TAJIKISTAN ENERGY SECTOR: PRESENT AND NEAR FUTURE

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Economically efficient use of energy is a major indicator which largely determines the economic development level of any country, its national security, and the well-being of its people.

Sustainable economic progress in modern societies implies that the energy factor is a key component of this progress. In the final years of the U.S.S.R., Tajikistan's electric power industry based on hydropower was one of the best not only among the Union republics, but also among Asian countries. Past political events have had an adverse effect on the republic's energy sector, but nevertheless, in contrast to many other sectors, it has passed this test and is now in the initial stage of recovery.

Let us consider the current state of the republic's electric power potential and its position compared to some CIS countries.

Tajikistan generates four times more electricity than Moldova, three times more than Armenia, over twice as much as Georgia, a third more than Turkmenistan, and more than Kyrgyzstan.

Nevertheless, there is an acute shortage of electricity in the republic. In winter, the population suffers and enterprises (including emerging businesses) incur losses, and this significantly hinders entrepreneurial activity in the country. In the conditions of tight restrictions on electricity consumption (limits), many enterprises suffer such heavy losses as to go out of business.

As it happens, hydroelectricity is the backbone of Tajikistan's energy sector. In this area, nature has endowed the republic with a huge potential. Its renewable and environmentally clean water resources hold promise of a bright future for Tajikistan. The country's 14,500 glaciers (with a total area of 11,000 sq km, or about 8% of its entire territory) give rise to all large rivers whose waters are used in the national economy.

Tajikistan has 947 rivers over 10 km long, with a total length of 28,000 km. Overall, there are more than 25,000 rivers and streams, totaling about 90,000 km in length. Average drainage density in the country is close to 0.6 km per sq km.

Rivers are mostly fed by seasonal snowmelt runoff, whose share of annual river flow is 75-80%; the share of glacial runoff is 15-20%, and that of rainfall runoff, close to 5%. Average annual flow in Tajikistan is 76.7 cu km (1990), including 22.1 cu km of transboundary inflow from the territory of neighboring countries and 54.6 cu km of internally generated river flow. The republic's lakes hold 46.3 cu km of water.

In view of the above, Tajikistan ranks first in Central Asia and eighth in the world in terms of hydropower resources, which exceed 527 billion kWh per year. In terms of potential hydropower resources per square kilometer (3,682.7 thousand kWh per sq km per year), the country ranks first in the world, far surpassing other states.

Unfortunately, only 3.1% of these resources are currently being used, mostly by hydroelectric power plants (HPPs) built on the Vakhsh River.

Total installed HPP capacity in Tajikistan is 4,070 MW. The energy system also includes two thermal plants with a total capacity of 318 MW. Average annual electricity production, depending

on the dryness of the year and the availability of fuel at thermal plants, is about 16.5 billion kWh.

Tajikistan's largest hydropower station, the Nurek HPP on the Vakhsh River, has nine generating units with a total capacity of 3,000 MW and average annual output of more than 11.2 billion kWh. Downstream lies the Baipaza HPP (600 MW, 2.5 billion kWh), followed by a system of smaller hydropower stations: Golovnaya (240 MW), Perepadnaya (29.5 MW) and Central (15.1 MW).

Under the project, the Vakhsh hydropower system should include nine HPPs with a total capacity of 9,195 MW, five of which are already in operation.

The main uncompleted projects on the Vakhsh River are the Rogun HPP with an installed capacity of 3,600 MW, the Shurob HPP with an installed capacity of 850 MW, and the Sangtuda-1 and Sangtuda-2 hydropower plants.

The Kayrakkum HPP (126 MW) on the Syr Darya River in the north of the republic is of unique importance to the region. Its reservoir is designed for irrigation and serves to regulate water flows to Uzbekistan and Kazakhstan in the summer months.

The Varzob hydropower system (25.43 MW) is located on the Dushanbe River that runs close to the capital. In addition, there are two combined heat and power plants: Dushanbe (198 MW) and Yovon (120 MW).

The current priority lines in the development of Tajikistan's energy industry are as follows.

