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Rogun Hydropower Plant Project of Tajikistan: Expected Benefits for Neighboring Countries

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Abstract: In this work, data about the hydropower resources of Tajikistan and Rogun Hydropower Plant project (RHPP) is presented. At present, Rogun Dam is under construction on the Vakhsh River in the southern Tajikistan. It would be the world's tallest dam with a height of 335 metres (1,099 ft). The water reservoir's volume is estimated as 13.5 km^3 and the estimated power of the hydropower plant is 3600 MW. Average estimated electric energy that will be generated annually is equal to 13.1 billion kWH. The plant will have six generators of power of 600 MW each. Estimated total cost of the plant is equal to USD 2.2 billions. This project can result the proper management of water resources of the river Vakhsh for irrigation and generation of electric power. The realization of the project will allow the Tajikistan to produce sufficient electric power for own needs and export electricity to neighboring countries as Afghanistan, Pakistan and China. The RHPP will definitely allow the realization of CASA-1000 project that aims at providing electric power for export from Tajikistan and Kyrgyzstan to Pakistan and Afghanistan. Completion of the RHPP project will bring guaranteed water for irrigation to Uzbekistan.

Key words: Rogun · Water resources · Irrigation · Hydro Power Plant · Electricity

INTRODUCTION

In Central Asia, the most important problems of present days are those related to electric power and water. The shortages of electricity and/or water, depending on the season, are very common at present. Tajikistan and Kyrgyzstan, as upstream countries, are situated in the flow forming zone of rivers Amu-Darya and Sir-Darya; and Uzbekistan, Turkmenistan and Kazakhstan, as downstream countries, are in the zone of utilization of water resources [1-9]. In these countries, water is needed mostly in summer time for irrigation and in winter time for generation of electric power. It can bring conflicts between countries that utilize the water mostly for irrigation and those that use water for generation of electric power.

Concerning non-renewable energy resources (NRER) and renewable energy resources (RER) the situation in Central Asian Republics is very different. Table 1 shows the resources of NRER of Central Asian Republic and shows as an example that Tajikistan has very few gas and oil resources [6, 8, 9]. There are relatively rich reserves of the coal, but is less utilized because of lack of good roads in the mountains and/or modem equipment for production. Table 2 shows hydro power resources of Central Asian countries [8, 9]. From the point of RER, in particular, hydropower resources, Tajikistan is rich as compared to NRER situation (Table 1). Concerning hydropower, Tajikistan occupies the first position in Central Asia, the second in former Soviet Union and the eighth position in the world. The total power of electric stations is almost 4420MW, including 378MW of thermal electric stations

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Table 1: Non-renewable energy resources (NREP) of the Central Asian Republics

		Total	Gas	Petroleum	
Sr #	Republic	Million Tons of equivalent fuel			Coal
1	Uzbekistan	3554.2	1425.4	190.5	1938.3
2	Kyrgyzstan	1359.9	7.7	87.4	1264.8
3	Tajikistan	719.3	15.0	37.0	667.3
4	Turkmenistan	2815.3	1971.4	840.9	3.0

Table 2: Hydro Power Resources of Central Asian countries

		Hydro Power Resources (TWh)			
Sr #	Country	Potential	Technical	Economical	Utilized
1	Uzbekistan	88	27.4	15	6.8
2	Kyrgyzstan	143	73	32	9.5
3	Tajikistan	300	144	88	15.8
4	Turkmenistan	24	5.8	5.8	--
5	Kazakhstan (south)	20	20	10	1.7
6	Afghanistan	10	10	6	0.6
	Total	585	280.2	156.8	34.4

Table 3: Main hydropower plants of Tajikistan

Sr. #	Details
1	Norak (3000 MW, height of dam is 300 m, constructed in 1960-1980)
2	Baipaza (600 MW)
3	Golovnaya (240 MW)
4	Kayarkkum (126 MW)
5	Sangtuda-1 (670 MW, constructed in 2009)
6	Total power at present: 4636 MW
7	Sangtuda-2 (220 MW, constructing)
8	Rogun (3600 MW, height of dam is 355 m, constructing)
9	Total power after construction of Sangtuda-2 and Rogun: 8256 MW

(which is only 10 % of hydro power). Hence, it is obvious that hydro power plays a dominant role in Tajikistan. At the time of Soviet Union, a number of hydropower plants were constructed [8] (Table 3). At present, the Republic continues construction of hydroelectric power stations of 3600MW in Rogun and 220MW in Sangtuda-2. Experts have estimated that Tajikistan can fulfils country's needs from electric energy and can even export part of it to Iran, Afghanistan and Pakistan, by the utilization of its hydraulic power resources only [8, 9].

