ECONOMIC ANALYSIS

A. Introduction and Methodology

1. The Balakot Hydropower Development Project is a power generation project on Kunhar River in Khyber Pakhtunkhwa, aiming at providing clean energy and decreasing a demand–supply gap in Khyber Pakhtunkhwa and adjacent regions. The project is expected to have total capacity of 300 megawatts (MW) and annual gross output of 1,140 gigawatt-hours (GWh), with a plant factor of 45%. The project scope also includes transmission infrastructure to evacuate the power generated from the plant to the nearby substation in Balakot, and a capacity development program for the Pakhtunkhwa Energy Development Organization (PEDO).[1]

2. The project's economic cost–benefit analysis was conducted following Asian Development Bank (ADB) guidelines,[2] using 2019 constant prices and the domestic price numeraire in Pakistani rupees. A shadow exchange rate factor of 1.09 was used to estimate the economic prices of tradable goods, and a conversion factor of 0.77 to the unskilled labor portion of the local currency costs. The economic internal rate of return (EIRR) was calculated by comparing the with- and without-project scenarios and discounting the incremental annual cash flows over 40 years, with a 7-year implementation period. A sensitivity analysis was conducted to ascertain the robustness of the analysis.

B. Demand Analysis

3. Pakistan has experienced acute power deficits since 2007. The country's total installed power generating capacity is 33,961 MW, with available supply of 26,135 MW and peak demand estimated at 25,227 MW. The country's power network is constrained and inefficient, with total system losses estimated at 20.3%, including distribution losses of 9%–38%.[3] The inadequacy and lack of reliability of the existing supply, as well as overloading in the system during peak demand, have resulted in an electricity shortfall of 1,800 MW and routine load shedding of up to 12 hours in rural areas and provinces.[4]

4. Thermal generation represents 63% of the total installed capacity, using a mix of expensive imported oil and dwindling supplies of domestic gas and imported liquefied natural gas. Domestic hydrocarbon reserves are projected to be depleted by 2030, placing increasing reliance on imported oil; this is expected to continue in the absence of other means of power generation.[5] Further, payments to fuel suppliers have not been timely, leaving suppliers unable to provide a steady supply of fuel to power generators. The development of hydropower generation is slow. With potential to generate up to 60,000 MW (30,000 MW of which is in Khyber Pakhtunkhwa), Pakistan has only been able to install 9,825 MW, and its share of the energy mix declined from 31% in 2014 to 16% in 2018—resulting in greater reliance on imported fuel oil and liquefied natural gas for electricity generation.

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[1] Created in 1986, PEDO (formerly the Small Hydel Development Organization) runs all power projects in Khyber Pakhtunkhwa, acting as the executing and implementing agency in power generation projects on behalf of the provincial government.

[2] ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

[3] National Electric Power Regulatory Authority. 2017. *State of Industry Report 2017*. Islamabad.

[4] National Transmission and Despatch Company. 2015. *Electricity Demand Forecast based on Power Market Survey, Period 2014 to 2024*. Islamabad.

[5] Domestic hydrocarbon production meets only 17% of the country's needs for power generation; the remainder is imported.

5. Pakistan's electricity demand is projected to increase by about 4% annually during 2020–2030 (footnote 3). The government has been trying to add new generation capacity every year. However, fast-growing demand, high system losses, and an unfavorable energy mix that relies heavily on expensive imported fuel have prevented it from narrowing the demand–supply gap below an estimated 3,000 MW because of constraints in the distribution and transmission networks.[6]

6. To mitigate these challenges, the federal and provincial governments have been working toward improving the reliability of electricity supply and diversifying the energy mix by investing in cleaner sources of energy, including small and medium hydro generation. The Government of Pakistan approved a comprehensive package of financial and fiscal incentives for the development of hydropower generation under the Policy for Power Generation Projects Year 2002 and the Policy for Development of Renewable Energy for Power Generation.[7] After the 18th amendment to the Constitution of Pakistan, the provincial governments are delegated with full authority to develop projects of any capacity through private and public investment. Guided by the Khyber Pakhtunkhwa Hydropower Policy 2016, PEDO is responsible for hydropower generation development in the region and for attracting investment in clean energy.[8] The total financing requirement for Khyber Pakhtunkhwa's hydropower development program, which will provide additional generation capacity of 4,903 MW over 2020–2035, is $11 billion.

7. Khyber Pakhtunkhwa's power generation capacity is 4,303 MW, increasing by 2% annually since 2014. In 2018, the provincial consumption was 9,659 GWh or 11% of the national supply. PEDO's current hydropower generation capacity is 161 MW, with annual energy output of 611 GWh, contributing to 6% of the total consumption in Khyber Pakhtunkhwa.[9] The remaining demand is supplied by the national grid. Electricity demand remained stable over 2008–2018, at an annual average growth rate of about 4%, and is projected to expand by 3% annually during 2020–2030. The reported distribution losses in Khyber Pakhtunkhwa are 28.0%–34.1% against the regulator's benchmark of 26.0% (footnote 3).

