

ASIAN DEVELOPMENT BANK

TAR: TAJ 35153

TECHNICAL ASSISTANCE
(Financed by the Japan Special Fund)

TO THE

REPUBLIC OF TAJIKISTAN

FOR THE

HYDROPOWER DEVELOPMENT STRATEGY

October 2002

CURRENCY EQUIVALENTS

(as of 18 October 2002)

Currency Unit	–	Somoni (TJS)
TJS 1.00	=	\$ 0.3389
\$1.00	=	TJS 2.95

ABBREVIATIONS

ADB	–	Asian Development Bank
BT	–	Barki Tajik
EA	–	executing agency
MOE	–	Ministry of Energy
PRC	–	People's Republic of China

NOTE

In this report, "\$" refers to US dollars.

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I. INTRODUCTION

1. To support Tajikistan's economic development by exploiting the country's abundant hydropower and other energy resources, the Government needs help to prepare a realistic and affordable energy sector development program that will ensure the optimal use of the country's scarce capital and the efficient development of the sector. This is a follow-up of earlier Asian Development Bank (ADB) technical assistance (TA),¹ which recommended development of hydropower as the main domestic energy resource. At the request of the Government of Tajikistan, TA for developing a hydropower development strategy was included in ADB's 2002 TA program. The TA² will identify export markets for the hydropower, develop a least-cost investment program, and provide a framework for coordinating external assistance for the sector, including the timing and priority of the proposed hydropower development projects, Rogun and Sangtuda, and other investments. The Fact-Finding Mission in August 2002 reached an understanding with the Government on the goals, purpose, scope, approach, cost estimates, and implementation arrangements for the TA. The TA framework is in Appendix 1.

II. ISSUES

2. Tajikistan has vast hydropower potential and less than 10% of its potential of 40,000 megawatt (MW) is currently used. More than 90% of the electricity produced in Tajikistan comes from hydropower that uses melt water from snow in summer around the Pamir and Fan mountain regions as key input. In winter, however, hydropower generation depends on storage water in reservoirs, and when storage level is low, the country has to rely on imported oil, gas, and coal and imported energy. Tajikistan imports electricity from Uzbekistan from January until April every year because of the limited storage capacity in reservoirs despite its ample generation capacity. In 2000, Tajikistan faced a major electricity shortage resulting from limited rainfall, and had to import a large amount of electricity from neighboring Uzbekistan. If there is an excess rainfall, and no demand for electricity, surplus water i.e., water above the safe reservoir storage level has to be spilled. Such spillage represents net economic loss. Nurek, the largest hydropower plant (with a capacity of 3,000 MW), spills water every summer as there is no demand for export for the excess electricity. Nurek has insufficient storage and the excess water in summer cannot be stored to supply the domestic winter deficit of about 4,000 gigawatt-hour (GWh).

3. Rehabilitation of existing power plant, transmission, and distribution assets are essential to maintain operations of the electricity system, which has been the focus of ADB's investment in the energy sector of Tajikistan. The state-owned electricity industry is unable to generate enough cash to invest in the rehabilitation work as electricity revenue barely meets operating costs, and collections are still poor. The Government has increased tariffs quite significantly over the last few years to meet the ADB loan³ covenants, but as a result of the devaluation of the Tajik somoni, tariff increases in United States dollar term still lag the levels required by the covenants. Export of relatively cheaper hydroelectricity to the neighboring countries is more profitable as export prices are higher than the domestic prices; thus revenue from a sustainable level of export is key for investments in new hydropower resources. The Government needs a plan for hydropower development to address the electricity deficit in winter and export potential for surplus hydropower in summer. The plan should be least cost, affordable, and should maximize export revenue from hydroelectricity.

¹ ADB. 1999. *Technical Assistance to Tajikistan for Power Sector Development Project*. Manila.

² The TA first appeared in *ADB Business Opportunities* (Internet edition) in February 2002.

³ ADB. 2000. *Report and Recommendation of the President to the Board on a Proposed Loan to the Republic of Tajikistan for the Power Rehabilitation Project*. Manila.