Continued Construction of the Rogun HPP

This project, designed and launched in Soviet times, is coordinated with all the republics. This HPP can ensure long-term flow management in the Vakhsh River, a tributary of the Amu Darya, which will enable Tajikistan to do away with the winter energy shortage and to nearly double the production of electricity. The project also provides for additional water supplies to Turkmenistan and Uzbekistan in dry years. Water storage in the reservoir will occur during floods, and this will partly protect downstream countries from inundation and destruction.

The initial design capacity of the Rogun HPP with six generating units 600 MW each is 3,600 MW; its annual output is 13.1 billion kWh, and its total cost is $2.5 billion, of which $804 million has already been utilized. The construction of the first phase of the Rogun HPP is a two-stage process. The first stage provides for the construction of a dam up to a normal water level of 1,100 meters, which will ensure additional generation of 0.45 billion kWh of electricity at the existing hydropower plants of the Vakhsh system. Later on, the dam is to be gradually heightened to a normal water level of 1,180 meters with the installation of two generating units totaling 800 MW. In this case, the Rogun HPP will be able to generate, in the process of long-term flow management in the Vakhsh River, 5.6 billion kWh per year, enabling downstream HPPs to produce an additional 0.7 billion kWh of electricity per year. The cost of the first stage of construction of the Rogun HPP is $160 million, and of the first project phase as a whole, $500 million. The capabilities of its regulating reservoir enable the Vakhsh hydropower system to operate in the required generation mode, producing base-load energy in summer and winter, and also to meet peak-load demand. This is particularly important in the Rogun HPP's joint operation with thermal power plants of neighboring states, which enhances the competitiveness of Rogun energy in the electricity market.

The completion of the Rogun HPP is of equal importance for the energy industry and for water supply to Uzbekistan, Turkmenistan and southern Kazakhstan. In dry years, its reservoir with a usable storage capacity of 10.3 billion cu m will be able to provide these countries with water.

Completion of Sangtuda HPP-1

Sangtuda-1 with a capacity of 670 MW and an annual output of 2.7 billion kWh has been under construction since 1992. There is a fully completed engineering design, which has undergone all the required expert examinations. Investment in the construction of this facility has exceeded $120 million; the amount of work done is over 25% of the design amount.

At present, the Sangtuda-1 project is being implemented under an Agreement between the Governments of the Republic of Tajikistan and the Russian Federation. The only purpose of this hydropower plant is to produce energy. The parties' equity stakes are as follows: Tajikistan has 25% (construction in progress), and Russia 75%.

When Sangtuda-1 is put into operation, this will make it possible, in the summer months, not only to supply domestic consumers with low-cost electricity, but also to export it to neighboring countries.

Preparatory works have been completed and construction has started on Sangtuda HPP-2 with a capacity of 220 MW. The project is co-financed by the governments of the Islamic Republic of Iran and the Republic of Tajikistan.

Sangtuda-2 is the downstream part of the Sangtuda hydrosystem; it operates in parallel (jointly) with Sangtuda-1 to release water from the Nurek Reservoir and makes it possible to balance storage and to meet, in part, peak load demand in winter.

With the completion of the Rogun and the two Sangtuda HPPs, generation of environmentally clean electricity in the country will reach 31-33 billion kWh. The possibilities for low-cost energy exports from the facilities being built in Tajikistan to consumers in Kazakhstan, Russia, Uzbekistan and Afghanistan will increase.

The implementation of these projects may be the first step toward tapping Tajikistan's enormous hydropower potential through the joint efforts of states and toward the development of a whole range of industries in neighboring countries.

Construction of Small Hydropower Plants

In order to supply electricity to population centers in hard-to-reach mountain areas, over 30 small hydro plants with a capacity of 100 kW to 1,500 kW and over 40 micro plants with a capacity of 5 kW to 100 kW have been built in the republic. Their ecological cleanness manifests itself, first and foremost, in much smaller areas of flooding and waterlogging; their dams and reservoirs inflict much less harm than other energy facilities on the natural human and wildlife habitat, especially when they are sited on mountain rivers with erosion-resistant boulder and gravel beds and rocky hillsides. This is extremely important to the local population. Small hydro plants are particularly effective in areas with dispersed energy consumers located far from energy systems.

The potential of Tajikistan's small and medium rivers as regards the construction of small HPPs is over 30 thousand MW with an annual output of about 100 billion kWh. Unit costs in their construction are roughly $600-$800 per kW of installed capacity. In order to harness the energy of small rivers, the government has developed and adopted a Long-Term Program for the Construction of Small Power Plants for 2007-2020, which provides for the construction of 71 small HPPs with a total capacity of 79.6 MW and an annual output of 481 million kWh.

