ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The proposed program has two components: a policy component covering power subsector reforms, and a project component dealing mainly with the investment requirement for advanced metering and distribution grid enhancement. The economic rationale of the policy component (paras. 4–5) and the economic and financial analyses of the project component were established based on Asian Development Bank (ADB) guidelines.[1]

2. The project component analysis evaluated the costs and benefits in 2020 constant prices for a period of 30 years starting from 2021, with investment assumed to take place over the period 2021−2024. The economic and financial internal rates of return were calculated by comparing the with-project and without-project scenarios. A sensitivity analysis was conducted to ascertain the robustness of the investment.

3. The project component will be implemented by Open Joint Stock Company Electricity Distribution Network (EDN) and involves the installation of advanced metering infrastructure (AMI) and supporting grid reinforcement (line replacement, new transformers and substations) in seven cities of Tajikistan: Buston, Dangara, Dushanbe, Isfara, Ishtaravshan, Isfara, Konibodom and Panjakent. The project also involves the installation of meters at substations to better measure flows between the distribution and transmission networks in Tajikistan. Several consultancy projects are incorporated: supervision consultancy, a management contractor, and consulting support to the Ministry of Energy and Water Resources.

B. Economic Assessment of the Policy Component

4. To overcome the critical financial challenges of the power subsector, the government is implementing comprehensive reforms for market development with ADB support. This includes unbundling the vertically integrated power utility, Barqi Tojik; restructuring the utility's excessive liabilities; establishing a regulator; adopting a more effective tariff methodology; and setting up a new centralized cash control system among unbundled entities. As a part of reforms and institutional capacity building, a newly formed power distribution company (EDN) will be operated under a 5-year management contract. Investments in the retail AMI in Dushanbe and 6 other cities will fill the key deficiencies in the subsector's power loss accounting and bill collection systems.

5. The overall economic impact of these reforms will be achieved through a more efficient and reliable power subsector with improved financial sustainability. Unbundling is imperative in Tajikistan to increase the transparency of operational efficiency and costs. The unbundled companies will start transacting with one another using cost-based tariffs based on a new methodology that will be governed by the newly established sector regulator. This will help the government recognize the gap between supply costs and the end-user tariffs, and pave the way for setting full cost-recovery tariffs. Furthermore, the introduction of a management contractor to EDN will lead to stronger corporate operation of the subsector. Combined with the revenue collection improvements from the AMI investment, the government aims to achieve full cost-recovery tariffs by 2025, at which point the subsector can be self-sustaining and ready for wider private sector participation, which will further improve its efficiency.

[1] ADB. 2009. *Financial Due Diligence - A Methodology Note*. Manila; and ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

C. Methodology and Demand Analysis for the Project Component

6. A system approach that considers the total capital, and operation and maintenance (O&M) costs of all project components was adopted in the cost–benefit analysis. As the new AMI equipment, boundary meters, and grid enhancement measures will have O&M requirements that are different to those of the existing equipment, additional costs were included in the analysis that are over and above the expenses currently reported by Barqi Tojik.

7. The financial internal rate of return (FIRR) and economic internal rate of return (EIRR) of the project have been estimated. For the financial analysis, cost streams used for calculating the FIRR and capital investment and O&M costs are at market prices and include taxes and duties. The project cash flows are expressed in post-tax terms after adjusting for corporate taxation. For the economic analysis, capital cost estimates include physical contingencies but exclude taxes and price contingencies.

8. Peak demand in Tajikistan is forecast to increase at about 2% per year. While the increase in demand may put pressure on the generation capacity during winter, when hydropower plants cannot run at full capacity, the new capacity from Dushanbe's thermal power plants, completed in 2016, has generally filled the supply deficiency since 2017. The modest increase in demand in Tajikistan is unlikely to cause a supply shortage or a surge in unmet demand in the near future, although some winter shortages are expected to continue.

D. Least-Cost Analysis

9. With ADB's support, Barqi Tojik prepared a feasibility study for a metering and network upgrade project in the seven cities by an international firm with ample experience in advanced retail metering and distribution grid enhancement. The consultants reviewed international practice and identified technical options appropriate for the distribution operations of EDN. Based on the assessment, they prepared an outline technical design, identified project benefits and costs, and presented an implementation and procurement plan to ensure that the project design was the least-cost option for the Tajikistan distribution system among the available alternatives.