4. The low electricity tariff encourages inefficient use of electricity. Tajikistan imports expensive electricity to meet early morning and late evening peak load in winter. The load can be significantly reduced if customers were conscious of their energy use. Appliances used in households are old and consume much more electricity than newer energy efficient appliances. Part of the evening peak load is also attributed to residential and commercial lighting, which can be significantly reduced if efficient lights (e. g., compact fluorescent lights) were used. Energy can be conserved by improving technical efficiency and reducing waste by consumers. The Government has addressed these issues by creating a new law on energy efficiency with a view to incorporate demand management options in planning to reduce overall cost of electricity generation and expansion and rehabilitation of the network.

5. Tajikistan's electricity network effectively has three separate grids. The northern (Leninabad region), southern (main grid), and small Gorno Badakhshan grid make up the national electricity grid. Because the network is only partly interconnected, system operators face increasing difficulty in balancing supply and demand while maintaining sufficient reserve. The industries around Khujand, which comprise most of the nonaluminum related industries in Tajikistan, contribute to a net deficit of 200 MW. This deficit in the north is supplied by Uzbekistan in return for exports from the southern grid, as the northern and the southern grids are linked only through Uzbekistan. Tajikistan suffers financially from this electricity trade, as the national import prices are higher than export prices, although, in most cases, the amount of electricity imported equals that exported, and the net result is a simple balance. This inequality results from trading peak power for base load power and providing ancillary services to support load flow without any charge. Before constructing a transmission link connecting the two grids, the Government should consider the costs and the benefits of (i) a transmission link between the north and south of the country, (ii) a new thermal power station in the northern region, and (iii) a long-term supply agreement with Uzbekistan.

6. Central planners from the former Soviet Union were committed to develop the hydropower resources of Tajikistan for supplying the region and built large dams and power stations. After the collapse of the Soviet Union, two projects remained unfinished. These large investments may only be viable with firm commitments from neighboring countries to import electricity at a reasonable price. Construction of Rogun hydropower is one of the incomplete projects designed for regional benefits. The current plan for Rogun hydropower is to build a preliminary dam 220 meters (m) height with two 440 MW generators. In a second phase the dam height will be increased to 330 m, making it one of the highest dam in the world, with generation capacity of 3,600 MW. Rogun is upstream of the 3,000 MW Nurek hydropower station, hence completion of the Rogun dam would allow better regulation of water flow to all downstream hydropower plants, including Nurek. The high siltation rate is a growing problem in this region and construction of Rogun stage 1 will protect the storage capacity of Nurek reservoir from further siltation. Sangtudin hydropower plant, immediately downstream of Nurek, is being constructed and will operate as a run-of-river plant. It will have very limited storage and will depend largely on releases from Nurek. The Government is currently unable to finance all of these projects and consideration has to be given to phasing them in. The Ministry of Energy (MOE) is responsible for energy sector planning, but lacks the capacity to carry out the least cost planning task independently.

7. Except for the deficit in winter, current generation capacity is enough to meet future demand without substantial investment in new capacity. Identified and committed export markets will generate funding for new projects. Power sector reforms are also necessary to commercialize activities and improve management of the sector. Current Government investments need to be integrated and prioritized to maximize the value of the limited available resources. The Government's planning effort should change focus from self-sufficiency to an

integrated approach for demand and supply options with export of low cost hydropower to the neighboring countries.

8. Tajikistan's electricity generation capacity that can not meet winter demand, lack of interconnection between the north and south of the country, inefficient use of energy resources, and funding for huge, partly completed hydropower projects that were designed for regional supply are the key challenges for the electricity industry of Tajikistan. Low cost hydropower for export could expedite the pace of economic growth of Tajikistan. The TA will address these issues.

9. TA concept had full support of the donor community and was endorsed at an "energy donors meeting" in March 2002. No overlapping or ongoing World Bank or other activity exists in this area. Recently, a World Bank team reviewed the investment needs of the two unfinished hydropower projects in a two week mission. The proposed TA will take an integrated approach to domestic and export demand, all candidate projects, and their required investments.