The average cost of the hydropower is about of 2000 US$/kW. Tariffs for large and small hydropower plants at present are almost 10 cent and 4 cent for 1 kWh respectively. Small hydropower plants have advantages due to the short terms of construction and, sometimes, low cost of electric energy, but it depends on number of factors. At the same time, the large water reservoirs of the large hydropower plants can accumulate sufficiently large volume of water that is important for the irrigation and electricity generation during long time. In this paper, we will present data about Rogun hydropower project of Tajikistan and its expected benefits for neighboring countries.

Rogun Hydropower Plant Project: In 1974, the technical project of Rogun Hydropower Plant (RHPP) on the Vakhsh River in the southern Tajikistan was approved. Preparatory work at RHPP was started in 1976 and construction of dam accordingly in 1987. But in 1991, due to the collapse of the Soviet Union, the construction was stopped. In 2008, Tajikistan started to continue the construction of the plant. At present, Rogun Dam is under construction. It will be the world's tallest dam with a height of 335 meters (1,099 ft). The water reservoir's volume is estimated as 13.5 km3 and power of the hydropower plant is 3600 MW. Average estimated electric energy that will be generated annually is equal to 13.1 billion kWH. The plant will have six generators of 600 MW power each.

Estimated total cost of the RHHP is equal to USD 2.2 billions. The cost of the first stage of the plant with two generators is USD 590 millions. At present, one of the largest hydropower plant in Tajikistan, Nurek hydropower plant (NHPP) has dam at 300 metres (980 ft), power of 3000 MW, it was constructed in the Soviet times (1960-1980) and shows stable performance though Tajikistan is considered as a seismic active zone. Having the volume of the water reservoir of 10.5 km^3, NHPP cannot control properly the use of the water for electric generation and irrigation as well. As is observed, electric power shortage is mostly in winter time, but the water for irrigation is needed much in summer time.

In the construction of hydropower plants, especially in a seismic active zone, the most important point is the composition and structure of the dam. In RHPP, a composite-type rock-filled dam with loamy-crushed-stone nucleus was designed. This kind of dam was exactly realized in the case of NHPP before.

At present, the two assessment studies, the Techno-Economic Assessment Study (TEAS) and the Environmental and the Social Impact Assessment (SEIA), are being conducted by two independent firms, Coyne & Bellier of France and Poyry of Switzerland, respectively. Upon the completion of the studies, two independent panels of experts will review them: the Engineering and Dam Safety Panel and the Environmental and Social Panel. These panels will be funded by the World Bank or World Bank-managed Trust Funds. Their role is to "ensure that international standards of design, risk evaluation and impact assessment are met". Thus far, Coyne & Bellier and Poyry have presented initial reports that outline the work programs and study approaches for the assessment studies. It should take the firms about 18 months to complete these reviews.

The construction of RHPP is going on but it is also facing a number of problems. First problem is political issues between Tajikistan and Uzbekistan and second problem is economical issues (shortage in funds for construction). On the other hand, this project is strongly supported by majority of population of Tajikistan because the country will become "rich" by electric power on summer and also on winter faces shortage of electricity in most part of country usually except of capital city Dushanbe. Installation of two generators of the RHPP approximately is expected at the end of 2012 or later.

Supporters and opponents of the Rogun project have a number of arguments to convince international community to their rightness [9]. The main argument of supporters in the support of dam is that the Rogun hydropower plant was designed by taking into consideration all requirements to these kinds of projects, i.e. first of all safety. Best example for RHHP project is the NHPP; Norak hydropower plant which is working successfully from last 30 years. Another example of very large hydropower plant is the largest Chinese three Gorges Dam across the Yangtze River with a total generating capacity of 18,200 MW. In the earthquakes in Japan during March-April, 2011 no hydropower plants were destroyed. All these facts are very supporting points for the construction of the Rogun hydropower plant. Realization of the project will allow Tajikistan to control water flow of Amu-Darya. Position of Uzbekistan: the country will not get sufficient water for irrigation. This is why Uzbekistan is the biggest and well known opponent of this dam. At the same time, Uzbekistan is trying to avoid discussions concerned improvement of irrigation system in this country which as hardly be considered as efficient and water saving. It is expected that under international intermediary effective management of water resources i.e. proper utilization for irrigation and generation of electric power, this problem will be solved. One of the best example is Indus Water Treaty (IWT) signed between India and Pakistan in 1960 [10, 11]. It is considered as successful water treaty in the world.

Expected Benefits for Neighboring Countries: Table 4 shows the data about the generation of electric power in Tajikistan in 2010 year. In the period from May to August 2010, the monthly generated electric power was approximately in the same level while unused hydropower (or power that could be used for generation of electricity) increased from 6 times May to August and finally exceed even the power of electricity 1.6 times. It means at present only present hydropower plants, including Nurek hydropower plant, cannot provide proper management of water for generation of electric power and irrigation, i.e. impossible to avoid losses of hydropower that could be used for generation of electricity. Therefore, there is need to construct Rogun hydropower plant.