By now, feasibility studies have been prepared for 19 small HPPs with a total capacity of 18 MW, which do not require large investments and can be built virtually within a year. They are relatively easy to operate and have a short payback period.

At present, the question of financing the construction of 17 HPPs has been decided by the government of Tajikistan and investors (Islamic Development Bank, Asian Development Bank, UNDP, etc.). These plants are to be built and put into operation before 2010.

Naturally, matters of compliance with safety standards at these and other HPPs will have to be resolved within the framework of reorganizations in the republic's electric power sector projected for the near future.

In accordance with the National Strategy for Developing the Energy Sector in the Republic of Tajikistan (2006-2015), electricity generation is to reach 26.4 billion kWh in 2010 and 35 billion kWh in 2015.

With the completion of projects launched in 2006-2015 (the second phase of the Rogun HPP, the Shurob HPP on the Vakhsh River, and the Dashtidzhum HPP) and with the development of the Zarafshan River basin, electricity generation is to reach 57-60 billion kWh by 2020.

On the Panj River—the main tributary of the Amu Darya—it is economically feasible to build 14 hydropower plans ranging from 300 MW to 4,000 MW, with a total capacity of 9,350 MW and an annual output of 86.3 billion kWh.

Transmission of electricity is assuming great importance for the national energy system.

The republic's power distribution networks mostly consist of 220/110 kV transmission lines, with 500 kV overhead lines serving to transmit power from the Nurek HPP and to connect the national energy system to the integrated power system of Central Asia.

The total length of 110-500 kV transmission lines is 4,371 km, and the installed capacity of 110-500 kV step-down substations is 10,161.0 thousand kVA. Substations of 110 kV and over are mostly double-transformer ones. All these transmission lines are connected to the energy system of Uzbekistan.

There is also the 220 kV Kanibadam-Batken transmission line connecting the energy system of Tajikistan's Sogd Region with Kyrgyzstan, and 110 kV and 35 kV lines linking Tajikistan with Afghanistan. The total length of transmission lines ranging from 0.4 kV to 500 kV is 60,819 km.

The limited technical capabilities of the existing 500 kV transmission lines of the Integrated Power System have long made it impossible to use the export potential of Tajikistan's electric power industry in the summer months.

It is necessary to create an integrated power system covering the whole country, because at present its industrial North has no electrical communications with the South, while most of the country's power generation facilities are concentrated in its southern regions. In the past, electricity was supplied to northern Tajikistan through Uzbek transmission lines, but today this is possible only on a limited scale, as agreed with the Uzbek side.

In this connection, the republic's government has adopted a number of decisions whose implementation will make it possible to sell surplus energy to neighboring states without hindrance.

Construction of a 500 kV South-North Transmission Line

This project provides for electricity supplies to energy-short areas in the republic's Sogd Region, the southern part of Kazakhstan, Kyrgyzstan, and then on to the Russian Federation and to China. This will enhance the security of the Integrated Power System.

The project is being implemented under an agreement with the PRC. The South-North high-voltage line has the following characteristics:

—length—386 km;

—cost—$282 million;

—PRC credit—$276 million;

—project implementation period—3 years;

—transfer capability—8.6 billion kWh per year;

—construction of two 500 kV substations (Dushanbe and Khujand);

—modernization of the 500 kV Regar substation.

All preliminary works are close to completion.
Characteristics of the 220 kV Lolazor-Khatlon transmission line:

—length—90 km;

—project cost—$58 million;

—PRC credit—$56 million;

—two 220 kV substations.

In 2007, in accordance with the ADB schedule, the parties started the construction of a double-circuit 220 kV transmission line from Sangtuda (Tajikistan) to Puli Khumri (Afghanistan) with an annual capacity of approximately 4 billion kWh, which will make it possible to meet Afghanistan's contract demand of 300 MW in 2008-2010 (in summer).

The implementation of this and other projects will significantly extend the republic's capabilities in regional electricity trade with a steady expansion of generating capacity and will help to achieve complete security of electricity supply.