III. THE TECHNICAL ASSISTANCE

A. Purpose and Output

10. The TA's objective is to help the Government prepare a hydropower development strategy. The strategy will identify for the Tajikistan energy sector the optimal energy development program that will meet domestic energy requirements and realize export opportunities given the energy resources available, existing power investments, and fiscal and other constraints. The strategy is expected to provide guidance to also other funding agencies and investors interested in the sector.

11. The TA will (i) review all energy and power sector studies that have been completed and interact with those ongoing, including the Government's energy policy and its plans for hydropower sector development; (ii) establish likely load forecasts for domestic and export markets for hydropower; (iii) consider new candidate projects, including phased construction of incomplete hydropower projects; (iv) undertake macroeconomic analysis to determine the fiscal constraints of the Government and self-financing ability of Barki Tajik; (v) develop a least-cost hydropower development strategy, including identification of external financing and investment possibilities; and (vi) provide training in energy sector planning to enable the Government to update the strategy on a regular basis.

B. Methodology and Key Activities

12. The TA will take a consultative approach and build on the work of the Government and external agencies. Wide participation and consultation with the agencies, neighboring countries with import potential, key stakeholders in the government, and large industrial customers will be the general approach. Key activities will include a review of existing construction activities; analysis of the current level of trade; quantification and assessment of the suitability of the operational guidelines for downstream irrigation and cross border water flow requirements; and collection and analysis of information on potential energy resources in the country, ongoing investments in energy sector, and fiscal constraints. Most of the hydropower is in the Vaksh River cascade and the catchment is sparsely populated. The unfinished hydropower projects have already addressed resettlement issues. This study pertains to the hydropower potential from the perspectives of least-cost supply planning, and the associated costs of resettlement and environmental issues will be factored into the analysis. The TA activities will be as follows:

- (i) **demand forecast**—development of domestic and regional electricity sales forecast;
- (ii) **establish candidate projects**—identification of hydropower and other power sector projects, and for the hydropower projects, development of appropriate phasing for construction/completion;
- (iii) **least-cost plan**—optimization of the list of candidate projects, including demand-side options to maximize benefits within the limits of technical constraints; and
- (iv) **financing constraints**—revision of the technically optimized plan: by applying external borrowing limits and self-funding limits select projects that are affordable.

13. One key component of the TA will be to strengthen the energy sector planning capability of Tajikistan. A planning unit will be established within MOE and appropriate training and other measures will be taken to ensure the planning unit is able to update the hydropower development strategy annually with the changes in planning parameters.

C. Cost and Financing

14. The total cost of the TA is \$720,000 equivalent, including foreign exchange of \$560,000 and local currency of \$160,000 equivalent. The Government has requested ADB to finance \$600,000 equivalent to cover the entire foreign exchange cost and \$40,000 equivalent of the local currency cost. The TA will be financed on a grant basis by the Japan Special Fund, funded by the Government of Japan (Appendix 2). The Government will finance the balance of the local currency cost.

D. Implementation Arrangements

15. The TA will require 46 person-months of consulting services: 16 from international and 30 from domestic consultants. The consulting team will comprise experts in power system analysis and planning; hydrology, reservoir management, and energy economists; and water system planning. ADB will select and engage a firm using the quality-and-cost-based selection method and a simplified technical proposal in accordance with the Guidelines on the Use of Consultants will be used. Outline terms of reference for the consultants are in Appendix 3.

16. MOE will be the Executing Agency for the TA. MOE will assign a project leader and counterpart staff to work with the consultant and will closely monitor the domestic consultants' work in close coordination with ADB. The TA will be implemented during 6 months, starting in February 2003 and ending in August 2003. A workshop in June 2003 will discuss the final list of candidate projects before the least-cost plan is developed.