E. Project Costs and Benefits

10. **Project costs.** The cost of the project consists of the capital investment in the AMI equipment and supporting grid reinforcement, boundary meters, as well as project installation and supervision consultancy. An additional allowance for O&M costs is included in project cash flows and is estimated at 4% of the total investment cost of the AMI equipment, and 2% of the total investment cost of the boundary meters and grid reinforcement works. These values are taken from the technical due diligence. An allowance for replacing the meters installed under the AMI component after 15 years is also included.

11. In the economic analysis, the basis of the total cost is the same as in the financial analysis. Investment costs in financial prices are adjusted to reflect the economic resource cost of project inputs in terms of a domestic price numeraire. Costs were grouped into traded goods, non-traded goods, land, foreign skilled labor, local skilled labor, and local unskilled labor, and were adjusted with appropriate conversion factors. The shadow exchange rate factor (assumed to be 1.11) was used to convert the market price of traded goods to the domestic price numeraire, while the shadow wage rate factor (assumed to be 0.90) was used for unskilled labor, based on recent

values used in Tajikistan.[2] Non-traded product prices and skilled labor costs were assumed to be their direct economic costs.

12. **Project benefits.** The investment will generate various direct impacts:

(i) Commercial losses (particularly theft) will be reduced by up to 6.6% thanks to AMI.[3] It is assumed that 70% of this reduction will be subsequently billed to the same customers, and 30% will be part of net energy saved (para. 13).[4]
(ii) Technical losses will decline by up to 3.4% in some cities, thanks to the grid investment.

13. The net energy saved by the above measures (commercial loss reduction not billed and technical loss reduction) provides EDN with additional available energy. Of this, the analysis assumes the following impacts:

(i) EDN can supply additional energy in winter months to energy-constrained areas (40% of the available energy). Of this amount, 60% is supplied to household customers who have no alternative energy supplies, while 40% is supplied to non-household customers who would otherwise use small-scale diesel generation.[5]
(ii) Exports to neighboring countries will increase in the remaining months (40% of the available energy).
(iii) Some reduction in generation will arise (20% of the available energy).

14. The project will also result in O&M savings from lower meter-reading costs, a reduction in emergency meter-related incidents, and a reduction in burnt meters. The project will reduce the cost of working capital for EDN by enhancing the collection rate.

15. In the financial assessment, increased sales to domestic customers are valued at an average electricity tariff of $0.037 per kilowatt-hour (kWh), with the export price assumed at $0.040/kWh.[6] In the economic assessment, the same value for exports is applied. Incremental sales to household customers are valued at a willingness to pay of $0.080/kWh.[7] Non-incremental sales to non-household consumers are valued at an alternative resource cost of 20.8c/kWh.[8] Generation savings are valued at 1c/kWh, consistent with recent ADB analysis in Tajikistan (footnote 2). Environmental benefits based on carbon dioxide reductions are included for the reduction in generation and the reduction in the use of diesel generation.[9]

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[2] ADB. 2018. *Tajikistan: Reconnection to the Central Asian Power System Project*. Manila.

[3] This value is taken from the AMI installation in Tajikistan's Sugd Province, where a 6.6% reduction in commercial losses was achieved by project completion. Further reductions in commercial losses are envisaged thanks to AMI, including fraud detection and detailed account and contract verification.

[4] While price elasticity of demand for electricity is low, moving from a zero price (under theft) to a positive price is likely to result in an elimination of important quantities of wasteful consumption, which is assumed to be 30% in this analysis.

[5] The presence of important unmet demand for household and non-household customers is seen in ADB. 2017. Tajikistan Power Sector Development Master Plan, Final Report, ADB Grant No: 0213-TAJ, Manila.

[6] Based on the export price to Afghanistan.

[7] A value of $0.080/kWh was adopted by updating a previous estimate of the World Bank made in 2012 ($0.07/kWh) to 2020 values based on United States inflation.

[8] This assumes fuel efficiency of small-scale generation of 0.3 liters/kWh based on the assumptions of a recent World Bank report (International Development Association. 2020. Project Appraisal Document on a Proposed Grant of SDR97.2 million to the Republic of Tajikistan for a Power Utility Financial Recovery Program for Results. Washington, DC) and a local delivered price of diesel of TJS6.72/liter.

