). Such agreements will set the same regional prices for electricity which, in addition to everything else, will only raise the profitability of Tajik export.

Moreover, the worries that Tajikistan could become a regional competitor in the electricity market after construction of the Rogun Hydropower Plant are groundless, since they do not take into account the current economic situation in this republic. Today more than one million of Tajikistan's more than 7.5 million population work abroad. So Tajikistan is faced primarily with developing its own economy and creating jobs for the local population. And using its own electricity in the economy is almost tenfold more advantageous than selling it to other countries.

Conclusion

Today, the use of hydropower plants is essentially the only realistically possible way to develop Tajikistan's energy industry and one of the priority projects in this sphere is to finish building the Rogun Hydropower Plant on the Vakhsh River.

The feasibility study carried out by the World Bank in 2011-2013 of the facilities of the hydropower plant built so far showed that the Rogun Hydropower Plant will only be sufficiently safe and reliable after its main parameters have been clarified and the corresponding design-planning and technological decisions made. This primarily requires doing some follow-up revision on the project of the Rogun Hydropower Plant, which has not been renovated since 1978.

On the one hand, the Rogun Hydropower Plant project should reflect its construction process and set forth operating procedures (regulation of water runoff), while on the other, it should also take into account the interests of the downstream countries (Turkmenistan and Uzbekistan) that need the water runoff for irrigation farming. Joint efficient use of water resources (for Tajikistan's energy needs and for irrigation of the downstream countries) can be achieved with the joint energy system that already exists in Central Asia by means of simple seasonal cross-flows (exchanges) of electric energy without any concessions and losses for the participating countries.

For such relations to be successful, they should be enforced in corresponding agreements among the participating countries. Their guarantors could be international financial institutions or large developed countries with the necessary levers of influence on the CA states.