IV. THE PRESIDENT'S DECISION

17. The President, acting under the authority delegated by the Board, has approved the provision of technical assistance not exceeding the equivalent of \$600,000 on a grant basis to the Government of Tajikistan for the Hydropower Development Strategy, and hereby reports this action to the Board.

TECHNICAL ASSISTANCE FRAMEWORK

Design Summary	Performance Targets	Monitoring Mechanism	Assumption and Risks
<p>Goals</p> <p>Promote economic development and poverty reduction by satisfying electricity demand and realizing export potential of hydropower resources.</p>	<p>Improve adequacy and reliability of power supply.</p> <p>Increase export of hydropower.</p>	<p>Energy institutions' annual reports.</p>	<p>Government's ability to provide counterpart funding and attract foreign investments to complete the large projects.</p>
<p>Purpose</p> <p>Better satisfy domestic electricity demand and realize export potential of hydropower resources by coordinated investments by donor agencies.</p>	<p>Better-coordinated external assistance for the sector and prioritized investments.</p>	<p>Consultants' reports, review missions.</p> <p>Funding agency meeting agreements.</p>	<p>Effective coordination of external aid and investor.</p> <p>High-level inter-government coordination for facilitation of power trade.</p>
<p>Outputs</p> <p>Formulate an integrated hydropower development strategy that is realistic and affordable for Tajikistan.</p> <p>Establish a planning unit in the Ministry of Energy.</p>	<p>Endorsement of strategy at the 2003 energy donors meeting.</p> <p>Government's decree issued to establish planning unit.</p> <p>Ability and commitment to update the hydropower development strategy annually.</p>	<p>Review missions, progress reports, and periodic reports by consultants.</p>	<p>Lack of external funding support.</p> <p>Weak counterpart support.</p> <p>Poor consultant performance.</p>
<p>Activities</p> <p>Demand Forecast Develop domestic and regional forecast.</p> <p>Candidate Projects Identify hydropower and other power sector projects. For the hydropower projects develop appropriate phasing for construction/completion. Regional workshop.</p> <p>Least-Cost Plan Optimize the projects to maximize benefits within the limits of technical constraints.</p> <p>Financing Constraints Revise technically optimized plan by applying external borrowing limits and self-funding limits (affordable).</p>	<p>16 person-months of international consulting and 30 person-months of domestic consulting services.</p> <p>\$720,000 equivalent—total cost; Asian Development Bank financing of \$600,000. Government contribution of \$120,000.</p> <p>10 computers; 2 printers; 1 photocopier, 1 liquid crystal display projector and software for least cost planning for the planning unit of Ministry of Energy.</p>	<p>Review missions, progress reports, and consultants' report.</p>	<p>Delay in consultant recruitment.</p> <p>Delay in obtaining relevant data and information.</p>

COST ESTIMATES AND FINANCING PLAN
(\$)

Item	Foreign Exchange	Local Currency	Total Cost
A. Asian Development Bank Financing^a			
1. Consultants			
a. Remuneration and Per Diem			
i. International Consultants	379,000	0	379,000
ii. Domestic Consultants	0	30,000	30,000
b. Reports and Communications	18,000	0	18,000
2. Travel			
a. International	50,000	0	50,000
b. Domestic	0	0	0
3. Equipment			
a. Computers, Softwares and Other Equipment	35,000	0	35,000
4. Training, Seminars, and Conferences			
a. Training Program	0	5,000	5,000
b. Workshop and Seminars	0	0	0
5. Representative for Contract Negotiations	5,000	0	5,000
6. Contingencies	73,000	5,000	78,000
Subtotal (A)	560,000	40,000	600,000
B. Government Financing – in kind contribution			
1. Office Accommodation	0	30,000	30,000
2. Remuneration and Per Diem of Counterpart Staff	0	30,000	30,000
3. Local Travel and Transport	0	5,000	5,000
4. Secretarial Support and Office Services	0	30,000	30,000
5. Office Equipment	0	10,000	10,000
6. Others	0	15,000	15,000
Subtotal (B)	0	120,000	120,000
Total	560,000	160,000	720,000