[9] Carbon dioxide (CO_2) savings from the reduction in generation are valued at 0.009 tons of CO_2 equivalent per megawatt-hour (tCO_2/MWh, with reductions in diesel usage valued at 0.800 tCO_2/MWh based on the emission factor for diesel (74.10 kilograms of CO_2 per gigajoule), a net calorific value of 43 megajoules per kilogram, and density of 0.837 kilograms per liter. ADB. 2017. *Guidelines for estimating greenhouse gas emissions of Asian Development Bank projects: Additional guidance for clean energy projects*. Manila.

16. There is an important non-quantified benefit associated with the project. The installation of meters at the boundaries between the distribution and transmission systems will promote energy management through the development of energy balances and detecting losses.

F. Weighted Average Cost of Capital

17. The project's weighted average cost of capital (WACC) was estimated from EDN's perspective. Since the ADB grant will be provided to EDN as equity, the cost of the grant uses the cost of EDN's equity as the proxy.[10] Funding also includes the cost of loan financing to be provided by the European Bank for Reconstruction and Development, and counterpart funding to be borne by the government and EDN. The estimated WACC is 5.0% (Table 1).

Table 1: Weighted Average Cost of Capital of the Project

Description		Financing Component			
		ADB Grant	EBRD Loan	Government Equity	Total
A	Weighting	68.0%	20.0%	12.0%	100.0%
B	Nominal cost	7.1%	1.4%	20.0%	
C	Tax rate	0.0%	16.3%	0.0%	
D	Tax adjusted nominal cost (B x [1 - C])	7.1%	1.2%	20.0%	
E	Inflation rate	1.6%	1.6%	8.0%	
F	Real cost ([1 + D] / [1 + E] - 1)	5.4%	0.0%	11.1%	
G	Weighted cost (F x A)	3.7%	0.0%	1.3%	5.0%
	WACC (real)				**5.0%**

ADB = Asian Development Bank, EBRD = European Bank for Reconstruction and Development, WACC = weighted average cost of capital.
Source: Asian Development Bank estimates.

G. Financial Internal Rate of Return

18. The project's FIRR is estimated to be 14.4%, and the estimated net present value is $113.2 million. The result is above the estimated WACC and supports the viability of the project (Table 2).

Table 2: Financial Internal Rate of Return ($'000)

Year	Capital cost	O&M	Additional revenue	Net benefit
2021	(8,668)	(137)	131	(8,673)
2022	(48,385)	(1,376)	4,327	(45,434)
2023	(29,187)	(1,991)	9,935	(21,242)
2024	(480)	(1,991)	12,364	9,893
2025	-	(1,991)	12,755	10,763
2026	-	(1,991)	13,160	11,169
2027	-	(1,991)	13,576	11,585
2028	-	(1,991)	14,008	12,017
2029	-	(1,991)	14,455	12,464
2030	-	(1,991)	14,919	12,928
2031	-	(1,991)	15,400	13,409
2032	-	(1,991)	15,899	13,908
2033	-	(1,991)	16,416	14,425
2034	-	(1,991)	16,958	14,967
2035	-	(1,991)	17,514	15,523
2036	-	(4,558)	18,476	13,918

[10] For lack of alternative methods of estimating EDN's cost of equity, the cost of the government's United States dollar-denominated bonds in 2017 of 7.1% is used as a proxy to this cost.

Year	Capital cost	O&M	Additional revenue	Net benefit
2037	-	(23,217)	20,820	(2,397)
2038	-	(16,810)	21,550	4,740
2039	-	(1,991)	20,989	18,998
2040	-	(1,991)	20,620	18,629
2041	-	(1,991)	21,312	19,321
2042	-	(1,991)	21,864	19,873
2043	-	(1,991)	22,089	20,098
2044	-	(1,991)	22,861	20,870
2045	-	(1,991)	23,662	21,671
2046	-	(1,991)	24,493	22,502
2047	-	(1,991)	25,355	23,364
2048	-	(1,991)	26,249	24,258
2049	-	(1,991)	27,177	25,186
2050	-	(1,991)	28,151	26,160
			FIRR	**14.4%**
		FNPV @ WACC ($ million)		**113.2**

( ) = negative, FIRR = financial internal rate of return, FNPV = financial net present value, WACC = weighted average cost of capital.
Source: Asian Development Bank estimates.