At present, generated electric power during summer time fully cover all requirements of the country in electricity and partly exported to Afghanistan. Absence of the power transmitting lines from Tajikistan to Pakistan doesn't allow exporting electric power on summer period. When construction of Rogun and Sangtuda-2 hydropower plants will be completed, the total power will be equal to 8256 MW (Table 3) that is more than installed hydropower stations capacity of Pakistan at present (6464 MWs [12-14]). Having population almost in 20 times

Table 4: Generation of electric power in Tajikistan in 2010 year

Month	Generated electric power, GWH	Unused hydropower, GWH
May	1348	372
June	1331	954
July	1412	1827
August	1388	2292

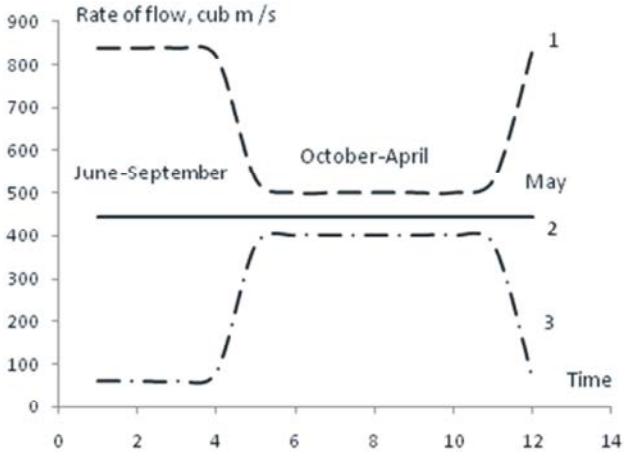

Fig. 1: The rate of water flow during of year (from June to May) from reservoirs of NHPP (1), RHPP (3) and average at cascade of the plants (2)

less than Pakistan, Tajikistan will be able to export sufficiently much electric power to Afghanistan and Pakistan. In this way, realization of the CASA-1000 is very important. The CASA-1000 aim is to provide electric power for export from Tajikistan and Kyrgyzstan to Pakistan and Afghanistan, mainly during the summer periods. According to the initial agreements, Tajikistan and Kyrgyzstan will equally supply electricity to Pakistan and Afghanistan which will receive 70-75 percent and 20-25 percent respectively.

Within the framework of CASA-1000, the construction of several new power transmission stations is planned: Datka-Khujand, which will connect the power energy supply systems of Kyrgyzstan and Northern Tajikistan; Khujand-Rogun-Sangtuda, which will connect Kyrgyzstan and Northern Tajikistan with the South of Tajikistan; and Sangtuda-Kunduz-Pol-e-Khumri-Kabul-Peshawar, which will connect Tajikistan, Kyrgyzstan, Afghanistan and Pakistan through one power energy system. The CASA-1000 electric power lines total length is planned to be about 1,600 kilometers (1,000 miles). It is planned that almost 90 percent of the project will be funded by international finance organizations like the Islamic Development Bank, the World Bank and others. The remaining 10 percent of the required funds will be provided by private investors. It is seems due to its significant energy shortages Pakistan is highly interested in importing electricity from Central Asia.

Construction of RHPP will help to realize proper management of water resources of Vakhsh River not only for electric power generation but also for irrigation as well. Figure 1 shows the graph between the rate of water flow from June to May from reservoirs of NHPP, RHPP obtained by modeling. From Figure 1, it is seen that rate of flow from NHPP reservoir is large mostly in the summer period. The rate of flow from RHPP is large in autumn-winter-spring period. It means NHPP will be used for irrigation and power generation while RHPP mostly for power generation. The presence of two hydropower plants and water reservoirs accordingly would allow equating the average rate of flow through the plants and power generation respectively during a year.

Completion of the RHPP project will bring guaranteed electric power to Afghanistan and Pakistan, water for irrigation to Uzbekistan and even Turkmenistan as well. To complete this project in time, political and financial supports from neighboring countries that are interested in realization of the project are necessary.

CONCLUSIONS

The data Presented in this paper shows that realization of the Rogun hydropower plants project is facing a number of political and economical problems especially. On the other hand, this project is supported by majority of population of Tajikistan who are facing

shortage of electric power in the winter time. Completion of this project will allow the proper water flow management of Vakhsh River for irrigation and power generation in the summer period and for generation of the electricity in the winter time. Especially, the operation of the two plants will be important, Nurek (NHPP) hydropower plant and Rogun hydropower plant (RHPP) in one cascade. NHPP will be used for irrigation and power generation while RHPP mostly for power generation. The presence of two hydropower plants and water reservoirs accordingly would allow equating the average rate of flow through the plants and power generation respectively during a year. This will allow Tajikistan to export electric power to Afghanistan and Pakistan and provide sufficient water for irrigation to Uzbekistan. Finally this project will facilitate to make strong political and economical links between Central Asian Republic of former Soviet Union and Afghanistan and Pakistan for benefit of population of all countries and all Muslim community.

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