^a Financed by the Japan Special Fund, funded by the Government of Japan.
Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. Energy Sector Review

1. The consultant will undertake the following:
 - (i) Review all energy and power sector studies that have been completed and interact with those ongoing including the Government's energy policy, restructuring plans, and plans for energy sector development.
 - (ii) Revised and update the recommendation of previous Asian Development Bank (ADB) technical assistance (TA)⁴ for Tajikistan. Previous tariff studies will also be updated.
 - (iii) Prepare an inventory of the hydropower system, including its characteristics, capabilities and operating records of generation stations, and transmission interconnection with the neighboring countries.
 - (iv) Prepare an inventory of identified sources of hydroelectric power with details of energy potential, reservoir capacity, seasonal variation in storage levels, investment costs, and possible implementation time frame.
 - (v) Review the Rogun and Sangtudin hydropower developments and future planning activities.
 - (vi) Assess the remaining operating life of existing power stations and transmission facilities and review likely retirement of plants.
 - (vii) Provide a complete overview of present power system operation and the trading relationships with neighboring countries; the work should include comments, if any, on the terms that are limiting trading under the existing contracts.
 - (viii) Establish volumes of potential bilateral electricity trade between Tajikistan and neighboring countries and summarize current and past trade initiatives and the reasons for lack of progress.
 - (ix) Prepare an overview of operations of existing reservoirs and new dams that may improve the storage capacity of existing dams, to optimize the operation of the reservoir. Highlight current challenges in reservoir management, including siltation, erosion, landslide, and other geomorphologic issues.
 - (x) Review hydropower development initiatives in neighboring countries and assess their strategic impact on the development and export of Tajikistan's hydropower resources.
 - (xi) Develop irrigation and navigation demand for downstream countries that rely on water released from hydropower stations in Tajikistan.

⁴ ADB. 1999. *TA to Tajikistan for Power Sector Development Project*. Manila; ADB. 2000. *Regional TA for Regional Power Transmission Modernization in Central Asian Republics*. Manila

- (xii) Prepare an overview of operations of existing cascading of reservoirs in Tajikistan, highlighting downstream irrigation, navigation and requirements, and the potential for pump storage options.

B. Domestic Demand

2. The consultant will prepare the most likely maximum and minimum load growth scenarios, for the planning period 2003-2018, with special attention to the period up to 2013, taking into account the projected economic growth (in consultation with the Government and ADB), changing pattern of electricity consumption, price elasticity, demand-side management. Load growth scenarios should be developed for the three separate regions within Tajikistan.

C. Export Market Potential

3. The consultant will do the following:

- (i) Undertake a power export market study including Central Asia, South Asia, and the People's Republic of China.
- (ii) Analyze growth in supply demand of electricity in the neighboring countries including, Afghanistan, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Turkmenistan and Uzbekistan.
- (iii) Establish key drivers for export of electricity from Tajikistan and develop scenarios for potential export in the region.
- (iv) Develop a marketing plan for Tajikistan's hydropower exports highlighting risks and options for managing the risks effectively. The analysis should highlight seasonal and daily variations in demand and supply.
- (v) Identify key barriers to bilateral electricity trading for the short, medium, and long term, and options for overcoming the barriers. Highlight the roles that ADB and other bilateral agencies can play as an honest broker.

D. Financing

4. The consultant will do the following:

- (i) Review the self-financing capability of Barki Tajik; identify external official financing limits.
- (ii) Undertake macroeconomic analysis to determine the fiscal constraints of the Government.
- (iii) Consider the potential for joint exploration of hydro resources in Tajikistan by other countries, highlighting international examples of such initiatives.
- (iv) Analyze the potential for private sector participation, identify existing barriers, and recommend solutions.