The government of the Republic of Tajikistan and the government of the Islamic Republic of Pakistan have signed a Memorandum of Understanding on the construction of a 765 kV (500 kV) Rogun-Khorog-Wakhan Corridor-Chirtal-Peshawar transmission line. The construction of a 500 kV Rogun-Sangtuda-Puli Krumri-Kabul-Peshawar line is under consideration.

With the Islamic Republic of Iran, Tajikistan has signed a Protocol of Intent on the supply of 6 billion kWh of electricity to that republic. Even today Tajikistan has an opportunity to export electricity to Iran in the summer months in the amount of 1.5-2 billion kWh. The Iranian side is considering the question of electricity transit through Uzbekistan and Turkmenistan, and has started the construction of a 400 kV transmission line 245 km in length from Mary (Turkmenistan) to Mashhad (Iran). The question of the construction of a 500 kV Rogun-Sangtuda-Kunduz-Puli Khumri-Herat-Mashhad line in under consideration.

The Tajik government has successfully attracted investment from a number of countries (Russia, China, Iran, India and U.S.); other investors have expressed an interest in implementing new projects (Kazakhstan, Czech Republic, Turkey and others).

Tajikistan, together with Afghanistan, Pakistan and Kyrgyzstan, takes part in the Central Asian and South Asian regional electricity market. Under an Intergovernmental Memorandum of Understanding, Pakistan is to buy, while Tajikistan and Kyrgyzstan are to sell 1,000 MW of electricity on a year-round basis. In the future, this amount may be increased to 4,000 MW.

The republic's program for developing the fuel and energy complex in 2007-2015 provides for continued implementation of projects designed to modernize and reconstruct the key facilities of the energy system, including power stations, transformer substations and transmission lines.

Projects to modernize HPPs provide for their rehabilitation and, at the same time, for an increase in the capacity of generating units by up to 10%, with a resulting increase in the installed capacity of hydropower plants by 350-400 MW. This includes, in the first place, projects to reanimate the Vakhsh

and Varzob hydropower systems and the Kayrakkum HPP. For the successful implementation of energy-saving programs, the initial phase is to rehabilitate (repair and modernize) the main elements of the energy system, primarily the most worn out power grids and transformer substations.

In order to rehabilitate and modernize the energy sector and to enhance the energy and economic efficiency of the energy system, the government is implementing a number of measures.

In particular, a Power Rehabilitation Project has been launched in Tajikistan to restore the energy infrastructure in the south of the country. Its total cost is $62.8 million.

A program called Reduction in Auxiliary Power Consumption at Power Stations and in Power Networks requires generation companies and grid operators to take measures to reduce transmission losses in 0.4-500 kV networks and auxiliary power consumption at power stations in 2007-2009.

A plan designed to reduce gas losses in municipal distribution networks is expected to save 65 million cu m of natural gas.

Work is underway to replace and repair internal oil supply lines in the south. The expected effect here is 6.0 thousand tons of oil.

An important task is to arrange an effective accounting system at every level, from end customers to generating plants.

To reduce excessive losses in electricity supply to customers in Dushanbe, Open Joint Stock Holding Company Barqi Tojik is implementing a project entitled "Energy Loss Reduction."

This project is designed to develop and install an automated control and accounting system and an automated billing system for electricity in Dushanbe. The project provides for the supply and installation of 160 thousand electricity meters, telecommunications and calibration equipment, and also materials for all electricity consumers in Dushanbe; an automated system designed to collect and transmit data from electric meters is to be developed and installed.

In pursuance of the Law of the Republic of Tajikistan on Energy Conservation, Barqi Tojik's training center has been training specialists under the Energy Conservation Program.

All these measures will undoubtedly enhance the efficiency of the country's energy sector.

At present, the power complex is going through reforms designed, among other things, to improve the environment for attracting investors, including private investors, into energy production and the development of the domestic energy sector.

Tajikistan has the lowest electricity prices among all CIS countries. Low-priced electricity, even with minimal production costs, does not allow the republic's electric power sector to repair all its equipment or to create new energy facilities at its own expense. This results in significant wear of equipment and makes it necessary to obtain foreign loans. With a correct tariff policy, Tajikistan's power industry should become one of the most profitable sectors. True, in today's conditions of winter electricity shortages and attendant restrictions imposed through power outages, two groups of consumers—enterprises and households—are faced with yet another problem: gaining access to electricity. This is partly due to the arrangement under which limits on electricity consumption in the country are fixed without regard to actual payments for electricity by consumers or their ability to pay more than the fixed rate (or, possibly, to the establishment of reduced rates for individual entities).