H. Economic Internal Rate of Return

19. The project's EIRR is estimated to be 12.0% (Table 3). This is above the hurdle rate of 9% suggested by ADB guidelines. The project's estimated net present value is $23.1 million.

Table 3: Economic Internal Rate of Return ($´000)

Year	Capital cost	O&M costs	Incremental benefits	Non-incremental benefits	Environmental benefits	Net benefit
2021	(9,273)	(160)	141	140	21	(9,132)
2022	(50,611)	(1,399)	1,664	1,951	247	(48,148)
2023	(28,707)	(2,014)	3,803	4,423	573	(21,923)
2024	(533)	(2,014)	4,627	5,281	706	8,067
2025	-	(2,014)	4,816	5,434	745	8,980
2026	-	(2,014)	5,012	5,592	785	9,375
2027	-	(2,014)	5,212	5,756	828	9,782
2028	-	(2,014)	5,419	5,926	874	10,204
2029	-	(2,014)	5,636	6,101	922	10,644
2030	-	(2,014)	5,861	6,282	972	11,100
2031	-	(2,014)	6,095	6,470	1,025	11,575
2032	-	(2,014)	6,339	6,663	1,081	12,069
2033	-	(2,014)	6,593	6,864	1,140	12,582
2034	-	(2,014)	6,864	7,071	1,203	13,123
2035	-	(2,014)	7,139	7,285	1,268	13,678
2036	-	(4,782)	7,426	7,506	1,338	11,488
2037	-	(24,213)	7,725	7,735	1,411	(7,342)
2038	-	(16,526)	8,035	7,972	1,488	969
2039	-	(2,014)	8,359	8,217	1,569	16,131
2040	-	(2,014)	8,696	8,470	1,655	16,807
2041	-	(2,014)	9,047	8,732	1,746	17,510
2042	-	(2,014)	9,422	9,002	1,841	18,251
2043	-	(2,014)	9,803	9,282	1,942	19,012
2044	-	(2,014)	10,199	9,572	2,048	19,804
2045	-	(2,014)	10,612	9,871	2,160	20,629
2046	-	(2,014)	11,042	10,180	2,278	21,486
2047	-	(2,014)	11,490	10,500	2,403	22,379
2048	-	(2,014)	11,957	10,831	2,534	23,307
2049	-	(2,014)	12,443	11,173	2,672	24,274

Year	Capital cost	O&M costs	Incremental benefits	Non-incremental benefits	Environmental benefits	Net benefit
2050	-	(2,014)	12,963	11,527	2,819	25,293
				EIRR		**12.0%**
				ENPV @ 9% ($ million)		**23.1**

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance.
Source: Asian Development Bank estimates.

I. Sensitivity Analysis

20. Sensitivity analysis was conducted on several project variables: 10% increase in capital costs, a 15% reduction in net energy saved, a reduction in the willingness to pay of $0.02/kWh, a 2-year delay in benefits, a 50% reduction in additional export sales, and a 33% reduction in the cost of alternative fuels. In all cases the estimated FIRR and EIRR remain at or above the respective benchmark, supporting project viability. However, the scenarios show the greatest sensitivity in the economic analysis with delays or reductions to benefits.

Table 4: Sensitivity Analysis (Financial and Economic)

Item	FIRR (%)	FNPV ($ million)	EIRR (%)	ENPV ($ million)
Base case	14.4%	113.2	12.0%	23.1
Capital cost increased by 10%	13.2%	106.2	10.9%	15.7
Net energy saved reduced by 15%	11.9%	79.9	9.6%	4.4
WTP reduced by $0.02/kWh	14.4%	113.2	11.1%	16.0
Benefits delayed by 2 years	11.0%	81.5	9.0%	0.0
Export sales reduced by 50%	13.3%	96.7	10.6%	12.1
Reduction in cost of alternative energy source (33% reduction in cost of diesel)	14.4%	113.2	9.9%	6.8

EIRR = economic internal rate of return, ENPV = economic net present value, FIRR = financial internal rate of return, FNPV = financial net present value, WTP = willingness to pay.
Source: Asian Development Bank estimates.