E. Candidate Energy Projects

5. The consultants will do the following:

- (i) Consider thermal power and cogeneration options for power and heat supply.
- (ii) Develop a strategy for meeting energy requirements such as heating from sources other than hydropower.
- (iii) Consider renewable power options other than hydropower, e.g., wind and solar.
- (iv) Analyze operations of key reservoirs and evaluate options for optimal operation, taking account of downstream flow constraints.
- (v) Review the hydropower development plans including the long-term Soviet plan for hydro expansion in Tajikistan and options for staged completion given maximum economic benefits of current investments.
- (vi) Evaluate for each potential hydropower project the hydrology, geological surveys, civil works, and electromechanical equipment requirements; costs; and implementation program.
- (vii) Consider phased approaches for new hydropower projects to maximize benefit and minimize cost, and include the environmental impact.
- (viii) Consider opportunities to rehabilitate existing thermal facilities and the transmission grid.
- (ix) Review operations of hydropower plants and identify rehabilitation or other investments that would increase and optimize their output.
- (x) Establish the basic parameters of proposed generation plants, transmission lines and the main substations. Prepare cost estimates including local currency and foreign currency costs in constant 2003 prices for all the recommended generation and transmission projects, including the cost of environmental and social mitigation measures.
- (xi) Present supply-demand scenario and a list of candidate projects at a regional workshop in June 2003.

F. Optimal Development Strategy

6. The consultants will do the following:

- (i) Given the existing power system, the candidate projects, resources, and constraints, develop a least-cost energy sector development program for Tajikistan up to 2018, identifying the least-cost sequencing of investments.
- (ii) For the program to optimize the power system, update the load flow and stability analysis study.

7. The consultant will address the following in formulating an appropriate development strategy:

- (i) alternative generation and transmission programs to meet the forecast loads;
- (ii) risk assessment of reliance on the region;
- (iii) strategies to optimize regional water use;
- (iv) establishment of the economic value of the water resources of Tajikistan to downstream neighbors;
- (v) determination of the cost and benefit of the north-south interconnection, highlighting the break-even point for the import price from Uzbekistan that makes the north-south connection economically viable;
- (vi) interconnection of the isolated grids with the main power system;
- (vii) possible future capacity increase in the interconnection to Uzbekistan and Afghanistan, taking into account the potential trading opportunities;
- (viii) availability of types of fuel in different parts of the country, and their economic costs;
- (ix) options for solar, wind, and geothermal generation to complement Tajikistan's huge hydropower resources;
- (x) financing constraints by international agencies and Tajikistan's own financing capability: three levels will be determined in consultation with the Ministry of Energy and ADB (unrestricted plus two levels of restriction in finance);
- (xi) analysis of the need to rehabilitate the transmission lines for increased trading, including potential for new transmission lines between Tajikistan and other countries and within the network of Tajikistan.
- (xii) environmental considerations, costs, and constraints, so that project cost estimates adequately reflect environmental mitigation costs.
- (xiii) energy efficiency initiatives that could minimize summer demands;
- (xiv) opportunities for reducing maximum demand during winter, including maintenance of large industries, for example, the TADAZ aluminum plant.

G. Economic and Financial Analysis

8. Using ADB methodology, the consultants will prepare a time-slice financial and economic analysis to establish the viability of the proposed energy development strategy.

H. Capacity Building

9. The consultants will provide training and technology transfer in energy sector planning to enable the Government to undertake such planning on a regular basis, as follows:

- (i) Assist MOE to establish a planning unit that will undertake future energy planning studies.
- (ii) Recommend the organization structure, functions, and proposed staffing levels of the unit.
- (iii) Prepare a suitable decree and other documentation for the minister of the Ministry of Energy (MOE) and/or other agencies to endorse.
- (iv) Identify long-term capacity building requirements and future computer hardware and software requirements.
- (v) Prepare a template for report of the annual energy sector planning study to be developed by the planning unit.
- (vi) Recommend a time-bound action plan for implementation by MOE.
- (vii) Maximize on-the-job training at and technology transfer to MOE and Barki Tajik during the study, paying special attention to integrated resources, planning approach, and associated techniques.
- (viii) Develop a strategy that will facilitate coordination of all investment and other donor activities in the energy sector.