Low electricity rates are usually explained by the grave economic situation in the republic and the population's low ability to pay. For some time this was undoubtedly justified, but this period in Tajikistan has lasted too long. As a result, these low rates themselves not only serve to perpetuate the people's poverty, but also "provoke" a low economic level.

Today, even after the adoption of a Government Decree on Tariffs for Electricity and Heat, approved in June 2007, industrial consumers and those equated to them pay 4.4 diram ($1 = 344 diram, 1 somoni = 100 diram) or 1.28 cents per kWh. Households pay 2.4 diram for less than 250 kWh, and 3.8 diram for over 250 kWh.

The existing energy system makes it possible to ensure the development of the national hydropower industry at its own expense with an electricity rate of 2.5 cents per kWh. To achieve this, the

government of Tajikistan has developed a program of gradual increases in electricity rates during 2007-2010 to the minimum level ensuring the system's financial viability: 2.5 cents per kWh, which will possibly make the republic more attractive to investors.

Gas consumers in Tajikistan pay 50 diram per cu m. The price of a ton of coal ranges from 47 to 80 somoni, depending on the method of its production (underground or surface mining) and its rank.

Low-priced electricity prevents wide use of gas and coal in the country.

Since hydropower is the cleanest and most economical kind of energy, the course for a regionalization of the hydropower market—at the current technological development level—can be regarded by all Central Asian states as an essential condition for future progress in the energy sector and the economy as a whole, and also for the creation of a Eurasian subregional economic space. The construction of hydropower plants and reservoirs in narrow mountain gorges will have a minimal impact on weather processes and the environment, preventing the evaporation of water, which is of great importance in a hot climate.

It is clear that in today's world an individual country, however well endowed with water and energy resources, will find it very difficult to ensure its security in isolation from international integration processes in the fuel and energy complex and close cooperation with neighboring states.

Fair and mutually beneficial distribution and rational use of water and electricity will resolve the problem of water and electricity supply in the region as a whole and, consequently, will guarantee agricultural growth. All these factors will improve the people's well-being and enhance political stability in Central Asia.

Generation and sale of renewable, low-cost and environmentally clean hydropower will make it possible to cover all costs incurred by investors with a big profit margin, to save oil, gas and coal for more effective use, and to improve the environmental and economic indicators of all electric power plants in the region.

Under normal operation, Tajikistan's energy system based on hydropower, which has no fuel component in its structure, can become highly efficient. This will allow more effective use of other energy sources available in the country.

Tajikistan has more than 40 coal deposits and fields with total reserves of about 5.0 billion tons. This includes the Nazaraylok deposit of superclean anthracite coal; the Fan-Yagnob coking coal deposit; the Ziddi hard coal deposit; and the oldest Shurob deposit (mine).

Nazaraylok anthracites are of a high quality and are identical to those of the Ha Tu deposit in northern Vietnam, considered the best in the world.

The Fan-Yagnob coking coal deposit is the largest one in Central Asia with total reserves of over 1.5 billion tons.

The Ziddi deposit with total geological reserves of 90 million tons lies 70 km north of Dushanbe. There is a project for test pit excavation at this deposit.

Coal is mined by 15 small enterprises; three of them engage in underground mining, and 12 in surface mining. Companies using the surface method have appeared since 2001. They have virtually no fixed assets or mining equipment on their balance sheet, leasing such (and other) equipment from individual and legal entities, which raises the cost of coal. Coal is mostly transported by road, and the cost of such transportation is double or triple the cost of the coal itself.

Oil and Gas Industry

Tajikistan has an area of 143.5 thousand sq km, including 34.6 thousand sq km of oil and gas prospects.

The development of the oil and gas sector is of particular importance in the national fuel and energy complex, because over 98% of oil and gas products are currently imported from abroad.

Oil and gas production in Tajikistan started back in 1907 (at the Selrokho field). From the 1960s on, 24 oil and gas fields with occurrence depths ranging from 300 m to 5,000 m were discovered in the republic. Gas production peaked in 1973 (520 million cu m), and oil production in 1979 (418 thousand tons).