8. The greatest demand for power in Khyber Pakhtunkhwa comes from residential customers, at 60% of total power consumption, followed by industrial consumers at 26% and agriculture at 10%. According to a willingness-to-pay (WTP) survey conducted in 2017, most households and small enterprises in Khyber Pakhtunkhwa face challenges in the quality of power supply, including blackouts, voltage drops, and surges. These weaknesses are especially critical in rural areas. Increasing industrial activities, such as construction and manufacturing, are expected to contribute the bulk of projected growth. The demand from industrial activities is projected at 8% of total power demand by 2030.

9. Pakistan's economy sustained a relatively high growth rate for over a decade, averaging about 4% from 2007 to 2018. In 2018, the growth rose to 5.5% from 5.2% in 2017, mainly because of moderate industrial growth.[10] Pakistan's economic growth contracted to 0.4% in 2020 as coronavirus disease (COVID-19) pandemic affected consumer demand and private sector activity, leading to a sharp decline in economic activity. Industrial growth, along with lifestyle changes promoted by higher income (e.g., the use of air conditioners from June through

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[6] National Electric Power Regulatory Authority. 2016. *State of Industry Report 2016*. Islamabad.

[7] Government of Pakistan, 2002. *Policy for Power Generation Projects Year 2002*; and Government of Pakistan, Alternative Energy Development Board. 2006. *Policy for Development of Renewable Energy for Power Generation*.

[8] Government of Khyber Pakhtunkhwa. 2016. *KP Hydropower Policy 2016*. Peshawar.

[9] National Transmission and Despatch Company. 2017. *Power System Statistics, 2016–2017*. Islamabad.

[10] Finance Division, Government of Pakistan. 2019. *Pakistan Economic Survey 2018–19*. Islamabad.

September), are expected to increase power demand from both industry and households. Energy demand is forecast to increase by 5.3% annually from 2020−2030.

C. Least Cost Analysis

10. As natural gas-based power generation is the most prevalent source of energy in Pakistan, least cost analysis compares the cost of power generation of the hydropower plant with a combined cycle natural gas power plant—the most efficient technology for natural gas-based power generation. Economic costs, including the cost of capital, fuel, and operation and maintenance (O&M), as well as the social cost of carbon dioxide (CO_2) during the economic life of the alternative power generation system, were compared with those of the hydropower plant. Comparative analysis shows that Balakot hydropower plant has the least cost based on (i) the social cost of greenhouse gases associated with natural gas-based power generation, and (ii) the hydropower plant's longer economic life compared with a thermal power plant.

D. Project Costs

11. The project cost includes (i) the project capital cost for power generation and transmission infrastructure to evacuate power to the national grid, (ii) annual O&M, and (iii) the cost of transmission and distribution of power from the grid to users of the existing national transmission and distribution infrastructure and Khyber Pakhtunkhwa's provincial network.[11]

12. The estimated total financial costs (of the capital and the capacity development program), excluding price contingencies and taxes are converted into economic costs. O&M represent 1% of the capital costs and include the cost of (i) sedimentation management, (ii) salaries (for administrative managers and workers), and (iii) general maintenance expenses for the building and other assets. A planned major overhaul is estimated at 2.5% of the project cost and scheduled every 6 years after commercial operations. The transmission cost is estimated at 3% of the project's capital cost.

E. Project Benefits

13. Balakot hydropower plant's net output is estimated at 862 GWh/year, factored by the plant's own use and internal losses of 1.76% of output, and transmission and distribution losses of 24.4%.[12] The project's benefits include the incremental and non-incremental supply of power to users, valued at WTP and resource cost savings, respectively; and net CO_2 reductions, valued at the social cost of carbon. Given the significant power deficits and load shedding in Khyber Pakhtunkhwa, this analysis assumed that demand would exist for the additional power generated by the hydropower plant. The economic price for additional (incremental) power was calculated based on the consumers' WTP for electricity. The WTP for three consumer categories (residential, commercial, and industrial) was estimated as the average of the tariff and resource cost savings. The estimated WTP was PRs20/kWh for residential consumers, PRs25/kWh for commercial consumers, and PRs32/kWh for industrial consumers. A weighted WTP of PRs23/kWh was used to calculate the value of incremental electricity supply for the country. Non-incremental benefits were valued at the resource cost savings. Residential and commercial consumers in Khyber Pakhtunkhwa use diesel, uninterrupted power supply systems, or kerosene

[11] It is projected that 33% of the generated power will be supplied via the Khyber Pakhtunkhwa distribution network and the remaining output will be evacuated to the national grid.
[12] Estimates are based on 2016–2018 technical losses for transmission and distribution in Khyber Pakhtunkhwa.

lamps as alternatives to electricity from the national grid. For nonresidential users, diesel generators are the typical alternative.

14. Environmental benefits are calculated as net CO_2 reductions for displacing diesel generators by hydropower. CO_2 is valued at the social cost of carbon ($36.30 per ton of CO_2 in 2016 prices), with a 2% annual increase in real terms, to allow for the potential of increasing marginal damage of global warming over time to account.