The top eight prospects in the country hold a total of 857 billion cu m of natural gas and 170 million tons of oil. Further exploration work may result in the discovery of large gas pools at depths of over 6-7 km (Rengan, Sargazon, Yalgizkak, Mahram, Khodja-Bakirgan, Eastern Supetau and Western Supetau). Tajikistan's proven oil and gas reserves now amount to less than 1% of total resources, estimated at 1,033 million tons of fuel equivalent. Over 100 prospects discovered in the country are awaiting geophysical and exploration work.

The most attractive renewable energy source in Tajikistan is solar energy, while wind energy, energy from biomass and waste, geothermal, and other kinds of energy can be ranked as secondary sources of little importance to the economy as a whole.

The share of renewable energy sources (excluding large HPPs) in the world as a whole is 1.6%. Most of these sources have a major shortcoming: irregular generation of energy. Units powered by such energy should be equipped either with storage batteries or with backup units running on conventional fuel, while electrical networks should be large and "flexible" enough to offset irregular supplies of energy. As a rule, energy obtained from such sources is more costly.

The republic has a huge potential for the use of solar energy comparable to its hydropower potential, but conversion of solar energy into electricity is so far economically inefficient.

At the same time, given foreign investment, solar power engineering is of great interest to the country's Murgab District, where the conditions for the operation of photovoltaic (PV) cells are extremely favorable. PV capacity may be gradually increased (as funds are obtained), using the resultant energy first for household needs, then for industrial production, and later possibly for export as well. PV cells may also be widely used in mountain expeditions, etc. Total PV capacity in the world exceeds 500 MW, and a number of countries have adopted national programs for large-scale PV installation (100,000 solar roofs in Germany and Japan, Million Solar Roofs Initiative in the U.S.). Given adequate insolation, the cost of photovoltaic electricity does not exceed 15-20 cents per kilowatt.

Since the high cost of energy generated by PV cells prevents their wide use, research and development designed to reduce their cost is conducted throughout the world.

The number of sunny days in Tajikistan ranges from 250 to 330 per year, which is why the use of solar energy is a major issue not only of today, but also of the near future.

The most effective way to obtain solar heat is in flat-plate solar collectors (solar water heaters). The total area of such collectors now installed in the world is estimated at 50-60 million sq m, which allows the annual production of thermal energy in the amount of 5-7 million tons of fuel equivalent.

Unfortunately, solar water heaters have not found wide application in Tajikistan, although local scientists conducted research and development in this area when such heaters had just come on the scene. In view of our climatic conditions, heat collectors of a mixed, solar-electric type are, in our opinion, particularly effective in the republic. Rising electricity rates will inevitably lead to the spread of such collectors among the population and in production.

In accordance with government documents, work has started in the republic to prepare normative legal acts for restructuring the power industry and the gas sector, since reforms here are long overdue. Their purpose is to enhance the economic efficiency of production and to improve service quality and reliability. The government is planning measures to separate energy production, transportation and distribution.

The country has a record of granting concessions to operate energy facilities. The government has concluded an agreement with the World Bank's International Finance Corporation, its International Development Association and the Aga Khan Fund for Economic Development on granting a concession to operate the Gorno-Badakhshan Autonomous Region's energy system for a term of 25 years.

Tajikistan has joined the common energy system of the CIS states, whose participants are working to harmonize their laws, regulatory frameworks and technical documentation in the field of energy and water saving. Another factor contributing to this is the republic's participation in EurAsEC and the SCO.

Joint work to reduce fuel and energy sector costs, ensure productive and mutually beneficial use of water and energy resources, and displace economically inefficient power-consuming equipment from the market can lead to a significant general increase in regional trade in goods and services.

To summarize, we can conclude that interest in Tajikistan's energy sector is bound to increase. In the foreseeable future, development in this sector will be concentrated in three main areas.

The first and most important area is hydropower. The more than 70-year operational experience of the republic's hydropower sector has confirmed the real possibility of effective industrial use of its hydropower resources and their very high profitability.

The second major area is effective use of the republic's oil, coal and gas potential.

And the third area is energy conservation, including wide use of solar energy to obtain hot water for heating and everyday purposes.