15. **Non-quantified project benefits.** Non-quantified benefits include the economic growth resulting from the incremental benefit of enhanced reliability of the power system and reduced load shedding during peak hours. In addition, power blackouts cause households and enterprises to experience frequent equipment damage, which creates significant repair costs.

F. Economic Internal Rate of Return

16. The EIRR of the project is 14.1% (Table 1), which is higher than ADB's hurdle requirement of 9.0%. The economic net present value, discounted at 9.0%, has a value of PRs46.3 billion. The EIRR, without greenhouse gas benefits, is estimated at 13.7%.

Table 1: Project Economic Internal Rate of Return

	Costs			Benefits			
Year	Capital	O&M	T&D	Non-Incremental	Incremental	Environmental	Net Benefits
2020	(23,573)	-	-	-	-	-	(23,573)
2021	(5,440)	-	-	-	-	-	(5,440)
2022	(9,067)	-	-	-	-	-	(9,067)
2023	(10,880)	-	-	-	-	-	(10,880)
2024	(20,853)	-	-	-	-	-	(20,853)
2025	(10,880)	-	-	-	-	-	(10,880)
2026	(9,973)	(706)	(2,571)	4,406	13,963	501	5,620
2027	-	(831)	(3,025)	5,183	16,592	602	18,521
2028	-	(831)	(3,025)	5,183	16,428	614	18,369
2029	-	(831)	(3,025)	5,183	16,428	626	18,381
2030	-	(831)	(3,025)	5,183	16,428	639	18,394
2031	-	(831)	(3,025)	5,183	16,428	651	18,407
2032	-	(3,140)	(3,025)	5,183	16,428	664	16,111
2033	-	(831)	(3,025)	5,183	16,428	678	18,433
2034	-	(831)	(3,025)	5,183	16,428	691	18,446
2035	-	(831)	(3,025)	5,183	16,428	705	18,460
2036	-	(831)	(3,025)	5,183	16,428	719	18,474
2037	-	(831)	(3,025)	5,183	16,428	734	18,489
2038	-	(3,140)	(3,025)	5,183	16,428	748	16,194
2039	-	(831)	(3,025)	5,183	16,428	763	18,518
2040	-	(831)	(3,025)	5,183	16,428	778	18,534
2041	-	(831)	(3,025)	5,183	16,428	794	18,549
2042	-	(831)	(3,025)	5,183	16,428	810	18,565
2043	-	(831)	(3,025)	5,183	16,428	826	18,581
2044	-	(3,140)	(3,025)	5,183	16,428	843	16,289
2045	-	(831)	(3,025)	5,183	16,428	859	18,615
2046	-	(831)	(3,025)	5,183	16,428	877	18,632
2047	-	(831)	(3,025)	5,183	16,428	894	18,649
2048	-	(831)	(3,025)	5,183	16,428	912	18,667
2049	-	(831)	(3,025)	5,183	16,428	930	18,685
2050	-	(3,140)	(3,025)	5,183	16,428	949	16,395

	Costs			Benefits			
Year	Capital	O&M	T&D	Non-Incremental	Incremental	Environmental	Net Benefits
2051	-	(831)	(3,025)	5,183	16,428	968	18,723
2052	-	(831)	(3,025)	5,183	16,428	987	18,742
2053	-	(831)	(3,025)	5,183	16,428	1,007	18,762
2054	-	(831)	(3,025)	5,183	16,428	1,027	18,782
2055	-	(831)	(3,025)	5,183	16,428	1,048	18,803
2056	-	(831)	(3,025)	5,183	16,428	1,069	18,824
2057	-	(3,140)	(3,025)	5,183	16,428	1,090	16,536
2058	-	(831)	(3,025)	5,183	16,428	1,112	18,867
2059	-	(831)	(3,025)	5,183	16,428	1,134	18,889
						EIRR	**14.1%**
						ENPV (PRs million)	**46,300**

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value, GWh = gigawatt-hour, O&M = operation and maintenance, T&D = transmission and distribution.
Source: Project's feasibility study estimates.

G. Sensitivity Analysis

17. Sensitivity analysis tested the economic viability of the project for the following adverse effects: (i) an increase of 20% in the investment cost, (ii) an increase of 20% in the O&M cost, (iii) a 20% decrease in output, and (iv) 1-year delay in construction.

18. The results (Table 2) indicate that the project EIRR is above ADB's hurdle rate of 9% against these adverse shocks. However, the EIRR is sensitive to a decline in revenues and capital cost escalation.

Table 2: Results of Sensitivity Analysis of the Project
(%)

Item	EIRR
Base case	14.1
20% increase in capital cost	11.5
20% increase in O&M cost	13.9
20% decrease in output	11.2
1-year delay in construction	12.6

EIRR = economic internal rate of return, O&M = operation and maintenance.
Source: Asian Development Bank staff estimates.